JOHN DAY RIVER BASIN

STATE OF OREGON

WATER RESOURCES DEPARTMENT

SALEM, OREGON

November 1986

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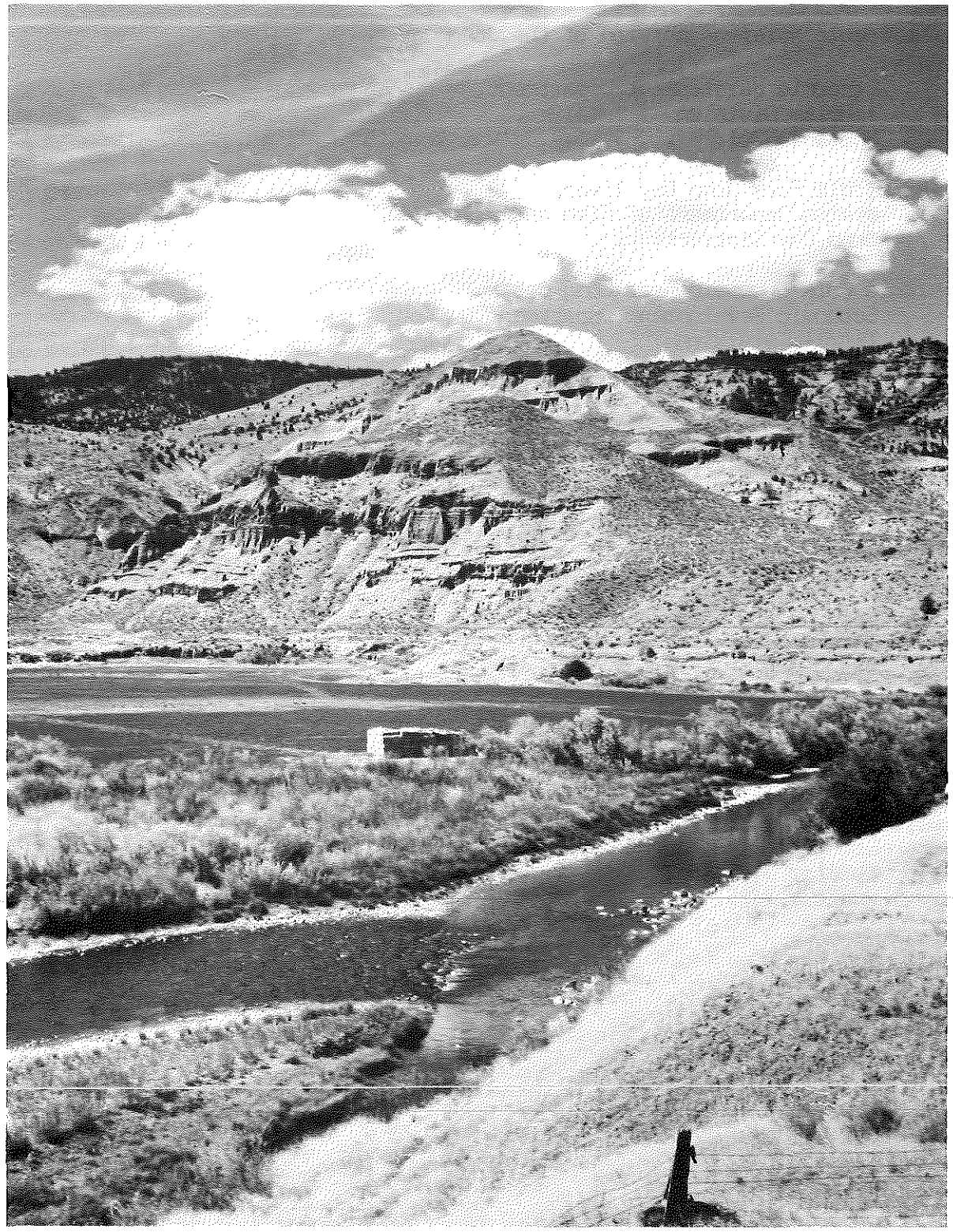


**The John Day River flows through a typical basin landscape --
higher elevation forests, mid-elevation rangelands, and streamside irrigated hay fields.**

SUMMARY

This report examines the current conditions and problems affecting the water resources of the John Day River Basin. Its purpose is to provide information for use in formulating a basin water management program as required by Oregon law. Problems are identified in this report, but no solutions are proposed. The water management plan will address the identified problems.

The John Day Basin is a semi-arid area of about 8,100 square miles in Northeastern Oregon. The basin is characterized by diverse landforms which range from loess-covered plateaus in the northwest to glaciated alpine peaks in the southeast. Streamflow is derived primarily from melting snow, with most runoff occurring in April and May. Highest peak flows generally result from rain falling on snow in December and January. During late summer, streamflow is largely dependent upon ground water discharge. The major tributaries of the John Day River are the North, Middle, and South Forks. Average annual discharge of the John Day River is nearly 1.5 million acre-feet.

