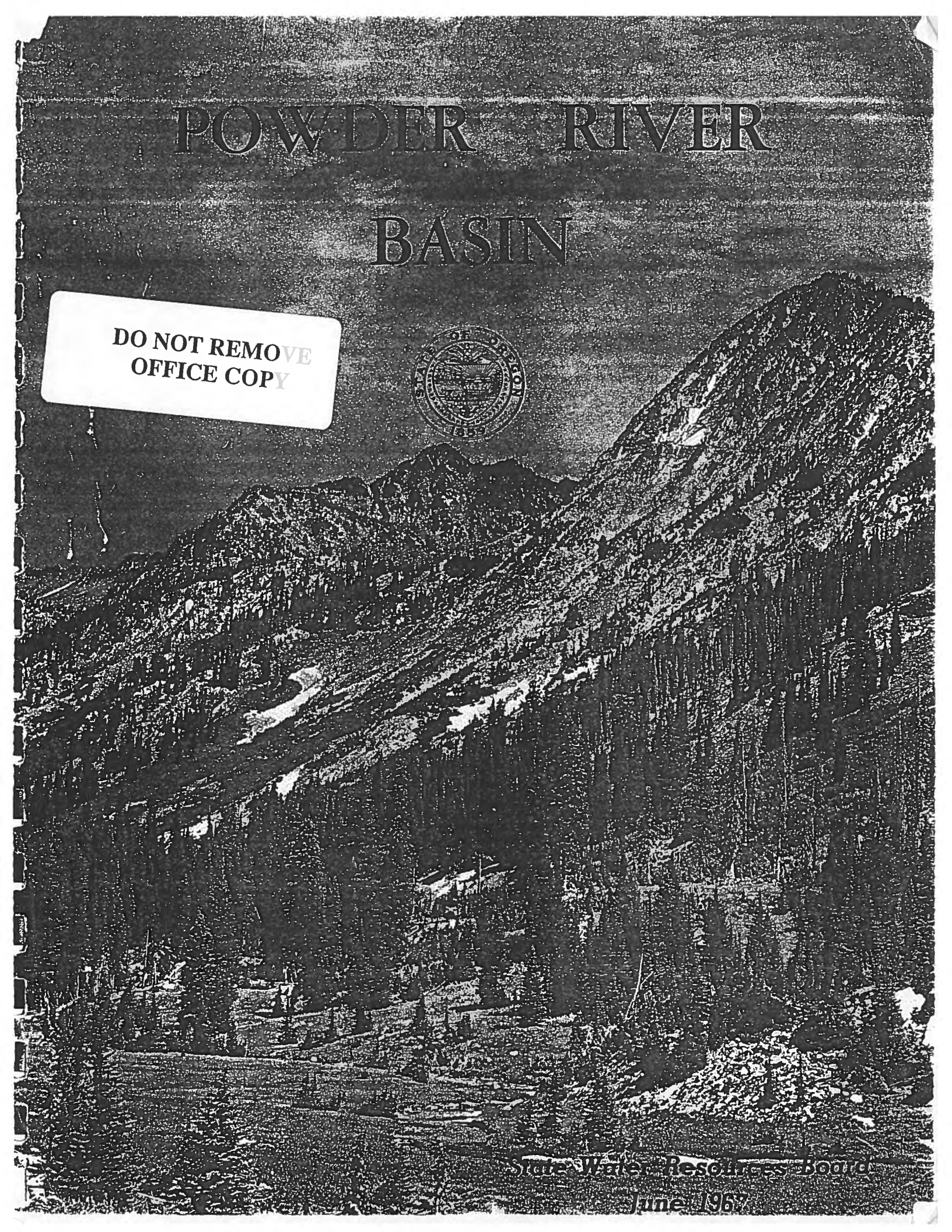
POWDER RIVER BASIN



State Water Resources Board
June 1967

POWDER RIVER BASIN

STATE WATER RESOURCES BOARD
SALEM, OREGON
June, 1967

COVER PICTURE

Wallowa Mountain scene near Boulder Park. Oregon State Highway Department photo.

Price $2.50

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PURPOSE AND INTRODUCTION

The purpose of this report is to set forth in a condensed form the major items considered by the State Water Resources Board in its formulation of an integrated, coordinated program of use and control of the water resources of the Powder Basin in Oregon.

The board's investigation activities were completed in December 1966. The study was made in conformity with ORS 536.300 (1) which states:

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

Having completed the study necessary to formulate and implement an integrated, coordinated water resources program, the board proposes to adopt a program for the Powder Basin. This program will fulfill the requirements of ORS 536.300 (2) which states:

> "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 standards 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.

FINDINGS AND CONCLUSIONS

TOTAL BASIN

A. Water Supply

1. The total basin yield is adequate on an average annual basis to supply all presently existing and some contemplated needs and uses of water, but serious shortages exist each year in most areas, because of the seasonal and geographical yield distribution pattern.

2. The basin's average annual yield, from streams and ground water, supplies water to irrigate 135,000 acres, supplies all other consumptive uses and supplies an outflow of 700,000 acre-feet to Snake River.

3. There are sufficient ground and surface water resources to supply supplemental water to the presently irrigated acreage, increase the irrigated acreage about 35 percent, plus supplying additional needs for domestic, municipal, industrial and recreation uses.

4. The surface water supply as now developed, even with maximum justifiable control and more efficient utilization, is inadequate in most areas to provide enough water for the basin needs. Therefore, the coordinated development of ground and surface water supplies is needed for proper development of the basin.

5. Natural flows are not sufficient during low flow months to meet existing or future demands.

6. Simultaneous use of a major portion of the existing consumptive water rights results in flows at or near the zero level in many streams during the summer and early fall months.

7. Flows at or near the zero level also occur under natural conditions on many streams having little water under appropriation.

8. Augmentation of the water supply in periods of need can come through storage of surplus runoff and through more efficient use of presently appropriated water.

9. There are numerous potential reservoir sites in the three major watersheds, but economically feasible

storage is somewhat limited by steep stream gradient in the watershed.

10. Sources which should be investigated include Pine Creek, Eagle Creek and Snake River along with more efficient use of presently developed supplies.

11. Available data indicate that the ground water resource is much smaller than available surface water supplies but represents an important source for domestic, livestock, municipal, irrigation and industrial needs, both present and future.

B. Water Rights

12. The basin has unappropriated water in the Pine and Eagle Creek drainages. The lower portions of most streams do not have water for further appropriation during much of the low flow season so storage is essential for best use of the water subject to jurisdiction of the State Water Resources Board.

13. No waters have been withdrawn by the State Engineer for out-of-basin diversions. Small quantities of floodflow waters are diverted into the basin from Catherine Creek of Grande Ronde River and North Fork John Day River.

14. There are approximately 2,700 water rights for 5,528 cfs within the basin. Irrigation rights account for the greatest consumptive use with 4,517 cfs for 203,819 acres.

15. Further effort is needed to review present water rights. Over 17 percent of the land holding water rights is not irrigated. Of the 16 within-basin power rights, which are for a total of 112 cfs, all but six have been abandoned or are not presently utilized. Although there are 86 mining rights for 588 cfs, or 425,712 acre-feet, less than two percent of these rights are presently used.

C. Water Use and Control

16. Diversion and pumping requirements for increased domestic, municipal, industrial, livestock, wildlife and recreation uses of water are estimated at 2,200

acre-feet annually.

17. To satisfy documented fish life needs in lower basin streams would require 183,000 acre-feet of annual outflow from the basin.

18. Additional storage and ground water withdrawal requirements for irrigation of the better basin lands would be about 465,000 acre-feet, depending on sources used, efficiencies of delivery and application, and use of return flows.

19. Irrigation presently uses, and will continue to use, about 98 percent of the consumptively used water.

20. There are over 92,000 acres of mapped potentially irrigable land within the basin plus fairly large areas which have not been mapped. Suitable land areas greatly exceed water supplies.

21. Irrigation development has been restricted by the economic fact that an agricultural economy based on beef cattle production cannot support high irrigation development costs. Proposals to irrigate inferior land have not received sufficient public support for project development.

22. Land quality should weigh heavily toward determining feasibility of large basin reclamation projects. The relative success of these new irrigation proposals can be forejudged by analyzing the soils, water supply, climate, and markets.

23. Over 80 percent of the irrigated lands have an inadequate water supply during the June through September portion of the irrigation season in average water years and experience severe shortages in critically low water years.

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

25. Fish life will continue to be an important nonconsumptive user of water of Pine and Eagle Creeks,

lakes and of headwater streams. Protection of the basin's natural lakes will protect the fish life and recreational potential.

26. Summer flows recommended by the Oregon State Game Commission are considerably in excess of available yield on most of the Powder Basin stream systems.

27. A conflict exists among flood control, irrigation, recreation, industrial, pollution abatement, and fish life uses of water.

28. Restrictions on further appropriations of natural streamflow would not materially enhance aquatic life on most streams during low-flow periods because of overappropriation during this time. A few streams would be benefited by such restrictions.

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

30. Flooding and streambank erosion are serious local problems on about 11,400 acres of valley land and where the streams pass through urban areas. Erosion of cropland is not a major problem due to extensive perennial sod-forming crops.

31. Flood damage benefits are not great enough to justify large single-purpose structures. Multipurpose structures are needed and are more easily justified.

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

33. Further studies are needed as to possible means of furnishing flow requirements for production and rearing of fish life.

34. Further knowledge of the quantity of surface flows is required. Reestablishment of inactive gages and establishing of stations at new sites are needed throughout the basin.

35. Detailed studies of ground water occurrance and yield capabilities are needed.

36. Comprehensive classification of irrigable lands is needed in designated areas.

37. A joint agency Powder Basin Review should be established to achieve the benefits of the multipurpose concept of basin planning. There is need to coordinate individual project plans into basin-wide plans.

38. The Powder Basin comprises three study areas which are similar in economy, land use and topography but somewhat divergent in water availability. For brevity and clarity these areas are referred to as the Pine, Powder and Burnt areas respectively with summaries and conclusions presented separately below.

BASIN AREAS

D. Pine Area

39. The available water supply within the Pine study area (including Snake River Misc. drainages) can meet all local requirements for domestic, municipal, industrial, mining, irrigation, recreation and fish life uses.

40. Developable surface and ground water is sufficient to supply needed supplemental water to 19,350 presently irrigated acres and to develop 8,600 acres of potentially irrigable land.

41. Full development would require a diversion of approximately 100,000 acre-feet of surface water and ground water, depending on efficiencies of operation.

42. Further studies are needed to adequately identify both ground water yield capability and surface flows, but they are believed to be more than sufficient to meet the Pine Valley needs.

43. The proposed Mehlhorn Mill Reservoir site on East Pine Creek could supply water for irrigation and other uses, and reduce flood damage in the valley. Three other reservoir sites are located on the potential development map.

E. Powder Area

44. In-basin water supplies are sufficient to supply a minimum of new land development, to furnish supplemental water to the present 127,750 irrigated acres, and to supply other consumptive uses. Alternative or additional water supplies include interbasin diversions from Eagle Creek or pumping from the Brownlee pool.

45. Presently irrigated lands would require an estimated 130,000 acre-feet of additional water. Located storage capacity on the Powder River and Eagle Creek amounts to about 200,000 acre-feet, according to a survey of potential reservoir sites. Reservoir construction plans at these sites have been hampered by problems encountered in financing, water rights, rights- of- way and fish life needs. Development of sites in these areas will be necessary to fully develop the water resource potential.

46. Further studies are needed to adequately identify the ground water yield capability, but available data is adequate to recommend use of ground water as supplemental sources in Baker and Lower Powder Valleys.

47. An extensive rehabilitation of land and water use facilities is needed on the larger blocks of irrigated land in the upper and lower valleys to increase crop production and to save considerable quantities of water for further water resource developments. Present rehabilitation efforts should be expanded.

48. The U. S. Department of Agriculture is preparing multipurpose developmental plans for Balm Creek, North Powder and Wolf Creek areas. Developed plans call for storage of 12,500 acre-feet on Wolf Creek, 5,500 acre-feet of Anthony Fork offstream storage and 20,000 acre-feet of storage on North Powder River.

49. Summer flows recommended by the Oregon State Game Commission for the Powder River system are considerably in excess of presently available summer flows.

Future storage development plans should give consideration to enhancement of fish life as one of the ten beneficial uses of water.

50. Power, mining, recreation, wildlife and pollution abatement do not now and are not expected to utilize appreciable quantities of water in the future.

F. Burnt Area

51. The U. S. Department of Agriculture has estimated there are about 20,100 additional irrigable acres along Burnt River and its tributaries. Surface yield is sufficient to provide supplemental water to presently irrigated acreages and to probably under one-half of the potentially irrigable lands.

52. The U. S. Bureau of Reclamation is completing a comprehensive development plan for the Burnt area. Storage proposals include 14,000 acre-feet on South Fork and 12,000 acre-feet on Burnt River.

53. Ground water studies are needed to properly identify the potential, but present indications are that available supplies are very limited.

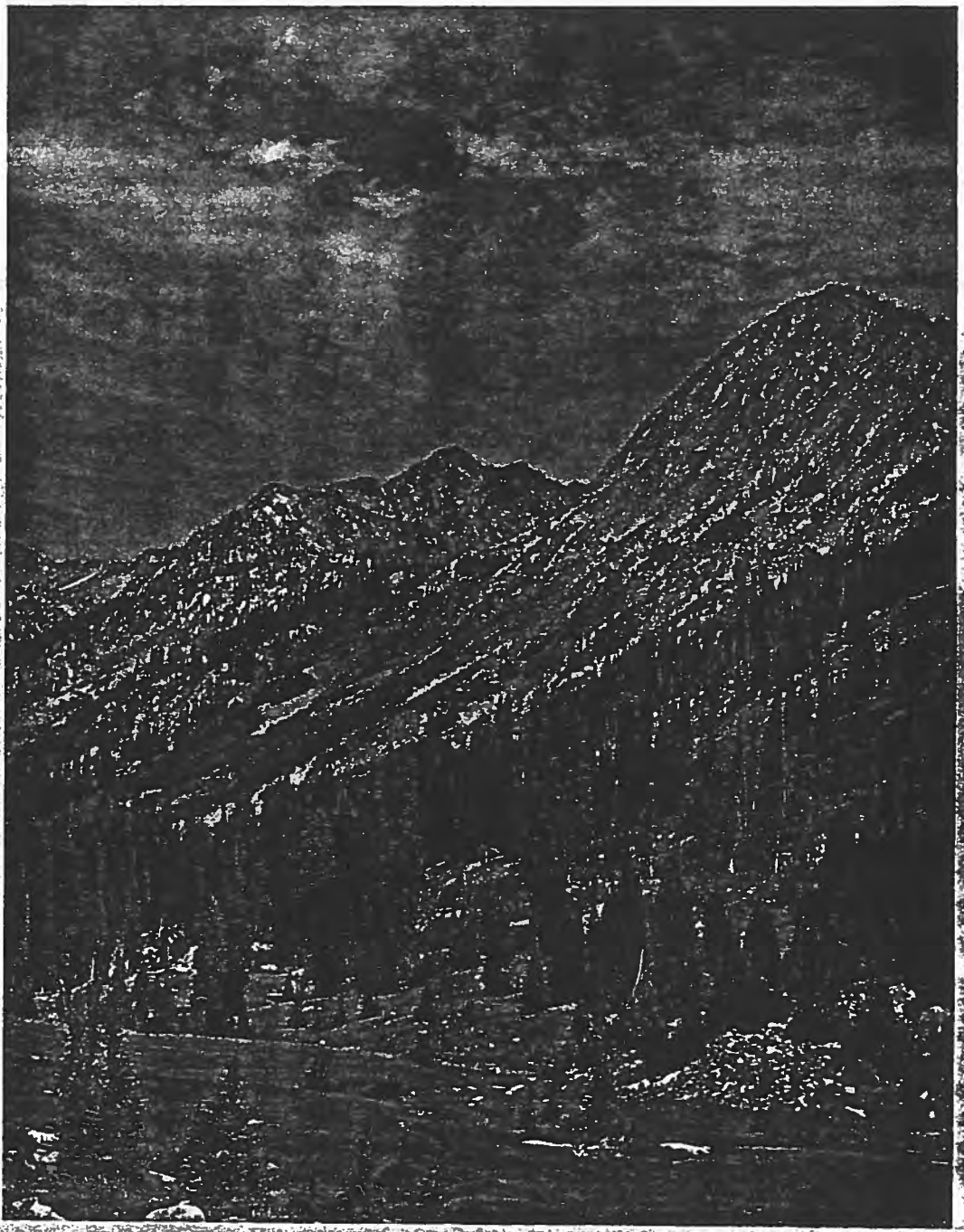
54. A large amount of water is available from the Snake River for lower valley lands, but this source needs further investigation as to feasibility.

55. The potential of the proposed Dark Canyon and Hardman Reservoirs should be fully utilized for storage and water resource development purposes.

56. Power, mining, recreation, wildlife and pollution abatement do not now and are not expected to use appreciable quantities of water in the future.

57. The Baker Valley rehabilitation plan can be adopted, with modification, throughout Powder Basin. Summarized development features include: Accumulate surface water supplies; reorganize distribution system; supplement supplies with ground water pumping; construct a network of drains; adopt a soil management program and initiate soil-plant-water research studies.

THE BASIN



Oregon State Highway Department photo

POWDER BASIN STUDY

PART I THE BASIN

NATURAL FEATURES

Location and Size

Figure 1 shows Powder Basin with its study areas outlined in

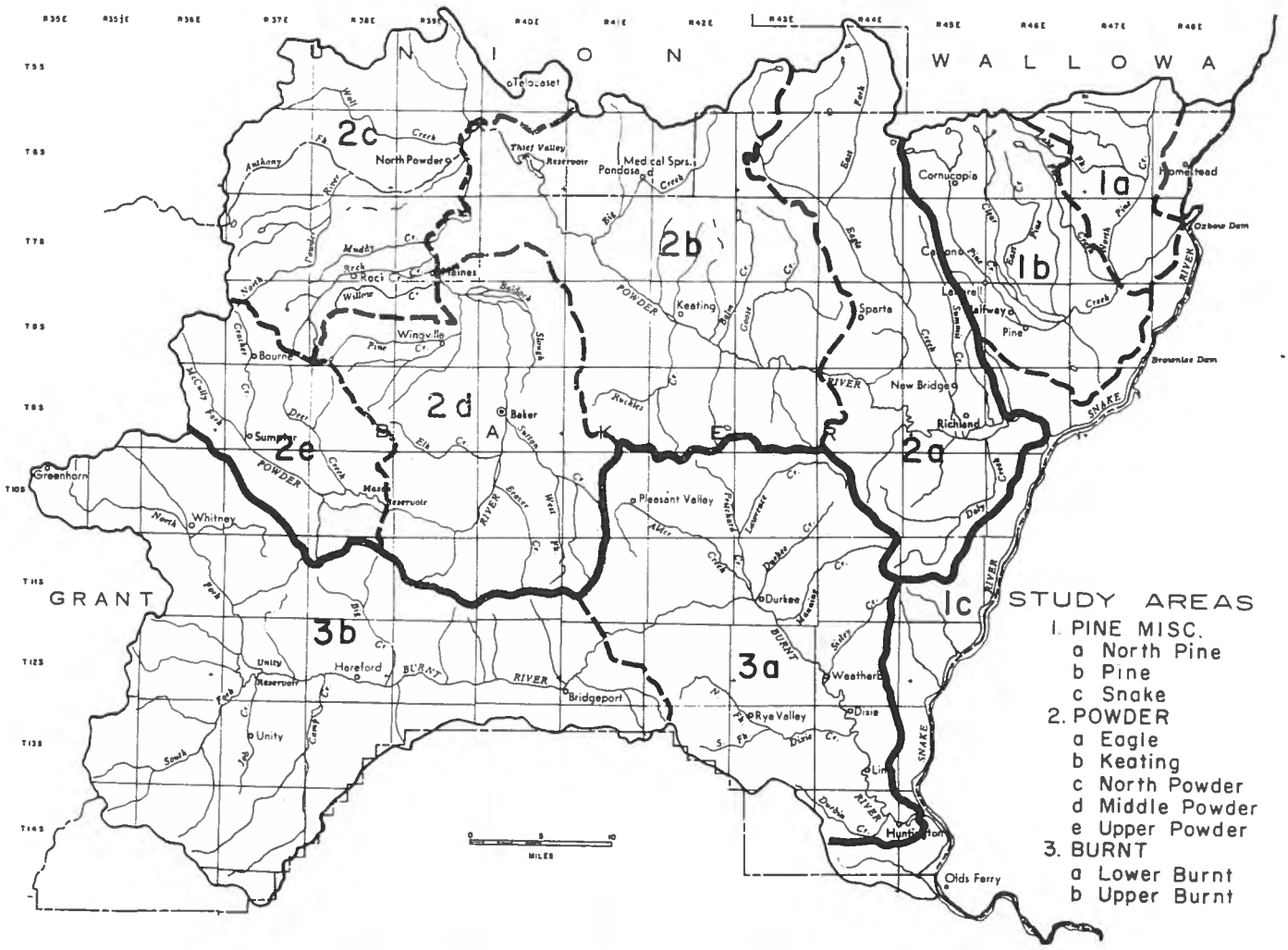


FIGURE 1. Powder Basin

red. Powder Basin, which includes the watersheds of Pine

Creek, Powder River, Burnt River and numerous small creeks, all draining into the Snake River, is located in the northeastern part of the State of Oregon. It is bounded on the north by the Grande Ronde River Basin, on the east by the Snake River, on the south by the Malheur River Basin, and on the west by the John Day River Basin.

The basin measures 85 miles from east to west and 64 miles from north to south and has a roughly rectangular shape. It drains an area of 3,240 square miles or 2,073,700 acres, which is about 3.4 percent of the state's area.

Counties and Basin Study Areas

As shown in Table 1, the basin includes about 96 percent of Baker County, slightly less than 13 percent of Union County,

TABLE 1

BASIN AREA BY COUNTY

COUNTY	TOTAL AREA	AREA WITHIN POWDER BASIN			
	Sq. Mi.	Sq. Mi.	Acres	Percent of County	Percent of Basin
Baker	3,085	2,949	1,887,800	96	91
Union	2,034	262	167,600	13	8
Malheur	9,925	13	8,200	-	-
Wallowa	3,181	16	10,100	1	1
TOTAL	-	3,240	2,073,700		100

Data Source: Oregon Blue Book and USLA 1966 Cooperative Report.

and less than one percent of Malheur and Wallowa Counties.

Because of differences in physical, hydrologic, and water-use characteristics, the basin has been divided into the Pine miscellaneous, Powder, and Burnt study areas (Figure 1). Reconnaissance data on the study areas are shown in Appendix, Table C and are discussed seperately where appropriate.

The Pine miscellaneous study area includes North Pine (1a), Pine (1b), and miscellaneous tributaries of the Snake (1c).

THE BASIN

The Powder study area includes Eagle (2a), Keating (2b), North Powder (2c), Middle Powder to Mason Dam (2d), and Upper Powder (2e).

The Burnt study area includes Lower Burnt (3a) from Huntington to near Bridgeport, and Upper Burnt (3b) including its headwaters. These areas are so designated in the tables and graphics.

Sections of this report consider conditions basinwide, then by study area, or stream system. Separate analysis is made by stream system for the 10 beneficial uses of water listed under ORS 536.300. These uses are domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, fish life, and pollution abatement.

Stream System

Table 2 lists the length of perennial and intermittent streams by study area. About 41 percent or 2,083 miles of streams have perennial flows, while 59 percent or 3,010 miles of streams have intermittent flows. Perennial streams are

TABLE 2

LENGTH OF STREAMS

STUDY AREA	PERENNIAL		INTERMITTENT		TOTAL
	Miles	%	Miles	%	
1. PINE MISC.					
(a) North Pine	97	78	27	22	124
(b) Pine	131	70	55	30	186
(c) Snake	156	73	58	27	214
2. POWDER					
(a) Eagle	362	81	84	19	446
(b) Keating	268	37	448	63	716
(c) North Powder	279	49	294	51	573
(d) Middle Powder	192	38	412	62	604
(e) Upper Powder	128	42	177	58	305
3. BURNT					
(a) Lower Burnt	263	40	390	60	653
(b) Upper Burnt	207	16	1,065	84	1,272
TOTAL	2,033	41	3,010	59	5,093

Data Source: Computed from SWRB base map 9.8.

shown on the basin maps (Appendix, Plates 1-5) as solid blue lines. Intermittent streams are shown by broken lines.

The Powder Basin contains about 5,100 miles of streams, which are shown on the Powder Drainage Basin map, Plate 1 of the Appendix.

Pine Creek has a length of 36 miles; Powder River, 162 miles; and Burnt River, 110 miles. Major streams originate in either the Blue Mountains, which form the western boundary of the basin, or the Wallowa Mountains in the northern portion. These streams, along with intermittent streams heading at lower elevations, flow in an easterly direction into a stretch of the Snake River from above the town of Huntington to below the community of Homestead.

Mainly, due to the prevailing semiarid conditions and to diversions for irrigation, the two rivers and most creeks have little or no flow in some reaches of their channels during the low-flow period of many years.

Stream gradients generally exceed 5 percent in the mountainous watersheds and are about 1 percent in most valley areas of the basin.

The principal stream in the Pine study area is Pine Creek with its tributaries, North Pine, Fish, East Pine, and Clear Creeks. Also included in this area are 30 named streams from 1 to 6 miles in length, which flow directly into the Snake River along the eastern border of the basin. Pine Creek originates in the southeastern portion of the Wallowa Mountains. It enters the Snake River 4 miles below Oxbow Dam and 25 miles below the mouth of the Powder River. The drainage area comprises about 200,000 acres.

Summer flows of Pine Creek and its major tributaries are augmented by releases from 7 private irrigation reservoirs. The stream and its tributaries often are completely diverted through the valley section around Halfway by about 60 irrigation diversion dams. North Pine, a tributary, enters Pine Creek 8 miles about its mouth.

The following Figure 2 shows a profile of Pine Creek from its headwaters to the confluence with the Snake River. In the short distance of 4.3 miles between Pine Lakes and

Cornucopia, the stream drops about 3,000 feet in elevation.

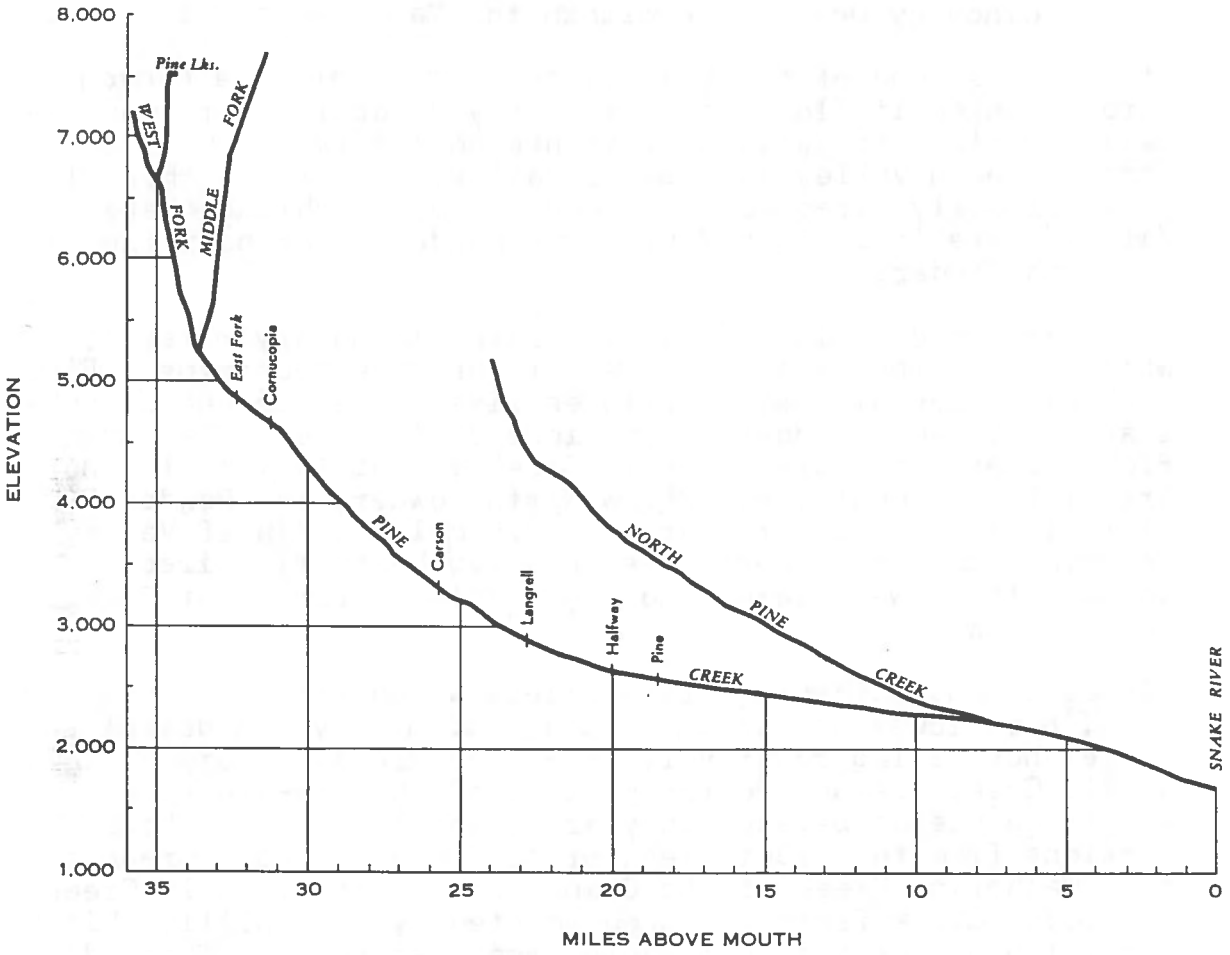


FIGURE 2. Profile of Pine Creek.

The upper Powder River drains the eastern slopes of the Blue Mountains. The drainage area includes about 104,000 acres with headwaters at the 6,000- to 9,000-foot elevation. Cracker and Deer Creek branches drain the southern slopes of the Elkhorn Range of the Blue Mountains where the most dependable summer flows originate. McCully Fork has its headwaters on Ireland Mountain, Grays Peak, and Spaulding Ridge along the Blue Mountain divide. Most of the lower elevation tributaries have intermittent flows. Benchlands on the north and south sides of Sumpter Valley are used for irrigated agriculture and involve numerous diversions.

THE BASIN

Powder River begins at the confluence of Cracker Creek and McCully Fork at the City of Sumpter. It flows in a southeasterly direction through Sumpter Valley for 9 miles where it is joined by Deer Creek within the Mason Reservoir site.

At the lower end of the valley, the river enters a canyon through which it flows in an easterly direction for approximately 9 miles to Salisbury, thence northerly for 9 miles through Bowen Valley into Baker Valley. The river then flows in a northerly direction for about 38 miles through Baker Valley where it is joined by North Powder River near the City of North Powder.

The North Powder River is an important tributary water source which drains the eastern slopes of the Blue Mountains. Five high elevation diversions between river miles 16 and 18 substantially deplete downstream flows during the summer months. Flows of Anthony Fork and Wolf Creek immediately to the north are similarly depleted. Below North Powder, the Powder River flows in a southeasterly arc for 7.5 miles to Thief Valley Reservoir thence it continues in a southeasterly direction through the Lower Powder and Eagle Valleys for about 75 miles to the Snake River.

Big Creek and adjoining tributaries, which serve the Keating area, have lower elevation headwaters, mainly, in desert and rangelands having relatively low-water yields. Summer flows of Big Creek are not representative of the low-elevation watershed yields because they are augmented by interbasin diversions from the Trout Creek branch of West Eagle Creek and from Catherine Creek of the Grande Ronde Basin. Balm Creek and Goose Creek flows are supplemented by the Phillips Ditch diversion out of the West Eagle Creek watershed. These diversions are shown on Plate 1 of the Appendix. The streamflow regimen varies because flows are manipulated for irrigation purposes.

Eagle Creek, which drains approximately 204,400 acres, originates in the Eagle Lake basin, drains the southern slopes of the Wallowa Mountains, and enters Brownlee Pool near Richland. East and West Eagle Creeks, as well as Eagle Creek main stem, have numerous cataracts and falls.

Low summer streamflows below mile 10 on Eagle Creek are depleted by 10 diversion ditches, which serve the Eagle Valley area.

THE BASIN

Burnt River is formed at Unity Reservoir by North, West, Middle, and South Forks and Job Creek. The various headwater tributaries rise in the Blue Mountains at elevations between 6,000 and 7,900 feet. The tributaries above Unity Reservoir have intermittent flows.

From Unity Reservoir, Burnt River flows in an easterly direction a distance of 80 miles through Hereford Valley, Bridgeport Valley, Burnt River Canyon, Durkee Valley, and ultimately enters the Snake River near Huntington. The stream gradient is generally moderate except for a short section of a steep gradient in Dark Canyon and several flat sections in Hereford Valley. The nearly flat valley portions are bordered by narrow terraces and high plateaus.

The side streams along Burnt River are small and have characteristically low-summer flows. Streamflows on the main stem are very erratic due to uncontrolled side streamflows and releases from Unity Reservoir. The discharge of Burnt River is regulated, largely, by Unity Reservoir for the needs of irrigators during the growing season. As shown on Plate 1, numerous diversion ditches are used to distribute flows of Burnt River and its tributaries. Three transbasin diversion ditches were constructed to transport water for mining purposes from the John Day Basin to the headwaters of the North Fork Burnt River. The Mann Ditch presently has a capacity to carry 22.5 cubic feet per second (cfs) from the North Fork John Day River.

Dixie Creek is an economically important stream of the lower Burnt River valley. It originates on Pedro Mountain at 6,455 feet, traverses the agricultural Rye Valley, then passes through a narrow valley and joins the Burnt River 12 miles above its mouth. Four diversion ditches deplete the main stream and tributary flows during the usual dry summer periods.

Topography

Principal features are the Blue Mountains to the west, the precipitous, glacial eroded Wallowa Mountains to the northeast, and the deeply incised Snake River Canyon to the east. Extending easterly from the Blue Mountains is one chain of peaks, Huckleberry Mountain, Sheep Rock, Bald Mountain, and Dooley Mountain, which forms the divide between the Burnt River valley and Sumpter-Upper Powder valley. Another

easterly projection, Elkhorn Ridge, is the divide between Sumpter Valley and Baker Valley.

The topography of the Powder Basin is illustrated in part by

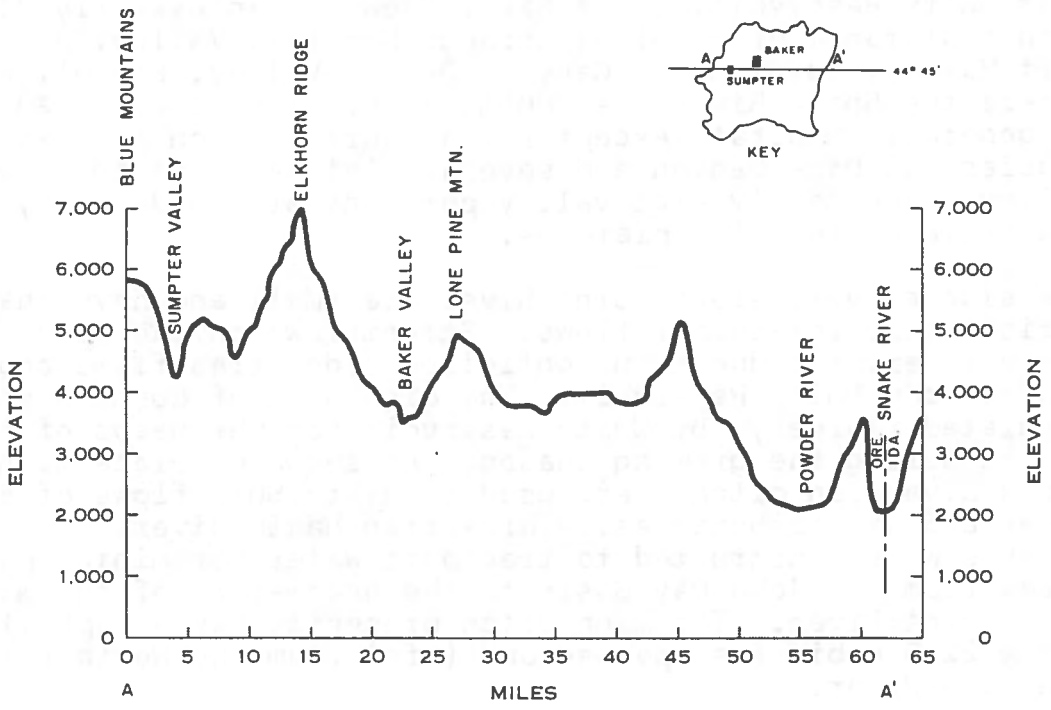


FIGURE 3. Generalized Cross Section of Powder Basin.

the generalized basin cross section shown in Figure 3.

A smooth gently sloping valley floor and low terraces, which rise abruptly into the Wallowa Mountains to the north and pass into lava formations to the south and east, are principal topographic features of Pine Valley.

Rugged topography characterizes the upper reaches of Eagle Creek above Boulder Park. Elevations in the drainage range from 9,595 feet on Eagle Cap Mountain to 2,077 feet which is the normal pool elevation for Brownlee Reservoir. Below Boulder Park, a forested plateau drops off to lower hills which border Eagle Valley.

THE BASIN

Lower Powder Valley, often called "Keating Valley", is a basinlike area traversed by Powder River. The valley floor is nearly level. Low benches border the valley and break sharply into the surrounding uplands and Wallowa Mountains to the north.

Physiographic features of Baker Valley include a nearly flat broad alluvial plain or river bottom with smaller valleys extending up the side streams. The west side of the valley is composed of gently sloping alluvial fans and terraces which merge into hills and the rugged Blue Mountains.

The Sumpter Valley floor has large areas of gravel piles caused by gold dredging operations. This valley is partly bordered on the north and south by old high gravelly terraces which merge into the mountain foothills.

Except in the mountainous areas, the Burnt River regional characteristics trend toward moderate relief.

The Burnt River valley comprises valley segments around Unity, between Hereford and Bridgeport, and around Durkee which are interspersed with deep canyon segments. The nearly flat valley portions are bordered by narrow terraces and high plateaus.

Basin elevations include: Halfway, 2,663 feet; Richland, 2,160 feet; Keating, 2,700 feet; Haines, 3,333 feet; Baker, 3,449 feet; Sumpter, 4,415 feet; Bridgeport, 3,380 feet; Durkee, 2,656 feet; Huntington, 2,113 feet; and the proposed Hells Canyon Pool, 1,688 feet.

Climate

The climate of the Powder Basin is continental, with low winter and high summer temperatures, low annual precipitation, very dry summers, and abundant sunshine. With a wide range of elevation, exposure, air movement, and precipitation, there is an extreme diversity of weather conditions in the basin.

The average annual precipitation ranges from 8 inches in the Haines area of Baker Valley to 80 inches in the Eagle Cap area.

Average annual precipitation of water years 1935 to 1964

measured at Baker is 10.73 inches, but annual precipitation has ranged from 6.05 to 19.25 inches. Almost one-half of the annual precipitation in Baker Valley occurs as rainfall during April through September and most of the remainder falls as snow. In the Richland area, about 40 percent of the precipitation falls during the growing season, as shown in Figure 4.

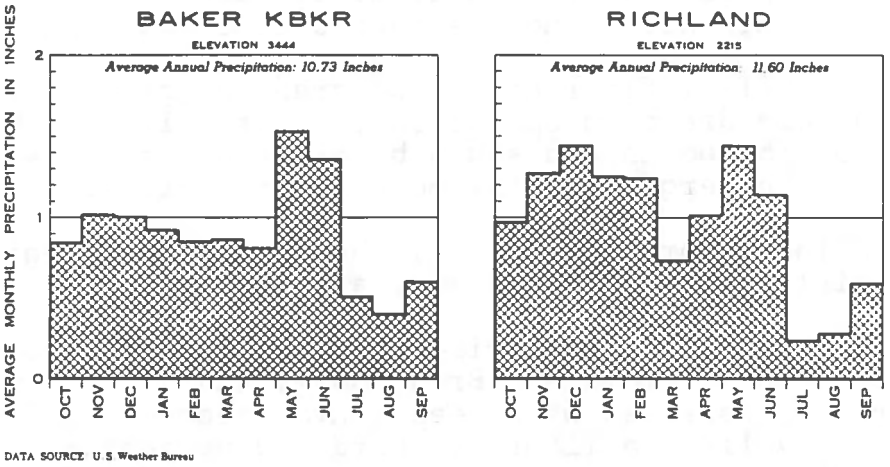


FIGURE 4. Long-Term Average Monthly Precipitation at Baker and Richland.

The base period average monthly precipitation at Baker and Richland is characterized by low precipitation during July, August and September. Powder Basin's mean cool summer temperatures and short growing seasons generally limit the type of crops that can be grown commercially to hay, hardy row crops, grain, and pasture.

Nearby mountains that remain snow covered until late spring are a source of much cold air that settles in the valleys. Prevailing winds are from the northwest in the summer and southeast the remainder of the year.

The isohyetal map (Figure 12, page 34) shows the distribution of average precipitation for the basin. This generalized map shows extremes from 8 inches in the lower Baker Valley to 80 inches in the Wallowa Mountains. Most agricultural lands are in the 8-to 20-inch average annual precipitation zones.

The average growing season between killing frosts is about

124 days at Baker and 130 days at Richland. Frost-free periods as long as 177 days and as short as 81 days have been recorded at basin weather stations. Hereford and Bridgeport Valleys have temperatures similar to Baker Valley while Pine Valley has lower recorded temperatures.

Baker has an average annual temperature of 46.7 degrees Fahrenheit (°F.), a mean January temperature of 25° F. and a mean July temperature of 68° F. Richland has a mean annual temperature of 51.9° F., a mean January temperature of 28° F. and a mean July temperature of 75° F. Recorded temperature extremes range from -30° F. at Baker to 113° F. at Huntington.

Figure 5 shows average long-term maximum, mean and minimum monthly temperatures at Baker and Richland.

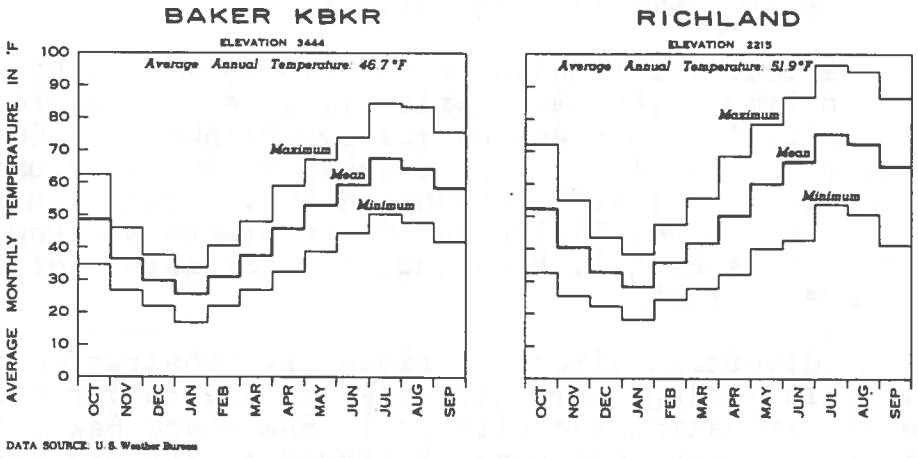


FIGURE 5. Long-Term Average Monthly Air Temperatures at Baker and Richland.

The annual snowfall varies from a trace along the Snake River to many feet at the upper elevations of the basin. Average annual snowfall is 35 inches at Baker and 294 inches at Cornucopia.

During the summer months, much of the basin is subject to violent cloudburst storms of small areal extent and high intensity.

THE BASIN

CULTURAL DEVELOPMENT

History

The first known settlement in Baker County was by gold miners in 1861 in the vicinity of Griffin Gulch, southwest of the present City of Baker. In 1862 three of the gold seeking party returned and erected a cabin and started to develop their claim. The town of Auburn, nearby, was founded in June of 1862. Many of the pioneers engaged in mining enterprises but stock raising and farming were undertaken by others to supply food for the miners. Irrigation in this area began in 1862 when farmers, seeking to improve the native hay meadows, made simple diversions from streams.

Baker, situated where the Oregon Trail entered the valley, was first settled in 1863. Construction of a railroad, now Union Pacific, through Baker Valley in 1884 encouraged expansion of the livestock and lumbering industries.

