USDA Report on

WATER and RELATED LAND RESOURCES

MALHEUR LAKE DRAINAGE BASIN

OREGON

Based on a cooperative Survey by
THE STATE WATER RESOURCES BOARD OF OREGON
and
THE UNITED STATES DEPARTMENT OF AGRICULTURE

Economic Research Service ··· Forest Service ··· Soil Conservation Service

APRIL 1967

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Cover Picture

A view of the high desert country, Malheur Lake Drainage Basin.
Oregon State Highway Commission photo

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SUMMARY

NATURAL RESOURCES OF THE BASIN

The Malheur Lake Drainage Basin is located in southeastern Oregon. It is bounded by the Goose and Summer Lakes Basin and the Deschutes River Basin on the west, by the John Day River Basin on the north, by the Malheur River Basin and the Owyhee River Basin on the east, and the state of Nevada on the south. The total area is 6,377,600 acres or about 10.4 percent of the state of Oregon.

The climate of the basin is semi-arid with relatively warm summers and rather severe winters. The extremes of temperature that have been recorded in the basin are a low of -50° F. and a high of 107° F. The growing season varies from 90 to 120 days in the lower cropland areas to 60 to 90 days in the higher elevations. Average annual precipitation varies from less than 8 inches in the cropland areas to more than 35 inches in the upper reaches of the basin. The annual snowfall varies from a few inches in the valleys to more than 70 inches in the mountains. Prevailing winds are from the west.

The basin is comprised of three geomorphic subdivisions--a portion of the Basin and Range Province in the south; the Harney high lava plain in the central section; and a portion of the Central Mountains in the north. The section in the Basin and Range Province offers an exceptional display of crustal breakup by block faulting characterized by north-trending fault-block mountains and closed basins. The rock formations are late Cenozoic lavas and sedimentary formations mostly of volcanic materials except in the Pueblo Mountains in the south and the Strawberry Mountains in the north where small areas of pre-Tertiary rocks crop out.

A limited supply of ground water occurs in the older crystalline, metamorphic, silicic flows, and sedimentary rocks. Considerable water is believed to be contained in the porous zones of the basalt flows and breccias, the Danforth and Harney formations, and the younger unconsolidated sediments.

Ten groups of soils are delineated in the basin. The lowland soils were developed in alluvium of different forms and at different locations, including flood plains, fans, lacustrine basins, and terraces. They vary from deep, well drained, fertile soils to shallow, very strongly alkaline soils with hardpans in the subsoil. The cropland and the areas susceptible to development are composed of these soils. The upland soils were developed mostly from volcanic materials. Most of the upland soils which support range are

shallow over silica-lime hardpans and the soils supporting timber are deep and well drained.

The management of the land directly influences the yield and quality of water and, in turn, all segments of the economy of the basin. The water yield, which varies from year to year, is approximately eight inches of runoff in the higher areas and less than one inch in the desert-like areas. The total average annual natural yield was about 572,500 acre feet for the 1935-64 period. Natural streamflow is characterized by high runoff in the spring and low runoff the remainder of the year. In most years, 60 to 80 percent of the annual discharge occurs in March, April, and May. The chemical quality of most of the surface and ground water is suitable for irrigation, livestock, and recreation; however, a few problem areas near Malheur and Harney Lakes have a concentration of soluble salts and boron that is great enough to be toxic to plants. Approximately 4 percent of the irrigated land is supplied from ground water and the greater portion of this is located in the Alvord area. The limited water supply and the seasonal runoff create problems of flooding, erosion, and drainage. The method of irrigation water management employed in the basin is the diversion of flood water and irrigation by wild flooding. Some reservoir storage is available for supplemental irrigation but there is inadequate storage for all the cropland developed for irrigation. The annual consumptive requirement of water for grasses and legumes, the major crops, is about two acre feet per acre. The precipitation during the irrigation season, April through September, amounts to about 0.3 of an acre foot per acre or about 1.7 acre feet per acre (about 385,390 acre feet for the basin) less than the irrigation requirement for the season. Livestock water developments are needed on the rangeland.

The big game resource of the basin consists of mule deer throughout the basin; Rocky Mountain elk in the northern, forested portion of the basin; California bighorn sheep in the Steens Mountains and Hart Mountain areas; and the pronghorn antelope in the southern portion of the basin and Bear Valley in the north. The Hart Mountain National Antelope Refuge consisting of about 240,000 acres was established in 1936 in the vicinity of Hart Mountain to insure preservation of the pronghorn antelope.

The Malheur National Wildlife Refuge was established in 1908. This tract of approximately 181,000 acres of shallow marshes and lakes, small ponds, irrigated meadows, grass and sagebrush uplands, and occasional greasewood covered alkali flats is a vital fall and spring gathering point for approximately one-half million waterfowl of the Pacific flyway.

The species of upland game birds are pheasant, chukar, mountain quail, California quail, sage grouse, blue grouse, ruffed grouse, and European partridge. Nearly 50 species of mammals are reported to live within the bounds of the Malheur National Wildlife Refuge including beaver, otter, mink, and muskrat which are valuable for their fur.

The fish resource includes resident trout and warm-water game fish which inhabit streams, lakes, and reservoirs throughout the basin. A large percentage of the resource is sustained on a put-and-take stocking program by the Oregon State Game Commission.

The Oregon State Game Commission judges this basin to be in a critical water-shortage game area. Big game and upland game birds suffer from a lack of water in the summer months and the big game winter range is overused. The amount of precipitation and runoff determines whether the waterfowl habitat is scarce or plentiful. Low stream flow and high temperatures of the water are the serious habitat problems of the fish resource.

Because climatic conditions made the study area difficult to settle, the hardy groups of people who pioneered here left a rich, colorful, historical heritage. The basin offers a variety of recreational opportunities including hunting, rock and fossil hunting, camping, and sightseeing. Hazards which might destroy the natural environment are forest and range fires and damage from flooding and erosion.

ECONOMIC DEVELOPMENT

Settlement of the Malheur Lake Drainage Basin followed the general pattern of the West--first, explorers and fur traders and then, cattle ranchers and farmers. During the late 1860's, the first permanent residents began to settle the area and, because of adverse climate and limited irrigation water, resorted to the production of livestock. The other major economic activity, lumber and wood products manufacturing, began in 1867 with a small mill in the northeast part of the county. Between 1906 and 1911, three National Forest reserves--the Deschutes, Malheur, and Ochoco National Forests--were proclaimed. Portions of each are in the Malheur Lake Drainage Basin.

Water was long ago overappropriated. Since the establishment of two irrigation districts in 1921 and 1922, there has been a controversy between irrigation interests and the wildlife water needs of the Malheur National Wildlife Refuge.

The Malheur Lake Drainage Basin is sparsely populated with less than one (0.7) person per square mile in 1960. Population increased by about 107 percent from 1900 to 1940, an average annual increase of about 2.6 percent per year. From 1940 to 1950, the average annual increase was 1.4 percent; and from 1950 to 1965, 1.1 percent. This indicates that population has been increasing at a decreasing rate.

Livestock ranching and lumber and wood products manufacturing are the two dominant economic activities of the Malheur Lake Drainage Basin. The Edward Hines Lumber Company is the largest lumber mill in the basin and employs approximately 20 to 25 percent of the entire basin labor force. Total employment in the basin increased by approximately 20 percent from 1940 to 1960.

Approximately 73 percent of the land area of the basin is owned and managed by the U. S. Government. Rangeland is the major classification of about 82 percent of the total basin land area. Forest land, some of which is also used for grazing livestock, constitutes about 12 percent. Four percent of the basin land area is classified as cropland and the remaining 2 percent as "other land".

Short growing seasons; low average annual precipitation; and hot, dry summers and cold winters have limited the variety of crops in the Malheur Lake Drainage Basin almost exclusively to hay and feed grain crops which supplement the livestock enterprise.

About 85 percent of all the cropland is developed for irrigation; however, because of variations in water supplies, the number of acres actually irrigated varies from year to year. Construction of reservoirs, improvements of channels, and more efficient use of water are some possible solutions to the problem of variable annual water supplies. Before construction begins on any specific project, a thorough study should be made to determine what the economic consequences might be. If the additional benefits to be derived from further irrigation developments do not exceed the costs of the improvements, it would appear unwise to make the capital investment. This problem should be analyzed both from the standpoint of developing additional irrigated acres and from the standpoint of improving present irrigation practices.

Since there is little possibility that any crops other than hay and small grains will be grown in this area, it is especially important that the economic feasibility of irrigation development proposals be examined thoroughly. Part of this analysis should include a study of expected future supply and demand--local, regional, and national--and the effect that it might have on prices of these commodities. Also, alternative methods of increasing production should be examined--fertilizers, chemicals, et cetera.

Production of cattle, calves, small grains, wild hay, and alfalfa hay is projected to increase significantly by 1980. Part of the increase expected in the production of cattle and calves will be made possible through continued private and public range improvement efforts.

Sheep and lamb numbers and wool production in the Malheur Lake Drainage Basin experienced a marked decrease from 1930 to 1950 and have since remained relatively stable and are projected to remain so through 1980.

Farm employment has decreased by about 33 percent from 1940 to 1960 but is projected to remain fairly stable from 1960 through 1980.

The number of farms decreased by 36 percent from 1940 to 1964 while the average size of farms increased by about 153 percent over the same period. In 1964, the size of an average farm in the Malheur Lake Drainage Basin was about 5,078 acres not including land leased from the government. The average value of land and buildings per farm in the basin was $189,600 in 1964--over three times the state average.

Approximately 82 percent or 5,237,600 acres of the basin are classified as rangeland. Including the forest land, most of which is grazed, a total of about 94 percent of the land is grazed by livestock. The various kinds of rangeland in different parts of the basin include open areas of grass in the forests of the north; juniper-brush areas in the central section; sagebrush-grass sites in the semi-arid southern portion of the basin; tracts such as Alvord Desert which are void of vegetation; and areas with unfavorable terrain. The productivity of the range is rated by five condition classes which are excellent, good, fair, poor, and very poor.

Because the bulk of the rangeland is under the management of several federal agencies, the number of livestock permitted to graze on federal land is a significant portion of the total number of livestock in the basin. The number of livestock, expressed in A.U.M.'s, includes 35,800 on National Forest, 267,000 on BLM-managed lands, and 108,000 on lands of the two wildlife refuges.

Projects to improve the grazing capacity of the rangeland are conducted by the Forest Service and the Bureau of Land Management. Some of these projects are conducted in conjunction with private landowners. Areas of land that have been treated for brush control and reseeded to crested wheatgrass have an estimated grazing capacity of 2 to 4 acres per animal unit month as compared to 25 to 30 acres per animal unit month on the untreated native grass areas. Better distribution of livestock by construction of fences and by development of water has increased the number of animal unit months of usable forage. Because jack rabbits congregate in the crested wheatgrass seedings, their control is necessary to establish grass seedings. Many thousands of acres of rangeland can be improved which would increase the overall carrying capacity; however, the optimum level of development is not known.

Forest land occupies 12 percent or 779,400 acres of the basin in the northern section at elevations above 5,600 feet sea level. The forests are almost exclusively softwoods, predominantly ponderosa pine, with stringers of hardwoods in the valleys. Minor species of softwoods include Douglas-fir, white fir, lodgepole pine, alpine fir, and Engelman spruce. Usually a belt of western juniper occurs between the commercial forest and the land with the grass-shrub association. Grassland areas, occasionally exceeding 1,000 acres, are intermingled in the forest-land zone.

The forest resource is characterized by approximately 558,750 acres of commercial forest land and 220,650 acres of noncommercial forest land. The commercial forest land supports a stand of 4,769 million board feet of commercial timber. Approximately 214,730 acres of western juniper and 5,920 acres of inaccessible land of rough terrain compose the noncommercial forest land. To re-establish the forest after harvesting, measures to prevent or to control animal damage are sometimes necessary. Adequate fire protection will assure the economic returns from tree farming and livestock ranching and the condition of the watershed. Regeneration practices include protecting young trees during logging, leaving groups of seed trees, seeding by aerial method, and protecting seedling trees from competing vegetation, big game, rodents, and livestock. Improvement of growth and quality of young stands is accomplished by precommercial thinning.

The cutting of logs and poles for cabins and corrals by ranchers and miners was the beginning of timber harvesting and the production of lumber began in 1867 at Robie's mill on Rattlesnake Creek. Approximately 86 percent of the commercial timber is more than 150 years old which is past the 125-140 year technical rotation age. The overmature stands must be harvested over a period of 30 to 50 years to assure a sustained supply of timber until the present young-growth stands reach maturity. The annual allowable cut under the multiple-use, sustained-yield principle is approximately 60 million board feet from National Forest lands and approximately 2 million board feet from BLM-managed lands. The harvesting technique ordinarily accepted in the ponderosa pine zone is the individual tree or group selection basis and the

logging method usually is skidding with a crawler-type tractor. The Edward Hines Lumber Mill at Hines with an installed annual capacity of 120 million board feet and combined with a plywood plant having an installed annual capacity of 80 million square feet based on 3/8-inch basis and a planing mill at Seneca are the two mills located in the basin.

The sawtimber cut is projected to increase by 13 percent for the period 1963 to 1985 and the sawtimber growth is projected at 107 percent for the period 1963 to 2000. Inventory volume for all lands is projected to decrease by 21 percent from 1963 to 2000 because a large proportion of old mature stands will be harvested.

Faster transportation, higher incomes, leisure time, and urbanization have enabled people to seek outdoor recreation farther from home. These factors are causing an increase in the recreational activity in the Malheur Lake Drainage Basin. The primary recreational activity of the basin is hunting since deer, elk, bighorn sheep, antelope, quail, pheasant, chukar, and sage grouse are plentiful in the basin. Fishing is limited to a few streams and man-made lakes. Camping facilities are available at developed campgrounds and undeveloped "hunter camps". There are several undeveloped ski areas in the northern portion of the basin. The most popular recreation spot is the Malheur National Wildlife Refuge where visitors may observe and photograph the 234 species of birds. A museum at the refuge headquarters displays mounted specimens of the wildlife. Rock and fossil hunting has become increasingly popular.

Visits to the National Forest have decreased since 1960 and the visits to the Malheur National Wildlife Refuge have increased steadily in the past 10 years.

WATER AND RELATED LAND RESOURCE PROBLEMS

The problems that are related to land are erosion damage, sediment damage, floodwater damage, impaired soil drainage, and range and forest fires. Water problems are those associated with water shortages, phreatophytes, and pollution.

Most of the arable land is protected from rill and sheet erosion by sod-forming crops; however, overgrazing subjects the land to both water and wind erosion. Estimates reveal that about 650,000 acres of arable or potentially arable land have a predominant erosion problem. Sedimentation results from flooding. The sediment damage occurs in the rural, urban, and municipal areas and consists of damage from the deposition of sediment and debris. The main source of floodwaters in the basin is spring snowmelt in March, April, and May. Occasional flooding is caused by rainfall augmenting snowmelt in the winter and thunderstorms in the summer. Approximately 50,000 acres are flooded annually with varying degrees of damage. Although the largest portion of this acreage is cropland, the damage is minimal because most of it is planted to sod-forming crops. Estimates disclose that approximately 121,200 acres of the cropland and readily irrigable land (land capability class I through IV) have a major wetness problem. A portion of the wet soils has been drained to the degree necessary to grow the present crops but 75,300

acres of this land need additional drainage.

The range and forest fire season in the basin extends from June to October reaching its peak in August. Lightning is the predominant cause of fires; however, man-caused fires are a menace and effort is necessary among the public agencies to reduce and to prevent their occurrence. Modern fire-fighting equipment and techniques such as helicopters, smokejumping, and air-tanker-delivered, chemical retardents have reduced the amount of land burned over in the past few years.

A water shortage for 205,300 acres or 90 percent of the irrigated land exists during some portion of the irrigation season. Even if the storage facilities were adequate to store the spring runoff, there would not be sufficient water in the basin to supply the present needs for irrigation. The majority of the rural domestic and livestock water is provided from wells. The quantity of water is adequate but the quality is inadequate. Municipal and industrial water is adequately supplied from ground water. The problem of phreatophytic consumption of water has not been studied fully; however, in many cases, phreatophytes are considered to be beneficial as protection for livestock in winter and as stabilizers of streambanks from erosion. Siltation and sedimentation are the only water pollution problems of the basin.

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Several federal and state programs are contributing technically and financially to the solutions of the water and related land problems. Nearly 861,500 acres or 13.5 percent of the basin lie within the bounds of the Grant, Fort Rock-Silver Lake, and Lakeview Soil and Water Conservation Districts. The Soil Conservation Service furnishes technical assistance to these self-administered districts. The technical assistance provided to the landowners includes soil surveys, farm and ranch plans, and engineering help. The Agricultural Conservation Program of the Agricultural Stabilization and Conservation Service provides cost-sharing with farmers and ranchers to defray part of the cost of essential, satisfactorily performed, conservation practices. Cost-sharing is available on agronomic, constructional, and cultural types of practices. The Extension Service serves as liaison between research agencies; educational institutions; federal, state, and local agencies; landowners and other people. County agents in the basin are assisting in the identification of the water and related land resource problems, needs, and solutions. The Farmers Home Administration makes financial loans to landowners, community groups, public bodies, and nonprofit organizations.

No active cooperative forestry project is operating in the basin. The U. S. Forest Service is carrying on development projects of cultural, constructional, and wildlife and recreational development on range and forest land. The Bureau of Land Management is in a program involving range improvements, wildlife management, and recreation. The U. S. Fish and Wildlife Service is improving wildlife habitat. The State of Oregon has a program of fish and wildlife management.

WATER AND RELATED LAND DEVELOPMENT POTENTIAL

The land resource developments that are discussed include availability of land, irrigation systems, channel improvements, recreational developments, and land treatment measures. The aspects of water resource developments discussed are impoundments of water, ground water developments, water table control, and fish and wildlife development. Water is one of the factors that limit the development of the ultimate potential of the basin. The natural water yield of the basin generally is inadequate for the present needs.

Estimates based on a reconnaissance soil survey of the Malheur Lake Drainage Basin indicate that approximately 1,424,000 acres of land are suited for irrigated cropland. The general consensus is that it is necessary to irrigate most of the present cropland and the potentially arable land. A recent estimate shows that 77,300 acres will be developed for irrigation in the next ten years from ground water or reservoir storage. Improved irrigation systems should include land leveling for soils suitable for flood irrigation, sprinkler systems for areas not suitable for flood irrigation, lining of ditches or pipe lines for transmission of irrigation water, and more research of water-holding capacities and intake rates of irrigable soils. The channels of Silvies River from Five-Mile Dam to Malheur Lake and stretches of Silver Creek need to be enlarged, aligned, and cleared. A great potential for development of water for recreation lies in the forested area of the northern portion of the basin. Adjustments in land use, such as retirement of steep and erodible rangeland and treatment involving agronomic, cultural, and constructional practices, are needed in some parts of the basin.

The impoundment of water has the following benefits: flood protection, irrigation, stockwater, industry, domestic, recreation, pollution abatement, and fish and wildlife development. The USDA River Basin Staff assembled data on 23 reservoir sites with more than 611,000 acre-feet storage potential. Studies indicate that much more ground water could be developed. An estimated 28,000 acres could be irrigated from ground water in the Alvord area and available geologic and well data indicate that Catlow Valley has a potential ground-water source. Additional studies are needed throughout the basin to determine the ultimate supply from the ground-water basins. Water table control in the vicinity of Malheur and Harney Lakes could be accomplished in conjunction with water storage and improved irrigation practices. The major wildlife developments which have been conducted in the basin were accomplished by the U. S. Fish and Wildlife Service on the two refuges. The future development will undoubtedly be implemented by this agency and will probably be the extension and improvement of irrigation and drainage systems, the establishment of productive wildlife habitat, development of drinking water facilities, and the construction of impoundments for fish.

PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

Development needs which involve predominantly the land resource are watershed protection and management, flood protection, land stabilization and sediment control, and drainage improvement. Development which involves primarily water are irrigation, rural domestic, livestock, municipal, forest tree growth, and industrial water supply, recreation, fish and wildlife, and quality control.

Improved management of the watershed condition and resources in the basin is needed and, as the use intensifies in the future, it will become more important. Flood protection is needed in several areas of the basin but the most critical section is the lower reaches of the Silvies River which has a relatively flat gradient and flows in an ill-defined course. Protection and stabilization of the soils of the watersheds are primary needs in a large portion of the basin. Approximately one-half of the watersheds which are predominantly rangeland are in poor condition because they are inadequately vegetated and moderately to severely eroded. An estimated 75,300 acres of land with excessively wet soils require some form of drainage improvement. The largest areas with drainage problems are in the vicinity of Malheur and Harney Lakes and the upper Silvies River valley.

The existing irrigation developments are the result of action by individuals, small groups, or projects. The ground-water source could be developed by individuals. Irrigation water management is necessary to realize maximum yields with present water supplies. If all the land suitable for irrigation were developed, it would be necessary to import water. A prerequisite of any plan of irrigation development should be a study to determine economic feasibility. In the Malheur Lake Drainage Basin, a thorough economic study would be especially desirable because of the nature of the agriculture. Livestock production, the most important agricultural endeavor, is projected to increase significantly by 1980. The comparative advantage of livestock production, the lack of close markets for higher-value crops, and the short growing seasons may limit the economic feasibility of future irrigation development. Future irrigation development, undoubtedly, would increase production; however, the cost of irrigation also would increase.

Improved quality of domestic water and additional stockwater developments are needed. It is anticipated that an additional water source will be required for municipal use in the near future. Studies show that the public prefers water-oriented activities such as swimming, fishing, boating, and water skiing. Campsite developments such as improved sanitary facilities and potable water supplies are needed to enhance the recreation of the basin. The greatest need for wildlife is drinking water in the semi-arid southern portion of the basin. The establishment of minimum drawdown in the reservoirs would help to alleviate the problem of high water temperatures for trout. Excessive sediment content and high summer temperature constitute the water-quality problems.

OPPORTUNITIES FOR DEVELOPMENT OF USDA PROGRAMS

Opportunities for the development of the water and related land resources exist in the basin. The USDA River Basin Survey Staff made a study of the possible P. L. 566 projects in the Malheur Lake Drainage Basin to provide information to guide long-range planning and coordination of future projects. The 35 watershed areas of the basin were studied and reconnaissance reports were written about each of them.

Projects in five watersheds appear to be feasible and projects in five other watersheds might be feasible; however, more detailed study would be necessary for determination. The watersheds with the best possibility for

a project are those having a high potential for agricultural and/or urban development and those having problems and needs such as flood protection, erosion control, improved drainage, irrigation water management, land treatment measure, municipal water supply, recreational development, fish and/or wildlife development, water quality, and improved timber growth.

Possibilities for development on public lands have been inventoried and projects of work are in progress at this time or being planned for the future. This work includes insect and disease control, recreational development, and fish and wildlife habitat improvement.

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

In the Malheur Lake Drainage Basin, there are project potentials that could be accomplished by alternative approaches as well as by programs of other agencies. Another possibility would be to plan a project which would utilize jointly the provisions of P. L. 566 and the programs of other agencies to solve the problems and needs of a particular watershed. For example, a joint study of potential improvements on the Silvies River should be made by the Soil Conservation Service and the Corps of Engineers to determine the best combination of improvements to provide downstream flood protection and water for irrigation.

INTRODUCTION

This report prepared by the USDA River Basin Survey Staff presents information concerning the water and related land resources of the Malheur Lake Drainage Basin. Its purpose is (1) to provide information of past and present uses of water and related land resources; (2) to supply production data from the use of these resources; (3) to assess the magnitude of water-related problems such as erosion, flooding, and drainage; (4) to indicate probable directions of future use of water and land for agriculture and forestry in comparison to competing uses; and (5) to outline a general program for water and land resource management as a background for future detailed study and planning.

The U. S. Department of Agriculture agencies participating in the study are the Economic Research Service, the Forest Service, and the Soil Conservation Service.

The Malheur Lake Drainage Basin is located in southeastern Oregon and contains 6,377,600 acres. It is a portion of the Columbia Intermontane and Basin and Range Provinces and is characterized by heavily forested mountains in the northern portion and sagebrush-covered mountains and flatlands in the southern portion. The climate is temperate and semiarid, characterized by low annual precipitation, low winter temperatures, high summer temperatures, and short growing seasons. Elevations vary from 4,030 feet at Harney Lake, the low spot in the basin, to 9,670 feet at the top of the Steens Mountains. The two major economic activities consist of livestock ranching and lumbering.

This study prepared by USDA is a result of a cooperative agreement between the U. S. Department of Agriculture and the State Water Resources Board of Oregon and it is conducted under the provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended).

The State Water Resources Board of Oregon is making a survey and an investigation of the Malheur Lake Drainage Basin to develop information needed for planning the coordinated development of the area's water resources. The information needed for its study includes: (1) the kind and location of desirable water resource developments; (2) the amounts of water required; (3) the physical opportunities for developments to meet water needs; and (4) the broad economic aspects of possible development. The State will use this information to formulate and to implement plans and programs to secure the

most beneficial use and control of the area's water resources. The State's programs are intended, by legislative decree, to be dynamic in nature with provision for changes as new information is available and as the physical or economic situation changes. The current survey is only the beginning of the State's work of this area.

The survey by the USDA River Basin Survey Staff consisted partly of accumulating and evaluating previously recorded data, both published and unpublished, much of which was furnished by cooperating groups. In addition, the staff made limited studies to gather basic information that was not otherwise available including physical characteristics of certain reservoir sites, land and water availability and use, problems and needs for many tributary watersheds, and forest land resources and ownership. These were not detailed surveys; much of the information was obtained through consultation with local, public, and private officials. The basic data used as a foundation for statistical information presented in this report are in the files of the USDA River Basin Survey Staff.

Several agencies and organizations provided helpful assistance in making this survey. The field office of the Soil Conservation Service furnished much of the basic information concerning reservoir sites and tributary watersheds. The County Extension Service and Agricultural Stabilization and Conservation Service assisted in the collection of tributary watershed data. Most of the land status information was obtained from County Assessor's records of the counties concerned. Much information on the forest land was furnished by the various field office of the Forest Service, the Pacific Northwest Forest and Range Experiment Station, the Bureau of Land Management, the Fish and Wildlife Service, and the State Forester of Oregon. Some of the agricultural data was obtained from publications of the Bureau of Census and from the Statistical Reporting Service. Several of these agencies also provided helpful consultation and comments concerning the preparation of this report. In accordance with the cooperative agreement, the State Water Resources Board developed and furnished information concerning existing water rights, major resources and their use, and other pertinent information in addition to furnishing hearing reports and maps.

NATURAL RESOURCES OF THE BASIN

LOCATION

The Malheur Lake Drainage Basin is located in southeastern Oregon (map 1). It is bounded by the Goose and Summer Lakes Drainage Basin and the Deschutes River Basin on the west, by the John Day River Basin on the north, by the Malheur River Basin and the Owyhee River Basin on the east, and the state of Nevada on the south. The basin has a total area of 6,377,600 acres which is about 10.4 percent of the state of Oregon. It contains 80.2 percent of Harney County, 10.8 percent of Lake County, 10.0 percent of Grant County, 4.9 percent of Malheur County, and 0.6 percent of Crook County.

For the purpose of this report, the basin was divided into four subbasins--Silvies, Donner und Blitzen, Silver Creek, and Alvord-Catlow. The Silvies Subbasin in the northeast contains 1,346,400 acres or 21 percent of the total area. It has been divided into seven watersheds. The major stream is the Silvies River which begins in the Aldrich-Strawberry Mountains and flows southward into Malheur Lake. The Donner und Blitzen Subbasin in the east-central portion of the basin contains 626,900 acres or 10 percent of the total acreage. This subbasin has been divided into three watersheds. The Donner und Blitzen River--the major stream--and its tributaries originate in the Steens Mountains. The Silver Creek Subbasin in the northwest portion contains 1,306,700 acres or 20 percent of the total area. It has been divided into eight watersheds. Silver Creek heads in the northwest corner and flows southeastward into Harney Lake. The Alvord-Catlow Subbasin is the south half of the basin and it includes 3,097,600 acres or 49 percent of the total acreage. This subbasin includes two large closed basins--Catlow Valley and Alvord Desert basin--and has been divided into 17 watersheds. Catlow Valley receives drainage from the surrounding hills and mountains including the Steens Mountains, Hart Mountain, Poker Jim Ridge, and the Pueblo Mountains. The Alvord Desert receives the drainage from the Pueblo and Steens Mountains on the west, the Sheepshead Mountains on the north and east, and the Trout Creek Mountains on the east.

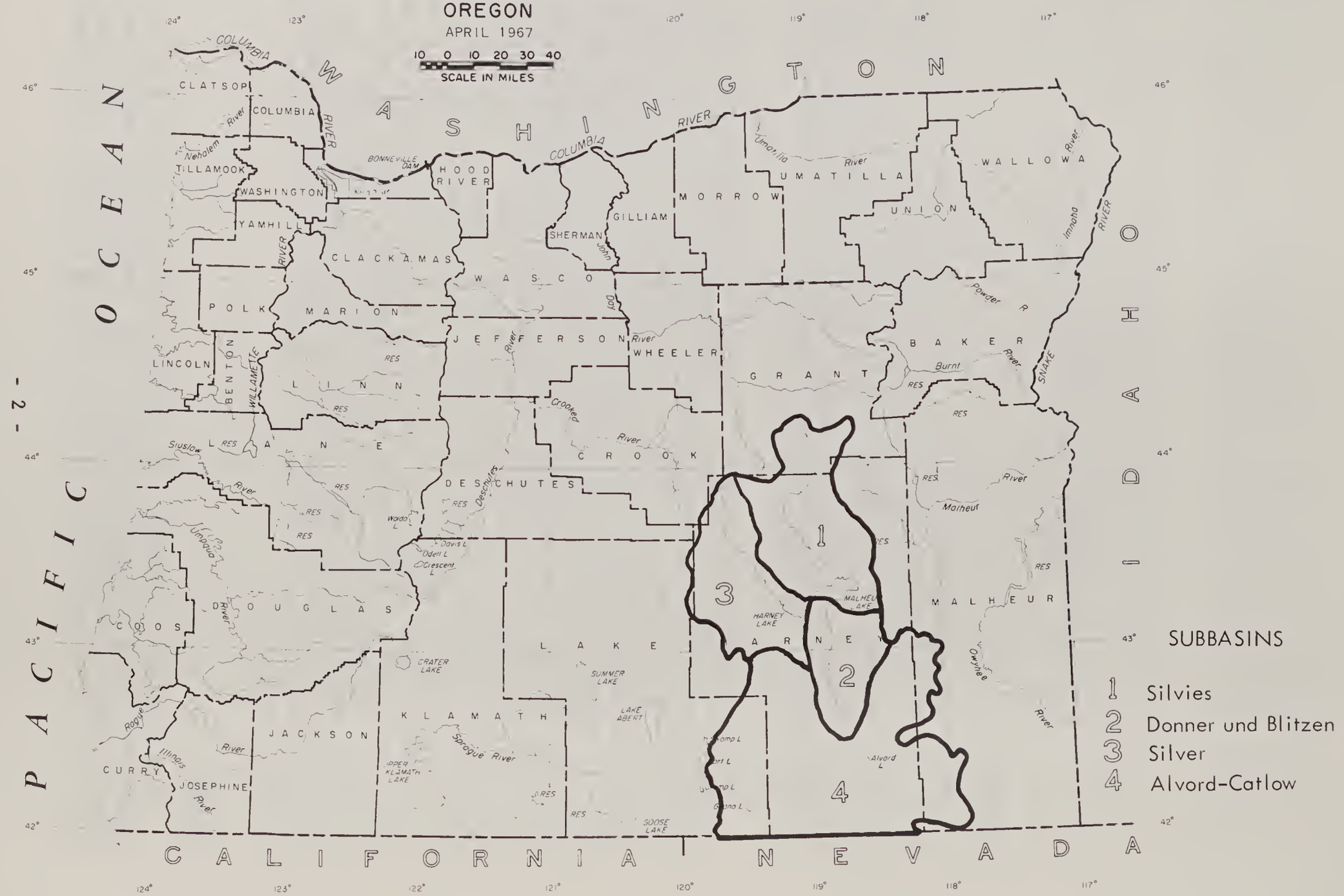
CLIMATE

The climate of the Malheur Lake Drainage Basin is semi-arid with relatively warm summers and rather severe winters. Extremes are largely due to the wide range of elevation and exposure. The average annual temperature at Burns is 46.5° F., ranging from an average minimum of 16.3° F. for January,

MAP 1

MALHEUR LAKE DRAINAGE BASIN
OREGON

APRIL 1967



SUBBASINS

1 Silvies
2 Donner und Blitzen
3 Silver
4 Alvord-Catlow

the coldest month, to an average maximum of 86.2° F. for July, the warmest month. The temperatures at Burns are typical of the open valleys of the basin. Extremes of -54° F. and 107° F. have been recorded in the basin. The short growing season ranges from 90 to 120 days in the open lower valleys and from 60 to 90 days in the upper valleys. Freezing temperatures have been recorded every month of the year.

Average annual precipitation varies from more than 35 inches in the upper reaches of the basin to less than 8 inches over the lower elevation agricultural areas (map 2). Average annual precipitation for five stations in the agricultural areas are as follows: Seneca, 12.6 inches; Burns, 11.5 inches; P Ranch, 12.0 inches; Blitzen, 8.5 inches; and Andrews, 7.7 inches. During the average year, less than 4 inches of precipitation falls during the irrigation season--April through September. During the summer months, much of the basin is subject to showers affected by convective conditions which frequently occur in the form of "cloudbursts". These storms cause severe soil erosion and flood damage and add very little to the soil moisture.

The annual snowfall varies from a few inches in the valleys to over 70 inches in the mountains. The mountain snowpack is the principal source of streamflow and is, therefore, an important source of water for irrigation, fish, wildlife, livestock, domestic, and other uses.

Evaporation studies were conducted at the Harney Branch Experiment Station in the Burns area for a 20-year period. The average annual evaporation for that period was about 42 inches in the agricultural cropland area.

The prevailing winds are from the west. Wind velocity varies from a maximum of 7.6 miles per hour to a minimum of 1.4 miles per hour with the average velocity being 3.9 miles per hour at the Harney Branch Experiment Station. Strong winds are common throughout the year, especially from March to June. Tornado-like storms are almost unknown in the basin.

PHYSIOGRAPHY AND GEOLOGY

The Malheur Lake Drainage Basin is largely a youthful high lava plain. It consists of three geomorphic subdivisions--a portion of the Basin and Range Province in the south; the Harney high lava plain in the center; and a portion of the Central Mountains in the north. The rock formations are late Cenozoic lavas and sedimentary formations, of mostly volcanic materials, except for a small area in the Pueblo Mountains in the south where pre-Tertiary schists and intrusive rocks crop out and the Strawberry-Aldrich Mountain uplift in the north where older rocks crop out along the summit. The generalized geologic map (map 3) and the narrative portion illustrate and describe the topography, structure, and formations.

Topography and Structure

Basin and Range Area. The Basin and Range geomorphic division covers the south two-fifths of the basin and is a portion of the Basin and Range Province which extends south and southeast from southern Oregon through

several states into Mexico. It offers an exceptional display of crustal deformation by block faulting and is characterized by north-trending fault-block mountains and basins of internal drainage into which sediments from the hills and mountains are deposited. All the area is above 4,000 feet in elevation and the highest point in the Steens Mountains is 9,670 feet. Hart Mountain and Poker Jim Ridge Range--the west border of the basin--is also a block-fault with a steep scarp on the west which is 5,000 feet high in places. This mountain range slopes gently eastward to the wide Catlow Valley--a down-dropped block--which was a large Pleistocene lake and is now a dry alluvial basin. The Jackass Mountains at the north end of the Catlow Valley are a westward tilted fault-block which forms the western margin of the Donner and Blitzen Valley near Frenchglen. The Steens Mountains and Pueblo Mountains on the east and south of Catlow Valley are west-tilted fault-blocks. The Steens Mountains (photo 1) with a steep scarp more than 5,000 feet high on the east side--the most impressive range in the basin--has been thoroughly dissected by erosion, much of it glacial as evidenced by the minor cirques and U-shaped valleys of the Blitzen and Little Blitzen Rivers and Indian and Kiger Creeks (photo 2). Fish Lake occupies a shallow, glacially formed depression at the head of Fish Creek. Lying at the foot of the Steens Mountains, the Alvord Lake basin is partially filled by alluvium. Low, west-facing scarps along the eastern border of Alvord Lake basin separate it from the Sheepshead and Trout Creek Mountains which are the east boundary of the Malheur Lake Drainage Basin.

Harney High Lava Plain. The Harney High Lava Plain in the central portion of the basin borders the Strawberry-Aldrich Mountain uplift on the north and merges into the Basin-Range area on the south. This region of moderate relief is a relatively undeformed expanse of young volcanics much of which is sedimentary. It is dotted by cinder cones and lava buttes such as Wagontire Mountain and undrained basins containing playa lakes at certain times of the year. Harney Basin is an evaporite, internally drained basin. Malheur and Harney Lakes near its center receive the drainage of the Silvies River and Silver Creek from the north and the Donner und Blitzen River from the south. During the times of greater rainfall, coinciding with Pleistocene glacial stages, water from a large lake in Harney Basin drained eastward into Malheur River. At first its course was by way of Malheur Gap at Princeton and later, when Pleistocene lavas blocked this channel, through the Crane Creek Gap at Crane until it was, also, subsequently blocked. At low points, lakes have formed--some perennial and alive, others intermittent, saline, and alkaline. Harney Lake, a large, saline-alkaline lake with an elevation of 4,030 feet, is at the lowest point and is the place of the ultimate drainage of the basin. Malheur Lake, a live lake, is the largest body of water in the basin. Other live lakes, including Silver and Mud Lakes, numerous playas, and dry lakes, occur throughout the area.

Central Mountains. The north portion of the basin in the Strawberry-Aldrich Mountain uplift is mountainous topography. This area generally slopes to the south with the lowest elevation about 4,500 feet and the summit elevation varies from about 5,100 to 8,000 feet. Some of the highest peaks or mountains are: Whiskey Mountain, 6,135 feet; Sugarloaf Mountain, 6,180 feet; Big Mowich Mountain, 6,242 feet; West Myrtle Butte, 6,384 feet; Telephone Butte, 6,398 feet; Jump Off Joe Mountain, 6,440 feet; Dry Mountain, about 6,600 feet; King Mountain, 6,678 feet; Calamity Butte, 6,695 feet;


U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
Malheur Lake Basin
BASIN LOCATION
GRANT
CROOK
HARNEY
MALHEUR
LAKE
NEVADA
COUNTY LOCATION
14a1-1
14a1-2
14a1-3
14a1-4
14a1-5
14a1-6
14a2-1
14a2-2
14b-1
14b-2
14b-3
14b-4
14b-5
14b-6
14b-7
14b-8
14b-9
10-1
10-2
10-3
10-4
10-5
10-6
10-7
10-8
BURNS
Hines
Riley
Seneca
Diamond
Crane
MALHEUR NAT'L WILDLIFE REFUGE
HARNEY LAKE
MALHEUR LAKE
SILVER L.
MNWR
BARTON RES.
MC RES.
LITTLE RES.
DESCHUTES CO.
CROOK CO
GRANT CO
HARNEY CO
LAKE CO
MALHEUR
NATIONAL FOREST
OCHOCO
MALHEUR
ANTELOPE
REFUGE
MOUNTAIN
HART
LEGEND
Basin Boundary
County Line
National Forest and/or Wildlife Area Boundary
14a1-1 Watershed Boundary & Number
10 Average Annual Precipitation in Inches
MAP 2
AVERAGE ANNUAL PRECIPITATION
MALHEUR LAKE BASIN
OREGON
JULY 1966
0 1 2 3 4 5
SCALE IN MILES
NEVADA
R 25 E
R 26 E.
R 27 E.
R 28 E.
R 29 E.
R 30 E.
R 31 E
R 32 E
R 33 E
R 34 E

M 7 - S - 18246

BASIN LOCATION

COUNTY LOCATION

LEGEND

- Unconsolidated Sediments of Pliocene to Recent Age
- Basalt Flows of Miocene to Recent Age
- Silicic Flows, Sedimentary Rocks, and Welded Tuffs of Pliocene Age
- Lava Flows and Flow Breccias of Miocene Age
- Silicic Flows, Sedimentary Rocks, and Welded Tuffs of Miocene Age
- Crystalline and Metamorphic Rocks of Permian to Miocene Age
- Drainage Basin Boundary
- Watershed Boundary
- National Forest and Refuge Boundaries
- Fault Traces (Hachures indicate downdrop side)
- Anticline Axis
- Syncline Axis

1 - SILVIES SUBBASIN

14a-1	Malheur Lake
14a1-1	Bear Valley
14a1-2	Silvies
14a1-3	Emigrant Creek
14a1-4	Willow Creek
14a1-5	Poison Creek
14a1-6	Hot Springs Creek

2 - DONNER UND BLITZEN SUBBASIN

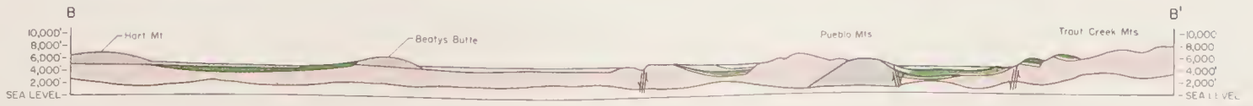
14a-2	Riddle Creek
14a2-1	Donner und Blitzen
14a2-2	Fish Lake

3 - SILVER SUBBASIN

14b-1	Upper Silver Creek
14b-2	Miller Canyon
14b-3	Chickahominy Creek
14b-4	Silver Lake
14b-5	Lower Silver Creek
14b-6	Wilson Creek
14b-7	Buzzard Creek
14b-8	Jackass Creek

4 - ALVORD - CATLOW SUBBASIN

14-1	Alvord Ranch
14-2	Alvord Lake
14-3	Trout Creek
14-4	Pueblo Slough
14a-3	Mann, Tudor & Fifteencent Lakes
10a-1	Coyote Lake
10a-2	Twelvemile Creek
10a-3	Whitehorse Creek
10-1	Rock Creek
10-2	Guano Slough
10-3	Catlow Valley
10-4	Roaring Springs
10-5	Guano Lake
10-6	Jack Creek
10-7	Shallow Lake
10-8	Rincon Creek
14b-9	Clover Creek



GENERALIZED GEOLOGIC CROSS SECTION

MAP 3

GENERALIZED GEOLOGIC MAP

MALHEUR LAKE DRAINAGE BASIN

OREGON

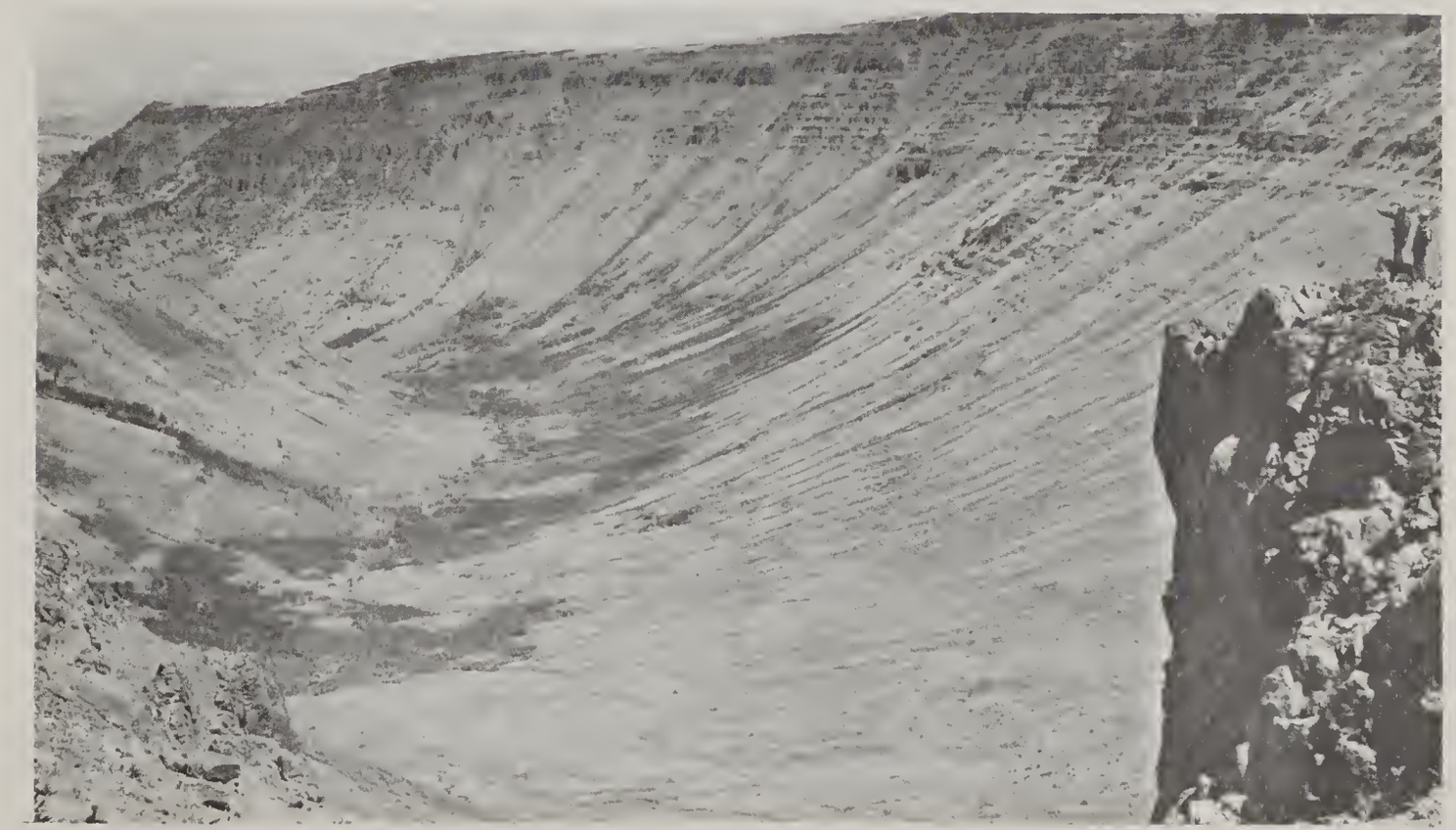
APRIL 1967

SCALE IN MILES

M7-S-17924-N

Photo 1.--The Steens Mountains are the most impressive range in the basin. OREGON STATE HIGHWAY COMMISSION PHOTO 3818

Photo 2.--Glacial erosion formed the U-shaped Kiger Gorge.
OREGON STATE HIGHWAY COMMISSION PHOTO 3819



Snow Mountain, 7,163 feet; and Strawberry Mountains, about 8,000 feet. The Silvies River, Silver Creek, and other small drainages are entrenched in this upland to form steep-walled canyons except where constrictions have left large alluvial valleys.