Approximately 14,000 people live in the basin. Major cities include Arlington, Condon, Fossil, Mitchell, John Day, Canyon City, and Prairie City. The economy is heavily based on timber and agriculture. The forest products industry is most important in the forested upper portions of the basin around Spray, John Day, and Prairie City. Livestock agriculture is important throughout the basin. Cattle ranching and associated hay crops are major components of this activity. Grass and alfalfa hay, grown mostly along stream bottoms above Service Creek, are the predominant irrigated crops in the basin. On the plateaus of the lower basin, dryland production of grain crops is the major economic activity. The timber and livestock industries are cyclic in nature and have experienced declines in recent years. However, tourism and recreation are growing and now constitute a significant sector of the basin economy.

The major out-of-stream water use is irrigation. Nearly 65,000 acres in the basin are irrigated. Ground water use is very limited and mostly for domestic and municipal purposes. The major instream uses are for fish life and pollution abatement. The John Day Basin has one of the last wild runs of anadromous fish east of the Cascades. Historically, over 6,000 spring chinook salmon and 35,000 steelhead spawned in the basin. Currently, the basin has populations cyclically ranging from 1,000 to 2,500 spring chinook and 2,250 to 20,000 steelhead. There also are important populations of warmwater gamefish and resident trout. Overall, water supplies are sufficient to meet present and foreseen water needs. Serious seasonal shortages occur, however, which adversely affect both the agricultural economy and fisheries resources.

The use of the watershed's resources to satisfy consumer demand for forest products, cattle, grains, minerals, and other commodities probably has accentuated the natural late winter/early spring runoff pattern at the cost of decreasing summer and fall flows. This uneven distribution of basin discharge causes flooding in winter and low water in summer. The high flows erode streambanks, change channel structure, and carry large amounts of sediment. This results in loss of farmland, riparian vegetation, and fish habitat. Low flows constrain the amount of agricultural lands in production, limit fish habitat, and degrade water quality.

Section I

INTRODUCTION

SECTION I

INTRODUCTION

A. PURPOSE OF REPORT

This report identifies the current water resource conditions and water problems of the John Day Basin. Its purpose is to provide data needed to revise the basin water resources program. This report makes no recommendations. A description of possible management alternatives and development of a preferred alternative will be included in a separate document.

The Water Resources Commission is responsible for managing the use and control of the state's water resources. The Commission establishes water management policies through adoption of coordinated, interagency water resources programs required by Oregon law (ORS 536.300 and 536.310; see Appendix A). These plans are periodically reviewed and revised to deal with changing water resource conditions.

The last John Day Basin report was written in 1962 (Oregon State Water Resources Board, 1962). It provides the basis of the John Day water resources program still in force today. The basin program was first approved by the Water Resources Board (a predecessor of the Water Resources Commission) in May 1962. It has been modified four times since that date. The program lists findings and establishes a number of administrative measures such as classifications of permitted water uses, withdrawals, and minimum streamflows.

During the quarter century since the program was formulated, basin conditions and the needs of the public have changed. The program adopted in 1962 focused on the Department's regulation of water use. There now is an interest in, and need for, basin programs that consider the watershed as a whole and involve many resource management agencies.

B. PLANNING PROCESS

The 1983 and 1985 Oregon Legislature mandated a coordinated interagency approach to water planning and management. This process requires and funds multi-agency cooperation in developing water plans and projects. The objective of the process is a water resources program that is broader in scope, yet more detailed in management prescriptions -- a program that explicitly addresses multi-agency concerns and identifies actions needed to improve water resource conditions. Such a program would aid other agencies in adopting programs consistent with the water resources program.

This report is the first step of the new process which will lead to a revised coordinated water resources program for the basin. This report is based on data compiled by the coordinated efforts of the Oregon Departments of

Agriculture, Forestry, Energy, Environmental Quality, Fish and Wildlife, Land Conservation and Development, Geology and Mineral Industries, and the Division of State Lands, Parks and Recreation Division, and Health Division. The Water Resources Department is using the report to prepare a recommended water resources program for consideration by the Water Resources Commission. The Commission will conduct a public hearing in the basin prior to approval. The approved water resources program will identify actions to be taken by the Commission and actions that might be undertaken by others.