One of the earliest irrigation water rights in the basin is that of John Troy which has a priority date of 1862 for 9 acres of irrigation in Pleasant Valley northwest of Durkee. Other 1862 rights include City of Baker municipal right for 4 cfs from Elk Creek; W. A. Green, Haines, irrigation of 52 acres from Rock, Sand, Willow and Clear Creeks and Powder River; and Thomas Seigel, Richland, for irrigation of 60.5 acres from Daly Creek.

Many of the diversion ditches, originally constructed for hydraulic gold mining, were converted to irrigation canals. The type of irrigation established in Bowen and Baker Valleys by the first settlers has been continued to the present time. At the turn of the century farmers began to improve the native hay meadows by seeding tame grasses in the bottomlands and planting alfalfa on the better drained slopes. Except for the trend toward increased production of forage per acre, there has been little change in farming practices to the present.

An inspection of numerous early investigation reports indicates the basin has had its present water problems back through recorded history. As an example, the progress report, "Irrigation and Drainage Study of Baker Valley," in 1929 by M. R. Lewis from the Department of Soils, Oregon Agricultural Experiment Station and the Division of Agricultural Engineering, U. S. Department of Agriculture,

cooperating, recommended the following:

1. Obtain additional late season water.
2. Reclaim the lands damaged by alkali.
3. Lower the water table by pumping to permit leaching of the accumulated alkali.
4. Utilize pumped water to supplement present irrigation supplies.

Mason Reservoir, which is now under construction, will provide part of the additional late season water requirements for Baker Valley in addition to providing some flood control benefits.

Population

Table 3 shows the population distribution in the basin by county and study area as estimated from the 1960 U. S. Bureau of the Census Data.

TABLE 3

COUNTY POPULATION
DISTRIBUTION BY STUDY AREA
1960

STUDY AREA	BAKER	UNION	MALHEUR	TOTAL
1. Pine Misc.	2,677	-	-	2,677
2. Powder River	13,193	889	-	14,082
3. Burnt River	1,425	-	6	1,431
Total	17,295	889	6	18,190
% By County	95	5		100

Data Source: U. S. Bureau of Census, Oregon Blue Book and SWRB Study.

Population of the Powder Basin for 1960, based on the U. S. Census Bureau report, was 18,190 with 58 percent of the population in the incorporated Cities of Baker, Haines, North Powder, Richland, Halfway, Huntington, and Sumpter.

Baker County, with 17,295 persons in 1960, accounted for 95 percent of the basin total. The remaining population included 889 in the southern portion of Union County and six in the small portion of Malheur County which is in the basin. The rural population is presently estimated at 7,758 people or 42 percent of the total basin population.

Population of Baker County increased from 0 in 1861, immediately prior to the first settlement, to 18,076 in 1910 then

gradually declined for 20 years. This population was not surpassed until 1940 when the number reached 18,297 after which a slow decline continued.

Population trends are shown in the following Figure 6.

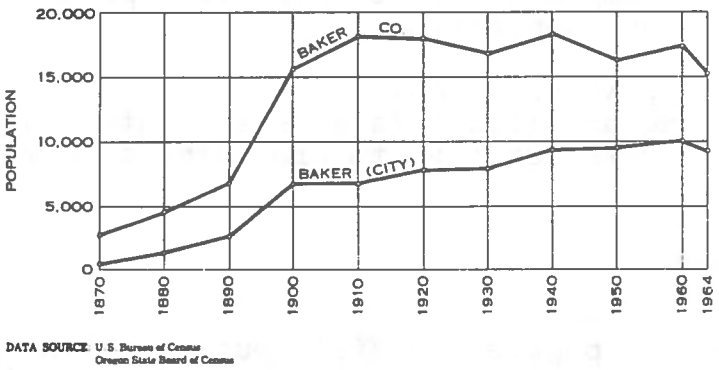


FIGURE 6. Population Trends.

A study of the population census data indicates the changing composition of the basin's families. While both the over 65- and under 18-age groups have shown a slight increase, the wage-earning group of 18 to 65 has shown a slight decrease. The result of this apparent trend is a loss of potential wage earners whose activities would contribute to the economic well being of the area, accompanied by an increase in those age groups characterized by relatively low incomes and low consumer needs.

An analysis of the development potential and census records indicates a future annual population growth rate of less than one percent for the basin. Assuming that some broadening of the Powder Basin general economy can be realized to offset job losses through mechanization, out-migration, and the decline of the birth-producing age groups, the population in the basin could reach about 21,000 by the year 1985.

Transportation

Most populated portions of the Powder Basin are readily accessible by a variety of transportation facilities. Secondary roads provide access to small villages and rural

farms even to many grazing and forest areas.

The basin is crossed from northwest to southeast by Interstate Highway 80N (formerly U. S. 30), connecting the Cities of North Powder, Haines, Baker and Huntington to outside points. The City of Baker is connected to the Cities of Union and La Grande outside the basin by State Highways 203 and 237 and to the basin Cities of Richland and Halfway by State Highway 86. The Cities of Baker and Sumpter are connected by State Highway 220. State Highway 7 connects Baker with U. S. Highway 26 in the southwestern portion of the basin, (Appendix, Plate 1).

The main line of the Union Pacific Railroad serves the larger cities of the basin with transcontinental passenger and freight service. Regular truck freight and bus service is available to all larger and most smaller towns.

The City of Baker is served by West Coast Airlines commercial service, while two privately operated airports at Haines and Homestead accommodate smaller planes.

Telephone service is by Pacific Northwest Bell, California-Pacific Utility, Haines Telephone, Pine Telephone, Juniper Telephone and Eagle Telephone Companies. About one-third of the area, comprising timber and rangelands, has no service.

There are two Idaho Power Company hydroelectric generating stations, one at Oxbow Dam and the other at Brownlee Dam, on the Snake River on the eastern boundary of the basin. The southern portion of the basin is served by Idaho Power Company while the middle and upper portions are served by California-Pacific Utility Company, which has a small hydroelectric power plant on Rock Creek west of Haines, Oregon.

Land Use and Ownership

Most of the 761,700 acres of high-elevation forest land, which provides some grazing, is concentrated in the Blue Mountains along the western portion of the basin and the Wallowa Mountains along the northern fringe of the basin. Other mixed forest and rangelands are found on Lookout Mountain northeast of Durkee and Dooley Mountain south of Baker. The 196,000 acres of cropland are scattered along river valleys, with the largest contiguous area in Baker and

North Powder Valleys, 169,300 acres are developed for irrigation, the remainder are dry farmed. The other 109,800 acres include towns, roads, water courses, and rocky areas.

Figure 7 and Table 4 show general land uses in the Powder

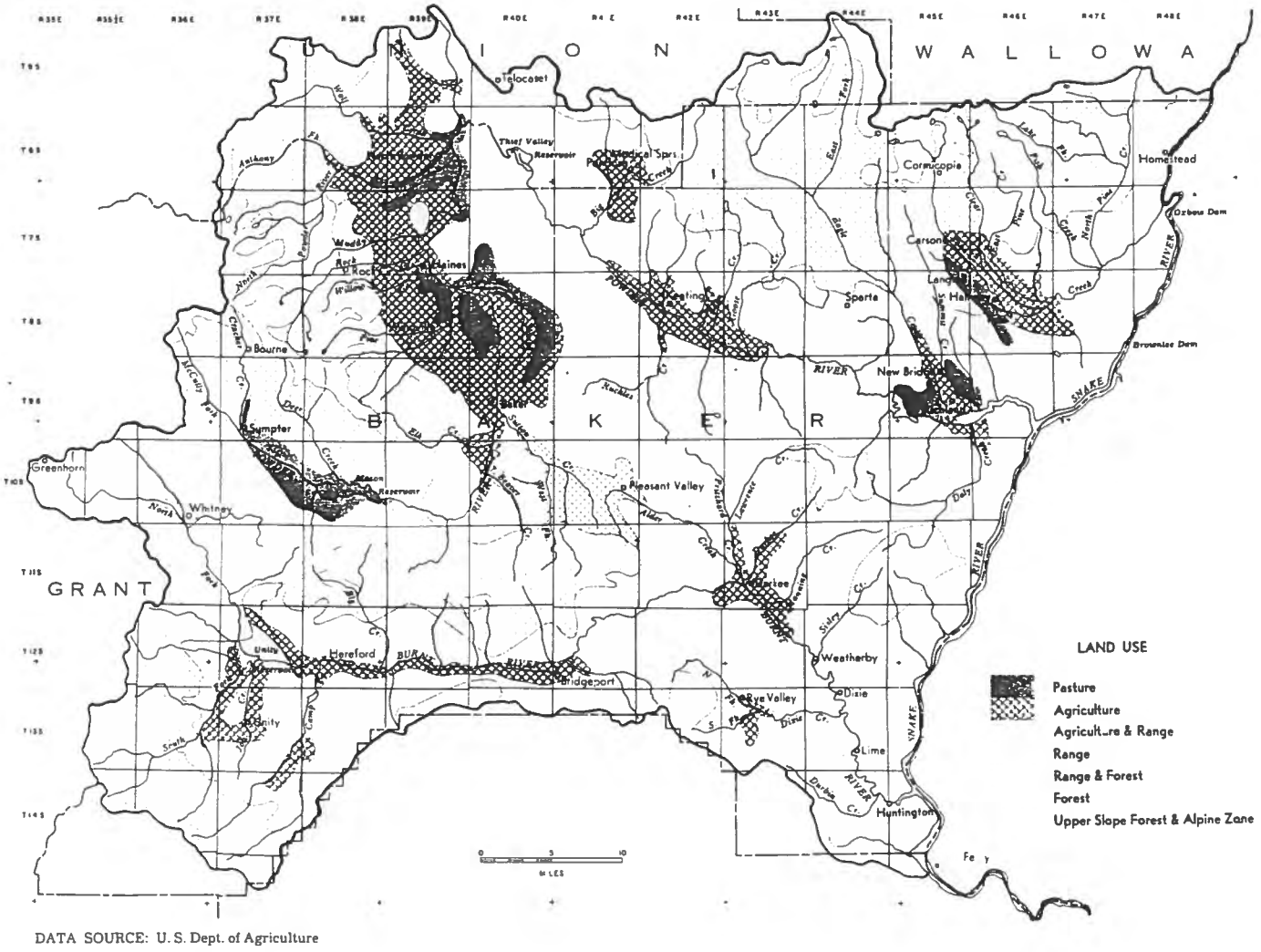


FIGURE 7. Generalized Land Use.

Basin. The 2,073,700-acre basin is 49 percent rangeland, 37

percent forest land, 9 percent cropland, and 5 percent towns, roads, and other public facilities.

TABLE 4

GENERAL LAND USE
Acres

STUDY AREA	FOREST-LAND	RANGE-LAND	CROP-LAND PASTURE	TOWNS, ROADS, ETC.	TOTAL
1. PINE MISC.					
(a) North Pine	45,400	22,900	50	4,350	72,700
(b) Pine	55,600	46,900	17,100	8,800	128,400
(c) Snake Misc.	5,400	111,900	1,000	3,600	121,900
2. POWDER					
(a) Eagle	94,400	84,100	10,400	15,500	204,400
(b) Keating	54,700	205,000	29,500	11,900	301,100
(c) North Powder	92,400	64,100	56,750	10,750	224,000
(d) Middle Powder	66,600	79,100	52,400	22,600	220,700
(e) Upper Powder	85,000	4,700	3,000	11,400	104,100
3. BURNT					
(a) Lower Burnt	17,100	256,800	8,600	6,500	289,000
(b) Upper Burnt	245,100	130,700	17,200	14,400	407,400
TOTAL	761,700	1,006,200	196,000	109,800	2,073,700
% of Use	37	49	9	5	100

Data Source: USDA 1966 Cooperative Report.

Rangeland, comprising 1,006,200 acres, constitutes the largest use of land in the basin. It includes basin land below 4,500 to 5,000 feet in elevation which is not used for farming purposes.

The 1,039,900 acres of federal land include 372,500 acres administered mainly by the U. S. Bureau of Land Management and 667,400 acres by the U. S. Forest Service. Lands administered by the U. S. Forest Service are within the Blue Mountain division of the Wallowa-Whitman National Forest while U. S. Bureau of Land Management lands are scattered throughout the remainder of the basin.

Ownership or administration of the land is about 50 percent federal; 2 percent state, county, and municipal, and 48 percent private according to the U. S. Department of Agriculture, 1966 cooperative study.

The ownership pattern for the basin is shown in Table 5.

TABLE 5

LAND OWNERSHIP OR ADMINISTRATION
Acres

OWNERSHIP	RANGE	CROP AND PASTURE	FOREST	OTHER	TOTAL
FEDERAL					
National Forest	55,500	-	550,000	61,900	667,400
Public Domain	333,600	-	36,900	2,000	372,500
STATE	9,500	-	1,000	10,000	20,500
COUNTY & MUNCIPAL	-	-	1,000	12,200	13,200
PRIVATE	607,600	196,000	172,800	23,700	1,000,100
TOTAL	1,006,200	196,000	761,700	109,800	2,073,700

Data Source: USDA 1966 Cooperative Report.

Less than 10 percent of the basin is privately owned cropland. The central, southern, and eastern parts of the basin are predominantly rangeland, about 60 percent is privately owned, and 33 percent is in the public domain.

ECONOMY AND RELATED NATURAL RESOURCES

General

Important contributors to the economy of Powder Basin have been agriculture, services and other industries, and wholesale and retail trades. Increasing economic benefits are now being derived from manufacturing, services, and tourism. Basin economic growth is expected to be slow and steady.

Census data indicate that total employment in Baker County was 6,381 in 1960. Agriculture was the basic industry employing 20 percent of the workers. The rest were employed in a variety of forestry, manufacturing, mining, construction, transportation, trade and service fields. Employment data are not available for the entire basin.

Table 6 lists employment by basic activity in Baker County. Since 96 percent of the basin's population is in Baker County, employment data presented for the county are indicative of basin employment.

TABLE 6

EMPLOYMENT IN BAKER COUNTY

EMPLOYER	1960	1950	1940
Agriculture	1,295	1,797	1,968
Forestry	144	33	32
Mining	16	125	572
Construction	841	337	265
Manufacturing	791	830	736
Transportation and utilities	500	499	483
Wholesale and retail trades	1,175	1,147	1,073
Services and other industry	1,619	1,617	1,545
TOTAL	6,381	6,385	6,679

Data Source: U.S. Bureau of Census.

Although agricultural production has continued to increase in recent years, employment has decreased. Farms and ranches are becoming larger and more mechanized, requiring fewer workers. The loss in employment in mining and agriculture has been offset by gains in employment in forestry, construction, trades and services, leaving total employment but little less than in 1940.

Median family incomes increased from $2,808 in 1950 to $5,266 in 1960 which is slightly better than the statewide income.

Agriculture

Agriculture and related services are the major source of income in the Powder Basin. About 85 percent of the basin area is used to produce forage and pasture crops. With improved breeding and marketing procedures, the cattle industry now produces a $7 million income. Today, 49 percent of the total agricultural income is from commercial production of Hereford and Angus cattle.

The availability of grazing resources forms the basis for agricultural livestock production. Livestock are grazed on range and forest land for about seven months of the year, while the forage from hayland and pasture is used for winter feed and supplementary summer forage. Forage production from rangelands could be increased substantially through planting of adapted domestic grasses in range areas. This practice is now being implemented successfully on large demonstration tracts.

Table 7 shows the 1964 value of farm products sold from Baker County.

TABLE 7

ESTIMATED AGRICULTURAL INCOME
BAKER COUNTY
1964

PRODUCT	GROSS INCOME	PERCENT
CROPS		
Hay and Silage	$ 2,228,000	20
Grain	1,062,000	9
Potatoes and sugar beets	350,000	3
Other crops	735,000	6
Total Crops	$ 4,375,000	38
LIVESTOCK		
Beef cattle	$ 5,657,000	49
Dairy products	426,000	4
Sheep and wool	825,000	7
Other livestock	272,000	2
Total Livestock	$ 7,180,000	62
TOTAL FARM PRODUCTS	$11,555,000	100

Data Source: Baker County extension report for period 1 Oct. 1963 to 30 Sept. 1964.

Irrigated pasture provides the major summer feed for dairy cattle and farm flocks of sheep, as well as supplementary feed for range livestock. About 48,000 of the 62,000 acres of pasture in the basin are irrigated. Almost all forage produced in the basin is utilized by livestock and considerable additional feed imports are required. The trend, however, is toward becoming more self-sufficient.

Climatological and other physical and economic factors have tended to discourage any major deviation from the established range livestock and irrigated valley feed-base types of operation. Animal quality and improved farm management are the basic improvements.

Alfalfa is the most important hay crop. Production from the 33,000 acres of alfalfa accounts for about 50 percent of the total hay produced in the basin. Average alfalfa hay yields are only about 2.5 tons per acre on irrigated land because inadequate water supplies in most areas limit production to one or two cuttings. Yields of eight tons per acre have been produced on the better soils with adequate irrigation water.

Other important hay corps include 13,000 acres of clover and grass mixtures and 27,000 acres of native meadow hay. Small acreages of corn, grass, and grain are cut for silage.

Forage production will continue to be the major use of cropland due to climatic and economic factors. The number of alternative crops that can be successfully grown is limited by climatic conditions, however, more diversification would

be desirable. The average frost-free growing season is about 130 days but the Baker Valley variation is from about 81 to 177 days.

Another climatic limitation is precipitation. Except on a few higher valleys and benches, summer precipitation is inadequate to sustain the vigorous growth of tillable crops. The average annual rainfall in the major agricultural areas varies from 8 to 20 inches.

A further limitation is the availability of water supplies for irrigation. Natural streamflow, the source of water for the major part of the irrigated land, is not usually available, for much of the land, after July first. Even those landowners with older water rights cannot depend upon a full water supply every year.

TABLE 8

AGRICULTURAL LAND USE

USE	ACRES
GRAZING LAND	
Open rangeland	1,006,200
Forest land	607,400
TOTAL	1,613,600
CROPLAND	
Wheat	10,000
Barley	8,000
Other small grains	3,000
Seed crops	1,500
Potatoes, sugar beets, and other crops	1,300
Fallow and idle	32,200
Subtotal	56,000
FORAGE CROPS	
Pasture	62,000
Alfalfa hay	33,000
Clover and grass mixed hay	13,000
Wild hay	27,000
Other hay and silage	5,000
Subtotal	140,000
TOTAL CROPLAND	196,000
TOTAL CROPLAND AND GRAZING LAND	1,809,600

Data Source: USDA 1966 Cooperative Report.

Forage crop and livestock production will continue to dominate the agricultural economy due to the above reasons, plus physical and economical factors, such as the lack of broad local markets and the distance to marketing facilities.

Table 8 shows acreages of various agricultural land uses.

Other crops occupy 13 percent of the harvested or pastured cropland acreage. Wheatland precominates with about 10,000 acres harvested in 1964. Small acreages of other crops include barley, oats, rye, corn, seed crops, potatoes, sugar beets, and minor quantities of peas, tree fruits, berries, and vegetables.

According to the 1964 County Extension Service report, there were 105,900 head of beef cattle, 2,700 milk cows, 55,000 sheep, and 3,000 horses and mules in Baker County. Trends in livestock numbers between 1920-60 are shown in Figure 8.

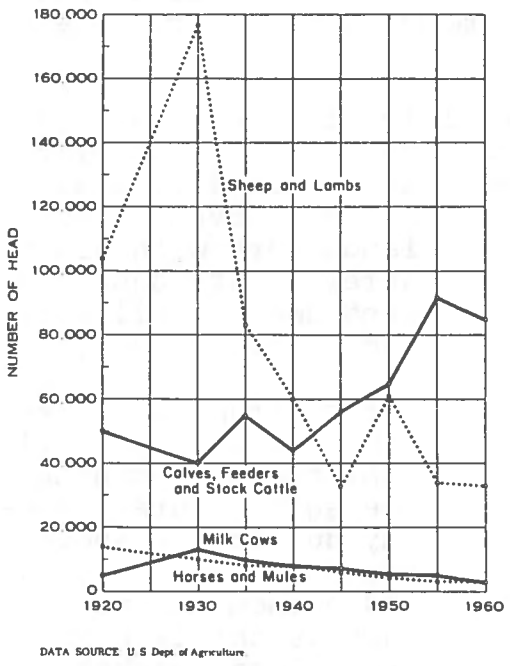


FIGURE 8. Trends in Livestock Numbers.

The general trend is for increased numbers of beef cattle and fewer milk cows, sheep, and horses. Unless price relationships change drastically, future use of land and water resources for agriculture will be primarily for the further expansion of beef cattle production.

As of 1965 there were 963 farms in the basin, of which about 75 percent were commercial farms. By areas, there were 157 farms in the Pine, 696 in the Powder, and 110 in the Burnt.

The average farm in Baker County, in 1959, contained 1,170 acres and represented an investment of $55,700. Since 1934, the size of farms has more than doubled and the investment in land and facilities has increased by more than six times.

Census data indicate that 62 percent of the farmers were full owners, 28 percent were part owners and 10 percent were renters or professional managers. About 30 percent of the farm people obtained the largest percentage of their income from off-farm enterprises.

There are no large processing plants in the basin for such crops as peas, potatoes, or sugar beets so these and about 70 percent of the milk produced must be shipped to outside markets in bulk form. A local program is well established for disposal of the 30,000 to 40,000 beef cattle produced for sale annually and for wool marketing.

Forestry

Forest land occupies about 761,700 acres or 37 percent of the basin land area. The forests are almost exclusively softwood except for small amounts of hardwood in the valleys. Ponderosa pine predominates at lower elevations and represents the major commercial species. As elevation and the accompanying precipitation increases, such species as Douglas fir, white fir, western larch, lodgepole pine and western white pine are found in increasing proportions. On the cool moist upper slopes, usually above 6,000 feet in elevation, alpine fir, lodgepole pine and Englemann spruce predominate.

Forest cover influences snowmelt, streamflow peaks, water quality and water supply for municipalities, industry and for irrigated cropland. The forest land also is used extensively for recreation due to its streams, lakes, and forest scenery that are significant tourist attractions.

Table 9 shows the distribution of forest areas in the basin.

TABLE 9

FOREST OWNERSHIP BY TYPE
Acres

TYPE	FEDERAL	STATE	COUNTY AND MUNICIPAL	PRIVATE	TOTAL
Ponderosa Pine	317,270	360	470	105,210	423,310
Associated Species	178,230	-	290	35,030	213,550
Lodgepole Pine	32,830	-	70	2,240	35,140
Hardwoods	560	-	70	2,440	3,070
Nonstocked	570	-	-	1,740	2,310
Noncommercial	57,440	640	100	26,140	84,320
TOTAL	586,900	1,000	1,000	172,800	761,700

Data Source: USDA 1966 Cooperative Report.

There are about 535,770 acres of commercial forest while the remaining forest land is in immature trees, noncommercial species, or is nonstocked. The basin's forest land contains about 6,408 million board feet of commercial timber. About 172,800 acres are in private ownership; 2,000 acres are in municipal, county, or state ownership; and the remaining 586,900 acres are in federal ownership.

Lumber has been the primary product manufactured from the basin's timber. Mills at Baker, Halfway and Unity have a combined capacity of 80 million board feet. An additional million board feet will be required annually by a plywood plant recently installed at Baker. This production capacity is greater than the estimated sustained yield, as shown in Figure 9, timber harvest in Baker County for the years 1930 through 1963.

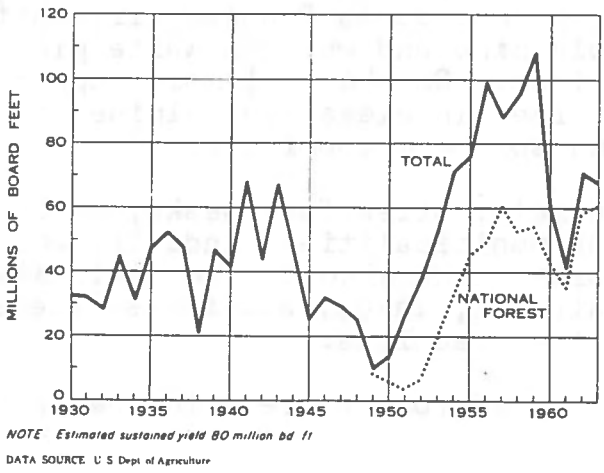


FIGURE 9. Timber Harvest in Baker County 1930-1963

With most of the private land now cut over, the industry is dependent upon national forest and public domain for a sustained supply of timber resources. The present allowable timber harvest from federal forest land in the basin is approximately 65 million board feet. A sustained yield of 15 million board feet is thought to be realistic for private land. This would allow a total sustained cut of 80 million board feet according to U. S. Department of Agriculture, 1966 cooperative study.

Recreation

The rugged and varied terrain of the basin contributes much to attract tourists and provides abundant recreation. Principal resources are the rivers, lakes, mountains, and forests, with the most significant recreational potential located along the Snake River and in the Wallowa-Whitman National Forest. The basin contains 183 lakes and reservoirs over one acre in size. As shown in Table 10, the largest of these is Brownlee Reservoir with a surface area of 15,000 acres. The Oregon State Game Commission has stocked 18 of the lakes and 11 of the reservoirs with fish to enhance the recreational potential. Mason Reservoir, when completed in 1967, will become the second largest body of water, within the basin, with 2,700 surface acres at maximum pool.

TABLE 10

LAKES AND RESERVOIRS

NAME	SURFACE ACRES
PINE MISC.	
Bearwallow Reservoir	18
Benson Reservoir	15
Brownlee Reservoir	15,000
Clear Creek Reservoir	42
Crow Reservoir	38
*Duck Lake	22
East Lake (2)	17
*Fish Lake	50
Hells Canyon Reservoir	2,520
Horse Lake	10
Laird Reservoir	14
Lost Lake Reservoir	10
Mehlhorn Reservoir	23
Motley Reservoir	2
Mud Lake	1
Mud Lake Reservoir	2
*Oxbow Reservoir	1,150
Pine Lakes (3)	20
Red Mountain Reservoir	2
Steele Reservoir No. 1	3
Steele Reservoir No. 2	3
Sugarloaf Reservoir	20
Unnamed (9)	23
Total over 1 acre (34)	19,005
under 1 acre (13)	-
POWDER	
*Anthony Lake	20
Arrow Lake	2
Becher Creek Reservoir	11
*Balm Creek Reservoir	112
*Bear Lake	10
Bennett Reservoir	20
Black Lake	6
Blue Canyon Res. No. 1	3
Blue Canyon Res. No. 2	4
Bridge Reservoir	3
Cached Lake	3
Clear Lake Reservoir	4
Constance Reservoir	10
*Crater Lake	17
Culver Lake	8
Curtis Lake	4
Downie Lake	2
*Dutch Flat Lake	5
*Eagle Lake	37
*Echo Lake	28
Elliot Reservoir	3
Goodrich Lake	23
Goose Lake	1
*Haines Pond 1	2
*Haines Pond 2	3
Haskell Reservoir	6
*Heart Lake	8
Hidden Lake	20
*Highway 203 Pond	1
Hoefer Lakes (2)	3
Holden Reservoir	14
Homesite Reservoir 1	6
Homesite Reservoir 2	2
Huddleson Reservoir	10
Johnson Reservoir	6
*Killamacue Lake	25
Kolb Reservoir	1
Licklider Reservoir	4
Little Park Reservoir	42
Little Summit Lake	20
Lodge Reservoir	1
*Looking Glass Lake	31
*Lost Lake	10
Love Reservoir	105
Mason Reservoir	2,700
McMurren Reservoir	1
Meadow Lake	6
Middle Slough Reservoir	1
Middle Slough Bridge Reservoir	4
Mitchell Reservoir	3
Moon Lake	2
Mud Lake	4
Nault Reservoir	3
Olive Lake	2
Palmer Reservoir	2
Palmer and Denham Reservoir	1
Pine Creek Reservoir	30
Powell Reservoir	7
*Red Mountain Lake	6
*Rock Creek Lake	25
Salt Grass Reservoir	6
Saw Mill Gulch Reservoir	14
Shaw Reservoir	55
Shaw North Reservoir	16
Shaw South Reservoir	3
Smith Lake	19
*Sparta Pond	2
Stevens Reservoir	1
Stices Gulch Mining Company	
East Fork Reservoir	1
Stices Gulch Reservoir	2
West Fork Reservoir	1
Stoddard Reservoir	8
*Summit Lake	18
*Thief Valley Reservoir	744
Toney Reservoir	5
Treverse Lake	19
*Twin Lakes (2)	11
*Van Patten Lake	24
Vogel Reservoir	5
Welch Reservoir	3
Widman Reservoir	7
Willow Creek Lake	1
Wirth Reservoir	3
Wyatt Reservoir	3
Unnamed (38)	126
Total over 1 acre (124)	4,550
under 1 acre (163)	-
BURNT	
*Camp Creek Reservoir	85
Elliott Reservoir	2
Elms Reservoir	25
Henby Reservoir	8
*Long Creek Reservoir	2
Metsker Reservoir	4
Moore Reservoir	5
Morfitt Reservoir	34
Munn Reservoir	18
*Murray Reservoir	13
Powell Creek Reservoir	1
Ruddle Reservoir	2
Stout Reservoir	3
Taylor Reservoir	1
True Blue Reservoir No. 1	1
True Blue Reservoir No. 2	1
*Unity Reservoir	923
Whited Reservoir	40
Whited Middle Fork Reservoir	8
Unnamed (6)	30
Total over 1 acre (25)	1,206
under 1 acre (95)	-
TOTAL BASIN	
Over 1 acre (183)	24,761
Under 1 acre (271)	-

*Stocked

Recreational activity in the basin has increased rapidly in recent years, as shown in Table 11 and Figure 10. Because this increase in recreational use occurred during a period when the area's population showed little or no gain, the per capita use made a substantial rise. It appears evident that the per capita use will continue to show substantial growth in the future with the stimulation of more leisure time, higher income, improved transportation, and continued development of water resources.

The opportunity for a broad variety of activities exist, such as hunting, fishing, photography, sightseeing, boating, swimming, water skiing, mountain climbing, skiing, tobogganing, rock hunting, prospecting, and horseback riding. Another activity which is becoming increasingly popular is visiting historical sites and "ghost" towns. Among these are Auburn, Greenhorn, and Cornucopia with their colorful past, which includes a fascinating history of early day mining operations.

Included in the Powder Basin are 2 state parks, 4 state waysides and rest areas, 18 U. S. Forest Service camps, 2 developed ski areas, 5 private camps and parks, 12 boat launching sites, and a portion of the Eagle Cap Wilderness Area. The locations of recreational areas in the basin are shown on Plate 3 and the names and facilities are described in Table B of the Appendix. About 667,000 acres, or one-third of the basin, lies within the Wallowa-Whitman National Forest. The 220,000-acre Eagle Cap Wilderness Area, located in the Wallowa Mountains along the basin's northern boundary, contains several peaks of over 9,000 feet, many clear mountain lakes, and provides a scenic alpine setting for the hardy and more adventuresome traveler. One-third of this restricted-use area lies within the Powder Basin. Present development in the Anthony Lakes Recreational Area includes 57 campsites encompassing 178 acres and 2 winter sports sites of 76 acres.

Forest facilities are being prepared on the basis that use will be doubled in 6 or 7 years and a 5-fold increase is to be expected by the end of the century. Studies made indicate about a $6.50 income to the area from each visitor day. The U. S. Forest Service has inventoried 65 observation sites, 40 boating sites, 12 swimming sites, and 6 winter sports sites for future development. Also considered for development are 76 botanical, geological, archeological, and historical sites.

Recreational use of national forest land within the basin is shown in Table 11, listed by primary purpose of visit. Total visits increased at an average annual rate of 13 percent and more than tripled during the period 1955-64. The most recent figures indicate that hunting has made the greatest increase and is now the number one attraction with about one-third of the total. The U. S. Forest Service estimates 50 percent of the hunters come from areas outside the basin with western Oregon being the largest contributor.

TABLE 11

RECREATIONAL USE OF NATIONAL FOREST LAND
Visits

PURPOSE OF VISIT	1955	1960	1964
Hunting	11,160	24,738	64,560
Picnicking	10,342	31,180	37,908
Camping	10,742	14,525	27,190
Fishing	10,022	10,260	22,977
General Enjoyment	7,454	6,660	19,020
Winter Sports	124	2,300	10,000
Hiking and Riding	862	1,610	2,500
Wilderness Travel	420	530	820
Organization Camping	180	200	725
Other	3,094	3,070	4,443
TOTAL	54,400	95,073	190,143

Data Source: U.S. Dept. of Agriculture.

The U. S. Bureau of Land Management has eight recreational sites programed for development between 1965 and 1969 on land under its administration. Recreational use in the desert portions of the basin is low and is not expected to increase materially due to low summer streamflow, high temperatures and occasional rattlesnake problems.

A study group representing a cross section of Baker County interests has completed a Park and Recreation Advisory Committee study. More than 20 public and private agencies were surveyed as to their recreational developments, plans and services. The report states that, "Outdoor recreation appears to be a must to meet the challenge of the future. Tourism is one of the top three industries in the state as it is also in Baker County today." The committee further observed that Baker County must cope with some of its own problems and correlate them with state, federal, and private development programing.

The completion of the Brownlee and Oxbow hydroelectric projects on the Snake River in 1958 and 1961 has attracted many visitors and greatly enhanced outdoor recreation. With completion of the Hells Canyon project in 1968, the entire 75-mile reach of the Snake River along the east boundary of the Powder Basin will be within the three reservoirs. Brownlee

and Oxbow Reservoirs provide excellent fishing, boating, and water skiing opportunities. Of the six boat landings, use of the Farewell Bend State Park landing made the most spectacular gain. The attraction of water-based recreation is reflected in Table 12 which shows the estimated annual visitors to lakes and reservoirs.

TABLE 12

ESTIMATED ANNUAL VISITORS TO LAKES AND RESERVOIRS 1965

*Brownlee Reservoir	120,000
*Unity Reservoir	80,000
*Anthony Lake	25,000
*Oxbow Reservoir	12,000
Balm Creek Reservoir	5,000
*Fish Lake	5,000
Murray Reservoir	5,000
North Powder Ponds	5,000
Camp Creek Reservoir	4,000
Haines Ponds	4,000
Mud Lake	2,600
Black Lake	2,000
Highway 203 Pond	2,000
Hoefer Lakes	1,500
Crater Lake	1,300
Pine Lakes	1,000
Rock Creek Lake	1,000
Summit Lake	1,000
Van Patten Lake	1,000

*Boat launching sites.

Data Source: Baker County Water Resources Committee.

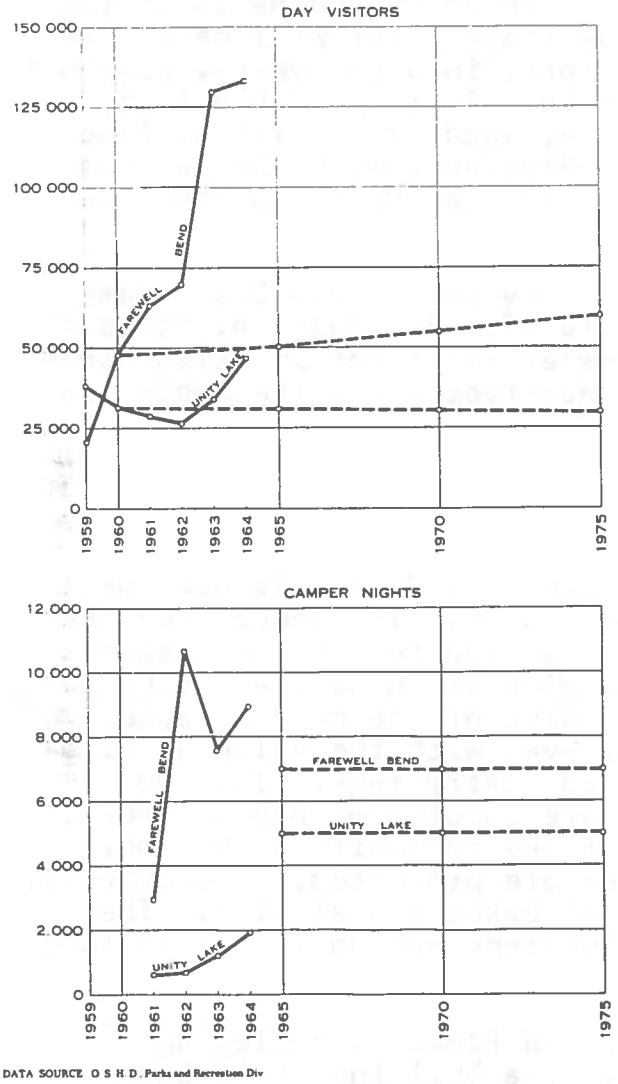
Although the number of registered boats in Baker County has not increased in the past four years, out-of-basin boaters using basin facilities has increased to 50 percent of the total.

Hunting is the most popular type of outdoor recreation in the basin. The wildlife resources which provide this attraction include big game, upland game birds, waterfowl, and furbearers. Mule deer population is plentiful with the most popular hunting areas being upper Pine Creek, Eagle Creek, northwest of Keating, Elkhorn Ridge, and Lookout Mountain. The 1963 deer harvest, as reported by the Oregon State Game Commission, lists the Lookout Mountain and Keating areas as the two top ranking regions of the state in terms of hunter success. Elk hunting is most productive in the Elkhorn Ridge and Eagle Creek areas.

Pheasants and chukar partridges can be found in large numbers in many parts of the basin. Some of the better hunting can be found in the Baker Valley, North Powder, and Keating areas, and around Richland, Halfway, and Durkee. The basin's streams provide good nesting and fair wintering grounds for waterfowl.

Day-visitor and camper-night usage at the two state parks, Farewell Bend and Unity Lake, are shown in Figure 10. The predicted use of Farewell Bend State Park (Figure 10) indicated by a dashed line, was from 47,000 day visitors in 1960 to 60,000 in 1975. The solid line in Figure 10 shows that

actual use through 1964 was almost three times as great as expected. Farewell Bend acreage is being expanded from 65 to 655 acres. New facilities will include a 56-unit trailer camp, a 32-unit tent camp, a boat dock, day-use facilities and a beach on Brownlee Reservoir.



DATA SOURCE O S H D. Parks and Recreation Div

FIGURE 10. Annual Use of State Parks.

Day-visitor predictions at Unity Lake State Park, as shown in Figure 10, were made in 1961 based on two years of records. Succeeding years of records since then show a continuation of the downward trend for two years, then a sharp upward trend through 1964. The downward trend in day visitors through 1962 was attributed to low-lake levels and poor fishing. Recent predictions indicate a continuation of the rising trend from 65,000 in 1965 to 100,000 in 1975. There was no overnight camping at the time the earlier predictions were made. More recent predictions indicate a rising trend from 3,500 camper nights in 1965 to 6,500 in 1975.

Sport fishing is one of the major recreation activities in the basin. Many streams contain rainbow trout, while brook trout are common in several headwater lakes and streams. Brownlee Reservoir is becoming one of the most popular warm-water fisheries in the northwest. Warm-water game fish can be found in the lower 130 miles of Powder River main stem and in the Burnt River below Hereford. The Pine and Eagle Creek systems have

remnant runs of steelhead and spring chinook, but these are diminishing rapidly due to the reservoirs on the Snake River. With the completion of High Mountain Sheep and Hells Canyon Dams, all anadromous fish in the Snake River will be transferred to hatcheries and, therefore, in a few years, will not reach any part of the Powder Basin. It is possible that, sometime in the indefinite future, anadromous fish will be reintroduced in these streams. Sturgeon, with the largest weighing several hundred pounds, are caught throughout the reach of the Snake River.

Many lakes are stocked with trout by the Oregon State Game Commission, as indicated in Table 10. In addition, streams that are stocked include the Powder River for 25 miles above Baker, Burnt River above Unity Reservoir, and the Eagle and Pine Creek systems.

Mining

The quarrying of limestone for use in industry is now the principal mining activity in the basin. The annual revenue derived from limestone products is reported by the Oregon State Department of Geology and Mineral Industries to be several times greater than the value of the gold produced during its best year of record, even with the value of limestone figured as raw, unprocessed quarry rock. The two largest quarries now operating are located on Baboon Creek, directly west of Baker, and near the community of Nelson. The products of the two quarries are processed, respectively, at plants at Wing Siding north of Baker and at Lime. The Baboon Creek quarry produces limestone having less than two percent impurities.

Volcanic tuff occurs near Baker and Pleasant Valley and in past years was used extensively as a building stone in the basin. Quartz diorite (popularly called granite) was quarried east of Haines for many years for use as monumental stone. A fire destroyed plant facilities some years ago and production has not resumed. A partly devitrified rhyolite quarried on Dooley Mountain since 1959 has attained wide popularity as an ornamental stone because of its attractive pastel colors and banding.

Sand and gravel aggregate is produced on the outskirts of Baker for most private construction purposes. Some deposits, however, contain chemically reactive volcanic material and do

not meet the standards for certain public works construction. Aggregate for these purposes, therefore, generally is imported from outside the basin. However, high-quality sand and gravel may be available within the basin, for example, near North Powder.

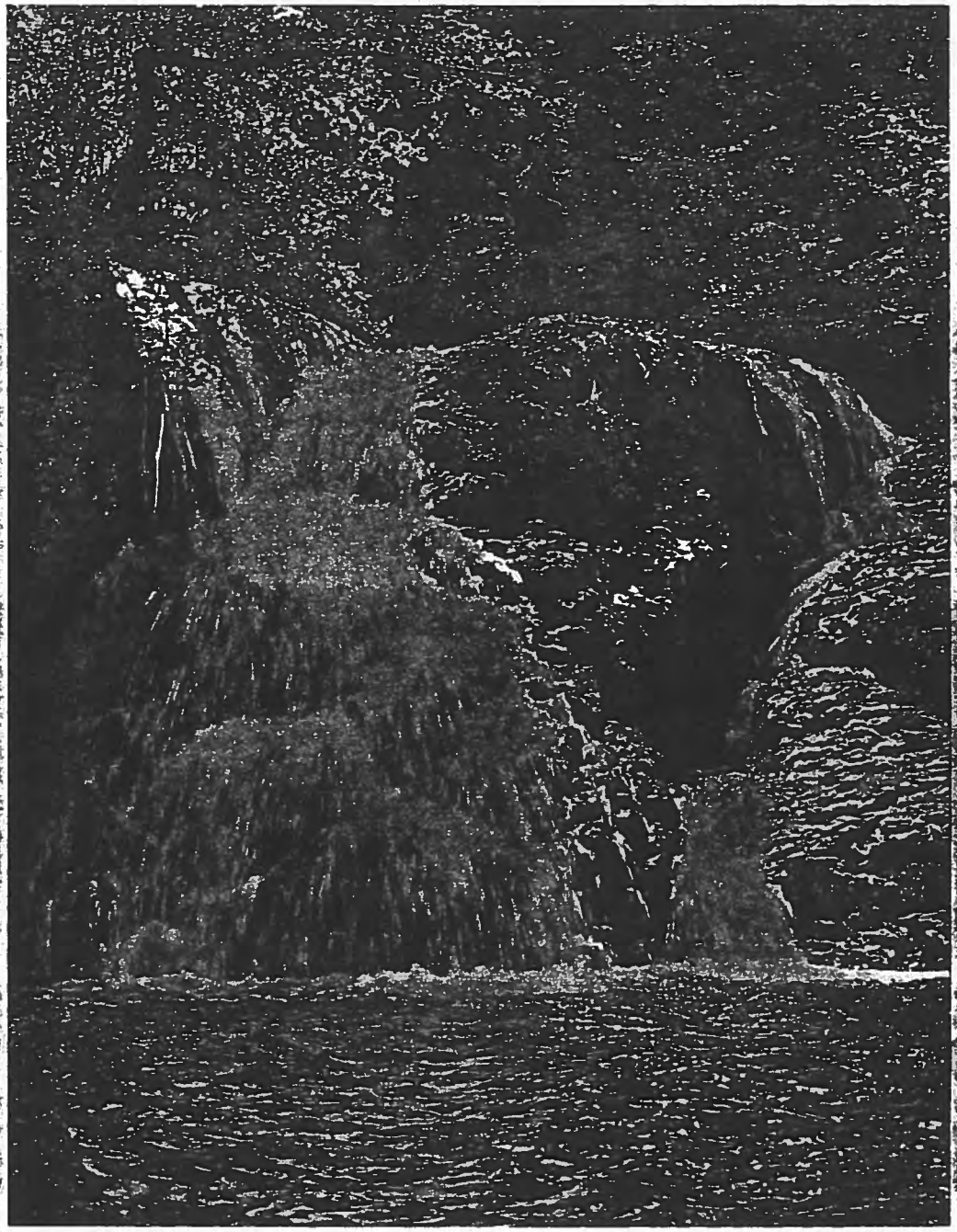
Baker County's mineral production from 1961 through 1964 amounted to approximately $4,714,000 per year. The commodities contributing to this total, listed in decreasing order of value, consisted of cement, stone, lime, clay, sand and gravel, gold, silver, and tungsten.