Geologic Formations

Crystalline and Metamorphic Rocks of Permian to Miocene Age. These older altered rocks appear on the surface at both ends of the basin. The oldest formations in the basin are schists, gneisses, phyllites, greenstone, and granitic intrusives which crop out in the southern part of the Pueblo Mountains and the Trout Creek Mountains. The Oligocene to Miocene Pike Creek and Alvord Creek formations are exposed along the base of the fault scarp along the Steens and Pueblo Mountains and in the fault scarp along the east side of the Alvord Desert area. In the Strawberry Mountains, ultramafic intrusions of dunite, peridotite, and pyroxenite, in places altered to serpentine, have intruded the Permian metamorphosed schistose rock. Thick sections of folded and faulted Jurassic sedimentary rocks--mudstone, siltstone, shale, calcareous sandstone, waterlaid tuff, and andesitic flows and breccias--are exposed in the vicinity of Seneca.

The occurrence of ground water is limited in these rocks.

Silicic Flows, Sedimentary Rocks, and Welded Tuffs of Miocene Age. These formations are exposed in the Trout Creek Mountains, the Beattys Butte area, other areas in the southern portion of the basin, and a small area along the east slope of the Silvies River valley. They underlie the younger rocks in a rather large portion of the basin. The sedimentary rocks are composed of igneous materials, including rhyolitic and dacitic tuff, lapilli pumice, and ashy diatomite. Rhyolitic and dacitic lava and tuff, partly to densely welded, were extruded over small areas. These units have not been named; however, they have been correlated to the Mascall, Beattys Butte, Skull Spring, Trout Creek, and Canon Rhyolite formations.

The occurrence of ground water is limited and probably is present only along the fractures.

Lava Flows and Flow Breccias of Miocene Age. Lava flows and breccias are exposed in about one-third of the south half of the basin and along the eastern border. Prominent in the northern portion of the basin are the Strawberry Volcanics and the rocks of the Columbia River group. The largest areas of volcanics are the Steens and Pueblo Mountain uplift and the hills southwest of Catlow Valley. The main scarp of the Steens Mountains is made up of two series of basaltic and andesitic flows totalling more than 4,000 feet in thickness. The older of the two series is the Steens Mountain Volcanics which is made up of poorly stratified andesitic and basaltic flows and breccias while the younger Steens Basalt is composed of parallel flows of basalt. The lava flows in the Sheepshead Mountains and along the east side of the Alvord Desert basin are mostly andesite with some flows of porphyritic olivine basalt, basaltic and andesitic breccias, and minor amounts of interbedded tuffaceous sedimentary rocks and tuff.

The porous zones of these volcanic rocks have considerable water-yielding capacity and, in the Donner und Blitzen Valley, there are several perennial, thermal springs along fault conduits.

Silicic Flows, Sedimentary Rocks, and Welded Tuffs of Pliocene Age. Approximately one-third of the basin, mostly in the north and central sections, is a dissected upland and is composed of a complex of sedimentary rocks and intermixed and interbedded basaltic and andesitic flows. The Danforth and Harney formations--probably the two most prominent formations--are described as follows: "The Steens basalt is overlain unconformably by the Danforth Formation of Pliocene age, which crops out extensively over the whole dissected upland and ranges in thickness between 20 feet and about 800 feet. In the northwestern part of the basin, the upper part of the Danforth Formation comprises stratified siltstone, sandstone, tuff, and volcanic ash with a few intercalated layers of glassy rhyolite and one distinctive rhyolite tuff-breccia member. Its lower part is massive rhyolite... The succeeding stratigraphic unit, the Harney Formation, of Pliocene (?) age, is about 750 feet thick and rests on the Danforth Formation with angular and erosional unconformity. The Harney Formation underlies an extensive plain of intermediate altitude in the west-central part of the basin and occurs in outliers along all margins of the central district except the northern. The formation includes massive basaltic tuff and breccia, sandstone, siltstone, some incoherent gravel, and a few layers of scoriaceous and massive basalt... A fanglomerate, also Pliocene (?) age, occurs locally along the north margin of the central area but lies above regional ground-water level." 1/ Beds of similar age and composition are found in the southern section of the basin.

The upper part of the Danforth formation yields considerable water to municipal wells at Burns and Hines and the entire formation yields considerable thermal water to large springs along fault conduits. The intermittent gravel members transmit water readily if they are in the zone of saturation.

Basalt Flows of Miocene to Recent Age. Basalt flows cap two comparatively large areas and several small ones. These volcanics may be in the form of dense to platy, gently dipping flows, collapsed lava tubes, dikes, sills, plugs, necks, domes, cinder cones, welded tuff, and basaltic ejecta, such as bombs, agglomerate, breccia, scoria, cinders, and ash. The Hart Mountain area is capped by a late Miocene and early Pliocene flow of highly feldspathic basalt containing small to moderate amounts of slightly altered olivine. Beattys Butte is a large dome of flows and flow breccia of rhyodacitic, basaltic, and andesitic composition. A basaltic lava field of Voltage lava extends northward from the Diamond Craters nearly to Malheur Lake and eastward to the base of Riddle Mountains. This formation dammed the ancestral Malheur Gap and thereby cut off Harney Basin from the Malheur River and caused it to fill with sediment. The youngest lava field, the Diamond Craters near the town of Diamond, may be Recent in age. This lava field is either hummocky with collapse pits and a few pressure ridges; or relatively smooth and composed of ropy (pahoehoe) lava; or blocky lava with

1/ Piper, A. M., Robinson, T. W., and Park, C. F., Jr., 1939, Geology and Ground-Water Resources of the Harney Basin, Oregon, U. S. Geological Survey Water-Supply Paper 841, p. 1-2.

a jagged surface that is almost impassable. Very little soil has accumulated because there has been very little weathering and erosion.

The porous zones of the late basalt are pervious and are charged by the natural precipitation as evidenced by the cool temperature of the water. The Voltage lava field supplies one moderately large perennial spring and several flowing wells along the south margin of Malheur Lake.

Unconsolidated Sediments of Pliocene to Recent Age. Almost all the alluvial basins in the north portion were formed structurally and they were alluviated while they were lakes; whereas, those in the north section are stream valleys which were filled by sediment when the valley was constricted, temporarily or permanently. The valley of the lower Silvies River and Malheur Lake area was alluviated when an extrusion of young basalt dammed Malheur Gap. The upper Silvies Valley and the Silver Creek Valley are natural valley fill except the lower Silver Creek valley which filled with sediment at the same time as Harney Basin. The Donner und Blitzen valley, the Alvord Lake basin, and the Guano Lake area are down-dropped fault-block basins which have been filled with alluvium, lacustrine deposits, and eolian sediments including volcanic ash--all of which were derived largely from the volcanic rocks of the uplands. The Catlow Valley is a down-dropped fault-block which was later folded downward. Coyote Lake is a syncline which is partly filled with sediment. Almost all these basins are characterized by shallow lakes or playas high in salt and alkali at the lowest elevation; an active dune area of silt and sand; live, intermittent streams and dry streambeds; and ancient shorelines.

"In the valley fill, the members, lentils, and tongues of gravel and sand are pervious. Those which are shallow hold unconfined water; near the center of the basin this shallow water contains considerable alkali. The deep permeable beds in the valley fill hold confined water and supply several irrigation wells in the northwestern part of the central alluvial plain." 2/ The major part of the ground water now being used is withdrawn from these sediments. There are several large irrigation wells in the Alvord Lake and Harney Basins.

LAND RESOURCES

Soils

Ten general groups of soils exist in the Malheur Lake Drainage Basin. The five factors which determined the nature and distribution of the soils are: geologic, source and kind of parent and underlying material; physiographic, kind and shape of land form; meteorologic, temperature and precipitation; organic, dead and living animal and plant life; and time, relative age and development of the soils. The interdependent action of climate and organic life upon the parent material, as conditioned by the relief and length of time, determines the characteristics of the soils.

2/ Piper, A. M., Robinson, T. W., and Park, C. F., Jr., p. 2.

The area of each of these groups of soils is delineated on the generalized soil map (map 4). The narrative contains a general description of each group. Table 1 lists the soil groups and the soil mapping units in each group and describes some of the prominent characteristics and qualities.

Fan and Flood-plain Soils. The recent alluvium on the fans and flood plains originated in the hills and terraces which lie at higher elevations. The mineralogy is a mixture of material mainly from volcanics and other sediments. The largest area is composed of fans which were deposited by live streams as they flowed out into the basins. These soils have medium textured profiles; have very little development; and are generally more than 36 inches to gravel. They are well drained except where dikes have created a marshy condition. These soils are cropland if water is available for irrigation.

Strongly Alkaline Flood-plain Soils. These soils are located in the low-lying areas near Harney, Malheur, and Alvord Lakes. The alluvial and lacustrine material of mixed mineralogy was deposited on flood plains and lake areas which have a seasonally fluctuating water table. The fluctuating water table caused a great quantity of saline and alkaline material to accumulate on the surface and in the soil profile and to be strongly alkaline or very strongly alkaline in reaction. Hardpans have formed in some soils. These soils are moderately deep to very deep and have weak to strong profile development. If irrigation water is available, these areas are cropped. Other areas are pasture land in normal years and marshland in wet years.

Mixed Area--Well Drained, Poorly Drained, and Strongly Alkaline Flood-plain Soils. These soils are intermixed areas of approximately 50 percent each of "Fan and Flood-plain Soils" and "Strongly Alkaline Flood-plain Soils".

Lake Basin Soils. In areas of internal drainage, small lakes and playa lakes have formed and alluvial and lacustrine material of mixed mineralogy has been deposited by the in-flowing streams. The largest area is the Catlow Valley; however, smaller areas are located around Guano Lake, Foster Lake, Coyote Lake, Harney Lake, and Malheur Lake. One of the two groups of soils is characterized by medium textured profiles, weak to strong development, and semi-permeable silica hardpan less than 20 inches below the surface. The other group of soils is very fine textured vertisols which average about 36 inches deep and are somewhat poorly drained and black to very dark gray colored. A small portion of these soils is irrigated cropland and the remainder is rangeland and wildlife habitat.

Older Fan and Terrace Soils. These soils were developed in sediments of predominantly volcanic origin. Almost all of these soils have weakly to strongly developed profiles with silica-lime hardpans in the coarse substrata of 15 to 20 inches deep. A few soils are deep and gravelly with no hardpan. Bordering the lake basins and flood plains with slopes of generally less than 7 percent, the surface soil is neutral in reaction and the subsoil is slightly alkaline and calcareous. The major land use is range; however, these soils are suitable for irrigated cropland.

Mixed Area--Flood-plain Soils and Older Fan and Terrace Soils. These soils are intermixed areas of approximately 50 percent each of "Fan and Flood-plain Soils" and "Older Fan and Terrace Soils".

Upland Soils--Below 5,600 Feet. This area lies below 5,600 feet elevation and comprises about 65 percent of the uplands. The major portion of the parent material is volcanics. These soils are uniform in depth, generally less than 20 inches, to a silica-lime hardpan which is directly over the bedrock. The soils are weakly to strongly developed, neutral in reaction, and gently sloping except for fault escarpments. They produce mostly range.

Upland Soils--Above 5,600 Feet. This area lies above 5,600 feet elevation and comprises about 21 percent of the uplands. The parent material is volcanics in a major portion and granodiorite and metamorphosed sedimentary rocks in a smaller section. These are moderately developed, neutral, moderately steep to steep, shallow soils with silica-lime hardpans over the bedrock. They produce range almost exclusively.

Upland Soils--Under Forest Cover. Constituting approximately 14 percent of the uplands, these soils were developed from volcanics and old sedimentary rocks. They are slightly acid to neutral, dark colored, moderately deep, and moderately developed. These soils support a forest cover and almost all this land is grazed.

Miscellaneous Land Types. Miscellaneous land types occur in many places in the basin--many areas are too small to show on the generalized map. Dune land--actively moving sand dunes--is found in the Alvord Desert, the Harney Lake area, and the Catlow Valley. Rock land--very shallow soils with rock outcrops--is mapped throughout the basin; however, Diamond Craters, the largest area, covers about six square miles. Playas--small units--are barren, flat, generally dry, strongly saline and alkaline, undrained basins. Badland is a mapping unit of steep to very steep, nearly barren land, occurring mostly in the Silver Creek and Silvies Subbasins. Volcanic ash--nearly unmodified deposits of volcanic ash--is found in the Donner und Blitzen Subbasin. Because these units are either barren of vegetation or sparsely vegetated and have almost no agricultural value, they are rated as land capability class VIII.

Land Capability

An interpretive grouping of soils into land capability classes has been developed by the Soil Conservation Service. Soil characteristics such as depth, texture, wetness, slope, erosion hazard, overflow hazard, permeability, structure, reaction, water-holding capacity, inherent fertility, and climatic conditions as they influence safe use and management of land are considered in grouping soils into eight land capability classes. These eight classes are designated by Roman numerals as indicated on the generalized land capability map (map 5). Class I land has few hazards or limitations whereas class VIII land is so limited that it is unfit for safe or economical use for crops, forest, and range, and it should be used only for recreation, wildlife habitat, and water supply.

The classification can be broken into two divisions: (1) land in capability classes I through IV is suited for cultivation and other uses, and (2) land in capability classes V through VIII is best suited for range, forest, wildlife habitat, and water supply because of limitations. Land capability classes are sometimes broken into subclasses to indicate the dominating

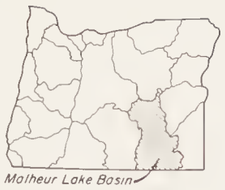
Table 1.--Characteristics, qualities, and other data of soils, Malheur Lake Drainage Basin, Oregon

Soil groups	Classification: Sub-groups	Classification: Family	Texture surface soil	Reaction surface soil	Texture subsoil	Restrictive layer: Kind	Restrictive layer: Depth	Drainage class	Permeability	Water-holding capacity	Infiltration	Suitability for irrigation	Major land use	Special problems	Elevation	Precipitation	Growing Season	Annual mean temperature
				pH value			Inches			Inches/foot					Feet	Inches	Days	°F.
Fan and flood-plain soils:																		
Mapping Unit																		
1	Xerollic Camborthid	Coarse-silty, mixed, mesic	Loam to silt loam	6.8-7.4	Loam	None	60+	Well	Moderate	2.0	Medium	Good	Crop and range lands	None	4,000-4,400	8-12	90-120	46-48
2	Xeric Torrifluvent	Coarse-loamy, mixed, noncalcareous, mesic	Gravelly sandy loam	6.8-7.4	Gravelly loam	Gravel	20-36	Well	Moderately rapid	1.7	Rapid	Good	Crop and range lands	Gravel substratum	4,000-4,400	8-12	90-120	46-48
4	Aridic Haploxeroll	Fine-loamy, mixed, mesic	Very stony loam	7.0-7.8	Very stony loam	Volcanics	14-20	Well	Moderate	1.7	Medium	Poor	Rangeland	Shallowness & stoniness	4,000-4,400	8-12	90-120	46-48
5	Lithic Xerollic Camborthid	Loamy, mixed, frigid	Fine sandy loam	6.8-7.4	Loam	Bedrock	14-20	Well	Moderately rapid	1.8	Rapid	Fair	Rangeland	Shallowness	4,000-4,400	8-12	90-120	46-48
6	Xeric Torriorthent	Coarse-loamy, mixed, noncalcareous, frigid	Fine sandy loam	7.4-7.6	Loamy sand	None	20-36	Well	Moderately rapid	1.8	Rapid	Good	Crop and range lands	Shallowness	4,000-4,400	8-12	90-120	46-48
10	Cumulic Haplaquoll	Fine-silty, mixed, calcareous, mesic	Silt loam	7.2-7.8	Silt loam	Gravel	36-60	Somewhat poorly	Moderate	2.0	Medium	Good	Cropland	Drainage	4,000	8-12	90-120	46-48
11	Histic Haplaquoll	Fine-silty, mixed, noncalcareous, mesic	Silt loam	6.8-7.4	Silt loam	Gravel	36-60	Somewhat poorly	Moderate	2.0	Medium	Good	Cropland	Drainage	4,000	8-12	90-120	46-48
12	Histic Haplaquoll	Fine, montmorillonitic,noncalcareous,mesic	Silty clay	7.8-8.4	Fine sandy loam	Clay layer	26-30	Very poorly	Slow	2.3	Slow	Good	Cropland	Drainage	4,000	8-12	90-120	46-48
13	Fluventic Haplaquoll	Fine-silty, mixed, calcareous, mesic	Silt loam to silty clay loam	8.0-8.6	Loam	None	36-60	Somewhat poorly	Moderately slow	2.2	Slow	Good	Cropland	Drainage & alkalinity	4,000	8-12	90-120	46-48
14	Fluventic Haplaquoll	Fine-silty, mixed, noncalcareous, mesic	Silt loam	7.0-7.4	Silt loam	None	36-60	Somewhat poorly	Moderate	2.0	Medium	Good	Cropland	Drainage	4,000	8-12	90-120	46-48
15	Cumulic Haplaquoll	Fine-silty, mixed, noncalcareous, mesic	Silt loam to silty clay loam	7.2-7.6	Silt loam	None	36-60	Somewhat poorly	Moderately slow	2.2	Medium	Good	Cropland	Drainage	4,000	8-12	90-120	46-48
Strongly alkaline flood-plain soils:																		
Mapping Unit																		
41	Xerertic Camborthid	Fine, montmorillonitic, mesic	Silt loam	6.5-8.2	Clay	None	36-60	Somewhat poorly	Moderately slow	2.0	Medium	Fair	Cropland	Drainage	4,000-4,400	8-12	90-120	46-48
42	Typic Natraquoll	Fine, montmorillonitic, calcareous, mesic	Silt loam	9.0-9.6	Clay	None	36-60	Poorly	Slow	2.0	Slow	Poor	Cropland	Drainage & alkalinity	4,000-4,400	8-12	90-120	46-48
43	Fluventic Halaquept	Coarse-silty, mixed, calcareous, mesic	Silt loam	8.8-9.6	Loam	None	60+	Somewhat poorly	Slow	2.0	Slow	Poor	Cropland	Drainage & alkalinity	4,000-4,400	8-12	90-120	46-48
44	Xerollic Natrargid	Fine-silty, mixed, mesic	Sandy loam to silt loam	8.0-9.0	Silt	None	60+	Well	Slow	2.0	Slow	Poor	Cropland	Drainage & alkalinity	4,000-4,400	8-12	90-120	46-48
45	Aquic Durorthid	Coarse-silty, mixed, mesic	Silt loam	9.6+	Silt loam	Alkali hardpan	20-36	Somewhat poorly to poorly	Slow	2.0	Slow	Poor	Cropland	Drainage & alkalinity	4,000-4,400	8-12	90-120	46-48
46	Typic Haplaquoll	Fine-silty, mixed, calcareous, mesic	Silt loam to silty clay loam	9.6+	Silt	None	36-60	Somewhat poorly to poorly	Slow	2.0	Slow	Poor	Cropland	Drainage & alkalinity	4,000-4,400	8-12	90-120	46-48
Lake basin soils:																		
Mapping Unit																		
25	Xerollic Paleargid	Clayey, montmorillonitic, frigid, shallow	Silt loam	6.8-7.4	Clay	Semiconsolidated sediments and silica hardpan	16-24	Well	Moderate	2.2	Medium	Good	Crop and range lands	Shallowness	4,000-4,400	8-12	90-120	46-48
26	Xerollic Camborthid	Loamy, mixed, frigid, shallow	Silt loam	6.8-7.4	Silt	Semiconsolidated sediments and silica hardpan	16-24	Well	Moderate	2.0	Medium	Good	Crop and range lands	Shallowness	4,000-4,400	8-12	90-120	46-48
30	Typic Pelloxerert	Montmorillonitic, frigid	Clay	7.0-7.4	Clay	Clay	60+	Somewhat poorly to poorly	Slow	2.3	Slow	Fair	Crop and range lands	Fine texture & drainage	4,000-4,400	8-12	90-120	46-48
31	Xerertic Torriorthent	Fine, montmorillonitic,noncalcareous,frigid	Silty clay	7.0-7.6	Silty clay	Clay	60+	Somewhat poorly to moderately well	Slow	2.3	Slow	Fair	Crop and range lands	Drainage	4,000-4,400	8-12	90-120	46-48
Older fan and terrace soils:																		
Mapping Unit																		
50	Xerollic Durorthid	Coarse-loamy, mixed, mesic	Gravelly loam to gravelly sandy loam	7.0-7.4	Loam	Silica hardpan	14-24	Well	Moderately rapid	1.7	Rapid	Fair	Crop and range lands	Shallowness	4,000-4,400	8-12	90-120	46-48
51	Xerollic Camhorthid	Coarse-loamy, mixed, mesic	Loamy sand to loam	7.0-7.4	Fine loam	Sand and gravel	36-60	Well	Moderately rapid	1.8	Rapid	Good	Crop and range lands	Gravel substratum	4,000-4,400	8-12	90-120	46-48
55	Xerollic Durargid	Fine-loamy, mixed, mesic	Gravelly loam	7.0-7.4	Fine loam	Silica hardpan	14-24	Well	Moderately rapid	1.8	Rapid	Fair	Crop and range lands	Shallowness	4,000-4,400	8-12	90-120	46-48
56	Xerollic Durargid	Fine, montmorillonitic, mesic	Loam	7.0-7.4	Clay	Silica hardpan	14-24	Well	Moderately rapid	2.0	Rapid	Fair	Crop and range lands	Shallowness	4,000-4,400	8-12	90-120	46-48
Upland soils--below 5,600 feet:																		
Mapping Unit																		
75	Lithic Xerollic Haplargid	Loamy, mixed, frigid	Stony to very stony loam	7.2-7.8	Stony loam	Silica hardpan over bedrock	10-22	Well	Moderate	1.6	Medium	Poor to very poor	Rangeland	Shallowness	4,000-6,000	8-13	80-120	45-48
S75	Lithic Xerollic Haplargid	Loamy-skeletal, mixed, frigid	Very stony loam	6.6-7.3	Fine loam	Silica hardpan over bedrock	10-22	Well	Moderate	1.5	Medium	Unsuitable	Rangeland	Shallowness	4,000-6,000	8-13	80-120	45-48
76	Lithic Xerollic Paleargid	Clayey, montmorillonitic, frigid	Stony to very stony loam	6.6-7.3	Clay	Silica hardpan over bedrock	10-22	Well	Moderate	1.6	Medium	Very poor	Rangeland	Shallowness	4,000-6,000	8-13	80-120	45-48
S76	Lithic Xerollic Paleargid	Clayey-skeletal, montmorillonitic, frigid	Very stony loam	6.6-7.3	Clay	Silica hardpan over bedrock	10-22	Well	Moderate	1.5	Medium	Unsuitable	Rangeland	Shallowness	4,000-6,000	8-13	80-120	45-48
77	Lithic Torriorthent	Loamy, mixed, frigid	Stony loam	6.6-7.3	Coarse loam	Silica hardpan over bedrock	0-10	Well	Moderate	1.7	Medium	Unsuitable	Rangeland	Shallowness	4,000-6,000	8-13	80-120	45-48
78	Lithic Xeric Torriorthent	Sandy-skeletal, mixed, frigid	Very stony loam	6.6-7.3	Coarse loam	Bedrock	10-18	Well	Moderate	1.3	Medium	Unsuitable	Rangeland	Shallowness	4,000-6,000	8-13	80-120	45-48
79	Xerollic Camborthid	Fine-loamy, mixed, mesic	Loam	6.6-7.3	Loam	Bedrock	36-60	Well	Moderately rapid	1.9	Medium	Fair	Cropland	None	4,000-6,000	8-13	80-120	45-48
Upland soils--above 5,600 feet:																		
Mapping Unit																		
82	Pachic Cryoboroll	Fine-loamy, mixed	Loam to silt loam	6.6-7.3	Silt loam	Bedrock	20-36	Well	Moderate	2.0	Medium	Unsuitable	Rangeland	Erosion on steeper slopes and climate	5,000-8,000	15-25	60-120	43-48
83	Argic Lithic Cryoboroll	Loamy, mixed	Stony silt loam	6.6-7.3	Stony silty clay	Bedrock	10-20	Well	Moderate	1.5	Medium	Unsuitable	Rangeland	Erosion on steeper slopes	5,000-8,000	15-25	60-120	43-48
Upland soils--under forest cover:																		
Series																		
Hall Ranch 1/	Argic Cryoboroll	Fine-loamy, mixed	Silt loam	6.0-6.8	Silt loam	Bedrock	24-40	Well	Moderate	2.0	Moderate	Unsuitable	Forest land	Erosion on steeper slopes	3,500-5,500	18-24	90-100	45
Klicker	Typic Argixeroll (Pachic)	Fine-loamy, mixed, frigid	Stony silt loam	6.2-6.6	Silty clay loam	Bedrock	16-36	Well	Moderate	2.0	Moderate	Unsuitable	Forest land	Erosion on steeper slopes	3,500-5,500	18-24	90-100	45
Laycock 1/	Pachic Ultic Haploxeroll	Fine-loamy, mixed, frigid	Shaly loam	6.1-6.5	Loam	Bedrock	20-36	Well	Moderate	2.0	Medium	Poor	Forest & range lands	Erosion on steeper slopes	4,200-5,500	16-20	80-120	43-48
Rock Creek 1/	Lithic Argixeroll	Loamy-skeletal, mixed, mesic	Very stony loam	6.2-6.8	Very stony silty clay loam	Bedrock	5-11	Well	Moderately slow	1.8	Moderate	Unsuitable	Rangeland	Shallowness and stoniness	3,000-8,000	17-26	60-90	43
Tolo	Typic Vitrandept	Ashy over loamy, mixed, frigid	Silt loam	6.6	Silt loam	Volcanic ash	30-50	Well	Moderate	2.0	Rapid	Unsuitable	Crop & forest lands	Erosion on steeper slopes	3,500-8,000	18-30	80-90	44
Miscellaneous land types:																		
Mapping Unit																		
95	Dune land																	
96	Rough stony land																	
97	Playas																	
98	Badland																	
Ash	Volcanic ash																	

1/ Tentative series, not yet correlated.

Oregon Agricultural Experiment Station, U. S. Department of Agriculture, Soil Conservation Service.

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



BASIN LOCATION

COUNTY LOCATION

LEGEND

- Fan and Floodplain Soils
- Strongly Alkaline Floodplain Soils
- Mixed Area–Well Drained, Poorly Drained and Strongly Alkaline Floodplain Soils
- Lake Basin Soils
- Older Fan and Terrace Soils
- Mixed Area–Floodplain Soils with Older Fan and Terrace Soils
- Upland Soils–with Forest Cover
- Upland Soils–above 5600 feet
- Upland Soils–under 5600 feet
- Miscellaneous Land Types

MAP 4

GENERALIZED SOIL MAP

MALHEUR LAKE DRAINAGE BASIN

OREGON

APRIL 1967

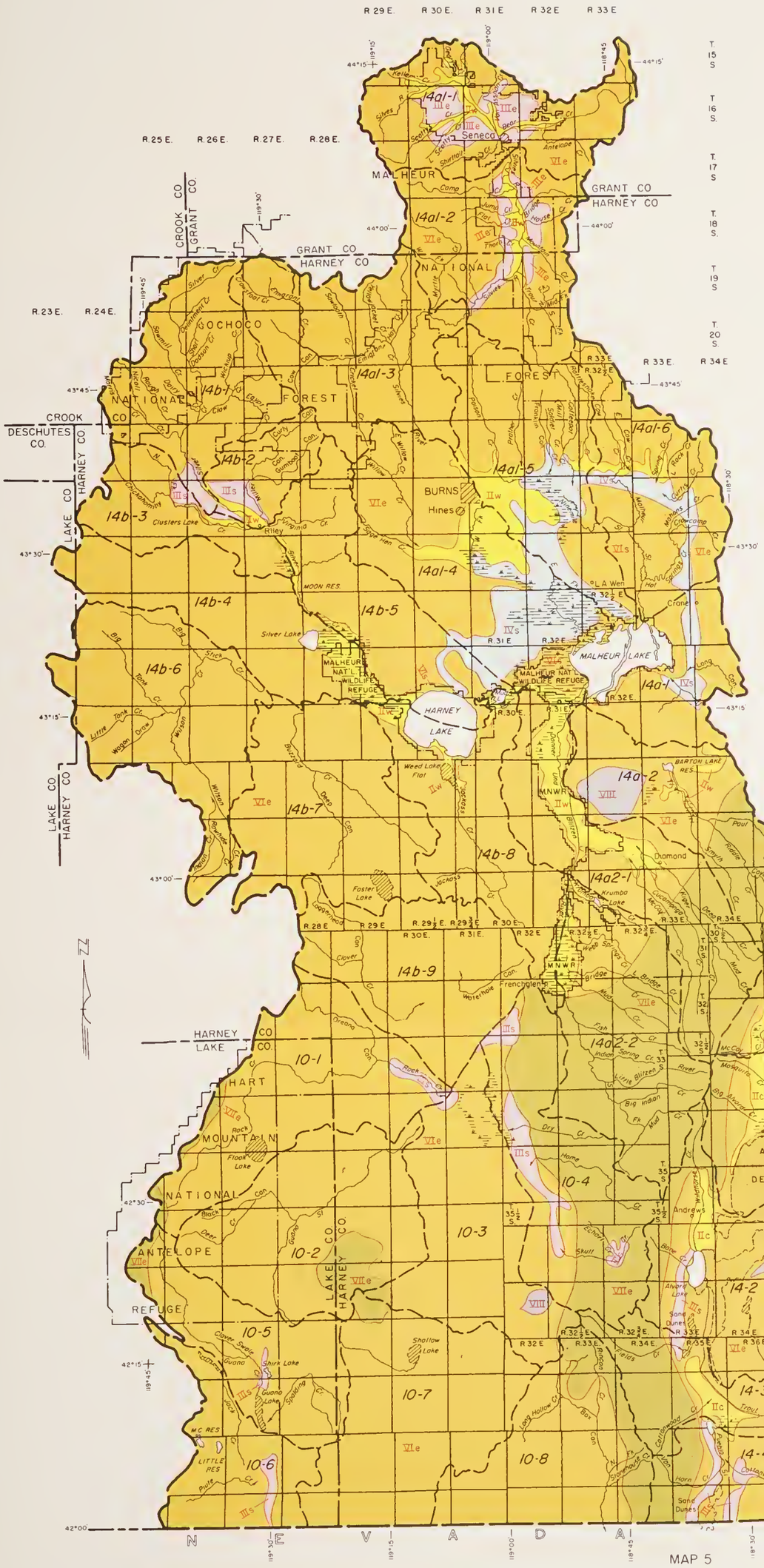
SCALE IN MILES 5 0 5 10 15

Data Source

Oregon Agriculture Experiment Station
USDA Soil Conservation Service

M7-S-17924-4-N

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



MAP 5

GENERALIZED LAND CAPABILITY CLASSES

MALHEUR LAKE DRAINAGE BASIN

OREGON

APRIL 1967

SCALE IN MILES 5 0 5 10 15

Data Source

Oregon Agriculture Experiment Station
USDA Soil Conservation Service

M7-S-17924-5-N

Table 2A.--Estimated acreage of land by capability and subclass, Silvies Subbasin and Donner und Blitzen Subbasin, Malheur Lake Drainage Basin, Oregon, 1967

Capability class	Silvies Subbasin								Donner und Blitzen Subbasin			
	14a-1 Malheur Lake	14a1-1: Bear Valley	14a1-2: Silvies	14a1-3 : Emigrant Creek	14a1-4: Willow Creek	14a1-5: Poison Creek	14a1-6 Hot Springs Creek	Total	14a-2 Riddle Creek	14a2-1 Donner und Blitzen	14a2-2: Fish Lake	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
IIw	800	17,000	13,100	400	22,500	13,000	7,000	73,800	1,500	22,100	9,000	32,600
IIc	0	0	0	0	2,000	4,200	2,000	8,200	0	1,400	0	1,400
Total II	800	17,000	13,100	400	24,500	17,200	9,000	82,000	1,500	23,500	9,000	34,000
IIIe	600	20,400	13,900	600	9,900	8,100	2,000	55,500	100	800	0	900
IIIs	1,600	0	0	0	600	600	1,000	3,800	300	1,600	300	2,200
Total III	2,200	20,400	13,900	600	10,500	8,700	3,000	59,300	400	2,400	300	3,100
IVe	1,000	0	0	2,300	2,300	500	0	6,100	2,800	14,900	800	18,500
IVs	4,000	0	0	0	22,700	23,600	13,000	63,300	1,300	9,200	900	11,400
Total IV	5,000	0	0	2,300	25,000	24,100	13,000	69,400	4,100	24,100	1,700	29,900
Total II-IV	8,000	37,400	27,000	3,300	60,000	50,000	25,000	210,700	6,000	50,000	11,000	67,000
VIe	70,000	133,900	145,900	160,800	145,200	115,000	76,700	847,500	70,000	103,300	163,300	336,600
VIs	15,800	0	0	40,000	23,300	33,300	56,000	168,400	15,300	25,000	3,200	43,500
Total VI	85,800	133,900	145,900	200,800	168,500	148,300	132,700	1,015,900	85,300	128,300	166,500	380,100
VIIe	0	3,700	5,600	4,500	1,000	3,000	3,000	20,800	40,000	50,000	52,800	142,800
VIIs	0	9,200	20,300	17,500	4,000	13,000	12,000	76,000	0	0	0	0
Total VII	0	12,900	25,900	22,000	5,000	16,000	15,000	96,800	40,000	50,000	52,800	142,800
VIII	2,200	300	300	2,200	15,800	0	600	21,400	21,200	14,100	1,200	36,500
Total VI-VIII	88,000	147,100	172,100	225,000	189,300	164,300	148,300	1,134,100	146,500	192,400	220,500	559,400
Water area 1/	100	400	100	300	300	300	100	1,600	100	200	200	500
Total in basin	96,100	184,900	199,200	228,600	249,600	214,600	173,400	1,346,400	152,600	242,600	231,700	626,900

1/ Water areas less than 40 acres in size and streams less than 1/8 mile in width.

Oregon Agricultural Experiment Station, U. S. Department of Agriculture, Soil Conservation Service.

Table 2B.--Estimated acreage of land by capability and subclass, Silver Creek Subbasin, Malheur Lake Drainage Basin, Oregon, 1967

Capability class	14b-1 Upper Silver Creek	14b-2 Miller Canyon	14b-3 Chickahominy Creek	14b-4 Silver Lake	14b-5 Lower Silver Creek	14b-6 Wilson Creek	14b-7 Buzzard Creek	14b-8 Jackass Creek	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
IIw	700	1,700	300	6,000	1,600	400	100	1,500	12,300
IIc	800	1,300	200	1,000	400	0	0	1,000	4,700
Total II	1,500	3,000	500	7,000	2,000	400	100	2,500	17,000
IIIe	3,000	2,000	1,400	1,000	600	400	100	1,000	9,500
IIIs	0	0	100	500	200	0	0	1,000	1,800
Total III	3,000	2,000	1,500	1,500	800	400	100	2,000	11,300
IVe	1,500	0	0	800	0	0	0	400	2,700
IVs	0	0	0	700	200	0	0	1,100	2,000
Total IV	1,500	0	0	1,500	200	0	0	1,500	4,700
Total II-IV	6,000	5,000	2,000	10,000	3,000	800	200	6,000	33,000
VIe	123,700	8,300	44,500	120,100	81,400	166,300	194,400	107,200	845,900
VIs	36,100	36,800	37,100	30,000	50,000	43,000	19,000	30,000	282,000
Total VI	159,800	45,100	81,600	150,100	131,400	209,300	213,400	137,200	1,127,900
VIIe	6,000	5,000	5,000	7,000	11,000	25,000	14,000	16,000	89,000
VIIs	12,000	0	0	0	0	0	0	0	12,000
Total VII	18,000	5,000	5,000	7,000	11,000	25,000	14,000	16,000	101,000
VIII	900	3,600	300	5,100	16,400	1,700	4,600	11,400	44,000
Total VI-VIII	178,700	53,700	86,900	162,200	158,800	236,000	232,000	164,600	1,272,900
Water area 1/	200	0	0	300	100	100	0	100	800
Total in basin	184,900	58,700	88,900	172,500	161,900	236,900	232,200	170,700	1,306,700

1/ Water areas less than 40 acres in size and streams less than 1/8 mile in width.

Oregon Agricultural Experiment Station, U. S. Department of Agriculture, Soil Conservation Service.

Table 2C.--Estimated acreage of land by capability and subclass, Alvord-Catlow Subbasin, Malheur Lake Drainage Basin, Oregon, 1967

Capability class	14-1 Alvord Ranch	14-2 Alvord Lake	14-3 Trout Creek	14-4 Pueblo Slough	14a-3 Mann, Tudor, & Fifteencent Lake	10a-1 Coyote Lake	10a-2 Twelvemile Creek	10a-3 Whitehorse Creek	10-1 Rock Creek	10-2 Guano Slough	10-3 Catlow Valley	10-4 Roaring Springs	10-5 Guano Lake	10-6 Jack Creek	10-7 Shallow Lake	10-8 Rincon Creek	14b-9 Clover Creek	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
IIw	500	300	600	0	300	0	0	500	200	0	0	100	0	0	0	0	0	2,500
IIc	5,700	3,700	5,000	400	2,500	700	0	3,000	0	0	0	400	200	0	0	0	200	21,800
Total II	6,200	4,000	5,600	400	2,800	700	0	3,500	200	0	0	500	200	0	0	0	200	24,300
IIIe	0	0	0	0	0	0	0	0	0	0	0	1,000	800	0	0	200	800	2,800
IIIs	500	2,300	1,000	1,500	500	0	500	400	1,800	0	500	7,500	800	600	0	0	1,000	18,900
Total III	500	2,300	1,000	1,500	500	0	500	400	1,800	0	500	8,500	1,600	600	0	200	1,800	21,700
IVe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IVs	300	200	400	100	200	0	0	100	0	0	0	0	0	100	0	0	0	1,400
Total IV	300	200	400	100	200	0	0	100	0	0	0	0	0	100	0	0	0	1,400
Total II-IV	7,000	6,500	7,000	2,000	3,500	700	500	4,000	2,000	0	500	9,000	1,800	700	0	200	2,000	47,400
VIe	40,500	99,100	63,100	79,200	148,900	137,200	84,400	160,800	217,800	180,900	149,800	59,400	99,000	91,900	94,500	94,200	173,600	1,974,300
VIs	80,000	50,000	25,000	5,000	20,000	13,000	20,000	25,000	4,000	40,000	46,000	35,100	37,500	20,000	142,600	58,200	20,000	641,400
Total VI	120,500	149,100	88,100	84,200	168,900	150,200	104,400	185,800	221,800	220,900	195,800	94,500	136,500	111,900	237,100	152,400	193,600	2,615,700
VIIe	19,000	24,000	55,000	24,000	50,000	0	0	0	8,300	20,000	3,000	113,500	7,000	2,000	0	1,000	2,000	328,800
VIIs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total VII	19,000	24,000	55,000	24,000	50,000	0	0	0	8,300	20,000	3,000	113,500	7,000	2,000	0	1,000	2,000	328,800
VIII	8,000	4,000	300	200	500	3,000	500	200	1,500	8,600	10,400	8,600	6,100	2,400	11,400	36,800	1,200	103,700
Total VI-VIII	147,500	177,100	143,400	108,400	219,400	153,200	104,900	186,000	231,600	249,500	209,200	216,600	149,600	116,300	248,500	190,200	196,800	3,048,200
Water area 1/	100	100	100	100	100	0	100	200	200	300	0	100	200	200	100	0	100	2,000
Total in basin	154,600	183,700	150,500	110,500	223,000	153,900	105,500	190,200	233,800	249,800	209,700	225,700	151,600	117,200	248,600	190,400	198,900	3,097,600

1/ Water areas less than 40 acres in size and streams less than 1/8 mile in width.

Oregon Agricultural Experiment Station, U. S. Department of Agriculture, Soil Conservation Service.

Table 2D.--Estimated acreage of land by capability and subclass by subbasin, Malheur Lake Drainage Basin, Oregon

Capability class	Subbasin 1 Silvies	Subbasin 2 Donner und Blitzen	Subbasin 3 Silver Creek	Subbasin 4 Alvord-Catlow	Total
	Acres	Acres	Acres	Acres	Acres
IIw	73,800	32,600	12,300	2,500	121,200
IIc	8,200	1,400	4,700	21,800	36,100
Total II	82,000	34,000	17,000	24,300	157,300
IIIe	55,500	900	9,500	2,800	68,700
IIIs	3,800	2,200	1,800	18,900	26,700
Total III	59,300	3,100	11,300	21,700	95,400
IVe	6,100	18,500	2,700	0	27,300
IVs	63,300	11,400	2,000	1,400	78,100
Total IV	69,400	29,900	4,700	1,400	105,400
Total II-IV	210,700	67,000	33,000	47,400	358,100
VIe	847,500	336,600	845,900	1,974,300	4,004,300
VIs	168,400	43,500	282,000	641,400	1,135,300
Total VI	1,015,900	380,100	1,127,900	2,615,700	5,139,600
VIIe	20,800	142,800	89,000	328,800	581,400
VIIs	76,000	0	12,000	0	88,000
Total VII	96,800	142,800	101,000	328,800	669,400
VIII	21,400	36,500	44,000	103,700	205,600
Total VI-VIII	1,134,100	559,400	1,272,900	3,048,200	6,014,600
Water area 1/	1,600	500	800	2,000	4,900
Total in basin	1,346,400	626,900	1,306,700	3,097,600	6,377,600

1/ Water areas less than 40 acres in size and streams less than 1/8 mile in width.

Oregon Agricultural Experiment Station, U. S. Department of Agriculture, Soil Conservation Service.

limitation or hazard. The subclasses are "e" for wind or water erosion, "w" for wetness or frequent inundation from overflow, "s" for soil limitation, and "c" for climatic limitations.

An estimate has been made of the amounts of land in each capability class and subclass for each watershed. These data were developed from the reconnaissance soil survey which is being conducted jointly by the Oregon Agricultural Experiment Station and the U. S. Department of Agriculture, Soil Conservation Service. Tables 2A, 2B, 2C, and 2D present the data by subbasin.

WATER RESOURCES

The management of farm, forest, and range lands has a direct influence on the yield and quality of water. The water resource influences all segments of the economy of the basin. The use and development of this resource have a direct bearing on agricultural productivity. Industry and community existence is based upon a dependable supply of good quality water. Because recreation, fish life, and pollution abatement are affected by volume and depth of flow, the yield and seasonal availability of water are prime importance in all areas of use.

Water Yield

Average annual precipitation in the Malheur Lake Drainage Basin ranges from less than 8 inches to more than 35 inches, with less than 4 inches during the irrigation season--April through September. The water supply of the basin is primarily the winter snowpack on the high mountains which is supplemented by summer precipitation. There is considerable variation in water yields in different watersheds because of meteorological differences in various parts of the basin. Water yields range from approximately 8 inches of runoff for some of the higher areas to less than 1 inch in the desert areas.

Total average natural yield 3/ for this 6,377,600-acre basin was about 572,500 acre feet annually for the 1935-64 period. The basin is divided into four subbasins for the purpose of estimating water yield and water use. Table 3 is an estimate of the average annual runoff and average natural yield by subbasins.

The yield varies considerably from year to year which is typical of streams in a semiarid region. Records of gauged measurements of the Silvies River near Burns show a minimum yield of 44,170 acre feet and a maximum of 270,400 acre feet. Trout Creek near Denio, Nevada, ranged from 5,200 acre feet to 27,000 acre feet for its gauged period.

Geographic and Seasonal Distribution

Natural streamflow is characterized by high runoff in the spring and low runoff the remainder of the year; however, warm temperatures or rain storms

3/ Natural yield as used herein is the yield usable by man.

Table 3.--Estimated average annual natural yield and average annual outflow by subbasins

Subbasin	Acres	Average annual natural yield	Average annual outflow
		Acre Feet	Acre Feet
Silvies	1,346,400	220,000	72,000
Silver Creek	1,306,700	75,500	49,000
Donner und Blitzen	626,900	177,000	69,000
Alvord-Catlow	3,097,600	100,000	100,000
Total	6,377,600	572,500	290,000

Oregon State Water Resources Board.

occasionally produce high flows in the winter. On the average, 60 to 80 percent of the annual discharge occurs in March, April, and May. These are the peak months of discharge for all streams except the Donner und Blitzen River and Trout Creek which peak approximately one month later.

Water Quality

In general, the chemical quality of the surface and ground water in the Malheur Lake Drainage Basin is suitable for irrigation, livestock, recreation, and forest growth. A few ground water problems exist because the quantity of sodium salts and boron is great enough to affect certain crops. For irrigation purposes, the characteristics most important in determining suitability are: The total concentration of soluble salts; the concentration of boron that may be toxic to crops; and the relative proportions of sodium to the principal cations in the water. A comparison of analyses of both ground water and surface water indicates that the ground water generally has greater concentrations of dissolved minerals than the surface water. The salinity increases in both ground water and surface water as it moves toward Malheur and Harney Lakes.

Ground Water

Ground water is used to irrigated only about 8,600 acres or less than 4 percent of the irrigated acreage in the basin. The principal use of ground water is for domestic and livestock purposes. In the Silvies Subbasin, ground water is used to provide supplementary water for crops during low summer streamflow. The greater percentage of the irrigated acreage in the Alvord area is irrigated from ground water. Very little information is available on ground water in the Silver Creek and the Donner und Blitzen Subbasins. There are a few irrigation wells in each of the subbasins but they are not pumped extensively. There is only one operating irrigation well in the Catlow Valley.

Water Use and Management

The major water use in the basin is irrigation of pasture and hay crops. Because the water supply is limited and the nature of the runoff is seasonal, there are many problems involving water use including flooding, erosion, and drainage. In general, the diversion of flood waters early in the spring and wild flooding are the present methods of irrigation water management. Some reservoir storage is available for supplemental irrigation but this storage is not adequate to provide water for all cropland developed for irrigation. Table 4 shows the acreage irrigated by subbasin and the water source.

Table 4.--Acreage of irrigated land and water source by subbasin, Malheur Lake Drainage Basin, Oregon

Item	Subbasin				Basin total
	Silvies	Silver Creek	Donner und Blitzen	Alvord-Catlow	
	Acres	Acres	Acres	Acres	Acres
Acres irrigated	124,800	26,100	41,100	34,700	226,700
Water source:					
Streamflow	122,700	23,900	39,600	24,400	210,600
Reservoir storage	400	2,100	1,400	3,600	7,500
Ground water	1,700	100	100	6,700	8,600

USDA River Basin Survey Staff.

The major irrigated crops in the basin are grasses and legumes for hay and pasture. The annual consumptive use for these crops is about 2.0 feet of water per acre. Precipitation provides about 0.3 foot during the irrigation season which leaves an irrigation requirement of 1.7 feet. At this rate, 385,390 acre feet of water are required for the land presently developed for irrigation. This does not consider water requirements for irrigation efficiency, transmission losses and other management practices.

Water for livestock is normally adequate during the spring; however, stockwater developments are needed throughout the range area to improve range management. These management practices are important to maintain adequate forage cover thereby minimizing runoff and damage from erosion.

FISH AND WILDLIFE RESOURCES

Big Game

The widely varied types of habitat and many species of game animals in the Malheur Lake Drainage Basin give the wildlife resource a position of great importance.

The important big game animals that inhabit the basin include mule deer, Rocky Mountain elk, California bighorn sheep, and antelope. California bighorn sheep, shown in photo 3, are found only in the Steens Mountains and the Hart Mountain area. Antelope, as shown in photo 4, range in herds located primarily in the southern portion of the basin; however, one herd of 30 to 40 animals congregates in the Bear Valley area in the northernmost portion of the basin. Elk occupy the northern forested portion of the basin and mule deer are found generally throughout the basin.