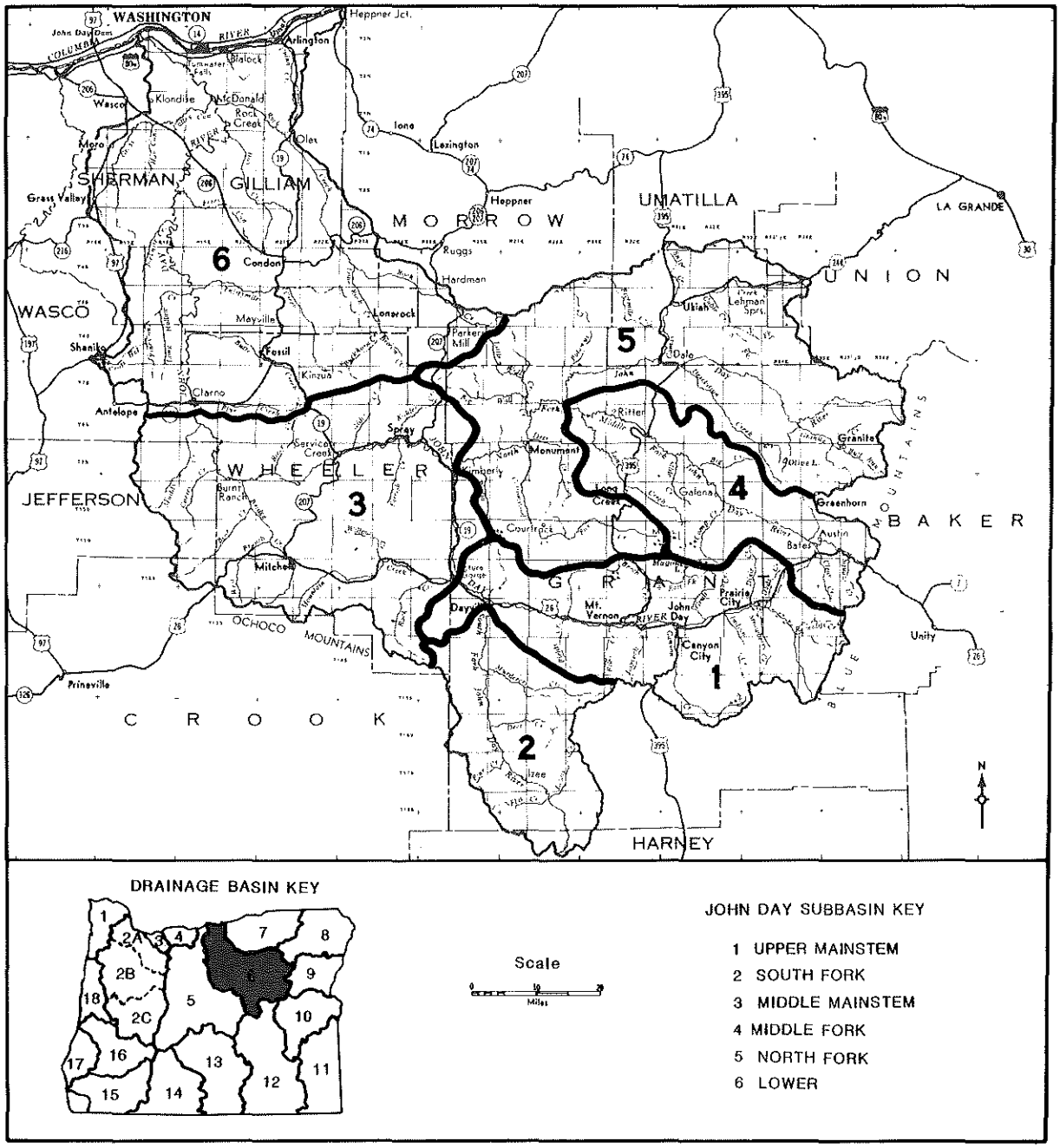
The public has been involved in reviewing data, identifying alternatives, and developing a recommended water resources program. An extensive mailing list has been developed to encourage public participation. The public involvement process also includes two advisory committees. The John Day Basin Advisory Committee provides direct input on matters of local concern. The Statewide Advisory Committee addresses items of overall state concern. The Water Resources Department is using the committees' comments and suggestions, as well as information provided by other members of the public and state agencies, during the preparation of a recommended program.

C. REPORT ORGANIZATION

This report is organized into nine major sections and seven appendices. The first section deals with background information on hydrology and water management concepts. It is followed by an overview of the John Day Basin. This overview gives general information on the basin's physical, cultural, and economic features, as well as the nature and quantity of water use. The remaining six sections each concentrate on a particular subbasin. These subbasins are distinguishable by geography, land and water use patterns, or watershed character. The subbasin sections document the environmental, cultural, and water-use setting peculiar to each subbasin. The six subbasins are the Upper Mainstem, South Fork, Middle Mainstem, Middle Fork, North Fork and Lower Subbasins. (See Figure 1.)

Figure 1

JOHN DAY RIVER BASIN AND SUBBASIN DIVISIONS



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Section II

BACKGROUND

SECTION II

BACKGROUND

A number of concepts related to water resources management are common to all river basins. These concepts are important to an understanding of the opportunities and alternatives for water management in the John Day Basin. The amount of water which is introduced into any river drainage is largely determined by the location and elevation of the basin. The routing of water through that drainage is a function of topography, geology, and land cover. These combine to determine the availability of water for beneficial uses. While the Water Resources Commission is charged with the responsibility for regulating the use of water, the forces which determine the amount of water available generally are beyond the direct control of the Commission. It is within this natural and institutional environment that the Commission must act to provide for the use and control of water in the manner which best serves the public interest.