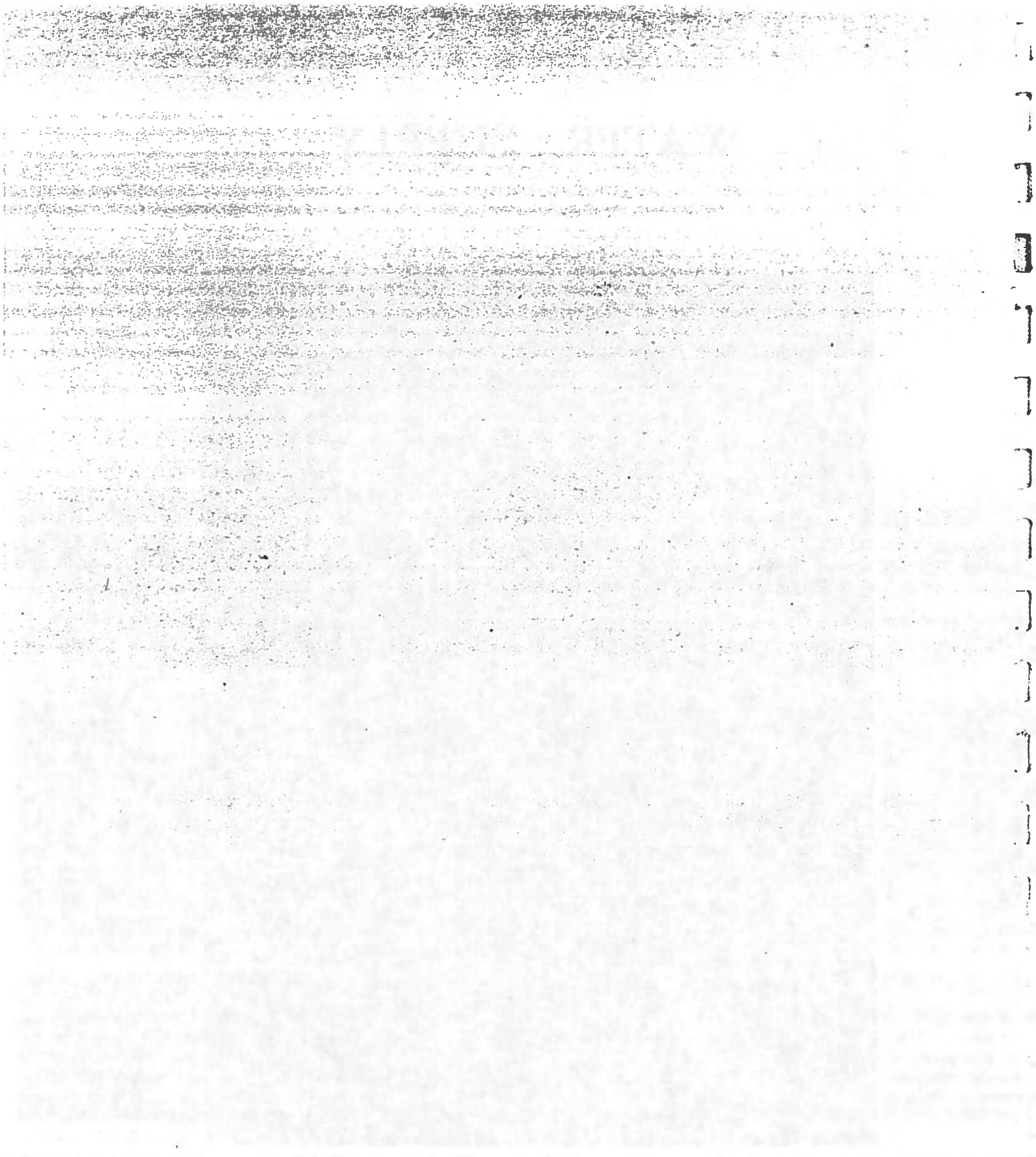
High-quality antinomy was mined several miles east of Baker during both World Wars. Manganese, another mineral mined domestically during periods of national emergency, occurs in small deposits near Pleasant Valley, Durkee, and on Dooley Mountain near the head of Coronet Creek. The inactive Iron Dike copper mine at Homestead is reported to have substantial reserves of good-grade ores that could be mined in times of critical need.

Several nonmentallic minerals, for the most part unexploited in the basin, likewise, have potential economic value. Deposits of diatomite, deemed extensive enough to mine under more favorable economic conditions, occur near Keating. Talc and perlite occur in commercial quantities on Dooley Mountain. The perlite satisfactorily met expansibility tests and is reported to be scheduled for commercial use. Recent investigations indicate that certain rock occurrences may have good pozzolanic properties and, therefore, merit consideration for use in retarding the generation of heat during the drying process of concrete. A good potential, likewise, exists for an increase in the production of building stone.

Little oil and gas exploratory work has been done in the basin because of the general absence of rock suitable for the formation of oil. The deepest test well, of the five in the basin, was drilled just east of Unity to a depth of 1,700 feet about 1941.

WATER SUPPLY





Oregon State Highway Department photo

PART II

WATER SUPPLY

SURFACE WATER

Introduction

Flow characteristics of the Powder Basin streams are typical of streams of semiarid regions. Extreme differences exist in both seasonal flows and annual yields as depicted in the following tables and graphics.

The determinations of stream yields, monthly distributions, and extreme discharges are based primarily on U. S. Geological Survey-State Engineer stream gaging records. All active and inactive hydrological stations are shown by locations on Plate 2. Table A of the Appendix lists these stations by name, location, type, and period of record. In addition to numerous long-term records, many short-term and miscellaneous records were analyzed during the basin study. Measurements considered in the two latter categories were made by the U. S. Geological Survey, U. S. Soil Conservation Service, and the State Engineer. A few of the records and duration of measurements considered are: Pine Creek above Carson, five years; Eagle Creek above New Bridge, seven years; Powder River near Robinette, 29 years; Powder River near Baker, 57 years; and Burnt River near Hereford, 36 years. A representative list of gaging records appears in Table 13.

The Powder Drainage Basin map on Plate 1 of the Appendix locates numerous springs distributed mainly in the desert portions of the basin. These springs are important as sources of domestic, irrigation, wildlife, and fish life water supplies.

Base Period

In order to determine the streamflow regimen of the major streams within the basin, a representative base period was selected. This period (1935-64) is of 30-year duration with the mean annual precipitation for this period being nearly equal to the 1889 to 1964 precipitation mean at Baker. This period includes a proportionate share of wet and dry years based on 75 years of precipitation and 57 years of streamflow records for Powder River near Baker.

Runoff

Maximum, minimum and average annual runoff of most principal or economically important streams of the basin are listed in Table 13. The average annual base period outflow for the

TABLE 13

MINIMUM, MAXIMUM, AND AVERAGE ANNUAL RUNOFF
OF PRINCIPAL STREAMS 1935-64

STREAM	USGS GAGE NO.	DRAINAGE AREA Sq. Mi.	COMPLETE WATER YEARS OF RECORD	ANNUAL RUNOFF			
				MINIMUM Acre-feet	MAXIMUM Acre-feet	AVERAGE Acre-feet	Inches
Pine Creek at Bridge above Carson		33	5	21,500*	114,200*	63,700*	36.1
Pine Creek at Mouth		313	-	-	-	200,000**	12.0
Powder River near Baker	2755	219	57	36,300	130,000	79,600	6.8
Powder River near Haines	2815	572	7	-	-	74,300*	2.4
Rock Creek near Haines		21	35	13,130	39,100	19,400	17.3
North Powder Subbasin 2-C		342	-	-	-	93,000**	5.4
Wolf Creek near North Powder	2840	33	12	6,500*	24,500*	15,400*	8.8
Powder River near Richland	2867	1,310	7	25,000*	333,900*	167,900*	2.4
Eagle Creek above Skull Creek near Newbridge	2882	156	7	133,000**	310,300*	240,700*	28.9
Eagle Creek at Mouth		195	-	133,000**	325,000**	243,000**	23.4
Powder River at Robinette	2895	1,660	29	192,900*	674,600*	412,100*	4.7
Burnt River near Hereford	2730	309	36	30,800	107,100	61,300	3.7
Burnt River near Bridgeport	2742	650	8	24,300*	150,000*	74,600*	2.2
Burnt River at Huntington	2750	1,093	9	21,400*	206,800*	95,600*	1.6

* Gaging records extended.
** Estimated
Data Source: USGS Water Supply Papers and SWRB correlations.

Powder Basin is about 700,000 acre-feet. The major contributing streams are Eagle Creek with 243,000 acre-feet, Pine Creek 200,000 acre-feet, Powder River 168,000 acre-feet, and Burnt River 96,000 acre-feet. The table includes information on drainage areas and water years of record for each gage. It also indicates the extreme variations in runoff from the averages.

The highest annual discharge of record for the Powder River near Baker was 130,000 acre-feet for the 1956 water year, and the lowest was 29,200 acre-feet during the 1934 water year. In general, a period of low-water years can be observed during the 1930's and a period of high-water years during the late 1940's and 1950's. The minimum discharge year for most Powder Basin streams was 1931. Selected stream runoff records are presented in Table 14, page 38.

Figure 11 shows the annual runoff of Powder Basin streams.

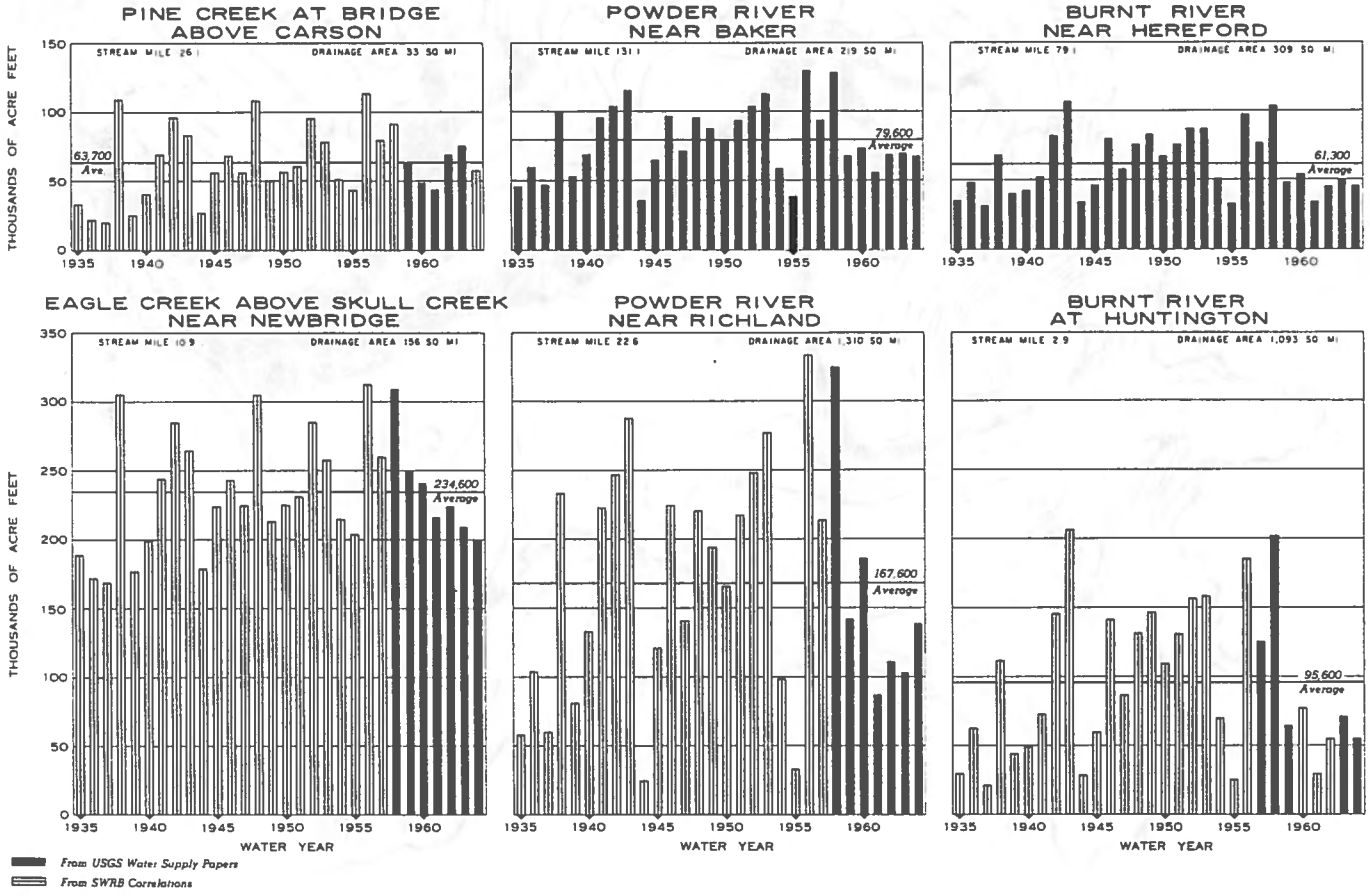


FIGURE 11. Annual Runoff of Selected Streams

The runoff patterns for all streams are considerably more uniform before they reach large irrigated areas where they are altered by diversions.

The graphs show that either 1937 or 1944, depending upon the stream, was the base period low-water year in the basin, with 1955 also very low. They show a definite need for carryover storage on Pine Creek, Powder River, and Burnt River. The lowest water years in sequence were 1930 through 1940.

The Powder Basin precipitation and runoff patterns are illustrated in Figure 12.

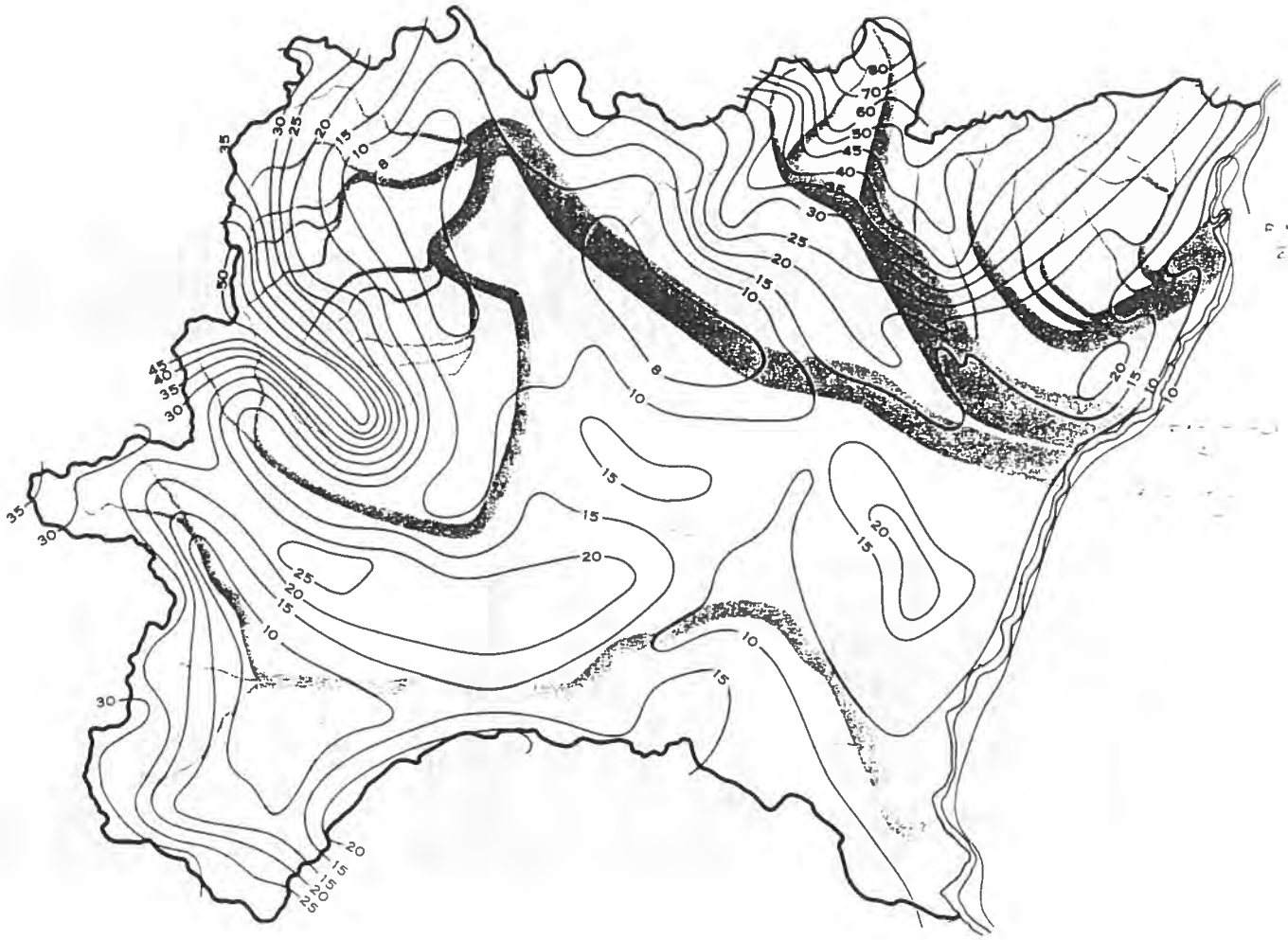


FIGURE 12. Average Annual Precipitation and Runoff.

Runoff decreases rapidly moving from northern and western

mountain areas to the southern and eastern portions of the basin due to rapidly decreasing rainfall.

Figure 13 is a long-term (1905-64) annual runoff graph for

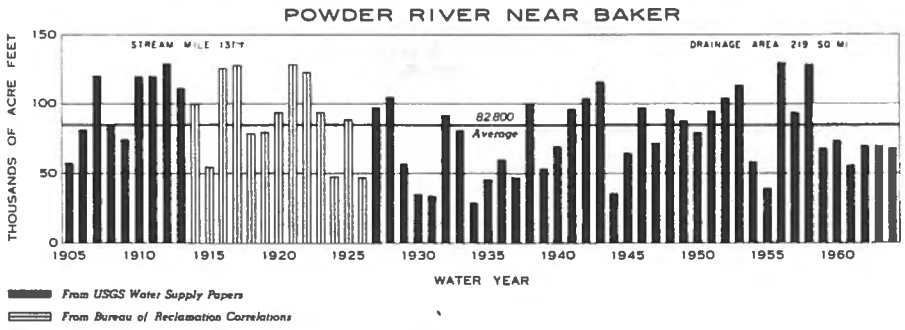


FIGURE 13. Long-Term Annual Runoff of Powder River near Baker

the Powder River near Baker. This bar graph illustrates the wide variation in annual runoff during the period of record.

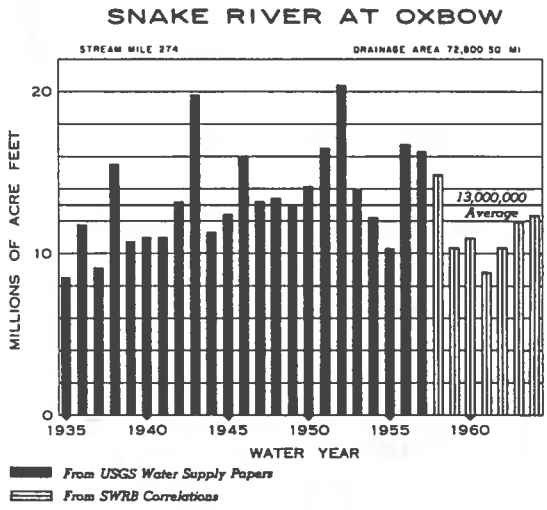


FIGURE 14. Annual Runoff of Snake River at Oxbow

Figure 14 shows the base period annual runoff of the Snake River at Oxbow. At Snake River stream mile 274, the average annual runoff is 13 million acre-feet. The variation is from 8.5 to 20.5 million acre-feet annually.

The U. S. Bureau of Reclamation has used the above long-term gage records to determine the storable runoff that may be expected at Mason Dam, which is now under construction. Calculations from their data indicate that the storable runoff will average about 71,000 acre-feet annually but that extreme variations will be from 25,000 to 120,000 acre-feet.

Seasonal Distribution

The average monthly recorded and correlated discharges at selected stations is shown in Table 14.

TABLE 14

AVERAGE MONTHLY AND ANNUAL DISCHARGE
AT SELECTED LOCATIONS
1935-64

SREAM	USGS GAGE NO.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	ANNUAL
Pine Creek at Bridge above Carson		24	32	33	27	22	32	120	260	370	84	31	19	88
Pine Creek at Mouth		75	100	100	85	68	100	410	910	1,300	130	26	13	276
Powder River near Baker	2755	14	25	40	38	60	140	340	360	230	47	14	10	110
Rock Creek near Haines (CPUC Intake)		8.7	8.7	8.1	7.3	7.8	8.8	28	83	95	37	20	8.8	27
Wolf Creek near North Powder	2840	2	3.6	6	5	6.3	18	88	94	24	5	1.5	1.5	21
Powder River near Richland	2867	38	51	100	140	270	460	770	430	340	71	66	48	232
Eagle Creek above Skull Creek near Newbridge	2882	110	140	140	110	120	170	510	1,000	1,000	380	140	100	327
Burnt River near Hereford (1935-37 records adjusted for storage)	2730	34	21	26	25	29	76	260	170	120	93	99	68	85

Data Source: U.S. Geological Survey and SWRB Correlations.

The pattern of seasonal distribution of runoff in the basin generally is typical of the semiarid regions which are influenced by snowmelt. Figure 15 illustrates the seasonal distribution of the Powder River near Baker and the Burnt River near Hereford. The peak months of discharge for these two rivers are April, May, and June. These three months account for 55 to 80 percent of the basin's annual runoff. The month of maximum discharge varies between April and June depending upon the percentage of the watershed area that is in the higher elevations and thus has a later snowmelt.

The Burnt River pattern shows the effects of releases from Unity Dam during July, August, and September. Powder River, without appreciable upstream storage, shows very low flows during the summer high-use period. Similar graphics on Eagle and Pine Creeks would show higher base flows and more subdued discharge peaks.

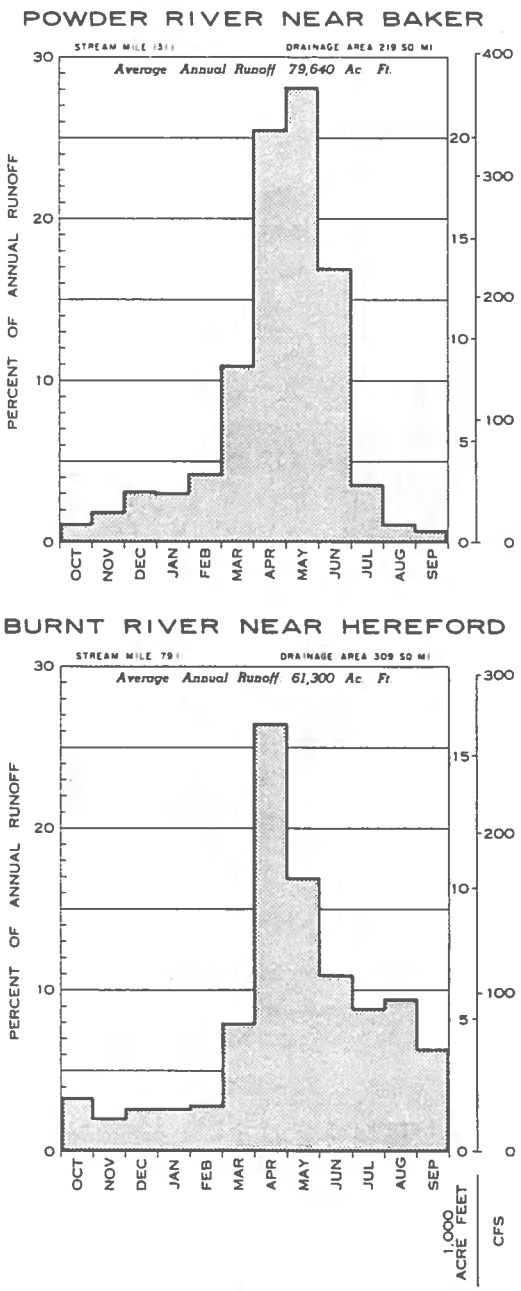


FIGURE 15. Monthly Distribution of Annual Runoff

Extreme Discharges

Outflow is rapid during late winter and spring when heavy spring rains melt the winter snowpack. The basin is also subject to summer cloudburst storms which result in short periods of heavy discharge, but the volume of runoff is quite small.

Two years of records on Pine Creek above North Pine Creek show maximum flows of 1,285 cfs in February 1924 and minimum flows of 4 cfs in August 1924. Correlated records indicate the probability of zero minimum flows on Pine Creek.

Only a portion of such wildly fluctuating floodflows can be economically stored to contribute, subsequently, to greater water-use efficiency.

Streamflow records for Burnt River before Unity Dam was constructed and for tributaries of upper Powder River are quite similar to the pattern shown in Figure 16, with short periods of floodflows, and long periods of low flows. Due to reservoir releases and different watershed characteristics, Eagle and Pine Creeks display a more uniform runoff rate.

The extreme differences in daily flows of Powder River above Baker during the base period low-water year of 1944 are illustrated in Figure 16.

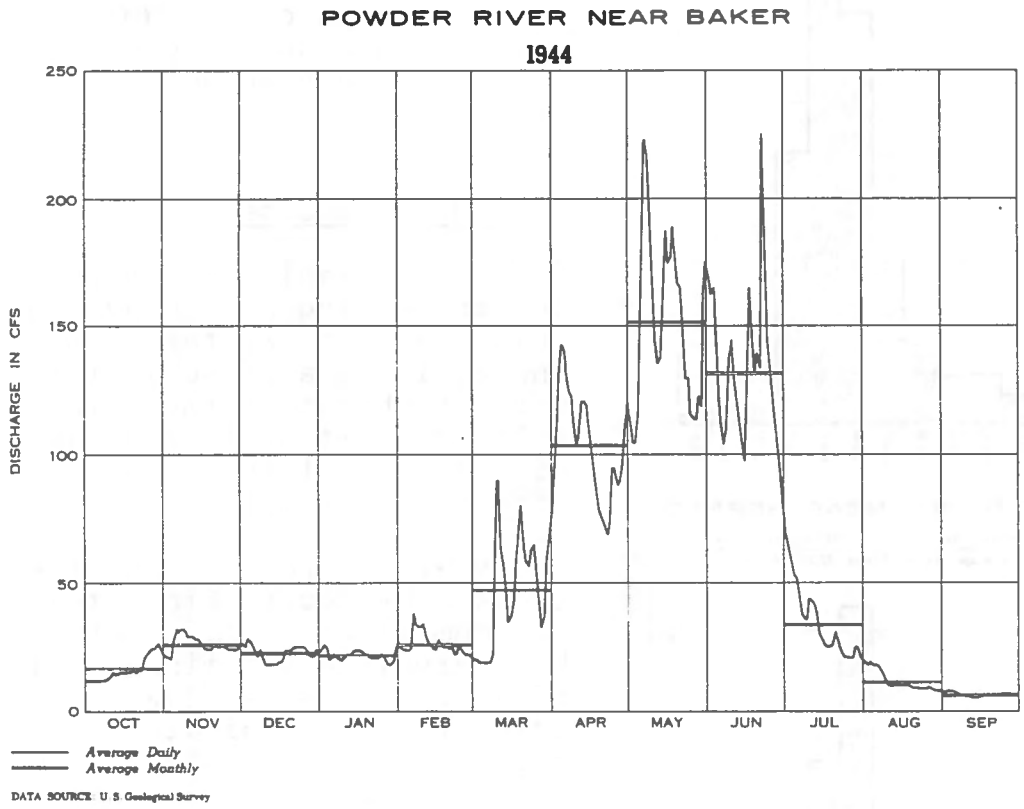


FIGURE 16. Extreme Fluctuations in Daily Flows of the Powder River near Baker

The above hydrograph illustrates the relationship of the average monthly flows to the daily fluctuations. It can be seen that the monthly averages result from wide fluctuations in daily discharge during spring flood periods.

Records between 1958 and the present for Eagle Creek above Skull Creek at Gage No. 2882 show a maximum runoff of 2,690 cfs on May 27, 1958 and a minimum of 50 cfs on January 3, 1964. Correlated records indicated the minimum flows above the farmland would be less than the recorded figures stated above. Inventory surveys conducted by the Fish Commission

of Oregon in 1958 and 1959 indicated dry sections in the lower Eagle Creek channel during much of the irrigation season.

Powder River near Robinette had a maximum flow of 5,500 cfs on May 27, 1956 and a minimum flow of 18 cfs on September 2 to 10, 1931. This gaging location was inundated in 1958 by Brownlee Pool. Eagle Creek flows now enter the pool rather than Powder River. Recorded extreme discharges on Powder River at USGS Gage No. 2755 show zero minimum flows on August 31, 1909 and September 7, 1931, with a maximum discharge of 1,820 cfs on March 20, 1910. For the 1935-64 base period, minimum flows were 0.55 cfs and maximum flows were 833 cfs.

In 1931, before construction of Unity Reservoir, Burnt River at Huntington had zero flows during August, September, and October. The maximum recorded flow was 2,190 cfs on February 26, 1957.

Practically all other Burnt River tributary streams and streams flowing directly into the Snake River have zero minimum flows in some sections of their channels according to information gathered from field surveys.

Table 15 lists available minimum and maximum instantaneous recorded discharges at 52 stream locations within the basin. It should be noted that many of these streams have very short or intermittent periods of record.

TABLE 15

EXTREMES OF DISCHARGE OF RECORD
AT STREAM GAGING STATIONS

STATION	GAGE NO.	YEARS OF RECORD	MINIMUM Cfs	MINIMUM Date	MAXIMUM Cfs	MAXIMUM Date
PINE MISC.						
Pine Creek at Bridge above Carson near Halfway	-	1958-64	7*	10- 7-60	1,450	6- 3-59
Pine Creek near Halfway at Ansons Bridge	-	1923-24	0.5	10 - 23	496	5 - 24
Clear Creek near Halfway near Mouth	-	1923-24	1.1	6 - 24	200	6 - 23
East Pine Creek near Halfway	-	1960-64	3.8*	9-14-61	230	5-25-61
East Pine Creek near Mouth	-	1923-24	0*	8 - 24	92	6 - 23
Dry Creek near Halfway	-	1923-24	0*	8 - 24	30	6 - 23
Pine Creek near Halfway at Brokaws Ranch	-	1923-24	4	8 - 24	1,285	2 - 24
Fish Creek near Halfway near mouth	-	1923	0.1	7 - 23	14	6 - 23
POWDER						
McCully Fork of Powder River near Sumpter	(1531)	1927	0.8	8 - 27	21	6 - 27
Cracker Creek at Sumpter	(1530)	1927	5.8	9 - 27	-	-
Clear Creek near Sumpter	(1535)	1927	0.4**	9 - 27	-	-
Deer Creek near McEwen	(1532)	1927	5	8 - 27	-	-
Alder Creek at McEwen	(1534)	1927	1**	9 - 27	-	-
Miners Creek near McEwen	(1533)	1927	1.2**	8 - 27	7.4	6 - 27
Powder River near Baker	2755	1904-14, 1926-64	0*	9- 7-31	1,820	3-20-10
Powder River at Baker	2770	1913-14	0*	9-11-13	748*	5-27-13
Pine Creek near Baker	2775	1913-14, 1929-30	1.5**	2 - 29	203	5-27-13
Goodrich Creek near Baker	2780	1913	0.5	9-30-13	15.8	5-28-13
Mill Creek near Baker	2790	1913-14, 1929-30	0*	-	-	-
Marble Creek near Baker	2795	1913-14, 1929-30	0.7*	9-26-28	15.5	5-30-13
Salmon Creek near Baker	2800	1913-14, 1929	0.1	7-29-13	47*	5-27-13
Willow Creek near Haines	2805	1913	1.4*	9-30-13	11.1	6-11-13
Powder River at Haines	2810	1914	6*	7-26-14	330	5-29-14
Rock Creek near Haines	(1523)	1913-14, 1929-30	0*	7 - 30	-	-
Powder River near Haines	2815	1947-53	0*	8-13-52	1,300*	6- 8-48
Anthony Fork below North Fork near North Powder	2824	1963-64	9.8*	11-27-63	256	6- 6-64

TABLE 15

EXTREMES OF DISCHARGE OF RECORD
AT STREAM GAGING STATIONS
(Continued)

STATION	GAGE NO.	YEARS OF RECORD	MINIMUM Cfs	MINIMUM Date	MAXIMUM Cfs	MAXIMUM Date
POWDER - Continued						
Anthony Fork near North Powder	2825	1912	2*	10- 8-12	387	6- 7-12
North Powder River at North Powder	2830	1912-14	0.1*	7-26-14	1,150	5-28-14
Wolf Creek near North Powder	2840	1947-53, 1954-64	0.2*	8- 5-51	460	5-11-58
Powder River near North Powder	2845	1913-16, 1920-25	1**	7-11-24	3,010*	5-20-21
Powder River below Thief Valley Reservoir near North Powder	2855	1909-12, 1932	0*	8- 9-10	2,920	3-21-10
Big Creek below Burn Creek near Medical Springs	2859	1963	0*	7-14-63	28	5-14-63
Big Creek near Medical Springs	2860	1913-14	0*	6-18-13	435	4-15-14
Goose Creek near Keating	2865	1913-14	0*	8- 8-14	164	4-15-14
Powder River near Richland	2867	1958-64	11	9-13-61	2,210	5-24-58
Eagle Creek above Skull Creek near Newbridge	2882	1958-64	50	1- 3-64	2,690	5-27-58
Powder River near Robinette	2895	1929-57	18*	9- 2-31	5,500	5-27-56
BURNT						
North Fork Burnt River near Whitney	2693	1964	0.9*	8-27-64	47	6-25-64
North Fork Burnt River at Audrey	2695	1915-17	0.3*	8-22-15	585	4-25-16
Middle Fork Burnt River near Audrey	2700	1915-16	0.3*	8- 1-16	-	-
South Fork Burnt River near Unity	2705	1915-16	10*	10-26-15	76	4-28-16
South Fork Burnt River above Barney Creek near Unity	2708	1963-64	14	11-21-63	61	5-20-64
South Fork Burnt River at Hardman Ranch near Unity	2710	1916-20, 1938-41	11*	9-29-19	85	4-20-38
Sawmill Creek near Unity	2720	1915	0*	6-15-15	-	-
Burnt River near Hereford	2730					
before Unity Reservoir		1915-16, 1929-38	1.6	8-31-35	1,510	4-14-36
after Unity Reservoir		1938-64	0*	-	2,220	4-17-43
Camp Creek near Hereford	2735	1915	0*	-	-	-
Burnt River at Bridgeport	2740	1915-16, 1931-36	0*	-	1,280	4-12-16
Burnt River near Bridgeport	2742	1957-64	9	1-12-63	1,270	2-26-57
Burnt River near Durkee	2745	1931-38	0*	-	1,290	4-15-36
Burnt River at Huntington	2750	1929-32, 1957-59, 1962-64	0*	-	2,190	2-26-57

*Given discharge occurs on more than one date.
**Estimated.

Note: Gage No. in parentheses referes to numbering system prior to Sept. 30, 1951.

Water Rights and Depletions

Basin water rights for irrigation using surface water are based on a flow of one-fortieth of a cfs not to exceed three and one-half acre-feet per acre during the irrigation season, except where otherwise specified. Livestock rights are based on one-fortieth of a cfs per 1,000 head continuous throughout the year, except where otherwise specified. Rights are contingent upon beneficial use and are ranked in order of priority; first in time, first in right. Date of priority for adjudicated rights stems from the date the use was initiated; for permit rights, from the date the application for permit was filed with the State Engineer.

The State Water Resources Board prepared and has on file separate Powder Basin water right compilation sheets which list all rights by stream, diversion point, priority date, and use.

Legal annual surface water depletions are shown in Table 16.

TABLE 16

LEGAL ANNUAL
SURFACE WATER DEPLETIONS
October 31, 1965
Acre-feet

STUDY AREA	CONSUMPTIVE						NONCONSUMPTIVE					TOTAL DEPLETION
	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	Acres	TOTAL	POWER	MINING	FISH	RECREATION	TOTAL	
1. PINE MISC.												
(a) North Pine	811	0	0	9,577	2,368	10,388	0	0	0	0		10,388
(b) Pine	20,326	362	0	48,908	17,003	70,597	9,796	65,884	0	0	75,680	146,277
(c) Snake Misc.	432	58	1,882	4,484	1,281	6,856		3,258	0	0	3,258*	10,114*
Total	21,569	420	1,882	63,970	20,652	87,841	9,796*	69,142	0	0	78,938*	166,779*
2. POWDER												
(a) Eagle	16,070	724	145	67,831	19,380	84,770	19,888	101,519	2,172	0	123,579	208,349
(b) Keating	6,587	0	0	90,706	25,916	97,272	181	3,837	0	181	4,199	101,471
(c) North Powder	14,328	1,448	10,245	155,885	50,035	181,906	40,645	23,168	30	203	64,046	245,952
(d) Middle Powder	23,038	41,774	116	173,953	49,701	238,881	2,172	22,263	14	0	24,449	263,330
(e) Upper Powder	3,417	52,056	0	22,282	6,366	77,755	7,602	17,159	0	0	24,761	102,516
Total	63,420	96,002	10,506	510,656	151,398	680,584	70,488	167,946	2,216	384	241,034	921,618
3. BURNT												
(a) Lower	9,716	0	2,534	25,015	8,338	37,265	724	79,807	0	0	80,531	117,796
(b) Upper	8,395	0	0	59,144	19,715	67,539	0	108,817	0	0	108,817	175,356
Total	18,111	0	2,534	84,159	28,053	104,804	724	188,624	0	0	189,348	294,152
TOTAL	103,100	96,422	14,922	658,785	200,103	873,229	81,008*	425,712	2,216	384	509,320*	1,382,549*

*Excludes 36,924,000 acre-feet for power at Oxbow and Brownlee on Snake River.

Data Source: Oregon State Engineer.

Tables 16 and 17 summarize these compilations by basin area and use.

Basin water rights, excluding Snake River rights, would permit an annual maximum legal depletion of 1,382,549 acre-feet,

which is considerably greater than the estimated 893,000 acre-feet historical average annual available yield. About 300,000 acre-feet of yield occurs in Eagle and Pine Creeks, which presently is uneconomical to develop.

Basin surface water rights total 5,479 cfs, of which 4,775 cfs are for consumptive uses (domestic, municipal, industrial, and irrigation) and 704 cfs are for nonconsumptive uses (power, mining, fish life, and recreation). In addition, nonconsumptive power rights on the Snake River amount to 51,000 cfs.

Table 17, surface water right summary, lists water rights in

TABLE 17

SURFACE WATER RIGHTS SUMMARY
October 31, 1965
Cfs

STUDY AREA	CONSUMPTIVE						NONCONSUMPTIVE					TOTAL RIGHTS
	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	Acres	TOTAL	POWER	FISH	MINING	RECREATION	TOTAL	
1. PINE MISC.												
(a) North Pine	1.12	0	0	40.19	2,367.50	41.31	0	0	0	0	0	41.31
(b) Pine	28.07	0.50	0	394.39	17,002.53	422.96	13.53	0	91.00	0	104.53	527.49
(c) Snake Misc.	0.60	0.08	2.60	22.77	1,281.28	26.05	0	0	4.50	0	4.50*	30.55*
Total	29.79	0.58	2.60	457.35	20,651.31	490.32	13.53*	0	95.50	0	109.03*	599.35*
2. POWDER												
(a) Eagle	22.20	1.00	0.20	359.80	19,380.34	383.20	27.47	3.00	140.22	0	170.69	553.89
(b) Keating	9.07	0	0	555.83	25,915.76	564.90	0.25	0	5.30	0.25	5.80	570.70
(c) North Powder	19.79	2.00	14.15	1,136.61	50,035.20	1,172.55	56.14	0.04	32.00	0.28	88.46	1,261.01
(d) Middle Powder	31.82	57.70	0.16	1,159.55	49,700.84	1,249.23	3.00	0.02	30.75	0	33.77	1,283.00
(e) Upper Powder	4.72	71.90	0	153.83	6,366.49	230.45	10.50	0	23.70	0	34.20	264.65
Total	87.60	132.60	14.51	3,365.62	151,398.63	3,600.33	97.36	3.06	231.97	0.53	332.92	3,933.25
3. BURNT												
(a) Lower Burnt	13.42	0	3.50	198.97	8,338.30	215.89	1.00	0	110.23	0	111.23	327.12
(b) Upper Burnt	11.60	0	0	457.22	19,714.58	468.82	0	0	150.30	0	150.30	619.12
Total	25.02	0	3.50	656.19	28,052.88	684.71	1.00	0	260.53	0	261.53	946.24
TOTAL	142.41	133.18	20.61	4,479.16	200,102.82	4,775.36	111.89*	3.06	588.00	0.53	703.48*	5,478.84*

*Excludes 51,000 cfs Idaho Power Company rights on Snake River.

Data Source: Oregon State Engineer.

the basin by location and use. A more detailed summary is shown in Table F of the Appendix.

The 142 cfs or 103,100 acre-feet of water rights for domestic purposes are considerably above present use due to generous allocations given early appropriators. Surface water rights have been obtained for the irrigation of 200,103 acres but only about 135,000 acres are actually irrigated in an average year due to water shortages. The rights of 112 cfs for power and 588 cfs for mining, shown in Table 17, greatly exceed present power and mining usage.

Hydrological computations reflect the fact that 60 to 80 percent of the outflow is from short duration floods during a 2-3 month period. In considering effective use, it is necessary to consider the wide daily variation in flow, illustrated by the daily discharge hydrograph of Powder River near Baker, Figure 16. Many of the high flows each year exist at times and places where full use is impractical. A large percentage of irrigators have rights to only floodwater which supplies but a small portion of the total needs. In poor water years, annual flows are frequently less than one-half the long-term mean flows.

Pine area (1) - Figure 17 illustrates the Pine Creek average annual natural (before human use) yield, in blue, as compared to total annual depletion authorized by legal rights, in red. The excess of the 220,000 acre-feet of natural average annual yield from Pine Creek and its tributaries over the 156,000 acre-feet of legal annual depletions is a measure of unappropriated water, water available for use. There are, in addition, about 10,100 acre-feet of rights from small streams that flow directly into Snake River. The largest water rights in Pine area are for irrigation in the amount of 457.4 cfs or 63,970 acre-feet. Other rights are for domestic, municipal, and industrial uses in the amount of 32.9 cfs or 23,871 acre-feet, power in the amount of 51,000 cfs on Snake River and mining in the amount of 95.5 cfs.

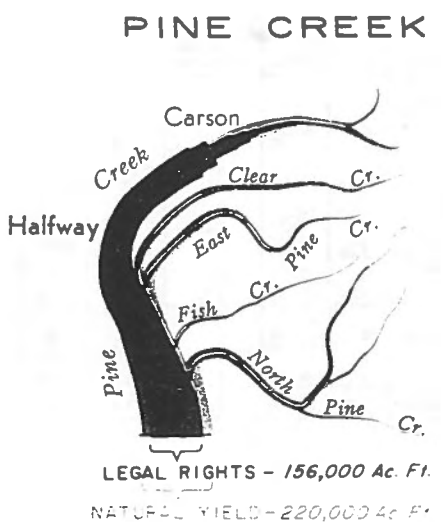


FIGURE 17. Average Natural Yield versus Legal Rights, of the Pine Creek Stream System.

All streams in the valley portions are overappropriated seasonally to the point that the only practical sources of additional surface supplies are in headwater streams for nonconsumptive purposes, storage of unappropriated spring flows, and small quantities of return flows in the lower canyon section.

North Pine Creek is overappropriated seasonally due to interbasin withdrawals of all available water from most higher

headwater streams by three irrigation canals. East Pine Creek has mean minimum summer flows of about 6 cfs due to interbasin streamflow augmentation. Clear Creek, above farmlands, has summer flows of about 16 cfs. Upper Pine Creek has rights which are greater than the natural flow.