Photo 3.--California bighorn sheep make their home in the Steens Mountains and Hart Mountain areas. USF&WS

The presence of Oregon's two largest wildlife refuges--the Malheur National Wildlife Refuge and the Hart Mountain National Antelope Refuge--adds considerably to the wildlife resource of the basin.

The Malheur National Wildlife Refuge was established in 1908. Primarily set aside as a nesting area for migratory birds, the refuge is a vital fall and spring gathering point for waterfowl of the Pacific flyway. The 181,000-acre refuge consists of vast shallow marshes and lakes, small ponds, irrigated meadows, grass and sagebrush uplands and occasional greasewood-covered alkali flats.

The Hart Mountain National Antelope Refuge was established in 1936 to provide a large area in southeastern Oregon to insure preservation of the pronghorn or antelope. The refuge comprises Hart Mountain and the surrounding desert range. The 240,000 acres in the refuge were purchased from private owners or withdrawn from the public domain by Executive order. This refuge

Photo 4.--The pronghorn is one of the most elusive big game animals. USF&WS

and several areas in northern Nevada include a considerable part of the fawning grounds as well as the summer and winter range of the pronghorn in the area.

Big game population trends are compiled by the Oregon State Game Commission from information gathered on census routes. Table 5 illustrates the trends developed for several selected routes within the basin. Agencies responsible for wildlife management within the basin feel that the overall numbers of big game have increased slightly within the past few years.

Hunter-success ratios are also indicators of game numbers within an area. The Oregon State Game Commission issues these figures annually. These figures for the Malheur Lake Drainage Basin are shown in table 6. There is no general hunting season for antelope and sheep which are hunted on a special tag permit basis. In 1965, 1,915 hunters applied for the six sheep tags issued for the Hart Mountain area. The 1965 wildlife census figures for the Malheur National Wildlife Refuge and the Hart Mountain National Antelope Refuge are shown in table 7.

The Burns District of the Bureau of Land Management, which conforms roughly to the basin boundary, estimated big game numbers on BLM managed lands as follows: antelope, 2,755; deer, 50,800; and elk, 1,060. The Forest Service estimated the number of big game animals on Forest Service lands at 20,000.

Table 5.--Big game population trends,
Malheur Lake Drainage Basin, Oregon

Animal	Year				
	1962	1963	1964	1965	1966
Antelope 1/:					
Sightings/mile	1.1	1.5	1.7	1.9	1.4
Mule deer 2/:					
Sightings/mile	19.1	29.2	37.4	23.1	19.2
Mule deer 3/:					
Sightings/mile	6.4	6.3	9.5	6.2	7.1

1/ Based on 1,620 air miles of census route.
2/ Based on 62 miles of horseback census route - Steens Unit.
3/ Based on 77 miles of horseback census route - Silvies Unit.

Oregon State Game Commission data.

Table 6.--1965 hunter-success ratio,
Malheur Lake Drainage Basin, Oregon

Item	Deer	Elk	Antelope	Sheep
Number of hunters	8,893	555	216	6
Animals harvested	5,593	120	135	5
Percent of hunters successful	62%	21%	62%	83%

Oregon State Game Commission data adjusted to basin by USDA River Basin Survey Staff.

Small Game and Fur Bearers

Upland game-bird species within the basin include pheasant, chukar, mountain quail, California quail, sage grouse, blue grouse, ruffed grouse, and European partridge.

Populations for the different species of game birds are quite variable. Because the condition of the pheasant habitat in the basin is not good, the number of pheasants is not high. The Oregon State Game Commission releases eight hundred 8- to 10-week old birds annually to supplement the pheasant population.

Poor nesting years have also lowered the chukar population in the basin, but quail populations are quite high. Hunting pressure has only a moderate

effect on quail and chukar numbers, but it does affect sage grouse (shown in photo 5) numbers as these birds are not as wary a species.

Photo 5.--The sage grouse is one of the upland game birds in the basin. USF&WS

Fur bearers and other small mammals are numerous in certain areas of the basin. The Malheur National Wildlife Refuge lists nearly 50 species of mammals which are found in varying numbers within the boundaries of the refuge.

When fur trappers originally came into the area, they took fur-bearing mammals such as beaver, otter, mink, and muskrat by the thousands. These species are still being trapped in limited numbers. The value of the annual fur pelt harvest is around $3,000.

Waterfowl

Approximately one-half million migratory waterfowl stop to rest and feed in the basin, and thousands stay and breed in the marshlands and along ditches and drains. Table 7 illustrates the census breakdown for waterfowl and other migratory birds utilizing the two refuges in the basin. Photos 6 and 7 show sandhill cranes and Canada geese in the Malheur Lake area. Twenty-two species of ducks and three species of geese have been observed in the basin during the migration periods.

Table 7.--1965 wildlife census figures for two refuges, Malheur Lake Drainage Basin, Oregon

Kind	Malheur National Wildlife Refuge	Hart Mt. National Antelope Refuge
	Number 1/	Number 1/
Big game:		
Antelope	100	520
Mule deer	800	450
Bighorn sheep		160
Upland game:		
Sage grouse	125	3,100
California quail	8,000	300
Ring-necked pheasant	3,000	
European partridge		50
Chukar	150	500
Waterfowl:		
Swans	5,640	200
Geese	99,420	500
Ducks	373,900	2,410
Coot	200,000	700
Migratory birds 2/:		
Water and marsh birds	40,700	90
Shore birds, gulls, and terns	55,500	1,080
Doves and pigeons	3,000	500
Predaceous birds	5,410	1,096

1/ Peak season numbers.
2/ Other than waterfowl.

Bureau of Sport Fisheries and Wildlife data.

Fishlife

Because the Malheur Lake Drainage Basin is an interior basin isolated naturally from the ocean, anadromous fish are not present.

Resident trout and warm-water game fish inhabit streams, lakes, and reservoirs throughout the basin. The upper Silvies River, the upper Silver Creek, the Donner und Blitzen drainages, and Trout Creek have the highest trout populations. Impoundments supplying good trout angling are Delintment and Fish Lakes; Chickahominy, Krumbo, Miller, Moon, and Rock Creek Reservoirs; and Burns Gravel Pond. The rainbow trout is the most common game fish in the basin.

Photo 6.--The spring dance of the sandhill crane can be observed in the Malheur National Wildlife Refuge. USF&WS

Photo 7.--The Malheur National Wildlife Refuge is a stop-off area for the Canada geese when they are migrating. USF&WS

Warm-water game fish in the basin include good populations of bluegill, sunfish, bullhead catfish, white crappie, and yellow perch in the Silvies River. Rough fish, such as suckers, carp, roach, chisel-mouth, shiners, and squawfish, are in the streams throughout the basin.

A large percentage of the fish resource is sustained on a put-and-take stocking program by the Oregon State Game Commission. Table 8 illustrates a typical year's stocking program within the basin.

Table 8.--Typical fish plantings by the Oregon State Game Commission within the Malheur Lake Drainage Basin, Oregon

Reservoir, lake, or stream	Number of fish planted	Size of fish planted	Species
Chickahominy Reservoir	75,000	Fingerling	Rainbow
Krumbo Reservoir	15,000	Legal	Rainbow
Moon Reservoir	10,000	Fingerling	Rainbow
Delintment Lake	3,000	Legal	Rainbow
Fish Lake	7,000	Legal	Rainbow
Juniper Lake	50,000	Fingerling	Rainbow
Mann Lake	100,000	Fingerling	Cutthroat
Wildhorse Lake	5,000	Fingerling	Cutthroat
Burns Gravel Pit	3,000	Legal	Rainbow
Bear Creek	3,000	Legal	Rainbow
Immigrant Creek	7,000	Legal	Rainbow
Silver Creek	2,000	Legal	Rainbow
Blitzen River	4,500	Legal	Rainbow

Oregon State Game Commission data.

Habitat Availability and Conditions

The Malheur Lake Drainage Basin lies in the center of that portion of Oregon that the State Game Commission judges to be the most critical water-shortage game area.

Large areas of the basin go uninhabited by big game and upland game because of the lack of water during the dry summer months.

Habitat condition for big game is generally good except for overused areas of winter range. High elevation summer range in the northern portion of the basin generally has good feed and water supplies.

Waterfowl habitat is scarce or plentiful depending on the amount of precipitation received by the basin during the year. Malheur Lake, the main area of use by waterfowl in the basin, receives an unregulated spring runoff from the Silvies River. Habitat is greatly regulated by the amount of spring runoff available from this source.

The very nature of the basin limits the fish habitat and it is further handicapped by low summer flows in the lower reaches of rivers and streams. Irrigation use of these waters increases the seriousness of the problem. Excessive draw-down of many reservoirs in the basin is such that fish production cannot be sustained. Summer water temperatures reach or approach upper tolerance limits for trout in all basin streams.

Food production is rich enough in many of the small lakes, ponds, and reservoirs to rear fingerling trout to legal size within a few months.

QUALITY OF THE NATURAL ENVIRONMENT

The study area of this report covers a portion of Oregon referred to by local residents as the "high desert" country. It was not an area of easy living; therefore, it was not settled early in Oregon's history. Those who did develop the area were a hardy, colorful group of people who left the area with a rich background.

The natural environment of the area means many things to different people. If one is looking for an area of hot, dry summers, cold winters, spring floods, and sparse populations, he can find it there. If one is a hunter looking for elk, deer, antelope, waterfowl, or upland game, it is a good place to start. An abundant accumulation of obsidian, agate, jasper, thundereggs, sunstones, petrified wood, or fossils in this area entices the rockhounds. Indian artifacts are also plentiful in the basin. If one enjoys viewing nature's wonderland by vehicle, he can start with open park-like stands of pine in the northern portion of the basin, drive south through wet marsh areas of the Malheur National Wildlife Refuge and observe the large numbers of waterfowl, then travel further south to the majestic Steens Mountains--one of the world's largest "block-fault" geological formations. These mountains rise gently from the west to an elevation of 9,670 feet then plunge sharply to the valley floor of the Alvord Desert to the east.

Destructive factors within the basin constituting hazards to the natural environment are forest and range fires, flooding, and erosion. These factors are discussed at length elsewhere in the report.

ECONOMIC DEVELOPMENT

HISTORICAL DEVELOPMENT

Early settlement of Malheur Lake Drainage Basin was basically similar to the pattern of settlement in the West. The explorers and fur traders came first, followed by cattle ranchers and then a few settlers who made various attempts at farming.

The first white men known to visit what is now Harney County were fur traders who came in 1826. In 1859, the U. S. Army began exploring the area for road sites. During the late 1860's, the first permanent residents began to settle in the area. 1/

Low average annual precipitation, short growing seasons, and limited water supplies for irrigation tended to discourage farming at a very diversified level. Hay and small grains became the most popular crops and these, in turn, helped to supplement and support the livestock industry which is now one of the two major economic activities of the basin.

Lumber and wood products manufacturing, the other major economic activity, began in 1867 with a small mill in the northeast part of the county. It was not until 1928 when the Edward Hines Lumber Company invested about $6 million in a mill at Hines that lumbering became a major industry in Malheur Lake Drainage Basin. 2/

Between 1906 and 1911, three National Forest reserves--the Deschutes, Malheur, and Ochoco National Forests--were proclaimed in and around Malheur Lake Drainage Basin. Under an agreement with the U. S. Forest Service, the Edward Hines Lumber Company cut about 1 million board feet of lumber annually from the Malheur and Ochoco National Forests. 3/

In 1908, the Malheur National Wildlife Refuge was set aside as a nesting area for migratory birds and a fall and spring gathering point for waterfowl

1/ Brimlow, George Francis, Harney County, Oregon, and Its Rangeland, Binford and Mort, Portland, 1951, pp. 10, 23, and 40.
2/ Ibid., pp. 37 and 240.
3/ Ibid., pp. 222 and 240.

on the Pacific Flyway. With a total of approximately 181,000 acres, it has a high rating among the 275 national refuges in the United States. 4/

In 1921, ranchers and farmers began to realize that there might be a possibility of developing water resources for irrigation in the Malheur Lake Drainage Basin. Two irrigation districts were established--the Blitzen Reclamation District in 1921 and the Harney County Irrigation District in 1922. Two dams were planned--one on Emigrant Creek and the other on the Silvies River. An election was held and voters authorized issuance of $2.2 million in construction bonds. 5/

It was then that the controversy started between the Malheur National Wildlife Refuge and citizens interested in developing storage reservoirs for irrigation; a controversy that still continues today. The irrigation districts would have stored the spring flood water from Emigrant Creek and the Silvies River, water which the refuge claimed was necessary to maintain proper water levels in Malheur Lake. After much heated controversy, the bonds were not issued and the storage reservoirs were not built. 6/

In 1957, the U. S. Army Corps of Engineers conducted another study of the area and determined that a dam on the Silvies River would be economically feasible and would provide irrigation and flood control benefits. They recommended, however, that no action be taken toward authorization of a federal project since water rights were still unresolved. 7/

GENERAL DESCRIPTION

Population and Social Structure

Of the total area of the Malheur Lake Drainage Basin, about 81.5 percent is located in Harney County. Population characteristics of the basin are assumed to be similar to those of Harney County.

Population increased by 4,502 persons in Harney County from 1900 to 1965 (figure 1). In 1960, population was 6,744 which amounted to a density of less than one person (0.7) per square mile and about 0.4 percent of Oregon's population of 1,768,687. 8/

4/ U. S. Department of Interior, Malheur National Wildlife Refuge, Fish and Wildlife Service, June 1962. (Information Bulletin).
5/ Brimlow, George Francis, p. 237.
6/ Ibid., pp. 237, 245, and 246.
7/ Survey Report on Silvies River and Tributaries, Oregon, U. S. Army Engineer District, Portland, Oregon, November 8, 1957, syllabus.
8/ Most of the economic information in this report is presented on a county basis since published data are generally unavailable for the basin as such; however, population statistics published by the U. S. Bureau of Census are broken down by census divisions. Thus, by excluding the Drewsey census division and including the Seneca division in Grant County, a population figure of 6,848 is derived for 1960. This may more closely approximate the Malheur Lake Drainage Basin population.

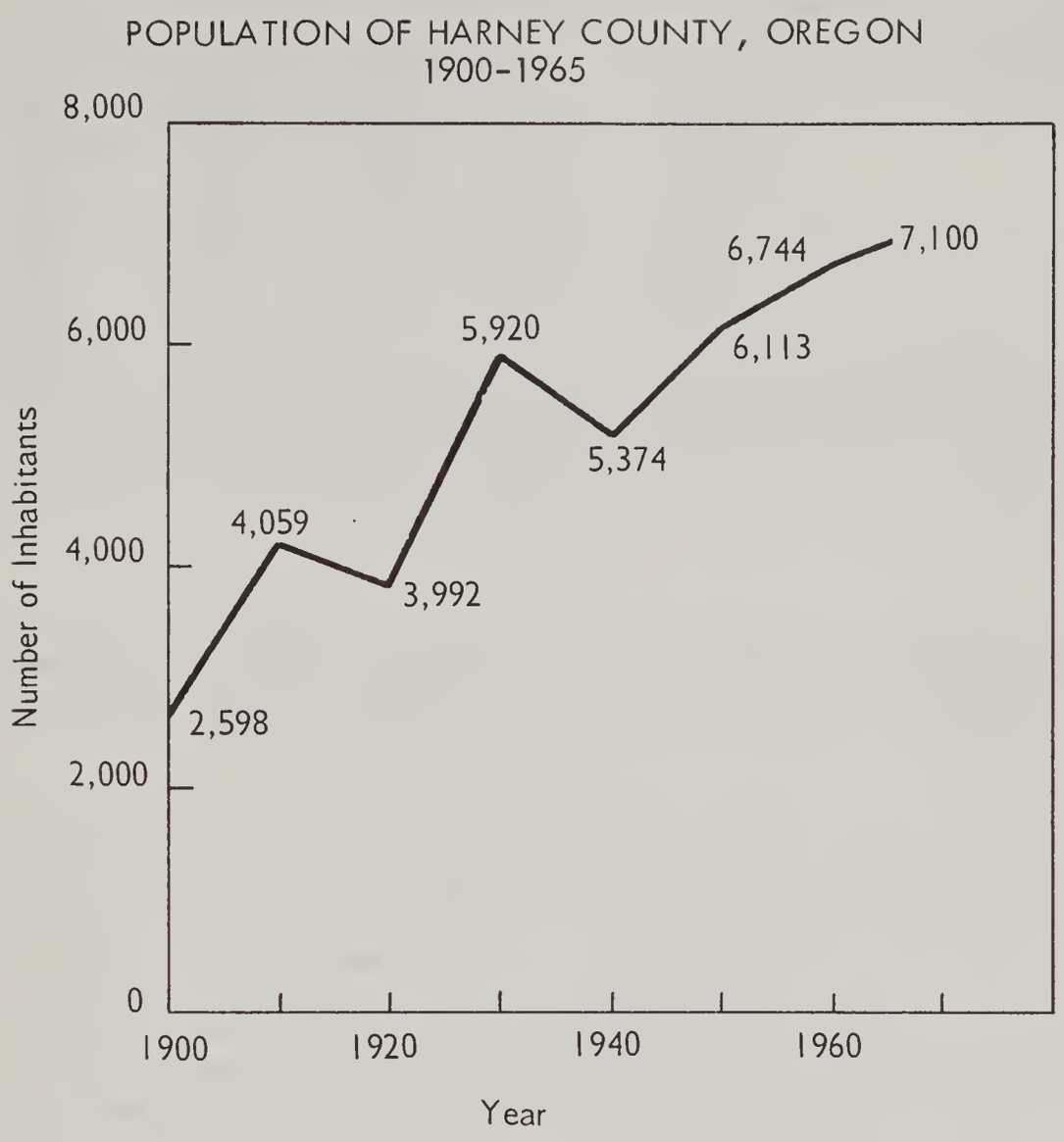


FIGURE 1

Population of Harney County is projected to increase by about 240 people from 1965 to 1980. It is interesting to note that the proportion of people in the productive age groups, 25-64, is projected to decrease slightly. In 1960, this group comprised 46.1 percent of the population. By 1980, it is projected at 41.7 percent. This indicates that there may be a smaller proportion of people in the productive age groups to provide goods and services for those in the dependent age groups.

Table 9.--Population projections for
Harney County, Oregon, 1960-1980

Year	By age group					
	Total	0-14	15-24	25-44	45-64	65+
	Number	Number	Number	Number	Number	Number
1960	6,744	2,213	898	1,781	1,328	524
1970	6,847	2,211	1,042	1,627	1,341	626
1975	6,842	2,176	1,086	1,587	1,312	681
1980	6,819	2,190	1,061	1,625	1,218	725

Oregon State Census Board, Population Bulletin, (P-9), Oct., 1963, p. 22. Mortality and fertility rates, intrastate migration and special populations (e.g., military, college, et cetera) were accounted for. Zero net interstate migration was assumed.

The two dominant economic activities in the Malheur Lake Drainage Basin--agriculture (principally ranching) and lumber and wood products manufacturing--form the nucleus for the major social structures. These two economic activities account for the largest share of employment and income.

The Malheur National Wildlife Refuge constitutes an important institutional influence. Any water resource development in the Malheur Lake Drainage Basin must consider water needs of the refuge. The position of the Bureau of Sport Fisheries and Wildlife of the U. S. Fish and Wildlife Service is described by the following statement: "... the use of these floodwaters (Silvies, Silver, Donner und Blitzen, and other streams emptying into the basin) in Malheur Lake for over 60 years has established a valid claim to them by right of use". 9/ Also, any projects which might affect the water level of Malheur and Harney Lakes will probably receive attention from numerous people all over the nation. That there is an interest in the wildlife refuge is shown by the following statement: "Twenty years ago at the Malheur Refuge, it was rare to see a car from any distance drive in. This past year (1965), we had about 15,000 visitors from 38 states, five foreign countries and four provinces of Canada". 10/

Since the majority of land in the basin is under management of the Bureau of Land Management, U. S. Department of Interior, this agency plays a large role in institutional arrangements. The Forest Service of the U. S. Department of Agriculture also holds an important institutional role because it manages significant portions of the land.

9/ "Statement of the Bureau of Sport Fisheries and Wildlife on Malheur Lake Basin", Exhibit No. 20, Hearing Record in the Matter of a Water Resource Program for the Malheur Lake Basin, State Water Resources Board of the State of Oregon, January 19, 1966.

10/ Ibid., p. 7.

Education of Harney County residents 25 years of age and over was a little higher in 1960 than for the nation as a whole. Six percent had four years of college or more and 87 percent finished the first eight grades. Only six-tenths of 1 percent of those over 25 years of age in 1960 had no education at all (table 10).

Table 10.--Years of school completed for residents 25 years old and over, Harney County, Oregon, 1960

School years completed	Residents completing	
	Number	Percent
College:		
4 years or more	225	6.2
1 to 3 years	456	12.7
High school:		
4 years	1,090	30.3
1 to 3 years	637	17.7
Elementary:		
8 years	744	20.7
7 years	178	4.9
5 and 6 years	157	4.4
1 to 4 years	91	2.5
Never attended school	23	0.6
Total	3,601	100.0
Median school years completed:		
Male	11.1	
Female	12.1	

U. S. Census of Population, 1960, Number of Inhabitants, PC(1)-39C, p. 143.

Major Types of Economic Activity, Employment, and Income

The two basic economic activities of agriculture and lumber and wood products manufacturing accounted for about 44 percent of the total employment in Harney County in 1960 (table 11). All the other manufacturing industries provided employment for only 3 percent of the labor force. Fourteen percent of the labor force was employed by the retail trades and 23 percent by the service industries. The remaining 16 percent of the labor force was distributed among forestry, mining, construction, transportation and communications, finance, insurance and real estate, and industries not reported.

The largest enterprise in the basin is the Edward Hines Lumber Company which employs about 90 percent of the labor force engaged in manufacturing and contributes a significant amount to personal income in the basin.

Table 11.--Employment, Harney County, Oregon, 1940, 1950, and 1960

Industry group	Employment distribution			Employment change		Proportion of total
	1940	1950	1960	1940-1950	1950-1960	1960
	Number	Number	Number	Number	Number	Percent
Agriculture	778	715	525	-63	-190	20.1
Forestry	3	26	50	23	24	1.9
Mining	17	14	23	-3	9	0.9
Contract construction	113	107	92	-6	-15	3.5
Lumber & wood products manufacturing	430	542	633	112	91	24.3
All other manufacturing	33	38	78	5	40	3.0
Transportation & communications	85	92	69	7	-23	2.6
Wholesale trades	22	50	41	28	-9	1.6
Retail trades	210	325	364	115	39	14.0
Service industries	435	471	606	36	135	23.2
Finance, insurance & real estate	18	31	61	13	30	2.3
Industry not reporting	31	32	67	1	35	2.6
Total	2,175	2,443	2,609	268	166	100.0

U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Vol. 8, Far West, 1965, pp. 7-18.

Total employment in the county increased by 268 workers from 1940 to 1950 and by 166 workers from 1950 to 1960 (table 11). During the same two periods, agricultural employment decreased by 253 people. Increases in employment from 1940 to 1960 in lumber and wood products manufacturing, the retail trades, and the service industries more than made up for the decrease in agricultural employment.

Increases or decreases in employment do not necessarily represent increases or decreases in the economic importance of these activities. In the case of agriculture, improvements in technology and efficiency have resulted in increased production even though agricultural employment declined.

The increase in employment in the service industries is partly due to additional amounts of leisure time. This, in turn, is reflected by a greater demand for leisure time activities which has stimulated greater employment in eating, drinking, entertainment, and recreation business concerns.

Average annual unemployment in Harney County from 1959 through 1965 has ranged between 3.7 percent and 4.4 percent. 11/ Monthly figures show

11/ State of Oregon, Department of Employment, Labor Force in Harney County, revised November 1966, (unpublished).

unemployment to be the greatest during the winter months (as high as 8 percent for March 1963) and lowest during the autumn months (as low as 1.1 percent for October 1961). 12/ This indicates that employment is somewhat seasonal for agriculture and lumber and wood products manufacturing.

Agriculture and lumber and wood products manufacturing--the two largest sources of personal income for the Malheur Lake Drainage Basin--accounted for approximately 41 percent of all personal income derived in Harney County in 1961 (table 12). Wage and salary disbursements to local, state, and federal government employees, the third largest source of personal income, accounted for 17 percent of all the personal income in the county in 1961. The contract construction industry provided 5 percent and the wholesale and retail trades contributed about 11 percent. Property income--rent, dividends, and interest--accounted for 12 percent, and transfer payments including government insurance, unemployment, retirement, and relief benefits accounted for 6 percent of Harney County's personal income in 1961. The remaining 8 percent consisted of all other wage and salary disbursements.

Table 12.--Personal income by major sources, percentages of total, Harney County, Oregon

Major source	Year				
	1951	1953	1956	1959	1961
	Percent	Percent	Percent	Percent	Percent
Agriculture 1/	33.4	27.9	24.5	18.4	21.9
Manufacturing	24.9	27.4	25.3	21.4	19.2
Contract construction 1/	2.9	4.0	2.2	3.8	4.7
Wholesale and retail trade 1/	11.1	10.2	10.9	11.8	10.5
Government 2/	7.3	8.1	15.3	18.0	17.2
Property income	9.2	10.1	10.4	12.3	12.2
Transfer payments 3/	2.8	3.4	3.6	5.5	6.1
All other personal income	8.4	8.9	7.8	8.8	8.2
Total	100.0	100.0	100.0	100.0	100.0
Total personal income in millions of dollars	11.87	12.40	14.81	13.77	16.13

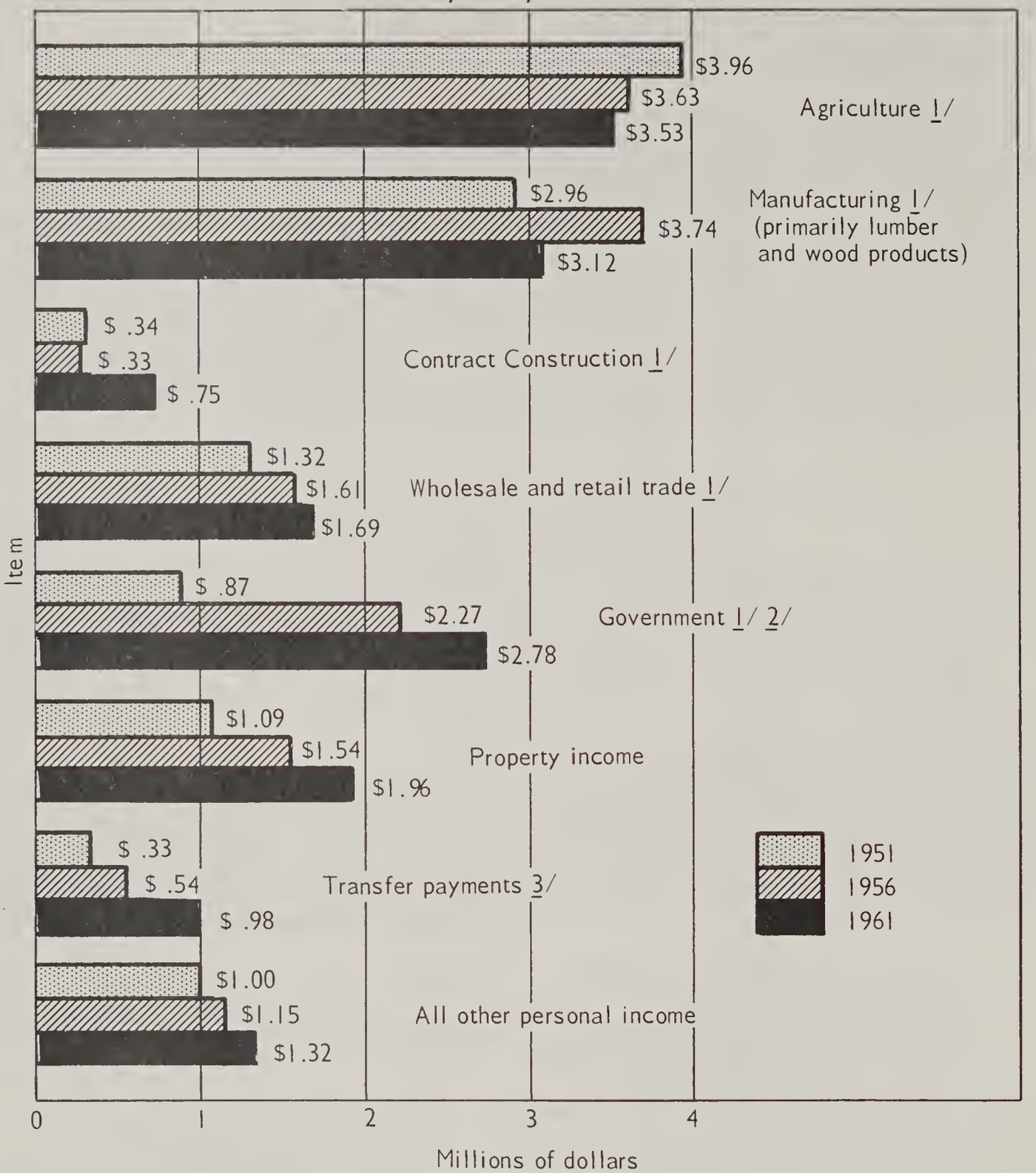
1/ Wages, salaries, and proprietor's income.
2/ Local, state, and federal.
3/ Local, state, and federal insurance, unemployment, retirement, and relief benefits.

Columbia Research Institute, Oregon Personal Income by County, 1950-1961, Portland, Oregon, tables 17 and A-14.

Figure 2 presents the dollar amounts of personal income by major economic activities for Harney County. Agriculture accounted for $3,960,000 in 1951, and $3,530,000 in 1961 - a decrease of $430,000 over the ten-year period.

12/ State of Oregon, Department of Employment.

PERSONAL INCOME BY MAJOR SOURCES, HARNEY COUNTY, OREGON
1951, 1956, and 1961



Columbia Research Institute, Oregon Personal Income by County, 1950-1961, Portland, Oregon, tables 17 and A-14.

1/ Wages, salaries and proprietor's income.

2/ Local, state, and federal.

3/ Local, state, and federal insurance, unemployment, retirement, and relief benefits.

FIGURE 2

Wages and salaries paid to government employees increased over three times from 1951 to 1961--$870,000 to $2,780,000. Local and state government salaries accounted for the largest share of this in 1961--$460,000 or about 53 percent.

An indication of the relative importance of the retail, wholesale, and selected service business activities in Harney County is shown in figure 3, "Sales and receipts by economic activity". The retail business establishments typically gross about three times as much in sales and receipts as do the wholesale business concerns. All business activities have experienced increases in sales and receipts from 1948 to 1963.

Harney County's median family income for 1960 was a little lower than for either the State of Oregon or the United States, and a larger percentage of Harney County families had incomes in the $3,000 to $9,999 range than did either the State of Oregon or the United States. The median earnings of Harney County farm workers was $841 higher in 1960 than median earnings of all farm laborers for the State (table 13).

Table 13.--Harney County incomes compared with Oregon and the United States, 1960

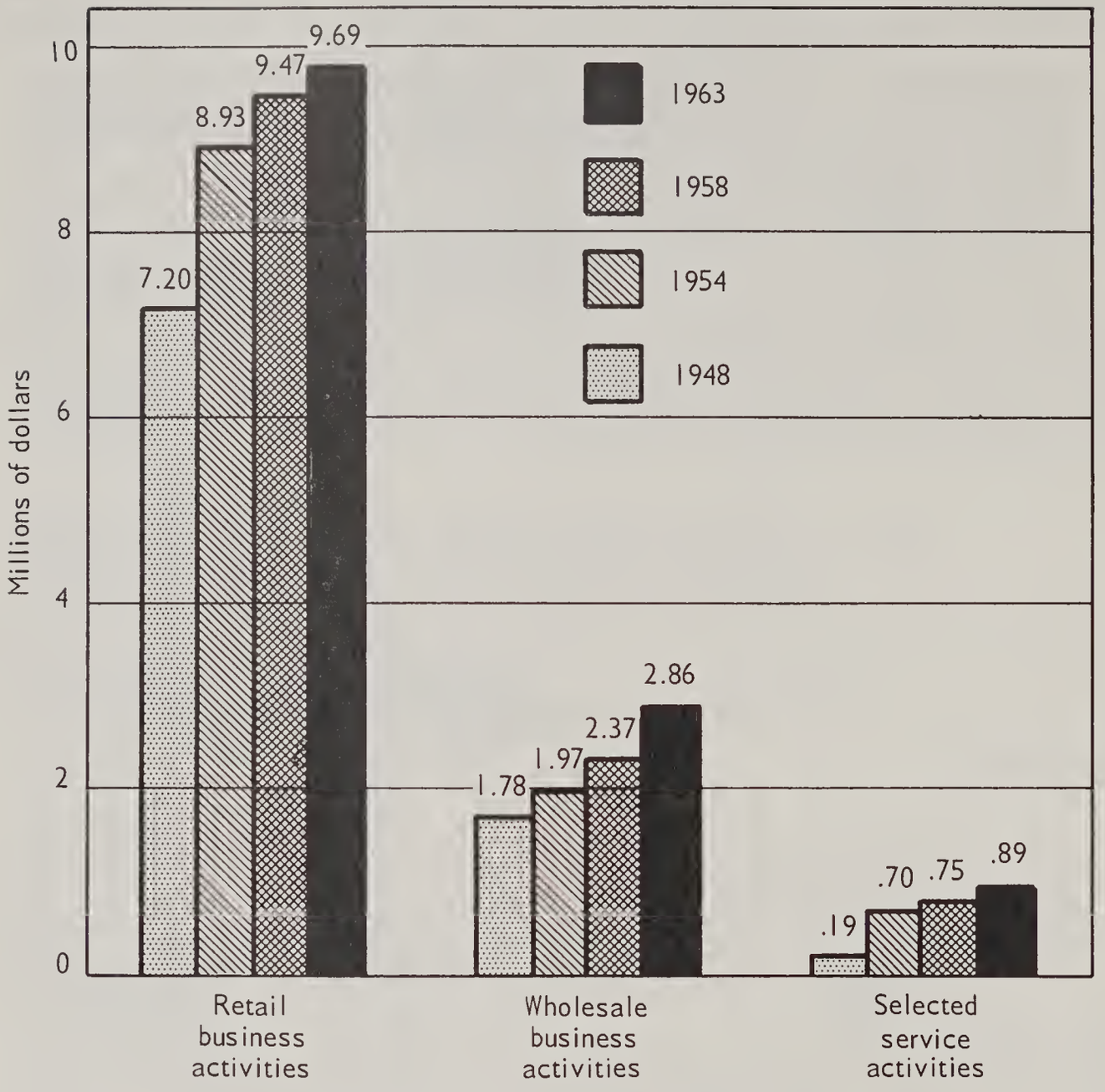
Income	Harney County	State of Oregon	United States
Family income:			
Median	$5,513	$5,892	$5,660
Percent, $10,000 and over	11.5	13.9	15.1
Percent, $3,000 to $9,999	69.3	69.1	63.5
Percent, under $3,000	19.2	17.0	21.4
Total	100.0	100.0	100.0
Median earnings of:			
Farm laborers	$2,330	$1,489	
Other laborers	$4,378	$4,121	
Craftsmen, foremen, and kindred workers	$5,446	$5,480	

U. S. Census of Population, 1960, Number of Inhabitants, PC(1)39C.

Current Growth Characteristics

The future of the two basic economic activities of agriculture and lumber and wood products manufacturing appears secure. It seems reasonable to conclude that no other industry will assume a major proportion of the economic activity of the Malheur Lake Drainage Basin within the next 10 to 15 years, and that agriculture and lumber and wood products manufacturing will continue to play a basic role in the economic activity of the basin. Most of the other economic activities are dependent, to an extent, on these two basic industries.

SALES AND RECEIPTS BY ECONOMIC ACTIVITY,
HARNEY COUNTY, OREGON



U.S. Department of Commerce, Bureau of Census, Census of Business, "Retail Trade," "Wholesale, Trade," and "Selected Service," Oregon, 1948, 1954, 1958, and 1963.

FIGURE 3

Projections are made for the important agricultural products and lumber and wood products in other sections of this report. It will only be mentioned here that, in terms of product output, the two major industries can reasonably be expected to expand in the future. Past and present growth characteristics would seem to indicate this. Growth in the volume of business of many of the other economic activities, such as the wholesale and retail trades and

the service industries, would probably follow as a result of expansion in agriculture and lumber and wood processing. It would also seem that growth in these industries would result in higher per capita incomes, and that employment would not increase in relative proportions. Employment in agriculture will probably remain stable.

Land Use and Ownership

Approximately 73 percent of the land area of the Malheur Lake Drainage Basin is owned and managed by the U. S. Government. About 4 percent is owned by state, county, and municipal governments. The remaining 23 percent is privately owned (table 14).

Table 14.--Land use and land ownership, Malheur Lake Drainage Basin, Oregon, 1966

Ownership	Range	Crop and pasture	Forest	Other	Total
	Acres	Acres	Acres	Acres	Acres
Federal:					
National Forest	50,400	0	528,780	8,200	587,380
Other	3,857,870	29,520	162,700	57,800	4,107,890
State	209,390	500	9,760	5,100	224,750
County and municipal	8,000	0	0	5,000	13,000
Private	1,111,940	232,680	78,160	21,800	1,444,580
Total	5,237,600	262,700	779,400	97,900	6,377,600

U. S. Forest Service, Bureau of Land Management, Oregon State Department of Forestry, and State Tax Commission data adjusted to basin.

Land used for range accounts for 5,237,600 acres or about 82 percent of the total land area. Only about 4 percent of the basin is used for cropland purposes. Twelve percent is classified as forest land and 2 percent consists of "other" land.

Generalized land status is shown on map 6 and generalized land use is shown on map 7.

Transportation

Improved highways constitute the major means of transportation in the Malheur Lake Drainage Basin. One branch railroad line enters the county from Ontario, Oregon.

The major improved highway in the basin is U. S. Highway 20 connecting Burns with Bend and Ontario to the west and east. U. S. Highway 395 connects Burns with Lakeview to the southwest and John Day to the north. Two paved state highways exist; one connects Burns with U. S. Highway 95 to the southeast and the other extends south out of Burns approximately to Frenchglen and continues as a graveled road about 70 miles to Denio, Nevada, on the state line and connects with a Nevada state-improved highway. Oregon State Highway 140 cuts across the southwest corner of Malheur Lake Drainage Basin in Lake County and connects Lakeview, Oregon, with Denio, Nevada. In addition to the improved highways, there are several "all weather" graveled roads in the basin and many unimproved dirt roads.

AGRICULTURE AND RELATED ECONOMIC ACTIVITY

Published crop and livestock statistics are generally unavailable for the Malheur Lake Drainage Basin as such but, since the land area of the basin lies largely within Harney County, it is assumed that the published data pertaining to Harney County are generally representative of the entire basin.

The major agricultural pursuit in the basin is livestock production. In terms of value of all farm products sold, livestock and livestock products accounted for about 92 percent of the total for Harney County in 1965; therefore, most of the emphasis in this section is placed upon the livestock enterprise and the hay and feed-grain crops which support it.

Major Crop Enterprises

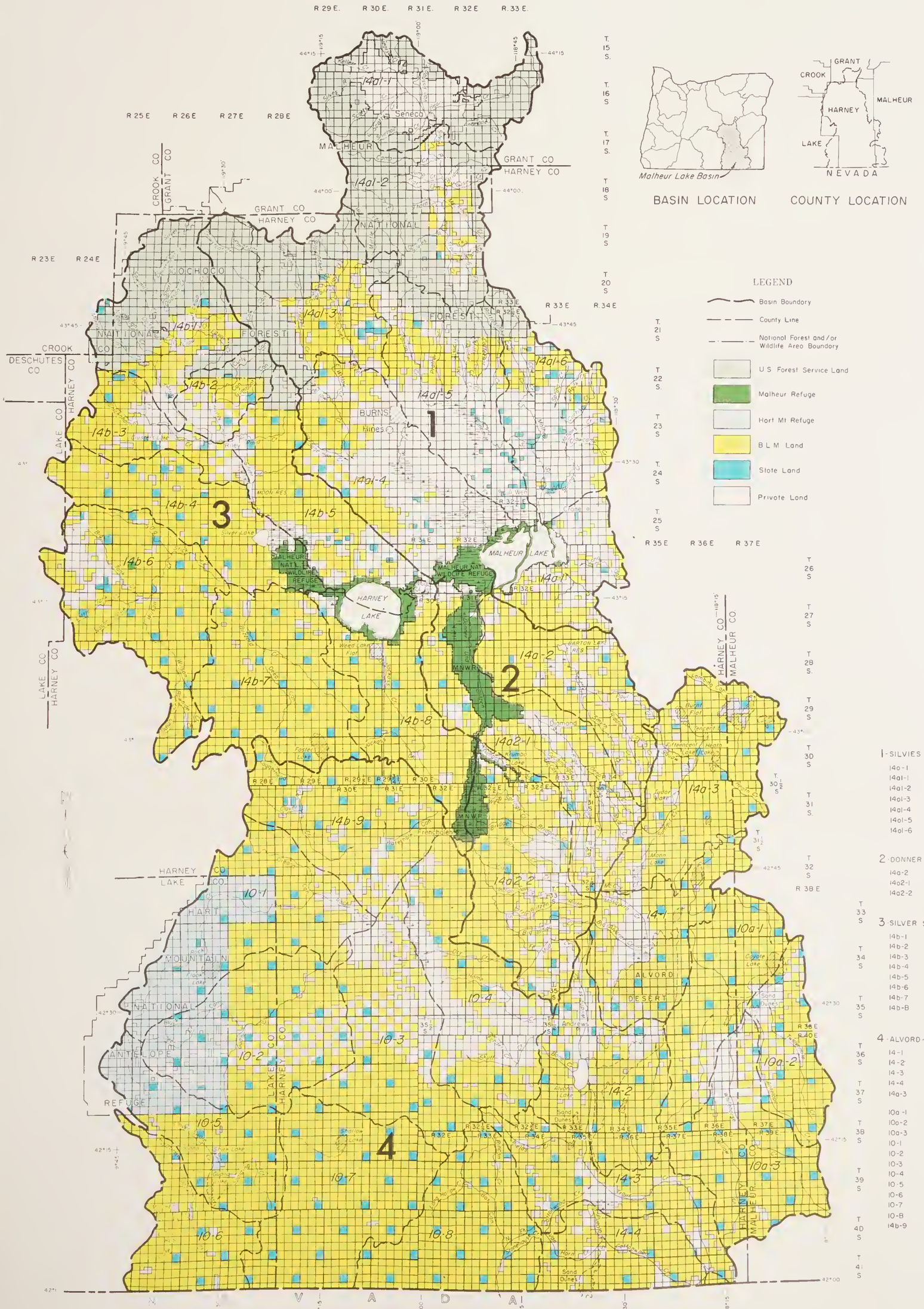
The major crop in Harney County, in terms of acres harvested, is hay (table 15). All the hay crops comprise from 83 to 90 percent of the total acres harvested, while wild hay accounts for about two-thirds of the total cropland acres. Alfalfa, grown for hay, is receiving more emphasis in Harney County--from 1950 to 1964, the acreage of alfalfa hay harvested increased over three times.

Of the small grains, wheat has decreased in importance from 9,240 acres harvested in 1950 to 863 acres in 1964. Acreage control and soil bank programs started in 1953 and 1956, respectively, by the Federal government were partly responsible for the reduction in wheat acres harvested.

The largest single use of land in farms and ranches in Harney County is for grazing livestock. In 1964, about 83 percent of all private land was classified as rangeland and an additional 4 percent was pasture land (table 15).

Short growing seasons, low average annual precipitation, and limited water supplies for irrigation are factors which tend to favor the growing of hay and small grains rather than other crops. Since livestock ranching is the major economic activity of the area, hay and feed grains are grown to provide winter feed.