A. HYDROLOGIC CYCLE

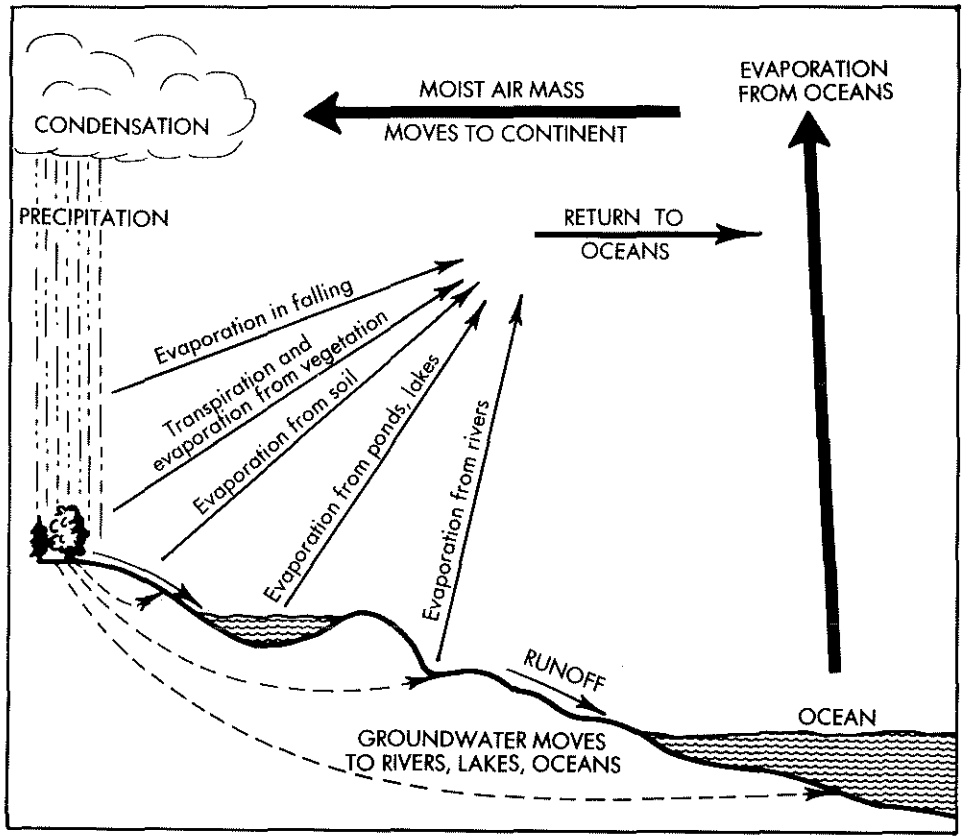
The hydrologic cycle (see Figure 2) is characterized by the interdependence and continual movement of water through the hydrologic system. Not all of the precipitation which occurs as rain and snow reaches the watercourses. Considerable quantities of precipitation evaporate into the atmosphere from vegetation and soil. Some precipitation enters the soil where it is taken up by plants and transpired back into the atmosphere. Some infiltrates the soil and percolates through permeable rock into ground water aquifers. The remaining precipitation enters stream channels as runoff, soil seepage, and as ground water discharge.

While water flowing through stream channels can be measured with relative ease, it represents only one part of the basin's total water resource. Water permeates many geologic formations. Flows through some of these formations discharge to stream channels, providing the baseflow in streams during periods of low precipitation. Unlike many areas of the state, the ground water resources of the John Day Basin do not supply large quantities of water for consumptive uses.

Every year a certain amount of water enters and leaves ground water systems. In an undisturbed system at equilibrium, the average amounts of water entering and leaving the system are the same. Areas where water enters the ground water system are called recharge areas and areas where water returns to the surface are called discharge areas. Recharge areas typically are areas of higher elevation receiving relatively large amounts of precipitation. Discharge areas typically are at the lower elevations, often in stream or river valleys.

Figure 2

HYDROLOGIC CYCLE



Source: After Strahler, 1967

The total volume of water contained in the ground is storage. When recharge is not equal to discharge, the amount of storage changes. Pumping water from storage reduces the amount of discharge, reduces storage, or both. A decrease in natural discharge may result in lower streamflows, especially in summer months. If pumpage plus natural discharge exceeds recharge on a continual basis, water levels and natural discharge will decrease. Unless withdrawals are modified or recharge increased, the aquifer eventually will be depleted.

In basins such as the John Day where recharge is chiefly from snowmelt, the water table is highest in late spring and summer, and ground water discharge is greatest during these periods. The ratio of ground water to surface water progressively increases in a stream as the stream discharge decreases. Natural ground water discharge becomes the main contributor to streamflow during the dry summer and fall months. Without the ground water discharge, many streams would dry up.

B. WATERSHED MANAGEMENT

Land and water resources are continually interacting. The land surface channels the precipitation it catches. Running waters, in turn, shape the land. Uplands are linked to riparian areas which are linked to stream channels. These three zones -- the uplands, riparian areas and stream channels -- are the components of the watershed continuum, running from summits of mountains to the mouths of streams.

Streams are imprinted with the character of surrounding uplands. Uplands catch water in the form of rain and snow. Some of this water flows over the surface directly into stream channels. Water also percolates through the soil and rock mantle to become ground water. Some of the ground water enters streams and contributes substantially to discharge during low-flow periods.