Eagle Area (2a) - Figure 18 illustrates the average annual natural yield, in blue, as compared to the total annual depletion authorized by legal rights, in red, for Eagle Creek. Here, as in Pine Creek, average annual runoff, 245,000 acre-feet, exceeds the legal annual depletion, 180,000 acre-feet, indicating unappropriated water available for use. Water is obtained also from small south side streams and Brownlee Pool.

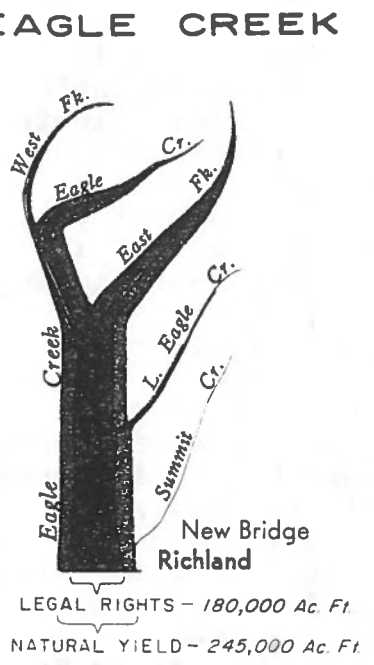


FIGURE 18. Average Natural Yield versus Legal Rights, of the Eagle Creek Stream System.

The largest surface water rights in the Eagle area are for irrigation in the amount of 359.8 cfs or 67,831 acre-feet. Domestic water rights are for 22.2 cfs or 16,070 acre-feet.

Mining water rights amount to 140.2 cfs. According to the watermaster, the mines to which these rights are appurtenant have not been in operation for five or more years. Some water is used, however, by prospectors and claim holders. As shown in Figure 18, a fairly large right exists on upper Eagle Creek with its diversion point in the Boulder Park area. This is the diversion point for the long abandoned Sparta ditch, which was constructed for mining purposes. Other large mining rights remain on the records with diversion points located near the mouth of East Fork and on Eagle Creek near its junction with the East Fork. A private fish right for 3 cfs exists on upper Eagle Creek.

All streams are overappropriated seasonally in the valley portions to the point that the only practical sources of additional supplies are in headwater streams for nonconsumptive purposes, storage of unappropriated spring flows, and pumping from Brownlee Pool.

Figure 19 graphically presents 30 years of annual natural yield together with the legal annual rights on Eagle Creek for the same period. Natural yield, as shown by the bar graph, is greater every year then the legal rights to the use of this water. As shown on this bar graph and the previous tree graph (Figure 18), there are surplus waters in Eagle Creek and larger tributaries for other beneficial uses.

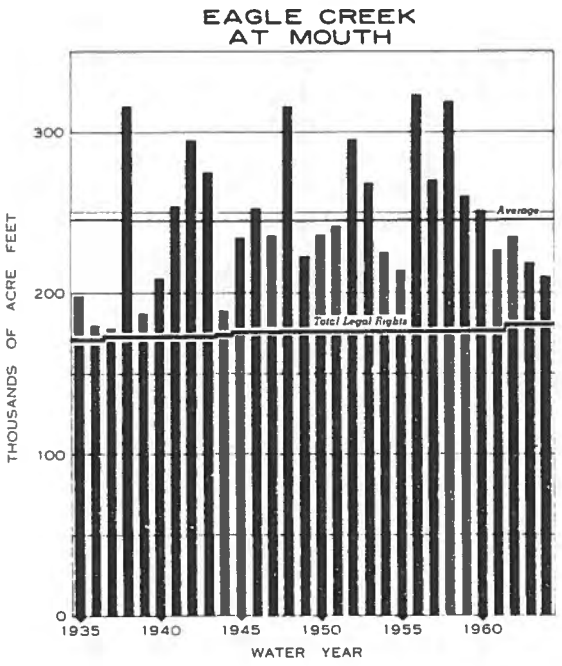


FIGURE 19. Annual Natural Yield versus Legal Rights, Eagle Creek at Mouth.

The 30-year natural yield varied from 180,000 to 323,000 acre-feet and averaged 245,000 acre-feet. With 1964 rights slightly under 180,000 acre-feet, the graph shows an average of 65,000 acre-feet available for other beneficial uses. For only two years in the 1930's were rights and natural yield in close proximity. There are about 106,000 acre-feet of power and mining rights on Eagle Creek subject to reconsideration in the near future. When these rights are reviewed and acted upon, there will be additional water available locally for appropriation and use.

Upper Eagle Creek, above USGS-State Engineer Gage No. 2882, and some of its higher elevation tributaries have substantial quantities of surface flows. East Fork Eagle and Eagle Creeks, above the gage, have natural flows and a potential for such nonconsumptive uses as recreation and fish life.

Powder Area (2) - In Figure 20, page 49, the natural average annual yield for Powder River, 320,000 acre-feet, shown in blue, is seen to be less than half the total legal annual depletion, shown in red. Although the Powder area includes Eagle Creek, which formerly flowed into Powder River, the

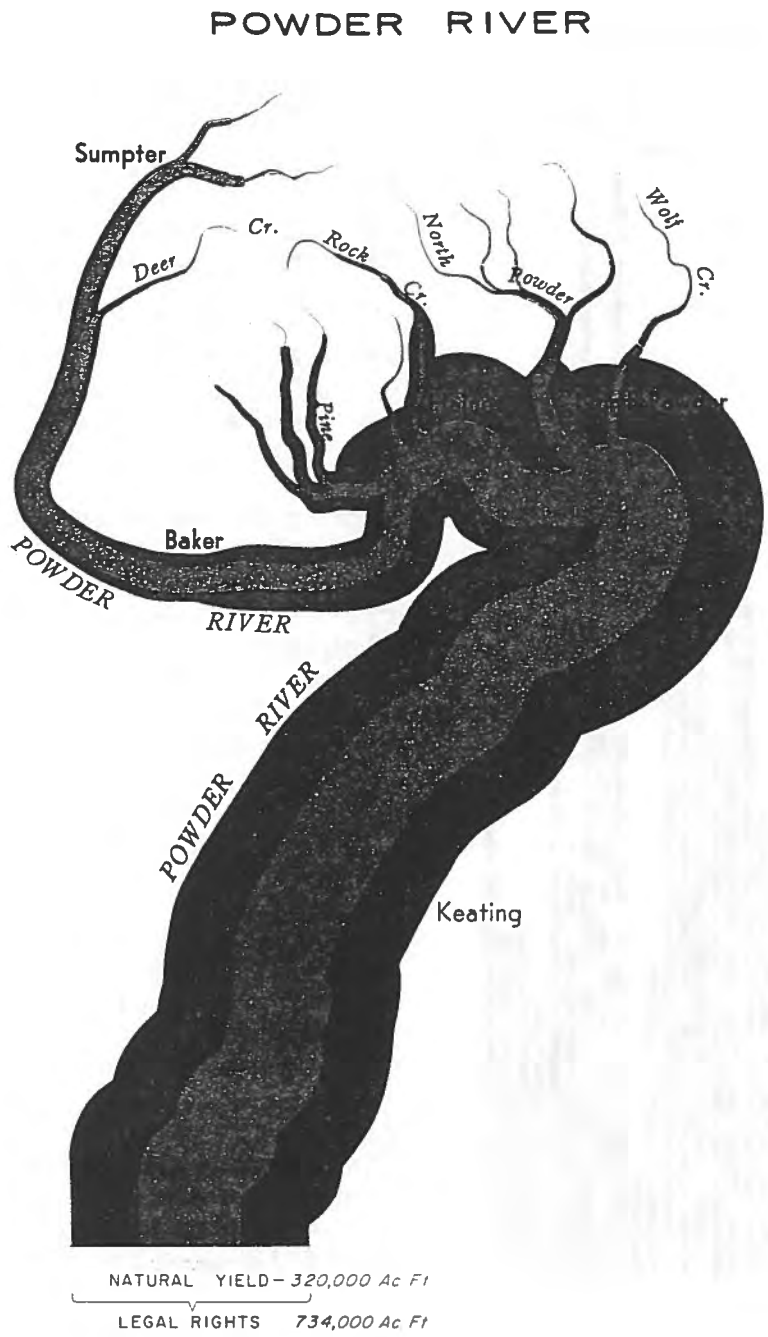


FIGURE 20. Average Natural Yield versus Legal Rights, of the Powder River Stream System.

runoff and consumptive-use figures are shown separately.

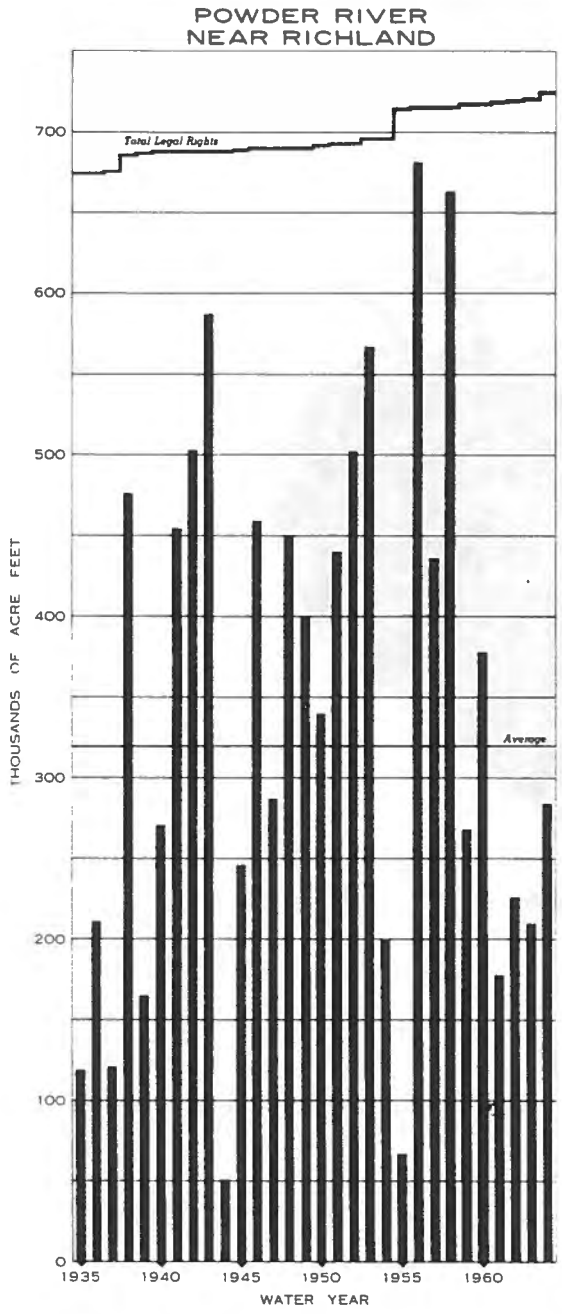


FIGURE 21. Annual Natural Yield versus Legal Rights, of Powder River near Richland.

The largest surface water rights are for irrigation in the amount of 3,006 cfs. Other rights include domestic, 65.4 cfs; municipal, 131.6 cfs; industrial, 14.3 cfs; and mining, 91.8 cfs. As reported for the Eagle Creek area, mining activity essentially is limited to work by prospectors and claim assessment work since the mines have been shutdown for many years.

Figure 21 graphically presents 30 years of annual natural yield and the legal rights on Powder River near Richland. Both the bar graph and the previous tree graph (Figure 20) show the legal depletion by existing water rights to exceed available water from the Powder River or its major tributaries.

Annual natural yield over the 30-year period varied from 50,000 acre-feet in 1944 to 680,000 acre-feet in 1956 and averaged 320,000 acre-feet. With 1964 rights equal to 734,000 acre-feet, the graph shows an average annual deficit of 414,000 acre-feet, for which no yield is available.

Keating Area (2b) - This area includes the lower Powder Irrigation District and the Big and Balm Creek areas. The largest surface water rights are for irrigation

in the amount of 555.8 cfs or 90,705 acre-feet. The other rights are for domestic purposes in the amount of 9 cfs or 6,567 acre-feet and for mining in the amount of 5.3 cfs. Mining activity is at a standstill except for sporadic prospecting.

The Big and Balm Creek portions of the Keating area are water-deficient areas which are dependent mainly upon inter-basin diversions from Catherine and West Eagle Creeks for their somewhat inadequate water supplies. None of the streams maintain summer flows through agricultural areas and the lower elevation headwater streams are depleted by early May of most years.

North Powder Area (2c) - The largest surface water rights are for irrigation in the amount of 1,137 cfs or 155,885 acre-feet. Other rights include domestic, 19.8 cfs or 14,328 acre-feet; municipal, 2 cfs or 1,448 acre-feet; and industrial, 14.1 cfs or 10,245 acre-feet.

All streams, in the valley portions and high in the watersheds, are overappropriated seasonally to the point where only floodflows are considered as surplus water. The 36 ditches, with decreed rights of 640 cfs, deplete most primary and return flow waters. The only practical source of additional surface water supplies is storage as outlined in the irrigation section of this report. Use of additional ground water for supplemental purposes is another possible source.

Middle Powder Area (2d) - The largest surface water rights are for irrigation in the amount of 1,160 cfs or 173,953 acre-feet. Other rights include domestic, 31.8 cfs or 23,083 acre-feet; municipal, 57.7 cfs or 41,774 acre-feet; and mining, 31 cfs. The lime plant north or Baker, using 1 to 2 cfs, was the only active mining operation reported in the area.

The Middle Powder area is a surface water-deficient area where large quantities of surface flows are lost annually to ground water. Ground water consumption in Baker Valley, about 50,000 acre-feet annually, is far below the estimated potential 30,000 to 75,000 acre-feet.

Most uncaptured flows of west side streams seep into the upper terrace gravel fans. Much of the floodflows in the

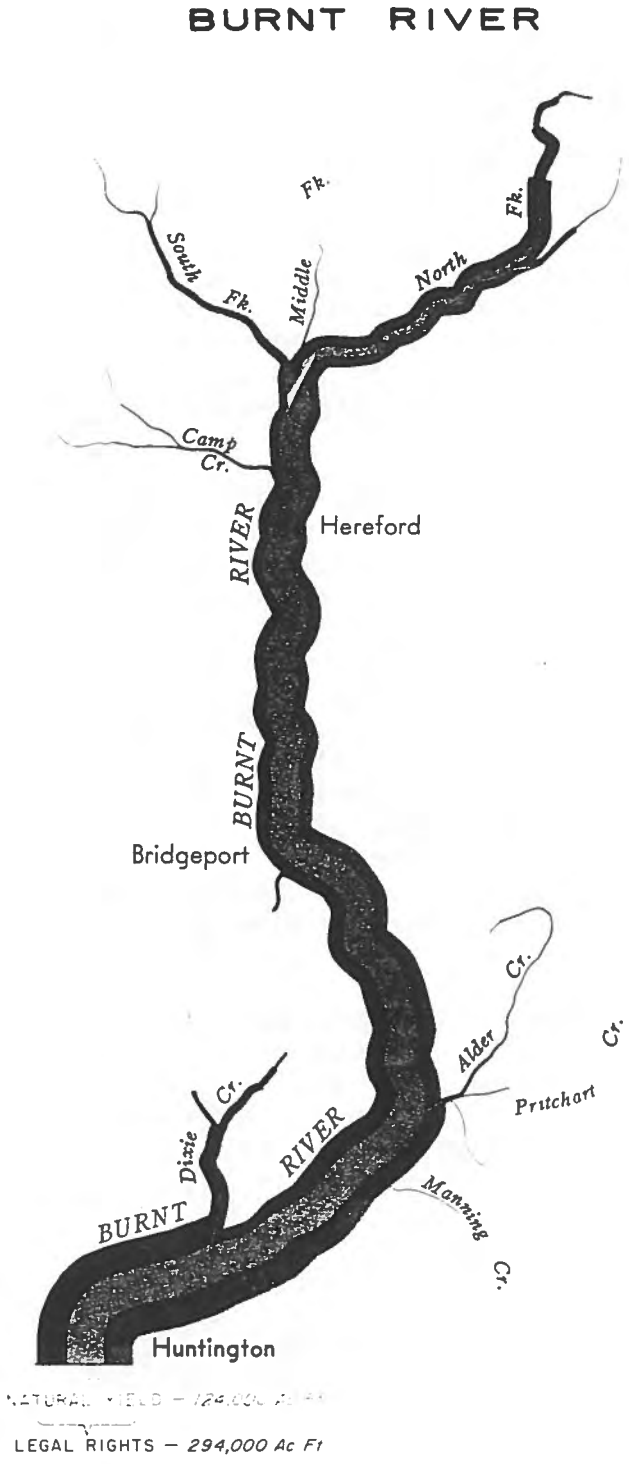


FIGURE 22. Average Natural Yield versus Legal Rights, of the Burnt River Stream System

valley bottom, plus flood irrigation releases, are added to the ground water causing a drainage problem on 17,000 acres.

Mason Reservoir, now under construction, will furnish irrigation water to 18,000 acres of irrigable lands, including some presently nonirrigated lands in the Lilley pump area. Small reservoirs in headwater streams and ground water are the other available sources.

Upper Powder Area (2e) - The largest surface water rights are for irrigation in the amount of 153.8 cfs or 22,282 acre-feet. Other rights include domestic, 4.7 cfs or 3,417 acre-feet; municipal, 71.9 cfs or 52,056 acre-feet; and mining, 23.7 cfs. Some prospecting and assessment work is done intermittently and no mining properties are being worked at the present time.

Burnt Area (3) - Figure 22 illustrates the natural average annual yield and the legal annual rights for Burnt River. Present legal rights of about 294,000 acre-feet are 2.5 times

the historical average annual yield to 124,000 acre-feet for this river.

Lower Burnt Area (3a) - The largest surface water rights are for irrigation in the amount of 199 cfs or 25,015 acre-feet. Smaller rights are for domestic uses in the amount of 13.4 cfs or 9,716 acre-feet and industrial, 3.5 cfs or 2,534 acre-feet. Mining rights amount to 110.2 cfs, but only one lime plant and one quarry were found to be in operation in 1965 using less than 10 cfs.

Lower Burnt area is a water-deficient area, dependent upon Unity Reservoir and return flows from irrigation to supply its basic needs.

Upper Burnt Area (3b) - The largest surface water rights are for irrigation in the amount of 457.2 cfs or 59,144 acre-feet. The only other rights are for domestic uses in the amount of 11.6 cfs or 8,395 acre-feet and for mining in the amount of 150.3 cfs. One small placer mine was operating in 1965.

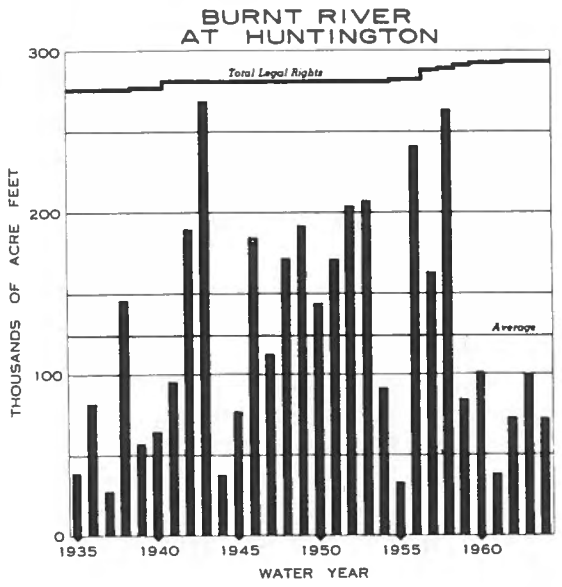


FIGURE 23. Annual Natural Yield versus Legal Rights, of Burnt River at Huntington.

Figure 23 graphically presents 30 years of annual natural yield and the legal rights on Burnt River. The total annual legal depletion under existing water rights is seen to exceed available water from Burnt River and its major tributaries.

Annual natural yield over the 30-year period varied from 28,000 acre-feet in 1937 to 270,000 acre-feet in 1943 and averaged 124,000 acre-feet. With 1964 rights equal to 294,000 acre-feet, the graph shows an average annual deficit of 170,000 acre-feet for which no yield is available.

All important tributaries are overappropriated seasonally at

their mouth, to the point that the only practical sources of additional surface supplies are proposed storage reservoirs. Headwaters of North Fork, South Fork, and Camp Creek of Burnt River often have small summer flows but these flows are rapidly depleted in agricultural areas where the need is much greater than the available water. The upper South Fork of Burnt River has the highest summer runoff of these tributary streams.

GROUND WATER

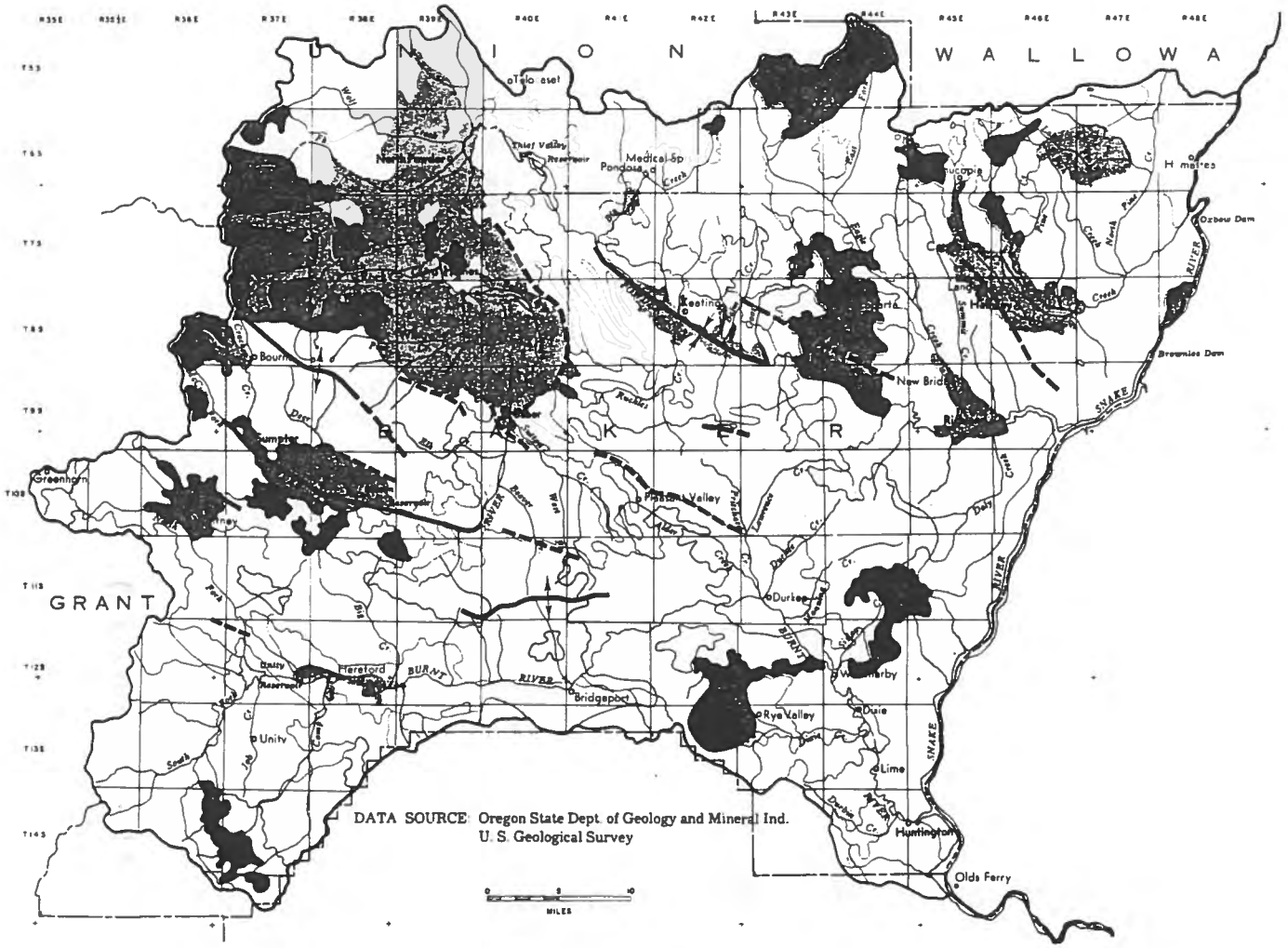
Ground Water Geology

The conditions favorable to the source, storage, and transfer of ground water are precipitation, porosity, and permeability, respectively. Unfortunately, these geologic and climatological conditions seldom occur together in optimum degree in the basin, and where they do, often they are deficient in extent or are situated distant from user needs. With local exceptions, therefore, such as exist in the Pine, Lower Powder, and Baker Valleys, ground water is not believed sufficiently available to contribute materially to the water needs of the basin.

The potential ground water yields of the various rock types, which herein are divided into six groups, are shown on the following generalized ground water geology map, Figure 24. Described in the order of their occurrence, from oldest to youngest, these rock groups yield ground water generally found as follows:

The oldest rocks are the metamorphic rocks (designated in pink in Figure 24) that were early intruded by diorite (popularly called granite) and related igneous intrusive rocks (red). All of these rocks underwent folding, faulting, and erosion to form, in large part, the mountains of the area. They yield negligible quantities of ground water because their former porous textures and permeable characteristics have been virtually eliminated by compression.

Succeeding geologic events produced additional rock types in the basin. Rhyolite and related volcanics (white) occur, principally, in the southwestern portion and yield but low quantities of ground water because they have little porosity or close interval fracturing. Basalts and basaltic andesites (dotted green) are exposed, for the most part, in



GENERALIZED GROUND-WATER GEOLOGY

GEOLOGIC UNIT	YIELD CAPABILITY
Quaternary Period	
Stream and Glacial Deposits	Medium
Tertiary Period	
Late-bed and related Sediments	Low to Negligible
Basalt and Basaltic Andesites	High to Low
Rhyolite and related Volcanics	Low
Pre-Tertiary Periods	
Diorite and related Intrusives	Negligible
Metamorphosed Sedimentary and Igneous Rocks	Negligible

STRUCTURES

- Fault (dashed where inferred)
- Anticline (dashed where inferred)
- Syncline (dashed where inferred)

FIGURE 24. Generalized Ground Water Geology.

the northern portion of the basin but underlie a much larger area. These lavas yield from low to high quantities of ground water and supply the largest producing wells in the basin. The higher yields are from the gravel interbeds of the thicker and larger sequences of lava flows. Lakebed and related sediments (light green) are concentrated in the central portion and yield low quantities of ground water from the gravel lenses and negligible quantities from the sediments, most of which contain impervious clays.

The youngest rocks, eroded and deposited during the present geologic period, form the unconsolidated glacial and stream deposits (dark green) of the larger valleys. The sand and gravel components of these sedimentary deposits yield medium quantities of ground water, particularly, from the alluvial fan material in the south and west portions of Baker Valley.

The faults and folds that form the principal structural features in the basin are oriented in a northwesterly direction and have considerable control over the ground water movement in the basin. The many springs, both thermal and cold, generally occur along fault zones.

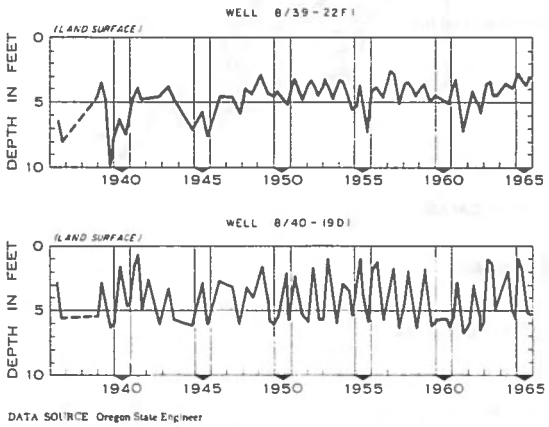


FIGURE 25. High Water Table at Two Wells near Wingville

Occurrence

The occurrence of ground water, indicated on the generalized ground water geology map, varies considerably throughout the basin because of different geologic and climatological conditions. For the most part, the basin is quite limited in ground water resources which, except where indicated, must be regarded as supplemental sources that cannot contribute materially to the water needs of the basin.

Hydrographs illustrating the high-water table recorded at two wells, located near Wingville in Baker Valley, are shown in Figure 25.

The location of the larger yielding wells are shown in Figure 26.

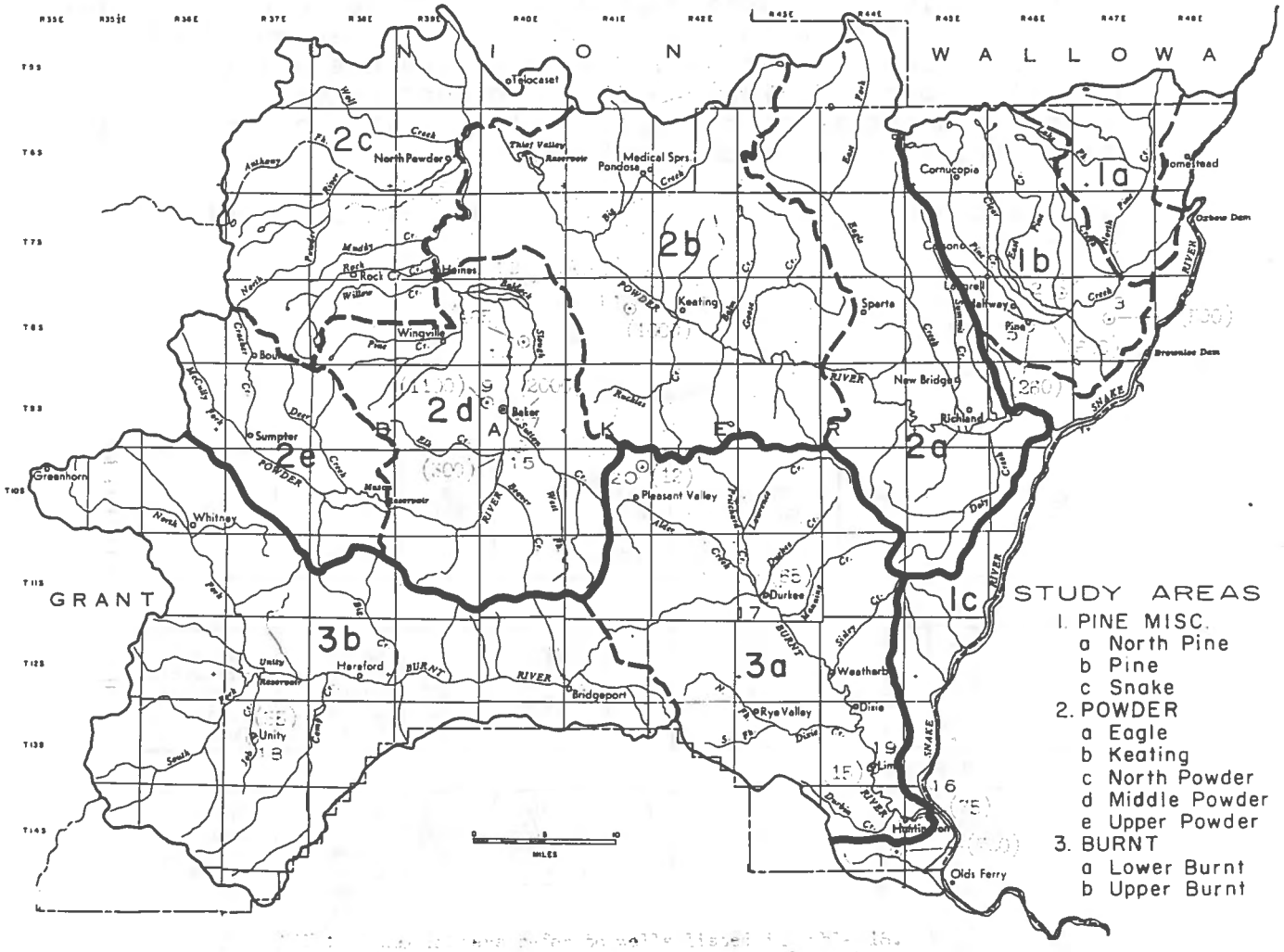


FIGURE 26. Representative Test-Pumped Wells

Several proposals have been made through the years to utilize Baker Valley excess ground water but to date nothing of consequence has been accomplished. The storing of floodflows in Mason Reservoir is expected to cause an alteration of ground

water levels in the valley, but the beneficial and detrimental results, by area, cannot be determined at this time. The City of Baker has a high-fluctuating ground water table which causes costly construction problems. The depth of the water table varies from a few inches to 20 feet, depending on river and irrigation ditch flows. Baker Valley has a large number of wells whose principal source of ground water is the unconsolidated deposits of the valley plain. The most productive strata are those near the surface.

Data pertinent to the larger yielding wells are listed in Table 18.

TABLE 18

REPRESENTATIVE TEST-PUMPED WELLS

MAP NO.	YIELD Gpm	DRAW-DOWN Feet	SPECIFIC CAPACITY Gpm per foot of drawdown	DEPTH TO STATIC WATER LEVEL Feet and date	DEPTH OF WELL Feet	AQUIFER Rock	WATER USE
	PINE AREA						
1	780	100	8	Flows - 12/65	237	Basalt	Irrigation
2	600	100	6	8 - 10/63	274	Gravel	Irrigation
3	590	130	4.5	20 - 9/65	307	Gravel	Industrial
4	270	70	4	4 - 12/61	122	Gravel	Irrigation
5	260	65	4	11 - 1/59	267	S. & G.	Domestic
	POWDER AREA						
6	2,200	90	24	Flows - 8/64	295	Sand	Irrigation
7	2,000	100	20	8 - 11/65	650	Basalt	Industrial
8	1,200	30	40	123 - 10/55	390	Gravel	Irrigation
9	1,100	166	7	29 - 4/55	575	Gravel	Irrigation
10	1,022	108	9.5	8 - 7/65	400	Gravel	Irrigation
11	1,000	65	15	18 - 5/63	685	Basalt	Irrigation
12	1,000	80	12.5	9 - -/56	150	S. & G.	Irrigation
13	1,000	100	10	46 - 5/65	487	Gravel	Irrigation
14	465	28	17	8 - 11/61	40	S. & G.	Irrigation
15	300	40	7.5	8 - 4/64	55	Gravel	Irrigation
	BURNT AREA						
16	75	60	1	465 - 5/44	583	Volcanics	Municipal
17	65	162	0.4	Flows - -/21	1,082	S. & G.	Domestic
18	35	10	3.5	18 - 11/64	70	Gravel	Domestic
19	15	40	0.4	42 - 10/65	137	Limestone	Domestic
20	12	10	1	4 - 9/64	38	Gravel	Domestic

Note: Map No. refers to well location plotted in Figure 26.

Data Source: Oregon State Engineer and U. S. Geological Survey.

Snake area (1c) has a recently completed irrigation well located south of Huntington that was test pumped at 780 gallons per minute (gpm). The well has an artesian flow of 430 gpm and is listed in Table 18 as number 1.

Pine area (1b) affords good potential for development of additional high-yielding wells in the broad alluvial Pine Creek valley in which Halfway is situated. Representative test-pumped wells are listed in Table 18 as numbers 2, 3, 4, and 5.

Eagle area (2a) has eight well logs on record describing wells in the Richland-New Bridge area. All are domestic, range from 19 to 136 feet in depth, tap sand and gravel aquifers in the valley alluvium, and were bailer tested at 3 to 26 gpm.

Keating area (2b) is believed to have a good ground water potential as indicated by the large Stewart-Morrissey irrigation well (number 11 in Table 18) located about four miles due west of Keating. This well was test pumped at a rate of 1,000 gpm with a drawdown of 65 feet after pumping four hours. It is 685 feet deep, and taps interflow aquifers in the basalt. Except for the above well, most of the wells of record are for domestic or stock use, range from 32 to 325 feet in depth, generally tap sand or sand and gravel aquifers, and were bailer tested at 3 to 40 gpm.

North Powder area (2c) has several high-yielding irrigation wells, listed in Table 18 as numbers 6, 8, 10, and 12. Other test-pumped wells are the Haines municipal well that yielded 167 gpm with a drawdown of 37 feet after nine hours of pumping, and the Haines cemetery well that produced 25 gpm with 146 feet of drawdown after four hours of pumping. These wells, respectively, draw from granitic-type sand and gravel and from granitic-type rock. A 310-foot irrigation well, located about one-half mile north of Haines, is reported to produce 1,075 gpm with no drawdown. The water table is said to be within 18 to 24 inches of the land surface in this area.

North Powder area is supplied by two adjoining municipal wells within the city with depths of 150 and 300 feet. The water quality is satisfactory except that pumping of sand necessitates the use of a settling tank. There are numerous bailer-tested wells in this area that yield 4 to 42 gpm and range in depth from 23 to 328 feet.

Middle Powder area (2d) generally has a adequate ground water supply. The bottom land of the valley has a high water table that makes considerable land of little value or difficult to manage.

Baker Valley has several high-yielding wells listed in Table 18 as numbers 7, 9, and 13. Wells 14 and 15 yield much less.

Upper Powder area (2e) has a half-dozen well logs on record for wells located, for the most part, at or near Sumpter. The wells are for domestic use, range from 35 to 158 feet in depth, tap volcanic and sand and gravel aquifers, and were bailer-tested at 2 to 8 gpm.

Burnt areas.(3a and 3b) have few good wells. Table 18 lists the characteristics of five test-pumped wells (number 16 through 20) located at or near Huntington, Lime, Durkee, Pleasant Valley, and Unity. All of the bailer-tested wells of record are for domestic use, range from 38 to 355 feet in depth, and yield from 3 to 40 gpm. The aquifers, for the most part, are sand and gravel, with some wells tapping volcanics or limestone.

Ground Water Rights and Withdrawal

The statewide Ground Water Act of 1955 does not require water rights for watering stock or for irrigating lawns and noncommercial gardens not exceeding one-half acre in area. Nor are water rights required for single or group domestic purposes not exceeding 15,000 gallons per day (gpd) or for any single industrial or commercial purpose not exceeding 5,000 gpd. The small quantity used for these general purposes is unknown and therefore not included in basin depletions.

Domestic water rights, where irrigation of a lawn or garden not exceeding one-half acre in area is claimed, allow a legal maximum rate of 1/100 cfs (4.5 gpm) or a legal maximum quantity of 6,463 gpd. A domestic water right for household use only, however, allows one-half these rates and quantities.

The 57 ground water rights in the basin, as of October 31, 1965, totaled 48.71 cfs for legal annual withdrawal of 21,315 acre-feet. The consumptive-use rights amounted to 0.14 cfs for domestic, 7.80 cfs for municipal, 0.11 cfs for industrial, and 37.88 cfs for irrigation purposes. The latter quantity, amounting to 13,474 acre-feet or 63 percent of the total legal

withdrawal, was to irrigate 3,716 acres. The nonconsumptive rights amounted to 2.40 cfs for power, 0.13 cfs for recreation, and 0.25 cfs for mining purposes.

The ground water rights and legal annual withdrawals are summarized by drainage area in Table 19 which includes registered wells and wells for which permits have been granted under the Ground Water Act of 1927, 1933 and 1955. Maximum legal annual

TABLE 19

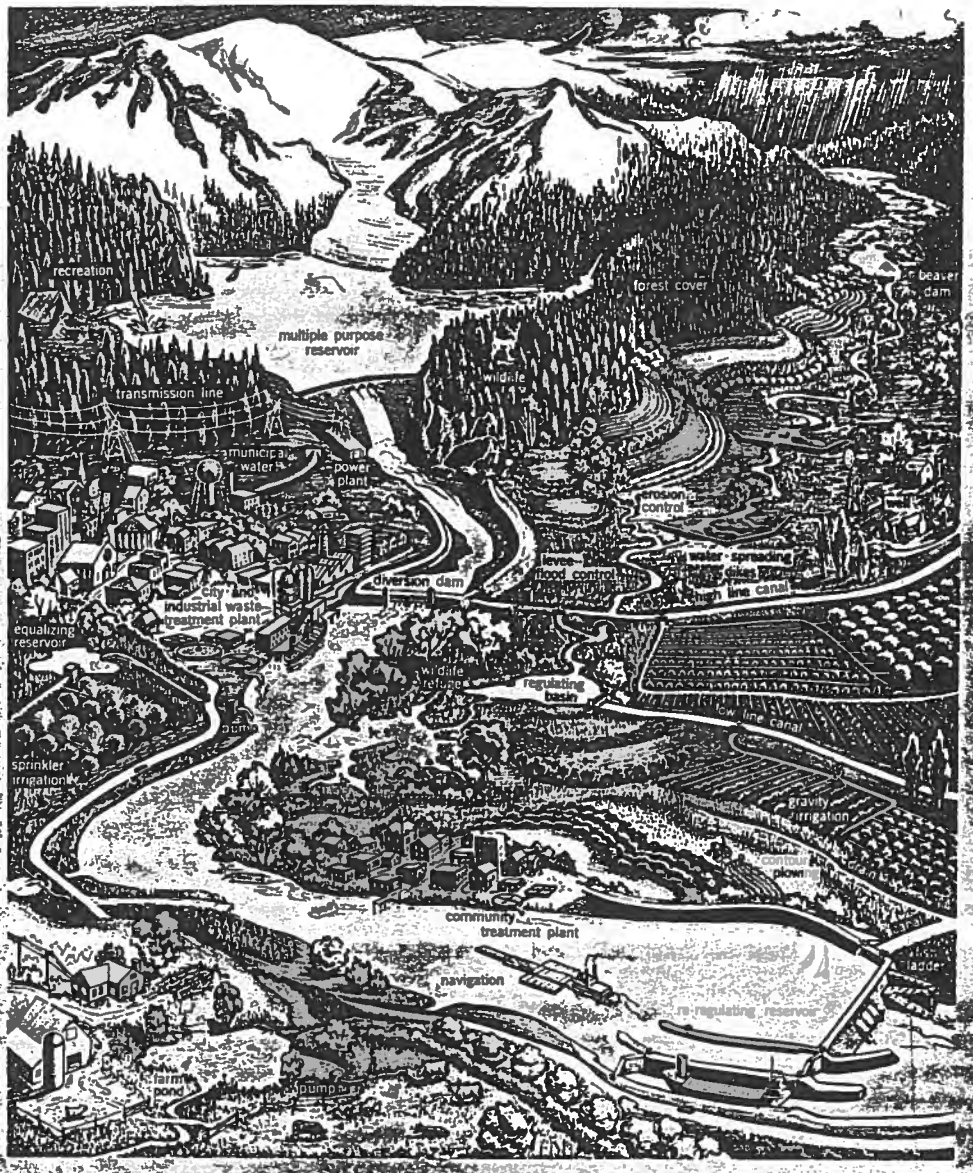
LEGAL ANNUAL
GROUND WATER WITHDRAWALS

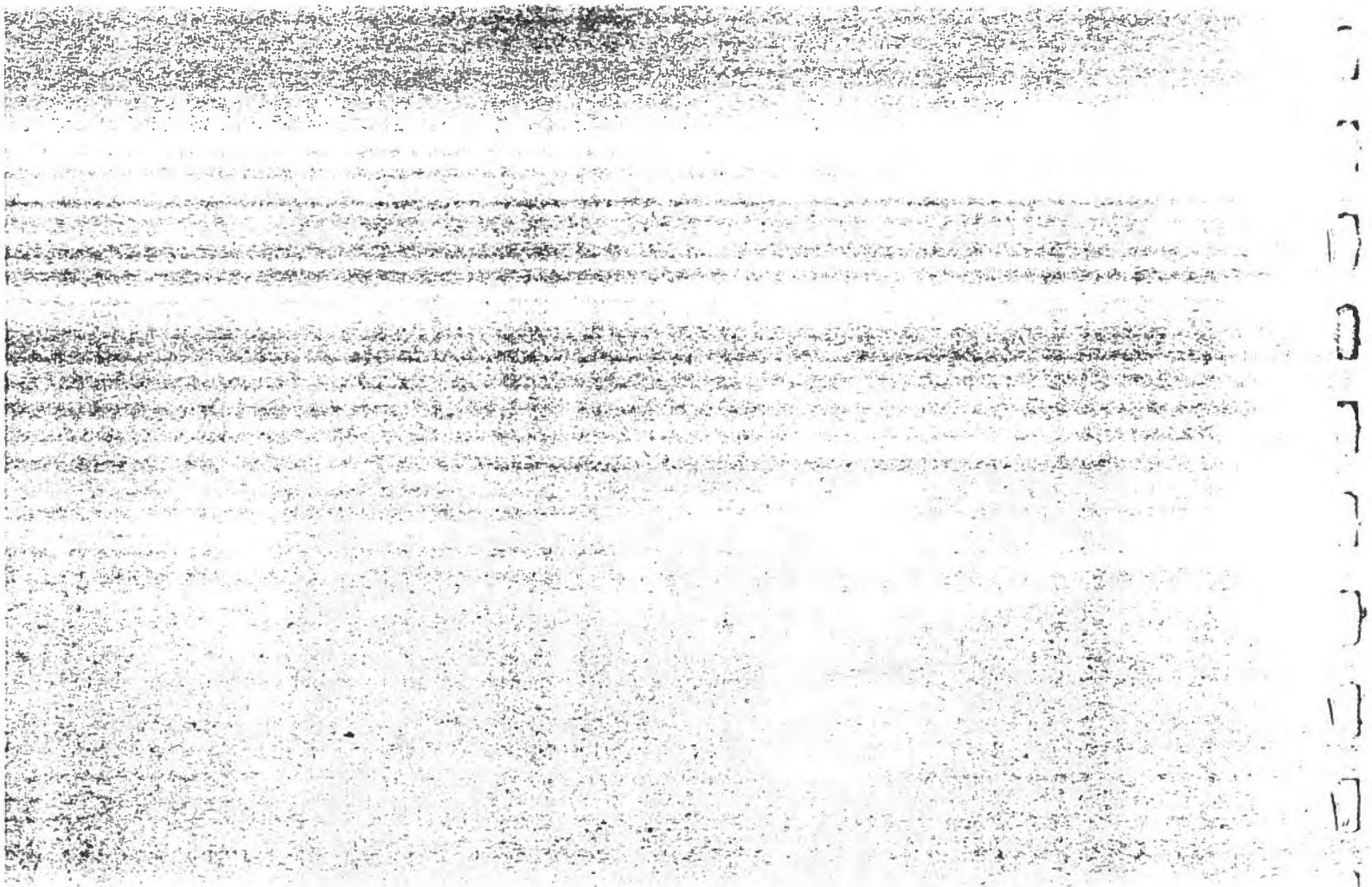
USE	STUDY AREA						TOTAL	
	PINE		POWDER		BURNT			
	Cfs	Ac-Ft	Cfs	Ac-Ft	Cfs	Ac-Ft	Cfs	Ac-Ft
CONSUMPTIVE								
Domestic	0.10	72	0.03	22	0.01	7	0.14	101
Municipal	0.25	181	7.55	5,436	0	0	7.80	5,647
Industrial	0	0	0.11	80	0	0	0.11	80
Irrigation	0.46	167	37.42	13,307	0	0	37.88	13,474
Total	0.81	420	45.11	18,875	0.01	7	45.93	19,302
NONCONSUMPTIVE								
Power	0	0	2.40	1,738	0	0	2.40	1,738
Recreation		0	0.13	94	0	0	0.13	94
Mining	0	0	0	0	0.25	181	0.25	181
	0							
Total	0	0	2.53	1,832	0.25	181	2.78	2,013
TOTAL	0.81	420	47.64	20,707	0.26	188	48.71	21,315

Data Source: Oregon State Engineer.

irrigation withdrawal is based on 4½ acre-feet per acre per year in the Pine area to irrigate 37 acres, 4 acre-feet per acre in the North Powder area to irrigate 701 acres, and 3½ acre-feet per acre in the remaining Powder area to irrigate 2,978 acres. The latter two areas are combined in this table. At present, ground water is not withdrawn in the Burnt area for irrigation.