The portion of total cropland acres that is irrigated in any one year varies with water supplies. In 1949, ninety-one percent of all cropland



Malheur Lake Basin

BASIN LOCATION

GRANT
CROOK
HARNEY
MALHEUR
LAKE
NEVADA

COUNTY LOCATION

LEGEND

- Basin Boundary
- County Line
- National Forest and/or Wildlife Area Boundary
- U S Forest Service Land
- Malheur Refuge
- Hart Mt Refuge
- B L M Land
- State Land
- Private Land

1 - SILVIES SUBBASIN

14a-1	Malheur Lake
14a1-1	Bear Valley
14a1-2	Silvies
14a1-3	Emigrant Creek
14a1-4	Willow Creek
14a1-5	Poison Creek
14a1-6	Hot Springs Creek

2 - DONNER UND BLITZEN SUBBAS

14a-2	Riddle Creek
14a2-1	Donner und Blitzen
14a2-2	Fish Lake

3 - SILVER SUBBASIN

14b-1	Upper Silver Creek
14b-2	Miller Canyon
14b-3	Chickahominy Creek
14b-4	Silver Lake
14b-5	Lower silver Creek
14b-6	Wilson Creek
14b-7	Buzzard Creek
14b-8	Jackass Creek

4 - ALVORD - CATLOW SUBBASIN

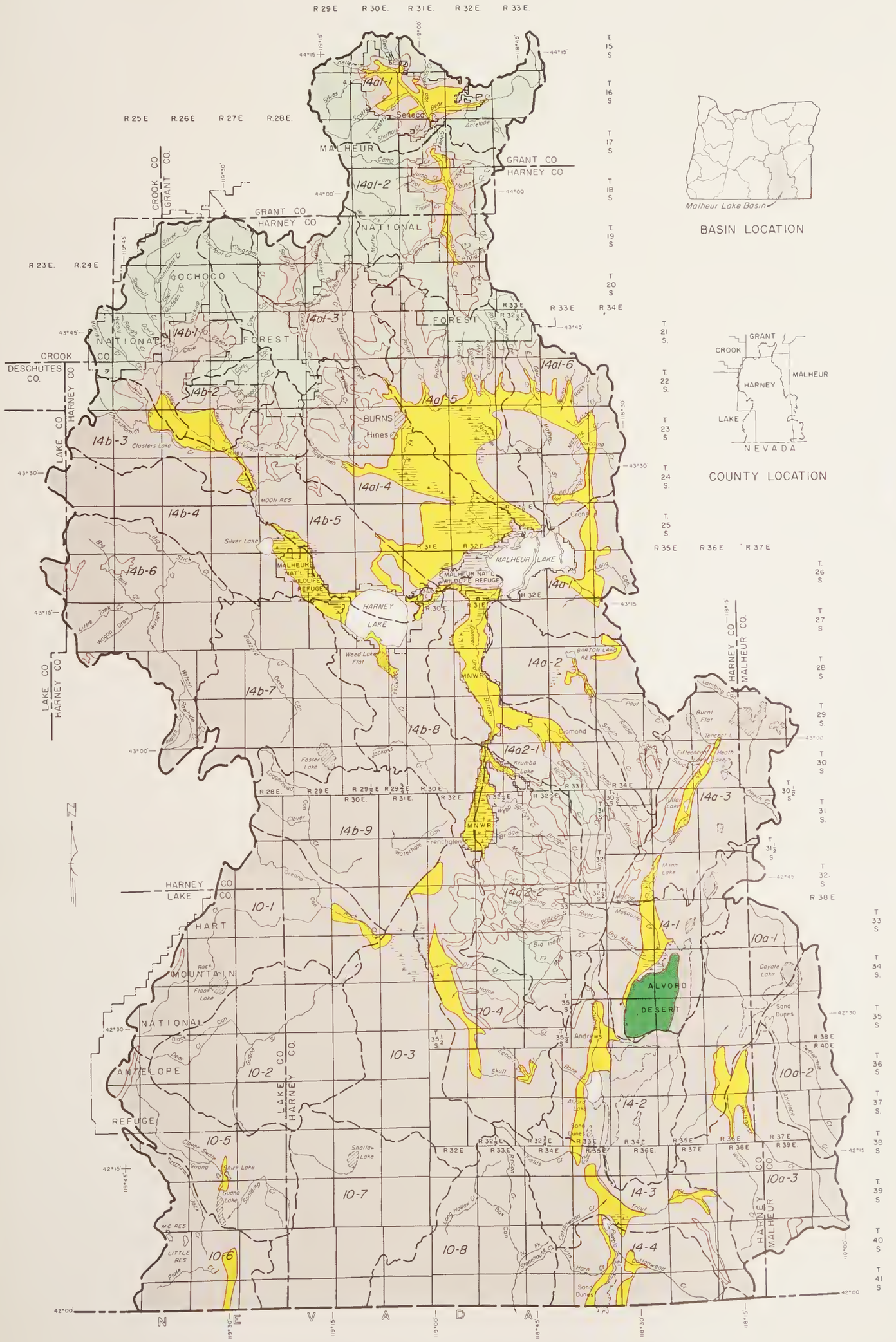
14-1	Alvord Ranch
14-2	Alvord Lake
14-3	Trout Creek
14-4	Pueblo Slough
14a-3	Mann, Tudor & Fifteencent Lakes
10a-1	Coyote Lake
10a-2	Twelvemile Creek
10a-3	Whitehorse Creek
10-1	Rock Creek
10-2	Guano Slough
10-3	Cattlow Valley
10-4	Roaring Springs
10-5	Guano Lake
10-6	Jack Creek
10-7	Shallow Lake
10-8	Rincon Creek
14b-9	Clover Creek

MAP 6

GENERALIZED LAND STATUS
MALHEUR LAKE BASIN
OREGON

APRIL 1967

SCALE IN MILES 0 5 10 15



MAP 7

GENERALIZED LAND USE

MALHEUR LAKE DRAINAGE BASIN

OREGON

JULY 1966

SCALE IN MILES

U S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

M7-S-17924-N

Table 15.--Acres of land in farms by major use, Harney County, Oregon, 1950-1964

Major use	Year			
	1950	1954	1959	1964
	Acres	Acres	Acres	Acres
Cropland harvested:				
Small grains	19,357	19,210	8,301	12,414
Wheat (winter and spring)	(9,240)	(2,306)	(913)	(863)
Oats	(1,518)	(1,295)	(651)	(1,627)
Barley	(6,022)	(14,083)	(5,608)	(7,272)
Rye and other grains	(2,577)	(1,526)	(1,129)	(2,652)
Hay crops	95,211	101,599	86,522	122,946
Alfalfa	(4,127)	(8,587)	(9,332)	(12,397)
Clover and timothy	(4,799)	(1,730)	(5,456)	(8,867)
Oats, wheat, barley, rye, and other grains	(5,603)	(7,296)	(5,887)	(9,137)
Wild hay	(77,068)	(81,866)	(64,211)	(89,381)
Other hay	(3,614)	(1,848)	(849)	(2,732)
Silage--grasses, alfalfa, clover and small grains	...	(272)	(787)	(432)
Corn	10	...	50	518
Potatoes	7	27	164	1
All other crops	94	558	1,437	676
Total acres harvested	114,679	121,394	96,474	136,555
Cropland for pasture	24,623	40,646	85,746	59,165
Rangeland 1/	1,109,441	1,139,679	1,317,155	1,172,963
Cultivated summer fallow	4,724	6,185	8,295	4,437
Crop failure, idle cropland & other	10,273	18,055	15,630	31,110
Other land 2/	14,693	14,101	11,796	12,477
Total land in farms & ranches 3/	1,278,433	1,340,060	1,535,096	1,416,707

1/ Includes small acreages of woodland pasture.
2/ Farm yards, roads, ditches, ponds, et cetera.
3/ Does not include government-leased land.

U. S. Bureau of Census, U. S. Census of Agriculture: 1964, Vol. I, Part 47, Oregon, and Census of Agriculture: 1954, Vol. I, Counties and State Economic Areas, Part 32.

acres were irrigated compared to 46 percent in 1959 and 72 percent in 1964 (table 16). This indicates that water supplies are highly variable in Harney County.

There are several reasons why water is often in short supply. First, average annual precipitation is generally low which limits water available for irrigation. Second, the greatest amount of precipitation occurs as snow during the winter months when it cannot be used to grow crops. Third, few storage reservoirs exist, which means that much of the early spring runoff flows to Malheur and Harney Lakes before it can be utilized for irrigation.

During many years, only enough water is available for one or two irrigation applications early in the growing season.

Table 16.--Total acres of cropland compared with acres irrigated, Harney County, Oregon, 1949-1964

Item	Unit	Year			
		1949	1954	1959	1964
Irrigated cropland harvested	Acres	84,089	103,008	72,640	103,361
Irrigated pasture and other	do.	42,636	33,628	11,516	36,825
Total irrigated land in farms	do.	126,725	136,636	84,156	140,186
Total cropland, harvested & pastured	do.	139,302	162,040	182,220	195,720
Increase in cropland	Percent		16	12	7
Portion of cropland irrigated	do.	91	84	46	72

U. S. Bureau of the Census, U. S. Census of Agriculture.

From 1949 to 1964, harvested and pastured cropland increased by about 40 percent; however, the portion of cropland irrigated has been highly variable (table 16). From 1949 through 1964, the portion of cropland irrigated has ranged from 91 percent in 1949 to a low of 46 percent in 1959.

Acreages of irrigated and nonirrigated cropland, by subbasin for the Malheur Lake Drainage Basin, are shown in table 17. About 57 percent of all the cropland in the Malheur Lake Drainage Basin is located within the Silvies Subbasin near Burns.

Major Livestock Enterprises

The livestock enterprise is the most important agricultural endeavor in Harney County. Livestock and livestock products account for the greatest share of the value of sales of all agricultural products. Approximately 83 percent of the total land area of the basin is classified as rangeland (photo 8). The cropland used to grow hay and grain crops for feed generally accounts for about 83 to 90 percent of total cropland use.

The major livestock enterprise is cattle ranching (table 18). In recent years, the number of cattle and calves has increased from 96,000 in 1959 to 104,000 in 1965. All other types of livestock have decreased in numbers from 1959 to 1965.

Sheep ranching was formerly much more important in Harney County than it is at present (figure 4). Several factors have contributed to the decline in sheep numbers. Among these are the problems of obtaining capable herders, lambing difficulties, fencing expenses, predatory animals, and unfavorable prices due to decreased national demand for wool products.

Table 17.--Irrigated and nonirrigated cropland by subbasin and major crop, Malheur Lake Drainage Basin, Oregon, 1965 1/

Major crop	Subbasin				Total
	Silvies	Donner und Blitzen	Silver Creek	Alvord-Catlow	
	Acres	Acres	Acres	Acres	Acres
Nonirrigated:					
Small grains	12,400	900	1,700	1,700	16,700
Hay and pasture	400	0	700	2,300	3,400
Grass	12,400	1,200	200	2,100	15,900
Subtotal	25,200	2,100	2,600	6,100	36,000
Irrigated:					
Small grains	6,800	200	1,050	850	8,900
Hay and pasture	108,190	39,100	22,850	30,650	200,790
Alfalfa	9,800	1,800	2,200	3,200	17,000
Potatoes	10	0	0	0	10
Subtotal	124,800	41,100	26,100	34,700	226,700
Total	150,000	43,200	28,700	40,800	262,700

1/ The data presented in this table are not strictly comparable with statistics presented elsewhere in this section because two different sources have been used, one for Harney County and the other for the Malheur Lake Drainage Basin. Also, the "irrigated" acres presented in this table are defined as acres "developed for irrigation" while irrigated acres in table 16 are defined as acres actually irrigated.

USDA River Basin Survey Staff.

Volume and Value of Farm Output

In terms of the value of farm products sold during the years 1959 through 1964, livestock and livestock products accounted for 90 to 96 percent of the total (table 19). The remaining 4 to 10 percent was divided among all crops, primarily hay crops.

The value of sales for potatoes, sheep, lambs, and wool has decreased since 1959 while the value of sales of grains, especially barley, has increased.

Production of cattle and calves, barley, oats, rye, and hay, including alfalfa, has increased since 1959 while production of sheep and lambs, wool, hogs, and wheat has decreased (table 20).

Table 18.--Livestock numbers, Harney County, Oregon, 1959-1965

Year 1/	Category				
	Cattle and calves	Sheep and lambs	Milk cows 2 years and over	Hogs	Chickens
	Number	Number	Number	Number	Number
1959	96,000	21,000	800	500	10,000
1960	96,000	21,500	600	500	9,000
1961	101,000	22,000	500	500	10,000
1962	101,000	20,000	500	400	10,000
1963	100,000	17,000	500	400	11,000
1964	104,000	17,000	500	400	10,000
1965 2/	104,000	16,500	500	300	8,000

1/ As of January 1.
2/ Preliminary

Statistical Reporting Service, USDA, Portland, Oregon, and the Extension Service, Oregon State University, Corvallis.

Photo 8.--This rangeland in the Seneca area has been improved with crested wheatgrass and alfalfa. SCS PHOTO F-312-2

Table 19.--Value of sales of agricultural products, Harney County, Oregon, 1959-64

Item	Year					
	1959	1960	1961	1962	1963	1964 1/
	1,000 Dollars	1,000 Dollars	1,000 Dollars	1,000 Dollars	1,000 Dollars	1,000 Dollars
Crops:						
Grains	77	96	53	50	100	170
Barley	(40)	(56)	(19)	(16)	(54)	(122)
Wheat	(22)	(25)	(14)	(16)	(19)	(20)
Other	(15)	(15)	(20)	(18)	(27)	(28)
Hay	246	231	176	167	235	319
Potatoes	54	44	44	31	4	4
Other	9	3	7	9	9	34
Total	386	374	280	257	348	527
Livestock and products:						
Sheep and lambs	256	233	219	226	211	222
Wool	100	100	92	93	94	94
Cattle and calves	5,517	5,141	5,552	5,834	5,065	4,860
Horses and mules	24	26	28	28	30	30
Milk and cream	7	6	5	5	5	5
Hogs	7	7	7	7	7	7
Chickens and eggs	18	21	19	18	16	17
Other	1	1	1	1	1	1
Total	5,930	5,535	5,923	6,212	5,429	5,236
Total all products	6,316	5,909	6,203	6,469	5,777	5,763

1/ Preliminary

Statistical Reporting Service, USDA, Portland, Oregon, and the Extension Service, Oregon State University, Corvallis.

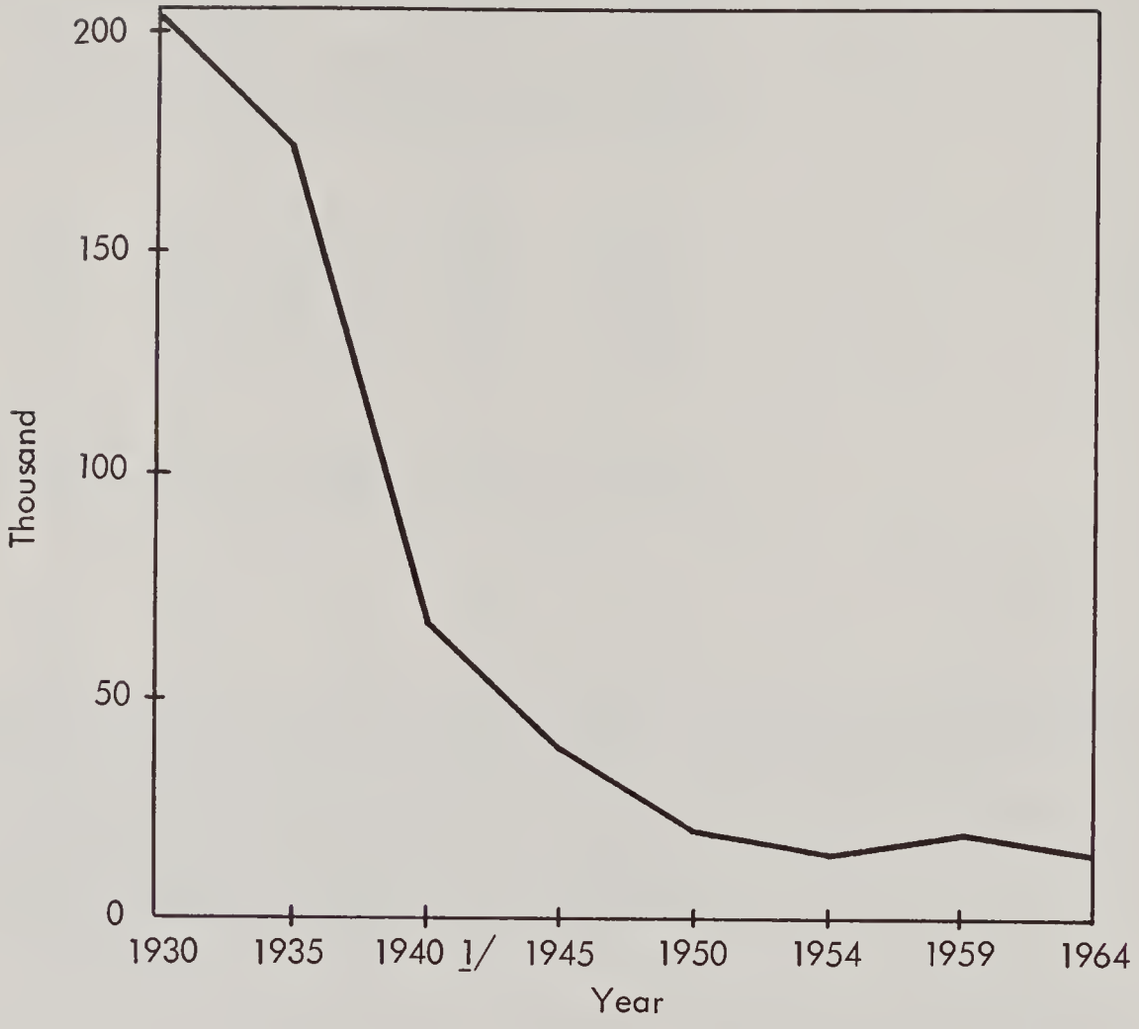
Employment and Income

Farm employment decreased from 778 workers in 1940 to about 550 workers in 1960. 13/ Since 1959, the number of farm workers has remained relatively constant (table 21).

Personal income to farm proprietors and wages and salaries to farm laborers are shown in figure 5 for the years 1950 to 1961. Total personal income to farm proprietors has been highly variable and probably reflected climatic conditions which determined yields of crops and range forage. In general, proprietor income has decreased somewhat over the 11-year period.

13/ Table 11 on page 36.

NUMBER OF SHEEP AND LAMBS,
HARNEY COUNTY, OREGON, 1930-1964



U. S. Census of Agriculture.

1/ Only sheep and lambs six months and over.

FIGUR E 4

Total wages and salaries to farm laborers have remained relatively constant, especially when compared to proprietor's incomes. The highest figure for all wages and salaries was $880,000 which occurred in 1954 and again in 1957. The lowest figure was $730,000 in 1960.

Capital Investment and Number of Farms

Agricultural units in Harney County consist mainly of ranches, which are generally composed of a large number of acres compared to the average farm in Oregon (table 22). Thus, the average value of land and buildings per farm has generally been higher for Harney County than for the state (figure 6).

Table 20.--Production of crop and livestock products, Harney County, Oregon, 1959-1965

Item	Unit	Year						
		1959	1960	1961	1962	1963	1964	1965 1/
		1,000	1,000	1,000	1,000	1,000	1,000	1,000
Crops:								
Small grains	bushels	150	199	98	92	196	280	364
Wheat	do.	(18)	(21)	(11)	(12)	(14)	(21)	(21)
Barley	do.	(101)	(141)	(47)	(41)	(130)	(210)	(250)
Oats	do.	(18)	(25)	(20)	(24)	(31)	(22)	(42)
Rye	do.	(13)	(12)	(20)	(15)	(21)	(27)	(51)
Hay	tons	88.0	108.8	92.7	77.1	109.0	132.9	141.3
Alfalfa	do.	(19.1)	(20.2)	(17.3)	(19.0)	(26.0)	(28.0)	(24.0)
Other hay	do.	(68.9)	(88.6)	(75.4)	(58.1)	(83.0)	(104.9)	(117.3)
Livestock:								
Cattle, calves	lbs. lwt.	26,918	26,351	27,390	26,725	27,543	29,590	...
Sheep & lambs	do.	1,367	1,400	1,397	1,178	1,109	1,021	...
Wool	pounds	213	223	214	190	188	177	...
Hogs	lbs. lwt.	102.5	102.5	102.5	82.0	82.0	82.0	...

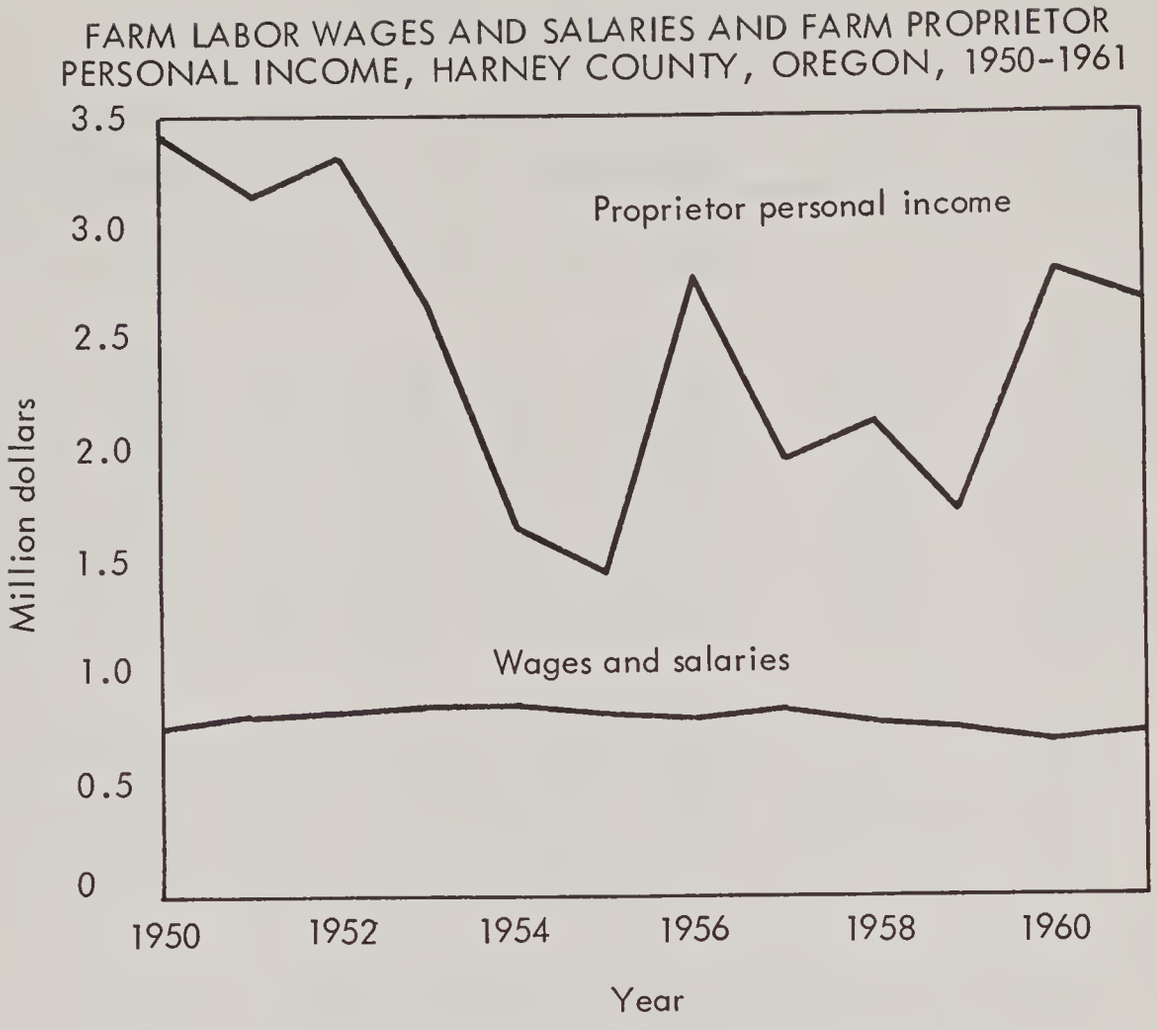
1/ Preliminary

Statistical Reporting Service, USDA, Portland, Oregon.

Table 21.--Average yearly farm employment, Harney County, Oregon, 1959-1965

Year	Average annual
	Number
1959	560
1960	550
1961	410
1962	550
1963	550
1964	560
1965	570

State of Oregon, Department of Employment, Labor Force in Harney County, revised November 1966, (unpublished).



Oregon Personal Income by County.

FIGURE 5

In 1964, the average value of land and buildings per farm in Harney County was over three times that for the state. Not only has the average value of land and buildings been higher in Harney County but it has also been increasing at a more rapid rate than for Oregon (table 22 and figure 6).14/

Because of the prevalence of large, specialized commercial livestock ranches, the owners and managers probably placed greater emphasis on investing funds for capital improvements in Harney County. In many other parts of the state, there are a larger number of part-time and less specialized farms which may help explain why Oregon, as a whole, does not match capital investment rates in Harney County (table 23).

14/ Average value per farm of land and buildings shown in table 22 for Harney County may be biased upward somewhat. The U. S. Census of Agriculture data probably reflects the value of grazing permits which often are included with the sale price of land and buildings.

Table 22.--Average value per farm of land and buildings and the percent increase by census years; and average size of farms, Harney County and Oregon

Year	Average value, per farm, of land and buildings				Average size of farms	
	Harney County		Oregon		Harney County	Oregon
	Dollars	Percent increase	Dollars	Percent increase	Acres 1/	Acres
1940	14,033		7,712		2,005.6	290.9
1944	21,766	55.1	11,054	43.3	2,995.4	312.9
1949	52,030	139.4	19,963	80.6	3,839.1	339.8
1954	74,231	42.7	27,789	39.2	4,161.7	386.6
1959	115,049	60.4	43,608	56.9	5,257.2	498.8
1964	179,522	56.0	59,079	35.5	5,077.8	515.9

1/ Does not include land leased from the government.

U. S. Bureau of the Census, U. S. Census of Agriculture.

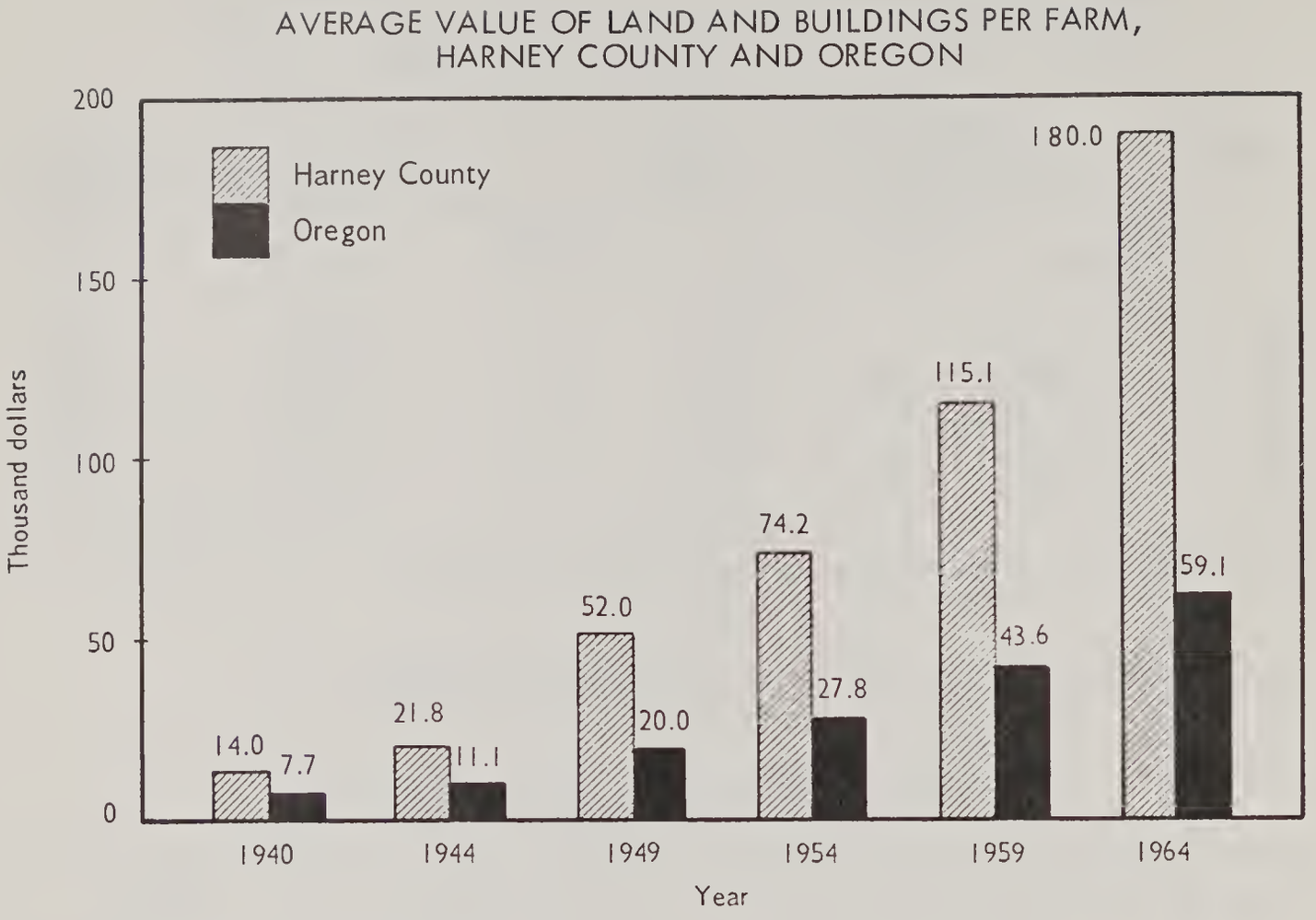
Table 23.--Number of farms by economic class, Harney County and Oregon, 1964

Farms by economic class 1/	Harney County		Oregon	
	Number	Percent of total	Number	Percent of total
Commercial farms	222	80	21,506	54
$40,000 or more	(26)	(10)	(2,301)	(6)
$10,000 to $39,999	(104)	(37)	(7,118)	(18)
$2,500 to $9,999	(77)	(28)	(8,566)	(21)
$50 to $2,499	(15)	(5)	(3,521)	(9)
Part time	40	14	13,648	34
Part retirement	15	5	4,566	12
Other 2/	2	1	37	0
Total	279	100	39,757	100

1/ A farm was defined as a place of 10 acres or more with annual sales of at least $50. A place of less than 10 acres was counted if annual sales were at least $250. Places with less than $50 or $250 annual sales were also counted if they could normally be expected to meet the above definition. Farms were classified as commercial if annual sales totaled $2,500 or more. If annual sales were $50 to $2,500, farms were classified as commercial if the operator was under 65 years of age, did not work off the farm more than 100 days annually, and if non-farm income was less than the value of all farm sales.

2/ Includes institutional farms and Indian reservations.

U. S. Bureau of the Census, U. S. Census of Agriculture.



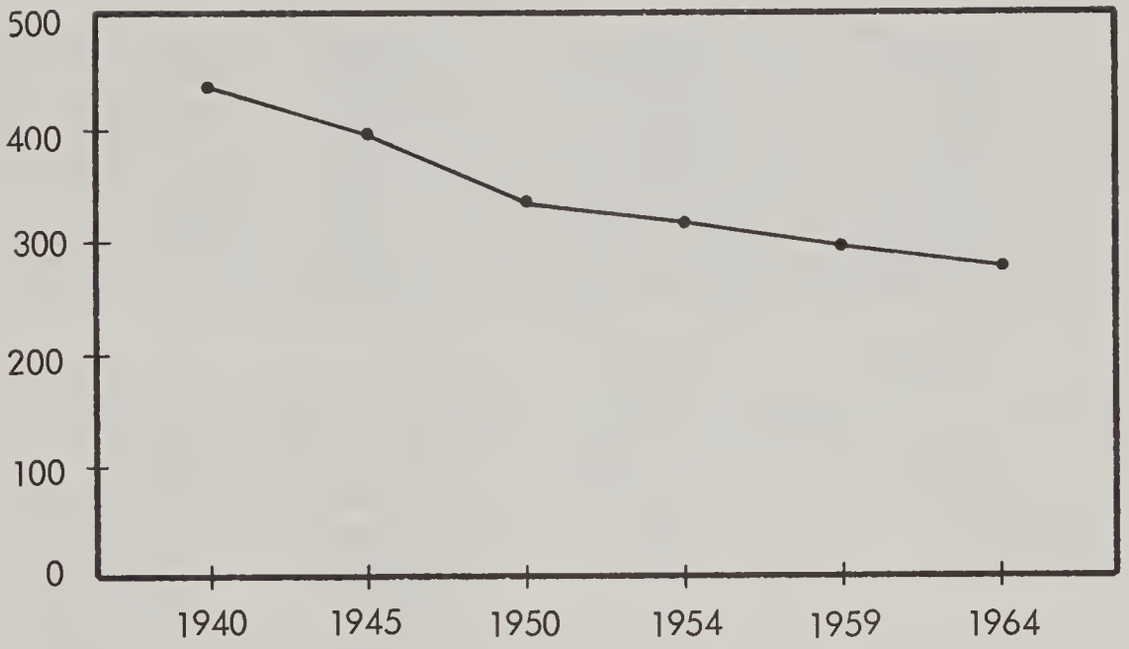
U. S. Census of Agriculture.

FIGURE 6

Possibilities for range improvement projects, more and better irrigation techniques, higher quality breeding stock, and cropland soil improvement practices will probably continue to result in increased capital investment outlays in Harney County.

The number of farms and ranches has been decreasing in Malheur Lake Drainage Basin representing a trend of consolidation of holdings into larger units. The number of farms in Harney County decreased from 436 in 1940 to 279 in 1964 (figure 7).

NUMBER OF FARMS, HARNEY COUNTY, OREGON, 1940-1964 1/



1/ Not all years are strictly comparable due to changes in census definitions.

U. S. Census of Agriculture

FIGURE 7

Agricultural Projections

A primary purpose of this report is to collect and analyze data to help determine future water requirements. Since irrigation is the most important use of water for agriculture, an appraisal of the number of acres that might be irrigated in the future is a necessary step in this examination; thus, it follows that an estimate must be made of the type and quantity of crops that might be grown in the future.

Agricultural projections are presented in this section. The projections are only what might happen if certain qualifying assumptions prove to be true.

If the assumptions do not prove valid, then the projections may not be realistic.

As a starting point, projections of Oregon agriculture in a report submitted by the Economic Research Service, USDA, to the Bonneville Power Administration (referred to here as the BPA report) were examined and assumed to be the most current and acceptable projections available for Oregon. 15/

Projections of Oregon crop and livestock production for 1980 are shown in table 24. Only the major commodities produced in the Malheur Lake Drainage Basin are presented. Increases in production for all commodities except sheep, lambs, and wool are projected. Production of cattle and calves is projected to double in Oregon by 1980. Sheep, lamb, and wool production is projected to remain at base period levels while hog production is projected to increase by about 20 percent. Production of small grains and hay is projected to increase about 73 and 39 percent, respectively.

Table 24.--Production of major crop and livestock products, projections to 1980 and percentage change, Oregon

Commodity	Unit	Base period 1/	1980	Change
		Thousand	Thousand	Percent
Small grains	Tons	1,307.7	2,267.3	73.4
Hay	do.	1,874.0	2,613.0	39.4
Cattle and calves	lbs. lwt.	412,000	837,000	103.2
Sheep and lambs	do.	51,000	51,000	0
Hogs	do.	54,000	65,000	20.4
Wool	pounds	7,000	7,000	0

1/ 1959-61 for crops, 1960 for livestock.

Agricultural Production and Food Processing in the Pacific Northwest, 1960-1985, U. S. Department of Agriculture, Economic Research Service, an administrative report to the BPA, USDI, Corvallis, Oregon, July 1964.

Harney County production of small grains, sheep, lambs, and hogs was projected to increase at approximately the same rate as Oregon's production. An examination of historical trend relationships did not indicate any significant change in Harney County's percentage contribution to total state production of these commodities, nor did there appear to be any other reason why it should change in the future. Small grains are projected to increase about 73 percent from the base period. Production of sheep, lambs, and wool is expected to remain constant or possibly decline slightly and production of hogs is projected to increase by approximately 24,000 pounds liveweight or about 20 percent by 1980 (table 25).

15/ Agricultural Production and Food Processing in the Pacific Northwest, 1960-1985, U. S. Department of Agriculture, Economic Research Service, an administrative report to the BPA, USDI, Corvallis, Oregon, July 1964.

Table 25.--Projections of major crop and livestock production, Harney County, Oregon, 1980

Commodity	Unit	Base period 1/	1980	Change from base period to 1980
				Percent
Crops:				
Small grains	Tons	3,568	6,190	73.4
Wheat	do.	(500)	(867)	
Barley	do.	(2,312)	(4,011)	
Other	do.	(756)	(1,312)	
Hay	do.	96,490	153,600	59.2
Alfalfa	do.	(18,847)	(30,004)	
Other hay	do.	(77,643)	(123,596)	
		Thousand	Thousand	Percent
Livestock:				
Cattle and calves	lbs. lwt.	26,351	41,898	59.0
Sheep and lambs	do.	1,400	1,400	0
Hogs	do.	103	124	20.4
Wool	pounds	223	223	0

1/ 1959-61 for crops, 1960 for livestock.

Production of cattle and calves in Harney County was projected to increase by about 15.5 million pounds or 59 percent by 1980 based upon an estimate of the amount of range forage that would be available. Range improvement projects are expected to provide additional forage on 798 thousand acres of rangeland by 1980 (table 26). Approximately 72 percent of this will be sprayed with chemicals to kill sagebrush, allowing native grasses to compete. The remaining 28 percent will be plowed to remove sagebrush and then seeded to grass. A grazing rate of about 5 acres per animal unit month (AUM) can be expected from rangeland treated by spraying and about 3 acres per AUM from land plowed and seeded. 16/ Without range improvements, approximately 25 to 30 acres per AUM is needed to provide forage.

Range improvement is one of the most promising means of increasing livestock production in the Malheur Lake Drainage Basin. In fact, it may be that range improvement, resulting in increased production of livestock, is the most feasible method of significantly increasing total agricultural production in the basin.

16/ An animal unit month (AUM) is the amount of forage which is necessary for the complete sustenance of a 1,000-pound cow for a period of one month; also a unit of measurement of grazing privileges within grazing districts which represents the privilege of grazing one animal unit for one month.

From tables 14 and 26, the acreage of rangeland susceptible and unsusceptible to improvement is as follows:

	Private		BLM	
	Acres	Percent	Acres	Percent
Rangeland susceptible to improvment	805,700	73	1,056,570	27
Rangeland unsusceptible to improvement	306,240	27	2,801,300	73
Total	1,111,940	100	3,857,870	100

It might, at first, appear that the BLM estimate of rangeland susceptible to improvement is somewhat low compared to the estimate for private range. However, BLM administers a higher percentage of poor rangeland that is less likely to respond to range improvement practices. Also, since BLM is a federal agency, range improvement must be viewed in terms of the overall public interest. Thus, while private improvement projects are aimed primarily at increasing forage production, BLM must consider many additional ramifications of spraying, plowing, and seeding (e.g., the effects on wildlife habitat).

The total number of cattle and calves possible on both improved and unimproved rangeland in 1980 was estimated at 122,700 animal units. This is an increase of 59 percent over the 1959 through 1961 average of 77,193 animal units. The same percentage increase of 59 percent was used to calculate the 1980 liveweight production of cattle and calves from the base period to 1980 (table 25).

Table 26.--Past and projected rangeland improvements, Harney County, Oregon

Type of improvement by ownership	Estimate of completed improvements		Estimated improvements possible by 1980	Estimated total acres susceptible to improvement
	1965	Total through 1966		
	Acres	Acres	Acres	Acres
Spraying	41,000	109,035	574,000	1,175,402
Private	(24,000)	(56,700)	(336,000)	(470,000)
Federal	(17,000)	(52,335)	(238,000)	(705,402)
Seeding	16,000	147,000	224,000	686,868
Private	(4,000)	(30,000)	(56,000)	(335,700)
Federal	(12,000)	(117,000)	(168,000)	(351,168)
Total	57,000	256,035	798,000	1,862,270

Estimates provided by District Managers, Bureau of Land Management, Burns and Lakeview Districts, and County Agent, Harney County, by letters and personal interviews. Estimates are for BLM and private land only. U. S. Forest Service lands are not included in these estimates.

Historical trends show that hay production has been increasing at a faster rate in Harney County than for Oregon. Assuming that this trend will continue, hay production is expected to reach 153,600 tons by 1980 or about 59 percent more than the base period production of 96,490 tons (table 25).

Acreages of major crops in Harney County were projected for 1980 (table 27). Crop acreages are not projected to increase in proportion to crop production since greater yields per acre are projected. On the basis of historical trends, crop yields are projected at: wheat, 22.1 bushels per acre; barley, 26.4 bushels per acre; oats, 26.9 bushels per acre; and all hay (including wild hay), 1.07 tons per acre. Total harvested acreage of small grains and hay crops is projected to increase by about 62 percent from 1959 to 1980.

Table 27.--Acres of major crops, Harney County, Oregon, 1959 and projections for 1980

Crops	Harvested acreage	
	1959 1/	1980
	Acres	Acres
Small grains	8,301	10,200
Wheat	(913)	(1,300)
Barley	(5,608)	(6,300)
Other	(1,780)	(2,600)
Hay	86,522	143,600
Alfalfa	(9,332)	(13,000)
Other hay crops	(77,190)	(130,600)
Total	94,823	153,800

1/ U. S. Bureau of the Census, U. S. Census of Agriculture.

Agricultural employment in 1980 is expected to remain at about the 1959 through 1965 average of 536 workers. The value of production of all agricultural products is projected at about $13.8 million in 1980, an increase of approximately 57 percent over the 1959 through 1961 average of $8.8 million. 17/ These projections of employment and value of production assume a corresponding increase in labor productivity due to anticipated increased output per farm worker because of labor-saving technological innovations.

RANGE RESOURCES AND RELATED ECONOMIC ACTIVITY

Extent and Nature of the Resource

Rangeland forms the bulk of the acreage within the Malheur Lake Drainage Basin. Table 14 on page 41 shows that 5,237,600 acres are classified as

17/ 1959-61 average prices were used.

rangeland. This is approximately 82 percent of the total land area. In addition to this, virtually all the area classified as forest land is grazed. These two groups make up approximately 95 percent of the land area of the basin.

There are considerable differences in the nature of the rangeland from the northern part of the basin to the southern section. Photo 9 shows cattle grazing in a forest opening with primarily grass and herb composition in the northern portion of the basin. As one moves south from the timbered areas, juniper-brush composition becomes prevalent as shown in photo 10. These areas, as compared to the timbered areas, produce less feed and water is less abundant. Photo 11, taken near Fields, Oregon, in the semi-arid southern portion of the basin, shows that sagebrush is the predominant plant. Juniper is not generally present.

Some areas within the basin, such as the Alvord Desert, do not support any plant life suitable for livestock. Many areas are not grazed because of steepness of terrain.

Range areas are rated by condition class for their productivity. The adjective descriptions used are generally excellent, good, fair, poor, and very poor. These would correspond to 100 percent, 80 percent, 60 percent, 40 percent, and 20 percent of their productive capabilities. Table 28 lists condition classes for some of the publicly owned land within the basin during 1966.

Table 28.--Condition class rating of selected publicly owned range areas, Malheur Lake Drainage Basin, Oregon, 1966

Condition class 1/	Malheur National Forest 2/	Ochoco National Forest 3/	Lakeview District, Bureau of Land Management 4/	Burns District, Bureau of Land Management 5/
	Percent	Percent	Percent	Percent
Excellent	1	1	0	1
Good	4	10	30	5
Fair	27	40	39	57
Poor	58	43	21	36
Very poor	10	6	10	1

1/ Based on relative levels of production.
2/ Portions of Burns and Bear Valley Ranger Districts.
3/ Entire Snow Mountain Ranger District.
4/ Entire Beattys Butte Unit.
5/ About three-fourths of the Burns District (various units).

U. S. Forest Service and Bureau of Land Management data.

Photo 9.--These cattle are grazing in a typical forest opening in the northern portion of the basin. SCS PHOTO 7-2011-11

Photo 10.--These cattle are gathering at a stock watering pond in the more arid juniper-brush type area. SCS PHOTO 7-1985-3

Photo 11.--Sagebrush is the dominant plant on rangeland near Fields, Oregon. SCS PHOTO 7-1985-8

Livestock Numbers

Total livestock numbers for the basin are listed in table 18. The bulk of the basin's rangeland is under the management of several federal agencies. The numbers of livestock permitted to graze on these lands have a direct effect on the total numbers. Table 29 shows the approximate amount of grazing, expressed in AUM's, permitted on federal lands.

Table 29.--Numbers of livestock permitted to graze on federal rangelands in 1965, expressed in AUM's, Malheur Lake Drainage Basin, Oregon

Unit or District	Agency	AUM's
Ochoco National Forest	Forest Service	9,800
Malheur National Forest	Forest Service	26,000
Burns District	Bureau of Land Management	231,000
Lakeview District	Bureau of Land Management	36,000
Malheur National Wildlife Refuge	Fish and Wildlife Service	107,000
Hart Mountain National Antelope Refuge	Fish and Wildlife Service	11,000

Data furnished by BLM, FS, and F&WS and adjusted to the basin by River Basin Survey Staff.

The numbers shown in table 29 have been fairly static for the past 10 to 15 years. In many cases, the full number of AUM's permitted has not been used by the local ranchers for varying reasons.

Current and Projected Growth

Many projects are being undertaken by both the Forest Service and the Bureau of Land Management to improve grazing capacity on lands in the basin under their jurisdiction.

The Burns District of the Bureau of Land Management lists the following accomplishments in the area of range improvements for fiscal years 1964 and 1965:

	Brush Control	Grass Seeding	Fencing	Water Developments
F.Y. 1964	...	12,700 A.	65 miles	35
F.Y. 1965	1,500 A.	4,994 A.	62 miles	16
F.Y. 1966	...	400 A.	105 miles	38
F.Y. 1967	...	6,700 A.	63 miles	36

Those involved in these projects estimate that untreated native areas generally have a grazing capacity of around 25-30 acres per animal unit month. Those areas that have been reseeded with crested wheatgrass are generally capable of a carrying capacity of 2-4 acres per animal unit month.

In addition to the range improvement projects being carried out by federal agencies, many acres of privately owned rangeland are being improved. The rehabilitation of privately owned range is generally being accomplished at a faster rate than on federally owned rangelands.

Photo 12 shows a Bureau of Land Management reseeding project near Fields, Oregon. The foreground area to the left of the road has been treated and the area to the right of the road is native rangeland.

Photo 13 shows the extent of brush removal and soil disturbance in a reseeding project.

Better distribution of livestock by fence construction and development of water sources have increased the number of animal unit months provided by land management agencies in the basin. All agencies have many additional developments planned for the future.

Development and adaptation of the helicopter have made many range improvement projects possible. Photos 14 and 15 show a helicopter being used to spray rangeland for brush control and to deliver a stock watering tank to a remote area.

One problem that has developed in conjunction with crested wheatgrass seedings in the basin is the concentration of jack rabbits in the areas of reseeding. Photo 16 illustrates a study area set up to study this problem. The area in the background is untreated native rangeland. In the right

Photo 12.--The land to the left of the road has been treated through a project conducted by the Bureau of Land Management. The area to the right of the road is native rangeland. SCS PHOTO 7-1985-9

Photo 13.--Through a Bureau of Land Management project, this land is being cleared for reseeding to crested wheatgrass. SCS PHOTO 7-1985-10

Photo 14.--The use of the helicopter has made possible many range improvement practices such as brush control shown in this photo. USFS

Photo 15.--This stock watering tank is being delivered to a remote range area by a helicopter. USFS

Photo 16.--This study area has been established to illustrate use of reseeded range by rabbits. SCS PHOTO 7-1985-11

foreground is an area reseeded and fenced against cattle and rabbits. The area in the left foreground is fenced against cattle only. It is obvious that rabbits are eating large amounts of the seedings.

The optimum level of development of the range resources of the basin is not known but it is obvious that there are many thousands of acres which can be improved to increase the overall carrying capacity.

FOREST RESOURCES AND RELATED ECONOMIC ACTIVITY

Extent and Nature of the Resource

Forest land in the Malheur Lake Drainage Basin occupies 12 percent of the total area or 779,400 acres (table 30). The forests are almost exclusively softwoods with small stringers of hardwoods in the valleys. The forest zone begins about 5,600 feet above sea level. Tree growth is limited by low moisture at low elevations. Usually a belt of western juniper occurs between the commercial forest land and the grass-shrub association lands.

Ponderosa pine predominates on much of the forested area and often occurs in pure stands at lower elevations. As elevation increases and moisture conditions become more favorable, such species as Douglas-fir, white fir, and lodgepole pine are found in increasing proportions. On the cool, moist, upper slopes, generally above 6,000 feet elevation, alpine fir, lodgepole pine, and

Photo 17.--The grassland opening is typical of those occurring in the ponderosa pine type. SCS PHOTO 7-2011-10

Engelman spruce predominate. Extensive pure stands of lodgepole pine are often found at higher elevations in areas where fire, insects, or disease removed the previous stand.

Areas of grassland, occasionally exceeding 1,000 acres, are intermingled in the forest-land zone. These areas occur in all elevation zones and furnish much of the summer feed for livestock and big game. Almost all the forest land is subject to grazing by domestic livestock at some time during the year.

Forests are an ever-changing association of plants and animals which are affected by man's actions. They are the source and storage area for much of the basin's water. They are the source of the raw material for a large segment of the basin's industry. They are the home of a large variety of game animals and the summer range for livestock. They are the center for the rapidly expanding field of outdoor recreation.

Characteristics of the Resource

Approximately 558,750 acres of land in the basin are suitable for growing commercial timber. This commercial forest land presently supports a stand of

4,769 million board feet of commercial timber. 18/ Ownership of the commercial forest land and timber is shown in table 30.

In addition to the 558,750 acres of commercial forest land, there are approximately 220,650 acres of forest land classed as noncommercial. Approximately 214,730 acres are stocked with western juniper which is considered a noncommercial species at this time and approximately 5,920 acres are classified noncommercial as they are inaccessible because of rough terrain. These are primarily aspen stands located in the Steens Mountains.