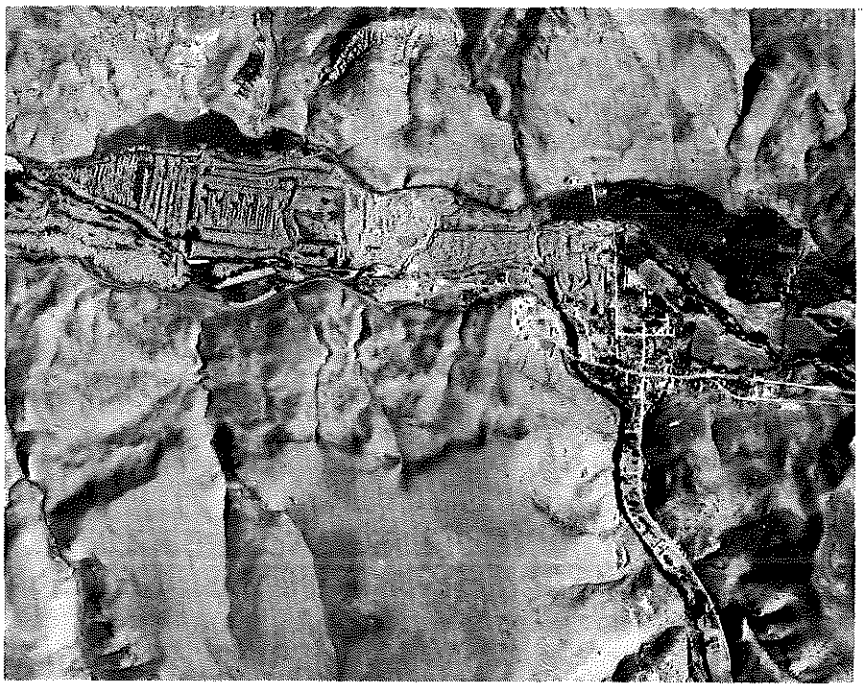
The interface between uplands and streams usually is a fringe of water-loving vegetation called a riparian zone. This zone filters upland inputs and contributes directly to stream character. The stream channel form is often a function of the upland and riparian zones. For example, the channel can be well defined, characterized by riffles and a gravel bottom; or it can be wide, wandering, and silty, depending on the immediate surroundings.

In short, the watershed continuum dictates that downstream waters are the product of upstream conditions. Proper water resources management is therefore inseparable from watershed management.

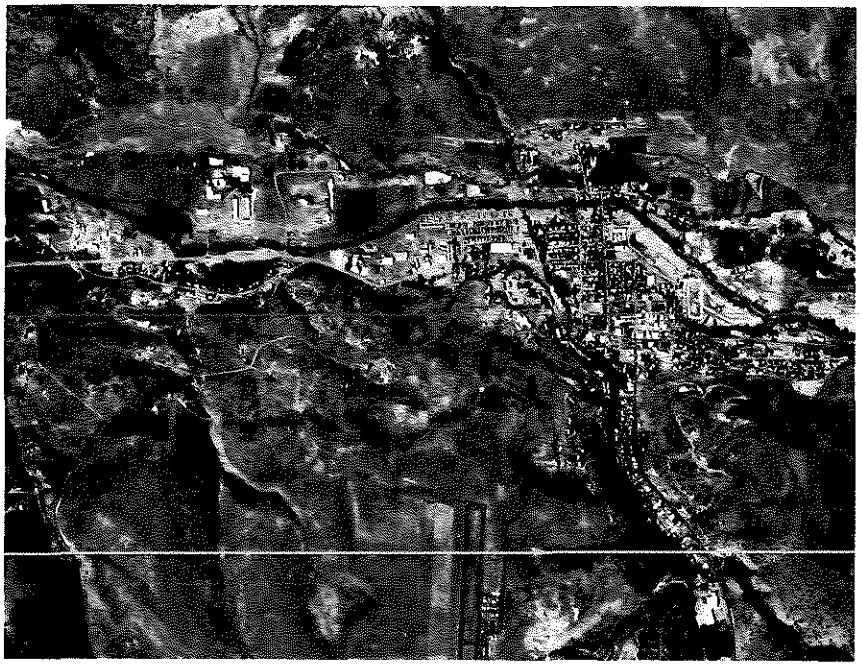
The goal of watershed management is to serve society's needs with the least disruption of the natural system. A watershed in natural condition is in balance with its environment. It readily absorbs precipitation, moderates run-off, and generally maintains conditions which facilitate storage and allow steady release of water to the stream system. Watersheds are subject naturally to erosion, sedimentation, and other conditions brought on by natural catastrophes such as forest fires and landslides. However, healthy watersheds recover from such events and gravitate toward the balance previously attained. Watershed management can maintain that balance only if it addresses the three components of the continuum.

The aerial photographs on the following page show how watershed areas can change. The photographs are of the John Day - Canyon City area. The John Day River flows from east to west (right to left) in the central portion of the photographs. Canyon Creek, in the lower right corner of the photographs, flows into the John Day River at John Day.

The first photograph was taken August 2, 1939. It shows dredge tailings from active gold dredging along the John Day River and a relatively small urban area. The second photograph was taken August 15, 1986 and shows the dredged areas now reclaimed for other uses, a well-developed urban complex, and denser stands of juniper west of John Day.