WATER USE & CONTROL





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PART III

WATER USE AND CONTROL

LEGAL RESTRICTIONS AND LIMITATIONS ON WATER USE

A check of State Engineer's records did not reveal any special statutory or State Engineer's withdrawals, restrictions, or limitations on water use within the Powder Basin.

WATER USE AND PROBLEMS

Domestic

About 24 percent of the basin's 1964 population of 15,850 utilize individual or small-group water systems. This water is obtained for human and livestock consumption from springs, wells, streams, and irrigation ditches by people living in unincorporated communities and rural areas.

Domestic surface water rights total 142 cfs for a maximum legal annual depletion of 103,100 acre-feet. These unusually large quantities allowed, for domestic purposes, are due to the nature of the decrees, which were granted with the following or similar wording:

> That all parties herein allowed the right to the use of water for irrigation shall be entitled to use such water for stock and domestic purposes, provided that during the irrigation season such appropriators shall not be entitled to divert any water for stock or domestic purposes in addition to the amount which they are entitled to divert for irrigation purposes. That outside of the irrigation season, the right to the use of water for stock and domestic purposes as herein confirmed, entitles the owner of such right to divert and use such quantity of water as is reasonably necessary for stock and domestic purposes, provided that the amount diverted for stock and domestic uses shall not exceed 0.10 cfs (for Pine Creek) for each family or farm. The decrees on Powder and Burnt Rivers specified one-fortieth cfs for each 1,000 head of stock continuous throughout the year.

The total maximum legal annual depletion for domestic ground water rights in Powder Basin is 0.14 cfs or 101 acre-feet.

Most domestic wells in the basin draw water from alluvial and other sedimentary deposits in the valley portions of the basin. The wells generally are less than 100 feet deep and,

when properly located, produce sufficient quantities of potable water. A few domestic wells, several hundred feet deep, along Burnt River have quantity and quality problems.

The Powder Basin Water Resources Committee surveyed group domestic water facilities and reported on the sources, quantities, and problems. Pine Valley domestic supplies are derived mainly from 10-to 45-foot depth driven or drilled wells. No quantity or quality problems were reported.

The New Bridge community domestic and livestock supplies are derived from over 15 wells, 5 springs, and several canals. Well depths range from 18 to 140 feet, most of which draw from shallow gravels. Some quality problems have developed from shallow wells so a community system is being considered.

Reports from the Muddy Creek area indicate that the schoolhouse well is 400 feet deep, another well near the shcool is 80 feet deep, and the quantity is adequate. The community of Muddy Creek reported some domestic water shortages.

Communities in lower Baker Valley, such as Wingville and the northern suburbs of Haines, obtain adequate quantities of domestic water from wells. Hardness and other quality problems were reported for the Wolf Creek area.

Unity and Unity Mill areas reported use of 36 wells ranging in depth to 520 feet. Water hardness was reported from deep wells. Both areas reported need for new sources and community systems due to water shortages.

The Hereford area obtains adequate water supplies mainly from wells. There is one artesian well and one deep well that have hard water. Durkee has about 15 shallow wells of depths between 18 and 45 feet. Most families use overflow from the railroad well but quantity is not dependable.

Municipal

Municipal surface water rights for the basin total 133 cfs, with 0.58 cfs from Pine Creek and the rest from the Powder River drainage area. These rights allow a maximum annual legal depletion for the basin of 96,422 acre-feet. The municipal ground water rights amount to 7.8 cfs or about 5,600 acre-feet for the basin. Huntington receives its municipal

water from the Burnt River Irrigation District which has rights that include unspecified municipal uses.

The seven incorporated communities in the basin have municipal water systems from ground water and stream sources. Table 20 lists the municipal water systems and the results of questionnaires sent out by local water resource committees, pertaining to supply source and present use.

TABLE 20

PUBLIC WATER SYSTEMS

SYSTEM	POPULATION SERVED	SOURCE	WATER RIGHTS Cfs	WATER RIGHTS Mgd	NEEDS
Halfway	467	Leep Spring and a well	0.50	0.325	System enlargement
Richland	300	A well and ground water collector on Eagle Creek	1.00	0.650	None
North Powder	357	Two wells	4.89	3.168	None
Haines	270	Two wells and Rock Creek	2.00		System rehabilitation
Baker	9,964	Elk, Goodrich, and Salmon Creeks	57.70		Increased winter supply
Sumpter	130	McCully Fork and Cracker Creek	70.00		System rehabilitation
Huntington	623	Burnt River (Irr. Dist.) and one well	-	-	System rehabilitation
TOTAL	12,111				

Data Source: Powder Basin Water Resources Committee and Oregon State Engineer.

These systems supplied 12,111 people in 1964 or about 76 percent of the basin's population. Several group services supplying unincorporated communities, such as Pine Valley, Wingville, Durkee, Unity, and Unity Mill, were included in the preceding section on domestic water.

Halfway obtains its water from a 275-foot depth, 220 gpm well and Leep Spring with a 6-inch gravity transmission line. Water from the spring is chlorinated. Expansion plans of about 2 percent annually include a larger pipeline and construction of additional wells.

The Richland municipal system serves 120 rural and urban customers from New Bridge to around Richland. About 600 gpm of chlorinated water is delivered through an 8-inch pipeline from a ground water collector on Eagle Creek to the users. This 2-year old system has no quantity nor quality problems.

North Powder obtains its water from two wells, 126 and 300 feet in depth. Water users have no meters to determine quantity of water used, no quality problems, nor do they report any expansion plans. Sand in the water has been a problem in prior years. Service is to 131 residential and commercial customers, according to the Powder Basin Water Resources Committee's survey.

Haines receives its municipal water for 122 customers from 2 wells with a combined capacity of 450 gpm. Problems include pumping water levels that drop from 36 to 120 feet and occasional contamination entering the distribution system. They expect about 2.5 percent annual expansion through use of additional deep wells.

The City of Baker is the dominant municipal water user of the basin with 2,796 residential and 420 commercial customers. Its water supply collector system includes Washington Gulch, along with Goodrich, Mill, Marble, Elk, Salmon, and Bear Creeks, and 15 springs, which are used selectively to obtain the best potable water. The water system is being rehabilitated to deliver 9.5 million gpd. The water quality is good, however, chlorine and ammonia treatment facilities are available. The greatest problem is low winter flows during long cold spells. Additional supply sources are being considered from Pine Creek and wells. Water from the system also operates a 200 kilovolt-ampere (kva) hydroelectric plant utilizing a Pelton wheel.

Sumpter's water for 44 customers is derived from McCully Fork of Powder River through a low-pressure 6-inch line. Plans include system enlargement and a new intake pipeline to support an estimated 3 percent annual growth. Currently, only about 1 cfs of Sumpter's water rights is used.

Huntington obtains about 350 gpm through perforated pipes in the gravels under Burnt River and a 500-foot well which produces 400 gpm. City use is about 365 acre-feet to serve 230 customers and the Union Pacific Railroad use is about 450 acre-feet annually. Expansion probably will be by purchase of more water from the Burnt River Irrigation District.

The urban areas of the basin will continue to draw from their municipal water systems for both domestic and lawn irrigation supplies. Water-use records throughout the Pacific Northwest have shown a considerable increase in consumption which is attributed to the wider use of water-using appliances and the

improvement of water systems. The increases in average consumption in this area probably will follow the general trend of 2 percent per year.

The Powder Basin Water Resources Committee has estimated the present and future municipal water consumption in acre-feet as shown in Table 21.

TABLE 21

MUNICIPAL WATER NEEDS

CITY	ANNUAL NEEDS IN ACRE-FEET			
	Present	5 yrs.	10 yrs.	20 yrs.
Halfway	69	75	85	100
Richland	57	60	-	70
North Powder	57	-	-	95
Haines	65	70	85	-
Baker	3280	3600	4000	5000
Sumpter	21	40	-	45
Huntington	186	230	265	-

Data Source: Powder Basin Water Resources Committee.

The detailed analysis of the systems indicated that summer use varied between 3 and 3.5 times the winter water use, mainly due to lawn irrigation. The City of Baker per capita summer consumption based on metered services was 490 gpd or 2.7 times the national average.

Of the seven cities, only Baker and Richland have adequate water-supply systems to meet actual municipal and fire demand flows. The other cities' shortages are in collection and transmission facilities.

Industrial

Water rights for industrial uses in the basin amount to 20.61 cfs from surface and 0.11 cfs from ground water sources for a total of about 15,000 acre-feet. The largest water users are the agricultural, forestry, and lime processing industries.

Increased production from supplemental irrigation water, being developed for Baker Valley, should lead to a moderate increase in water demand for industrial purposes. Considering climatic factors, resources, and distance from major markets, water use for industrial purposes is not expected to increase materially in most basin areas.

The actual water consumed is considerably less than the total legal right because of intermittent use by most industries and because of the nonconsumptive nature of most industrial uses.

Municipal water systems supply a large part of the industrial needs.

The small agricultural and service industries within the City of Baker obtain their industrial water from the municipal system. Larger forestry, lime processing, and mining industrial users with developed water sources are at Halfway, near Baker, at Unity, on upper South Fork Burnt River, and at Lime. The plant at Lime uses about 60 acre-feet of water annually from the Burnt River Irrigation District and has plans for increased usage.

Mining

Little water is used by the mining industry in the basin due to greatly curtailed gold placer mining activities and the shutdown of lode mines. Although numerous water rights for mining purposes were still on record as of October 31, 1965, only a few are used. This contrasts with early history of the area when gold mining was a major water user.

The 86 surface water rights and 1 ground water right for mining purposes total 588.25 cfs for an annual legal withdrawal of 425,893 acre-feet. The lone ground water right is for 0.25 cfs. The surface water rights amount to 95.5 cfs for the Pine, 231.97 cfs for the Powder, and 260.53 cfs for the Burnt drainage areas. The 3 largest rights, in the Pine drainage and 2 in the Powder drainage, are for 50 cfs each.

Placer mining invariably causes siltation in the streams unless adequate settling ponds or other off-channel barriers are provided. Except for this difficulty, and the fact that placering is limited to the spring and early summer months when water is sufficient, few mining water quantity or quality problems are known to exist at present.

Future demands for water by the mining industry depend, for the most part, on the possible reactivation of the metal mines and marketing conditions which warrant mining the several potentially commercial nonmetallic deposits. Use of water would be negligible for the talc, perlite, pozzolan, and building stone operations, and nominal for the diatomite operation. The two presently active limestone operations, likewise, use nominal quantities of water. In contrast, however, water would be vitally essential to the washing and/or milling processes used by metal mines. Too many unpredictable

factors are involved to estimate the quantity of water that would be required if some of these mines were reactivated. However, many of the mines have exhausted their resources or abandoned operations to a point where reactivation would not be economical. Water rights held by such mines, which have not been in operation for five or more years, should be cancelled.

Irrigation

With irrigation consuming about 98 percent of the total streamflow consumptive-use water, broad coverage is given to this section of the report.

Irrigation of agricultural lands began within the Powder Basin in 1862 to feed gold miners who started arriving in large numbers. The acreage under irrigation increased rapidly until 1919 when an estimated 193,000 acres were irrigated. By 1929, farmers realized that normal available water was far overappropriated so irrigation on extensive areas was abandoned. Although up to 169,300 acres (Table 22) have been reported as irrigated in good water years, the trend in acres normally irrigated has stabilized at about 135,000 acres through 1959. Figure 27 shows this trend.

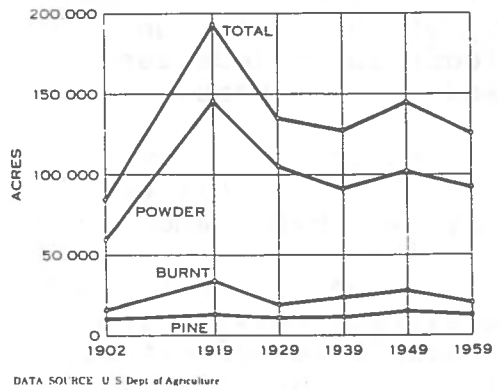


FIGURE 27. Irrigation Trends - Pine, Powder and Burnt River Areas.

Even with the construction of Thief Valley Reservoir in 1931 and Unity Reservoir in 1938, irrigated acreages did not increase significantly. Stored water was used mainly to extend the irrigation season in both areas rather than to expand acreages under irrigation. Within local areas, poor lands frequently were not irrigated so that water use could be transferred to better irrigable lands.

There are almost 69,000 acres, which have water rights, that are not used during dry years. The acreage with rights is 203,819, while the land actually irrigated is basically around 135,000 acres. About 750 farms in the basin have irrigated land with the average irrigated area per farm being 180 acres. About 169,300 acres are developed for irrigation.

Table 22 lists acreages for which water rights are held and those irrigated when water supplies are available.

TABLE 22

IRRIGATION WATER RIGHTS AND USE

STUDY AREA	SURFACE WATER Acres	GROUND WATER Acres	TOTAL IRRIGATION RIGHTS Acres	TOTAL IRRIGATION RIGHTS Cfs	LAND UNDER IRRIGATION Acres
Pine	20,651	37	20,688	458	19,750 *
Powder	151,399	3,679	155,078	3,403	127,750 *
Burnt	28,053	-	28,053	656	21,800
TOTAL	200,103	3,716	203,819	4,517	169,300 *

* Irrigated when water is available.

Data Source: Oregon State Engineer and USDA 1966 Cooperative Report.

Land with surface water rights equals 200,103 acres while land with ground water rights equals 3,716 acres.

The total irrigation rights call for flows of 4,517 cfs, of which only 0.8 percent are from ground water sources. Irrigation rights call for irrigation season flows of 458 cfs on Pine Creek, 3,403 cfs on Powder River, and 656 cfs on Burnt River. As shown in Table 14, page 38, of the Water Supply section, the average runoff of the floodflow periods cannot supply these legal rights on Powder and Burnt Rivers.

By reconstructing the historical Powder River floodflows for April, May, and June, the average runoff is 1,150 cfs while the legal depletion is 3,403 cfs. Only two (Eagle and Pine Creeks) of the basin's ten study areas (Figure 1) have sufficient average spring floodflows to meet the irrigation water rights requirements. None of the streams serving appreciable irrigated areas have available quantities of natural summer flow or storage water to supply fully the irrigation season requirements. According to the U. S. Department of Agriculture's 1966 cooperative survey, about 80 percent of the reported 169,300 acres of the land subject to irrigation have water shortages in dry years.

The only water left for appropriation is ground water and water to be stored. It is estimated that forage yields could

be more than doubled through development of storage reservoirs and improved management practices. Unless costs of irrigation are less than the value of increased production, however, farmers cannot benefit from such developments.

The lack of water except for a short runoff period, the fairly high cost of potentially available storage facilities, the high operation and maintenance costs of distribution facilities, and the moderate returns that can be expected from irrigation under basin conditions all necessitate holding irrigation costs to the minimum. Any actions, which would tend to increase irrigation costs, would affect the competitive position of basin farmers adversely.

The average annual precipitation, in most agricultural areas of the Powder Basin, ranges between 8 and 20 inches. Only about 0.5 inches of this precipitation (Figure 4) falls during each of the 3 driest months, July, August, and September at Baker, while the quantity is even less at Richland. Irrigation is essential, therefore, to the agricultural economy of this basin.

Table 23 shows the trend in acres per farm for Baker County.

TABLE 23

FARMS
BAKER COUNTY

YEAR	NUMBER OF FARMS	AVERAGE SIZE OF FARMS Acres	FARMS REPORTING IRRIGATION	PERCENT OF FARMS IRRIGATING	AVERAGE ACREAGE IRRIGATED PER FARM
1929	1,383	487	1,113	80	107
1939	1,259	632	1,050	83	116
1949	1,052	878	900	86	136
1959	792	1,170	675	85	177

Data Source: USDA 1965 Cooperative Report.

Based on census data for 1959, the number of irrigated farms has decreased gradually during the reported 25-year period, while the average acres irrigated per farm has increased gradually. These trends are associated with the national trend of fewer, larger, and more efficient farms. About 30 percent of the farmers reporting irrigation had less than 50 acres under irrigation and 62 percent had more than 100

acres. Eight percent of the irrigators had 500 acres or more under irrigation.

About 750 farms in the basin had irrigated land in 1964. Natural streamflow is the source of water for 85 percent of the irrigated land, reservoirs are the source for 13 percent, and ground water is the source for less than 2 percent. Gravity irrigation methods are used on all but about 7,700 acres where sprinkler systems are used. The use of sprinkler systems should be accelerated to conserve water supplies, improve distribution, permit better control, and reduce drainage problems.

Table 24 shows the presently irrigated acreage by water source.

TABLE 24

PRESENTLY IRRIGATED
ACREAGE BY WATER SOURCE

STUDY AREA	STREAM FLOW	STORAGE	GROUND WATER	TOTAL ACRES
1. PINE MISC.				
(a) North Pine	50	-	-	50
(b) Pine	18,900	-	200	19,100
(c) Snake Misc.	380	220	-	600
Total	19,330	220	200	19,750
2. POWDER				
(a) Eagle	10,300	-	-	10,300
(b) Keating	8,960	9,240	600	18,800
(c) North Powder	44,300	600	650	45,550
(d) Middle Powder	47,960	990	1,250	50,200
(e) Upper Powder	2,900	-	-	2,900
Total	114,420	10,830	2,500	127,750
3. BURNT				
(a) Lower Burnt	3,150	2,350	-	5,500
(b) Upper Burnt	7,700	8,600	-	16,300
Total	10,850	10,950	-	21,800
TOTAL	144,600	22,000	2,700	169,300*

*Includes 34,300 acres which receives water in only the better water years.

Data Source: USDA 1966 Cooperative Report.

Most of the basin irrigation development has been accomplished by small cooperative ditch companies or by individual farmers. In 1950, there were 171 irrigation organizations in the Powder

Basin. These organizations maintained about 900 diversion structures and distribution systems cooperatively.

The only irrigation districts presently operating in the basin are the Burnt River with 17,800 acres and the Lower Powder River with 7,550 acres under irrigation. The Baker Valley Irrigation District has been formed to distribute stored water from the Mason Dam reservoir.

After June of most years there is little streamflow, and except for pumping from some wells, mainly concentrated in Baker Valley, the irrigation season is about ended.

Baker Valley conditions will be used as typical for water requirements of basin agricultural lands. The average annual consumptive use of water for crops has been estimated at 2.0 acre-feet per acre. Of this amount, precipitation provides 0.5 acre-feet leaving 1.5 acre-feet to be supplied by irrigation. Allowing 1.5 acre-feet per acre for diversion and other watershed losses and assuming a farm irrigation efficiency of 50 percent, the gross irrigation requirement is about 4.5 acre-feet per acre for irrigable land. Using this diversion rate, up to 1.0 acre-foot per acre of return flow would be available for further use downstream in those areas where it could be captured for reuse. More specific data on irrigation water use, by designated areas (Figure 1), are supplied in the following paragraphs.

Pine - The Pine area, as herein discussed, includes Pine Creek drainages, plus small streams flowing into the Snake River along the east side of the basin.

There were about 19,750 acres actually irrigated in the Pine area during 1964. The distribution of irrigated lands was about 19,100 acres in Pine Valley, 50 acres in North Pine Valley, and 600 acres along small streams which flow directly into the Snake River. There are about 6,600 potentially irrigable acres along the Snake River and 2,000 irrigable acres around the fringes of Pine Valley. About 37 acres were irrigated from ground water sources and ground water supplemented surface supplies on another 120 acres.

The Powder Basin Agricultural Water Use Subcommittee reported that there are 8 small reservoirs (Mehlhorn, Clear Creek, Fish Lake, Lower Pine Lake, Upper Pine Lake, Sugarloaf, Bearwallow, and East Lakes) with a total capacity of 2,130 acre-feet serving Pine Valley. There are 14 large distribution ditches with

a total capacity of 230 cfs used to serve most of the irrigated land. All of these ditches were reported as being in poor condition or needing repair.

The distribution of irrigated crops grown includes 28 percent pasture, 67 percent hay, and 5 percent cereal grain. About 3,000 acres receive a fairly adequate water supply, 8,000 acres are out of water by the end of July, and the remaining 8,750 acres suffer even more severe water shortages.

Eagle - In the Eagle Creek headwaters, there are 5 small reservoirs (Echo, Traverse, Crater Lake, Eagle, and Looking Glass) with a total capacity of 1,967 acre-feet. Other water sources for the irrigation of 500 acres, include pumping from Brownlee Reservoir and the Powder River. There is no known irrigation from ground water sources.

Table 25 shows the Eagle Creek reservoir data.

TABLE 25

EAGLE CREEK RESERVOIRS

RESERVOIR	STREAM	USABLE STORAGE Acre-feet	LOCATION		
			Twp.	Rng.	Sec.
Looking Glass Lake	Tribs. Eagle Creek	500	5S	44E	32
Eagle Lake	Eagle Creek	800	5S	44E	17
Crater Lake	Unnamed Drainage	197	6S	47E	31
Echo & Traverse Lakes	*W. Eagle Creek	470	5S	43E	21
TOTAL		1,967			

*Part of the flows from West Eagle Creek are diverted into the Keating area.

Data Source: Oregon State Engineer and USDA 1965 Cooperative Report.

There are 11 large distribution ditches with a total capacity of 186 cfs and numerous smaller ditches serving Eagle Valley. Most of the canals are in good condition but diversion structures (except Waterbury) are temporary and require replacement after each flood. The Phillips Ditch has a water right to divert 38.4 cfs from West Eagle Creek and its western tributaries to Goose and Balm Creeks in the Keating area. Flows measured on West Eagle Creek in 1965 varied from 5 to 23 cfs.

The Trout Creek Ditch diverts up to 8 cfs from Trout Creek tributary of West Eagle Creek to the Big Creek drainage.

The distribution of irrigated crops grown in Eagle Valley includes 50 percent pasture, 43 percent hay, and 7 percent other crops, such as tree fruit, cereal grain, and corn. About 5,000 acres receive a fairly full-season water supply. Normally, no water is available by August 15 for approximately 2,000 acres, and 3,300 acres suffer severe shortages in dry years.

Powder - In the Powder area (Figure 1), surface water rights to irrigate 151,398 acres total 3,366 cfs for a legal annual depletion of 510,656 acre-feet. There were about 127,750 acres irrigated in the Powder River system in 1964. Ground water rights to irrigate 3,679 acres total 37.4 cfs for a legal annual depletion of 13,307 acre-feet.

The distribution of actually irrigated lands was 10,300 acres in Eagle Valley, 18,800 acres in the Keating area, 45,550 acres in the North Powder area, 50,200 acres in the Middle Powder area, and 2,900 acres in the Upper Powder area. Other data from Baker Agricultural Water Use Subcommittee's reports and other available records concerning these study areas are supplied in the following paragraphs.

Keating - The Keating area (Figure 1) includes the lower Powder River plus tributary streams, such as Big, Balm, and Goose Creeks.

The major irrigation project is the 7,550-acre Lower Powder Irrigation District. District lands are served by gravity flows from the Thief Valley Reservoir, which has a storage capacity of 17,400 acre-feet. This concrete-buttress dam was built by the U. S. Bureau of Reclamation in 1931. Some consideration is being given to enlarging the storage capacity, but the quality of soils, cost determinations, and the effects of Mason Dam construction on yield must first be determined.

The river is used as a delivery channel between the reservoir and the north and south side canals. Lower canals collect district return flows for reuse. There is no serious water shortage most years but more water could be used if available. Two district ranchers, during 1965, installed a pump in the river near Keating with an 18-inch line to irrigate 400 acres of formerly sagebrush benchland. The pump lift is about 160 feet to lands above the district's canals.

WATER USE AND CONTROL

The district experiences flood, erosion, water distribution, drainage, and alkalinity problems which are being overcome slowly through development programs. The serious flood problems are expected to be reduced somewhat when Mason and Wolf Creek Dams are completed.

The north side district water charges amount to $0.30 for operation and maintenance and $0.82 for repayment of construction which equals a total annual assessment of $1.12. The South Side Improvement District levies $0.50 to $4.00 per acre to maintain their canal distribution system. Costs for services are quite nominal in comparison to other irrigation district services in the State of Oregon.

Table 26 shows crop values in 1964 for the Lower Powder Irrigation District.

TABLE 26

CROP VALUES
LOWER POWDER IRRIGATION DISTRICT

CROP	ACRES	YIELD Per Acre	CROP VALUES Per Acre	CROP VALUES Total
Cereals	2,660	50 Bu.	$45.00	$120,624
Hay	3,075	2-3 Tons	50.00	153,140
Irrigated pasture	1,325	5 AUM	25.00	33,125
Other	510	-	78.00	40,150
TOTAL	7,570	-	$45.84	$347,039

Data Source: Adapted from U. S. Bureau of Reclamation Crop Census - 1954.

Dividing the crop values by the irrigated acreage gives a gross average return of about $46 per acre. The greatest return is derived from livestock, which are supported by the pasture-hay feed base.

There are about 12,100 acres of district and private land presently irrigated and 6,500 acres of potentially irrigable land in the Keating area. The Big Creek and associated drainages were studied jointly with the Keating area.

The Big Creek area includes about 5,860 acres irrigated. About 840 acres are irrigated from storage at Balm Creek,

Little Park, Echo, and Traverse, plus other small reservoirs. There are numerous interbasin diversions and plans for water exchange, which will be documented, for further project coverage, in the Potential Development section.

Big Creek ranches receive irrigation water from Big Creek natural flows, two Little Park Reservoir (490 acre-feet), plus interbasin diversions from Catherine and Trout Creeks. Consideration is being given to obtaining supplemental late-season needs by further storage on upper Big Creek or Eagle Creek.

The Balm and Clover Creek areas are considered jointly because they share common water sources. Balm Creek Reservoir is the primary source of water for 458 acres on lower Balm Creek and a supplemental source to upper Clover Creek. With its 1964 enlargement, Balm Creek Reservoir has a capacity of 2,926 acre-feet, but seldom fills from the watershed runoff. A total of 1,500 acres are irrigated from storage and natural streamflow in the Balm Creek area.

Table 27 shows present reservoirs in the Big, Balm, and Goose Creek valleys.

TABLE 27

BIG, BAIM, AND GOOSE CREEK RESERVOIRS

RESERVOIR	STREAM	CAPACITY Acre-feet	LOCATION Twp.	Rng.	Sec.
Cranston Reservoir	Balm & Clover Creeks	50	8S	42E	23
Balm Creek Reservoir	Balm Creek	2926	7S	43E	7
Saw Mill Gulch	Saw Mill Gulch	150	8S	43E	13
Bacher Creek Reservoir	Bacher Creek	120	8S	43E	35
Traverse & Echo Lakes	West Eagle Creek	470	5S	43E	21
Little Park Reservoir	Little Park Creek	490	6S	41E	15
TOTAL		4,206			

Data Source: Oregon State Engineer and USDA 1966 Cooperative Report.

The Phillips-Ingle interbasin diversion ditch from West Eagle

Creek transports water to the lower Goose and Balm Creek valleys. This ditch also carries 470 acre-feet of primary and supplemental water which is exchanged for storage at Echo, Traverse, and Looking Glass Lakes. Approximately 1,800 acres are irrigated at the lower end of Balm and Clover Creeks from this system. The other small, low-elevation watersheds supply only spring floodwaters.

In summary, Big and Goose Creek natural flows are reliable for irrigation rights until about July 15. Balm and Clover Creeks are reliable to about June 15, while Tucker, Houghton, Spring, and Bacher Creeks are short by May 15. The water is used almost exclusively for hay and pasture feed-base production. Distribution systems generally are simple and operated by water users. The major problem is lack of late-season water. Users have few economically available water sources to overcome this problem.

North Powder - The North Powder area (Figure 1) encompasses west side tributary drainages of Powder River in the north end of Baker Valley. The principal streams are Rock, Wolf, Muddy, Willow, Jimmy, and Antelope Creeks, and the North Powder River.

In the North Powder area, about 13,200 acres are irrigated in the Union County portion and 32,350 acres are irrigated in the Baker County portion. Potentially irrigable lands amount to about 7,000 and 5,200 acres in the Union and Baker County portions, respectively. Approximately 44,300 acres are irrigated primarily from unregulated streamflows which are inadequate after July 15 of most years.

There are about 600 acres receiving supplemental storage water and 650 acres receiving water from ground water sources, at the present time.

Additional data were supplied by the Baker Agricultural Water Use Subcommittee for the Rock and Willow Creek portions of the North Powder area. About 10,260 acres are irrigated from Rock Creek and 1,200 acres from Willow Creek. In an average water year, about 3,500 acres are summer fallowed due to a lack of water. Numerous large canals carry flows from high in the headwaters of east slope streams above the points where the water naturally would disappear in the gravelly valley terraces. Most canals and ditches have inadequate diversion structures, require extensive maintenance, and lose considerable flows to seepage.

Agricultural use is based on pasture-hay production. Where floodflows supply less than one acre-foot of water, cereal grains are produced. Native pasture and hay are produced on most of the 3,400 acres with poor drainage or a high water table around Haines and North Powder.

Major needs include more water from storage and ground water sources, consolidation and lining of distribution canals, gravity sprinkling and land leveling for better water distribution, drainage for the wet and alkaline lands, and improved water management.

Middle Powder - There were 50,200 acres irrigated in the Middle Powder area (Figure 1) in 1965. Of this acreage, 47,960 were irrigated from streamflow, 990 from storage, and 1,250 from ground water.

Intensity of present land use, water supply, flood control, and drainage problems soon will be altered by Mason Dam, which is now under construction.

The major problem is that most of the Middle Powder Valley land use is limited by either flooding or poor drainage. About 4,000 acres are flooded annually and 14,000 acres have poor drainage. Most of the lands on the Bowen and Baker Valley lowlands have a seasonal high water table, which rises to the surface or to within two or three feet of the surface each spring and summer. This rise is due to annual flooding, excessive application of irrigation water in the spring, and an inadequate valley outlet.

Harmful salts have accumulated in the soils of about three-fourths of the area having a high water table. The problem of leaching these soils becomes quite difficult because alkalinity is the limiting factor more often than salinity. Removal of alkali from the soils, either through open surface or deep drains, would be difficult because of the generally fine-textured soils.

Despite the foregoing conditions, even though these factors reduce per acre incomes, project lands are being utilized profitably.

Previous studies indicate that the upper 40 feet of Baker Valley soils contain some 230,000 acre-feet of water. U. S. Bureau of Reclamation studies indicate that ground water

available annually from streamflow, irrigation loss, and precipitation for recharge of the aquifer would average about 70,000 acre-feet.

As discussed in the Ground Water portion of this report, only a few high-producing wells exist in the valley-floor area. The effectiveness of dual-purpose pumping of these wells for irrigation and leaching has not been fully established.

The proposed Blue Canyon (Appendix, Plate 4) 2,900 acre-foot reservoir site has been investigated. The U. S. Bureau of Reclamation formerly had considered a 100,000 acre-foot reservoir in Bowen Valley on Powder River, but this site was rejected in favor of Mason Reservoir.

Upper Powder - There were 2,900 acres irrigated from streamflow in the upper Powder area (Figure 1) during 1965. Another 2,600 acres are irrigable, potentially, around the fringes of Sumpter Valley but no reservoir sites have been located for needed storage.

There were 10 farm ponds reported existing in this area. The only potential reservoir site studied was Mason Reservoir, a dominant feature, which will flood a 5-mile length of the Sumpter Valley bottom lands.

At present, irrigation exists on the higher benchlands. South side lands receive Powder River waters through the McEwen Valley Ditch. Most north side lands are irrigated from Deer Creek and its tributaries. Moderate water shortages are experienced in dry years for hay and pasture production.

Burnt - There were about 21,800 acres irrigated in the Burnt River area (Figure 1) during 1965. Irrigated acres by area included lower Burnt, 5,500 and upper Burnt, 16,300.

Agriculture is the principal economic activity of this study area. Farming is undergoing a transition from mixed farming to meat producing, and an increasing portion of the total farm area available is being used for hay and pasture land.

There are 20 fairly large and several small canals below Unity Reservoir serving district lands. All of them are earth canals in fair condition. These and similar canals above Unity Reservoir are shown on Plate 1 of the Appendix.

Approximately 10 percent of the land is irrigated by sprinklers and 90 percent by surface spreading.

Drainage problem areas are relatively small and scattered. The greatest problems are water shortage above Unity Reservoir and difficulty of serving lands in the Durkee-Huntington area.

Table 28 shows crop values received in 1964 from the Burnt River Irrigation District.

TABLE 28

CROP VALUES
BURNT RIVER PROJECT

CROP	ACRES	YIELD Per Acre	CROP VALUES Per Acre	Total
Cereals	1,150	50 Bu.	$45.91	$ 52,800
Hay	8,800	2-3 Tons	46.00	404,800
Irrigated pasture	4,750	5 AUM	25.00	118,750
Other	1,070	-	80.52	86,155
TOTAL	15,770	-	-	$662,505

Data Source: Adapted from U. S. Bureau of Reclamation Crop census - 1964.

The other crops included potatoes, alfalfa seed, peaches, vegetables, and berries from family gardens. The greatest income per acre was derived from alfalfa seed and family gardens.

Recreation

Surface water rights for recreation total only 0.53 cfs and ground water rights, 0.13 cfs in the Powder Basin.

Water is the prime attraction, generally, for recreational development whether along the Eagle Cap Wilderness Area, around Anthony Lake, or in the Snake River gorge. The demand for outdoor recreation based on these resources is multyplying rapidly.

Principal water-based activities include fishing, boating, skiing, camping, swimming, and sightseeing. Associated recreational activities include hunting, furbearing animals, upland game birds, big game, and waterfowl.

The rivers and reservoirs, in or adjacent to the basin, provide areas for the rapidly expanding water-based recreational use. Basin waters provided about 311,500 visitor days of usage in 1965. See Recreation, under Economic and Related Natural Resources, for a more general coverage of this subject.

Power

There are 16 power rights for water within the Powder Basin totaling 111.9 cfs. These quantities are far overshadowed by the 2 Idaho Power Company rights at Brownlee and Oxbow Dams on the Snake River totaling 51,000 cfs.

Of the 16 power rights within the basin, only 6 are active (Table 29), at the present time. These include the California-Pacific Utilities Company's plant on Rock Creek with an

TABLE 29

ACTIVE
HYDROELECTRIC POWER RIGHTS

NO.	RIGHT HOLDER	AMOUNT Cfs	INSTALLED CAPACITY kw	STREAM	LOCATION Twp.	Rng.	Sec.
A-9862 P-6536 C-6128	Eastern Oregon Light & Power Co. (Cal. Pac.)	3.0	200	Powder River	9S	40E	28
C-4120	Eastern Oregon Light & Power Co. (Cal. Pac.)	13.0	800	Rock Creek	8S	38E	7
C-9608	City of Baker	3.5	120	Goodrich Cr., etc.	8S	38E	35
HE 187	Cornucopia Gold Mines	9.3	-	Pine Creek	6S	45E	23
HE 161	Idaho Power Co. (Oxbow Dam)	26,500.0	190,000	Snake River	7S	48E	9
HE 188	Idaho Power Co. (Brownlee Dam)	24,500.0	360,400	Snake River	8S	47E	25

Data Source: Oregon State Engineer and Public Utility Commissioner.

installed capacity of 800 kilowatts (kw) and the City of Baker's 120 kw plant which uses Goodrich Creek water. The other rights have not been used for power production in recent years.

Good undeveloped power sites within the basin are scarce according to data supplied by cooperators. Ample power, however, is available presently from the aforementioned utility companies.

With completion of the Hells Canyon project, Idaho Power Company's projects will make multipurpose use of a 93-mile stretch of the Snake River and produce over 1,000,000 kw of power.

Fish Life

There are 3.06 cfs of nonconsumptive water rights for fish life in the Powder Basin. Two rights accounting for 3.0 cfs exist at stream mile 15 on Eagle Creek for a private fish pond and hatchery. Two other small rights are for fish ponds on North Powder River and Goodrich Creek.

Historically, each of the basin's major stream systems supported important runs of spring chinook salmon and steelhead trout. However, the encroachment of civilization has caused a steady decline in these species.

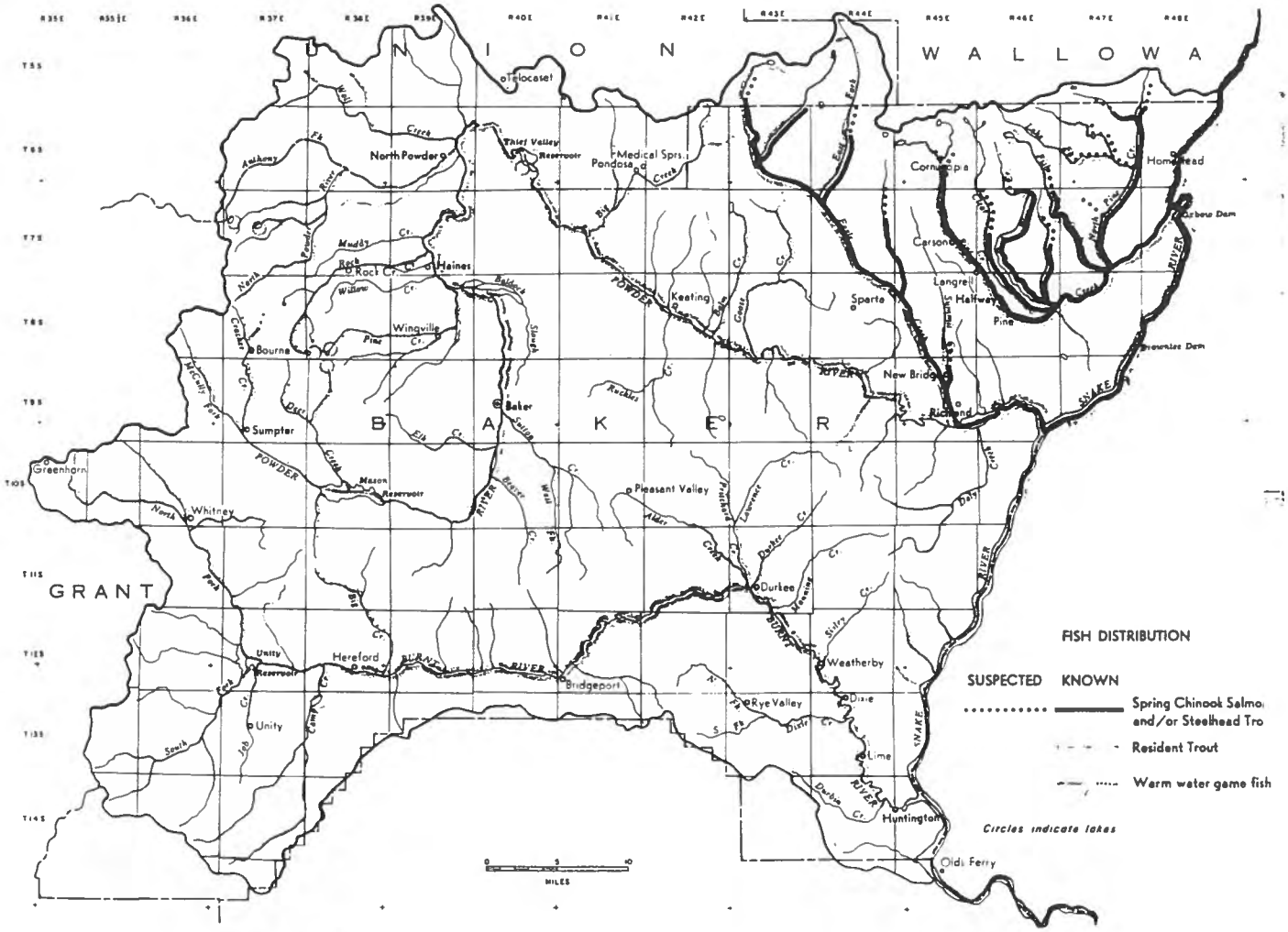
According to the Fish Commission of Oregon, anadromous fish moving to the upper reaches of the Middle Snake River to spawn now must pass 4 dams, and future runs could be faced with 10 dams, when those being constructed or planned, are completed. From an average run of about 17,000 fall chinook during the years immediately prior to the construction of Oxbow and Brownlee Dams, the run has dwindled until, in 1965, there were only 1,000 fall chinook in the run. Spring chinook and steelhead also have declined drastically in the Middle Snake River.

Primarily responsible for this is the inability, to date, to solve the problem of passing downstream migrants through the extensive, slackwater reaches of Brownlee Reservoir. In view of this, the responsible state and federal fisheries agencies recently adopted a policy which will result in placing all fish, now migrating upstream of the proposed High Mountain Sheep damsite, in hatcheries.

Currently, all fall chinook are collected below Oxbow and handled in a hatchery nearby. About 300 spring chinook of the remaining run are collected and the eggs handled at a hatchery on Rapid River, a Salmon River tributary. Last year some 250 adult steelhead were held in Oregon for eventual

incubation of the eggs and rearing of the young at one of the Idaho hatcheries. The last of the Eagle Creek salmonids are being transported to other stream systems below Hells Canyon Dam.

Figure 28 shows the distribution of resident and anadromous fish as of 1965.



DATA SOURCE: Oregon State Game Commission

FIGURE 28. Fish Distribution

The Oregon State Game Commission's 1966 planting of legal-size rainbow trout included 46,940 for Baker County. Several thousand fingerlings were airdropped into the high mountain

lakes. The largest trout populations occur in those higher elevation streams and lakes which maintain adequate volumes of good quality water throughout the year. A notable exception is Unity Reservoir, a lower elevation impoundment, where planted trout often experience favorable water conditions. Rainbow are the most plentiful trout in the basin, with brook trout common in certain headwater lakes and streams. Other trout species and whitefish are recorded occasionally in various streams.