The commercial forest stands occur as solid blocks in the mountainous areas in the northern portion of the basin. Noncommercial forest stands of western juniper and aspen occur throughout the basin where rainfall is slightly higher than the normal.

Part of the job of forest management is the protection of forests from fire and other damage-causing agents. Sometimes overlooked by people unfamiliar with forest management is the need for protection from insects, disease, animals, and weather. These needs are considered in planning timber harvest.

One of the guides for selecting ponderosa pine for harvest is based on the relative health of each tree as indicated by the size and density of the crown. Healthy trees with luxurious crowns are often resistant to attacks from insects and disease. The possible occurrence of wind damage is considered when selecting areas or trees for harvest.

In order to re-establish the forest after harvest, it is sometimes necessary to take measures to prevent or control animal damage. In some instances, the rodent population may need to be controlled to prevent excessive loss of tree seed or excessive nipping of planted tree seedlings. Occasionally, sensitive areas like recent burns, plantations, and municipal watersheds must be protected from overuse of big game by fencing, when feasible, or through special hunts set by the Oregon State Game Commission. Studies aimed at reducing animal damage are conducted by the Oregon State Game Commission, the Bureau of Land Management, the U. S. Forest Service, and other agencies.

Maintenance of an optimum watershed condition on forest lands in the Malheur Lake Drainage Basin depends, in addition to other factors, upon protection of the land from widespread wildfire. Fires often cause destruction of the vegetative cover and soil organic matter, which, in turn, produces accelerated soil erosion and rapid surface runoff resulting in downstream flooding and siltation. Adequacy of fire protection will also determine, to a large extent, the economic value realized from tree farming and livestock ranching. This is particularly true of land used for timber production because many years are required to produce a marketable crop, and fire, at any time during this period, could destroy the entire investment.

18/ U. S. Forest Service, Bureau of Land Management, State Tax Commission, and State Department of Forestry data adapted to the basin for USDA River Basin Survey Staff.

Table 30.--Forest area and timber volumes by forest type and ownership class, Malheur Lake Drainage Basin, Oregon, 1966

Type	Private		State		National Forest		Other Federal		Total	
	Acres	MMBF	Acres	MMBF	Acres	MMBF	Acres	MMBF	Acres	MMBF
Commercial forest:										
Mature 1/										
Ponderosa pine	11,820	51.0	760	2.7	406,430	4,068.8	10,000	40.0	429,010	4,162.5
Associated species	0	0.5	30	0.3	46,290	552.2	0	0.0	46,320	553.0
Lodgepole pine	0	0.0	0	0.0	6,610	24.8	0	0.0	6,610	24.8
Hardwoods	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Immature										
Ponderosa pine	22,900	0.0	470	0.3	44,490	2.2	0	0.0	67,860	2.5
Associated species	0	0.0	0	0.0	5,410	19.5	0	0.0	5,410	19.5
Lodgepole pine	0	0.0	0	0.0	1,200	6.6	0	0.0	1,200	6.6
Hardwoods	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Nonstocked	540	0.0	0	0.0	1,800	0.0	0	0.0	2,340	0.0
Subtotal	35,260	51.5	1,260	3.3	512,230	4,674.1	10,000	40.0	558,750	4,768.9
Noncommercial forest										
Juniper	40,000	0.0	8,500	0.0	16,230	0.0	150,000	0.0	214,730	0.0
Noncommercial Rocky	2,900	0.0	0	0.0	320	0.0	2,700	0.0	5,920	0.0
Total	78,160	51.5	9,760	3.3	528,780	4,674.1	162,700	40.0	779,400	4,768.9

1/ 11 inch D.B.H. and larger, except 5 inch and larger for lodgepole pine.

USFS, BLM, Oregon State Department of Forestry, and Oregon Tax Commission data adjusted to basin.

Regeneration practices include protecting existing young trees during logging, leaving groups of trees as a source of seed, and occasional aerial seeding. Tree planting is successful when competing vegetation is adequately controlled. Tree protection from big game and rodents may be necessary in some areas. Livestock is usually adequately controlled to protect seedlings but, at times, local damage occurs along or near heavily grazed streamsides, bedding grounds, or other concentration points.

The program of improving the growth and quality of young stands is being accelerated by precommercial thinning. As an example, the Malheur National Forest has thinned 15,000 acres to date within the basin in the past 10 years and estimates 146,000 acres yet to be done. This increased activity in thinning has been brought about primarily by the adaptation of power equipment (photos 18 and 19). These photos show a stand of young pine being thinned and a stand after thinning was completed. Private owners have done very little in the area of timber-stand improvement.

Photo 18.--Thinning of overstocked stands has proved economical with the adaptation of power equipment. USFS

Utilization: Kind, Volume, and Value of Output

Timber harvesting began with the cutting of logs and poles for cabins and corrals by ranchers and miners. The production of lumber in the basin began in 1867 when Albert H. Robie brought machinery from Boise, Idaho, to saw lumber for the interior of the buildings at Fort Harney. Robie's mill

Photo 19.--Ponderosa pine stands after thinning appear more open and park like. USFS PHOTO 492741

was located on Rattlesnake Creek near the site of old Fort Harney. Lumber from this mill was hauled by wagon as far away as Frenchglen, some 70 miles to the south, by Pete French for his ranch house.

To give the reader some idea of past utilization of forest resource, the following statement is taken from "Forest Statistics for Harney County, Oregon": 19/

"Only in recent years has the forest resource of the county been utilized to any appreciable extent for timber products. During the period 1925-46, the volume of live sawtimber cut annually averaged about three-fourths of a million board feet, log scale, Scribner rule. In the seven-year period 1947-53, however, the annual cut averaged 35 million board feet, nearly all in the form of sawlogs; there was a small volume of poles, fence posts, and fuel wood. In recent years, about 95 percent of the timber cut has been taken out of the woods in the form of timber products and 5 percent has been left in the form of logging residue. Seventy percent of the volume cut during the seven recent years was national forest timber; nearly all the remainder was private timber."

Approximately 86 percent of the commercial forest land supports stands of timber which are over 150 years old. The timber is past technical rotation

19/ Forest Survey Report No. 118, USDA, Forest Service, November 1954.

age (rotation age is 125-140 years in the basin). Much of it is slow growing and susceptible to insect and disease attack. Thrifty trees under good management practices will continue growth at acceptable rates to age 200 years and beyond. Full potential growth of timber will not be realized until these overmature stands are replaced by an even distribution of age classes, younger than rotation age; however, this cannot be realized over a short period of time. The overmature stands must be harvested over a period of at least 30 to 50 years to assure a sustained supply of timber until the present young-growth stands reach maturity.

Lands managed by the Forest Service and the Bureau of Land Management are under the multiple-use, sustained-yield principle, therefore, only a certain amount of their sawlog supply is sold each year. The annual allowable cut within the Malheur Lake Drainage Basin from Forest Service lands is approximately 69 million board feet per year, and from BLM managed lands is approximately 2 million board feet.

Since the installed capacity of the mill at Hines is more than 120 million board feet per year, logs from other basins are imported to meet its needs. Some of this need is met from its private holdings and from federal lands. Figure 8 illustrates the timber harvest within Harney County for the past 14 years.

The harvesting technique ordinarily accepted for the ponderosa pine type is the individual tree or group selection basis. Overstory removal cuts are applied when adequate advance regeneration is already present. Regeneration cuts may be either patch clearcuts or final overstory removal in preparation for natural or artificial reforestation.

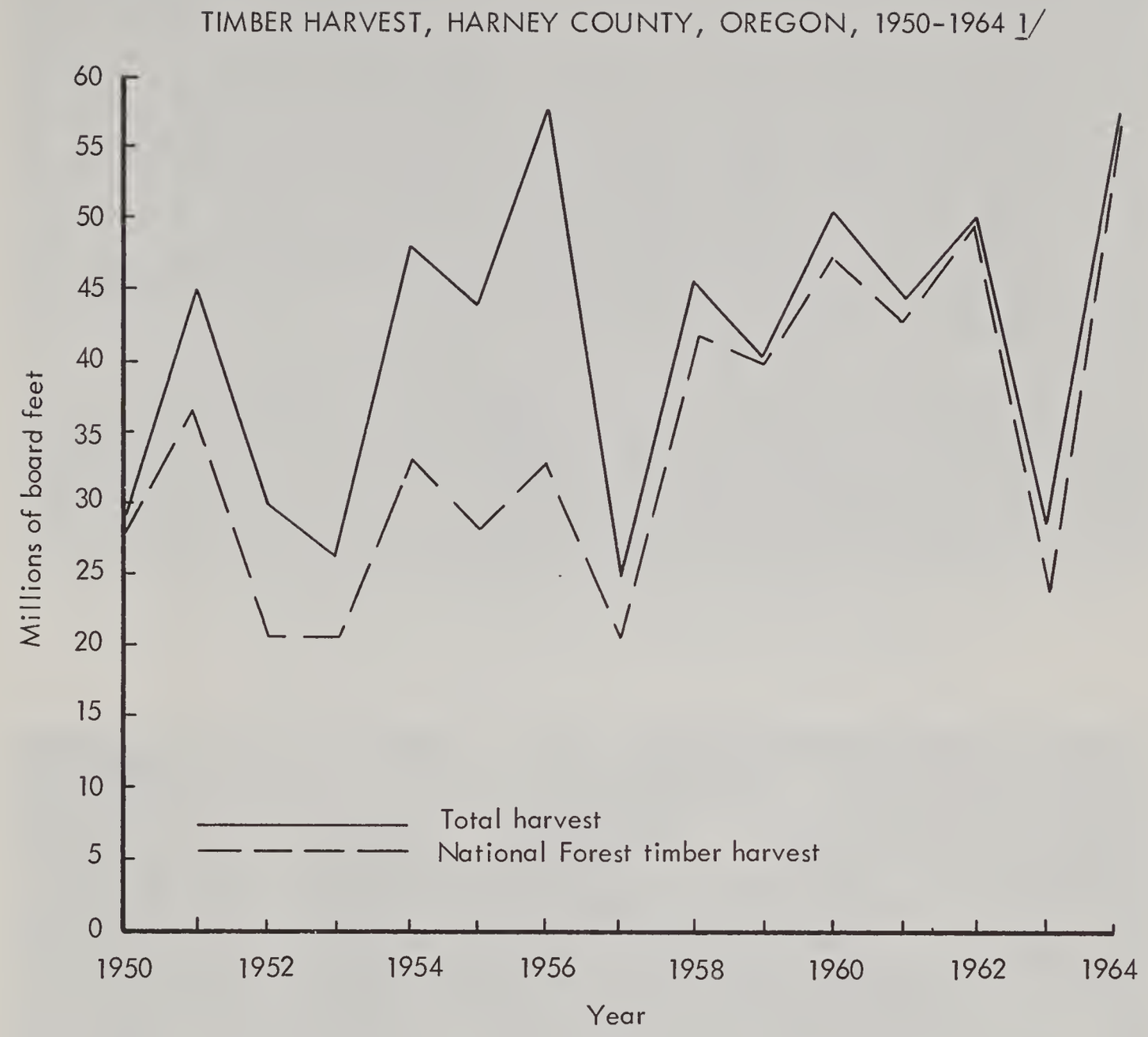
The logging method most commonly used within the basin is skidding with a crawler-type tractor as shown in photo 20. Transportation of the logs to the mill is by trucks as shown in photo 21 or by train as shown in photo 22.

In certain situations, the use of large equipment has proved uneconomical. The method pictured in photo 23 is a technique of logging in lodgepole pine stands where volume per acre is low and the logs are small in size.

Lumber has been the primary product manufactured from the basin's timber. Associated species are generally cut into dimension lumber, while ponderosa pine is cut into boards or further manufactured into molding. The Edward Hines mill located in Hines, Oregon, is the only primary manufacturing plant in the basin. Hines also owns a planing mill located at Seneca, Oregon

The Edward Hines Lumber Mill has an installed annual capacity of 120 million board feet. The recent installation at the mill of a plywood plant, with an installed annual capacity of 80 million square feet based on 3/8-inch basis, will increase utilization of logs within the basin.

Lumber and plywood are generally shipped from the basin by railroad to midwestern and eastern markets. Wood products from the basin have been curtailed in the California markets because of adverse rail freight rates.



1/ U. S. Forest Service data

FIGURE 8

The only mill basically dependent on the basin for its log supply is the Edward Hines Mill. Some of the logs from the northern end of the basin can be milled at John Day.

Photo 20.--Logging within the Malheur Lake Drainage Basin is most commonly accomplished with a crawler-type tractor. USFS PHOTO 492724

Photo 21.--Trucks, such as the one shown above, are generally used for transporting logs to the mill in eastern Oregon. USFS PHOTO 492731

Photo 22.--The Malheur Lake Drainage Basin is one of the few places where logs are still transported to the mill by train. USFS

Photo 23.--Horse teams are occasionally used to haul small logs from lodgepole pine stands where volume per acre is low. SCS PHOTO 7-2011-13

Current and Projected Growth

During 1966, the U. S. Forest Service, through its Pacific Northwest Forest and Range Experiment Station, prepared a report under cooperative agreement with the Bonneville Power Administration. The report is titled "Prospective Economic Developments Based on the Timber Resources of the Pacific Northwest". In this report, all of eastern Oregon is considered as one study unit. Projections made for this area can be applied to the forest lands of the Malheur Lake Drainage Basin as it is not dissimilar from other areas of eastern Oregon. All the following projection figures are taken from the aforementioned report.

The trends in sawtimber growth, cut, and inventory for eastern Oregon are presented in graphic form in figure 9 for the period 1950 to year 2000. The cut on both National Forest lands and on other public lands in eastern Oregon is projected to increase by 13 percent for the period 1963 to 1985. The projected total net sawtimber growth for the combined owner groups of eastern Oregon is 107 percent for the period 1963 to year 2000. This increase takes place even though the cut is projected as being well above the growth during the entire period. This is primarily due to the harvest of slow-growing, mature and overmature timber stands and their replacement by younger, faster growing stands, improved utilization and management by using thinnings, and better salvage of current mortality.

Inventory volume for all lands is projected to decrease by 21 percent from 1963 to year 2000 due to the harvesting of old mature stands during this period.

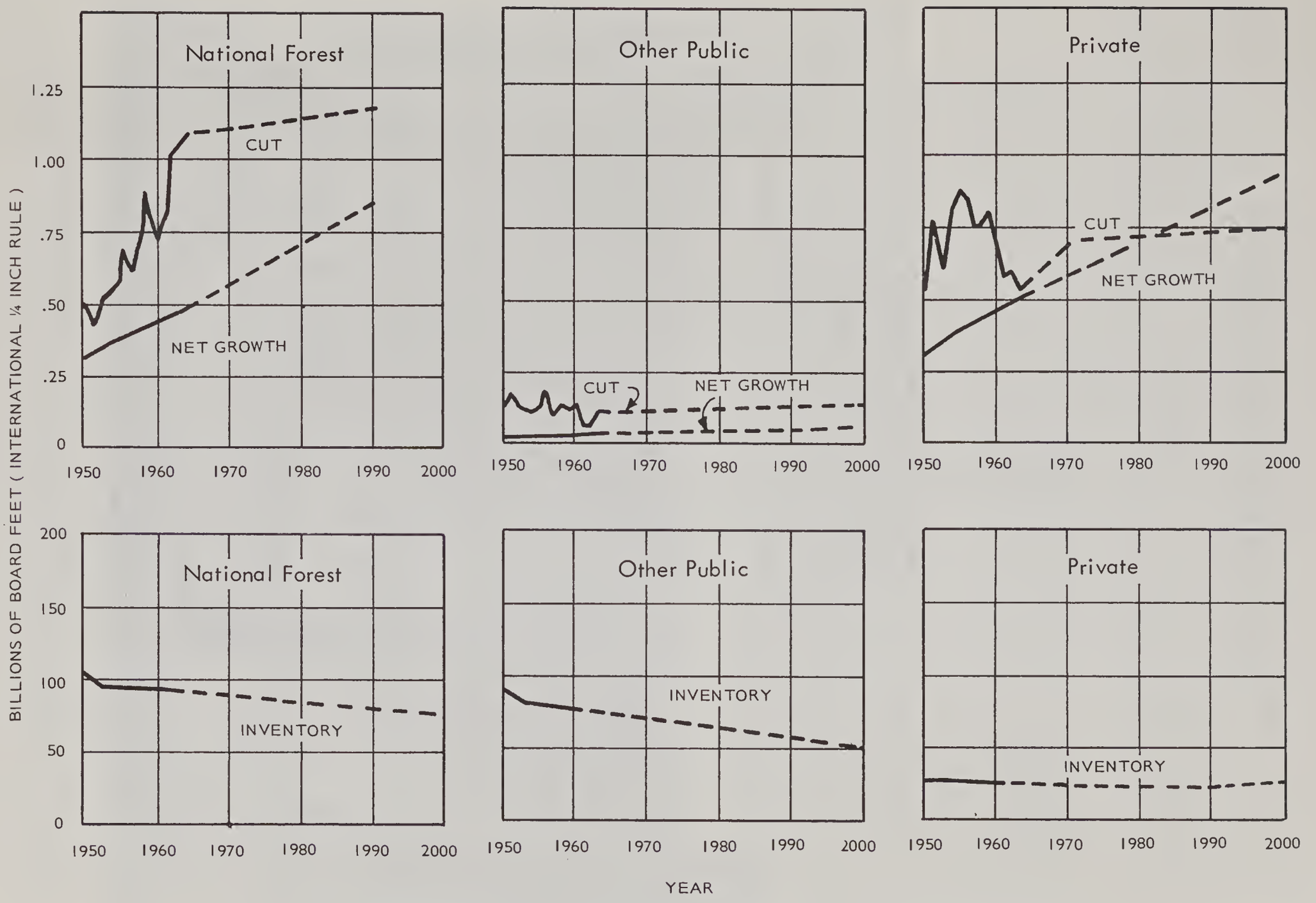
OUTDOOR RECREATION AND RELATED ECONOMIC ACTIVITIES

Extent and Nature of the Resource

Outdoor recreation has always attracted many of the local residents. Hunting and fishing are parts of their pioneer heritage. The expanding population and increased urbanization in other areas have caused more people to seek outdoor recreation--sightseeing, hunting, fishing, picnicking, rock hounding, and other related activities. Better and faster transportation, higher family incomes, and increased leisure time have enabled people to travel farther and spend more time and money for recreation. All these factors have brought about an increase in the recreational use of the Malheur Lake Drainage Basin.

The Malheur Lake Drainage Basin is largely a wild, unaltered semi-desert. The recreation potential is not fully known even to the local residents.

Developed outdoor recreational facilities are not numerous within the basin. Table 31 lists the facilities as they now exist. In addition to the campgrounds, the Oregon State Highway Department has a roadside rest area at Buchanan Springs. Many undeveloped spots in the forest portion of the basin are used regularly and commonly as "hunter camps" (photo 24).



SAWTIMBER GROWTH, CUT AND INVENTORY IN EASTERN OREGON

FIGURE 9

Table 31.--Developed campgrounds within the Malheur Lake Drainage Basin, Oregon

Facility name	Ownership	Number of camping units
Rock Spring	U. S. Forest Service	2
Blue Spring	do.	3
Delintment Lake	do.	22
Starr Campground	do.	12
Idlewild	do.	45
Joaquin Miller	do.	37
Parrish Cabin	do.	30
Page Springs	Bureau of Land Management	20
Fish Lake	Oregon State Game Commission	20
Yellow Jacket	Oregon State Game Commission	35
Chickahominy	Bureau of Land Management	...
Theimer	Harney County	...

Data obtained from U. S. Forest Service, Bureau of Land Management, and Oregon State Game Commission.

Photo 24.--This is a "hunter camp" site in the Ochoco National Forest. SCS PHOTO 7-1985-4

There are several undeveloped ski areas in the northern portion of the basin. All the developed recreation areas are in the northern half of the basin or in the Steens Mountains.

Hunting is the primary recreational activity of the basin. The basin provides 2 percent of the state's deer, quail, and pheasant hunting; 15 percent of the chukar hunting; 25 percent of the antelope hunting, and over 50 percent of the sage grouse hunting.

Fishing is limited to a few streams and man-made lakes (photo 25).

Table 32 gives a summary of the recreational activities available at the more popular lakes within the basin.

Photo 25.--Man-made lakes are popular fishing spots within the basin. SCS PHOTO F-431-7

The most popular recreation spot within the basin is the Malheur National Wildlife Refuge. The refuge recorded approximately 15,000 visitor-day's use in 1965. The 181,000-acre refuge attracts thousands of visitors to observe and photograph some of the 234 known species of birdlife which inhabit the refuge. A museum located at the headquarters building of the refuge displays mounted specimens of the wildlife frequenting the refuge.

Wildlife photographers, such as shown in photo 26, find the area very rewarding.

Table 32.--Lakes summary, Malheur Lake Drainage Basin, Oregon

Name	Size	Annual visits	Activities available
	Acres	Number	
Malheur Lake	120-64,000	4,500	Sightseeing, waterfowl hunting
Harney Lake	0-33,000	500	Sightseeing
Moon Reservoir	8-619	...	Fishing, water skiing
Baca Lake	600	3,000	Fishing
Chickahominy Reservoir	3-529	10,000	Fishing, water skiing
Rock Creek Reservoir	2-384	500	Fishing, water skiing
Mann Lake	0-325	1,000	Fishing
Juniper Lake	0-200	200	Fishing
Krumbo Reservoir	158	1,000	Fishing, picnicking
Delintment Lake	35-52	3,000	Fishing, water skiing, camping, picnicking, swimming
Fish Lake	20	2,800	Fishing, picnicking, swimming
Wildhorse Lake	15-16	...	Fishing

Data collected by Oregon State Water Resources Board.

Photo 26.--The opportunity to photograph wildlife in the Malheur National Wildlife Refuge attracts many visitors. USF&WS

The basin is a paradise for themore than 20,000 rock hounds who visit the area annually because it offers obsidian, agate, jasper, thundereggs, sunstones, petrified wood, and fossils just for the taking. There are also Indian relics and symbolic writings and carvings on cliffs, large rocks, and the walls of caves.

Trends in Use

Because of a change in the method of reporting recreation visits on National Forest lands, the figures presented in table 33 do not present the true picture of the increased number of recreation visits to the National Forests. Administrators of both the Ochoco and Malheur National Forests feel that the actual increase in visits to the National Forests may be as high as 150 percent.

Table 33.--National Forest recreation visits by primary purpose, Malheur Lake Drainage Basin, Oregon

Primary purpose	Year					
	1959	1960	1961	1962	1963	1964
	Number	Number	Number	Number	Number	Number
Camping	9,300	8,600	7,100	7,400	7,600	8,100
Picnicking	12,065	10,865	10,100	11,300	10,000	7,500
Swimming	50	50	50	50	50	...
Winter sports	150	1,170	250	1,050	200	350
Hunting	14,500	18,800	18,900	16,200	15,700	17,850
Fishing	6,900	6,975	6,400	7,300	7,800	9,100
Hiking and riding	1,000	1,100	800	750	750	750
Canoeing	100	100	50	50	...	...
Organization camping	321	295	457	450	...	...
General enjoyment	7,500	7,000	6,800	5,700	6,700	6,700
Gathering forest products	1,900	2,450	1,600	1,600	1,600	1,800
Scientific hobbies	550	600	700	800	600	700
Cross country travel	...	...	...	150	350	350
Motor vehicle trail travel	...	...	...	200	400	400
Other	950	1,142	1,315	1,250	1,250	1,350
Total	55,286	59,147	54,522	54,250	53,000	54,950

U. S. Forest Service data adjusted to basin by field party.

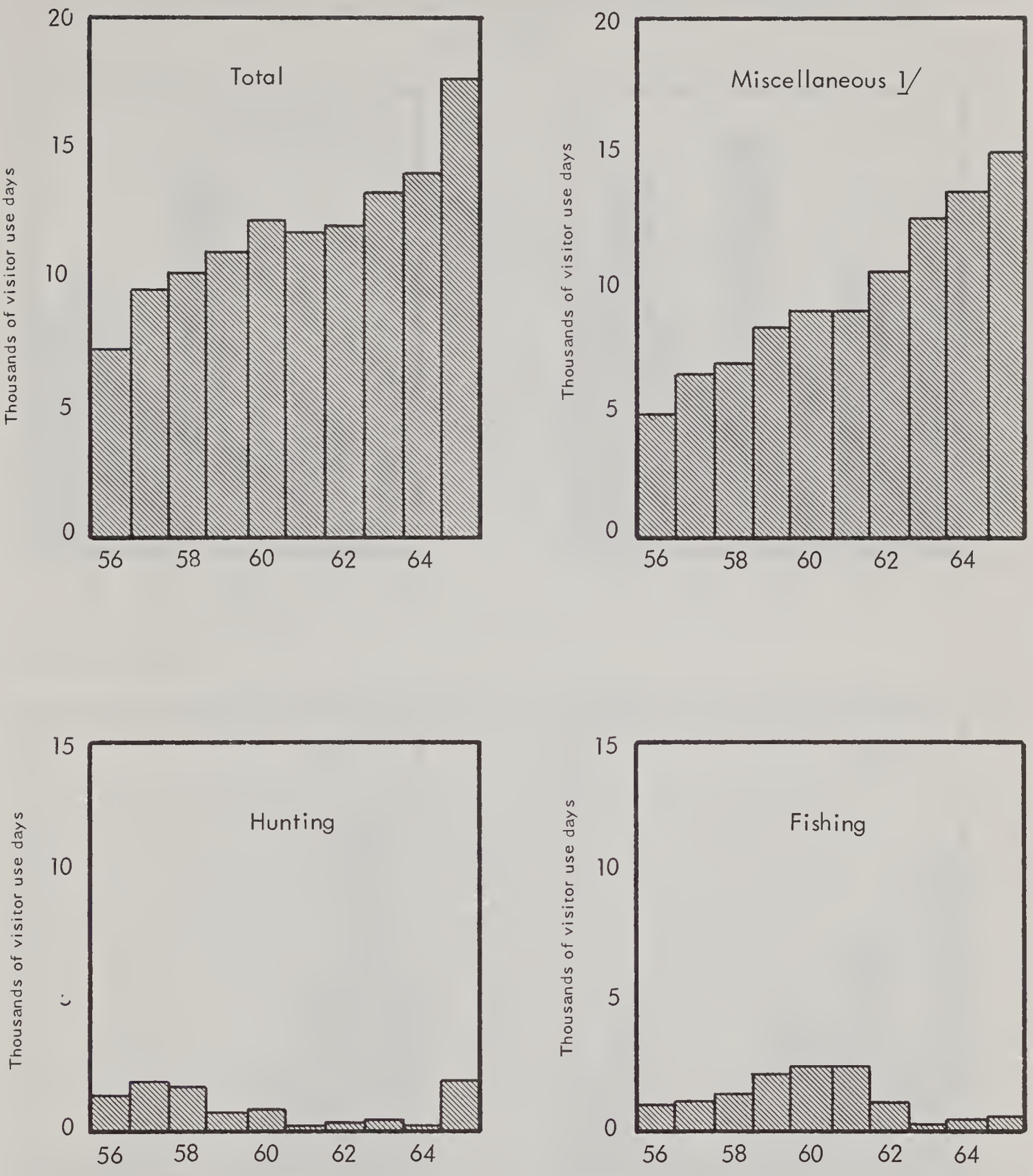
Very little data is available on the number of man-days recreation provided by private lands, but hunting and rock hounding are very predominant on these areas.

Recreation-use figures for the wildlife refuges in the basin have shown a steady increase over the past 10 years (figures 10 and 11).

The Malheur Lake Drainage Basin has been, and still is, relatively remote from major population centers. Increasing populations in the northwest and in eastern Oregon, improved highways, and more leisure time will stimulate changes in recreational uses of the basin. Many areas of the basin are presently undeveloped but plans are being made to open up these areas. Increasing numbers of people are attracted to the southern part of the basin because it is not developed and offers the opportunity to "get away" from it all and return to nature. This activity will show an upward trend as the coastal areas of Oregon and adjacent states become more urbanized.

Hunting, fishing, rock hounding, and nature study, the most popular recreational activities in the basin, will probably continue to show the greatest increases.

RECREATIONAL USE, MALHEUR NATIONAL WILDLIFE REFUGE, 1956-1965

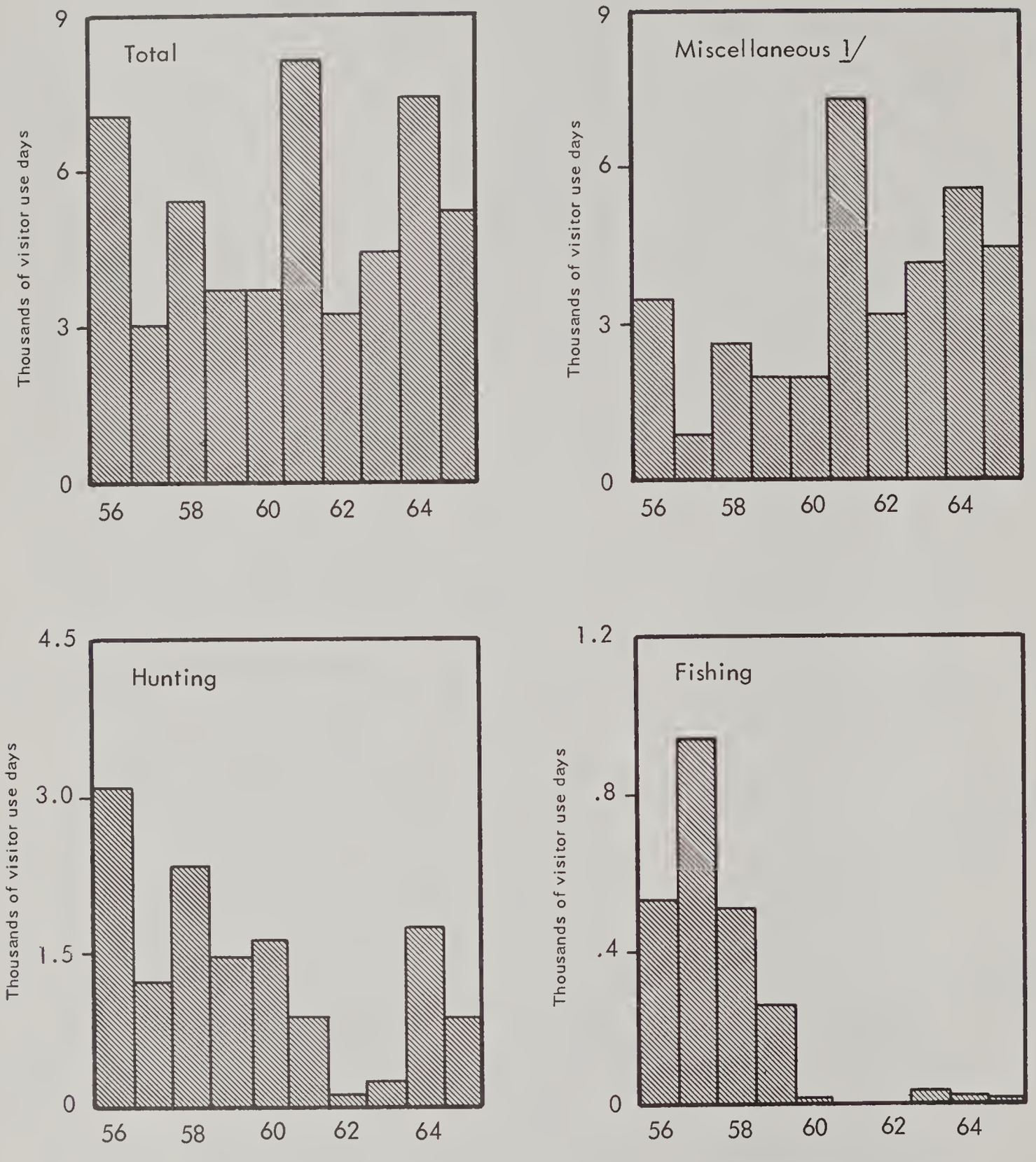


1/ Includes nature study, driving and sightseeing, picnicking, and camping.

Data from Bureau of Sport Fisheries and Wildlife.

FIGURE 10

RECREATIONAL USE, HART MOUNTAIN NATIONAL ANTELOPE REFUGE, 1956-1965



1/ Includes nature study, driving and sightseeing, picnicking, and camping.
Data from Bureau of Sport Fisheries and Wildlife

FIGURE 11

WATER AND RELATED LAND RESOURCE PROBLEMS

INTRODUCTION

The principal problems in the Malheur Lake Drainage Basin to be discussed in this report are flood protection, erosion control, and water use and conservation. These problems are extremely important to consider in connection with improved land use, more beneficial use of the available water resources and improved management and opportunities for agriculture, range, and forestry. The individual problems will be discussed for all land uses under the specific subject headings.

LAND RESOURCE PROBLEMS

Erosion Damage

Damage to land from erosion and scour is significant but extremely difficult to evaluate and is probably inadequately appraised.

Most of the arable land is protected from rill and sheet erosion by perennial, sod-forming crops; however, when these crops are plowed for re-establishment or replacement by annual crops, care should be taken to protect the soil against erosion. Estimates show that about 650,000 acres of arable or potentially arable land have a predominant problem of erosion. Erosion, a more serious problem on rangeland than on cropland, is primarily due to low precipitation which makes it difficult to maintain adequate cover for protection. Overgrazing on the steeper land also is a serious problem, because the land is more vulnerable to both water and wind erosion.

Considerable land is lost through streambank erosion (photo 27). Damage is usually more severe in the high velocity portions of the streams, although a lesser problem exists in the slow, meandering portions of the streams.

Gully erosion is prevalent in the steeper upper reaches of the watersheds of the basin where deep soils exist (photo 28).

Sediment Damage

Sediment damage results from flooding. Much of the land that floods is along the lower reaches of the streams where the channel gradients are flat

Photo 27.--The upper Silver Creek in the Ochoco National Forest is eroding the streambank. SCS PHOTO 7-1985-6

Photo 28.--Gully erosion is still active on Hay Creek in the Malheur National Forest. SCS PHOTO 7-2011-8

and the banks are not well defined. When heavy runoff reaches these areas, the water overflows the channels and floods many of the fields where it drops its sediment and debris. Sediment deposition in irrigation structures, canals, road culverts, and reservoirs can be damaging as well as expensive to restore to usable condition. Deposits of sediment and debris on cropland, pasture and hay land are costly to clean up and reduce yields. Although there has been sediment and debris deposition in the urban and municipal areas of the basin, most of the sediment damage is in the rural areas.

Floodwater Damage

Floodwater problems are a result of both natural factors and human management of land. Through intensive use of the land and other natural resources, man has greatly intensified flooding problems in some areas while he has protected other areas.

The main source of floodwater in this basin is spring snowmelt although other causes such as rainfall augmented by snowmelt and thunderstorms result in occasional flooding. Floods originating principally from snowmelt are most likely to occur in March, April, and May. Flooding also results from early spring rains or snowmelt if the ground is frozen. Agricultural land along the main rivers and tributary streams is subject to overflow during high runoff periods (photo 29).

Photo 29.--Hayland in Harney County is flooded by spring runoff.

SCS PHOTO 7-1992-1

Damage would be more widespread and severe if crops other than hay and pasture were produced. Approximately 50,000 acres of land are flooded annually to varying degrees; the largest portion of this acreage is cropland. Crop damage is minimized because a large percentage of the land is in sod-forming crops.

Man-made structures and improvements are often damaged by flooding. Some towns and farmsteads have suffered damage from floods. Many county roads and some highways are damaged by undercutting, sedimentation, and destruction of bridges and culverts due to flooding.

According to a study made by the Corps of Engineers on the Silvies River in 1957, major floods have entered the city of Burns and flooded a residential area containing about 50 homes lying between the business section and Silvies River. This report also states that the average annual flood damages for the lower Silvies River are estimated to be about $154,000 on the basis of development and price levels of 1957. Of this amount, about 83 percent is agricultural, 10 percent urban, and 7 percent other damage.

Impaired Drainage

With the present system of wild-flood irrigation, drainage is a critical problem in portions of the basin. The elimination of prolonged flooding is frequently a prerequisite for effective drainage. In most cases, this can be classified as flood control; however, surface drainage is required in some instances where the land is broad, flat valleys where the channel gradient is fairly flat.

Estimates show that approximately 121,200 acres or about one-third of the readily irrigable soils (land capability classes I through IV) have a major wetness problem. Wet soils have either been drained to a degree necessary for the crop being grown or are used for purposes that do not require drainage. An estimated 75,300 acres, or about 62 percent of the excessively wet soils, need to be drained under present use.

Seepage water from higher land is also a common drainage problem although not critical in this basin.

Range and Forest Fires

The wildfire season in the basin extends from June to October, reaching its peak in August. It is characterized by a near absence of precipitation, low day-time humidity, high temperatures, and strong winds. Lightning is the predominant cause of fires but man-caused fires are a menace and effort is necessary among the public agencies to prevent and to reduce their occurrence. Because of ground fuels--light, flashy grass and litter--in forested areas, prompt initial suppression action is important if large fires are to be avoided.

Access via roads and trails is usually adequate in the more hazardous, low elevation areas; however, in some parts of the upper watersheds, which

are relatively inaccessible, the travel time to the fire is so great that smokejumpers are often needed.

In the arid, semi-desert, southern portion of the basin, range fires in native cover are not a problem because fuels are so scattered that a fire cannot spread quickly. Crested wheatgrass seedings and native perennial grasses do not present the fire hazard experienced with native annual grasses such as cheatgrass.

The use of modern fire-fighting techniques and equipment such as smokejumpers, helicopters, and chemical retardants delivered by air tankers has reduced the number of acres burned in recent years.

Figure 12 shows the fire occurrence on National Forest lands within the basin from 1961 to 1965. The Burns District of the Bureau of Land Management reported 47 fires in 1964 with 8,347 acres being burned over. In 1965, it reported 40 fires with only 432 acres being burned.

WATER PROBLEMS

Phreatophytes

Phreatophytes are water-loving plants that grow mainly along stream courses where they extend their roots into the water table or the capillary fringe overlying it. They form a definite group of plants but do not belong to any specific family. Their common characteristic is heavy use of water.

In the Malheur Lake Drainage Basin, these plants, primarily willows, grow along most live streams. They are common along the Silvies River from Seneca to the Malheur National Wildlife Refuge south of Burns.

Some people believe that the high consumption of limited water supplies by phreatophytes is a serious problem in the West.

The effect of phreatophytes within the basin has not been studied thoroughly. In many cases, phreatophytes are considered beneficial because they offer protection for livestock during winter storms and they stabilize the streambanks.

Water Shortages

Agricultural Crops. A water shortage exists in the Malheur Lake Drainage Basin for the total irrigation season. Estimates show that 205,300 acres or 90 percent of the total irrigated acreage are short of water during some portion of the irrigation season. A monthly breakdown for the basin shows that 4,900 acres are short by May 1; 166,400 acres are short by June 1; 184,800 acres are short by July 1; and 205,300 acres are short by August 1. Storage facilities which would greatly increase the water available for agricultural crops are extremely inadequate to store the spring flood flows. Even with stored spring snowmelt and floodwaters, there is not sufficient water in the basin to supply the present needs for irrigation. Table 34 shows the irrigation water rights and the irrigated acreage for the basin.

FIRE OCCURRENCE ON NATIONAL FOREST LAND,
MALHEUR LAKE DRAINAGE BASIN, OREGON,
1961-1965

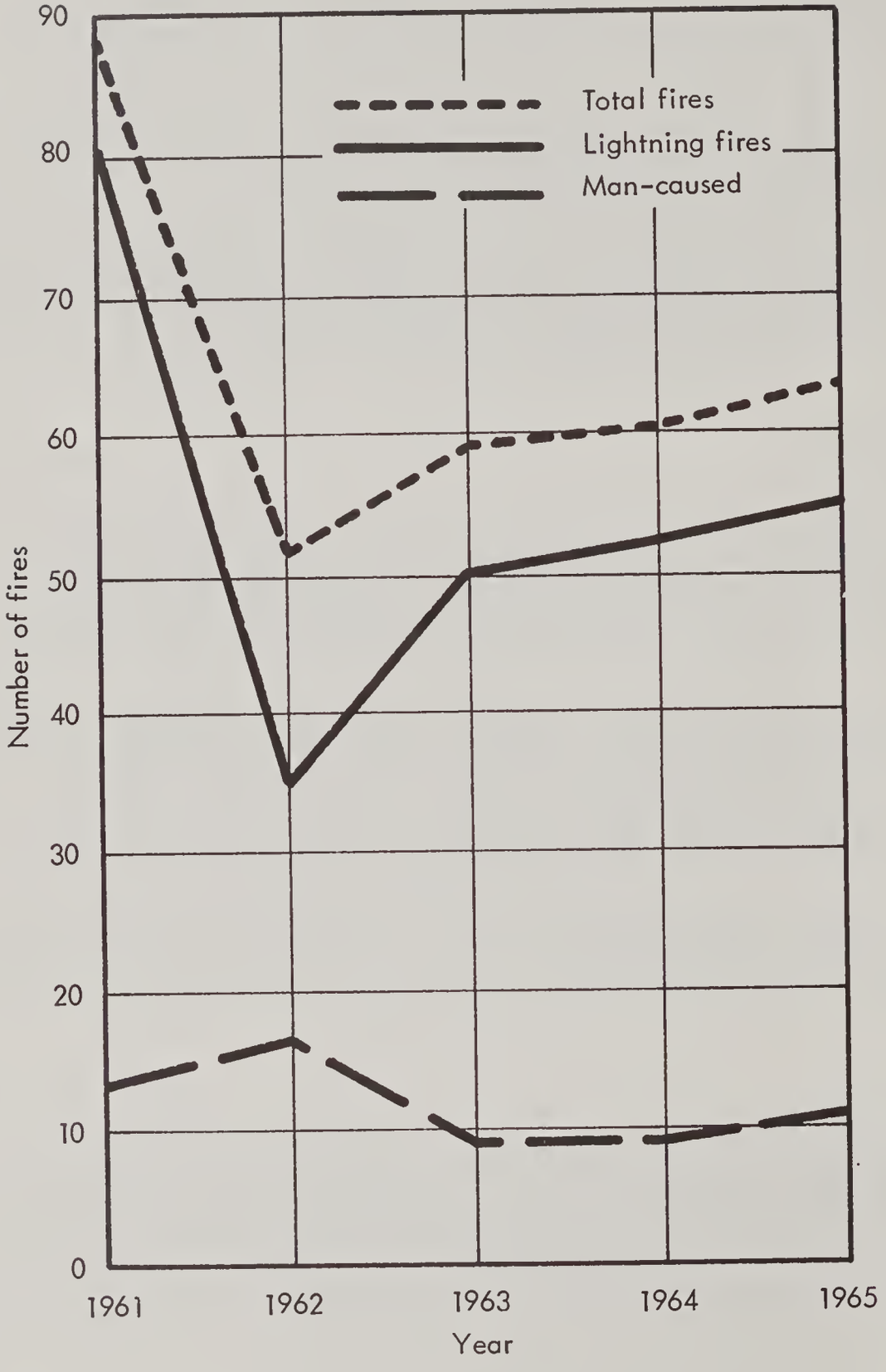


FIGURE 12

Table 34.--Irrigation water rights and irrigated acreage by water source by subbasin, Malheur Lake Drainage Basin

Subbasin	Water rights 1/			Irrigated acreage 2/ Water Source			
				Surface			
	Surface	Ground water	Total	Stream-flow	Reservoir	Ground water	Total
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Silvies	146,173	8,233	154,406	122,700	400	1,700	124,800
Silver Creek	36,650	152	36,802	23,900	2,100	100	26,100
Donner und Blitzen	52,298	76	52,374	39,600	1,400	100	41,100
Alvord-Catlow	40,681	7,292	47,973	24,400	3,600	6,700	34,700
Total basin	275,802	15,753	291,555	210,600	7,500	8,600	226,700

1/ Data furnished by Oregon State Engineer.
2/ Data gathered by USDA River Basin Survey Staff.

Assuming two acre feet per acre as the duty of water, 286,250 acres of land could be irrigated with the average annual natural yield of 572,500 acre feet. Because this statement completely ignores losses and inefficiences, a water shortage exists even if the best water management practices were employed in the basin.

Livestock and Rural Domestic. Water supply for livestock and rural domestic uses comes from wells, springs, creeks, and streams, or lakes. The majority of the water for these uses is provided from wells. In general, the quantity is adequate but the quality is inadequate. Some of the quality problems are hardness, rust, and contamination, the latter is a greater problem where shallow wells are being used.

Nonagricultural. At the present time, there is adequate water for both municipal and industrial needs. The source of water for these needs is ground water. It is anticipated that an additional source of water needs to be developed in the near future for municipal needs. Water-related recreational facilities are limited in the Malheur Lake Drainage Basin at present. Additional developments are needed but it is questionable whether or not this is a problem.

Pollution

Water pollution is not a serious problem in the basin. Two locations exist where septic tank discharges are delivered to a natural stream or an irrigation ditch. There is also a problem at times from suspended sediment in the streams and rivers. Excessive stream siltation has created detrimental effects for fish and wildlife.

PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

INTRODUCTION

A great need exists for water and related land resource development in the basin. The need to conserve the available water and to make more beneficial use of this water exists. When this need is realized, many of the problems that presently result in damage and economic loss will be modified or solved.

LAND DEVELOPMENT NEEDS

Watershed Protection and Management

Whether the watershed is logged, grazed, or cropped, careful and proper management practices are very important to the water supply from that watershed. Improper management of these resources results in flooding, erosion, and sedimentation problems. Improvement in the condition of watersheds in the basin is presently needed and, as the intensity of uses increases in the future, management will be of greater importance. The specific needs to accomplish watershed protection and management will be discussed in the following paragraphs.

Flood Protection

Flood protection is needed in several areas of the basin but the most critical area is the lower reaches of the Silvies River from Five-Mile Dam to Malheur Lake. The channel has inadequate capacity, flat gradient, and, in some cases, an almost undefined course. Upstream storage together with channel improvement would alleviate the flooding. The Corps of Engineers in its 1957 Survey Report on the Silvies River estimated average annual benefits from flood protection at $148,300.

Needs exist in other areas of the basin but not on as large a scale as in the Silvies. Storage facilities and channel clearance and alignment are needs for preventing localized flooding in the basin.

Land Stabilization and Sediment Control

Protection and stabilization of the watershed soils are primary problems in a large portion of the basin. Low annual rainfall results in sparse

vegetation on the upper reaches of some watersheds causing increased erosion during heavy spring snowmelt or severe rainstorms.

Approximately half of the rangeland watersheds are in poor condition with deficient vegetative cover and considerable accelerated erosion. Rehabilitation of the rangeland is essential to realize maximum benefits from the land and to minimize downstream flood and sediment damage. Some programs and practices that should be initiated or continued are:

1. Large scale land treatment programs including erosion control measures, removal of brush species which occupy the site but furnish little forage for soil protection, and revegetation with soil-protecting, drought-resistant grasses.
2. Reseeding and water spreading to provide additional forage on the better rangeland.
3. Control of timing and intensity of livestock grazing through (a) development of additional water supplies for consumption by livestock; (b) construction of fences to control livestock movement; (c) salt distribution and management of livestock to obtain more uniform consumption of forage.
4. Rapid control of forest and range fires and prompt revegetation of burned areas to protect the forage crop and watershed cover.
5. Study availability of and need for additional winter game range and control big game numbers in balance with available winter range.