Aerial photograph of John Day/Canyon City area taken on August 2, 1939.



Aerial photograph of John Day/Canyon City area taken on August 15, 1986.

1. UPLANDS

Uplands account for almost all watershed area. Uplands may be viewed as the non-stream-corridor portions of any basin. The watershed's definitive physical characteristics such as climate, topography, geology, soils, and biota all find expression in the upland areas. These characteristics determine the extent to which the basin holds or releases precipitation. This, in turn, determines the quantity, quality and timing of water leaving the drainage basin.

Of the factors affecting watershed quality, landcover is most susceptible to alteration by society's activities. This alteration has both benefits (such as food production) and costs (flooding). Many of the water problems of the John Day Basin may be viewed as the costs of landcover alterations. Landcover is the salient characteristic of the first link in the watershed continuum, the uplands. The three landcover types of importance in the John Day Basin are forestland, rangeland, and cropland. Although urban land is also present, the area involved is not of a significant size. Each landcover type has particular problems and management opportunities, which are discussed below.

Late nineteenth century view of John Day.

a) Forestlands

Healthy forests act as natural reservoirs. A large percentage of precipitation falls on higher elevation forest lands during the winter. Much of this precipitation falls as snow and is stored until spring when it runs off or infiltrates into the ground. More than a third of the John Day Basin is forested. A large portion of these lands are managed by the U.S. Forest Service. The management policies controlling harvest and other uses of these lands can affect the storage potential of the basin in several ways.

One of the major impacts of timber harvest upon a watershed is the construction of roads. Roads can act as water transportation systems by speeding runoff. Road surfaces are frequently a source of sediment. Careful planning that makes maximum use of the existing network and provides for more carefully designed roads (i.e., narrower and steeper) is an important dimension in watershed management.

Timber harvest increases the amount of rain and snow reaching the ground surface. The removal of canopy cover decreases evapotranspiration. This may increase the water yield of a basin and slightly increase peak flows. Some harvest operations compact soils, decreasing infiltration capacity and discouraging regeneration. These effects can speed runoff, increasing peak flows and decreasing late season low flows. Other operations disturb soil and may increase the likelihood of erosion.

While the effects of timber harvest on a watershed are potentially severe, studies conducted on the Umatilla National Forest and in Colorado generally indicate that harvesting is not the primary cause of damaging high streamflows. Nor has harvesting been shown to alter significantly low streamflows of late summer in an area like the John Day Basin. Planning that takes into account slope, aspect, regeneration potential, and harvest method helps moderate the watershed impacts of logging.

b) Rangelands

Rangeland, the other dominant landcover type in the John Day Basin, is found at many lower, drier locations east of the Cascades. Native rangeland vegetation was well adapted to the arid environment. With the coming of European civilization, the rangeland resource was severely damaged by overgrazing. Native vegetation suffered and soils were compacted. Runoff increased and resulted in erosion and gully formation. Suppression of natural range fires further disrupted the natural succession of range vegetation, allowing the spread of such species as juniper and increased density of sage. Although range conditions have stabilized, the rangeland resource of many Eastern Oregon areas has never fully recovered. Sound grazing practices aid recovery through grazing rotation, salt block placement, stock-pond development, juniper and sage removal, and reseeding where practicable.