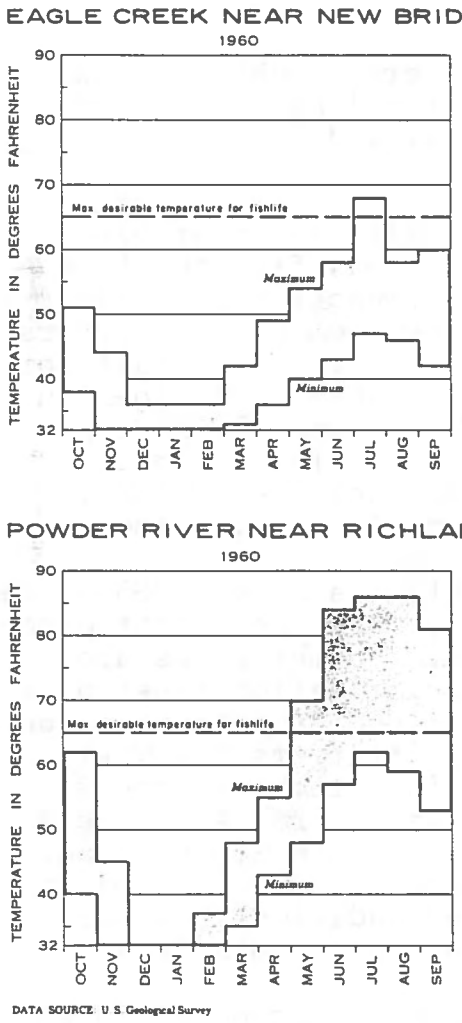


FIGURE 29. Water Temperatures - Eagle Creek and Powder River.

Figure 29 shows water temperatures of Eagle Creek and Powder River.

Warm-water game fish are established in a few reservoirs and in the lower portions of the Burnt and Powder River systems. These species, particularly channel catfish, commonly enter these two rivers from Brownlee Reservoir. That impoundment supports far greater warm-water game fish populations and associated angling pressures than any other water in or around the basin. Large and small mouth bass are using lower Eagle Creek for spawning and rearing purposes.

Several kinds of rough fish are abundant in most middle and low elevation streams and reservoirs. These fish are more adaptable than trout to the low, warm, turbid flows which prevail throughout much of the year in the lower elevation streams.

The Fish Commission of Oregon, through funds supplied by the U. S. Fish and Wildlife Service, conducted a fairly intensive survey of Powder River streams during the period between 1957 and 1959. The publication is entitled "Environmental Survey Report Pertaining to

Salmon and Steelhead in Certain Rivers of Eastern Oregon and the Willamette River and Its Tributaries," dated June 1960. These data were used extensively in determining the streamflow regimen of basin streams.

Water temperatures on Powder River exceed maximum desirable temperatures for fish life during May through September. Similar high summer water temperatures were recorded on Burnt River. Recorded water temperatures on upper Pine and Eagle Creeks were much better adapted to fish life habitat.

Well documented were enviromnental factors, such as streams that are intermittently dry in agricultural areas, streamflow estimates, streamflow temperatures, and habitat characteristics.

Pine Area - Perennial flows generally exist in lower Pine Creek as a result of irrigation return flows from the Pine Valley area. North Pine Creek has very meager summer flows due to three large interbasin diversions from its headwaters to the East Pine and Dry Creek areas. Water rights call for the diversion of over 9,000 acre-feet during the irrigation season. East Pine, Clear, and Pine Creeks usually have perennial flows above irrigation diversions. The 11 small irrigation reservoirs, which exist near their headwaters, supplement these flows for short periods in early summer.

Eagle Area - Eagle Creek and its tributaries above USGS-State Engineer Gage No. 2882 has the largest, most consistent perennial flows of the larger basin streams. Summer flows are supported for short periods by 5 small irrigation reservoirs near its headwaters. There is and will continue to be a conflict between irrigation and fish life interests for West Eagle Creek flows. The 38.4 cfs Phillips Ditch and the 8 cfs Trout Creek Ditch withdraw irrigation water from West Eagle Creek for the water-short Big, Balm, and Goose Creek areas. Upper West Eagle Creek is depleted frequently by those diversions. Future plans include developing additional summer flows and potential storage water from upper Eagle Creek.

Keating (Big Creek) Area - The Lower Powder Irrigation District frequently drains Thief Valley Reservoir for service of project lands. This occurrence severely limits the reservoir for fish and wildlife uses. The only apparent alternative is to enlarge the reservoir, setting aside a part of the capacity for fish, wildlife, and recreational purposes. Powder River normally has perennial flows near its mouth due to

irrigation return flows from this area.

Summer flows on Big, Balm, and Goose Creeks are dependent upon the vagaries of interbasin diversion and the needs of irrigated ranches. Big, Balm, and Goose Creeks may have flows usable for fish life until July 15, but the other streams frequently are dry by May 15 of normal water years. A Public Law 566 project is proposed for this area.

North Powder Area - North Powder River, Wolf Creek, and the smaller streams have streamflow patterns radically altered by diversion canals which penetrate high into the watersheds. For development plans under a Public Law 566 proposal, refer to the preceding Irrigation section of this report. Proposed reservoirs on the North Powder River and Wolf Creek should enhance the fish life and recreational potential. Perennial flows usually are present in upper Wolf, Anthony Fork, Antone, Dutch Flat, and Rock Creeks, as well as upper North Powder River at points above irrigation diversions. Most flows are supported by small irrigation storage reservoirs.

Middle Powder (Baker) Area - An agreement has been reached between the U. S. Bureau of Reclamation, the Oregon State Game Commission, and the Fish Commission of Oregon to release 10 cfs from the proposed Mason Dam for downstream fish enhancement. These flows would be maintained at all times, except during severe drought periods when the 10 cfs would be reduced in proportion to the irrigation shortages then being experienced.

Perennial flows exist, except during long cold periods, on Rock Creek above the California-Pacific Utilities Company's powerplant diversion canal. This flow is being maintained with the support of small storage reservoirs.

Upper Powder Area - Both McCully Fork and Cracker Creek normally have perennial flows in their upper areas. These flows are subject to large power, mining, and municipal rights, which are not being used extensively at the present time. Deer Creek has a small perennial flow above farmlands, supported by two small irrigation reservoirs.

Burnt Area - Before 1938, Burnt River at the mouth frequently had zero flows recorded in July or August back through the period of record. Since construction of Unity Dam, the zero flow frequency interval has been about 1 in 10 years. Summer flows are controlled by the Burnt River Irrigation District

for its paying customers who are irrigators, the cement plant at Lime, the Union Pacific Railroad shop at Huntington, and the Huntington municipal water system. In early summer, releases must be made from Unity Reservoir to supply basic needs, while return irrigation flows supply part of the Durkee to Huntington needs later in the summer. Appreciable flows exist only in the vicinity of Mammoth Springs on the South Fork Burnt River. This is a water-short area where only about one-half of the present water needs are being supplied from natural streamflow.

Wildlife

No water rights have been issued specifically for wildlife usage. The numerous springs and streams furnish fairly well distributed water supplies for high mountain areas, but lack of full-season water limits use in the central and southeastern semidesert portions of the basin.

According to the Oregon State Game Commission, the wildlife resources of the Powder Basin provide about 4 percent of the deer hunting, about 5 percent of the elk hunting, and about 1 percent of the fur harvest of the State of Oregon. This represents 7,600 deer hunters spending 38,770 recreation days to harvest 4,640 mule deer, 2,800 elk hunters killing 735 Rocky Mountain elk, and 650 fur pelts with a market value of $1,770.

Deer, elk, and upland game distribution is controlled rigidly by the availability of water and cover.

Pollution Abatement

Pollution abatement is not a major problem or water user in the basin due to the relatively small industrial development and a sparse population.

Baker and Huntington are served by lagoon-type sewage treatment plants with final disposal into the Powder and Burnt Rivers, respectively. Northern sections of Halfway, North Powder, and Baker have small urban unsewered areas with a high water table.

The Oregon State Sanitary Authority states that the existing works are adequate and that existing problems of pollution

control in streams and ground water are minimal. The existing treatment facilities require a 20 to 1 dilution factor for waste discharge entering the streams.

The method of domestic sewage disposal in areas not served by treatment plants is septic tank and disposal field. Pit privies are still used in isolated areas.

A small related problem of mosquito breeding areas exists around Brownlee Pool south of Richland, around Thief Valley Reservoir, east of North Powder, north and south of Baker, around Unity Reservoir, and south of Huntington.

North Fork Burnt River carries mine wastes that are filtered in lagoons fairly effectively before the water reaches agricultural lands.

WATER CONTROL

Flood Control

The history of the area includes periodic floods of serious magnitude. The greatest part of the damage occurs in Baker to public facilities, residential, and commercial properties. Damages outside the city involve agricultural lands and improvements, such as bridges, roads, fences, and utilities. In addition, flood waters inundate large acreages for long periods, reducing production and aggravating the drainage problem.

The most significant flood of record, in terms of damage in the basin, was on Powder River in February 1957. The peak discharge at Baker was estimated at 2,350 cfs. Damages were estimated at $250,000 with the City of Baker suffering $200,000 of this amount.

Flows in Powder River are typical of the streamflow regimen for the basin. Floodflows in Powder River occur from a combination of snowmelt and rains, with snowmelt as the dominant cause of most flows and rainstorms as a major factor in intermittent high flows of short duration.

Some floods occur from heavy snowmelt at lower elevations when ice still exists in the Powder River channel. This ice is carried downstream to structures at Baker and other points where it lodges and forces the floodwaters to inundate

adjoining land. Only a portion of this problem is expected to be alleviated when Mason Dam is completed.

Table 30 lists the acres subject to flooding in Powder Basin.

TABLE 30

FLOODING

STUDY AREA	ACRES
1. PINE MISC.	
(a) North Pine	-
(b) Pine	800
(c) Snake Misc.	90
2. POWDER	
(a) Eagle	60
(b) Keating	2,200
(c) North Powder	400
(d) Middle Powder	4,000
(e) Upper Powder	600
3. BURNT	
(a) Lower Burnt	250
(b) Upper Burnt	3,000
TOTAL	11,400

Data Source: USDA 1966 Cooperative Report.

About 11,400 acres of the basin's agricultural lands are flooded to varying degrees. Of this acreage, 80 percent is cropland and the remaining 20 percent is low-lying woodland and range, according to the U. S. Department of Agriculture's cooperative survey. Most of this land is along main rivers and tributary streams where the channel gradients are low and the banks are not well defined. Forest and rangelands, which have been burned over or too heavily grazed, also are subject to flood and erosion damage due to the steep gradients in much of the basin.

Flows are low consistently during the months of July through February, except on rare occasions when warm rains cause a rapid increase in flow. Usually flows increase in March and are high in April and May. Normally during June, flows are receding but occasionally during the month, warm rains cause some abnormally high flows. Annual maximum discharges occur during periods of high fluctuating flows which last from several days to several weeks.

The problem to agriculture resulting from floods include erosion, sedimentation, loss of crops, and damage to structures. Crop damage is minimized because most of the land is in sod-forming crops. Alfalfa and clover cannot be grown in some areas which are subject to serious flooding. Municipal and domestic water supplies, diversion works, and canals often are damaged by high water and sediment.

There is a need for more stream channel improvement, bank protection, and reservoir storage capacity to reduce flood damages.

Drainage

About 28,550 acres, or 11 percent of the arable soils in the basin, have a major wetness problem. Other wet soils either have been drained to a degree necessary for crop production or are used for purposes that do not require drainage. Plate 5 of the Appendix shows the general location of poorly drained arable soils.

The Middle Powder drainage area (Baker Valley) has the largest portion of poorly drained soils in the basin, as shown in Table 31.

TABLE 31

ARABLE LAND NEEDING DRAINAGE

STUDY AREA	ACRES
1. PINE MISC.	
(a) North Pine	-
(b) Pine	2,500
(c) Snake Misc.	-
2. POWDER	
(a) Eagle	1,500
(b) Keating	2,000
(c) North Powder	3,400
(d) Middle Powder	14,000
(e) Upper Powder	600
3. BURNT	
(a) Lower Burnt	400
(b) Upper Burnt	4,150
TOTAL	28,550

Data Source: USDA 1966 Cooperative Report.

Erosion

The U. S. Department of Agriculture's 1966 cooperative study indicates that damage to land from erosion, scour, and deposition is significant but very difficult to evaluate and probably is appraised inadequately to date.

Streamflow water quality is higher than in most basins due to the dominance of permanent vegetative cover on croplands. Much of the silt-laden floodwaters are spread over hay meadows where the soil particles are filtered before the water reaches larger valley streams.

Erosion presents a more serious problem on rangeland than on cropland in the Powder Basin. Most of the arable land is protected effectively from rill and sheet erosion by the growing of perennial sod-forming crops. However, when the perennial crops are removed for reestablishment or replacement by annual crops, care should be taken to insure that the soil is protected from erosion.

Studies indicate that about 190,000 acres of arable or potentially arable land are subject to erosion problems. Considerable land is lost through streambank erosion.

Water Quality

The chemical quality of the surface water in the Powder Basin generally is favorable.

Only one surface water sample, Baldock Slough northeast of Baker, showed fairly high concentrations of sodium bicarbonate and a very high specific conductance. (Specific conductance is a rough indication of the concentration of dissolved minerals.) Use of this type of water on presently alkaline lands or poorly drained soils where excess salts could not be leached downward would result in an adverse effect on crop yields. The analyses of samples of river water show a higher chemical concentration during low flows and a general increase in mineral concentrations in a downstream direction.

Other specific water quality data are discussed under the preceding Domestic, Municipal, Irrigation, Fish Life, and Flood Control sections.

The Oregon State Sanitary Authority reports that the few domestic and recreational water pollution problems within the basin occur because the sources are not developed or protected properly.

The characteristics most important in determining suitability of water for irrigation in the Powder Basin are the total concentration of soluble salts, the concentrations of boron that may be toxic to farm crops, and the relative proportion of sodium to the principal cations in the water. These characteristics then must be compared with planned use because alkaline or poorly drained soils will not tolerate salt concentrations which could be used on free-draining sandy soils. Areas analyzed with higher-than-desirable sodium and salinity characteristics, careful chemical analyses should be made of water from other nearby wells which may tap similar ground water before considering use of the water for irrigation or domestic purposes.

Of the 185 wells tested between 1947 and 1965, 11 samples were chosen. Most other wells tested were within limits which generally are accepted for chemical water quality. A comparison of the analyses of ground and surface waters shows that the ground water generally has greater concentrations of dissolved minerals than the surface water.

Known problem-area wells are located and their analyses given in Table 32.

TABLE 32

MINERAL ANALYSES OF PROBLEM AREA WELLS
Parts Per Million

	WELL LOCATION AND NUMBER*									
	8/39 - 1J1	8/39 - 24K1	8/40 - 19D1	8/40 - 19D2	8/40 - 30Q1	9/40 - 15G1	9/40 - 16H1	9/40 - 16J1	11/43 - 28D1	12/40 - 26P1
Depth of Well/Feet	24	7.5	13	-	21	740	600	-	900	-
Calcium	15	85	3.4	9	11	12	14	13	0.8	18
Magnesium	4	35	2.9	4	6.8	7.6	7.3	15	1	6.7
Sodium	187	294	289	336	290	175	172	185	212	397
Potassium	3.0	6.3	13	20	15	9.8	9.8	10	1.6	15
Carbonate	0	0	19	39	17	0	0	0	82	0
Bicarbonate	311	802	634	604	608	476	543	573	372	1,150
Sulfate	102	249	81	98	76	12	1	1	12	1
Chloride	79	91	18	25	15	14	18	18	12	24
Boron	3.27	Tr.	0.47	0.88	0.48	1.9	1.6	1.8	3.6	2.3
Specific Conductance	986	770	1,070	1,100	940	600	650	650	871	1,590
pH	7.6	7.8	9.2	9.2	8.3	8.1	7.9	8.0	9.4	7.8

*Numerals that precede hyphen indicate township and range.
Data Source: Oregon State Engineer, U. S. Geological Survey and SWRB Records.

The few ground water analyses (Table 32) are not intended to represent the chemical quality of all ground water in any specific area. They do indicate, however, that there is a wide variation in the chemical quality of ground water in some Baker Valley and Burnt area locations.

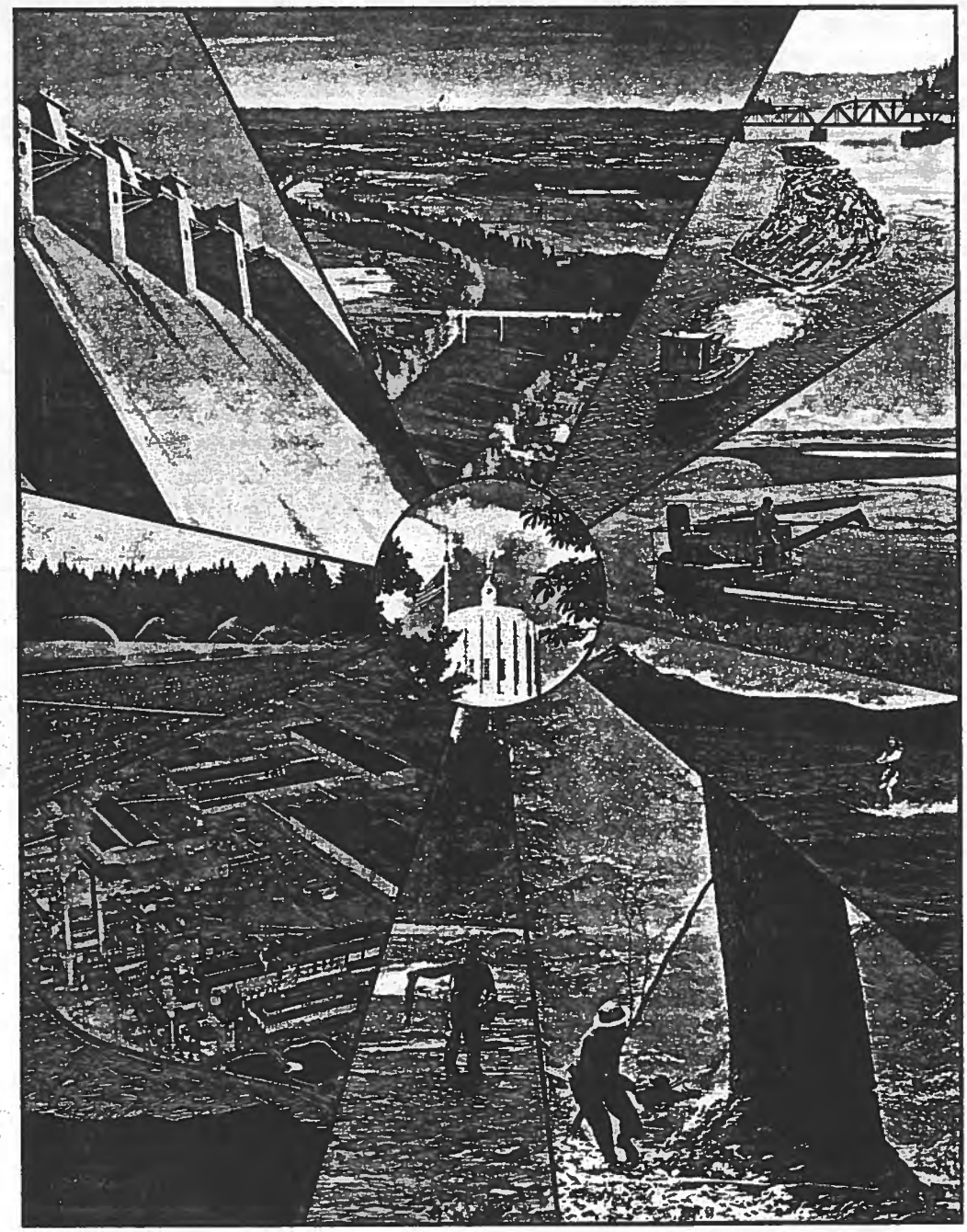
Analyses of samples from 5 wells north and east of Wingville and 3 wells in and around Baker indicate that the water from those wells may be undesirable for irrigation purposes owing

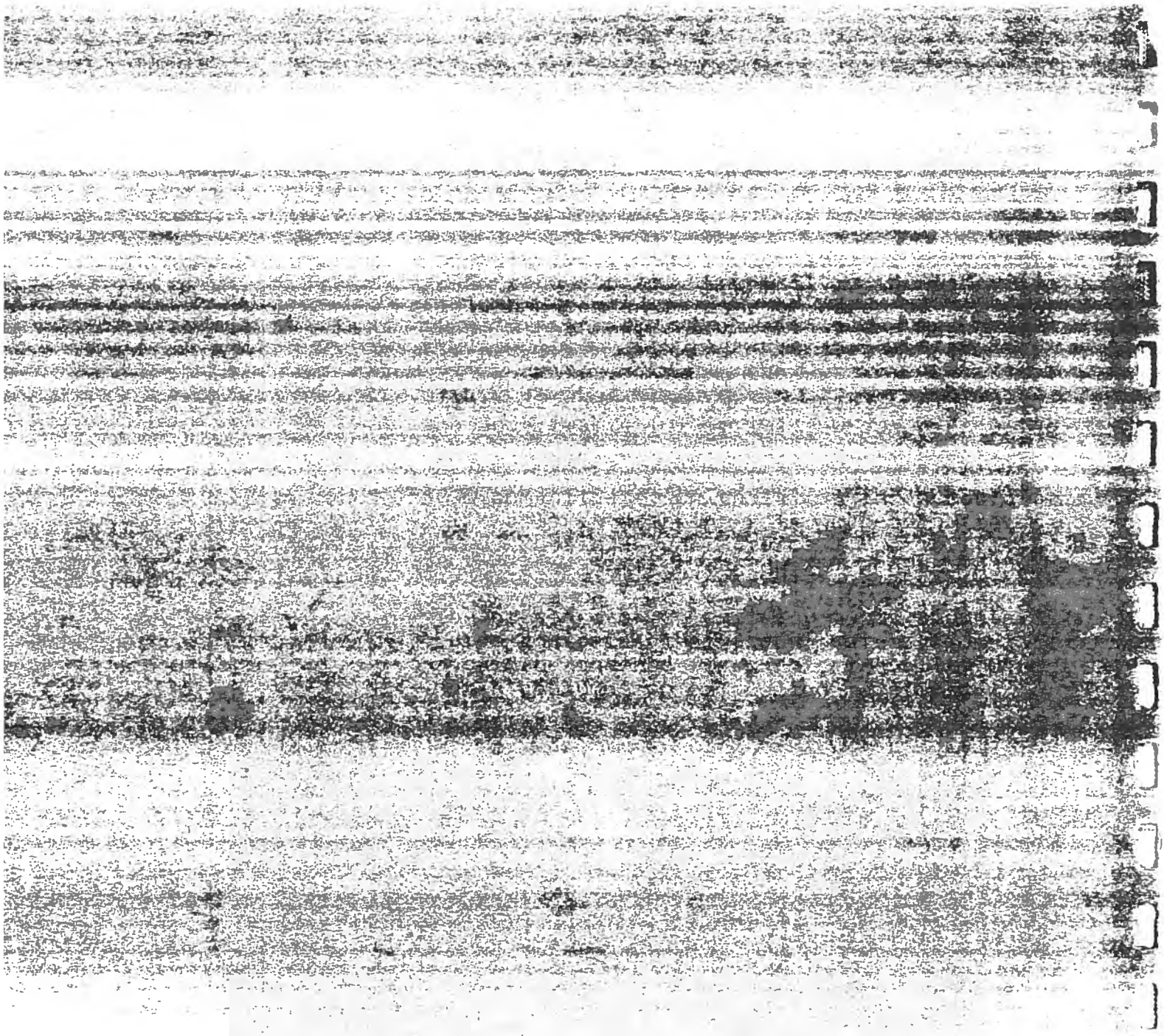
to relatively high concentrations of boron (except 8/39 - 24K1) and sodium. One well in the Wingville vicinity (8/39 - 1J1) had concentrations of boron of 3.27 parts per million (ppm) that would be toxic to even the most boron-tolerant plants.

Table 32 shows the analyses of 2 Burnt area wells which may be undesirable for irrigation purposes owing to relatively high concentrations of boron (3.6 and 2.3 ppm) and sodium. A sample (not shown) from another well (12/38 - 27A1) contained 205 ppm nitrate, which is far in excess of the 45 ppm maximum allowable in drinking water according to standards set by the U. S. Public Health Service. Most of the Burnt area wells produce domestic water which requires use of a water softner.

The presence of potentially toxic amounts of sodium salts and boron indicates that ground water, from a few problem areas, should be checked for chemical quality before it is used for human consumption or applied to crops.

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 IV

POTENTIAL DEVELOPMENT

GENERAL

Studies indicate that the water resource potential development of the Powder Basin is about 35 percent greater than the present level. Such development, from both surface flows and ground water, would increase the irrigated acreage from 135,000 to 185,000 and would increase other consumptive uses proportionately.

Table 33 indicates the potentially irrigable acres, capacity of studied storage sites, and most practical import possibilities by area.

TABLE 33

POTENTIAL IRRIGABLE AREA
& SOURCE OF SUPPLY

STUDY AREA	SOURCE OF SUPPLY				POTENTIAL STORAGE
	STREAM-FLOW Acres	STORAGE, IMPORTS Acres	GROUND WATER Acres	TOTAL Acres	Acre-feet
1. PINE MISC.					
(a) North Pine	-	-	-	-	-
(b) Pine	-	2,000	-	2,000	14,400
(c) Snake Misc.	100	6,500	-	6,600	16,500*
Total	100	8,500	-	8,600	30,900*
2. POWDER					
(a) Eagle	-	3,000	-	3,000	3,200
(b) Keating	1,800	12,100	-	13,900	80,850*
(c) North Powder	3,000	9,200	-	12,200	63,050
(d) Middle Powder	-	29,700	2,500	32,200	2,900
(e) Upper Powder	-	2,600	-	2,600	100,000
Total	4,800	56,600	2,500	63,900	250,000*
3. BURNT					
(a) Lower Burnt	450	7,850	1,800	10,100	19,700
(b) Upper Burnt	150	9,850	-	10,000	64,400
Total	600	17,700	1,800	20,100	84,100
TOTAL	5,500	82,800	4,300	92,600	365,000*

*Includes imports.
Data Source: USDA 1966 Cooperative Report.

These projections are based on constructing storage reservoirs with a nominal carry-over capacity and assuming a

maximum 30 percent shortage during periods comparable to the dry years of record. Factors not fully analyzed but, which might provide still further development, include ground water pumping, return flows relative to use on lower lying lands, interbasin diversions, and pumping from the Snake River.

Plate 4 and Table G in the Appendix further locate the basin's water resource development potential. Poor seasonal distribution of surface water can be improved by storage, in many places. More detailed studies are needed on the proposed storage sites.

Table 34 lists the estimated future diversion requirements for domestic, municipal, industrial, and irrigation purposes by area. As shown under the column "Average, Shortage, or Surplus," Pine and Eagle Creeks are water surplus areas, while Powder and Burnt Rivers are water-deficient areas. Table 34

TABLE 34

ESTIMATED
FUTURE DIVERSION REQUIREMENTS
Acre-feet

STUDY AREA	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	TOTAL	AVERAGE SHORTAGE OR SURPLUS*
1. PINE MISC.	200	100	200	99,500	100,000	+ 100,000
2. POWDER						
(a) Eagle	200	70	130	47,600	48,000	+ 192,000
(b) Keating	700	-	-	146,300	147,000	- 81,000
(c) North Powder	1,500	200	1,400	254,700	258,000	- 100,000
(d) Middle Powder	2,500	5,000	100	312,400	320,000	- 146,000
(e) Upper Powder	350	50	-	11,600	12,000	- 3,000
3. BURNT						
(a) Lower Burnt	1,200	300	300	61,200	63,000	- 42,000
(b) Upper Burnt	900	-	100	102,000	103,000	- 45,000
TOTAL	7,550	5,720	2,230	1,035,500	1,051,000	- 125,000

*Rounded to the nearest thousand.
Data Source: USDA 1966 Cooperative Report and SWRB Correlations.

shows a basin shortage of 125,000 acre-feet but does not reflect the present uneconomic Pine Creek source.

To fully develop the interior portions of the basin at least 125,000 acre-feet of additional imports would be required for

consumptive uses and an undetermined quantity for nonconsumptive uses, such as fish life enhancement and recreation.

As in the past, future irrigation requirements will equal over 98 percent of the total consumptive water requirements for the basin. Nonconsumptive requirements, as presently used, do not materially alter the stream regimen and, therefore, must be determined on an individual project basis.

When considering the Snake River as a water source, there is adequate water to supply basin needs, but the economic justification for extensive use of this source does not exist presently.

Table 34 is based on assumptions which must be varied for individual projects but should reflect quite closely the water quantities to be developed for each study area. The storage requirement is based on 4.5 acre-feet per acre for irrigable land, of which 1.5 acre-feet per acre is for diversion and other watershed losses, 1.5 acre-feet per acre is for consumptive irrigation water, assuming an irrigation efficiency of 50 percent, plus effective rainfall of 0.5 acre-foot. According to the water budget computations, about 1.0 acre-foot per acre of return flow would be available for further use downstream in those areas where it could be captured for reuse.

Domestic and municipal requirements are based on present needs of about 260 gallons per capita per day, plus projected future growth requirements. Industrial requirements are based on present needs, plus a nominal future growth.

Supplemental irrigation requirements used in developing Table 34 are based on an average additional requirement of 1.0 acre-foot per presently irrigated acre. The actual requirement will vary from under 0.5 acre-foot on lands served by early water rights to almost 1.5 acre-feet on lands having only flood water rights. Ground water and Brownlee Pool withdrawal needs for the table are based on pumping between 2.0 and 2.5 acre-feet per irrigable acre through pressure distribution systems.

Detailed surveys will be required to determine the portion of these water needs that can be obtained economically by storage, interbasin diversions, ground water, the Brownlee Pool, improvement of water distribution systems, greater use of return flows, and importation. Due to location, only a part of the appreciable yield from the Eagle and Pine Creek areas can

be used presently for basin development purposes.

Local interests have proposed that a portion of the Eagle Cap Wilderness boundary, lying for the most part in Baker County, be shifted to allow the owners of several reservoirs access with modern machinery, for the purpose of maintenance and/or further development.

The proposed boundary adjustment is based on deleting the designated reservoir and access areas from the wilderness and adding certain lands in the upper Minam River drainage to the wilderness, where management complications are less involved.

Consideration also was given to boundary changes in the upper Eagle and West Eagle Creek drainages lying within the wilderness. However, due to administrative complications and a large area transfer from the wilderness, the proposal was dropped for the present.

Approximately 13 sections are involved in the boundary change, as shown on Plate 4 of the Appendix.

The reservoirs involved and their respective priority dates are shown in Table 35.

TABLE 35

EAGLE CAP RESERVOIRS

RESERVOIR	WATER RIGHT PRIORITY DATE	TYPE OF RIGHT
Clear Cr. Res.	1921	Certificate
East Lakes Res.	1903	Adjudication
Red Mountain Res.	1935	Certificate
Pine Lakes	1903	Adjudication
Looking Glass Lake	1917	Certificate

Data Source: Oregon State Engineer.

Reservoir owners in the Eagle Cap Wilderness are required to maintain their facilities in good repair. However, the owners are hampered in performing the necessary work by federal restrictions and regulations.

The records show that the present wilderness involving 220,416 acres was not established until 1940, whereas, the reservoir priority dates vary from 1903 to 1935. A shifting of the boundaries would return effective use of the reservoirs to the water users and simplify Forest Service administration of the area.

POTENTIAL DEVELOPMENT

Basin Needs

Present diversion within the Powder Basin, resulting from irrigation of agricultural lands, use of water for rural, urban, and industrial purposes, averages 583,000 acre-feet annually. Present divertible supplies are surplus to present needs by about 212,000 acre-feet before consideration is given to other needs and unavoidable distribution losses. By constructing investigated storage reservoirs, pumping from Snake River, constructing interbasin diversions, and utilizing available ground water, the potential divertible supplies can be increased by about 365,000 acre-feet.

By adding all diversion needs in the foreseeable future, the annual shortage will be about 125,000 acre-feet, plus unavoidable losses, water for fish life, recreational purposes, and pollution abatement.

Although detailed studies are needed in order to locate more ground water aquifers and identify their characteristics for areas reported on in this report, analysis of the relationship between precipitation, runoff, and consumptive use lends weight to the conclusion that there is sufficient ground water in some areas to supplement surface water sources for domestic needs, and the development of at least 4,300 acres of potentially irrigable lands. The economic and physical feasibility of developing surface and ground water should be determined concurrently in each area under consideration.

Future development dictates detailed studies of the development potential for interbasin diversions in the headwaters of Pine and Eagle Creeks, and the Powder and Burnt Rivers. Potential development would involve diversion of more of the Eagle and Pine Creek outflow to the semidesert areas in the eastern portion of the basin. An outline plan for the studies to be initiated in the future would involve diversion of water at high elevations and replacement by storage or pumping at low elevations.

Annual outflow from Powder Basin averages over 700,000 acre-feet but quantities in dry years are closer to 300,000 acre-feet. The geographical and seasonal distribution of runoff is such that only a portion of the runoff can be economically diverted for beneficial use. As shown in Table 33, studied storage and imports could conserve about 365,000 acre-feet for beneficial use. About 11,000 acre-feet could be developed from presently known ground water sources.

POTENTIAL DEVELOPMENT

Excess water exists in the high elevation Wallowa Mountain bench and lake areas which is available for interbasin diversion to drier areas of the basin. Below this level to just above the agricultural valleys, little development potential exists due to the precipitous nature of the topography and steep stream channel gradients. At lower elevations, numerous opportunities exist for multipurpose reservoirs which would handle more adequately present and future needs of valley residents. Snake River reservoir pools are additional sources for potential water resource developments.

A portion of these developments will be practical physically and economically in the near future, while the remainder must await economic justification. Due to the complications involved, such developments must be preceded by detailed surveys and plans. Problems to be investigated fully include: wilderness area regulations and limitations; development problems in the rugged, precipitous topography; equitable transfer of water rights involved; evaluation of soils for suitability under irrigation; economic justification for such developments; and full consideration of all potential needs as for domestic, municipal, industrial, irrigation, fish life, recreation, mining, and flood control purposes.

Agricultural Needs

Economic factors indicate that beef production supported by irrigated agriculture will continue to be the dominant productive enterprise of the basin. Due to the short growing season and remote location, farmers are at a disadvantage in marketing most products other than livestock and a limited variety of cash crops.

There is no known alternative for using rangeland other than for grazing animals. To utilize the range resources adequately, supplemental forage and pasture is needed from the irrigated land. Any improvement in range-carrying capacity will further increase the supporting needs from irrigated land. The dependence of the livestock man on his irrigated land feed base was clearly shown during the 1966 drought when basic herds had to be reduced and large imports of feed grains and hay were required.

Livestock holds its competitive advantage mainly due to the availability of low-cost forage from rangeland, irrigated pasture, and hayland. Although average yields from irrigated hay

and pasture land have been low cut to inadequate water supplies, the costs for irrigation have been low also. In most cases, irrigation costs have been limited to those of constructing and maintaining simple diversion structures and canals.

Recreational Needs

The Baker County Fish, Wildlife and Recreation Subcommittee offered the following conclusions and recommendations, which should be carefully considered in future developments.

(1) Full recreational development of the basin is curtailed due to reservoir fluctuations and low streamflows. This situation could be alleviated by more water storage and water manipulation, which would be designed to guarantee the fullest possible recreational development of present and future impoundments.

(2) Although all reservoir impoundments are primarily for irrigation purposes, their multipurpose aspects could be greatly improved. Excellent angling has been provided periodically at Unity Reservoir, while lack of a minimum pool level at Thief Valley Reservoir has made it impossible to realistically manage a fishery program.

(3) The upper lake and stream areas provide excellent recreational potential, while lower streams have a limited potential due to low summer flows. All future impoundments should provide minimum pools and downstream flows to permit maximum recreational development.

(4) The famous Cornucopia mining area excels in scenic beauty and historic lore, which is not fully utilized.

(5) Strategically located parks, picnic sites, and boat ramps, throughout the basin, would materially enhance recreational use.

A program that has as its goal the stabilization of natural

and artificial waters, the efficient distribution of water, and the maintenance of dependable and clean water supplies will be of much benefit to the valuable wildlife and fish life resources.

Fish Life Needs

On December 22, 1965, the Oregon State Game Commission presented a report to the State Water Resources Board pertaining to the fish and wildlife resources of the Powder Basin. A principal goal of their study was to recommend a minimum streamflow regimen for the several streams and their tributaries sufficient to accommodate fish movements, reproduction, and rearing closer to levels that the streams formerly supported.

The Oregon State Game Commission's list of recommended flow is included in Table D of the Appendix. Present studies and the Game Commission's statements indicate that streamflows are available to meet only a part of these needs.

Flow consideration should be given to trout whose spawning and rearing requirements exist throughout the year. Low, warm flow volumes in summer months contribute most to depleted trout populations in many streams.

Following are a part of the Oregon State Game Commission's statements pertaining to basin cooperative studies:

"The following eight stream areas are of greatest importance for current fish production and angling:

1. Eagle Creek drainage above Little Eagle Creek.
2. North Powder River and Anthony Fork drainages above their confluence.
3. South Fork Burnt River.
4. North Fork Burnt River.
5. Powder River upstream from Baker, including its tributaries Cracker and Deer Creeks, and McCully Fork.
6. Pine Creek drainage (Snake River tributary).

7. Wolf Creek and Clear Creek drainages above their confluence.

8. Upper Pine and Rock Creek drainages (Powder River tributaries).

"If acceptable minimum flow volumes in these areas cannot be integrated into the Board's forthcoming water-use program, the Commission urges programing which will protect existing volumes from excessive future appropriation. All high elevation lakes providing trout angling also should be considered for protection.

"Other streams and reservoirs have substantial habitat potentials, but the present lack of acceptable flows prevents existence of desirable fish life.

"High turbidities accompanying low, warm flows have been widespread for several decades. Extreme siltation resulting from mining activities have severely affected the fish spawning and rearing capabilities of Powder River, Burnt River and other streams. Although most mining operation which created heavy silt loads were terminated prior to 1960, fish habitat recovery will take many years if left to the natural corrective processes. This can be accelerated materially if better streamflow regimens are provided and other corrective measures applied.

"Because of the large fish enhancement potential in the Powder Basin, any storage or water quality improvement proposal should include full consideration of fish life benefits."

Drainage Needs

Baker Valley has about one-half of the 28,550 acres of poorly drained soils in the basin. About four-fifths of the excessively wet soils need to be drained for better crop production. The elimination of prolonged flooding on some of the land may be prerequisite to successful drainage. About two-thirds of this land could be served by open drains while the remainder needs tile drainage. Besides increasing production drainage would increase, to some degree, the number and variety of crops that could be grown.

In locations, such as the Pine, Baker, and Lower Powder

Valleys, ground water pumped to lower the water table could be used for irrigation purposes. Alkalinity or salinity, however, is a factor in over one-half of the poorly drained lands and may be a limiting factor in recycling ground water. More studies will be required to determine which alkaline soils will react to leaching with irrigation water. Seepage waters from irrigated land also are a common cause of drainage problems. Frequently, the adverse effects of seepage can be eliminated by using interceptor ditches or tile drainage lines.

Pollution Control Needs

Rangeland with steep slopes, unstable soil characteristics, and overgrazing provide conditions conducive to severe erosion and soil movement. Improved range management and proper placement of stock water facilities have done much to reduce range deterioration, increase water availability, and improve water quality. There is need to protect banks with rock and vegetation and to remove gravel bars, driftwood, and brush in places where obstructions restrict flow and cause channel cutting. Such structural developments will help to reduce operating costs and improve water quality which is vitally important to the full use of basin water resources.

The state and national policy is to maintain reasonable standards of purity of the water of all rivers, streams, lakes, and watersheds of the state consistent with the protection and conservation of public health, recreational enjoyment of the people, the economic and industrial development of the state, and for the protection of human life and property and conservation of plant, aquatic and animal life. Water quality problems developing in Oxbow and Brownlee Reservoirs are now receiving attention.

As more industries develop in or near urban areas, additional pollution control facilities will be required.

Water Right Adjustments

The 86 surface water rights for mining purposes total 588 cfs for an annual legal withdrawal of about 426,000 acre-feet. Only a few of these rights presently are used for their intended purpose, while most of this water, for many years, has been used for other purposes. The Powder Basin, however, is

one of the three principal mineralized areas in the state. A change in the price of gold, even though presently not foreseen, a prolonged national recession, or involvement in a major war are factors that could result in a reactivation of the basin's mining which was a mainstay to the basin's economy during the great depression of the 1930's. Although mining warrants consideration as a continued permissive use of water, actual beneficial use remains the criteria for holding a water right in good standing. Those rights that have not been exercised for five or more years should be cancelled as provided by statute. New rights would have to be obtained for properties subsequently reactivated. Where use is other than authroized by right, the holder of the right should apply to the State Engineer for change in use and/or point of diversion as provided by statute.

Table 36 lists the acre-feet of water required to satisfy nonconsumptive surface water rights.

TABLE 36

NONCONSUMPTIVE SURFACE WATER RIGHTS
Acre-feet

STUDY AREA	POWER	MINING	FISH	RECREATION	TOTAL
1. PINE MISC.					
(a) North Pine	0	0	0	0	0
(b) Pine	9,796	65,884	0	0	75,680
(c) Snake Misc.	36,924,000	3,258	0	0	36,927,258
2. POWDER					
(a) Eagle	19,888	101,519	2,172	0	123,579
(b) Keating	181	3,837	0	181	4,199
(c) North Powder	40,645	23,168	30	203	64,046
(d) Middle Powder	2,172	22,263	14	0	24,449
(e) Upper Powder	7,602	17,159	0	0	24,761
3. BURNT					
(a) Lower Burnt	724	79,807	0	0	80,531
(b) Upper Burnt	0	108,817	0	0	108,817
TOTAL	37,005,008	425,712	2,216	384	37,433,320

Data Source: Oregon State Engineer.

Specific areas with the greatest potential for reactivation of mining operation are in upper Pine Creek, the Sparta area, the Pondosa area, above Sumpter, along upper North Fork Burnt River, and along Dixie Creek in Rye Valley.

POTENTIAL DEVELOPMENT

Of the 16 power rights for water use within the basin, only those used by the California-Pacific Utilities Company's plant on Rock Creek and the City of Baker's plant are now active. As in the case of mining rights, unused power rights should be either transferred, updated, or rescinded so that full use can be made of the basin's water resource potential.

Future development of the water resources of this basin is dependent upon provision for adequate storage, diversion and transmission facilities, control of the quality of surface return flows for reuse, maximum utilization and protection of ground water supplies, improvements in methods of control and application, and the desire and economic ability of water users to develop the existing potential.

If maximum use of the water resource is to be achieved, compromises will be necessary and all beneficial uses must be considered in project planning and development.

A joint agency Powder Basin review should be established to achieve the benefits of the multipurpose concept of basin planning. There is need to coordinate individual project plans into basinwide plans. There are several U. S. Department of Agriculture's Public Law 566 proposals and U. S. Bureau of Reclamation's proposals that probably will be modified materially during joint agency reviews. Use of Eagle Creek water in the Keating area has not received joint agency consideration.

The following sections summarize the physical and economic characteristics, water supply and distribution, and potential water-related needs and problems, by major stream system, as they coincide with designated study areas.

Pine Area (1)

The Pine area, as designated, includes Pine Creek and small streams which flow directly into the Snake River. This area, with an average annual runoff of 200,000 acre-feet, has sufficient surface water to support its future domestic, municipal, and industrial growth; increase the present irrigated acreage by 8,600; and handle other beneficial needs, such as recreation, fish life, and pollution abatement. Requirements can be met by constructing relatively small impoundments in the watersheds, pumping from Snake River pools where potentially irrigable lands border the river, and by improving water distribution systems.

POTENTIAL DEVELOPMENT

Estimates of need indicate that an additional 34,000 acre-feet would be required to fully develop the resource potential. The best sources are from storage and the Snake River.

Four reservoir sites, with a total storage capacity of 14,400 acre-feet (Appendix, Plate 4), were investigated in the watershed. Table 37 lists irrigation data for the Pine study area.