Rangeland areas of steep topography, naturally sparse vegetation, or extremely erodible soils should be left in a relatively undisturbed condition. Grazing should never deplete the ground cover to a point where protection of the watershed and maintenance of desirable vegetation are impaired.

Drainage Improvement

The principal needs for improved drainage are in the Malheur and Harney Lakes area and the upper Silvies River Valley. These needs include improved surface drainage to permit farming operations earlier in the season; open drain ditches to lower the water table; improved and additional outlets; construction of sumps and pumping plants; and tile drains to lower the water table as well as to intercept seepage waters from higher lands. An estimated 75,300 acres of excessively wet arable soils in the basin require one or more of the aforementioned needs. Improved forage and increased yield would occur if these needs were resolved; however, more study is required to determine if the short- and long-run economic benefits would exceed the costs of providing drainage.

WATER DEVELOPMENT NEEDS

Irrigation

Irrigation is a major consumptive use of water in the basin. Existing

development has been, in general, an individual effort although some systems have been developed by small groups. Where surface water is to be used for irrigation, future development is going to require larger groups and project action. Developing ground water for increased irrigation can be accomplished best by individual efforts.

Additional and enlarged reservoirs for storage of spring flood-flows are needed to reduce damage from flooding and to make more beneficial use of the limited water supply in the basin. Irrigation water management is essential if maximum yields are to be realized with existing water supplies. On some soils, this could mean increased use of sprinkler systems (photo 30).

Photo 30.--Sprinkler irrigation is being used on alfalfa fields near Burns, Oregon. SCS PHOTO 7-1992-7

Other practices needed to conserve water and to get more beneficial use of it include: land leveling; pipelines; ditch linings; and irrigation structures. The need for more factual information on water-holding capacities and intake rates of soils would facilitate more efficient use of the available water.

If the ultimate physical potential for irrigation in the Malheur Lake Drainage Basin is to be achieved, supplemental water will have to be imported from outside the basin.

Prior to any construction of irrigation works, the economic aspects should be studied to determine economic feasibility. In the Malheur Lake Drainage Basin, a thorough economic study of proposed irrigation developments

would be especially desirable because of the nature of agriculture in this area. Livestock production is the most important agricultural endeavor and is projected to increase significantly by 1980. Hay production, which helps to support the livestock enterprise, is also projected to increase. The comparative advantage of livestock production--resulting from availability of low-cost forage from rangeland, irrigated pasture, and hayland--makes it appear that livestock ranching will remain the dominant agricultural enterprise in the foreseeable future.

Hay yields have been relatively low in Harney County but, at the same time, irrigation costs have also been low because of the type of irrigation used. Wild-flood irrigation is common which generally costs less than irrigation methods used for higher value crops. In contrast to future irrigation developments which will require group and project action, past irrigation systems have generally been constructed by individual farmers, often resulting in reduced costs.

Further irrigation development will undoubtedly increase yields and production but the costs of irrigating will also increase. Irrigation costs must be less than the value of increased production or farmers will not benefit.

In a previous section (Agricultural Projections), high value crops such as sugar beets, potatoes, and vegetables were not projected to become important in the future. The comparative advantage of livestock production, the lack of markets for higher value crops, and the short growing seasons are factors which will tend to limit future crop production to hay and small grains. Thus, prior to any future irrigation developments, it would seem highly desirable to study carefully the economic consequences of proposed projects to insure that additional benefits would exceed additional irrigation costs.

Only one study is known to have been conducted along these lines in the Malheur Lake Drainage Basin. This study was conducted by the Bureau of Reclamation and the Corps of Engineers on the Silvies River. The 1957 Survey Report estimated an average annual benefit cost ratio of 1.40 to 1, which would indicate that the project studied was economically feasible. 1/ Additional study, using recent production data and current prices, would be desirable prior to starting any construction. The project was not recommended in 1957 because of complications arising from unresolved water rights problems.

Since irrigation is but one of many alternative investment opportunities, efficient allocation of resources will result only if returns from the investment are comparable with returns from other possible investments. Inputs such as fertilizer, improved pasture, and drainage are some of the possible alternative investments. Opportunities for improving efficiency through combining irrigation distribution works and reallocating water to the more productive soils are some other possibilities that could be investigated. Although changes such as these might involve modification of existing institutions, the resultant increase in efficiency may be judged worthy of such changes.

1/ Survey Report on Silvies River and Tributaries, Oregon, U. S. Army Engineer District, Portland, Oregon, November 8, 1957, p. 46. Average annual irrigation benefits totaled $260,400 and average annual flood control benefits totaled $148,300 (p. 57). Average annual costs totaled $292,000.

Rural Domestic and Livestock Water Supply

The primary need in this area is for additional stockwater developments on the rangeland. Several hundred stockwater developments presently exist but, in some areas, better range management would be possible with additional stockwater locations.

The rural domestic water supply is primarily provided for by wells. The quantity appears to be adequate but there is a definite need for improved quality.

Municipal and Industrial Water Supply

Ground water adequately supplies the municipal and industrial water needs at present. It is anticipated that an additional source of water will be needed to develop municipal needs in the near future. The source of this water could be either from ground water or from reservoir storage in connection with a multi-purpose project.

Recreation

The following statement is taken from the multiple-use plan of the Snow Mountain Ranger District, Ochoco National Forest: "One of the crying recreation needs in Harney County is for more fishing water. Delintment Lake is the only lake in a forested setting within 2 hours driving time from Burns. East Lake on the Deschutes (National Forest) and Magone Lake on the Malheur (National Forest) are the next closest lakes from a driving time standpoint. Every opportunity to develop additional lakes needs to be explored."

In recent years, the public has shown through pattern-of-use studies conducted by state and federal agencies that there is a marked preference for activities that are water orientated such as swimming, fishing, boating, and water skiing. Data also show that while camping or picnicking recreationists prefer to be near water. A 34 percent increase in the number of pleasure boats in Harney County, an increase from 123 in 1962 to 165 in 1966, supports the foregoing statements.

Several lakes and reservoirs popular for fishing and other water activities, such as Chickahominy Reservoir shown in photo 31, are in need of improved sanitary facilities and potable water supplies. Some areas are totally lacking improvements of any kind.

Fish and Wildlife

The greatest water need for wildlife is to provide additional sources in the semi-arid southern portion of the basin. Limited supplies of drinking water keep big game and upland game from inhabiting many areas. Low summer flows in streams and heavy drawdown in reservoirs allow water temperatures to rise to a point where they become critical for trout. The establishment of minimum drawdown regulations for reservoirs would help alleviate this problem

Photo 31.--This popular fishing spot on Chickahominy Reservoir is in need of development. SCS

but, since most of the reservoirs are in private ownership, this may be difficult to achieve.

Water Quality Control

There is a need for water quality control in this basin. Excessive suspended sediments in the streams has created problems for fish and wildlife. In the area of Seneca and Frenchglen, septic tanks discharges are delivered into a natural stream and an irrigation ditch. A minimum flow is needed for quality control and, with present practices, this is not possible. There is a great need for adequate storage facilities in this basin.

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

INTRODUCTION

At the present time, there are no active water and related land resource projects in the Malheur Lake Drainage Basin. Several federal and state programs are making financial and technical contributions for the water and related land problems and needs. These various programs and their contributions are described briefly in the following paragraphs.

FARMER-ORIENTED PROGRAMS

Soil and Water Conservation District Activities

Approximately 861,500 acres or only 13.5 percent of the basin lie within the bounds of Soil and Water Conservation Districts. These areas are in the Grant Soil and Water Conservation District in Grant County and the Lakeview Soil and Water Conservation District and the Fort Rock-Silver Lake Soil and Water Conservation District in Lake County. Technical assistance to these self-administered districts is furnished by the Soil Conservation Service.

The technical assistance provided to local landowners through the Soil and Water Conservation Districts includes:

1. Soil surveys provide an inventory of soil resources. They show the capability of land and serve as a guide in planning needed conservation practices.
2. Assistance is available to individual landowners to develop conservation farm and ranch plans that delineate the particular needs on their own land and outline an action program for the conservation of soil and water that is tailored to their operations and resources.
3. Technical assistance is available in planning and applying conservation practices in the fields of: engineering, agronomy, geology, woodland, range, soils, hydrology, biology, plant materials, and water forecasting. This involves practices such as conservation cropping systems, crop residue use, pasture improvement and management, range improvement and management, pond construction, woodland protection and management, waterway development, farm drainage including tile and open

ditch, land grading and smoothing, irrigation system design, proper irrigation water use and similar practices.

4. Assistance is available to groups of landowners to plan and apply drainage and irrigation measures that cover more than one ownership.

Agricultural Stabilization and Conservation Service

This agency at the state and local level administers the Agricultural Conservation Program which is one of the active programs concerned with conservation of soil and water resources.

The Agricultural Conservation Program is designed to provide cost-sharing with farmers and ranchers to partly defray the cost of carrying out essential conservation practices. Cost-sharing is provided only on those practices that are satisfactorily performed.

Practices for which cost-sharing is available in this basin are as follows: establishment of permanent protective cover for soil protection and improvement of structure, permeability, and water-holding capacity of the soils; establishment of trees and timber stand improvement on farmland; improvement of meadows; reseeding of rangeland; deferred grazing on rangeland; fencing of grazing land for protection of vegetative cover; control of competitive shrubs on rangeland; provision of livestock water by means of wells, springs, seeps, dams, pits, ponds, and pipelines; establishment of sod waterways; construction of diversion terraces, ditches, or dikes; construction of erosion control structures; streambank and shore protection; open and closed drains; shaping and land leveling; reorganization or irrigation systems for conservation of water or erosion control; construction of spreader ditches and stock trails; establishment of vegetative cover to provide wildlife food plots and habitat; development or restoration of shallow water areas for wildlife; and construction of ponds or dams for wildlife.

Cooperative Extension Service

The Extension Service serves as liaison between research agencies; educational institutions; local, federal, and state agencies; landowners and other individuals. It makes information and educational materials on improved crop varieties and livestock, land management use and practices, soil testing, and other similar problems relating to livestock, crops, range, farm management, and economics available to all groups or individuals who are interested.

County agents in the Malheur Lake Drainage Basin are actively assisting in the identification and solutions of the water and related land resource problems and needs.

Farmers Home Administration

This agency makes loans, accompanied by technical management assistance, to owners or operators of farms and ranches, to rural residents, to community

groups, to public bodies, and to nonprofit organizations. Loans are made only when credit from other sources is not available at reasonable rates and terms.

The purposes of individual loans are: to buy farms or land to enlarge farms; to construct, repair or purchase buildings including homes; to improve land, develop water, forestry, and fish farming resources; to establish recreational enterprises; to develop, conserve, and make better use of soil and water resources; to purchase livestock and equipment; to build or to finance the purchase of homes; to assist farmers who suffer from a natural disaster such as hail, flood, or drought.

The purposes of group (including public bodies and nonprofit organizations) loans are to develop domestic water supply systems and waste disposal systems; to develop irrigation, drainage, and other soil and water conservation facilities; to develop community recreational facilities; to develop grazing associations including the purchase and improvement of land; to develop forestry associations; to construct migrant labor camp facilities; and to construct rural rental housing facilities.

AGENCY-ORIENTED PROGRAMS

Cooperative State-Federal Forestry Programs

No active cooperative forestry project is in operation presently in the basin. Residents within the basin are eligible for assistance from the State Department of Forestry through the farm forestry program; however, there is little likelihood that much activity will develop. There are very few small woodland owners.

National Forest Development

The National Forests within the basin are continually carrying on development projects. All areas of resource management have recurring work programs, and funds are allocated for specialized projects on priority basis. Various range improvements such as spraying and reseeding, fencing, and water development, along with recreational developments, road and trail construction, and wildlife habitat improvements are the most common National Forest developments.

Other Lands

The Bureau of Land Management is involved in a continuing program of range improvements. Its vast range reseeding program is the most important but works in the areas of wildlife management and recreation are also noteworthy.

The U. S. Fish and Wildlife Service has a continuing program to improve wildlife habitat. It also is entering into the area of outdoor recreation.

State Developments for Recreation and Fish and Wildlife

There is no active program for developing additional recreation facilities within the basin by the State agencies. The State is involved in a continuing program of fish and wildlife management and has a stocking program for fish and upland game birds.

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

INTRODUCTION

Water is one of the factors that limit the development of the ultimate potential of this basin. In average years, the natural yield of the basin is not adequate to supply the present needs. Considerable study will be needed to determine the specific areas of the water and related land resource development potential of this basin. The following paragraphs will identify some of the overall basin potentials in a general way.

LAND RESOURCE DEVELOPMENT POTENTIAL

Availability of Land for Potential Development

Estimates based on a reconnaissance soil survey of the Malheur Lake Drainage Basin indicate that large tracts of land are composed of soils suitable for cropland and irrigated cropland. Approximately 1,424,000 acres are estimated to be suited for cropland and approximately 1,426,000 acres are judged to be suited for irrigation--the difference of 2,000 acres is presently cropland. The principle that it is necessary to irrigate land before it can be considered cropland applies in this basin and explains why the acreages of cropland and irrigated cropland are practically the same. In addition, large acreages of land capability class VIe have a possible potential for development as irrigated land. In order to irrigate such a large amount of land, water must be imported from outside the basin. A large portion of this land is owned by the Federal Government but other areas are owned by state, local, and private interests.

A recent estimate shows that, in the next ten years, 77,300 acres of land will be developed for irrigation. The source of the irrigation water will be either ground water or reservoir storage on the streams.

The estimates of the land available for potential development were also made for each of the subbasins. Land that could be developed for irrigated cropland by subbasins was as follows: Silvies Subbasin, 293,200 acres; Donner und Blitzen Subbasin, 48,200 acres; Silver Creek Subbasin, 155,800 acres; and Alvord-Catlow Subbasin, 929,000 acres. Land that could be developed for irrigated cropland in the next ten years by subbasin was as follows: Silvies Subbasin, 27,900 acres; Donner und Blitzen Subbasin, 900 acres; Silver Creek Subbasin, 3,100 acres; and Alvord-Catlow Subbasin, 45,400 acres.

Irrigation Systems

A physical potential for improving irrigation systems exists in several areas of the basin. This improvement could and should include the following: land leveling and shaping for better water management on the flatter slopes with soils suitable for flood irrigation; sprinkler systems on the areas with steeper slopes and with the coarser-textured soils; ditch lining and pipe lines to reduce loss of water in transmission and distribution systems; and increased information on water-holding capacities and intake rates of the irrigable soils.

Channel Improvements and Levees

Streams in several areas of the basin need channel and levee improvement. The Corps of Engineers, in its survey of the Silvies River, identified the reach of the river from Five-Mile Dam to Malheur Lake as being badly in need of channel improvement. The channel is obstructed by irrigation diversions and vegetation. Due to the flat gradient of the river along the lower reaches, debris deposits cause the river to meander and cut into fields. Channel capacity is also inadequate throughout this reach. Reaches of Silver Creek through the valley floor are inadequate and congested. Enlarging, aligning, and clearing these channel are great needs.

Some other problem areas exist but the problems are not as great as the ones mentioned. The degree of channel and levee improvement is dependent on the development or lack of development of upstream storage for flood protection. The need to align and clear these channels would not change greatly but the channel capacity could be considerably smaller with storage.

Drainage channels in specific areas adjacent to Malheur Lake could be improved.

Recreational Developments

A great potential for additional recreational developments lies in the northern forested portion of the basin. The Forest Service has several sites identified where lakes, such as Delintment Lake shown in photo 32, could be developed. Sites are also available on other public lands as well as on private land for recreational impoundments. In addition to sites which are developed primarily for recreational purposes, any potential impoundment within the basin would have possible recreational benefits.

There are several existing impoundments where full potential has not yet been developed. The addition of tables, toilets, and potable water supplies will make these areas much more desirable.

Water developments have the most potential because of the many different activities associated with water-orientated recreation.

Additional public hunting areas on the Malheur National Wildlife Refuge exist but they should be developed only in line with good management practices.

Photo 32.--Water impoundments in forested settings are popular recreation areas. SCS PHOTO 7-1985-5

Associated Land Treatment and Adjustments

Adjustments in land use and land treatment practices are needed in various areas of the basin. Practices of revegetating with soil-protecting, drought-resistant grasses; planting windbreaks; constructing terraces; and other practices are needed to reduce erosion from both water and wind. Rangeland areas of steep topography and extremely erodible soils should be left in an undisturbed natural condition and all other rangeland should be protected from overgrazing by livestock.

WATER RESOURCE DEVELOPMENT POTENTIAL

Impoundments

The opportunity for conservation of excessive, often damaging, runoff water in reservoirs for flood protection and subsequent use for irrigation, stockwater, industry, domestic, recreation, pollution abatement, and fish and wildlife has considerable potential in the Malheur Lake Drainage Basin.

Estimates from various portions of the basin indicate that the need exists for the development of both large and small reservoirs to insure maximum beneficial use of the water resource. Reservoir storage would also be

required to store imported water from outside the basin if maximum irrigation development is to be achieved. This storage should be developed when and where it is needed. There is a definite potential for more farm ponds and small reservoirs. In addition, many medium-sized reservoir sites of less than 25,000 acre-feet storage capacity exist and should be considered for water development for individual and group needs. Table 35 summarizes reconnaissance data assembled by the USDA staff on 23 sites that appear to have some merit and warrant future consideration. Various agencies or individuals conducted the investigation of these sites. The locations of these sites are shown on map 8. This is not a complete reconnaissance of potential reservoir sites in the basin and others should be investigated before a final decision is made in a specific watershed or area.

The total storage potential of the 23 sites exceeds 611,000 acre feet of water. The majority of these sites were not studied in sufficient detail to determine the storage allocation for the various purposes but all new reservoirs should be developed for economic multiple-purpose usage, with all possible uses and benefits from the stored water as well as the needs of the area being considered.

Ground Water Development

Studies indicate that ground water could be developed to a much greater extent in some areas of this basin. Presently, the most extensive use of ground water for irrigation is in the Alvord and Harney Valleys. Data on existing wells in the Alvord area indicate that substantial quantities of good quality ground water exist within economic pumping lifts. The Catlow Valley also has a potential ground water source based on available geologic and well data. In the Silvies River and Donner und Blitzen Subbasins, many irrigation wells are used to supplement water requirements during low streamflow periods.

Estimates show that an additional 28,000 acres of land could be irrigated from ground water in the Alvord area. Additional studies are needed throughout the Malheur Lake Drainage Basin to determine the ultimate potential of the ground water basins. These studies should show the recharge capabilities as well as the safe yield rate.

The U. S. Geological Survey made the following statement in a report on water prepared for the Bonneville Power Administration. 1/

"Proposed water management methods include artificial recharge, exchanges of ground water for surface water to allow more effective use of total water supply, and lowering of ground water tends to drain waterlogged land and salvage water now lost to evaporation.

"The benefits to be derived from management of the ground-water reservoirs in this area are potentially great. Full and effective management has been

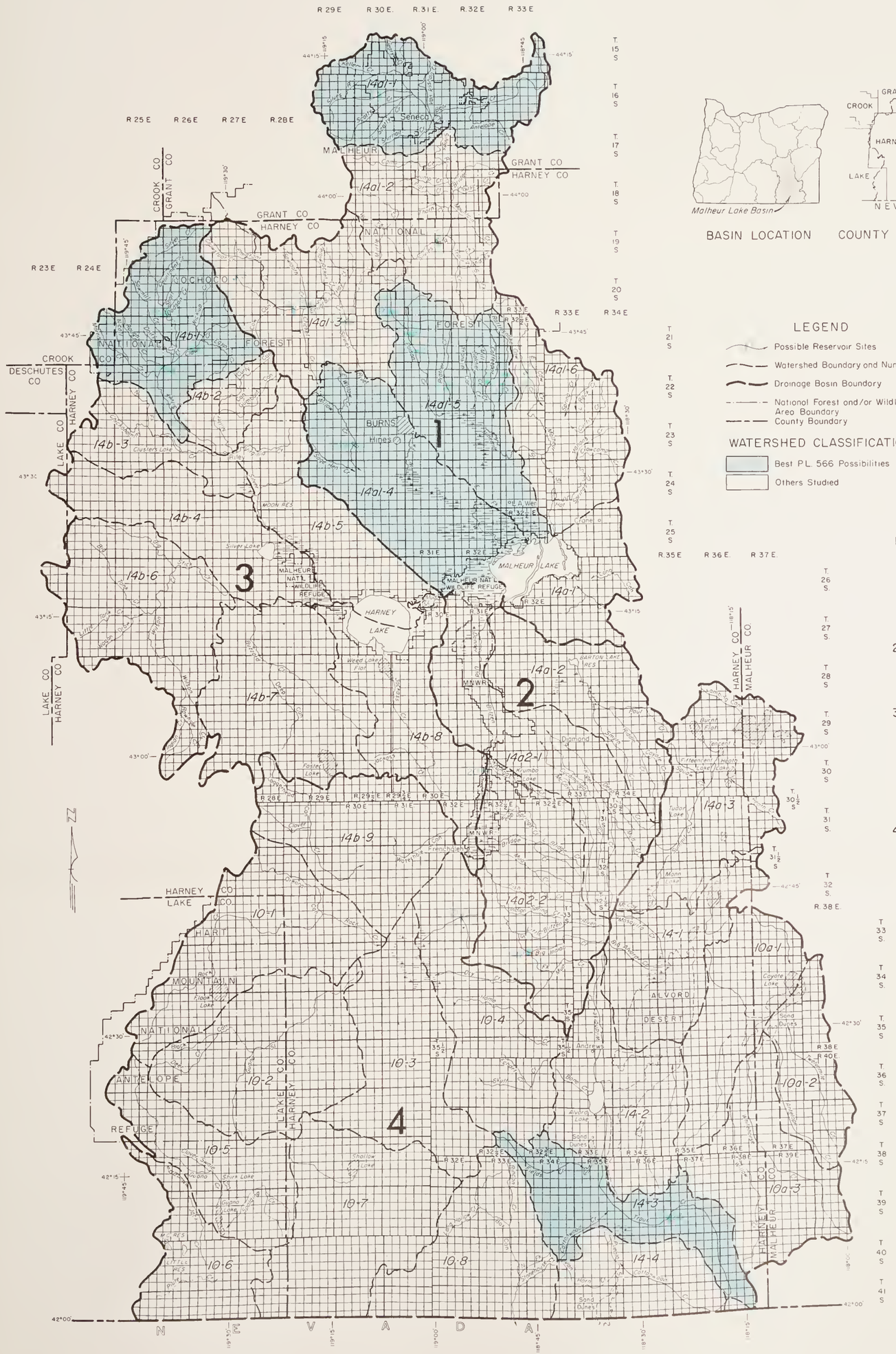
1/ Pacific Northwest Economic Base Study for Power Markets, Vol. 11, Part 10, Water, U. S. Department of the Interior, U. S. Geological Survey for the Bonneville Power Administration, 1965.

Table 35.--Reconnaissance data on some reservoir sites, Malheur Lake Drainage Basin, Oregon, 1966

Stream	Watershed index	Reservoir index	Location			Drainage area	Estimated annual yield	Storage capacity	Reservoir water depth	Reservoir surface area	Top length of embankment	Estimated embankment volume	Fill storage	Possibilities	Source
Name	Number	Number	Township	Range	Section	Acres	Ac. ft.	Ac. ft.	Feet	Acres	Feet	Cu. yds.	Cy/ac. ft. 1/	Uses 2/	Number 3/
Silvies Subbasin															
Jacks Creek	14a1-1	1	16S	30E	14	3,200	500	500	14	90	800	20,600	41	I,R	1
Silvies River	14a1-2	2	19S	31E	14	...	...	100,000	50	5,500	350	120,600	2	I,F,R,S	2
Bear Canyon Creek	14a1-3	3	20S	27E	3 & 10	4,700	900	1,300	40	80	500	94,600	73	R	1
Emigrant Creek	14a1-3	4	20S	28E	35	66,200	12,400	22,000	110	800	780	780,000	36	I,F,R	1
Emigrant Creek	14a1-3	5	20S	29E	30 & 31	115,200	21,600	40,000	80	1,500	400	208,300	5	I,F,R	1 & 2
Silvies River	14a1-3	6	21S	29E	2	576,000	109,800	190,000	142	3,200	1,700	1,300,000	7	I,F,R,S	3
Dry Creek	14a1-5	7	20S	30E	35	10,400	1,600	3,000	40	190	700	105,200	35	I,F,R	1
Poison Creek	14a1-5	8	21S	31E	18	20,400	3,200	6,000	100	150	700	488,900	81	I,F,R	1
Poison Creek	14a1-5	9	21S	31E	29	24,500	3,800	2,600	70	90	600	264,300	102	I,F,R	1
Prater Creek	14a1-5	10	22S	31E	24	9,300	900	2,500	60	105	500	215,900	86	I,F,R	1
Coffeepot Creek	14a1-5	11	22S	32E	14	8,300	1,400	5,700	110	130	1,150	1,227,800	215	I,F,R	1
Rattlesnake Creek	14a1-5	12	22S	32½E	8	9,600	1,600	1,600	60	70	400	127,000	79	I,F,R	1
Rattlesnake Creek	14a1-5	13	22S	32½E	18	9,700	1,700	31,300	180	440	1,500	3,694,400	118	I,F,R	1
Cow Creek	14a1-6	14	22S	32½E	10	16,600	2,600	8,300	80	260	1,300	833,300	100	I,F,R	1
Mortimer Canyon	14a1-6	15	22S	32½E	21	2,800	500	12,000	120	250	1,600	1,685,200	140	I,F,R	1
Willow Creek	14a1-4	19	23S	29E	25	23,700	3,700	4,500	80	140	300	150,000	34	I,F,R	1
Donner und Blitzen Subbasin															
Donner und Blitzen River	14a2-2	22	34S	32-3/4E	7	52,000	20,300	9,660	152	201	955	661,400	68	I,F,R	1
Silver Creek Subbasin															
Silver Creek	14b-1	16	20S	26E	31	46,300	9,300	2,000	35	140	300	64,000	33	R	1
Claw Creek	14b-1	17	21S	26E	22	48,000	7,500	7,500	70	...	...	...	...	I,F,R	1
Silver Creek	14b-1	18	22S	26E	6	166,400	33,500	40,000	72	1,300	360	170,000	5	I,F,R	2
Donner und Blitzen River	14b-8	20	30S	31E	15	...	...	120,000	32	9,000	1,000	...	...	I,F,R	2
Alvord-Catlow Subbasin															
Kuney Canyon	10-4	21	33S	32E	14 & 23	6,000	600	900	22	72	500	18,800	21	I,R	1
Trout Creek	14-3	23	39S	36E	24 & 25	44,200	9,000	10,000	...	...	...	...	...	I,F,R	1

1/ A comparative figure derived from dividing the estimated earth fill in cubic yards by the estimated water storage capacity in acre feet.
2/ I - irrigation, F - flood protection, R - recreation--fishing, hunting, and boating, S - water supply--industrial, municipal, and domestic.
3/ Source: 1 - Soil Conservation Service, 2 - Bureau of Reclamation, 3 - Corps of Engineers.

Based on a survey by the U. S. Department of Agriculture River Basin Survey Staff.



BASIN LOCATION COUNTY LOCATION

LEGEND

- Possible Reservoir Sites
- Watershed Boundary and Number
- Drainage Basin Boundary
- National Forest and/or Wildlife Area Boundary
- County Boundary

WATERSHED CLASSIFICATION

- Best P.L. 566 Possibilities
- Others Studied

1-SILVIES SUBBASIN

14a-1	Malheur Lake
14a1-1	Bear Valley
14a1-2	Silvies
14a1-3	Emigrant Creek
14a1-4	Willow Creek
14a1-5	Poison Creek
14a1-6	Hot Springs Creek

2-DONNER UND BLITZEN SUBBASIN

14a-2	Riddle Creek
14a2-1	Donner und Blitzen
14a2-2	Fish Lake

3-SILVER SUBBASIN

14b-1	Upper Silver Creek
14b-2	Miller Canyon
14b-3	Chickahominy Creek
14b-4	Silver Lake
14b-5	Lower silver Creek
14b-6	Wilson Creek
14b-7	Buzzard Creek
14b-8	Jackass Creek

4-ALVORD-CATLOW SUBBASIN

14-1	Alvord Ranch
14-2	Alvord Lake
14-3	Trout Creek
14-4	Pueblo Slough
14a-3	Mann, Tudor & Fifteencent Lakes
10a-1	Coyote Lake
10a-2	Twelvemile Creek
10a-3	Whitehorse Creek
10-1	Rock Creek
10-2	Guano Slough
10-3	Catlow Valley
10-4	Roaring Springs
10-5	Guano Lake
10-6	Jack Creek
10-7	Shallow Lake
10-8	Rincon Creek
14b-9	Clover Creek

MAP 8

INDEX MAP OF WATERSHED AREAS AND POSSIBLE RESERVOIR SITES

MALHEUR LAKE DRAINAGE BASIN

OREGON

JULY 1966

SCALE IN MILES

0 5 10 15

M7-S-18677-N

hampered by lack of adequate information on the complex pattern of groundwater recharge and flow, and by conflicts with established water rights."

Water Table Control

In the Harney and Malheur Lakes area of the basin, there is a potential for some water table control; however, the development of upstream storage for spring runoff and improved irrigation practices would lessen the need.

Fish and Wildlife Developments

The major wildlife-development projects undertaken to date within the Malheur Lake Drainage Basin have been conducted by the U. S. Fish and Wildlife Service on the Malheur National Wildlife Refuge and the Hart Mountain National Antelope Refuge.

Projects on the Malheur refuge have been directed toward extension and improvement of irrigation and drainage systems and establishment of productive waterfowl habitat. On the Hart Mountain area, efforts have been primarily directed toward habitat improvement and water developments. One such water development is shown in photo 33. These pits are excavated in dry lake beds because the water table is closer. Additional developments of this type will allow game to use areas which they normally would not inhabit during dry periods.

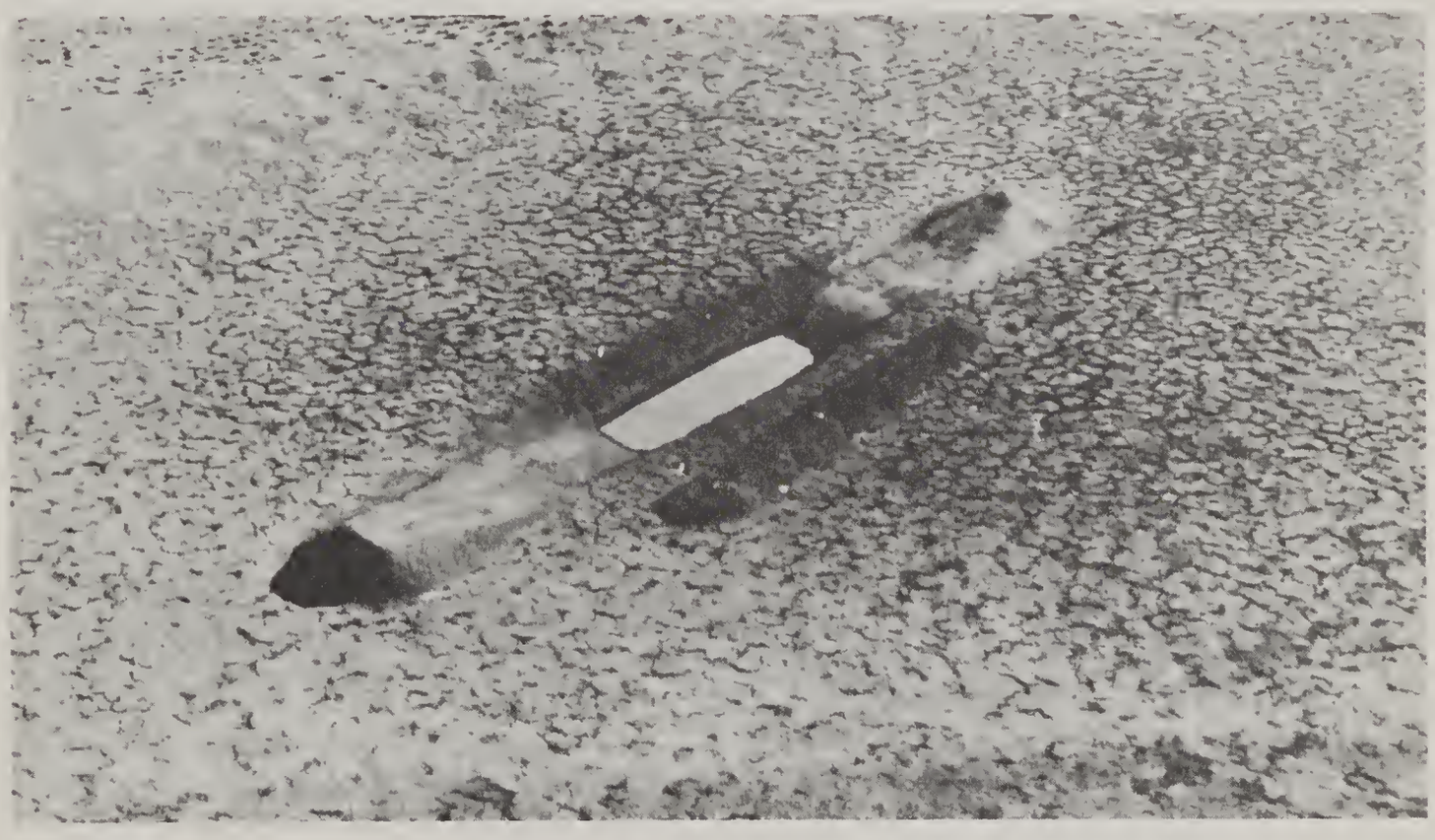


Photo 33.--This aerial photograph shows a waterhole developed in a dry lake bed. USF&WS

The greatest potential for additional fish and wildlife developments consists of impoundments which would provide additional fish habitat and drinking water for other wildlife.

OPPORTUNITIES FOR DEVELOPMENT OF USDA PROGRAMS

INTRODUCTION

Opportunities exist in many areas of the basin for development of water and related land resource potential. To develop this potential, solutions must be found for the problems and needs. These solutions sometimes involve a large group of people and require an organization to sponsor a project. Often, individuals or small groups of 3 or 4 landowners can work out the solutions to these problems and needs. In this section, the problems and needs are shown in tables 36A, 36B, 36C, 36D, and 37 as well as an explanation of how USDA programs can be applied in the solutions.

PROJECT POTENTIAL UNDER PUBLIC LAW 566

Description of P. L. 566

The Watershed Protection and Flood Prevention Act, Public Law 566, as amended, authorizes the Secretary of Agriculture to cooperate with local organizations in planning and carrying out works of improvements for flood prevention and/or for the conservation, development, utilization, and disposal of water in watershed or sub-watershed areas smaller than 250,000 acres. The Act provides for technical, financial, and credit assistance by the U. S. Department of Agriculture to landowners, operators, and other people living in small watersheds. Project-type action under the Act is intended to supplement other soil and water conservation programs and other programs for the development and flood protection of major river valleys.

Watershed Survey

The USDA River Basin Survey Staff made a survey of the potential for P. L. 566 work in the Malheur Lake Drainage Basin to provide information as a guide to long-range coordination and planning of future projects. The basin was divided into 35 tributary watershed areas which are designated by number and are delineated on map 8. A preliminary survey was made of each watershed gathering basic reconnaissance data on land and water use and water-related problems and summarizing it into tables 36A, 36B, 36C, and 36D.

Information in these tables is based upon estimates by local personnel of the Soil Conservation Service, County Extension Service, Forest Service, and Bureau of Land Management. Although the information is of a reconnaissance nature, it has been checked with data from U. S. Census of Agriculture and other sources. These data are used throughout much of this report.

Further detailed investigations would be necessary to determine engineering and economic feasibility of a given project. The Survey Staff's findings are presented in individual watershed reports found in the appendix and summarized in table 37 and shown on map 8.

Factors that Improve Feasibility

A field reconnaissance and an evaluation of available data for each watershed were made to obtain additional information on opportunities for P. L. 566 action based upon watershed area, physiographic conditions, land use, water yield and its seasonal distribution, and water-related problems and needs. Some of this material is limited because of lack of time for making more detailed field observation; however, many of the water-related problems of the Malheur Lake Drainage Basin could be reduced or solved under P. L. 566. Under existing conditions and laws, it appears that a solution of these problems may be practicable and feasible in several watersheds. The Survey Staff's findings indicate that watersheds with best possibilities for P. L. 566 action have a combination of some of the following conditions:

1. Part of the watershed lies at higher elevations and has relatively high water yields.
2. The watershed contains highly erodible soils that are subject to wind and/or water erosion.
3. The watershed has, or has potential for, a high degree of agricultural, residential, or urban development.
4. The watershed has a large area suitable for irrigation development and lacks water sources that can be developed by individual farmers, but has water sources that can be developed by group action.
5. The watershed has localized flooding and/or drainage problems which are related to floods of moderate duration.
6. The watershed contains one or more storage sites which appear feasible for multiple-purpose development.

Factors that Limit Feasibility

Some watersheds studied do not appear to be suitable for P. L. 566 action. These watersheds usually have a combination of some of the following conditions:

1. The watershed has high water yield and large peak flows which produce flooding that cannot be controlled by structures within the scope of P. L. 566.
2. Most of the watershed needs are for land treatment on forest and range lands where there is presently little economic incentive for land treatment measures.

Table 36A.--Reconnaissance data on small watersheds, Silvies and Donner und Blitzen Subbasins, Malheur Lake Drainage Basin, Oregon

Item	Unit	Silvies Subbasin								Donner und Blitzen Subbasin			
		14a-1 Malheur Lake	14a1-1 Bear Valley	14a1-2 Silvies	14a1-3 Emigrant Creek	14a1-4 Willow Creek	14a1-5 Poison Creek	14a1-6 Hot Springs Creek	Total	14a-2 Riddle Creek	14a2-1 Donner und Blitzen	14a2-2 Fish Lake	Total
Farms	Number	11	12	8	2	45	32	25	135	4	28	2	34
Watershed area	Acres	96,100	184,900	199,200	228,600	249,600	214,600	173,400	1,346,400	152,600	242,600	231,700	626,900
GENERAL LAND USE													
Forest land (grazed)	Acres	100	108,000	139,100	183,300	13,600	60,400	37,600	542,100	500	7,300	18,700	26,500
Cropland	do.	7,000	13,900	10,000	3,100	49,300	46,300	20,400	150,000	5,600	29,300	8,300	43,200
Irrigated 1/	do.	1,100	13,200	10,000	3,100	43,800	42,300	11,300	124,800	3,800	29,200	8,100	41,100
Nonirrigated	do.	5,900	700	0	0	5,500	4,000	9,100	25,200	1,800	100	200	2,100
Rangeland	do.	87,800	61,200	49,100	41,100	179,500	105,400	113,900	638,000	142,300	200,500	203,800	546,600
Other	do.	1,200	1,800	1,000	1,100	7,200	2,500	1,500	16,300	4,200	5,500	900	10,600
IRRIGATION													
Water source:													
Streamflow	Acres	400	13,200	9,800	2,700	43,800	42,200	10,600	122,700	2,600	29,200	7,800	39,600
Ground water	do.	700	0	100	400	0	0	500	1,700	100	0	0	100
Reservoir storage	do.	0	0	100	0	0	100	200	400	1,100	0	300	1,400
Method of application:													
Sprinkler	Acres	700	0	0	0	1,000	1,000	0	2,700	0	0	0	0
Gravity	do.	400	13,200	10,000	3,100	42,800	41,300	11,300	122,100	3,800	29,200	8,100	41,100
Water rights:													
Surface water	Acres	323	9,750	7,100	2,800	51,500	49,500	26,200	147,173	1,572	39,810	10,916	52,298
Ground water	do.	2,085	0	0	0	2,410	2,797	941	8,233	0	76	0	76
Water shortage	do.	400	13,200	9,800	2,700	43,800	42,200	10,600	122,700	3,700	29,200	300	33,200
POTENTIAL													
Cropland (suitable soils)	Acres	30,000	33,400	18,000	800	76,000	60,000	75,000	293,200	0	40,000	6,400	46,400
Irrigable land (suitable soils)	do.	30,000	33,400	18,000	800	76,000	60,000	75,000	293,200	1,800	40,000	6,400	48,200
Possible to be developed by 1977	do.	300	2,800	4,000	800	10,000	5,000	5,000	27,900	200	300	200	900
Water source:													
Streamflow	Acres	0	0	0	0	0	0	0	0	0	0	0	0
Ground water	do.	0	0	0	0	0	0	0	0	0	0	0	0
Reservoir storage	do.	30,000	33,400	18,000	800	76,000	60,000	75,000	293,200	1,800	40,000	6,400	48,200
DRAINAGE													
Arable land needing drainage	Acres	800	6,000	6,200	400	20,000	8,000	2,000	43,400	1,200	12,000	6,300	19,500
FLOODING													
Area	Acres	200	6,500	7,000	300	10,000	3,000	10,900	37,900	800	2,000	0	2,800
STORAGE													
Ponds (existing)	Number	1	10	16	27	50	15	20	139	22	50	100	172
Reservoirs (existing)	do.	0	1	1	1	1	1	2	7	2	0	1	3
Reservoir sites studied	do.	0	2	1	4	1	6	2	16	0	0	1	1

1/ Land developed for irrigation.

Based on data collected by the USDA Oregon River Basin Survey Staff. Estimates provided by local personnel of the ASCS, Forest Service, Soil Conservation Service, BLM, Harney County Extension Service, and Harney County Assessor.

Table 36B.--Reconnaissance data on small watersheds, Silver Creek Subbasin, Malheur Lake Drainage Basin, Oregon

Item	Unit	14b-1 Upper Silver Creek	14b-2 Miller Canyon	14b-3 Chickahominy Creek	14b-4 Silver Lake	14b-5 Lower Silver Creek	14b-6 Wilson Creek	14b-7 Buzzard Creek	14b-8 Jackass Creek	Total
Farms	Number	5	5	0	2	5	2	0	6	25
Watershed area	Acres	184,900	58,700	88,900	172,500	161,900	236,900	232,200	170,700	1,306,700
GENERAL LAND USE										
Forest land (grazed)	Acres	154,000	22,000	1,300	2,400	12,400	2,100	100	100	194,400
Cropland	do.	4,900	4,800	1,600	9,100	2,200	700	0	5,400	28,700
Irrigated 1/	do.	4,100	4,500	1,200	8,900	1,600	500	0	5,300	26,100
Nonirrigated	do.	800	300	400	200	600	200	0	100	2,600
Rangeland	do.	25,300	30,700	85,600	158,000	140,400	233,200	230,000	159,800	1,063,000
Other	do.	700	1,200	400	3,000	6,900	900	2,100	5,400	20,600
IRRIGATION										
Water source:										
Streamflow	Acres	4,100	4,000	700	8,500	800	500	0	5,300	23,900
Reservoir storage	do.	0	400	500	400	800	0	0	0	2,100
Ground water	do.	0	100	0	0	0	0	0	0	100
Method of application:										
Sprinkler	Acres	0	0	0	0	0	0	0	0	0
Gravity	do.	4,100	4,500	1,200	8,900	1,600	500	0	5,300	26,100
Water rights:										
Surface water	Acres	3,197	4,478	1,723	11,486	7,748	567	0	6,451	35,650
Ground water	do.	0	1	0	0	151	0	0	0	152
Water shortage	do.	4,100	4,000	700	8,500	800	500	0	5,300	23,900
POTENTIAL										
Cropland (suitable soils)	Acres	2,800	18,000	15,000	13,000	40,000	35,000	12,000	20,000	155,800
Irrigable land (suitable soils)	do.	2,800	18,000	15,000	13,000	40,000	35,000	12,000	20,000	155,800
Possible to be developed by 1977	do.	200	0	0	2,000	300	500	0	100	3,100
Water source:										
Streamflow	Acres	0	0	0	0	0	0	0	0	0
Reservoir storage	do.	2,800	18,000	15,000	13,000	40,000	35,000	12,000	20,000	155,800
Ground water	do.	0	0	0	0	0	0	0	0	0
DRAINAGE										
Arable land needing drainage	Acres	500	1,500	200	5,000	1,200	400	0	1,200	10,000
FLOODING										
Area	Acres	2,500	2,000	300	0	800	0	0	0	5,600
STORAGE										
Ponds (existing)	Number	9	25	32	37	28	82	43	85	341
Reservoirs (existing)	do.	1	1	1	0	3	0	0	1	7
Reservoir sites studied	do.	3	0	0	0	0	0	0	1	4

1/ Land developed for irrigation.

Based on data collected by the USDA Oregon River Basin Survey Staff. Estimates provided by local personnel of the ASCS, Forest Service, Soil Conservation Service, BLM, Harney County Extension Service, and Harney County Assessor.