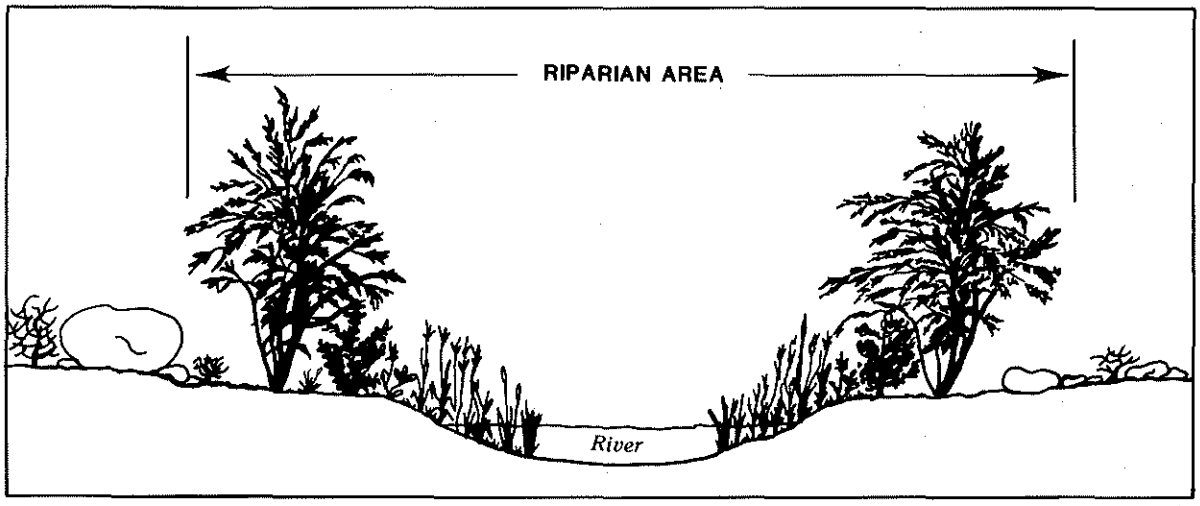
c) Croplands

Cropland, a major landcover type in the lower John Day Basin, affects watersheds in several ways. Tilled land is subject to the direct impacts of rain and overland flow. This is critical during months when precipitation can be intense or when frozen or saturated soils decrease infiltration. Like any unvegetated surface, tilled land can speed the delivery of water to streams. This water may carry sediment, animal wastes, or chemical residues. The broken, loose soil is susceptible to erosion and subsequent gullying. Conservation techniques such as contour plowing, terracing, subsoiling, and no-till practices can reduce erosion by as much as 75 percent.

2. RIPARIAN AREAS

Riparian areas are streamside zones characterized by vegetation requiring free-flowing water (see Figure 3). They represent the interface between uplands and stream channels. Riparian areas are much more moist, have a greater diversity of species, and are generally more productive in terms of biomass than the surrounding areas. They represent vital watershed areas and deserve special attention in watershed management.

Figure 3
RIPARIAN ZONE



Riparian areas occupy only a small part of any watershed but are extremely important. For example, according to the U.S. Forest Service, 75 percent of the terrestrial species known to occur in the Blue Mountains are either directly dependent on riparian habitats or use them more than any other habitat. Riparian zones also are the most important determinants of the amount of sunlight reaching the stream ecosystem and of nutrients entering the stream.

Riparian zones provide many benefits. Roots of riparian vegetation stabilize streambanks and prevent sloughing. The vegetative zone along the streams filters overland flows, preventing sedimentation. Trees and limbs fall into the stream, creating pools which stair-step water more slowly downstream. Overhanging vegetation and fallen trees provide important habitat for fish. The pooling action of woody debris combined with the friction of bank vegetation and roots raise the local water table. Riparian vegetation shades the stream, maintaining cool temperatures needed for healthy aquatic life. The streamside belt of trees, shrubs, and grasses contribute nutrients in the form of leaves and terrestrial insects to the system. Finally, the riparian zone provides important habitat and travel routes for wildlife.

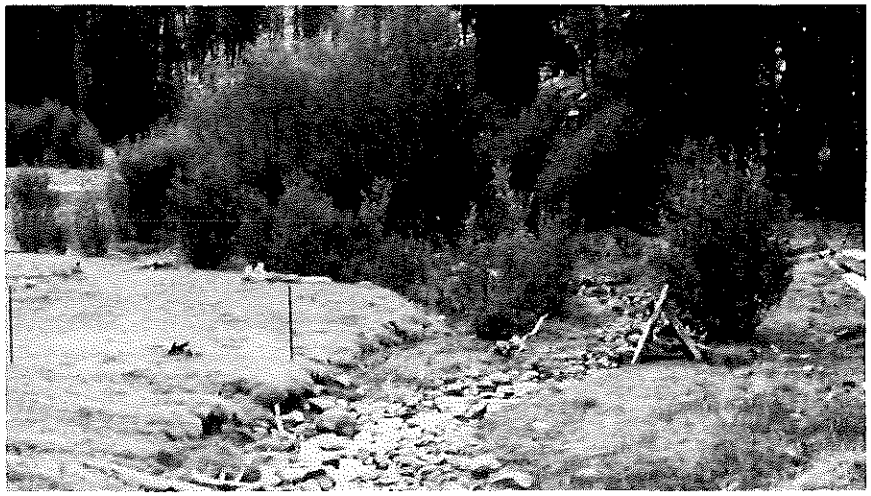
Riparian areas are heavily used by both humans and animals. If over-used, the areas can be severely damaged and the many benefits lost. Animals are attracted to the climate, cover, nearness to water, and feeding opportunities afforded by riparian habitat. The impacts of uncontrolled grazing can be severe. Trampling of vegetation, over-grazing, and soil compaction denude streambanks, thereby increasing stream temperatures and triggering erosion. Dense populations of animals in proximity to streams may also cause bacterial contamination of the water. Animals can be encouraged to use upland areas more distant from streams by distributing salt blocks and developing alternative water sources. Fencing riparian areas also is an effective management tool in controlling animal access. Cattle and wildlife may be excluded completely from more sensitive areas, and cattle may be moved between fenced areas in a grazing rotation system. Fencing may be necessary where the riparian area is particularly degraded.

Riparian areas frequently offer the best location for roads because of the available space and grade. According to the USFS, road construction probably has a more critical and long-lasting effect on riparian areas than any other activity. Roads remove vegetation, increase bare surface area and thus sediment supply, and cause disturbance from traffic. Roaded access to streamside areas can result in human-wildlife conflicts and sanitation problems. Careful planning that locates roads away from streams offers the best solution to these problems. Road closures, either seasonal or permanent, provide another management tool.