TABLE 37

PINE CREEK IRRIGATION DATA

STUDY AREA	IRRIGATED Acres	POTENTIALLY IRRIGABLE Acres	LEGAL RIGHTS		RESERVOIR CAPACITY	
			SURFACE Acre-feet	GROUND Acre-feet	EXISTING Acre-feet	POTENTIAL Acre-feet
1. (a) North Pine	50	-	9,577*	0	0	-
(b) Pine	19,100	2,000	49,909	167	5,437	14,400
(c) Snake Misc.	600	6,600	4,484	0	100	-
TOTAL	19,750	8,600	63,970*	167	5,537	14,400

*Includes three large interbasin diversions to Dry and East Pine Creek valleys.
Data Source: Oregon State Engineer, USDA 1966 Cooperative Report and SWRB Estimate.

Ground water has and probably will continue to supply a nominal portion of the area's water needs. Although several good wells have been developed (Table 18), there are insufficient technical data available concerning the ground water potential to make reliable appraisal of quantities available for future use. Therefore, it is important that studies be conducted to identify the location and physical characteristics of the major ground water aquifers, including safe annual yields from these aquifers, possible recharge programs, and cost of developing this water. These studies should be conducted simultaneously with present surface water pumping and storage investigations in order to make full use of the area's water resources in providing for future needs.

Potential development includes a Public Law 566 proposal on East Pine Creek, which has been approved for planning. This project to develop water for irrigation, fish life, recreation uses, flood protection, channel improvement, and irrigation system rehabilitation appears to be feasible. A similar

project could be developed for the Benson Creek area (south of Huntington) according to the U. S. Department of Agriculture's 1966 cooperative report.

Reference is herewith made to the State Water Resources Board's hearing of July 7, 1961 in the matter of the application of Pine Valley Development Group to appropriate water of East Pine Creek for an irrigation and flood prevention project and the board's resolution (see Appendix), dated June 5, 1962. Board determinations included the request for additional planning activities to develop information sufficient to determine feasibility of meeting the following objectives: (1) replacing spawning gravel; (2) utilization of flows to enhance the fishery; (3) mitigation for loss of fish habitat; (4) maintaining minimum streamflows; (5) providing fish passage at diversion structures; and (6) improving water quality.

In a meeting on August 22, 1966 between staff members of state and federal agencies, the group generally concurred in the belief that the present change from an anadromous to a resident fish resource would alter the compliance with items (1) and (3) above, but that it would not alter materially the need for compliance with items (2), (4), (5), and (6).

Field studies by the Soil Conservation Service indicated the Mehlhorn Mill site on East Pine Creek was the best location to store water for supplemental irrigation of the 19,100-acre Pine Valley. Construction of this reservoir would be beneficial for flood control, irrigation, fish life, and recreational purposes. Due to legal requirements under Public Law 566, physical limitations on the water supply and economic justification for construction features, it would appear that item (4) above would be the most difficult to attain. Construction plans should include consideration of provisions for fish-passage facilities at diversion structures, a minimum reservoir pool, and a provision for releasing highest quality water from the proposed reservoir. The average annual runoff of East Pine Creek, at the mouth, has been determined to be approximately 30,000 acre-feet.

Proposed plans include a 10,000 acre-foot reservoir with a minimum pool of 50 surface acres or 1,100 acre-feet. The U. S. Forest Service has plans for camping and recreational facilities around the reservoir. All water possible is needed to supply irrigation to irrigable lands in Pine Valley. Nevertheless, uses under consideration are possible municipal needs, fish life needs, recreational uses, and flood control.

POTENTIAL DEVELOPMENT

This development would be beneficial to Pine Valley and the State of Oregon and should be given maximum support and assistance. Full consideration is being given to the board's six above-stated objectives.

Domestic, municipal, and industrial water use in the Pine area is only 400 acre-feet annually, with a nominal anticipated increase in the future. Irrigation is the largest consumptive water user with diversion requirements of about 65,600 acre-feet to serve 19,750 acres. Future irrigation requirements will increase to almost 100,000 acre-feet when 8,600 additional irrigable acres are developed.

About 2,000 acres of this irrigable land are around the fringes of Pine Valley, requiring Pine Creek water. The other 6,600 acres are along the Snake River or along Benson Creek in the southeastern corner of the basin, where water use can be either from ground water or the Snake River. For maximum crop production, supplemental needs for the inadequately irrigated land are about one acre-foot per acre. Potential irrigation development is limited to the above-stated acreage due to lack of suitable land within economic reach. The ultimate development will depend on more detailed soil, physical, and economic resource studies.

Certain Pine area (1b) waters have a very high potential for recreation, wildlife, and fish life purposes. These include upper Pine, East Pine, and Clear Creek above existing irrigation headworks; unappropriated return flows from irrigation in the lower Pine Creek canyon; and natural headwater lakes where use is not controlled by water rights.

Protection is needed for about 400 acres of cropland, which receive moderate damage from annual flooding, sediment deposition, and streambank erosion. About 2,500 acres of the Pine Valley irrigable soils need drainage to be more productive.

Future studies will be needed to develop more detailed information about surface water flows in the Pine area. Stream gages are needed on Pine Creek at its mouth, at stream miles 13.6 and 27.3, and on Clear Creek at stream mile 9.5 (Appendix, Plate 2). To improve the isohyetal map for projecting runoff from precipitation, a climatological station should be installed at the Fish Lake Guard Station.

Eagle Area (2a)

The Eagle area, with an average annual runoff of 243,000 acre-feet, has sufficient surface water to support its future domestic, municipal, and industrial growth; increase the present irrigated acreage by 3,000; and handle other beneficial needs, such as recreation, fish life, and pollution abatement. Requirements can be met by constructing relatively small impoundments in the watersheds, pumping from Brownlee Pool where it borders Eagle Valley, and by improving water distribution systems.

Eagle Creek has the best record of the basin for unappropriated perennial streamflow. Even on this stream, however, the major problem is a lack of season-long irrigation water supplies. This shortage could be alleviated partly by construction of some of the potential reservoirs. Table 38 lists four of the Eagle Creek potential reservoir sites.

TABLE 38

EAGLE CREEK POTENTIAL RESERVOIR SITES

SITE NAME	STREAM	CAPACITY Acre-feet	LOCATION Twp.	Rng.	Sec.
Upper Eagle Creek Reservoir	Eagle Creek	-	7S	44E	8
Empire Gulch (Eagle)	Empire Gulch	2,500	7S	44E	20
Lower Eagle Reservoir	Eagle Creek	-	8S	45E	7
Brooks Reservoir	Summit Creek	700	7S	45E	28

Data Source: Oregon State Engineer and USDA 1966 Cooperative Report.

The U. S. Bureau of Reclamation investigated another reservoir site with a large capacity on Eagle Creek near the mouth of East Eagle Creek. The study was dropped due to the anadromous fish problem, but should be reactivated due to present changed conditions. Empire Gulch, Summit Creek, lower Powder River, and natural Snake River flows within Brownlee Pool are additional potential sources for late-season water. The using of waters from within the Brownlee Pool area would require obtaining access rights from the Idaho Power Company.

Consideration should be given to making greater use of land

and water resources in this area, which has an appreciable development potential. Surveys have delineated 3,000 acres of potentially irrigable land in the Dry Gulch, Brooks Ditch, Fivemile, and Chalk Creek areas.

Typical needs are controlled late-season water supplies, more efficient use of floodflows, distribution system rehabilitation, and more efficient water application, mainly through sprinkler system usage.

Ground water has been and probably will continue to be used for domestic and municipal purposes, mainly, because the adjacent Brownlee Pool can supply any large quantity needs which may develop. Studies should be conducted jointly between storage and pumping of pool waters, in order to make full use of the area's water resources in providing for future needs.

Potential development includes a Public Law 566 Eagle area proposal, which has been approved for planning. A project to develop water for irrigation, fish life, recreational uses, flood protection, channel improvement, and irrigation system rehabilitation appears to be feasible. There may be some advantages to planning this development concurrently with the Big Creek watershed of the Keating area. A joint effort could supply all Eagle Valley needs and supplement needs in the Balm-Goose Creek area. Immediate studies of this potential development should be encouraged.

Domestic, municipal, and industrial water use in the Eagle area is only 300 acre-feet annually, with a nominal anticipated increase in the future. Irrigation is the largest consumptive water user with about 29,700 acre-feet used to serve 10,300 acres. Future irrigation requirements will increase to 47,600 acre-feet when 3,000 additional acres are developed around the fringes of Eagle Valley. About 6,000 acres now being irrigated need additional water after the first of July. Development of additional acreage would depend upon more detailed soil, physical, and economic resource studies.

It would appear that the best use of certain Eagle area waters would be for recreation, wildlife, and fish life purposes. Because Eagle and East Fork Eagle Creeks provide the main access to the Eagle Cap Wilderness Area, the increase in recreational use will be significant. These cold, clear streams with a high summer yield provide fish production and rearing advantages. The high mountain natural lakes and Eagle Creek

down to USGS-State Engineer Gage No. 2882, likewise, provide fish production and rearing advantages.

Protection is needed for channels, structures, and about 60 acres that are flooded annually. About 1,500 acres of the Eagle Valley irrigable soils need drainage, and some land leveling is desirable to increase land productivity through more efficient irrigation.

Future studies will be needed to develop more detailed information about surface water flows in the Eagle area. Stream gages are needed on Eagle Creek near its mouth and on East Fork Eagle Creek near its mouth. Gages should be reactivated above the juncture of West Eagle (No. 54 on Plate 2) and main Eagle Creeks (No. 56). To improve the isohyetal map for projecting runoff from precipitation, climatological stations should be installed on or near Bennet Peak and Little Lookout Mountain.

Keating Area (2b)

The Keating area is a water-deficient area, which must depend on water mainly from upstream sources, interbasin diversions, ground water, or the Snake River. Present water use is about 66,000 acre-feet, most of which is for the irrigation of 18,800 acres.

Water for an appreciable portion of the 13,900 acres of potentially irrigable land and for other potential uses probably could be obtained from upper Eagle Creek. Detailed investigations would be required to confirm the practicability of further storage development or diversion from upper Eagle Creek, and the replacement of lower Eagle Valley needs by either storage or pumping from Brownlee Pool. Another future possibility, which should be investigated, is the direct pumping from the Snake River to the Keating area, based on a water exchange with users in the upper basin to accomplish full development of the basin. About 81,000 acre-feet of additional water would be required to fully develop the area potential. It is possible that about 50,000 acre-feet of additional floodflow water could be diverted from Eagle Creek with a resultant benefit to all water users.

Eagle Creek floodflows above farmlands average 500 cfs in April and 1,000 cfs in May and June. These excessive flows cause considerable flood damage and are not beneficial to

resident fish life, recreation, or irrigation uses. About one-half of the stated flows originate in the main Eagle Creek above an elevation of about 5,000 feet. Interbasin diversion into Goose Creek probably could be accomplished from this watershed. Consideration also should be given to the former U. S. Bureau of Reclamation's storage site on Eagle Creek below the East Fork for the purpose of supplying Eagle Valley irrigation needs, flood control, recreation, and diverting floodflows to the Goose Creek area.

Six reservoir sites, with a combined storage capacity of 31,350 acre-feet, were investigated in the watershed. Consideration should be given to enlarging Thief Valley and Balm Creek reservoirs, as well as constructing several small reservoirs in tributary watersheds. It is conceivable that floodflows from West Eagle Creek could be stored at Balm Creek or other reservoir sites within this study area.

Table 39 lists the Big and Goose Creek potential reservoir sites with their storage capacity.

TABLE 39

BIG & GOOSE CREEK POTENTIAL
RESERVOIR SITES

SITE NAME	STREAM	CAPACITY Acre-feet	LOCATION Twp.	Rng.	Sec.
Park	Beagle Creek	12,200	6S	41E	14
West Eagle Creek	West Eagle Creek	1,800	6S	43E	5
Sanger Gulch	Goose Creek	2,550	7S	43E	10
Upper Site	Goose Creek	6,000	7S	43E	14
Lower Goose	Goose Creek	1,300	8S	43E	8
Sawmill	Sawmill Creek	7,500	8S	43E	12
	Total	31,350			

Data Source: Oregon State Engineer and USDA 1966 Cooperative Report.

Ground water has and will continue to supply a nominal portion of the area's water needs. Although a few good wells have been developed (Table 18), there are insufficient technical data available about the ground water potential to make

an intelligent appraisal of quantities available for future use. Therefore, it is important that studies be conducted to identify the location and physical characteristics of the major ground water aquifers, including safe annual yields from these aquifers, possible recharge from floodwaters, and the cost of developing this water. The studies should be conducted simultaneously with surface water storage investigations, in order to make the most economical use of the area's water resources in providing for future needs.

Potential development in the Big Creek portion includes a Public Law 566 application which has been approved for planning. A project to develop water for irrigation, fish life, recreation, flood protection, and land development appears to be feasible. There may be some advantages to planning this development concurrently with the Eagle area.

A Public Law 566 project was investigated but does not appear feasible under existing conditions for the Keating portion of this area, according to the U. S. Department of Agriculture's 1966 cooperative study.

Domestic water use in the Keating area is only 700 acre-feet annually, with little anticipated increase in the future. Irrigation is the largest consumptive water user with diversion of about 65,350 acre-feet to serve 18,800 acres. About 600 acres of this total are supplied supplemental water from ground water sources. Future irrigation requirements would increase to 147,000 acre-feet, if 13,900 acres of potentially irrigable land were irrigated.

Studies indicate that most of the water requirements could be supplied through storage and interbasin diversions. Lower Powder Irrigation District's lands would benefit by small additions of supplemental water, while the remaining area could use over 1 acre-foot per acre additional late-season water. Further studies will be required before the full development potential can be determined, because natural streamflow is not adequate for future developments in higher elevation portions of the watershed. However, as shown in Figure 13, the average annual runoff of Powder River is 168,000 acre-feet at its mouth, so presently available water is not fully utilized.

Protection is needed for channels, structures, roads, and land where over 2,000 acres were flooded in 1965. About 1,600 acres of the lower Powder Valley irrigable soils need drainage, Land leveling, additional sprinkler irrigation,

and nominal erosion control are other needs. Studies on enlargement of Thief Valley Dam should include determining the availibility of federally owned lands for use, financial arrangements, and application of the 160-acre land limitation.

Future studies will be needed to develop more detailed information about surface water flows in the Powder River and tributary streams. Stream gages (nos. 46 and 47 on Plate 2) should be reactivated on Powder River above and below Thief Valley Reservoir. An active gage is needed on Phillips Ditch where it leaves the Eagle Creek watershed. To improve the isohyetal map for projecting runoff from precipitation, climatological stations should be installed at or near Medical Springs and Keating.

North Powder Area (2c)

The North Powder area, with an average annual runoff of 98,000 acre-feet, presently is a summer water-deficient area, which must depend upon storage in headwater streams, ground water, improved distribution systems, and better irrigation practices for augmentation of its water needs. Present water use is about 158,000 acre-feet, most of which is for the irrigation of 45,000 acres. Water is available for developing only a portion of the 12,200 potentially irrigable acres, furnishing supplemental supplies to presently irrigated land and for the other potential uses. The Public Law 566 Wolf Creek watershed work plan, recently published, further clarifies the development potential.

About 100,000 acre-feet of additional storage and ground water would be required to fully develop the area potential. Most of the present runoff is fully appropriated and used by the downstream Lower Powder Irrigation District.

Ground water presently is used to irrigate 850 acres and probably will supply water for an even greater portion of the area's water needs. Although several good wells have been developed (Table 18), there are insufficient technical data available about the ground water potential to make an intelligent appraisal of quantities available for future use. Therefore, it is important that studies be conducted to identify the location and physical characteristics of the major ground water aquifers, including safe annual yields from these aquifers, possible recharge programs, and the cost of developing this water. Available data indicate that the

ground water potential is appreciable. These studies should be conducted simultaneously with present water storage investigations, in order to make full use of the area's water resources.

Potential development includes two Public Law 566 proposals, one on each side of the North Powder River. The Wolf Creek proposal was approved for federal funding in 1966, while the south side proposal requires further study.

The scope and preliminary cost estimates of these proposed developments are shown in Table 40. The two plans include

TABLE 40

NORTH POWDER AREA WATERSHED
PLAN AND COST ESTIMATES
(Preliminary)

ITEM	P. L. 566	OTHER COSTS	TOTAL
LAND TREATMENT			
Grassland	0	$ 730,250	$ 730,250
Cropland	0	370,440	370,440
Woodland	0	101,200	101,200
Technical Assistance	$ 135,100	0	135,100
TOTAL LAND TREATMENT	$ 135,100	$1,201,890	$1,336,990
STRUCTURAL MEASURES			
Construction			
Reservoirs	2,724,625	2,377,805	5,102,430
Channel Improvement	179,360	0	179,360
Canals and Pipelines	358,515	358,515	717,030
Recreational Facilities	22,085	22,085	44,170
Total Construction	$3,284,585	$2,758,405	$6,042,990
Installation Service	$1,494,785	$ 4,735	$1,499,520
OTHER COSTS			
Land Easements and Rights-of-way	290,215	567,755	857,970
Contract Administration	0	35,360	35,360
Total Other Costs	$ 290,215	$ 603,115	$ 893,330
TOTAL STRUCTURAL MEASURES	$5,069,585	$3,366,255	$8,435,840

Data Source: Baker Agricultural Water Use Subcommittee, February 1965.

stabilizing the watershed, constructing two multiple-purpose (irrigation, flood prevention, and recreation) reservoirs,

constructing regulating reservoirs, and initiating water management and land treatment practices.

Construction plans provide for a development program affecting the operation of approximately 200 ranches and improving economic conditions for the Haines and North Powder areas. Average annual benefits are estimated at $410,110 by the project sponsors, while average annual costs are estimated at $316,490.

As shown on Plate 4 of the Appendix, there are 13 potential storage reservoirs with a total capacity of 59,550 acre-feet in the North Powder study area. The 2 largest proposed reservoirs are North Powder with a storage capacity of 20,000 acre-feet and Wolf Creek with a storage capacity of 12,500 acre-feet. The Wolf Creek watershed work plan of September 1966 should be supported and augmented.

Domestic, municipal, and industrial water use in the North Powder area is about 2,500 acre-feet annually with an anticipated future use of about 3,100 acre-feet.

It would appear that the best use of certain North Powder area natural lakes would be for recreation, wildlife, and fish life purposes, and that future storage proposals should provide for such use where economically feasible.

Protection is needed for about 400 acres of cropland, which are flooded annually and for about 3,400 acres of irrigable soils, which need drainage to be more productive. Erosion problems are minor in this and other areas, because most of the cropland is seeded to permanent hay and pasture crops.

Future studies will be needed to develop more detailed surface water flow and climatological data in the North Powder area. Stream gages are needed above diversions on North Powder River, Anthony Fork, Antone Creek, and Dutch Flat Creek. The former Gage No. 43 (Appendix, Plate 2), near the mouth of North Powder River, should be reactivated. To improve the isohyetal map for projecting runoff from precipitation, climatological stations should be installed at North Powder and Anthony Lakes Resort.

Middle Powder Area (2d)

The middle Powder area (Baker Valley), with an average annual

runoff approaching zero due to water loss to ground water and to the present level of consumptive use, is a water-deficient area, which must depend on water mainly from upstream sources and ground water. Present water use is about 173,000 acre-feet, while another 146,000 acre-feet annually would be required to fully develop the resource potential.

Mason Reservoir, now under construction, will furnish fairly adequate supplemental supplies to the 18,000 acres within the presently organized Baker Irrigation District. Reservoir influence on the other 32,200 acres in the middle Powder area cannot be determined at this time due to several imponderable factors. The owners of a large portion of the "withdrawan" lands, with some of the earliest water rights, elected not to participate in the project. Large areas depend on subirrigation, while others are dependent increasingly upon ground water sources.

Reference is made to the January 1961, U. S. Bureau of Reclamation's report, entitled "Baker Project, Upper Division." This report documents the Bureau's plan for furnishing water to 18,000 acres of irrigable lands, including some new lands to the Lilley pump area. District water users will be responsible for rehabilitating and operating their distribution system. Withdrawn lands that did not join the district will continue to receive water under their established rights from natural streamflow.

The plan of development involves construction of the multi-purpose Mason Dam, a rolled-earth structure, and construction of the Lilley pumping plant and discharge lines. The reservoir will supply storage space for irrigation, flood control, recreational values, and fishery enhancement. The storage of 100,000 acre-feet is allotted as follows: irrigation, 57,000 acre-feet; flood control, 17,000 acre-feet; joint flood control and irrigation use, 21,000 acre-feet; and sediment deposition and recreation, 5,000 acre-feet.

The estimated annual runoff at the reservoir is 65,500 acre-feet, but this quantity varies from 24,900 to 110,600 acre-feet annually.

Ground water presently supplies water for irrigation of 1,250 acres, plus other uses, and probably can be used to irrigate an additional 2,500 acres. Although a few good wells have been developed (Table 18), there is insufficient technical knowledge about the quantity or quality of ground water to

accurately appraise this source for future use. Further studies are needed to determine whether ground water withdrawal would be effective in reducing the drainage problem and producing supplemental irrigation water. Hydrological studies indicate that over 70,000 acre-feet of ground water are available for use annually, although a study of many of the well logs indicates that yields to wells may be only low to moderate. Numerous studies have been made on ground water usage but complicated physical, chemical, and water right problems have prevented formulation of an acceptable water development program.

Table 41 supplies additional Powder River irrigation data.

TABLE 41

POWDER RIVER IRRIGATION DATA

STUDY AREA	IRRIGATED Acres	POTENTIALLY IRRIGABLE Acres	LEGAL RIGHTS		RESERVOIR CAPACITY	
			SURFACE Acre-feet	GROUND Acre-feet	EXISTING Acre-feet	PROPOSED Acre-feet
2. (a) Eagle Creek	10,300	3,000	67,831	-	1,967	5,000
(b) Keating	18,800	13,900	90,705	3,354	41,051	31,350
(c) North Powder	45,550	12,200	155,885	3,168	3,552	59,550
(d) Middle Powder	50,200	32,200	173,953	6,785	2,481	2,900
(e) Upper Powder	2,900	2,600	22,282	-	-	100,000
TOTAL	127,750	63,900	510,656	13,307	49,051	198,800

Data Source: Oregon State Engineer and USDA 1966 Cooperative Report.

Following authorization for construction of Mason Reservoir, the U. S. Army Corps of Engineers has tentatively dropped plans for constructing a flood control channel through the City of Baker. There are no other U. S. Army Corps of Engineer's flood control plans for the basin at the present time. Additional flood control studies are needed, because many features of the flood problem are unsolved and some areas are without protection. Mason Reservoir cannot eliminate completely flood damages, because large floods can originate downstream from the reservoir. The February 1957 flood had an estimated peak discharge of 2,350 cfs at Baker, of which probably not over 400 cfs was contributed from above Mason Reservoir site. Channel improvements would be needed through Baker to protect against such floods.

POTENTIAL DEVELOPMENT

Baker Valley will be used as an example of needed long-range rehabilitation plans in the basin as follows:

1. Water supplies from the Powder River and tributary streams should be accumulated in a master control and distribution system before they percolate into the valley outwash gravel fans and are lost to surface water users.

2. A system of main canals and distribution laterals should replace the numerous individual and small-group distribution ditches. This system should be supplied with sufficient control structures and measuring devices for efficient, economical, and equitable water distribution.

3. Surface supplies should be supplemented by pumping from ground water into the main distribution system. These pumping plants should be so located that they would lower the high water table under the valley lowlands. Studies indicate that, under existing conditions, between 15,000 and 20,000 acre-feet of water annually are lost to phreatophytes, other poor-quality vegetation, and to surface evaporation.

4. A network of surface and subsurface drains would be needed to reclaim the 14,000 acres subject to poor drainage and another 4,000 acres subject to flooding. An alternative would be to shift to better drained lands at higher elevations.

5. A soil management program is needed to reduce soil salinity and increase crop production. The salt concentrations in the surface soil could be reduced by supplying all water from the surface, washing the harmful salts downward to below the crop root zone and, eventually, out of the basin as drainage water.

6. To be effective, the rehabilitation program should be accompanied by research to study the existing complicated soil-plant-water relationship for the purpose of determining best methods of improving the agricultural economy.

Full development, which would permit optimum use of all farmlands and water resources of Baker Valley and the Powder River, would be desirable.

The Oregon State Game Commission recommended maintaining minimum streamflows between Mason Dam and Thief Valley Reservoir. Hydrological studies indicate that unappropriated water is not available for this purpose and losses in the porous channel would negate the desired results.

According to the U. S. Department of Agriculture's 1966 cooperative study, a Public Law 566 Baker Valley project for flood protection and land treatment might be feasible. Reference is made to their report, entitled "Water and Related Land Resources, Powder Drainage Basin," dated December 1965, for further detailed data.

Domestic, municipal, and industrial water use in the middle Powder area is about 5,700 acre-feet annually with a future use estimated at 6,600 acre-feet.

It is estimated that 32,200 acres of additional land is suitable for irrigation development. Water imports would be required for most of this development, because present supplies are not adequate for supplemental irrigation needs during dry years.

For future-need studies, stream gages should be reactivated on the Powder River near Haines (No. 25, Plate 2) and on Rock Creek above the power canal diversion (No. 36). A climatological station should be installed on Dooley Mountain.

Upper Powder Area (2e)

The upper Powder area has sufficient water from either ground or surface water sources to support its present and future domestic and municipal needs. Availability of water for other future surface water development is limited by existing downstream prior rights. The average annual runoff from the upper Powder area is estimated at 67,000 acre-feet.

No suitable reservoir sites have been located to date near the headwaters. Little ground water is used at present and knowledge as to its nature, occurrence, and use is limited. The generalized ground water geology map (Figure 24) indicates that the potential should be appreciable.

Domestic and municipal water use in the upper Powder area is only 400 acre-feet and its future needs are not expected to increase materially. Existing municipal water rights are considered adequate to allow for future growth. Irrigation is

the largest consumptive water user with present diversion rights of about 10,600 acre-feet to serve 2,900 acres. Water imports would be needed to serve the 2,600 potentially irrigable acres and to supplement needs of presently irrigated land.

It would appear that the best use of certain upper Powder area stream sections above diversions, and existing natural lakes would be for recreation, fish, and wildlife purposes.

For future studies, active stream gages need reestablishment on Deer Creek (No. 19, Plate 2), Cracker Creek (No. 17), and McCully Fork above diversions. A climatological station should be installed at McEwen in Sumpter Valley.

Burnt Area (3)

The Burnt area, with an average annual runoff of 96,000 acre-feet, has sufficient surface water to support specifically designated development proposals and to support its other future consumptive needs. Table 34, page 96, shows that full development of the Burnt area would require development of an additional 87,000 acre-feet of water. A future possibility, which should be investigated, is the direct pumping from the Snake River to the Durkee area based on a water exchange with users in the upper basin to accomplish full development of the basin. Domestic, municipal, and industrial needs probably will increase about 550 acre-feet in the foreseeable future.

Potentially irrigable acres include lower Burnt area, 10,100 and upper Burnt area, 10,000.

Reference is made to a U. S. Bureau of Reclamation's report, which will be released in 1967, entitled "Burnt River Project, Dark Canyon Division." The investigation will evaluate the quantities and distribution of water available for irrigation of presently dry lands and a supplemental supply for lands inadequately irrigated. Development of multipurpose storage at the Hardman site with a storage capacity of 14,000 acre-feet, on the South Fork Burnt River and at the Dark Canyon site with a storage capacity of 12,000 acre-feet on the Burnt River (Appendix, Plate 4) are possibilities of providing most of the additional water required.

Dark Canyon Reservoir would regulate the flows of the Burnt River for both more efficient irrigation operations on 2,100

acres in the Durkee-Huntington area, and to provide storage for a supplemental water supply to 680 acres, as well as a full supply for 1,220 acres in the Durkee Valley, which lie above the Burnt River Irrigation District lands.

Table 42 presents data on Burnt River irrigated acreage, potentially irrigable acreage, legal water rights, and present and proposed reservoir capacity.

TABLE 42

BURNT RIVER IRRIGATION DATA

STUDY AREA	IRRIGATED Acres	POTENTIALLY IRRIGABLE Acres	LEGAL RIGHTS		RESERVOIR CAPACITY	
			SURFACE Acre-feet	GROUND Acre-feet	EXISTING Acre-feet	PROPOSED Acre-feet
3. (a) Lower Burnt	5,500	10,100	25,015	0	50	39,760
(b) Upper Burnt	16,300	10,000	59,144	0	59,972	69,500
TOTAL	21,800	20,100	84,159	0	60,022	109,260

Data Source: Oregon State Engineer, USDA 1966 Cooperative Report and SWRB Estimate.

The proposed reservoirs, together with Unity Reservoir, would control about one-half of the average annual discharge of Burnt River at Huntington. This storage water would augment natural flows, which are deficient as the season advances.

A storage reservoir at the Hardman site would have a total capacity of 14,000 acre-feet, with inactive storage of 1,850 acre-feet. Irrigation development would include full service, 5,055 acres and supplemental service, 5,460 acres, which totals 10,515 acres. Other benefits such as flood control, recreation, fish life, and wildlife are provided. These proposals should be supported and augmented.

In addition to their studies on the proposed Hardman Reservoir site, the U. S. Bureau of Reclamation also has studied the raising of Unity Dam, and dam construction at the Petticoat site. Both have been eliminated, however, as less desirable.

Two Public Law 566 projects, for flood protection, water

management for irrigation and recreation, and land treatment, appear to be feasible in the Durkee and Unity areas, according to the U. S. Department of Agriculture's 1966 cooperative report. Reference is made to their report, entitled "Water and Related Land Resources, Powder Drainage Basin," dated December 1965, for further detailed data.

The U. S. Department of Health, Education and Welfare prepared a report, dated December 1965, which supplements the U. S. Bureau of Reclamation's Burnt River Project, Dark Canyon Division study, now in progress. Available data on water uses, waste sources, and water quality were examined, evaluated, and projected to the year 2010.

They report that controlled water quality is needed in the Burnt River to protect fish and wildlife, maintain recreational opportunities, safeguard public health, and preserve the attractiveness of stream waters. They indicate there is a need for adequate waste treatment, including effluent disinfection, controlled surface drainage, and assured quantities of streamflow in the lower reaches of the river to dilute and assimilate residual waste materials.

If the 12,000 acre-foot Dark Canyon Reservoir is constructed, the U. S. Department of Health, Education and Welfare proposes that 600 acre-feet be reserved in this reservoir to establish a minimum 5 cfs perennial streamflow. Storage releases from Dark Canyon Reservoir for water quality control would help preserve the existing fishery, provide an attractive stream, and affect the well-being of more than 1,000 people in the area.

The U. S. Bureau of Reclamation and the U. S. Department of Health, Education and Welfare have concluded through an exchange of letters that "The Lower Burnt River flows are subject to appropriation and cannot, therefore, be considered a part of the Burnt River base flow past Huntington." Hydrological records support this conclusion because, before construction of Unity Reservoir, Burnt River was dry frequently from 1 to 3 months in the summer. Burnt River Irrigation District controls all rights to Unity Reservoir water.

Ground water has and will continue to supply only a small portion of the Burnt area's water needs. Although a few low-yield domestic and municipal wells have been developed (Table 18), there is insufficient technical knowledge of the ground water potential to make an intelligent appraisal of quantity

or quality (Water Quality section) available for future use.

Lower Burnt Area (3a)

The lower Burnt area, with a runoff averaging 96,000 acre-feet from floodwaters and return irrigation flows, is a water deficient area, which must depend on water mainly from upstream sources. Present water use is about 21,000 acre-feet, most of which is for the irrigation of 5,500 acres.

Future additional surface water needs of about 21,000 acre-feet for the irrigation of 10,100 potentially irrigable acres, and to supply other beneficial uses probably can be supplied from the Dark Canyon Reservoir and other known sources. The Snake River is an assured source of water for low elevation areas. Lawrence and Alder Creek reservoir sites, with a combined storage capacity of possibly 18,300 acre-feet (Appendix, Plate 4), were investigated in the watershed above Durkee. The reservoir sites and the U. S. Department of Agriculture's 1966 cooperative report proposal of irrigating about 1,800 acres in the Durkee area from ground water sources needs further investigation.

Upper Burnt Area (3b)

The upper Burnt area, with an average annual runoff of 74,600 acre-feet, must depend upon storage in Unity Reservoir and natural streamflow for the greatest portion of its water needs. Present water use is about 58,000 acre-feet, mainly for the irrigation of about 16,300 acres. The other consumptive uses for domestic and industrial purposes total about 900 acre-feet.

Future surface water needs of an additional 29,000 acre-feet would be for supplemental irrigation and for the irrigation of 10,000 potentially irrigable acres. A portion of these needs could be supplied from the 10 reservoir sites studied (Appendix, Plate 4) in the watershed having a total storage capacity of 69,500 acre-feet. However, the average annual runoff is not distributed properly in the watershed to fill these reservoirs. Ground water is thought to be inadequate for other than domestic or industrial uses. Unity Reservoir probably will need to supply most other domestic and industrial water, due to difficulties in finding acceptable ground water in this study area.

POTENTIAL DEVELOPMENT

Existing reservoirs in the watershed include Unity Reservoir with a total capacity of 25,820 acre-feet, and four small reservoirs with an aggregate storage capacity of about 3,900 acre-feet.

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 and reclamation.

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

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

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

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

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

"(4) Multiple-purpose impoundment structures are to be preferred over single-purpose structures; upstream impoundments are to be preferred over downstream impoundments. The fishery resource of this state is an important economic and recreational asset. In the planning and construction of impoundment structures and mill dams 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 of paramount importance in all cooperative programs that the principle of the sovereignty of this state over all the waters within the state be protected and preserved, and such cooperation by the board shall be designed so as to reinforce and strengthen state control;

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

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

RESOLUTION

WHEREAS, Pine Valley Development Group filed applications with the State Engineer of Oregon to store and appropriate waters of East Pine Creek, Baker County;

WHEREAS, these applications were designated by the State Engineer as R-33414 and 33415;

WHEREAS, the State Engineer acting under the authority of ORS 537.170 referred the aforementioned applications to the State Water Resources Board;

WHEREAS, under the authority of ORS 537.170 and after proper notice, the State Water Resources Board held a hearing on the matter of the aforementioned applications;

WHEREAS, the hearing record discloses that insufficient information was available to adequately show the effect of the proposed project on the fishery resources;

WHEREAS, additional information is needed to determine the effect of the proposed project on fishery resources; and

WHEREAS, it is the intention of the State Water Resources Board that additional planning activities should be undertaken to develop information sufficient to determine feasibility of meeting the following objectives:

1. Replacing spawning gravel to be made inaccessible to anadromous fish through construction of East Pine Creek Dam and Reservoir to the extent that the net usable gravel area would be the same with the project finished as it is now without the project.

2. Utilizing as completely as possible all available irrigation waters and other flows provided by the project for fisheries benefits.

3. Insofar as practicable, developing mitigation measures within East Pine Creek drainage for East Pine Creek fish.

4. Maintaining a minimum streamflow below the lowest point of diversion.

RESOLUTION

5. Providing fish passage past all diversion structures except East Pine Creek Dam.

6. Improving water quality.

NOW THEREFORE BE IT RESOLVED, that the State Water Resources Board finds attaining the foregoing objectives to be in the public interest providing that meeting such objectives does not impair project feasibility.

The Board hereby orders that the applications be approved subject to these objectives being met to the satisfaction of the Oregon State Game Commission and the Fish Commission of Oregon prior to the issuance of a permit for the aforementioned project.

Further, in the event that agreement cannot be reached by project sponsors and the state fisheries agencies, it is the request of the State Water Resources Board that these applications be returned to the Board for further proceedings.

Adopted June 5, 1962

STATE WATER RESOURCES BOARD

/s/ DONEL J. LANE

By

Donel J. Lane, Secretary

SWRB
6/5/62

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TABLE A

HYDROLOGICAL STATION SUMMARY

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	North Fork Burnt River near Whitney	2693	11S	36E	23	10.0	110	4,000	Recording	x	1964	0	USGS
2	North Fork Burnt River at Audrey	2695	11S	37E	31	6.3	139	3,930	Staff		1915-17	0	USGS
3	Middle Fork Burnt River near Audrey	2700	12S	36E	22	-	10	4,150	Staff		1915-16	0	USGS
4	South Fork Burnt River near Unity	2705	13S	36E	32	11.9	31	4,450	Staff		1915-16	0	USGS
5	South Fork Burnt River above Barney Creek near Unity	2708	13S	36E	28	10.6	39	4,347	Recording	x	1963-64	1	USGS
6	South Fork Burnt River at Hardman Ranch near Unity	2710	13S	36E	27	9.8	4.	4,300	Recording		1916-20, 1938-41	5	USGS
7	Fleetwood (Cavin) Ditch near Unity	2715	13S	36E	27			4,300	Staff		1918-20	0	USGS
8	Sewall Creek (Pole Gulch) near Unity	2720	13S	36E	11	-	-	-	Staff		1915	0	USGS
9	Unity Reservoir near Unity	2725	12S	37E	21	79.3	309		Staff	x	1938-64	27	USGS
10	Burnt River near Hereford	2730	12S	37E	21	79.1	309	3,757	Recording	x	1915-16, 1929-64	36	USGS
11	Camp Creek near Hereford	2735	12S	38E	29	0.5			Staff		1915	0	USGS
12	Burnt River at Bridgeport	2740	12S	41E	20	46.3	600	3,350	Recording		1915-16, 1931-36	3	USGS
13	Burnt River near Bridgeport	2742	12S	41E	3	42.6	650	3,223	Recording	x	1957-64	8	USGS
14	Burnt River near Durkee	2745	11S	42E	25	30.7	700	2,750	Recording		1931-38	7	USGS
15	Burnt River at Huntington	2750	14S	44E	13	2.9	1,093	2,105	Recording	x	1929-32, 1956-59, 1962-64	9	USGS
16	McCully Fork of Powder River near Sumpter	(1531)	9S	37E	29	0.7	-	-	Staff		1927	0	OSE
17	Cracker Creek at Sumpter	(1530)	9S	37E	20	2.5	-	-	Staff		1927	0	OSE
18	Clear Creek near Sumpter	(1535)	10S	38E	19	0.2	-	-	Staff		1927	0	OSE
19	Deer Creek near McEwen	(1532)	9S	38E	31	4.0	-	-	Staff		1927	0	OSE
20	Alder Creek at McEwen	(1534)	9S	38E	32	0.7	-	-	Staff		1927	0	OSE
21	Miners Creek near McEwen	(1533)	10S	38E	4	0.1	-	-	Staff		1927	0	OSE
22	Powder River at Mason	(1536)	10S	38E	25	139.6	-	-	Staff		1927	0	OSE
23	Powder River near Baker (Powder River near Baker City 1904-06) (Powder River at Salisbury 1906-14)	2755	10S	39E	36	131.1	219	3,632	Recording	x	1904-14, 1926-64	57	USGS
24	Old Settlers Slough at Baker	2760	9S	40E	20	-	-	3,430	Staff		1913-14	0	USGS
25	Baldock Slough at Baker	2765	9S	40E	16	-	-	3,420	Staff		1913-14	0	USGS
26	Powder River at Baker	2770	9S	40E	16	119.6	351	3,420	Staff		1913-14	0	USGS
27	Williams Ditch near Baker	(1515a)	8S	38E	23				Staff		1929	1	OSE
28	Pine Creek near Baker	2775	8S	38E	26	-	9	4,600	Staff		1913-14, 1929-30	1	USGS
29	Goodrich Creek near Baker	2780	8S	38E	36	-	3	4,200	Staff		1913	0	USGS
30	Lee Polly (Nelson) Ditch near Baker	2785	9S	38E	1			4,100	Staff		1914	0	USGS
31	Mill Creek near Baker	2790	9S	38E	1	-	4	4,200	Staff		1913-14, 1929-30	1	USGS
32	Marble Creek near Baker	2795	9S	39E	6	-	4	4,100	Staff		1913-14, 1929-30	0	USGS
33	Salmon Creek near Baker	2800	9S	39E	8	-	4	3,800	Staff		1913-14, 1929	1	USGS
34	Willow Creek near Haines	2805	8S	38E	4	-	2	4,700	Staff		1913	0	USGS
35	Powder River at Haines	2810	7S	39E	34	101.6	539	3,300	Staff		1914	0	USGS
36	Rock Creek near Haines	(1523)	8S	38E	5	9.6	-	-	Staff		1913-14, 1929-30	0	OSE
37	Eastern Oregon Light and Power (EPCO) Canal near Haines	(1523a)	8S	38E	5				Staff		1929-30	2	OSE
38	Powder River near Haines	2815	7S	39E	21	98.4	572	3,294	Recording		1947-52	7	USGS
39	North Powder River near North Powder	2820	7S	38E	5	13.6	48	3,800	Staff		1912	0	USGS
40	Carnes Ditch near North Powder	2823	6S	37E	13				Recording	x	1963-64	0	OSE*
41	Anthony Fork below North Fork near North Powder	2824	6S	37E	13	-	-	-	Recording	x	1963-64	0	OSE*
42	Anthony Fork near North Powder (Anthony Fork near North Powder 1912)	2825	6S	38E	20	-	37	3,710	Staff		1912	0	USGS

TABLE A

HYDROLOGICAL STATION SUMMARY
(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												
43	North Powder River at North Powder	2830	6S	39E	22	1.3	129	3,230	Staff		1912-14	0	USGS
44	Wolf Creek at Bauers Ranch near North Powder	2835	6S	39E	22	9.0	30	3,710	Staff		1913-14	0	USGS
	(Wolf Creek near North Powder 1913-14)	2840											
45	Wolf Creek near North Powder	2840	6S	38E	11	7.7	33	3,577	Recording	x	1947-58, 1962-64	12	USGS SCS*
46	Powder River near North Powder	2845	6S	39E	12	81.0	860	3,200	Staff		1913-16, 1920-25	4	USGS
47	Thief Valley Reservoir near North Powder	2850	6S	40E	26	71.8	-	-	Staff		1932	0	OSE
48	Powder River below Thief Valley Reservoir near North Powder	2855	6S	40E	26	71.6	910	3,090	Staff		1909-12, 1932	2	USGS
	(Powder River near North Powder 1909-12)												
49	Big Creek Ditch near Medical Springs	2858	6S	42E	28	-	-	-	Recording	x	1963-64	0	OSE*
50	Big Creek below Burn Creek near Medical Springs	2859	6S	42E	28	-	-	-	Recording	x	1963-64	0	OSE*
51	Big Creek near Medical Springs	2860	6S	42E	31	-	36	3,450	Staff		1913-14	0	USGS
52	Goose Creek near Keating	2865	8S	43E	8	-	42	2,950	Staff		1913-14	0	USGS
53	Powder River near Richland	2867	9S	44E	14	22.6	1,310	2,277	Recording	x	1959-64	7	USGS
54	Eagle Creek above West Fork near Baker	2870	6S	43E	21	-	-	-	Staff		1911	0	USGS
55	Phillips Ingle Ditch	2873	6S	43E	8			-	Recording	x	1952-64	0	OSE*
56	West Fork Eagle Creek near Baker	2875	6S	43E	21	-	-	-	Staff		1911	0	USGS
57	Eagle Creek near Baker	2880	6S	43E	28	27.0	42	4,400	Staff		1909-10	0	USGS
58	Eagle Creek above Skull Creek near Newbridge	2882	8S	45E	7	10.9	156	2,800	Recording	x	1958-64	7	USGS
59	Eagle Creek near Newbridge	2885	8S	45E	20	9.1	170	2,885	Staff		1910-12, 1914	1	USGS
60	Dely Creek near Richland	2890	10S	46E	18	-	41	2,500	Staff		1913	0	USGS
61	Powder River near Robinette	2895	9S	46E	22	2.9	1,660	1,937	Recording		1929-57	29	USGS
62	Brownlee Reservoir at Brownlee Dam	2897	17N	5W	2 Idaho Grid	284.7	72,590	-	Recording	x	1958-64	6	USGS
63	Snake River at Oxbow	2900	7S	48E	16	273.8	72,800	1,697	Recording		1923-58	34	USGS
64	Pine Creek at Bridge above Carson near Halfway	13	7S	45E	23	26.1	33	3,400	Recording		1958-64	5	SCS*
65	Pine Creek near Halfway at Arsons Bridge	-	7S	45E	25	24.7	-	-	Staff		1923-24	1	OSE
66	Clear Creek near Halfway	-	7S	46E	19	8.3	-	-	Staff		1923-24	0	OSE
67	Clear Creek near Halfway near Mouth	-	8S	46E	14	1.1	-	-	Staff		1923-24	0	OSE
68	East Pine Creek near Halfway	-	7S	46E	21	-	-	-	Staff		1923-24	0	OSE
69	East Pine Creek near Halfway	17	7S	46E	20	-	18	3,100	Recording		1960-64	3	SCS*
70	East Pine Creek near Halfway near Mouth	-	8S	46E	13	1.5	-	-	Staff		1923-24	0	OSE
71	Dry Creek near Halfway	-	8S	46E	13	0.1	-	-	Staff		1923-24	0	OSE
72	Pine Creek near Halfway at Brokows Ranch	-	8S	47E	7	13.3	-	-	Staff		1923-24	1	OSE
73	Fish Creek near Halfway near Mouth	-	7S	47E	34	0.2	-	-	Staff		1923	0	OSE
74	North Pine Creek near Halfway near Mouth	-	7S	47E	34	0.2	-	-	Staff		1923	0	OSE
75	Snake River below Pine Creek at Oxbow	2902	7S	48E	9	269.9	73,150	1,668	Recording	x	1959-64	6	USGS
	CREST-STAGE GAGING												
76	Middle Fork Burnt River near Unity	2699	12S	36E	22	-	9	4,150	Peak Flow		1952-57	6	USGS
77	California Gulch near Baker	2754	10S	39E	29	-	3	3,900	Peak Flow	x	1964	1	USGS
78	Imigrant Gulch near Richland	2891	9S	46E	18	-	7	2,420	Peak Flow	x	1964	1	USGS
	WATER TEMPERATURE												
(10)	Burnt River near Hereford	2730	12S	37E	21	79.1	309		Spot	x	1951-64		USGS
(13)	Burnt River near Bridgeport	2742	12S	41E	3	42.6	650		Spot	x	1956-64		USGS
(15)	Burnt River at Huntington	2750	14S	44E	13	2.9	1,093		Spot	x	1961-64		USGS
(23)	Powder River near Baker	2755	10S	39E	36	139.6	219		Spot	x	1951-64		USGS