Table 36 C.--Reconnaissance data on small watersheds, Alvord-Catlow Subbasin, Malheur Lake Drainage Basin, Oregon

Item	Unit	14-1 Alvord Ranch	14-2 Alvord Lake	14-3 Trout Creek	14-4 Pueblo Slough	14a-3 Mann, Tudor & Fifteencent: Lakes	10a-1 Coyote Lake	10a-2 Twelvemile Creek	10a-3 Whitehorse Creek	10-1 Rock Creek	10-2 Guano Slough	10-3 Catlow Valley	10-4 Roaring Springs	10-5 Guano Lake	10-6 Jack Creek	10-7 Shallow Lake	10-8 Rincon Creek	14b-9 Clover Creek	Total
Farms	Number	1	6	10	7	1	0	1	1	3	0	0	3	1	1	0	0	2	37
Watershed area	Acres	154,600	183,700	150,500	110,500	223,000	153,900	105,500	190,200	233,800	249,800	209,700	225,700	151,600	117,200	248,600	190,400	198,900	3,097,600
GENERAL LAND USE																			
Forest land(grazed)	Acres	1,100	1,100	2,100	1,100	2,200	100	100	2,100	1,000	200	400	3,100	500	400	200	500	200	16,400
Cropland	do.	6,200	5,900	6,300	1,500	3,000	600	400	3,700	1,600	0	400	8,000	1,300	600	0	100	1,200	40,800
Irrigated 1/	do.	6,200	5,900	4,000	1,500	3,000	600	400	3,700	1,600	0	300	6,500	300	600	0	100	0	34,700
Nonirrigated	do.	0	0	2,300	0	0	0	0	0	0	0	100	1,500	1,000	0	0	0	1,200	6,100
Rangeland	do.	139,100	172,500	141,500	107,400	216,900	150,200	104,200	183,900	230,400	246,200	204,300	210,300	147,100	114,900	244,200	180,800	196,100	2,990,000
Other	do.	8,200	4,200	600	500	900	3,000	800	500	800	3,400	4,600	4,300	2,700	1,300	4,200	9,000	1,400	50,400
IRRIGATION																			
Water source:																			
Streamflow	Acres	5,000	5,800	3,200	1,100	2,100	0	400	100	0	0	300	6,300	0	0	0	100	0	24,400
Reservoir storage	do.	0	0	0	200	800	0	0	0	1,600	0	0	200	200	600	0	0	0	3,600
Ground water	do.	1,200	100	800	200	100	600	0	3,600	0	0	0	0	100	0	0	0	0	6,700
Method of application:																			
Sprinkler	Acres	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
Gravity	do.	6,200	5,800	4,000	1,500	3,000	600	400	3,700	1,600	0	300	6,500	300	600	0	100	0	34,600
Water rights:																			
Surface water	Acres	125	5,307	7,040	1,875	749	0	289	0	3,755	289	0	20,235	0	324	0	404	40	40,681
Ground water	do.	1,190	80	134	578	0	0	0	5,310	0	0	0	0	0	0	0	0	0	7,292
Water shortage	do.	4,000	5,800	3,200	1,300	2,900	600	400	400	0	0	300	6,500	0	0	0	100	0	25,500
POTENTIAL																			
Cropland (suitable soils)	Acres	82,000	105,000	36,000	51,000	39,000	48,000	43,000	56,000	34,000	65,000	120,000	50,000	33,000	15,000	44,000	47,000	61,000	929,000
Irrigable land (suitable soils)	do.	82,000	105,000	36,000	51,000	39,000	48,000	43,000	56,000	34,000	65,000	120,000	50,000	33,000	15,000	44,000	47,000	61,000	929,000
Possible to be developed by 1977	do.	4,500	2,000	2,000	2,000	0	3,000	5,000	3,000	2,400	0	10,000	5,500	0	0	0	5,000	1,000	45,400
Water source:																			
Streamflow	Acres	1,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,500
Reservoir storage	do.	77,500	103,000	31,000	49,000	34,000	45,000	38,000	53,000	34,000	65,000	120,000	50,000	33,000	15,000	44,000	47,000	61,000	899,500
Ground water	do.	3,000	2,000	5,000	2,000	5,000	3,000	5,000	3,000	0	0	0	0	0	0	0	0	0	28,000
DRAINAGE																			
Arable land needing drainage	Acres	500	300	600	0	300	0	0	400	200	0	0	100	0	0	0	0	0	2,400
FLOODING																			
Area	Acres	400	100	0	0	600	0	0	0	500	100	0	0	200	1,300	0	0	100	3,300
STORAGE																			
Ponds (existing)	Number	48	0	12	19	29	2	3	7	28	30	9	77	40	100	12	20	24	460
Reservoirs (existing)	do.	0	0	0	0	2	0	0	0	1	1	0	1	2	5	0	0	0	12
Reservoir sites studied	do.	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2

1/ Land developed for irrigation.

Based on data collected by the USDA Oregon River Basin Survey Staff. Estimates provided by local personnel of the ASCS, Forest Service, Soil Conservation Service, BLM, Harney County Extension Service, and Harney County Assessor.

Table 36D.--Reconnaissance data on small watersheds, Malheur Lake Drainage Basin, Oregon

Item	Unit	Subbasin				Basin total
		Silvies	Donner und Blitzen	Silver Creek	Alvord-Catlow	
Farms	Number	135	34	25	37	231
Watershed area	Acres	1,346,400	626,900	1,306,700	3,097,600	6,377,600
GENERAL LAND USE						
Forest land (grazed)	Acres	542,100	26,500	194,400	16,400	779,400
Cropland	do.	150,000	43,200	28,700	40,800	262,700
Irrigated 1/	do.	124,800	41,100	26,100	34,700	226,700
Nonirrigated	do.	25,200	2,100	2,600	6,100	36,000
Rangeland	do.	638,000	546,600	1,063,000	2,990,000	5,237,600
Other	do.	16,300	10,600	20,600	50,400	97,900
IRRIGATION						
Water source						
Streamflow	Acres	122,700	39,600	23,900	24,400	210,600
Reservoir storage	do.	400	1,400	2,100	3,600	7,500
Ground water	do.	1,700	100	100	6,700	8,600
Method of application:						
Sprinkler	Acres	2,700	0	0	100	2,800
Gravity	do.	122,100	41,100	26,100	34,600	223,900
Water rights:						
Surface water	Acres	147,173	52,298	35,650	40,681	275,802
Ground water	do.	8,233	76	152	7,292	15,753
Water shortage	do.	122,700	33,200	23,900	25,500	205,300
POTENTIAL						
Cropland (suitable soils)	Acres	293,200	46,400	155,800	929,000	1,424,400
Irrigable land (suitable soils)	do.	293,200	48,200	155,800	929,000	1,426,200
Possible to be developed by 1977	do.	27,900	900	3,100	45,400	77,300
Water source						
Streamflow	Acres	0	0	0	1,500	1,500
Reservoir storage	do.	293,200	48,200	155,800	899,500	1,396,700
Ground water	do.	0	0	0	28,000	28,000
DRAINAGE						
Arable land needing drainage	Acres	43,400	19,500	10,000	2,400	75,300
FLOODING						
Area	Acres	37,900	2,800	5,600	3,300	49,600
STORAGE						
Ponds (existing)	Number	139	172	341	460	1,112
Reservoirs (existing)	do.	7	3	7	12	29
Reservoir sites studied	do.	16	1	4	2	23

1/ Land developed for irrigation

Based on data collected by the USDA Oregon River Basin Survey Staff. Estimates provided by local personnel of the ASCS, Forest Service, Soil Conservation Service, BLM, Harney County Extension Service, and Harney County Assessor.

Table 37.--Watershed summary of needs and project potential, Malheur Lake Drainage Basin, Oregon, 1966

Watershed		Needs											Project potential, P. L. 566		
Name	Number	Flood protection	Erosion control	Drainage	Irrigation	Land treatment	Rural water supply	Municipal or industrial water supply	Recreational development	Fish and/or wildlife	Water quality control	Appears to be feasible	Might be feasible	Not feasible
Silvies Subbasin														
Malheur Lake	14a-1	X		X	X	X								X
Bear Valley	14a1-1	X	X	X	X	X			X	X	X	X		
Silvies	14a1-2	X	X	X	X	X			X	X	X		X	
Emigrant Creek	14a1-3	X	X		X	X			X	X	X			X
Willow Creek	14a1-4	X	X	X	X	X		X	X	X	X	X		
Poison Creek	14a1-5	X	X	X	X	X			X	X	X	X		
Hot Springs Creek	14a1-6	X	X	X	X	X			X	X	X			X
Donner und Blitzen Subbasin														
Riddle Creek	14a-2	X	X	X	X	X			X	X			X	
Donner und Blitzen	14a2-1	X	X	X	X	X			X	X	X			X
Fish Lake	14a2-2		X	X	X	X			X	X				X
Silver Creek Subbasin														
Upper Silver Creek	14b-1	X	X	X	X	X			X	X		X		
Miller Canyon	14b-2	X	X	X	X	X			X	X			X	
Chickahominy Creek	14b-3	X	X		X	X			X	X				X
Silver Lake	14b-4		X	X	X	X			X	X				X
Lower Silver Creek	14b-5	X	X	X	X	X			X	X				X
Wilson Creek	14b-6		X	X	X	X			X	X				X
Buzzard Creek	14b-7		X			X			X	X				X
Jackass Creek	14b-8	X	X	X	X	X			X	X				X
Alvord-Catlow Subbasin														
Alvord Ranch	14-1	X	X	X	X	X			X	X				X
Alvord Lake	14-2	X	X	X	X	X			X	X			X	
Trout Creek	14-3	X	X	X	X	X			X	X		X		
Pueblo Slough	14-4		X		X	X			X	X				X
Mann, Tudor and Fifteencent Lakes	14a-3	X	X	X	X	X			X	X				X
Coyote Lake	10a-1				X	X								X
Twelvemile Creek	10a-2				X	X								X
Whitehorse Creek	10a-3	X	X	X	X	X			X	X				X
Rock Creek	10-1	X	X		X	X			X	X				X
Guano Slough	10-2		X			X								X
Catlow Valley	10-3		X		X	X								X
Roaring Springs	10-4	X	X	X	X	X			X	X				X
Guano Lake	10-5				X	X								X
Jack Creek	10-6	X			X	X				X	X			X
Shallow Lake	10-7					X								X
Rincon Creek	10-8	X	X		X	X				X				X
Clover Creek	14b-9	X	X		X	X				X				X

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3. Only a small part of the watershed would benefit materially from flood protection and drainage under agricultural, residential, or urban uses and there is limited potential for expansion of these land uses.
4. The watershed has minor drainage, flooding, and water supply problems that can best be solved through individual action.
5. Group irrigation development is not feasible in the watershed because of land capability factors or insufficient water supply.

Factors that Could Change Feasibility in the Future

There are several factors that were not taken into account in this study that, in the future, may affect the feasibility of a given watershed for P. L. 566 action. They are:

1. Revision of P. L. 566 to provide greater federal contribution for land treatment, flood protection, recreation, and fish and wildlife benefits would improve the possibility for a project in several watersheds.
2. Increased demands for water arising from urbanization, industrialization, and for specialized agricultural crops may improve the need for P. L. 566 action in some watersheds.
3. Small watershed projects may be feasible in some areas adjacent to, or part of, planned Corps of Engineers or Bureau of Reclamation projects. Such small watershed projects could be complementary to larger projects.
4. The degree of local interest in a given project will influence the immediate prospects for P. L. 566 action in many watersheds where projects appear to be physically and economically feasible. Interest in irrigation and more intensive land use will be particularly important as many potential projects center around irrigation development.
5. Improvements made by individuals or groups in a watershed may reduce future benefits which would adversely affect the possibility of a P. L. 566 project.

Other Development Opportunities

Many of the watersheds listed in table 37 show needs to correct various water and related land problems but are not considered physically feasible for project action. These problems are, in many cases, small acreages or isolated areas that can be corrected by an individual or a group of 3 or 4 landowners.

USDA programs are available to provide landowners and operators with technical and financial assistance in the solution of problems relating to

soil and water. These programs have been discussed in some detail earlier in this report and investigations were not in sufficient detail to specifically point out which problems can be best handled under the various programs.

PROGRAMS AND PROJECTS ON PUBLIC LANDS

Cooperative State-Federal Forestry Program

There is little opportunity for additional cooperative forestry programs within the basin. The bulk of the timberlands within the basin are in federal ownership or large private holdings. The few possibilities for cooperation are in the areas of insect and disease control or fire control.

National Forest Development

In 1966, the Forest Service conducted its project work inventory for all National Forests. This is a listing of non-recurrent work which should be initiated on each unit to meet public needs if the funds required could be made available. The inventory for those portions of the Malheur and Ochoco National Forests within the basin include several projects which are primarily in the fields of recreation and wildlife.

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

In the Malheur Lake Drainage Basin, there are project potentials that could be accomplished by alternative approaches as well as by programs of other agencies. One example of this is the Silvies River; storage potential as well as storage requirements exceed the limitations of P. L. 566 but, with impoundment structures on several of the smaller tributary streams, peak flows could be greatly reduced on the main river, affording some degree of downstream flood protection and additional water for irrigation. This might be considered an alternative approach to the project proposed by the Corps of Engineers on the Silvies River to eliminate downstream flooding and to provide water for irrigation and for other beneficial uses.

Opportunities for development on Bureau of Land Management lands within the basin lie primarily in range management. There are many additional acres which are suitable for rehabilitation. Side benefits will also accrue to wildlife through this program.

The U. S. Fish and Wildlife Service has opportunities to improve wildlife habitat on its lands through a program of drainage and canal and dike construction. There is also a potential for additional recreational development.

This study only points out the physical problems, needs, and potentials that could be affected by project action. Economic feasibility was not determined because of insufficient detailed information. It is important that, in the planning stages of any project, alternative approaches to solving problems and to meeting demands also be considered.

APPENDIX

RECONNAISSANCE REPORTS FOR WATERSHEDS

INTRODUCTION

Reconnaissance reports are presented for each watershed in the Malheur Lake Drainage Basin. The basin was divided into 35 tributary watershed areas as shown on map 8 following page 106. The USDA River Basin Survey Staff made a survey to provide information which should be a guide for potential Public Law 566 work and for long-range coordinated planning for projects. Determining the engineering and economical feasibility of a given watershed as a project would require more detailed investigations.

SOURCE OF WATERSHED INFORMATION

Almost all data in these watershed reports were presented in the main section of the report. The information which describes the land use, the crops grown, the status of irrigation, the problems and needs involving water, and the potential development is portrayed in tables 36A, 36B, 36C, and 36D on pages 111, 113, 115, and 117, respectively. The generalized land use map (map 7 following page 42) illustrates the pattern of land use in the basin and the watersheds. The amounts of annual precipitation are extracted from the precipitation map (map 2 following page 4). Brief descriptions of the soils are given; however, more detailed descriptions appear in the main section. The prominent characteristics and qualities of the soils are tabulated in table 1, page 11, and the generalized soil map (map 4 following page 12) locates the kinds of soils. The location and storage capacity of the reservoir sites which were investigated are reported but more information is given in the narrative section of the main report and in table 35, page 105. The problems and needs are discussed in the main section of the report and the information by each watershed is presented in the tables 36A, 36B, 36C, and 37 on pages 111, 113, 115, and 119, respectively. The watersheds which have been determined by the River Basin Survey Staff to have possibility as a P. L. 566 project are noted in table 37, page 119, and on the index map of watershed areas and possible reservoir sites (map 8 following page 106).

WATERSHED REPORTS

SILVIES SUBBASIN

Watershed 14a-1, Malheur Lake

Description. The Malheur Lake watershed contains 96,100 acres in Harney County. This watershed lies between the south and east edges of Malheur Lake to the basin boundary. Although several streams flow from the mountains, channels are undefined through the valley floor. The community of Crane is located near the northern boundary. Elevations range from slightly less than 4,100 feet to over 5,200 feet with the agricultural area lying below 4,200 feet. Average annual precipitation ranges from 8 to 10 inches with an average growing season varying from 90 to 120 days in the agricultural area.

Three soil groups, based on parent material and physiography, occur in the watershed. About one-third of the watershed is the upland soil group lying under 5,600 feet elevation and these soils originated mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Lake-basin soils near the town of Crane are medium textured, weakly to strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Irrigated cropland, rangeland, and wildlife habitat are the land uses. Large acreages of strongly alkaline flood-plain soils near Malheur Lake are moderately deep to very deep and weakly to strongly developed. If irrigation water is available, areas of these soils are cropland; other areas are pasture land in normal years and marshland in wet years. Fan and flood-plain soils, covering a small area along Malheur Lake, are medium textured, weakly developed, and deep to gravel. They are well drained except where dikes have created a marshy condition. They are cropland, both irrigated and nonirrigated, and pasture land.

A reconnaissance survey indicates 94,900 acres are used for the production of either crops or livestock. Of this, 100 acres are grazed forest land; 87,800 acres are rangeland; and 7,000 acres are cropland. About 1,100 acres grow irrigated hay, pasture, and grain. The nonirrigated cropland produces grain and grass. There are 11 farms in this watershed.

Forests cover approximately 100 acres of this watershed. They consist primarily of juniper but isolated stands of aspen occur in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 200 acres of cropland are flooded annually with only minor damage occurring. Some damage is received by roads and culverts due to silt and sediment deposition.

Estimates show that 800 acres of arable land need improved subsurface drainage, including open drains and improved outlets.

Approximately 30,000 acres of additional land are suitable for irrigation. Of this acreage, only about 300 acres will probably be developed within the next 10 years due to the lack of surface water and because the quantity of ground water is unknown. To develop the total acreage, a source of water from

outside the basin would be required. The existing need is for supplemental water after June 1 for about 400 acres of presently irrigated land.

Opportunities for Project Action. The immediate need for flood protection, drainage, irrigation water management, and land treatment in this watershed would not require project action. Some of these problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14a1-1, Bear Valley

Description. Located in the Grant Soil and Water Conservation District, the Bear Valley watershed contains 184,900 acres in Grant County. This watershed is the headwaters of the Silvies River which flows in a northeasterly direction to the valley floor and then southerly where it leaves the watershed south of Seneca. The largest tributary to the Silvies River is Bear Creek which flows from the east and enters the river near Seneca. The community of Seneca is located in the south-central portion of the watershed. The watershed is about 14 miles long and 30 miles wide. Elevations range from 4,600 feet to 8,000 feet with the major agricultural area below 4,800 feet. Average annual precipitation ranges from 11 inches to 40 inches with an average of about 22 inches. The growing season in the agricultural area varies from 60 to 90 days. Freezing temperatures have been recorded every month of the year.

Three groups of soils, based on parent material and physiography, occur in the watershed. Upland soils, developed from volcanics and old sedimentary rocks under forest cover, compose the largest portion of the watershed. They are slightly acid to neutral, dark colored, moderately deep, and moderately developed. These soils support a forest cover which is nearly all grazed. Between the flood plain and the uplands, older fan and terrace soils occur which are strongly developed and neutral in reaction. They are on slopes of less than 7 percent and are suitable for irrigation if water is available. Fan and flood-plain soils along Silvies River and Bear Creek are medium textured, weakly developed, and deep to gravel. These soils produce both irrigated and nonirrigated crops and pasture.

A reconnaissance survey indicates that 183,100 acres are used for the production of livestock or crops. Of this, 108,000 acres are grazed forest land; 61,200 acres are rangeland; and 13,900 acres are cropland. About 13,200 acres are irrigated hay and pasture. The nonirrigated cropland produces grain, hay, and pasture. There are 12 farms in this watershed.

Approximately 108,000 acres of this watershed consist primarily of ponderosa pine with scattered stands of lodgepole pine and some intermingled associated species at higher elevations and wetter sites.

Watershed Problems and Needs. Approximately 6,500 acres of cropland receive minor flood damage annually. No forest land is flooded and a small acreage of rangeland receives minor damage. Silt and debris deposition slightly damages roads, bridges, culverts, fences, and irrigation facilities each year. The banks of the Silvies River where it flows through cropland

are eroded slightly to moderately each year.

Estimates reveal that impaired subsurface drainage is a problem on 6,000 acres of arable land. The estimate shows that it is possible to drain 400 acres with closed drains. Open ditches would drain the remaining 5,600 acres but grading and land shaping might be necessary to convey the surface water to the ditches.

Approximately 33,400 acres of land are composed of soils that are suitable for irrigation. It has been estimated that 2,800 acres will be developed for irrigation within the next 10 years and that the source of the water will be reservoirs on the streams. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be required. One reservoir site (index number 1), investigated by the Soil Conservation Service, has an estimated storage capacity of 500 acre feet and would have irrigation and recreational benefits. All the 13,200 acres of land that are being irrigated need supplemental water after August 1.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, fish and/or wildlife development, and water quality control appears to be feasible in this watershed. Some of these problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14a1-2, Silvies

Description. The Silvies watershed is composed of 199,200 acres of land in Grant and Harney Counties. The portion in Grant County is in the Grant Soil and Water Conservation District. This watershed includes the section of the main Silvies River drainage which begins two miles south of Seneca and extends approximately 22 miles downstream. Bridge, House, Camp, Crooked, Jump, Mountain, Trout, East, Thorn, Hall, Sagehen, Myrtle, West Myrtle, and Lost Creeks empty into the Silvies River. The watershed is approximately 25 miles long and varies from 10 to 20 miles wide. Elevations range from about 4,500 feet to 6,695 feet on Calamity Butte with the major agricultural areas below 4,700 feet. Other prominent peaks are: King Mt., 6,678 feet; Jump Off Joe Mt., 6,440 feet; West Myrtle Butte, 6,384 feet; Telephone Butte, 6,398 feet; Black Rock, 6,320 feet; and Rail Creek Butte, 6,020 feet. Average annual precipitation ranges from 13 to 30 inches with an average of about 18 inches. The growing season varies from 60 to 90 days in the agricultural area. Freezing temperatures have been recorded every month of the year.

Based on parent material and physiography, four soil groups are found in the watershed. The largest portion of the upland is covered by forest soils which were developed from volcanic materials, old sedimentary and metamorphic

rocks. These soils are moderately developed, moderately deep, dark colored, and slightly acid to neutral in reaction. The area of non-forested upland soils along the east slope of the Silvies River is moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. The older fan and terrace soils along Silvies River are strongly developed and neutral in reaction. The slopes are less than 7 percent and they produce range forage and irrigated crops. Fan and flood-plain soils along Silvies River are medium textured, weakly developed, deep to gravel, and well drained. Irrigated crops and pasture forage are produced on these soils.

A reconnaissance survey discloses that 198,100 acres of land are used for the production of crops or livestock. Of this land, 139,100 acres are grazed forest land, 49,100 acres are rangeland, and 10,000 acres are irrigated cropland. The cropland produces 6,700 acres of meadow hay and pasture and 3,300 acres of pasture. Eight farms are located in the watershed.

Approximately 139,100 acres of this watershed are forested. Ponderosa pine is the predominant species with a few hardwoods found along stream bottoms and scattered stands of juniper on the drier sites. Young-growth stands are found in lower elevations along the Silvies River as a result of past fire history in the area.

Watershed Problems and Needs. Approximately 7,000 acres of cropland receive minor flood damage annually. No forest land is flooded and a small acreage of rangeland is damaged slightly. Silt and debris deposition damages roads, bridges, culverts, fences, and irrigation facilities to a small degree each year. The streambanks of the Silvies River where it flows through cropland are eroded slightly to moderately each year.

Estimates reveal that impaired subsurface drainage is a problem on 6,200 acres of arable land. The estimate shows that it is possible to drain 500 acres with closed drains. Open ditches would drain the remaining 5,800 acres but grading and land shaping might be necessary to convey the surface water to the ditches.

Approximately 18,000 acres are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 4,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To develop the total potentially irrigable land, ground water or stored water would be required. One reservoir site (index number 2), investigated by the Bureau of Reclamation, has an estimated storage capacity of 100,000 acre feet and would have irrigation, flood protection, recreation, and water supply benefits. Supplemental water is needed from June 1 to August 1 on 9,800 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measure, recreational development, fish and/or wildlife development, and water quality control might be feasible in this watershed.

Some of these problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14a1-3, Emigrant Creek

Description. This watershed contains 228,600 acres in Grant and Harney Counties. The portion in Grant County is in the Grant Soil and Water Conservation District. This watershed includes approximately 17 miles of the Silvies River, the Emigrant Creek drainages, and some small streams on the east side of Silvies River. Curry Gordon, Yellowjacket, Skull, Crowsfoot, Bear Canyon, Little Emigrant, Stinger, Blue, Spring, Sawtooth, and Cricket Creeks are the small streams which drain the watershed. The watershed averages about 18 miles from north to south and about 20 miles from east to west. Elevations range from 4,200 feet to 7,163 feet in the northwest section with the major agricultural areas below 4,600 feet. Prominent peaks are: Snow Mt., 7,163 feet; Emigrant Butte, 5,390 feet; Bear Canyon Butte, 5,440 feet; Green Butte, 5,975 feet; Donnelly Butte, 6,033 feet; Sugarloaf Mt., 6,128 feet; and Whiskey Mt., 6,135 feet. Average annual precipitation ranges from 12 to 25 inches with an average of about 18 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, three groups of soils occur in this watershed. The largest portion of the upland is covered by forest soils which were developed from volcanic materials, old sedimentary rocks, and metamorphic rocks. These soils are moderately developed, moderately deep, dark colored, and slightly acid to neutral in reaction. The area of non-forested upland soils on the lower elevations along Silvies River and Emigrant Creek is moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. Fan and flood-plain soils along Silvies River and Emigrant Creek are medium textured, weakly developed, deep to gravel, and well drained. Irrigated crops and pasture forage are produced on these soils.

A reconnaissance survey discloses that 227,500 acres are used for the production of crops or livestock. Of this land, 183,300 acres are grazed forest land, 41,100 acres are rangeland, and 3,100 acres are cropland. The cropland is irrigated and produces 100 acres of grain, 2,000 acres of meadow hay and pasture, and 1,000 acres of pasture. Two farms are located in the watershed.

Approximately 183,300 acres of this watershed are forested. Forests consist of non-commercial juniper stands in the lower, drier sites, and ponderosa pine on the greater portion of the forest land with a few acres of associated species and hardwoods in the higher elevations and moister sites.

Watershed Problems and Needs. Approximately 300 acres of cropland receive minor flood damage annually. No forest land or rangeland is flooded. Silt and debris deposition damages roads, bridges, culverts, and fences slightly each year.

Estimates disclose that impaired subsurface drainage is a problem on 400 acres of arable land. It could be drained by open ditches but grading and land shaping might be necessary to convey the surface water to the ditches.

It is estimated that about 800 acres of land that have soils suitable for irrigation will be developed in the next 10 years. To develop this potentially irrigable land, stored water would be required. Four reservoir sites (index numbers 3, 4, 5, and 6) have been investigated by either the Soil Conservation Service, the Bureau of Reclamation, or the Corps of Engineers. These reservoirs have an estimated total storage capacity of 253,300 acre feet and would have irrigation, flood protection, recreation, and water supply benefits. Supplemental water is needed from May 1 to June 15 on 2,700 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of this watershed are for flood protection, erosion control, irrigation water management, land treatment measures, recreational development, fish and/or wildlife development, and water quality control. A P. L. 566 project is not feasible as the solution for these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14a1-4, Willow Creek

Description. The Willow Creek watershed comprises 249,600 acres in Harney County of which 16,700 acres lie within the bounds of the Malheur National Wildlife Refuge. The watershed encompasses the northwest portion of Malheur Lake, the west side of the flood plain of Silvies River, and the Willow Creek drainage. Willow Creek flows from the northwest and enters Silvies River about six miles south of Burns. Several channels or drainage canals cross and intersect the flood plain of the Silvies River. The towns of Burns and Hines are located in the watershed. Oriented northwest-southeast, the watershed is about 32 miles long and about 11 miles wide. The elevations range from 4,085 feet at Malheur Lake to 5,285 feet at the summit in the northwest end of the watershed with the major agricultural area below 4,400 feet. Average annual precipitation ranges from 8 inches to about 22 inches with an average of 12 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, six soil groups occur in this watershed. The two groups of soils which cover the uplands south and west of Burns were developed mostly from volcanic materials. The forested soils are moderately developed, moderately deep, dark colored, and slightly acid to neutral in reaction. The non-forested soils, which compose the larger area, are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. Areas of older fan and terrace soils near Burns and Malheur Lake are strongly developed and neutral in reaction. The slopes are less than 7 percent and they produce range forage and both irrigated and nonirrigated crops. Small areas of strongly alkaline flood-plain soils--one north of Wrights

Point and two west of Malheur Lake--are moderately deep to very deep and weakly to strongly developed. They produce range forage and irrigated crops. Fan and flood-plain soils occupy large areas south and east of Burns and west of Malheur Lake. They are medium textured, weakly developed, deep to gravel, and well drained except where dikes have created a marshy condition. They produce both irrigated and nonirrigated crops and pasture forage. A large acreage of intermixed, well drained, poorly drained, and strongly alkaline flood-plain soils occupies an area bordering the north shore of Malheur Lake and extends about 12 miles to the northwest.

A reconnaissance survey discloses that 242,400 acres are used for the production of either crops or livestock. Of this land, 13,600 acres are grazed forest land, 179,500 acres are rangeland, and 49,300 acres are cropland. The nonirrigated cropland produces 2,500 acres of grain and 3,000 acres of grass. The crops produced on the 43,800 acres of irrigated cropland include the following: 33,090 acres of meadow hay and pasture, 6,000 acres of alfalfa hay, and 4,500 acres of grain, 200 acres of grain and alfalfa hay, and 10 acres of potato seed. Forty-five farms are located in the watershed.

Approximately 13,600 acres of this watershed are forested. Stands are primarily juniper and young-growth pine in this lower elevation watershed.

Watershed Problems and Needs. Approximately 10,000 acres receive minor flood damage annually. No forest land, 6,000 acres of rangeland on the wetter sites, and 4,000 acres of cropland are flooded. Silt and debris deposits damage roads, bridges, culverts, fences, and irrigation facilities slightly each year. The streambanks along Sagehen and Willow Creeks and Silvies River are eroded slightly to moderately where the streams flow through cropland.

Estimates show that 20,000 acres of arable land have drainage problems. This land could be drained with a system of open ditches and grading and land shaping to allow the surface water to drain into the ditches.

Approximately 76,000 acres of land are composed of soils that are suitable for irrigation. It has been estimated that 10,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be required. One reservoir site (index number 19), investigated by the Soil Conservation Service, has an estimated storage capacity of 4,500 acre feet and would give irrigation, flood protection, and recreation benefits. The presently irrigated land needs supplemental water after June 1.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A. P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, fish and/or wildlife development, municipal or industrial water supply, and water quality control appears to be feasible in this watershed. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14a1-5, Poison Creek

Description. The Poison Creek watershed contains 214,600 acres of land in Harney County with about 900 acres within the bounds of the Malheur National Wildlife Refuge. Included in this watershed are Poison, Dry, Prater, Soldier, Mill, Coffeepot, and Rattlesnake Creeks which empty into the Silvies River. The Silvies River is the boundary on the southwest for about 23 miles and Malheur Lake is the boundary on the southeast. The communities of Lawen and Harney are located in the watershed. The watershed is about 35 miles long and varies in width from 3 to 16 miles. Elevations range from 4,085 feet at Malheur Lake to 6,678 feet on King Mt. in the northwest with the major agricultural area below 4,400 feet. Average annual precipitation varies from 8 to 20 inches with an average of almost 15 inches. The growing season varies from 90 to 120 days in the agricultural area.

Based on parent material and physiography, seven soil groups occur in the watershed. The two groups of soils which cover the uplands north and east of Burns were developed mostly from volcanic materials. The forested soils are moderately developed, moderately deep, dark colored, and slightly acid to neutral in reaction. The non-forested soils are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. An area of older fan and terrace soils north of Burns is strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce range forage and both irrigated and nonirrigated crops. An area of strongly alkaline flood-plain soils in the east-central section of the watershed is moderately deep to very deep and weakly to strongly developed. These soils produce range forage and both irrigated and nonirrigated crops. Fan and flood-plain soils occupy smaller areas near Burns, Harney, and Lawen. They are medium textured, weakly developed, deep to gravel, and well drained except where dikes have created a marshy condition. They produce both irrigated and nonirrigated crops and pasture forage. Intermixed fan and flood-plain and older fan and terrace soils occupy an area at Lawen. A large acreage of intermixed, well drained, poorly drained, and strongly alkaline flood-plain soils occupies an area northwest of Lawen.

A reconnaissance survey discloses that 212,100 acres of land are used for the production of crops or livestock. Of this land, 60,400 acres are grazed forest land; 105,400 acres are rangeland, and 46,300 acres are cropland. The 4,000 acres of nonirrigated cropland produces grain. The crops grown on the irrigated cropland are as follows: 35,700 acres of meadow hay and pasture, 1,500 acres of alfalfa hay, 1,000 acres of grain, and 4,100 acres of pasture. Thirty-two farms are located in the watershed.

Forests cover approximately 60,400 acres of this watershed. They consist of juniper in the lower and drier sites, and ponderosa pine in the higher, moister areas. Past logging operations and fires have created large areas of young growth in the lower elevations.

Watershed Problems and Needs. Approximately 3,000 acres of cropland receive minor flood damage annually. Silt and debris deposition damages roads, bridges, culverts, fences, and irrigation facilities slightly each year. The streambanks of Silvies River, Poison Creek, and the other large tributaries

are eroded slightly to moderately where the streams flow through cropland.

Estimates denote that 8,000 acres of arable land have problems of impaired subsurface drainage. Open drainage ditches can be used to drain this land but grading and land shaping might be necessary to convey the surface water to the ditches.

About 60,000 acres of land are composed of soils that are suitable for irrigation. It has been estimated by the Harney County committee for the Conservation Needs Inventory that 5,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation for water from outside the basin would be necessary. Seven reservoir sites (index numbers 7, 8, 9, 10, 11, 12, and 13) have been investigated by the Soil Conservation Service. These reservoirs have an estimated total storage capacity of 52,700 acre feet and they would provide irrigation, flood protection, and recreational benefits. Supplemental water is needed on 42,200 acres of presently irrigated land after June 1.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, fish and/or wildlife development, and water quality control appears to be feasible in this watershed. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14a1-6, Hot Springs Creek

Description. The Hot Springs Creek watershed is composed of 173,400 acres in Harney County with approximately 300 acres in the Malheur National Wildlife Refuge. Hot Springs Creek is the major stream and its tributaries include Malheur Slough, Ninemile Slough, Crowcamp Creek, Little Rock Creek, Big Rock Creek, and Cow Creek. After these streams flow out of the hills, their channels are rather undefined across the valley floor to Malheur Lake. The community of Buchanan is located in the north part of the watershed. Oriented north and south, the watershed is about 30 miles long and varies from 2 to 13 miles wide. Elevations range from 4,085 feet at Malheur Lake to 6,678 feet on King Mt. in the north tip of the watershed with the major agricultural area below 4,400 feet. Average annual precipitation varies from about 9 to 20 inches with an average of almost 14 inches. The growing season varies from 90 to 120 days in the agricultural area.

Based on parent material and physiography, six groups of soils are mapped in the watershed. The north portion of the watershed is covered by upland forest soils which were developed from volcanic materials, old sedimentary rocks, and metamorphic rocks. They are moderately developed, moderately deep, dark colored, and slightly acid to neutral in reaction. The area of non-forested upland soils along the north and east sections of the watershed is

moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. A small area of lake-basin soils near Crane is medium textured, weakly to strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Cropland, rangeland, and wildlife habitat are the land uses. A large area in the watershed consists of strongly alkaline flood-plain soils which are moderately deep to very deep and weakly to strongly developed. They produce pasture forage and both irrigated and nonirrigated crops. Fan and flood-plain soils occupy small areas near Harney and Lawen. They are medium textured, weakly developed, deep to gravel, and well drained except where dikes have created a marshy condition. Intermixed fan and flood-plain and older fan and terrace soils occur in an area northeast of Lawen.

A reconnaissance survey reveals that 171,900 acres are used for the production of either crops or livestock. Of this land, 37,600 acres are grazed forest land, 113,900 acres are rangeland, and 20,400 acres are cropland. The nonirrigated cropland produces 4,100 acres of grain and 5,000 acres of grass. The crops grown on the irrigated land consist of the following: 7,000 acres of meadow hay and pasture, 1,500 acres of alfalfa hay, 900 acres of grain, and 1,900 acres of pasture. Twenty-five farms are located in the watershed.

Approximately 37,000 acres of this watershed are forested. The forest is primarily ponderosa pine with scattered juniper stands in the lower, drier elevations.

Watershed Problems and Needs. Approximately 10,900 acres of cropland receive minor flood damage annually. Silt and debris deposition damages roads, bridges, culverts, fences, and irrigation facilities slightly each year. The banks of the streams where they flow through cropland are eroded moderately each year.

Estimates reveal that impaired subsurface drainage is a problem on 2,000 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to conduct the surface water to the ditches.

About 75,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 5,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Two reservoir sites (index numbers 14 and 15), investigated by the Soil Conservation Service, have an estimated total storage capacity of 20,300 acre feet and they would have irrigation, flood protection, and recreational benefits. Supplemental water is needed on 10,600 acres of presently irrigated land after June 1.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water manage-

ment, land treatment measures, recreational development, fish and/or wildlife development, and water quality control might be feasible in this watershed. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

DONNER UND BLITZEN SUBBASIN

Watershed 14a-2, Riddle Creek

Description. The Riddle Creek watershed contains 152,600 acres of land in Harney County. Approximately 600 acres are included in the bounds of the Malheur National Wildlife Refuge. The Coyote, Smyth, and Riddle Creeks head in the Steens Mountains and flow northwest to an unnamed lake in the north-central section of the watershed. Oriented in a northwest-southwest direction, the watershed is approximately 32 miles long and varies from 3 to 10 miles wide. The elevations range from about 4,100 feet to about 7,000 feet at a summit of the Steens Mountains. The average annual precipitation varies from 8 to 12 inches with an average of about 10 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four soil groups occur in the watershed. The largest portion, composed of two upland soil groups, originated mostly from volcanic materials. These soils are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. In the west extreme of the watershed, strongly alkaline flood-plain soils occur. They are moderately deep to very deep and weakly to strongly developed and they produce pasture and irrigated crops. The Diamond Craters, covering about six square miles, is the largest area of the miscellaneous land type, rough stony land.

A reconnaissance survey indicates that 148,400 acres are used for the production of either livestock or crops. Of this acreage, 500 acres are grazed forest land, 142,300 acres are rangeland, and 5,600 acres are cropland. On the nonirrigated cropland, 800 acres of grain and 1,000 acres of grass are grown. On the irrigated land, 3,500 acres of meadow hay and pasture, 100 acres of alfalfa hay, and 200 acres of grain are produced. Four farms are located in this watershed.

Forests cover approximately 500 acres of this watershed. They consist primarily of juniper with isolated stands of aspen occurring in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 800 acres receive minor flood damage annually. No forest land, 600 acres of rangeland on the wetter sites, and 200 acres of cropland are flooded. Silt and debris deposition damages roads, bridges, culverts, fences, and irrigation facilities slightly each year.

Estimates show that impaired subsurface drainage is a problem on 1,200 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to allow the surface water to flow to the ditches.

About 1,800 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 200 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, storage reservoirs would be necessary. Supplemental water is needed from June 1 to July 1 on 3,700 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development might be feasible in this watershed. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14a2-1, Donner und Blitzen

Description. This watershed comprises 242,600 acres of land in Harney County. Approximately 47,600 acres are included in the bounds of the Malheur National Wildlife Refuge. It includes the downstream section of the Donner und Blitzen River and its tributaries--Swamp, McCoy, Kiger, Deep, and Cucamonga Creeks--which head in the Steens Mountains. These streams empty into Malheur Lake. Several small lakes are located in the mountainous area. Oriented in a northwest-southeast direction, the watershed is approximately 40 miles long and ranges from 6 to 15 miles wide. The elevations vary from 4,085 feet at Malheur Lake to 9,255 feet at a summit of the Steens Mountains. The average annual precipitation ranges from 8 to 25 inches with the average about 10 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, five soil groups occur in the watershed. The largest portion composed of the two upland soil groups was developed mostly from volcanic materials. These soils are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber grow on these soils. Areas of strongly alkaline flood-plain soils occur next to the upland soils. They are moderately deep to very deep, weakly to strongly developed, and produce pasture and irrigated crops. Fan and flood-plain soils along the Donner und Blitzen River are medium textured, weakly developed, and deep to gravel. They are well drained except where dikes have created a marshy condition. They are cropland, both irrigated and nonirrigated, and pasture. One area is a mixture of fan, well drained flood-plain, and strongly alkaline flood-plain soils.

A reconnaissance survey indicates that 237,100 acres are used for the production of either livestock or crops. Of this acreage, 7,300 acres are grazed forest land, 200,700 acres are rangeland, and 29,300 acres are cropland. Grass is grown on the 100 acres of nonirrigated cropland. On the irrigated cropland, 20,700 acres of meadow hay and pasture, 1,300 acres of

alfalfa hay, and 7,200 acres of pasture are grown. Twenty-eight farms are located in the watershed.

Forests cover approximately 7,300 acres of this watershed. They consist primarily of juniper with isolated stands of aspen occurring in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 2,000 acres of cropland receive minor damage from floods annually. Roads, bridges, culverts, fences, and irrigation facilities are damaged slightly each year by silt and debris deposition.

Impaired subsurface drainage is a problem on an estimated 12,000 acres of arable land on the flood plain of the Donner and Blitzen River. This land can be drained with open ditches but grading and land shaping might be necessary to allow the surface water to flow to the ditches.

About 40,000 acres of land are composed of soils that are suitable for irrigation. It has been estimated that 300 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, storage reservoirs would be necessary. Supplemental water is needed after June 1 on 29,200 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, fish and/or wildlife development, and water quality control. A P. L. 566 project is not feasible as the solution for these problems because most of the benefit area is in the Malheur National Wildlife Refuge.

Watershed 14a2-2, Fish Lake

Description. The Fish Lake watershed comprises 231,700 acres of land in Harney County. It includes the upstream section of the Donner und Blitzen River and its tributaries--Krumbo Creek, Webb Spring Creek, Bridge Creek, Mud Creek, Fish Creek, Little Fish Creek, Indian Creek, Little Blitzen River, and South Fork Blitzen River--which head in the Steens Mountains. Almost 18,000 acres are in the Malheur National Wildlife Refuge. The watershed, oriented in a north-south direction, is approximately 36 miles long and varies from 10 to 15 miles from east to west. Numerous small lakes are located in the mountainous area; the largest one is Fish Lake. Baca Lake, along the lower Donner und Blitzen River, and Krumbo Lake on Krumbo Creek are man-made lakes. The elevations range from about 4,100 feet to 9,670 feet at a summit in the Steens Mountains. The average annual precipitation varies from 8 to 30 inches with an average of 13 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, three groups of soils occur in the watershed. The largest portion, composed of the two upland soil groups,

was developed mostly from volcanic materials. These soils are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber grow on these soils. Fan and floodplain soils along the Donner und Blitzen River are medium textured, weakly developed, and deep to gravel. They are well drained except where dikes have created a marshy condition. They are cropland, both irrigated and nonirrigated, and pasture land.

A reconnaissance survey denotes that 230,800 acres of land are used for the production of either crops or livestock. Of this acreage, 18,700 acres are grazed forest land, 203,800 acres are rangeland, and 8,300 acres are cropland. The 200 acres of nonirrigated cropland produces grass. The irrigated land produces 7,700 acres of meadow hay and pasture, 100 acres of alfalfa hay, and 300 acres of small grain and alfalfa. Two farms are located in the watershed.

Approximately 18,700 acres of the watershed are forested. Stands consist of juniper on the lower, drier sites and aspen in the creek bottoms and higher elevations. These aspen stands add considerably to the aesthetics and recreational attraction of the area.

Watershed Problems and Needs. No flooding occurs in this watershed because the flood protection structures are adequate.

Impaired subsurface drainage is a problem on an estimated 6,300 acres of arable land on the flood plain of the Donner und Blitzen River. It can be drained by open ditches but grading and land shaping might be necessary to allow the surface water to flow to the ditches.

About 6,400 acres of land have soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 200 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, storage reservoirs would be necessary. One reservoir site (index number 22), investigated by the Soil Conservation Service, has an estimated storage capacity of 9,600 acre feet and it would give irrigation, flood protection, and recreational benefits. Supplemental water is needed after August 1 on 300 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution for these problems because most of the benefit area is in the Malheur National Wildlife Refuge.

SILVER CREEK SUBBASIN

Watershed 14b-1, Upper Silver Creek

Description. This watershed contains 184,900 acres of land in Crook and Harney Counties. This watershed is the headwaters of Silver Creek which flows in a southerly direction. The tributaries of Silver Creek are Jacks, Morris, Nicoll, Rough, Dairy, Sawmill, Copper, Delintment, Short, Dodson, Wickiup, Claw, and Egypt Creeks. These streams, heading in the forested area, flow almost all the year. The watershed is about 26 miles long and varies from 2 to 20 miles wide. The elevations vary from about 4,200 feet to 6,135 feet along the north boundary with the major agricultural area below 4,500 feet. Donnelly Butte is 6,033 feet, Emigrant Butte is 5,390 feet and Dry Mountain is more than 6,000 feet. Average annual precipitation ranges from about 12 to more than 25 inches with an average of about 19 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four groups of soils are found in the watershed. The group of soils on the uplands which are covered by forests was developed from volcanic materials and old sedimentary rocks except for a small area in the north which originated from crystalline and metamorphic rocks. They are slightly acid to neutral in reaction, dark colored, moderately deep, and moderately developed. The group of upland soils which are not forested is moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. The older fan and terrace soils are strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce range forage and both irrigated and nonirrigated crops. Fan and flood-plain soils along Silver Creek are medium textured, weakly developed, deep to gravel, and well drained. Irrigated and nonirrigated crops and pasture forage are produced on these soils.

A reconnaissance survey discloses that 184,200 acres of land are used for the production of crops and livestock. Of this acreage, 154,000 acres are grazed forest land, 25,300 acres are rangeland, and 4,900 acres are cropland. On the nonirrigated cropland, 300 acres of grain and 500 acres of pasture are grown. On the irrigated cropland, 3,000 acres of meadow hay and pasture, 300 acres of alfalfa hay, and 200 acres of grain are produced. Five farms are located in the watershed.

Forests cover approximately 154,000 acres of this watershed. The forests vary from juniper stands in the lower, drier sites to aspen in the higher, moister sites. Ponderosa pine predominates in the watershed forests but some scattered associated species occur in moister areas.

Watershed Problems and Needs. Approximately 2,500 acres of cropland receive minor flood damage annually. Roads, bridges, culverts, fences, and irrigation facilities are damaged slightly each year by silt and debris deposition. The banks of the streams which are bordered by cropland are eroded slightly each year.

Estimates disclose that impaired subsurface drainage is a problem on 500 acres of arable land. This land can be drained with open ditches but

grading and land shaping might be necessary to allow the surface water to flow to the ditches.

About 2,800 acres of land are composed of soils that are suitable for irrigation. The Conservation Needs Inventory Committee of Harney County estimated that 200 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, storage reservoirs would be necessary. Three reservoir sites (index numbers 16, 17, and 18) have been investigated--two by the Soil Conservation Service and one by the Bureau of Reclamation. These reservoirs have an estimated total storage capacity of 49,500 acre feet and would provide irrigation, flood protection, and recreational benefits. Supplemental water is needed on 4,100 acres of presently irrigated land after June 1.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development appears to be feasible. Some of the problems for all or a portion of the watershed could be solved by non-project means, such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14b-2, Miller Canyon

Description. The Miller Canyon watershed comprises 58,700 acres of land in northwestern Harney County. It includes the flood plain of Silver Creek near Riley and the junction of U. S. Highway 395 and State Highway 20. Oriented in a northeast-southwest direction, it is approximately 14 miles long and varies from 3 to 8 miles wide. Miller Canyon with its tributaries including Gum Boot Canyon compose the drainage system. Elevations range from about 4,200 feet to 5,975 feet on Green Butte. Average annual precipitation ranges from about 11 inches to 24 inches with an average of about 18 inches. The growing season varies from 90 to 120 days in the agricultural area.

Based on parent material and physiography, four soil groups are found in the watershed. Two groups of soils covering the upland were developed mostly from volcanic materials. The area at the higher elevations was developed under forest cover and is slightly acid to neutral in reaction, dark colored, moderately deep, and moderately developed. The remaining area of upland soils has moderate profile development, is gently to steeply sloping, and is shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. The older fan and terrace soils are strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce range forage and irrigated and nonirrigated crops. Fan and flood-plain soils along Silver Creek are medium textured, weakly developed, deep to gravel, and well drained. Irrigated and nonirrigated crops and pasture forage are grown on these soils.

A reconnaissance survey discloses that 57,500 acres of land are used for the production of crops and livestock. Of this acreage, 22,000 acres are grazed forest land, 30,700 acres are rangeland, and 4,800 acres are cropland. Grain is produced on 300 acres of nonirrigated cropland. The irrigated cropland produces 300 acres of alfalfa hay, 3,550 acres of meadow hay and pasture, 250 acres of grain, and 400 acres of pasture. Five farms are located in the watershed.

Approximately 22,000 acres of this watershed are forested. Ponderosa pine predominates with scattered juniper stands occurring in the lower, drier elevations.

Watershed Problems and Needs. Approximately 2,000 acres of cropland receive minor flood damage annually. Roads, bridges, culverts, fences, and irrigation facilities are damaged slightly each year by the floods and by silt and debris deposition. The streambanks which are bordered by cropland are eroded slightly each year.

Estimates show that impaired subsurface drainage is a problem on 1,500 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to allow the water to flow to the ditches.

Approximately 18,000 acres of land are composed of soils that are suitable for irrigation. To irrigate this land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed after June 1 on 4,000 acres of presently irrigated land.

Rural domestic water is supplied from springs and wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development might be feasible. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14b-3, Chickahominy Creek

Description. The Chickahominy Creek watershed comprises 88,900 acres in northwestern Harney County. Chickahominy Creek, the main stream, flows from the northwest section into Clusters Lake, a reservoir, and empties into Silver Creek in the eastern section. Silver Creek is the east boundary for about six miles. Dry lakes or playas occur in several locations. U. S. Highway 395 traverses the east end and State Highway 20 goes through the watershed from east to west. The watershed, oriented in a northwest-southeast direction, is approximately 23 miles long and varies from 3 to 11 miles wide. The elevations range from about 4,200 feet to about 5,000 feet. The average annual precipitation is about 11 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four soil groups occur in the watershed. Covering the uplands are two groups of soils developed mostly from volcanic materials. The smaller area of these soils located in the north section and developed under a forest cover is slightly acid to neutral in reaction, dark colored, moderately deep, and moderately developed. The other group of upland soils has moderate profile development, is gently to steeply sloping, and is shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. The older fan and terrace soils are strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce range forage and irrigated and nonirrigated crops. Fan and flood-plain soils along Silver Creek are medium textured, weakly developed, deep to gravel, and well drained except where dikes have created a marshy condition. Irrigated and nonirrigated crops and pasture forage are grown on these soils.

A reconnaissance survey indicates that 88,500 acres of land are used for the production of crops and livestock. Of this acreage, 1,300 acres are grazed forest land, 85,600 acres are rangeland, and 1,600 acres are cropland. Grain is produced on the 400 acres of nonirrigated cropland. The irrigated land produces 1,000 acres of meadow hay and pasture, 100 acres of alfalfa hay, and 100 acres of pasture. No farms are located in the watershed.

Forests cover approximately 1,300 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 300 acres of cropland receive minor flood damage annually. The streambanks which are bordered by cropland suffer slight erosion each year.

Estimates reveal that impaired subsurface drainage is a problem on 200 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to allow the surface water to flow to the ditches.

Approximately 15,000 acres of land are composed of soils that are suitable for irrigation. To irrigate this land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed after June 1 on 700 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution for these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14b-4, Silver Lake

Description. The Silver Lake watershed contains 168,000 acres in Harney and Lake Counties. The portion in Lake County is in the Fort Rock-Silver Lake Soil and Water Conservation District. Approximately 15,700 acres are in the Malheur National Wildlife Refuge. The watershed lies west of Silver Creek which is the east boundary for about 15 miles. It is oriented in a northwest-southeast direction and it is approximately 37 miles long and varies from 6 to 10 miles wide. Moon Reservoir, Silver Lake, and other smaller lakes are located on the flood plain of Silver Creek. Dry or playa lakes occur in several locations. U. S. Highway 395 cuts through the center of the watershed. Elevations vary from about 4,100 feet to 5,745 feet on the west end. Squaw Butte has an elevation of 5,265 feet and Sheep Mountain has an elevation of 5,680 feet. The average annual precipitation ranges from 7 to 15 inches with an average of about 11 inches. The growing season varies from 90 to 120 days in the agricultural area.

Based on parent material and physiography, three soil groups occur in the watershed. The largest section of the watershed is upland soils which were developed mostly from volcanic materials. These soils are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrocks. Range forage is produced on these soils. A small area near Silver Lake and a small area in the west end of the watershed are older fan and terrace soils. They are strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce range forage and irrigated crops. Fan and flood-plain soils near Silver Lake and Silver Creek are medium textured, weakly developed, deep to gravel, and well drained except where dikes have created a marshy condition. Irrigated crops and pasture forage are produced on these soils.

A reconnaissance survey reveals that 169,500 acres of land are used for the production of either livestock or crops. Of this acreage, 2,400 acres are grazed forest land, 158,000 acres are rangeland, and 9,100 acres are cropland. Grain hay is produced on the 200 acres of nonirrigated cropland. The irrigated land produces 5,800 acres of meadow hay and pasture, 2,800 acres of pasture, and 300 acres of grain and alfalfa hay. Two farms are located in the watershed.

Forests cover approximately 2,400 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. No flooding occurs in this watershed.

Estimates disclose that impaired subsurface drainage is a problem on 5,000 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to allow the surface water to flow to the ditches.

Approximately 13,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 2,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To irrigate

the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed after June 1 for 8,500 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution for these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14b-5, Lower Silver Creek

Description. The Lower Silver Creek watershed contains 161,900 acres in Harney County. Approximately 18,600 acres are in the Malheur National Wildlife Refuge. The watershed includes about one-half of Harney Lake and a portion of Mud Lake and extends approximately 34 miles to the northwest with Silver Creek and Moon Reservoir as the southwest boundary. It varies in width from six to nine miles. Several unnamed streams, which flow only intermittently, empty into Silver Creek, Harney Lake, and Mud Lake. Several lakes or playas are located in the central section of the watershed. U. S. Highway 395 and State Highway 20 traverse the northern part of the watershed. The community of Riley is in the northwest portion of the watershed. The elevations vary from 4,030 feet at Harney Lake to about 5,600 feet at the north end. The average annual precipitation ranges from 7 to 24 inches with an average of about 11 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, five groups of soils occur in the watershed. Two groups of soils, which were developed from volcanic materials, cover the uplands. A small area of upland soils in the north section which support a forest cover is slightly acid to neutral in reaction, dark colored, moderately deep, and moderately developed. The other upland soils have moderate profile development, are gently to steeply sloping, and are shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. Older fan and terrace soils in an area north of Harney Lake and along Virginia Creek are strongly developed and neutral in reaction. They have slopes of less than 7 percent and they produce mostly range forage; however, they are suitable for irrigation if water is available. Strongly alkaline flood-plain soils near Harney Lake are moderately deep to very deep and weakly to strongly developed. They produce pasture forage and irrigated and nonirrigated crops. Fan and flood-plain soils near Harney and Mud Lakes and along Silver Creek are medium textured, weakly developed, deep to gravel and well drained except where dikes have created a marshy condition. The land uses are irrigated cropland, nonirrigated cropland, and pasture land.

A reconnaissance survey indicates that 155,000 acres of land are used for the production of livestock and crops. Of this acreage, 12,400 acres are

grazed forest land, 140,400 acres are rangeland, and 2,200 acres are cropland. The 600 acres of nonirrigated cropland produces grain. The irrigation land produces 300 acres of alfalfa hay, 1,100 acres of meadow hay and pasture, 100 acres of grain, and 100 acres of grain and alfalfa hay. Five farms are located in the watershed.

The forests of this watershed cover approximately 12,400 acres. Juniper stands cover the majority of the forest area with ponderosa pine growing in the moister areas.

Watershed Problems and Needs. Approximately 800 acres of land receive minor flood damage annually. No forest land, 200 acres of rangeland on the wetter sites, and 600 acres of cropland are flooded. Roads, bridges, culverts, fences, and irrigation facilities are damaged slightly each year by the floods and by silt and debris deposition. The banks of the streams which are bordered by cropland are damaged slightly by erosion each year.

Estimates disclose that impaired subsurface drainage is a problem on 1,200 acres of arable land along Silver Creek. This land can be drained with open ditches but grading and land shaping might be necessary to permit the surface water to flow to the ditches.

Approximately 40,000 acres of land possess soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 300 acres will be developed for irrigation in the next 10 years and that water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed after June 1 for the 800 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14b-6, Wilson Creek

Description. The Wilson Creek watershed contains 236,900 acres of land in Lake and Harney Counties. The portion in Lake County is in the Fort Rock-Silver Lake Soil and Water Conservation District. The streams flow into a lake in the northeast portion of the watershed. Wilson Creek, the main stream which flows north with its tributary, Rawhide Creek, is joined by Little Tank Creek from the west and by Big Tank Creek from the north. These streams flow only intermittently. U. S. Highway 395 traverses the watershed and the community of Wagontire is located in the west section. Elevations range from about 4,200 feet to 6,510 feet on Wagontire Mountain with most of the watershed below 5,000 feet. The average annual precipitation varies

from 10 to 20 inches with an average of 15 inches. The growing season in the agricultural area varies from 90 to 120 days.

Two groups of soils, based on parent material and physiography, occur in the watershed. The largest portion of the watershed is upland soils which were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and timber are produced on these soils. Older fan and terrace soils in the northern portion are strongly developed and neutral in reaction. The slopes are less than 7 percent and the land use is rangeland and cropland. These soils are suitable for irrigation if water were available.

A reconnaissance survey indicates that 236,000 acres are used for the production of livestock and crops. Of this acreage, 2,100 acres are grazed forest land, 233,200 acres are rangeland, and 700 acres are cropland. Grass is grown on the 200 acres of nonirrigated cropland and meadow hay and pasture are grown on the 500 acres of irrigated cropland. Two farms are located in the watershed.

Forests cover approximately 2,100 acres of this watershed. They consist of primarily juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. No flooding occurs in this watershed.

Impaired subsurface drainage is problem on an estimated 400 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to permit the surface water to flow to the ditches.

Approximately 35,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 500 acres will be developed for irrigation in the next 10 years and that water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be required. Supplemental water is needed after June 1 for the 500 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution for these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14b-7, Buzzard Creek

Description. The Buzzard Creek watershed contains 232,200 acres of land in Harney County. Approximately 700 acres are within the bounds of the

Malheur National Wildlife Refuge. The drainage system is Buzzard Creek and its tributaries which head at Foster Lake, a lake that is usually dry, and flow north to one of the lakes in the vicinity of Iron Mountain and Silver Lake. These streams flow only intermittently. The watershed is approximately 25 miles from north to south and varies from 15 to 20 miles wide. The elevations vary from about 4,200 feet to 5,370 feet on Iron Mountain in the north portion of the watershed. The average annual precipitation varies from about 7 inches to 16 inches with an average of about 13 inches.

Based on parent material and physiography, three groups of soils occur in the watershed. Most of the watershed is upland soils which were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Older fan and terrace soils occur in the northern part and they are strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce mostly range forage. They are suitable for irrigation if water is available. Lake-basin soils around Foster Lake are medium textured, weakly to strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Rangeland and wildlife habitat are the land uses.

A reconnaissance survey indicates that 230,100 acres are used for the production of livestock. Of this acreage, 100 acres are grazed forest land and 230,000 acres are rangeland. There is no cropland and no farms in the watershed.

Forests cover approximately 100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. No flooding occurs in this watershed.

None of the arable land has a drainage problem.

Approximately 12,000 acres of land are composed of soils that are suitable for irrigation. Before this land can be irrigated, construction of storage reservoirs would be necessary.

Opportunities for Project Action. The needs of the watershed are for erosion control, land treatment measures, recreational development, and wildlife development. A P. L. 566 project is not feasible as the solution for these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14b-8, Jackass Creek

Description. This watershed comprises 198,000 acres of land in Harney County. Approximately 30,800 acres are included in the Malheur National Wildlife Refuge. The watershed includes a portion of the Donner und Blitzen drainage with the boundary along the Donner und Blitzen Canal, the Jackass Creek drainage, the area along Mud Lake and Harney Lake, and an area west of

Harney Lake along Silver Creek. The watershed is approximately 32 miles long and varies from 2 to 15 miles wide from east to west. The community of Frenchglen is located along the Donner und Blitzen River in the southern tip of the watershed. Elevations range from 4,030 feet at Harney Lake to 5,710 feet on a peak in the Jackass Mountains. The average annual precipitation varies from about seven to ten inches with an average of eight inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, five groups of soils occur in the watershed. The largest part of the watershed is upland soils which were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. A small area composed of older fan and terrace soils is strongly developed and neutral in reaction. The slopes are less than 7 percent. The soils produce mostly range forage. They are suitable for irrigation if water is available. Lake-basin soils are found between Weed and Harney Lakes. They are medium textured, weakly to strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Irrigated cropland, rangeland, and wildlife habitat are the land uses. Strongly alkaline flood-plain soils around Harney Lake are moderately deep to very deep and weakly to strongly developed. They produce pasture forage and irrigated crops. Fan and flood-plain soils occur along the Donner und Blitzen River and around Weed Lake. They are medium textured, weakly developed, deep to gravel, and well drained except where dikes have created a marshy condition. They are irrigated cropland, nonirrigated cropland, and pasture land.

A reconnaissance survey denotes that 165,300 acres are used for the production of livestock and crops. Of this acreage, 100 acres are grazed forest land, 159,800 acres are rangeland, and 5,400 acres are cropland. The nonirrigated cropland produces grain and the irrigated cropland produces 500 acres of grain, 4,000 acres of meadow hay and pasture, and 800 acres of grain and alfalfa hay.

Forests cover approximately 100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Only a small area in the Malheur National Wildlife Refuge suffers flood damage.

Impaired subsurface drainage is a problem on an estimated 1,200 acres of arable land on the flood plain of the Donner und Blitzen River. This land can be drained with open ditches but grading and land shaping might be necessary to permit the surface water to flow to the ditches.

Approximately 20,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 100 acres will be developed in the next 10 years and that water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water or the construction of storage reservoirs would be necessary. One reservoir site (index number 20), investigated by the Bureau of Reclamation, has an estimated storage capacity of 120,000 acre feet and would provide irrigation, flood protection, and

recreational benefits. Supplemental water is needed from May 1 to June 1 on 5,300 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

ALVORD-CATLOW SUBBASIN

Watershed 14-1, Alvord Ranch

Description. The Alvord Ranch watershed contains 154,600 acres in Harney and Malheur Counties. No defined streams flow out of the Sheepshead Mountains. The Cottonwood, Mosquito, Big Alvord, Little Alvord, Pike, and Indian Creeks flow out of the Steens Mountain into the Alvord Desert. Elevations in the watershed range from about 4,045 feet to 9,670 feet with most of the agricultural land below 4,300 feet. Average annual precipitation ranges from 8 to 25 inches. The growing season in the agricultural area varies from 120 to 140 days.

Five groups of soils, based on parent material and physiography, occur in the watershed. The two upland soil groups are developed mostly from volcanic materials except for a small area of soils below 5,600 feet developed from metamorphosed sedimentary rocks. They are moderately developed, shallow over silica-lime hardpans and bedrock, and gently to steeply sloping. They produce range forage. A large area of strongly alkaline flood-plain soils covers the lowest portion of the watershed including Alvord Desert. These soils are moderately to very deep and weakly to strongly developed. About two-thirds of the area is class VIII and one-third produces pasture and irrigated crops. Fan and flood-plain soils in a large area along the west side of the valley are medium textured, weakly developed, and deep to gravel. They are cropland if water is available for irrigation. Actively moving dune land occurs along the east side of Alvord Desert.

A reconnaissance survey indicates that 146,400 acres are used for the production of crops and livestock. Of this acreage, 1,100 acres are grazed forest land, 139,100 acres are rangeland, and 6,200 acres are cropland. The cropland is irrigated and 1,200 acres of alfalfa hay and 5,000 acres of meadow hay and pasture are grown. There is only one farm in the watershed.

Juniper and isolated stands of aspen in the higher, moister areas near creeks or springs constitute the cover on the 1,100 acres of forest land.

Watershed Problems and Needs. Approximately 400 acres receive minor flood damage annually. No forest land, 300 acres of rangeland on the wetter sites, and 100 acres of cropland are flooded. Silt and debris deposition damages roads, bridges, culverts, and fences slightly each year. Irrigation

facilities are damaged moderately to severely each year.

Estimates reveal that 500 acres of arable land have soil drainage problems. This land can be drained with open ditches but grading and land shaping might be necessary to convey the surface water to the ditches.

About 82,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 4,500 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs or ground water To irrigate the total potentially irrigable land, the development of ground water or the importation of water from outside the basin would be necessary. Supplemental water is needed after July 1 on 5,000 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14-2, Alvord Lake

Description. The Alvord Lake watershed contains 183,700 acres in Harney County. It is oriented mostly in a north-south direction and is approximately 17 miles wide and long. The west boundary follows the Steens Mountains for approximately 24 miles. The Wildhorse, Carlson Creeks, and several other streams flow from the Steens Mountains into Alvord Lake which is in about the center of the watershed in the valley floor. Trout Creek flows from the south and other streams flow from the east. The elevations vary from 4,040 feet at Alvord Lake to 9,670 feet on a peak in the Steens Mountains. The average annual precipitation ranges from 7 to 15 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, six groups of soils occur in the watershed. The upland soils above 5,600 feet in the Steens Mountains are developed mostly from volcanic materials and they are moderately developed, shallow over silica-lime hardpans and bedrock, and gently to steeply sloping. The upland soils produce mostly range forage. Older fan and terrace soils on either side of the valley are weakly to strongly developed and neutral in reaction. They border the lake basins and flood plains, and have slopes of less than 7 percent. They are mostly range but are suitable for irrigated cropland. A large area of strongly alkaline flood-plain soils lies on the valley floor near Alvord Lake. These soils are moderately to very deep and weakly to strongly developed and they produce pasture and irrigated crops. An area of fan and flood-plain soils along Wildhorse Creek are medium textured, weakly developed, and deep to gravel. They are cropland if water is available for irrigation. An area of actively moving sand dunes is found in the

northeast section of the watershed.

A reconnaissance survey indicates that 179,500 acres are used for the production of crops and livestock. Of this acreage, 1,100 acres are grazed forest land, 172,500 acres are rangeland, and 5,900 acres are cropland. The cropland is irrigated and includes 200 acres of alfalfa hay, 2,400 acres of meadow hay and pasture, and 3,300 acres of irrigated pasture. Six farms are located in the watershed.

Forests cover approximately 1,100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 100 acres of rangeland receive minor flood damage annually. Silt and debris deposition damages roads, bridges, culverts, fences, and irrigation facilities slightly each year. About two miles of stream channel suffer damage from flooding and erosion each year.

Estimates disclose that impaired subsurface drainage is a problem on 300 acres of arable land. This land can be drained with open ditches but grading and land shaping might be necessary to conduct the surface water to the ditches.

About 105,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 2,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied mostly from ground water. To irrigate the total potentially irrigable land, the development of ground water or the importation of water from outside the basin would be necessary. Supplemental water is needed from May 1 to July 1 for 5,800 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development might be feasible. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14-3, Trout Creek

Description. The Trout Creek watershed contains 150,500 acres in Harney County. It lies in an east-west direction and extends from the summit of the Trout Creek Mountains on the east to the Steens and Pueblo Mountains on the west. The watershed is approximately 36 miles long and ranges from 3 to 12 miles wide. The main drainage is Trout Creek with its tributaries, Little Trout and Stony Creeks, which head in the Trout Creek Mountains. The Fields, Secena, Horse, Willow, and Cottonwood Creeks head in the Steens-Pueblo

Mountain area and flow eastward to the valley. The elevations range from 4,160 feet to 8,545 feet in the Pueblo Mountains and more than 7,900 feet in the Trout Creek Mountains. The average annual precipitation ranges from about 10 to 25 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, five soil groups occur in the watershed. The two upland soil groups are developed mostly from volcanic materials and they are moderately developed, shallow over silica-lime hardpans and bedrock, and gently sloping to steeply sloping. They produce mostly range forage. The older fan and terrace soils are weakly to strongly developed and neutral in reaction. They border the lake basins and flood plains with slopes of less than 7 percent. They are mostly range but these soils are suitable for irrigated cropland. A small area of lake-basin soils in the southern section of the watershed is medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses of the soils. An area in the lowest portion of the watershed is strongly alkaline flood-plain soils. They are moderately deep to very deep, weakly to strongly developed, and produce pasture and irrigated crops. In the bottom along Trout Creek, a fairly large area of fan and flood-plain soils was developed. These soils are medium textured, weakly developed, and deep to gravel.

A reconnaissance survey denotes that 149,900 acres of land are used for the production of crops and livestock. Of this acreage, 2,100 acres are grazed forest land, 141,500 acres are rangeland, and 6,300 acres are cropland. The cropland is irrigated and it produces 300 acres of small grain, 200 acres of alfalfa hay, and 3,500 acres of meadow hay and pasture. Ten farms are located in the watershed.

Forests cover approximately 2,100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Only a small area is flooded; however, about two miles of stream channel suffer bank cutting and erosion annually.

Estimates disclose that impaired subsurface drainage is a problem on 600 acres of arable land. This land may be drained with open ditches but grading and land shaping might be necessary to conduct the surface water to the ditches.

Approximately 36,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 2,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied mostly from ground water. To irrigate the total potentially irrigable land, the development of ground water or the importation of water from outside the basin would be necessary. One reservoir site (index number 23), investigated by the Soil Conservation Service, has an estimated storage capacity of 10,000 acre feet and it would provide irrigation, flood protection, and recreational use. Supplemental water is needed from June 1 to July 1 for 3,200 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. A P. L. 566 project which would include flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development appears to be feasible. Some of the problems for all or a portion of the watershed could be solved by non-project means such as the pooling agreement provision of the Agricultural Conservation Program or individual action.

Watershed 14-4, Pueblo Slough

Description. The Pueblo Slough watershed comprises 110,500 acres in Harney County. It lies along the state of Nevada with the west boundary in the Pueblo Mountains and the east boundary in the Trout Creek Mountains. It is approximately 24 miles long and varies from 2 to 10 miles wide. The drainages from the Pueblo Mountains include Van Horn and Denio Creeks, and other streams and the drainages from the Trout Creek Mountains are the Oreana, Red Mountain, Dry, and Cottonwood Creeks. Pueblo Slough on the valley floor drains northward into Tum Tum Lake. Elevations in the watershed range from 4,100 to about 8,000 feet in the Pueblo and Trout Creek Mountains. The average annual precipitation ranges from about 10 to 25 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, six soil groups occur in the watershed. The upland soils above 5,600 feet are developed from mostly volcanic materials and they are moderately developed, shallow over silica-lime hardpans and bedrock, and gently to steeply sloping. They produce mostly range forage. The upland soils below 5,600 feet on the west side of the valley were developed from metamorphosed sedimentary rocks and on the east side from volcanic materials. They are moderately developed, shallow over silica-lime hardpans and bedrock, and gently to steeply sloping. They produce mostly range forage. The older fan and terrace soils are weakly to strongly developed and neutral in reaction. They border the lake basins and flood plains, and have slopes of less than 7 percent. They are mostly range but these soils are suitable for irrigated cropland. A strip of lake-basin soils through the central section of the watershed is medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses of the soils. A smaller area in the lowest portion of the watershed is strongly alkaline flood-plain soils. These soils are moderately deep to very deep, weakly to strongly developed, and they produce pasture and irrigated cropland.

A reconnaissance survey denotes that 110,000 acres of land are used for the production of crops and livestock. Of this acreage, 1,100 acres are grazed forest land, 105,400 acres are rangeland, and 1,500 acres are cropland. All of the cropland is irrigated and it produces 50 acres of small grain, 150 acres of alfalfa hay, and 1,300 acres of meadow hay and pasture. Seven farms are located in the watershed.

Forests cover approximately 1,100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Only a small area is flooded; however, about two miles of stream channel suffer damage from erosion each year.

None of the arable land has a drainage problem.

Approximately 51,000 acres of land possess soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 2,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied mostly from ground water. To irrigate the total potentially irrigable land, the development of ground water or the importation of water from outside the basin would be necessary. Supplemental water is needed from June 1 to July 1 for 1,300 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for erosion control, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14a-3, Mann, Tudor, and Fifteencent Lakes

Description. This watershed contains 223,000 acres in Harney and Malheur Counties. Located in the northern end of the Alvord Desert area, the Steens Mountains are on the west boundary and the Sheepshead Mountains are on the east boundary. It is approximately 28 miles long from north to south and approximately 15 miles from east to west. Mann, Tudor, Tencent, Juniper, Fifteencent, Heath Lakes and several unnamed lakes are located in this watershed. Most of these lakes have water in them only during the spring-flood runoff. Heath Creek drains from the Sheepshead Mountains and Squaw and Stonehouse Creeks and several other streams drain from the Steens Mountains. Elevations range from 4,055 feet near Follyfarm to 9,255 feet on a peak of the Steens Mountains in the southwest corner of the watershed. The average annual precipitation ranges from 10 to 25 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, three groups of soils occur in the watershed. The two groups of upland soils are developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is the main crop on them. Fan and flood-plain soils occur along Follyfarm, Tencent, Fifteencent, Tudor, and Mann Lakes in a band from one to four miles wide for the entire length of the watershed. They are medium textured, weakly developed, and deep to gravel. They are rangeland unless water is available and then they are cropland.

A reconnaissance survey indicates that 222,100 acres are used for the production of crops and livestock. Of this acreage, 2,200 acres are grazed forest land, 216,900 acres are rangeland, and 3,000 acres are cropland. All

the cropland is irrigated and 2,200 acres of meadow hay and pasture and 800 acres of pasture are grown. Only one farm is located in the watershed.

Forests cover approximately 2,200 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 600 acres receive minor flood damage annually. No forest land, 500 acres of rangeland, and 100 acres of cropland are flooded. Silt and debris deposition damages roads, bridges culverts, fences, and irrigation facilities slightly each year. About five miles of streams suffer stream channel damage each year and require channel alignment and cleaning.

None of the arable land has a drainage problem.

Approximately 39,000 acres of land are composed of soils that are suitable for irrigation. To irrigate this land, the development of ground water or the importation of water from outside the basin would be required. Supplemental water is needed from June 1 to July 1 on 2,900 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10a-1, Coyote Lake

Description. The Coyote Lake watershed comprises 153,900 acres of land in Harney and Malheur Counties. It is oriented mostly in a northeast-southwest direction and it is approximately 30 miles long and varies in width from 5 to 10 miles. This watershed is characterized by an indistinct drainage system, large areas of dunes, and a large dry lake. Elevations vary from a low point of 4,040 feet to 5,050 feet in the north and 5,590 feet in the south. The average annual precipitation ranges from 8 to 10 inches. The growing season in the agricultural area ranges from 90 to 120 days.

Based on parent material and physiography, five groups of soils occur in the watershed. The upland soils below 5,600 feet are developed mostly from volcanic materials. They are moderately developed, shallow over silica-lime hardpans and bedrock, and gently to steeply sloping. They produce mostly range forage. Older fan and terrace soils in the east side of the watershed are weakly to strongly developed and neutral in reaction. These soils border the lowland around Coyote Lake, have slopes of less than 7 percent and are mostly range; however, they are suitable for irrigated cropland. Near Coyote Lake, lake-basin soils occur which are medium textured, weakly to

strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses of these soils. In the southern section, an area of fan and flood-plain soils is medium textured, weakly developed, and deep to gravel. These soils are cropland if water is available and otherwise they are rangeland. A small portion along the west boundary of the watershed is actively moving sand dunes.

A reconnaissance survey denotes that 108,800 acres of land are used for the production of crops and livestock. Of this acreage, 108,200 acres are rangeland and 600 acres are cropland. All the cropland is irrigated and it produces meadow hay and pasture. No farms are located in the watershed.

Watershed Problems and Needs. Only a small area is flooded annually. None of the arable land has a drainage problem.

Approximately 48,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 3,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied mostly from ground water. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed after July 1 on the 600 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for irrigation water management and land treatment measures. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10a-2, Twelvemile Creek

Description. The Twelvemile Creek watershed comprises 105,500 acres in Malheur County. It lies in a north-south direction and is approximately 27 miles long and varies from 3 to 10 miles wide. Twelvemile and Antelope Creek and other streams drain from the Trout Creek Mountains toward Coyote Lake. Elevations in the watershed vary from 4,040 feet to more than 7,000 feet. The average annual precipitation ranges from 8 to 10 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four groups of soils occur in the watershed. The two groups of upland soils are developed mostly from volcanic materials and are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. They produce mostly range forage. Older fan and terrace soils in the central section bordering the lowland around Coyote Lake are weakly to strongly developed and neutral in reaction. Pasture is produced on them. Lake-basin soils near Coyote Lake are medium textured, weakly to strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife

habitat are the land uses of these soils.

A reconnaissance survey reveals that 104,700 acres are used for the production of crops and livestock. Of this acreage, 100 acres are grazed forest land, 104,200 acres are rangeland, and 400 acres are cropland. All the cropland is irrigated and it produces meadow hay. Only one farm is located in the watershed.

Forests cover approximately 100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Only a small area is flooded annually. None of the arable land has a drainage problem.

Approximately 43,000 acres of land are composed of soils that are suitable for irrigation. It has been estimated that 5,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied mostly from ground water. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be required. Supplemental water is needed after June 1 for the 400 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for irrigation water management and land treatment measures. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10a-3, Whitehorse Creek

Description. The Whitehorse Creek watershed contains 190,200 acres of land in Harney and Malheur Counties. It is oriented in a north-south direction and is approximately 27 miles long and ranges from 2 to 22 miles in width. Whitehorse, Fish, Doolittle, Fifteenmile, and Willow Creeks drain from the Trout Creek Mountains to the north. Elevations range from about 4,200 feet to about 7,600 feet. The average annual precipitation ranges from 8 to 20 inches. The annual growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four soil groups occur in the watershed. The two groups of upland soils are developed mostly from volcanic materials and are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. They produce mostly range forage. Older fan and terrace soils in the west section are weakly to strongly developed and neutral in reaction. They produce pasture. The fan and floodplain soils on the flood plain of Willow and Whitehorse Creeks are medium textured, weakly developed, and deep to gravel. They are cropland if water is available and otherwise they are rangeland.

A reconnaissance survey reveals that 189,700 acres are used for the production of crops and livestock. Of this acreage, 2,100 acres are grazed forest land, 183,900 acres are rangeland, and 3,700 acres are cropland. All the cropland is irrigated and 1,300 acres of alfalfa hay, 400 acres of small grain, 1,900 acres of meadow hay and pasture, and 100 acres of pasture are produced. Only one farm is located in the watershed.

Forests cover approximately 2,100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in higher, moister spots near creeks or springs.

Watershed Problems and Needs. Only a small area is flooded annually.

Estimates disclose that impaired subsurface drainage is a problem on 400 acres of arable land. This land may be drained with open ditches but grading and land shaping might be necessary to conduct the surface water to the ditches.

Approximately 56,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 3,000 acres will be developed for irrigation in the next 10 years and that the water will be supplied mostly from ground water. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed from June 1 to July 1 for 400 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-1, Rock Creek

Description. The Rock Creek watershed comprises 233,800 acres of land in Lake and Harney Counties. The portion in Lake County is in the Lakeview Soil and Water Conservation District. The watershed is oriented in a northeast-southwest direction and is approximately 28 miles long. The width varies from about 6 miles to 18 miles. The major drainage is Rock Creek which heads in Hart Mountain and flows northeast into Catlow Valley. A few other streams and lakes, including Oreana Canyon, Flook Lake, and several playas or intermittent lakes, constitute the drainage system. The elevations vary from about 4,550 feet to 7,585 feet. The average annual precipitation ranges from 8 to 25 inches with an average of 11 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, five groups of soils occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. A very small area of fan and terrace soils occurs in the east end of the watershed and the soils are weakly to strongly developed and neutral in reaction. They have slopes of less that 7 percent and are producing mostly range forage. The area of lake-basin soils in the Catlow Valley is medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses. A fairly large area of fan and flood-plain soils occurs in the east section. These soils are medium textured, weakly developed, and deep to gravel. Most of these soils produce range forage.

A reconnaissance survey denotes that 233,000 acres of land are used for the production of crops and livestock. Of this acreage, 1,000 acres are grazed forest land, 230,400 acres are rangeland, and 1,600 acres are irrigated cropland. The cropland produces hay and pasture. Three farms are located in the watershed.

Forests cover approximately 1,000 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 500 acres of land receive minor flood damage annually. No forest land, 200 acres of rangeland, and 300 acres of cropland are flooded. Silt and debris deposits damage roads and bridges slightly each year.

Estimates disclose that impaired subsurface drainage is a problem on 200 acres of arable land. This land can be drained with open ditches.

Approximately 34,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 2,400 acres will be developed for irrigation in the next 10 years and that the water will be supplied from reservoirs. To develop the total potentially irrigable land, it would be necessary to construct storage reservoirs. No shortage of water for the presently irrigated land has been reported.

Rural domestic water is supplied from wells and springs.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution for these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-2, Guano Slough

Description. The Guano Slough watershed contains 249,800 acres of land in Harney and Lake Counties. It is in the Beattys Butte area and extends west to the Hart Mountain area. The portion in Lake County is in the Lakeview Soil and Water Conservation District. This watershed is approximately 27 miles from east to west and varies from 5 to 20 miles from north to south. Several playas or intermittent lakes, including Alger Lake, occur in the watershed. Guano Slough, the main stream, and some ill-defined tributaries compose the drainage system. The elevations range from about 4,550 feet to 7,885 feet on Beattys Butte and slightly more than 7,000 feet on Hart Mountain. The average annual precipitation ranges from 8 to 20 inches with an average of 12 inches.

Based on parent material and physiography, four soil groups occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Older fan and terrace soils in the eastern section are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are producing mostly range forage; however, if water is available, they are suitable for irrigated cropland. The area of lake-basin soils along Guano Slough is medium textured, weakly to strongly developed and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses.

A reconnaissance survey reveals that 246,400 acres of land are used for the production of livestock. Of this acreage, 200 acres are grazed forest land and 246,200 acres are rangeland. No farms are located in the watershed.

Forests cover approximately 200 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 100 acres of rangeland receive minor damage from floods annually.

None of the arable land has a drainage problem.

About 65,000 acres of land are composed of soils that are suitable for irrigation. To develop this land for irrigation, the construction of storage reservoirs in the watershed or the importation of water from outside the basin would be required.

Rural domestic water is supplied from a well.

Opportunities for Project Action. The needs of the watershed are for erosion control, land treatment measures, recreational development, and wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-3, Catlow Valley

Description. The Catlow Valley watershed comprises 209,700 acres of land in Harney County. Lying in a north-south direction, the east, north, and northwest boundaries are in Catlow Valley and the southwest boundary is in the lowlying hills which rise from the valley. The watershed is approximately 35 miles long and ranges from 7 to 15 miles from east to west. Approximately two-thirds of the watershed is the alluvial lowland of Catlow Valley at 4,550 to 4,600 feet elevation. The lowlying hills in the southwest portion range in elevation from 4,600 feet to 7,030 feet. There are no well defined stream courses in the alluvial plain and a few small intermittent streams flow from the hills. The average precipitation ranges from 8 to 20 inches with an average of 9 inches. The growing season in the agricultural area varies from 80 to 100 days.

Based on parent material and physiography, five groups of soils occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Narrow strips of older fan and terrace soils lie adjacent to the upland soils and they are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are producing range forage; however, if water were available, they would be suitable for irrigated cropland. The area of lake-basin soils in the Catlow Valley is medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses. An area of approximately 2,500 acres of actively moving dune land is found in the southern portion of the watershed.

A reconnaissance survey denotes that 205,100 acres of land are used for the production of crops and livestock. Of this acreage, 400 acres are grazed forest land, 204,300 acres are rangeland, and 400 acres are cropland. The irrigated cropland produces meadow hay and pasture and the nonirrigated cropland produces grass. No farms are located in this watershed.

Forests cover approximately 400 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. No flooding occurs in the watershed. None of the arable land has a drainage problem.

Approximately 120,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 10,000 acres will be developed for irrigation in the next 10 years and that water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. Supplemental water is needed after July 1 for the 300 acres of presently irrigated land.

Opportunities for Project Action. The needs of the watershed are for erosion control, irrigation water management, and land treatment measures.

A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-4, Roaring Springs

Description. The Roaring Springs watershed contains 225,700 acres of land in Harney County. It lies in a north-south direction with the border along the top of the Steens Mountains and covers the flootslopes of these mountains and the east section of the Catlow Valley. The west boundary is the low elevation point of Catlow Valley. The watershed is approximately 40 miles from north to south and ranges from 5 to 15 miles from east to west. Some small lakes or reservoirs are found in the mountainous area and in the valley. The streams flow from the mountains into the valley; some of these are Long Hollow, Skull Creek, Threemile Creek, Home Creek, Dry Creek, Black Canyon, Kuney Canyon, and Solomon Canyon. The elevations range from 4,550 feet to 7,710 feet and 7,075 feet on Alvord Peak. The average precipitation ranges from 8 to 15 inches with an average of 11 inches. The growing season in the agricultural area varies from 80 to 100 days.

Based on parent material and physiography, four groups of soils occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage and forests are produced on these soils. A narrow strip of older fan and terrace soils lies along the upland soils and the soils are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are producing mostly range forage; however, if water were available, they would be suitable for irrigated cropland. The area of lake-basin soils in the Catlow Valley is medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses of these soils.

A reconnaissance survey denotes that 221,400 acres of land are used for the production of crops and livestock. Of this acreage, 3,100 acres are grazed forest land, 210,300 acres are rangeland, and 8,000 acres are cropland. The nonirrigated cropland produces 1,000 acres of small grain and 500 acres of grass. The irrigated cropland produces 150 acres of alfalfa hay, 5,850 acres of meadow hay and pasture, and 500 acres of pasture. Three farms are located in the watershed.

Forests cover approximately 3,100 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. No flooding occurs in the watershed. Estimates disclose that impaired subsurface drainage is a problem on 100 acres of arable land. This land can be drained with open ditches.

Approximately 50,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee

has estimated that 5,500 acres will be developed in the next 10 years and that the water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water in the watershed or the importation of water from outside the basin would be necessary. One reservoir site (index number 21), investigated by the Soil Conservation Service, has an estimated storage capacity of 900 acre feet and it would provide irrigation and recreational benefits. Supplemental water is needed after July 1 for the 6,500 acres of presently irrigated land.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, drainage, irrigation water management, land treatment measures, recreational development, and fish and/or wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-5, Guano Lake

Description. The Guano Lake watershed comprises 151,600 acres of land in Lake and Harney Counties. The portion in Lake County is in the Lakeview Soil and Water Conservation District. This watershed, in the southwest corner of the basin, extends from Hart Mountain southeastward. It is approximately 27 miles long and varies in width from 6 to 13 miles. Several lakes and reservoirs, such as Shirk Lake, Guano Lake, and Spaulding Reservoir, occur in the watershed. Most of these lakes have water in them only during the runoff time in the spring. Guano Creek from the northwest is the major stream which flows into Shirk Lake and Guano Lake. Spaulding Creek in the east portion flows northwest. The elevations range from 5,100 feet to 7,710 feet on Hart Mountain and 8,065 feet on Mt. Warner. The average annual precipitation ranges from 9 to 25 inches with an average of 14 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four groups of soils occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Older fan and terrace soils in the central section are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are producing mostly range forage. If water were available, they would be suitable for irrigated cropland. An area of lake-basin soils near Guano Lake is medium textured, weakly to strongly developed, and about 20 inches deep over a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses of these soils.

A reconnaissance survey denotes that 148,900 acres are used for the production of crops and livestock. Of this acreage, 500 acres are grazed forest land, 147,100 acres are rangeland, and 1,300 acres are cropland. One thousand acres of cropland are producing nonirrigated grass and 300 acres of irrigated meadow hay and pasture. Only one farm is located in this area.

Forests cover approximately 500 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 200 acres of cropland and rangeland suffer minor flood damage annually. Silt and debris deposition damages roads, bridges, and culverts slightly each year.

None of the arable land has a drainage problem.

About 33,000 acres of land are composed of soils that are suitable for irrigation. To irrigate all of this land, the development of ground water in the watershed or the construction of storage reservoirs would be required. No shortage of water for the presently irrigated land has been reported.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for irrigation water management and land treatment measures. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-6, Jack Creek

Description. The Jack Creek watershed contains 117,200 acres of land in Lake County and the Lakeview Soil and Water Conservation District. The state line of Nevada is the south boundary of the watershed and the basin boundary is the west border of the watershed. The watershed is triangular with the point extending to the north in the Wool Lake area. It is approximately 25 miles from north to south and approximately 16 miles wide along the Nevada line. There are several lakes and reservoirs including Wool Lake, Jack Lake, "MC" Reservoir, Little Reservoir, and Barry Reservoir. Some of these are dry most of the year. The streams are indistinct and intermittent. The elevations range from 5,100 feet to 6,890 feet. The average annual precipitation is between 8 and 10 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four groups of soils occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Older fan and terrace soils in the south part are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are mostly rangeland; however, they are suited for irrigated cropland. A small area in the lowest portion of the watershed of strongly alkaline flood-plain soils is moderately deep to very deep and weakly to strongly developed and the soils produce pasture and irrigated crops. An area of lake-basin soils near Guano Lake is medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, rangeland, and wildlife habitat are the land uses of these soils.

A reconnaissance survey discloses that 115,900 acres are used for the production of crops and livestock. Of this acreage, 400 acres are grazed forest land, 114,900 acres are rangeland, and 600 acres are cropland. All the cropland is irrigated and meadow hay and pasture are grown on it. Only one farm is located in the watershed.

Forests cover approximately 400 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 1,300 acres of rangeland suffer minor flood damage annually. Silt and debris deposition damages roads, bridges, and culverts slightly each year.

None of the arable land has a drainage problem.

About 15,000 acres of land are composed of soils that are suitable for irrigation. To irrigate all this land, the development of ground water in the watershed or the construction of storage reservoirs would be required. No shortage of water for the presently irrigated land has been reported.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, irrigation water management, land treatment measures, wildlife development, and water quality control. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 10-7, Shallow Lake

Description. The Shallow Lake watershed contains 248,600 acres in Harney and Lake Counties. The portion in Lake County is in the Lakeview Soil and Water Conservation District. The state line is the south boundary and the west boundary generally parallels the Harney-Lake County line. The watershed is shaped rectangular and is approximately 22 miles long from north to south and varies from 15 to 20 miles from east to west. This watershed is almost all drained internally with a majority of the streams flowing into Shallow Lake during spring runoff time. The elevations range from less than 5,100 feet to 7,030 feet on a peak in the northwest corner of the watershed. The average annual precipitation is 10 inches.

Three groups of soils, based on parent material and physiography, occur in the watershed. The two groups of upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. Older fan and terrace soils in the northern portion are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are mostly rangeland; however, they are suited for irrigated cropland.

A reconnaissance survey indicates that 244,400 acres are used for the production of livestock. All this land is rangeland. There are no farms in the watershed.

Watershed Problems and Needs. No flooding occurs in the watershed. None of the arable land has a drainage problem.

Approximately 44,000 acres of land are composed of soils that are suitable for irrigation. To irrigate the total potentially irrigable land, the development of ground water and the construction of storage reservoirs in the watershed or the importation of water from outside the basin would be necessary.

Opportunities for Project Action. The only need reported in the watershed is for land treatment measures which could be taken care of by individual action.

Watershed 10-8, Rincon Creek

Description. The Rincon Creek watershed comprises 190,400 acres in Harney County. The state line of Nevada is the south boundary and the top of the Pueblo Mountains is the east boundary of the watershed. It is roughly triangular in shape with each side approximately 22 to 26 miles long. Rincon Creek and its tributaries drain south into Nevada. Elevations range from about 4,800 feet to 8,545 feet in the Pueblo Mountains. The average annual precipitation ranges from 10 to 15 inches with an average of 11 inches. The growing season in the agricultural area varies from 90 to 120 days.

Four groups of soils, based on parent material and physiography, occur in the watershed. The two groups of upland soils are developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. The main vegetation produced on them is range forage. Older fan and terrace soils in the central portion are weakly to strongly developed and neutral in reaction. They have slopes of less than 7 percent and are mostly rangeland; however, they are suitable for irrigated cropland. Two small areas of lake-basin soils occur along the southern border. They are medium textured, weakly to strongly developed, and about 20 inches deep to a semi-permeable silica hardpan. Irrigated cropland, range, and wildlife habitat are the land uses of these soils.

A reconnaissance survey indicates that 181,400 acres are used for the production of crops and livestock. Of this acreage, 500 acres are grazed forest land, 180,800 acres are rangeland, and 100 acres are cropland. All the cropland is irrigated and small grain is grown. No farms are located in the watershed.

Approximately 500 acres consist primarily of juniper cover with isolated stands of aspen located in the higher, wetter spots near creeks or springs.

Watershed Problems and Needs. No land is damaged by floods in the watershed. None of the arable land has a drainage problem.

Approximately 47,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 5,000 acres will be developed for irrigation in the next 10 years and that water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water and the construction of storage reservoirs or the importation of water from outside the basin would be required. Supplemental water is needed for the 100 acres of presently irrigated land after July 1.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, irrigation water management, and wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.

Watershed 14b-9, Clover Creek

Description. The Clover Creek watershed contains 198,900 acres in Harney County. This watershed includes Clover Creek, Clover Swale, Loggerhead Canyon, Waterhole Canyon, and several unnamed streams which flow into Catlow Valley. In the north section, internally drained Keg Springs Valley receives the drainage of a small portion of the watershed. The streams flow only intermittently. Several playa lakes and the Walls Lake Reservoir are located in the watershed. Elevations range from 4,575 feet to 5,270 feet in the northwest corner. Average annual precipitation ranges from about 9 to 15 inches with an average of about 10 inches. The growing season in the agricultural area varies from 90 to 120 days.

Based on parent material and physiography, four groups of soils occur in the watershed. The upland soils were developed mostly from volcanic materials. They are moderately developed, gently to steeply sloping, and shallow over silica-lime hardpans and bedrock. Range forage is produced on these soils. An area in the south section of older fan and terrace soils is strongly developed and neutral in reaction. The soils have slopes of less than 7 percent and they produce mostly range forage; however, they are suitable for irrigation if water were available. Areas of lake-basin soils in the south, west, and north section of the watershed are medium textured, weakly to strongly developed, and about 20 inches to a semi-permeable silica hardpan. Irrigated cropland, rangeland, and wildlife habitat are the land uses. Fan and flood-plain soils occur in two small portions of the watershed. They are medium textured, weakly developed, and deep to gravel and are cropland if water is available.

A reconnaissance survey denotes that 197,500 acres are used for the production of livestock and crops. Of this land, 200 acres are grazed forest land, 196,100 acres are rangeland, and 1,200 acres are cropland. The cropland is nonirrigated and produces 200 acres of grain and 100 acres of grass. Two farms are located in the watershed.

Forests cover approximately 200 acres of this watershed. They consist primarily of juniper and isolated stands of aspen in the higher, moister spots near creeks or springs.

Watershed Problems and Needs. Approximately 100 acres of cropland receive minor flood damage annually.

Impaired subsurface drainage on arable land is not a problem in this watershed.

Approximately 61,000 acres of land are composed of soils that are suitable for irrigation. The Harney County Conservation Needs Inventory Committee has estimated that 1,000 acres will be developed in the next 10 years and that water will be supplied from reservoirs. To irrigate the total potentially irrigable land, the development of ground water or the importation of water from outside the basin would be required.

Rural domestic water is supplied from wells.

Opportunities for Project Action. The needs of the watershed are for flood protection, erosion control, irrigation water management, and wildlife development. A P. L. 566 project is not feasible as the solution of these problems; however, the problems might be solved under the pooling agreement provision of the Agricultural Conservation Program or by individual action.