TABLE A

HYDROLOGICAL STATION SUMMARY
(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
	WATER TEMPERATURE												
(36)	Powder River near Haines	2815	7S	39E	21	98.4	572		Spot		1946-53		USGS
(45)	Wolf Creek near North Powder	2840	6S	38E	11	7.7	33		Spot Recording	x	1946-53, 1964	0	USGS
79	Wolf Creek at Bridge	-	6S	38E	13	5.8	-		Recording	x	1964	0	SCS
(53)	Powder River near Richland	2867	9S	44E	14	22.6	1,310		Recording		1959-61	2	USGS
(58)	Eagle Creek above Skull Creek near Newbridge	2882	8S	45E	7	10.9	156		Recording		1959-61	2	USGS
(61)	Powder River near Robinette	2895	9S	46E	22	2.9	1,660		Spot		1947-58		USGS
(62)	Snake River at Brownlee Dam	2897	17N	5W	2 Idaho Grid	284.7	72,590		Recording		1957-60	3	USGS
(64)	Pine Creek near Halfway	-	17S	45E	23	26.1	33		Recording	x	1952-64	1	SCS
80	Clear Creek at Jackson Place	-	8S	46E	5	-	-		Recording	x	1962-64	0	SCS
81	East Pine Creek at Tarter Place	-	8S	46E	4	-	-		Recording	x	1962-64	0	SCS
(75)	Snake River below Pine Creek at Oxbow	2902	7S	48E	9	269.9	73,150		Recording	x	1954-64	10	USGS
	WATER QUALITY												
82	Powder River near Sumpter	-	10S	37E	4	150.7	-				1947		USGS*
83	Powder River near Salisbury	-	10S	40E	31	130.6	-				1947		USGS*
84	Baldock Slough at Baker	-	9S	40E	15	-	-				1947		USGS*
85	Baldock Slough near Baker	-	8S	40E	5	-	-				1947		USGS*
86	Powder River	-	8S	40E	20	112.2	-				1947		USGS*
87	Powder River below Baker	2771	8S	40E	17	112.0	-				1960-62		USGS*
88	Pine Creek near Baker	-	8S	39E	28	-	-				1947		OSSA USGS*
89	Powder River below Haines	-	7S	39E	34	101.4	-				1947		USGS*
(48)	Powder River below Thief Valley Reservoir near North Powder	2855	6S	40E	26	71.6	910				1911-12		USGS
(53)	Powder River near Richland	2867	9S	44E	14	22.6	1,310				1960		USGS
	SEDIMENTATION												
(47)	Thief Valley Reservoir	-	6S	40E	26	71.8	-		Res. and Sed.		1932-49		C of E
(48)	Powder River below Thief Valley Reservoir near North Powder	2855	6S	40E	26	71.6	910		Sus. Sed. Load Sta.		1911-12		C of E

MAP 1/ INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	ELEVATION Feet	TYPE	ACTIVE	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	SNOW SURVEY COURSES										
90	Anthony Lake	18E1	7S	37E	18	7,125	SS	x	1936-64		SCS
91	Barney Creek	18E14	14S	36E	16	5,950	SS	x	1945-64		SCS
92	Blue Mountain Summit	18E13M	12S	36E	6	5,093	SS	x	1931-64		SCS
93	Looley Mountain	17E1M	11S	40E	32	5,430	SS and SM	x	1939-64		SCS
94	Eldorado Pass	18E20	14S	38E	20	4,600	SS	x	1955-64		SCS
95	Elertson Meadows	18E3	8S	38E	18	5,400	SS	x	1938-64		SCS
96	Goodrich Lake	18E6	9S	38E	4	6,775	SS	x	1947-64		SCS
97	Ladd Summit	17D12m	5S	39E	9	3,730	SM	x	1963-64		SCS
98	Little Alps	18E23	7S	37E	10	6,200	SS	x	1959-64		SCS
99	Old Sheep Camp	18E4	8S	37E	35	5,000	SS		1929-33, 1935		SCS
100	Schneider Meadows	17D8	6S	45E	35	5,400	SS	x	1938-64		SCS
101	Summit Springs	18E10	6S	37E	9	6,000	SS		1936-59		SCS
102	Taylor Green	17E7	6S	42E	3	5,740	SS	x	1938-64		SCS
103	Tipton	18E9	10S	35½E	34	5,100	SS	x	1929-64		SCS
	CLIMATOLOGICAL										
104	Begleys Ranch	-	10S	41E	8	4,100	P		1911	0	USWB
105	Baker FAA Airport (Baker Airport 3 NNE 1943-48) (Baker CAA Airport 1948-59)	0412	8S	40E	28	3,368	PT	x	1943-64	22	USWB
106	Baker KBKR (Baker City 1889-1910)	0417	9S	40E	20	3,466	PT	x	1889-1964	69	USWB

TABLE A

HYDROLOGICAL STATION SUMMARY
(continued)

MAP 1/ INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	ELEVATION Feet	TYPE	ACTIVE	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	CLIMATOLOGICAL										
	(Baker 1910-48)										
	(Baker Weather Bureau-City 1948-53)										
107	Baker No. 2	0409	9S	40E	21	3,465	HP	x	1955-64		USWB
	(Baker 1 S 1955-62)										
108	Buena Vista	-	6S	3EE	17	3,700	P		1909-14	4	USWB
109	Columbia Mine	-	8S	37E	32	6,000	P		1909-17	7	USWB
110	Cornucopia	1852	6S	45E	34	4,700	P	x	1909-35, 1950-64	38	USWB
	(Cornucopia 5 NNW 1950-64)										
111	Cracker Creek	-	9S	37E		4,800	P		1910-15	4	USWB
112	Durkee 3 NNW	2482	11S	43E	7	2,740	PT	x	1948-64	13	USWB
	(Durkee 1948-52)										
113	Greenhorn	-	10S	35E	9	6,250	P		1910-15	4	USWB
114	Halfway	3604	8S	46E	17	2,671	PT	x	1936-64	19	USWB
	(Halfway - near 1936-42)										
	(Halfway one-half mile West 1942-49)										
115	Huntington	4098	14S	44E	13	2,150	PT	x	1901-18, 1923-64	45	USWB
116	Pine	-	8S	46E	21	2,600	P		1902-05	2	USWB
117	Richland	7160	9S	45E	23	2,215	PT	x	1891-1901, 1905-23, 1945-64	31	USWB
	(Newbridge 1891-1901)										
118	Rock Creek	7250	7S	38E	33	4,150	PT	x	1920-64	41	USWB
119	Sparta	-	8S	44E	15	4,150	PT		1892-1926, 1934-35	6	USWB
120	Unity	8780	13S	37E	16	4,031	PT		1908-11, 1936-64	24	USWB

*Unpublished records.

1/ Map index number refers to Plate 2

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

ABBREVIATIONS

C of E - U. S. Army Corps of Engineers
OSE - Oregon State Engineer
OSSA - Oregon State Sanitary Authority
SCS - Soil Conservation Service
USGS - U. S. Geological Survey
USWB - U. S. Weather Bureau

HP - Hourly Precipitation
P - Precipitation
PT - Precipitation and Air Temperature
SM - Soil Moisture
SS - Snow Survey Course

TABLE B

RECREATION AREA SUMMARY

MAP INDEX NO.	NAME	LOCATION Twp.	Rng.	Sec.	WATER FEATURE	WATER SUPPLY	COMFORT STA.	STOVES/ FIREPL.	PICNIC TABLES	CAMP-SITES	TRLR. SITES	SWIM.	BOAT.	FISH.	HUNT.	HIKING
	U. S. FOREST CAMPS															
1	Anthony Lakes	7S	37E	18	Anthony Lakes	x	x	27	11	22	6	x	Ramp	x	x	x
2	Eagle Creek	7S	44E	17	Eagle Creek	x		12	3	9				x	x	
3	Eagle Forks	8S	45E	6	Little Eagle Creek				4	7				x	x	
4	Elk Creek	13S	36E	32	Lookout Creek	x		2		2				x	x	
5	Fish Lake	6S	46E	16	Fish Lake	x	x	21		21		x	Ramp	x	x	
6	Kettle Creek	6S	44E	21	East Fork Eagle Creek	x		12		12				x	x	x
7	Lakefork	6S	47E	25	Elk Creek	x		9	1	5	3			x	x	
8	Mamouth Spring	13S	36E	30	Large Spring			2		2				x	x	
9	Marble Creek	9S	39E	7	Marble Creek	x		15	15					x	x	
10	McBride	7S	45E	28	Summit Creek			2		5				x	x	
11	McCully Forks	9S	36E	24	McCully Fork			7		5	2					
12	Mud Lake	7S	37E	7	Mud Lake			15	4	15				x	x	x
13	North Fork Anthony	6S	37E	14	North Fork Anthony Creek			3		3				x	x	
14	Oregon	12S	36E	6		x		10	2	8					x	
15	South Fork	13S	36E	28	South Fork Burnt River	x		22	5	10	7			x	x	
16	Tamarack	6S	43E	21	Eagle Creek	x		10		10				x	x	
	Trouble Creek See Mud Lake															
17	Two Color	6S	43E	15	Eagle Creek	x		13	14	13				x	x	x
18	Wetmore	12S	36E	16		x	x	21	8	4	9				x	
	DEVELOPED SKI AREAS (USFS)															
19	Anthony Lakes	7S	37E	7												
20	Little Alps	7S	37E	9												
	STATE PARKS, WAYSIDES AND ROADSIDE REST AREAS															
21	Bishop Springs RRA	9S	44E	6	Powder River	x	x		x							
22	Dooley Mountain RRA	11S	40E	20	Stream	x	x		x							
23	Farewell Bend	14S	45E	33	Brownlee Reservoir	x	x	x	x	10		x	Ramp	x		
24	Rattlesnake Springs Wayside	12S	43E	13	Burnt River	x	x		x							
25	Unity Forest Wayside	14S	37E	1	East Camp Creek											
26	Unity Lake	12S	37E	28	Unity Reservoir	x	x	x	24	5		x	Ramp	x		
	PRIVATE PARKS															
27	Ebell Park	9S	39E	6	Marble Creek	x	x		11							
28	Harry N. Hewitt Memorial Park	9S	46E	30	Brownlee Reservoir		x	13	11	x	x	x	Ramp	x	x	
29	Main Eagle Bridge Camp	7S	44E	6	Eagle Creek											
30	Radium Hot Springs	7S	39E	28	Radium Hot Springs				x	x		x				
31	Union County Boat and Ski Club Park	6S	40E	23	Thief Valley Reservoir		x	1	8			x	Ramp	x		
	BOAT LANDINGS															
(1)	Anthony Lakes	7S	37E	18	Anthony Lakes	x	x	27	11	22	6	x	x	x	x	x
32	Carters Landing	8S	48E	36	Oxbow Reservoir								x	x		
(23)	Farewell Bend	14S	45E	33	Brownlee Reservoir	x	x	x	x	10		x	x	x		
(5)	Fish Lake	6S	46E	16	Fish Lake	x	x	21		21		x	x	x	x	
(28)	Harry N. Hewitt Memorial Park	9S	46E	30	Brownlee Reservoir		x	13	11	x	x	x	x	x	x	
33	Middle Fork	12S	37E	20	Unity Lake		x						x	x		
34	Oxbow Pool	8S	48E	9	Oxbow Reservoir		x						x	x		
35	Pine Creek	7S	48E	9	Pine Creek								x			
36	Timber Canyon	9S	46E	23	Brownlee Reservoir								x			
(31)	Union County Boat and Ski Club Park	6S	40E	23	Thief Valley Reservoir		x	1	8			x	x	x		
(26)	Unity Lake	12S	37E	28	Unity Lake	x	x	x	x	5		x	x	x		
37	(Unnamed)	7S	48E	28	Oxbow Reservoir		x						x			

NOTE: Map index numbers refer to Plate 3.

TABLE C

RECONNAISSANCE DATA ON STUDY AREAS
Acres

	PINE MISC.			POWDER					BURNT		TOTAL
	NORTH PINE	PINE	SNAKE MISC.	EAGLE	KEATING	NORTH POWDER	MIDDLE POWDER	UPPER POWDER	LOWER BURNT	UPPER BURNT	
Watershed Area	72,700	128,400	121,900	204,400	301,100	224,000	220,700	104,100	289,000	407,400	2,073,700
Forest Land	45,400	55,600	5,400	94,400	54,700	92,400	66,600	85,000	17,100	245,100	761,700
Cropland	50	17,100	1,000	10,400	29,500	56,750	52,400	3,000	8,600	17,200	196,000
Rangeland	22,900	46,900	111,900	84,100	205,000	64,100	79,100	4,700	256,800	130,700	1,006,200
Irrigation Water Source: Streamflow	-	18,900	430	10,300	8,960	44,300	47,960	2,900	3,150	7,700	144,600
Ground Water	-	200	-	-	600	650	1,250	-	-	-	2,700
Water Shortage	-	12,000	350	6,000	6,520	44,300	48,000	2,900	3,190	7,640	130,900
Potentially Irrigable Land	-	2,000	6,600	3,000	13,900	12,200	32,200	2,600	10,100	10,000	92,600
Arable Land Needing Irrinage	-	2,500	-	1,500	2,000	3,400	14,000	600	400	4,150	28,550
Flooding Area	-	800	90	60	2,200	400	4,000	600	250	3,000	11,400
Farms (Number)	-	150	7	100	106	220	260	10	56	54	963

Data Source: USDA 1966 Cooperative Report.

TABLE D

OREGON GAME COMMISSION FLOW RECOMMENDATIONS
FOR RESIDENT FISH
CFS

STREAM	FEB.	MAR. APR. MAY	JUNE	JULY	AUG. THRU. JAN.	LOCATION
Pine Creek	60 - 80	100	100 - 80	60	60	Mouth
North Pine Creek	20 - 30	45	45 - 30	20	20	Mouth
Little Elk Creek	2 - 4	6	6 - 4	2	2	Mouth
Lake Fork Creek	7 - 15	25	25 - 15	7	7	Mouth
Elk Creek	3 - 6	10	10 - 6	3	3	Mouth
Lake Fork Creek	2 - 5	8	8 - 5	2	2	Just above Elk Creek
Duck Creek	3 - 6	10	10 - 6	3	3	Mouth
North Pine Creek	3 - 6	10	10 - 6	3	3	Just above Duck Creek
Pine Creek	40 - 50	65	65 - 50	40	40	Just above Long Branch Creek
East Pine Creek	6 - 10	16	16 - 10	6	6	Mouth
East Pine Creek	6 - 10	16	16 - 10	6	6	0.5 mi. above Beecher Creek
Clear Creek	15 - 23	30	30 - 23	15	15	Mouth
Clear Creek	15 - 20	25	25 - 20	15	15	3.5 mi. below Meadow Creek
Pine Creek	15 - 20	25	25 - 20	15	15	0.8 mi. below Tunnel Creek
Powder River	60 - 70	80	80 - 70	60	60	USGS Gage 13-2367
Daly Creek	1.5 - 2	3	3 - 2	1.5	1.5	Mouth
Eagle Creek	60 - 70	80	80	70	60	Mouth
Little Eagle Creek	2 - 5	11	11 - 5	2	2	Mouth
Eagle Creek	60 - 70	80	80	70	60	USGS Gage 13-2882
Eagle Creek	30 - 50	60	60	50	30	Just above East Fork Eagle Creek
East Fork Eagle Creek	30 - 50	60	60	50	30	Mouth
Eagle Creek	20 - 30	50	50	30	20	Just above West Fork Eagle Creek
West Fork Eagle Creek	10 - 25	40	40 - 25	15	10	Mouth
Goose Creek	1.5 - 3	5	5 - 3	1.5	1.5	Mouth
Powder River	60 - 70	80	80 - 70	60	60	0.5 mi. above Goose Creek
Big Creek	3 - 5	9	9 - 5	3	3	USGS Gage 0.1 mi. below Lick Creek
Powder River	50 - 60	70	70 - 60	50	50	Just below Thief Valley Dam
Powder River	25 - 30	40	40 - 30	25	25	Entering Thief Valley Reservoir
Wolf Creek	4 - 8	12	12 - 8	4	4	Mouth
Wolf Creek	4 - 8	12	12 - 8	4	4	Just above Clear Creek
Clear Creek	2 - 4	7	7 - 4	2	2	Mouth
Powder River	25 - 30	40	40 - 30	25	25	Just above North Powder River
North Fork Powder River	12 - 20	25	25	20 - 15	12	Mouth
North Fork Powder River	8 - 15	25	25	15 - 10	8	Just above Anthony Fork Creek
Anthony Fork Creek	10 - 18	25	25	18 - 12	10	Mouth
North Fork Anthony Fork	4 - 7	12	12 - 9	7	4	Mouth
Anthony Fork Creek	8 - 15	20	20	15 - 10	8	Just above Indian Creek
North Fork Powder River	8 - 15	25	25	15 - 10	8	Just above Antone Creek
Antone Creek	4 - 6	10	10 - 8	6	4	Mouth
Dutch Flat Creek	3 - 8	13	13 - 10	8 - 5	3	Mouth
Powder River	25 - 30	40	40 - 30	25	25	5 mi. below Muddy Creek
Rock Creek	9 - 15	20	20 - 15	12	9	Mouth
Rock Creek	6 - 12	20	20 - 15	12	6	Power plant diversion headgate
Powder River	25 - 30	40	40 - 30	25	25	1.5 mi. below Sutton Creek
Powder River	25 - 30	40	40 - 30	25	25	USGS Gage 13-2765
Deer Creek	6 - 10	15	15 - 10	8	6	Just above Smith Creek
Deer Creek	6 - 10	15	15 - 10	8	6	Just above Alder Creek
Crooker Creek	9 - 15	20	20 - 15	12	9	Mouth
McCully Fork Creek	5 - 10	15	15 - 10	8	5	Mouth
Burnt River	25 - 40	50	50 - 40	25	25	USGS Gage 13-2750
Burnt River	25 - 40	50	50 - 40	25	25	USGS Gage 13-2742
East Fork Camp Creek	2 - 4	6	6 - 4	2	2	Mouth
West Fork Camp Creek	3 - 5	8	8 - 5	3	3	Mouth
Burnt River	20 - 30	40	40 - 30	20	20	USGS Gage 13-2730
South Fork Burnt River	4 - 6	10	10 - 8	6 - 4	4	Mouth
South Fork Burnt River	10 - 15	20	20 - 15	10	10	USGS Gage 13-3703
South Fork Burnt River	7 - 10	15	15 - 12	7	7	Just above Elk Creek
Elk Creek	10 - 15	20	20 - 15	10	10	Mouth
North Fork Burnt River	6 - 12	25	25 - 20	12 - 6	6	Mouth
North Fork Burnt River	6 - 12	25	25 - 20	12 - 6	6	USGS Gage 13-2693
Camp Creek	1 - 2	3	3 - 2	1	1	Mouth
North Fork Burnt River	5 - 10	20	20 - 15	10 - 5	5	1.0 mi. above Patrick Creek

Source: Oregon State Game Commission

TABLE E

WATER YIELD AND CONSUMPTIVE USE

WATERSHED	TOTAL AREA	YIELD FROM RAINFALL 1/		CONSUMPTION									RUNOFF 2/	DIFFERENCE MAINLY GROUND WATER
				TIMBERLAND		RANGE & OTHER		DRY CROPLAND		IRRIGATED LAND		TOTAL		
	Acres	Inches	Ac-ft	Acres	Ac-ft	Acres	Ac-ft	Acres	Ac-ft	Acres	Ac-ft	Ac-ft	Ac-ft	Ac-ft
1. PINE & MISC.								-	-					
(A) North Pine	72,700	23.4	141,800	45,400	64,300	27,250	18,200	-	-	50	100	82,600	57,000	2,200
(B) Pine	128,400	27.1	290,000	55,600	83,400	55,700	37,100	-	-	17,100	22,800	143,200	143,000	3,700
(C) Snake Misc.	121,900	12.1	122,900	5,400	8,100	115,500	96,300	400	300	600	1,100	105,800	8,000	9,100
Total	323,000		554,700	106,400	155,800	193,450	151,600	400	300	17,750	24,000	331,700	208,000	15,000
2. POWDER														
(A) Eagle	218,000	28.1	510,500	108,000	171,000	99,600	83,000	2,100	2,100	8,300	13,100	269,200	244,000	-2,700
(B) Keating	286,200	13.6	301,700	41,100	65,100	198,600	182,000	10,700	10,700	15,500	26,300	284,100	8,000	9,600
(C) North Powder	245,300	18.0	365,000	92,400	146,300	93,200	77,700	12,200	12,200	47,500	63,300	299,500	98,000	-29,500
(D) Middle Powder	220,700	15.4	283,200	66,500	99,900	101,700	84,800	4,200	3,500	46,200	72,300	260,500	0	22,700
(E) Upper Powder	104,100	24.6	213,400	85,000	127,500	16,100	13,400	100	100	2,900	4,400	145,400	65,000	3,000
Total	1,054,300		1,676,800	393,100	609,800	509,200	440,900	29,300	28,600	122,700	179,400	1,258,700	415,000	3,100
3. BURNT														
(A) Lower Burnt	289,000	11.9	286,600	17,100	27,100	263,300	219,200	3,100	2,600	5,500	8,300	257,200	21,000	8,400
(B) Upper Burnt	407,400	17.7	600,900	245,100	388,100	145,100	108,800	900	900	16,300	21,700	519,500	75,000	6,400
Total	696,400		887,500	262,200	415,200	408,400	328,000	4,000	3,500	21,800	30,000	776,700	96,000	14,800
GRAND TOTAL	2,073,700		3,119,000	761,700	1,180,800	1,116,050	920,500	33,700	32,400	162,250*	233,400	2,367,100	719,000	32,900

1/ SWCB Isohyetal

2/ USGS Records and SWCB Correlations

Data Source: USDA, USGS, and SWCB

*Does not include 7,000 acres of partially irrigated rangeland.

TABLE F

SURFACE WATER RIGHTS SUMMARY
October 31, 1965

STUDY AREA & STREAM	CONSUMPTIVE						NONCONSUMPTIVE					TOTAL RIGHTS
	Dom. Cfs	Mun. Cfs	Ind. Cfs	Irrigation Cfs	Irrigation Acres	Total Cfs	Power Cfs	Fish Cfs	Mining Cfs	Rec. Cfs	Total Cfs	Cfs
PINE & MISC.												
A. North Pine												
Pine Creek	0.300	0	0	3.790	262.40	4.090	0	0	0	0	0	4.090
North Pine Cr.	0.600	0	0	10.610	609.30	11.210	0	0	0	0	0	11.210
North Pine Cr. Misc.	0.220	0	0	25.790	1,495.80	26.010	0	0	0	0	0	26.010
Total	1.120	0	0	40.190	2,367.50	41.310	0	0	0	0	0	41.310
B. Pine												
Pine Creek	15.500	0	0	202.550	8,499.93	218.050	2.870	0	79.000	0	81.870	299.920
Clear Creek	6.615	0	0	82.605	3,465.90	89.220	0	0	0	0	0	89.220
East Pine Creek	4.000	0	0	70.680	3,123.60	74.680	0	0	0	0	0	74.680
Fish Creek	0.700	0	0	10.710	427.20	11.410	0	0	0	0	0	11.410
Long Branch	0	0	0	2.180	162.20	2.180	0	0	0	0	0	2.180
Pine Cr. Misc.	1.260	0.500	0	25.655	1,323.70	27.425	10.660	0	12.000	0	22.660	50.085
Total	28.075	0.500	0	394.390	17,002.53	422.965	13.530	0	91.000	0	104.530	527.495
C. Snake Misc.												
Snake River	0.050	0	0.100	17.960	920.88	18.110	51,000.000	0	0	0	51,000.000	51,018.110
Snake River Misc.	0.546	0.080	2.500	4.805	360.40	7.931	0	0	4.500	0	4.500	12.431
Total	0.596	0.080	2.600	22.765	1,281.28	26.041	51,000.000	0	4.500	0	51,004.500	51,030.541
PINE TOTAL	29.791	0.580	2.600	457.345	20,651.31	490.316	51,013.530	0	95.500	0	51,109.030	51,599.346
POWDER												
2A Eagle												
Eagle Cr. & Misc.	17.900	1.000	0.200	224.053	12,489.68	243.153	0	3.000	75.000	0	78.000	321.153
E. Eagle Cr. & Misc.	0.046	0	0	0.802	535.36	0.848	0	0	50.000	0	50.000	50.848
L. Eagle Cr. & Misc.	0	0	0	10.902	631.40	10.902	4.170	0	9.000	0	13.170	24.072
Summit Cr. & Misc.	0.480	0	0	17.188	782.19	17.668	0	0	2.000	0	2.000	19.668
W. Eagle Cr. & Misc.	0.010	0	0	38.410	1,762.50	38.420	0	0	0	0	0	38.420
Eagle Cr. Misc.	0.390	0	0	2.515	119.50	2.905	0	0	3.000	0	3.000	5.905
Immigrant Cr. & Misc.	0	0	0	0.570	45.41	0.570	0	0	0	0	0	0.570
Maiden Gulch & Misc.	0	0	0	0	0	0	0	0	0	0	0	0
Powder River	1.400	0	0	31.608	1,334.30	33.008	23.300	0	0	0	23.300	56.308
Powder River Misc.	0.960	0	0	13.553	671.40	14.513	0	0	1.220	0	1.220	15.733
Daly Creek	1.010	0	0	20.201	1,008.60	21.211	0	0	0	0	0	21.211
Total	22.196	1.000	0.200	359.902	19,380.34	383.198	27.470	3.000	140.220	0	170.690	553.888
2B Keating												
Balm Cr. & Misc.	1.100	0	0	38.572	1,950.00	39.672	0	0	1.800	0	1.800	41.472
Big Cr. & Misc.	0.450	0	0	93.000	3,832.80	93.450	0.250	0	0	0.250	0.500	93.950
Clover Cr. & Misc.	0.600	0	0	15.872	692.40	16.472	0	0	0	0	0	16.472
Goose Cr. & Misc.	0.600	0	0	19.873	930.50	20.473	0	0	3.000	0	3.000	23.473
Love Cr. & Misc.	0.600	0	0	11.798	463.10	12.393	0	0	0	0	0	12.398
Ritter Cr. & Misc.	0.400	0	0	1.963	73.50	2.363	0	0	0	0	0	2.363
Ruckles Cr. & Misc.	0.520	0	0	7.751	330.00	8.271	0	0	0.500	0	0.500	8.771
Powder River	3.600	0	0	325.898	15,386.06	329.498	0	0	0	0	0	329.498
Powder River Misc.	1.200	0	0	35.524	1,697.40	36.724	0	0	0	0	0	36.724
W. Eagle Cr. & Misc.	0	0	0	5.580	570.00	5.580	0	0	0	0	0	5.580
Total	9.070	0	0	555.831	25,915.76	564.901	0.250	0	5.300	0.250	5.800	570.701
2C North Powder												
Hot Cr. & Misc.	0.220	0	0	2.525	101.00	2.745	0.540	0	0	0	0.540	3.285
Jimmy Cr. & Misc.	0.830	0	0	24.105	1,003.30	24.935	0	0	0	0	0	24.935
Little Muddy Cr. & Misc.	0.110	0	0	4.590	239.10	4.700	0	0	0	0	0	4.700
Muddy Cr. & Misc.	0.510	0	0	19.845	793.50	20.355	0	0.041	0	0	0.041	20.396
N. Powder R. & Misc.	5.730	0	14.150	542.825	25,670.60	562.705	25.000	0	0	0	25.000	587.705
Rock Cr. & Misc.	7.200	2.000	0	290.134	11,647.09	299.334	30.600	0	20.000	0	50.600	349.934
Willow Cr. & Misc.	0.760	0	0	45.042	1,814.91	45.802	0	0	0	0	0	45.802
Wolf Cr. & Misc.	3.130	0	0	132.329	5,387.00	135.459	0	0	12.000	0	12.000	147.459
Powder River	0.900	0	0	69.730	2,921.10	70.630	0	0	0	0	0	70.630
Powder River Misc.	0.400	0	0	5.480	457.60	5.880	0	0	0	0.280	0.280	6.160
Total	19.790	2.000	14.150	1,136.605	50,035.20	1,172.545	56.140	0.041	32.000	0.280	88.461	1,261.006
2D Middle Powder												
Beaver Cr. & Misc.	1.140	0	0	11.679	512.10	12.819	0	0	0	0	0	12.819
Blue Canyon & Misc.	0.020	0	0	6.740	377.50	6.760	0	0	0	0	0	6.760
Elk Cr. & Misc.	0.400	4.000	0	23.768	984.90	28.168	0	0	6.250	0	6.250	34.418
Griffin Cr. & Misc.	0.300	0	0	3.900	212.00	4.200	0	0	0	0	0	4.200
Pine Creek	3.800	0	0	168.483	7,376.07	172.283	0	0	0	0	0	172.283
Goodrich Cr. & Misc.	1.210	41.947	0	54.223	2,687.40	97.380	0	0.020	0	0	0.020	97.400
Salmon Cr. & Misc.	3.320	11.750	0	122.472	5,481.18	137.542	0	0	15.500	0	15.500	153.042
Pine Cr. Misc.	1.670	0	0	32.155	1,348.10	33.825	0	0	0	0	0	33.825
Sutton Cr. & Misc.	1.700	0	0	34.958	1,419.90	36.668	0	0	0	0	0	36.668
Powder River	16.500	0	0.025	642.624	26,485.46	659.149	3.000	0	0	0	3.000	662.149
Powder River Misc.	1.760	0	0.135	58.541	2,816.23	60.436	0	0	9.000	0	9.000	69.436
Total	31.820	57.697	0.160	1,159.553	49,700.84	1,249.230	3.000	0.020	30.750	0	33.770	1,283.000
2E Upper Powder												
Crocker Cr. & Misc.	0.200	51.900	0	2.655	106.20	54.755	8.000	0	1.200	0	9.200	63.955
Deer Cr. & Misc.	1.410	0	0	47.538	2,066.17	48.948	0	0	14.000	0	14.000	62.948
McCully Fork & Misc.	0	20.000	0	0	0	20.000	0	0	8.000	0	8.000	28.000
Powder River	2.700	0	0	94.901	3,804.72	97.601	2.500	0	0	0	2.500	100.101
Powder River Misc.	0.410	0	0	8.735	389.40	9.145	0	0	0.500	0	0.500	9.645
Total	4.720	71.900	0	153.829	6,366.49	230.449	10.500	0	23.700	0	34.200	264.649
POWDER TOTAL	87.596	132.597	14.510	3,365.620	151,398.63	3,600.323	97.360	3.061	231.970	0.530	332.921	3,933.244

TABLE F

SURFACE WATER RIGHTS SUMMARY
October 31,1965
(Continued)

STUDY AREA & STREAM	CONSUMPTIVE						NONCONSUMPTIVE					TOTAL RIGHTS
	Dom. Cfs	Mun. Cfs	Ind. Cfs	Irrigation Cfs	Irrigation Acres	Total Cfs	Power Cfs	Fish Cfs	Mining Cfs	Rec. Cfs	Total Cfs	Cfs
BURNT												
3A Lower Burnt												
Burnt River	1.450	0	1.912	43.080	2,070.60	46.442	0	0	10.300	0	10.300	56.742
Dixie Creek	1.505	0	0.040	20.695	907.60	22.241	1.000	0	68.000	0	69.000	91.241
Morning Creek	1.320	0	0	18.741	704.00	20.061	0	0	0	0	0	20.061
Pritchard Creek	0.400	0	0	15.075	595.00	15.475	0	0	0	0	0	15.475
Alder Creek	2.700	0	0.450	30.526	1,253.00	33.676	0	0	6.000	0	6.000	39.676
Durkee Creek	0.815	0	0.100	13.279	528.30	14.194	0	0	0	0	0	14.194
Lawrence Creek	1.100	0	0	10.529	380.00	11.629	0	0	0	0	0	11.629
Sisley Creek	0.810	0	0	6.765	210.00	7.575	0	0	5.000	0	5.000	12.575
Burnt R. Misc.	3.320	0	1.000	40.278	1,689.80	44.598	0	0	20.930	0	20.930	65.528
Total	13.420	0	3.502	198.969	8,338.30	215.891	1.000	0	110.230	0	111.230	327.121
3B Upper Burnt												
Burnt River	2.300	0	0	137.267	5,566.00	139.567	0	0	2.000	0	2.000	141.567
Camp Cr.	0.400	0	0	13.786	682.80	14.186	0	0	0	0	0	14.186
East Camp Cr.	0.200	0	0	12.505	697.50	12.705	0	0	0	0	0	12.705
West Camp Cr.	0.800	0	0	22.650	982.00	23.450	0	0	0	0	0	23.450
Clerks Cr.	0.215	0	0	11.935	487.40	12.150	0	0	10.000	0	10.000	22.150
Job Cr.	0.200	0	0	9.631	409.00	9.831	0	0	0	0	0	9.831
Head Meadow Cr.	0.200	0	0	4.717	308.10	4.917	0	0	0	0	0	4.917
No. Fk. Burnt R.	1.000	0	0	37.722	1,987.20	38.722	0	0	27.000	0	27.000	65.722
Camp Cr.	0.100	0	0	8.125	325.00	8.225	0	0	29.000	0	29.000	37.225
Mid. Fk. Burnt R.	0.400	0	0	8.225	389.80	8.625	0	0	0	0	0	8.625
N. Fk. Burnt R.	0.100	0	0	7.612	304.50	7.712	0	0	0	0	0	7.712
N. Fk. Burnt R. Misc.	0.200	0	0	9.275	389.60	9.475	0	0	66.000	0	66.000	75.475
So. Fk. Burnt R.	2.400	0	0	121.407	4,952.50	123.807	0	0	0	0	0	123.807
Bull Run Cr.	0.400	0	0	11.652	635.50	12.052	0	0	0	0	0	12.052
S. Fk. Burnt R. Misc.	0.660	0	0	5.940	234.00	6.600	0	0	0	0	0	6.600
Burnt R. Misc.	2.020	0	0	34.769	1,363.68	36.789	0	0	16.300	0	16.300	53.089
Total	11.595	0	0	457.218	19,714.58	468.813	0	0	150.300	0	150.300	619.113
BURNT TOTAL	25.015	0	3.502	656.187	28,052.88	684.704	1.000	0	260.530	0	261.530	946.234
GRAND TOTAL	142.402	133.177	20.612	4,479.152	200,102.82	4,775.343	51,111.890	3.061	588.000	0.530	51,703.481	56,478.824

TABLE G

POTENTIAL WATER DEVELOPMENT PROJECTS
DAMSITES

MAP INDEX NO.*	STREAM	SITE NAME	LOCATION			DR. AREA Acres	AVERAGE ANNUAL YIELD Ac.-ft.	PURPOSE	DAM		RESERVOIR				SOURCE NO.
			Twp.	Rng.	Sec.				HEIGHT Feet	CREST LENGTH Feet	MAX. POOL ELEV. Ft.-Msl	MAX. POOL AREA Acres	USABLE STORAGE Ac.-ft.	TOTAL STORAGE Ac.-ft.	
	PINE														
	1B Pine														
1	East Pine Creek	Mehlhorn Mills	7S	46E	20	12,000	18,000	I-F-R	125	560		140		10,000	1
2	Deer Creek	Deer Creek	8S	47E	29	7,500	9,400	I-F-R	85	500		69		2,210	1
3	Meadow Creek	Schneider Meadows	6S	45E	35	700	2,100	I-R	45	450		45		690	1
4	The Sag	Sag	9S	46E	3			I-R	65	700		80		1,500	1
	POWDER														
	2A Eagle														
5	Eagle Creek	Lower Eagle	8S	45E	7	84,300		I-F-R							2
6	Eagle Creek	Upper Eagle	7S	44E	8	54,200	203,200	I-F-R							2
7	Summit Creek	Brooks	7S	45E	28	1,800	6,000	I-R	70	600		27		700	1
8	Empire Gulch	Empire Gulch (Eagle)	7S	44E	20			I	90	1,200		97		2,500	1
	2B Keating														
9	West Eagle Creek	West Eagle Creek	6S	43E	5	6,300	18,900	I-F-R	49	375				1,800	1
10	Goose Creek	Lower Goose	8S	43E	8	39,500	82,300	I-F-R	96	440		36		1,300	1
11	Goose Creek	Upper Site	7S	43E	14	6,800	17,000	I-F-R	145	435		65		6,000	1
12	Sawmill Creek	Sawmill	8S	43E	12	4,100	7,500	I-F-R	108	1,150		250		7,500	1
13	East Fork Goose Creek	Sanger Gulch	7S	43E	10	5,100	12,700	I-F-R	90	700				2,550	1
14	Beagle Creek	Park	6S	41E	14	6,850	8,600	I-F-R	112	840		415		12,200	1
	2C North Powder														
15	Jimmy Creek		5S	39E	35	25,200	7,100	I-F-R	73	420		160		3,600	1
16	Wolf Creek	Lower Wolf Creek	6S	38E	11	21,100	15,100	I-F-R	130	1,700		233		12,650	1
17	Wolf Creek	Upper Wolf Creek	6S	38E	11	19,500	14,500	I-F-R	110	760		85		3,500	1
18	Pilcher Creek	Pilcher Creek	6S	38E	22	3,500	1,500	I-R	100	1,250		160		5,500	1
19	Anthony Fork	Anthony Gorge	7S	37E	6									1,200	2
20	Anthony Fork	Mud Lakes	7S	37E	7									600	2
21	Anthony Fork	Anthony Lakes	7S	37E	18									1,000	2
22	North Powder River	North Powder River	7S	38E	5	28,800	34,900	I-F-R	205	1,000		260		20,000	1
23	Dutch Flat Creek	Dutch Flat	7S	37E	13									1,000	2
24	Dutch Flat Creek	Dutch Flat Meadows	7S	37E	20	1,250	2,000	I-R	55	900		68		2,000	1
25	Muddy Creek	Muddy Creek	7S	39E	21	12,700	4,900	I-F-R	40	1,700		100		1,000	1
26	Rock Creek	Lower Rock Creek	8S	38E	7	9,300	13,400	I-R-Su	90	1,000		90		3,500	1
27	Rock Creek	Eilertson Meadows	8S	38E	18	8,200	12,200	I-R-Su	100	1,000		100		4,000	1
	2D Middle Powder														
28	Blue Canyon	Blue Canyon	10S	39E	24	5,850	5,400	I-F-R	65	450		133		2,900	1
	2E Upper Powder														
29	Powder River	Mason	10S	39E	24/25	112,000	65,500	I-F-R	185	920	4,071	2,450		100,000	1
	BURNT														
	3A Lower Burnt														
30	Alder Creek	Alder Creek	10S	41E	35	3,300	4,400	I-R	55	270		14		300	1
31	Lawrence Creek	Lawrence Creek Dam #2	10S	43E	29/32			I-F-R						18,000	2
	3B Upper Burnt														
32	Burnt River	Dark Canyon	12S	41E	10	407,400	75,000	I-F-R	101	215				12,000	2
33	Burnt River	Hereford	12S	38E	25									5,100	2
34	South Fork Burnt River	Carnegie	13S	36E	23			I-F-R						4,000	2
35	South Fork Burnt River	Hardman	13S	36E	22	28,400	25,500	I-F-R	83	520				14,000	2
36	North Fork Burnt River	Petticoat	11S	36E	14		25,400	I-F-R	75	400				6,600	2
37	North Fork Burnt River	Antlers	11S	36E	3			I-F-R						20,000	2
38	North Fork Burnt River	Rico	10S	35½E	25	18,600	38,700	I-R	45					2,000	1
39	Trout Creek	Trout Creek	11S	36E	2	18,800	31,300	I-R	55	184		182		3,500	1
40	Trout Creek	Walker	10S	36E	35	13,500	22,500	I-R	35	350				300	1
41	Trib. North Fork Burnt River	Howard Meadows	10S	35E	36	1,000	2,200	I-R				120		2,000	1

Note: This table includes damsites with conflicting reservoir areas.

Purpose: I - Irrigation
R - Recreation
F - Flood Control
Su - Supplemental Irrigation

Source: 1 - Soil Conservation Service
2 - Bureau of Reclamation

* Map index numbers refer to Plate 4.

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

ABBREVIATIONS AND SYMBOLS

Ac.	Acre
Ac-ft	Acre-feet
AUM	Animal unit month
Ave.	Average
CAA	Civil Aeronautics Administration
Can.	Canyon
cfs	Cubic feet per second
Co.	County
Cr.	Creek
D.	Ditch
Div.	Division
Dom.	Domestic
DR.	Drainage
ele.	elevation
°F	Degrees Fahrenheit
FAA	Federal Aviation Agency
Fk.	Fork
Ft.	Foot, Feet
G.	Gulch
gpd	gallons per day
gpm	gallons per minute
Ind.	Industrial
Irr.	Irrigation
kw	kilowatt
L.	Lakes, Little
Ls., Lks.	Lakes
Max.	Maximum
MBF	Million Board Feet
Mdw.	Meadow
Mgd.	Million gallons per day
Mi.	Mile
Misc.	Miscellaneous
Mtn.	Mountain
Mun.	Municipal
No.	Number
ORS	Oregon Revised Statute
OSHD	Oregon State Highway Commission
pH	degree of acidity
ppm	parts per million
%	per cent
Pt.	Point
R., Rng.	Range
Rec.	Recreation
Res.	Reservoir
RRA	Roadside Rest Area
S&G	Sand and Gravel
Sec.	Section
Sed.	Sediment
Spr.	Spring
Sq.	Square
Sta.	Station
Sus.	Suspended
SWRB	State Water Resources Board
T., Twp.	Township
Temp.	Temperature
USDA	United States Department of Agriculture
USGS	United States Geological Survey
Yrs.	Years

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The Powder Basin Water Resources Committee presented valuable basin data at the State Water Resources Board hearing, and was composed of the following people:

Chairman - Alvin Ward

Secretary - John Hesketh

Basin Subcommittees:

Watershed - Co-chairmen, Norman S. Wagner, Leo A. Moser, Frank C. Piper, Marvin Hammersmark, Richard Looney

Domestic - Chairman, Roger K. Blomberg

Municipal - Co-chairmen, Fred C. Dyer and Vernon Z. Jacobson

Industrial, Mining, and Power - Co-chairmen, Clinton P. Haight and Norman S. Wagner

Fish, Wildlife, and Recreation - Co-chairmen, David L. Gardiner and Gilbert C. Jones

Pollution - Chairman, Roger K. Blomberg

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Irrigation - Chairman, Truscott Irby
Area Chairmen: Norbert Sieg, Walter Schumway, Joe Pinare, Earl Blank, John Hesketh, Merton Davis, Lloyd Davis, Robert Steward

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