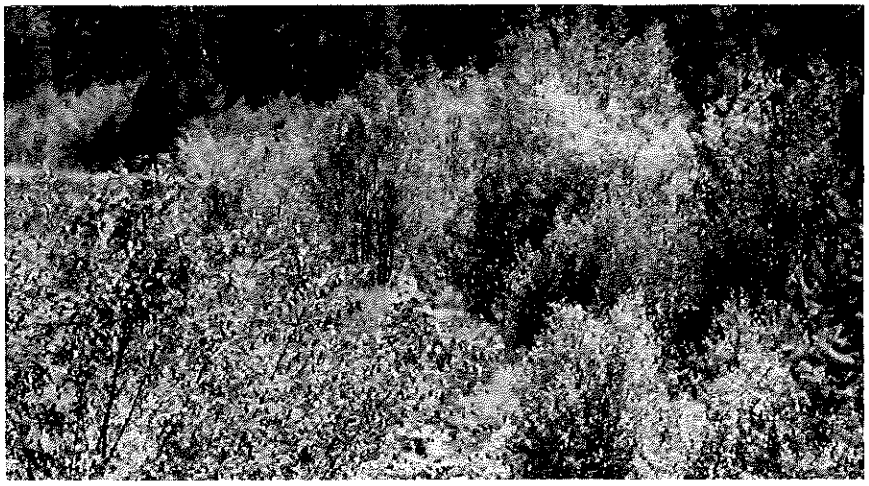
Wholesale removal of timber in riparian areas causes increased water temperatures and severely alters wildlife habitat. Selective cutting or shelterwood cuts cushion the impact of harvest in riparian areas. Sound harvest practices buffer the streamside zone, keep haul roads and skid trails away from streams, prevent excessive woody material from entering streams, and generally keep contact with streams to a minimum.

The photographs on the following page show a section of Camp Creek, a tributary of the Middle Fork John Day River, over a period of 18 years. In 1964 (top photo), the riparian area along the creek was in poor condition. The Malheur National Forest and the Oregon Department of Fish and Wildlife cooperated in building a fence which permits improved management of livestock use of the area. By 1982 (bottom photo), the area had recovered significantly.

Camp Creek, 1964, showing degraded riparian area.



Camp Creek, 1974, with riparian area recovering after fencing.



Camp Creek, 1982, with good riparian cover.

In agricultural lands, removal of riparian vegetation by cultivation or farm animal grazing can cause damage. Without riparian vegetation, sediment can be carried directly into streams by overland flow and valuable farmland can be eroded by streams. Feedlots located adjacent to streams may cause bacterial contamination. Recognition of the value of riparian areas is important in the agricultural community's stewardship of the water resource.

In urban settings, riparian areas offer open space and flood plain protection opportunities. Many times these are overlooked in housing construction and channelization projects. Planning and development ordinances that recognize both the functional and amenity values of riparian zones represent effective management options.

Many management opportunities exist for restoring degraded riparian areas. Programs that reestablish native vegetation can be very successful. Many organizations, such as Soil and Water Conservation Districts, the Oregon Department of Fish and Wildlife, the U.S. Forest Service, the Bureau of Land Management, and the Bonneville Power Administration are undertaking such efforts in the John Day Basin.

In addition, there are at least two state policies regarding riparian areas. The Oregon Riparian Tax Incentive Program represents a statewide effort to protect and restore riparian areas. Under this program, a limited amount of riparian land in each county having an acknowledged land use plan may be eligible for tax breaks. In addition, the state pays part of the cost of fencing or habitat improvement in such lands. Secondly, the Oregon Forest Practices Act, applicable on all lands in the state, has specific provisions relating to protection of riparian zones.

3. STREAM CHANNELS

Stream channel characteristics are a function of the surrounding land. There is a gradation in form from headwaters to stream mouths. Typically, headwaters are characterized by steep, narrow, well-defined channels. These channels are usually littered with boulders and rocks contributed by the mountainous surroundings. At the mouths, stream channels are wider, more gentle in gradient and are more likely to have silty substrates.

Channels develop in accordance with streambank structure which is heavily influenced by the riparian character. Channels also are sensitive to stream load -- the material the stream transports -- as well as to stream volume. For example, streambanks deprived of supporting riparian structure can collapse, widening the channel. During floods, stream channels can be scoured and deepened significantly. Repeated flooding, such as that produced by a watershed in poor condition, can incise the stream permanently, lowering the water table in the immediate vicinity. This is especially true in smaller tributaries. In such a situation, riparian vegetation recovery is suppressed, and water may be lost to existing or potential users. Pulses of sediment, such as those produced by volcanic eruptions or landslides, can overwhelm a stream's transporting ability, causing a change in channel dimension and location. Stream life is adjusted to channel character. Anadromous fish, for

example, do best with specific combinations of riffles and pools. Instream cover provided by woody material and boulders also is important to fish and other aquatic life.

Any practice that disturbs stream channels requires careful planning to avoid damage. In the John Day Basin, dredging for gold earlier in this century had severe impacts upon fisheries resources still felt today. Floods triggered by improper land management can scour channels upstream and cover downstream gravels. Activities on uplands that contribute to sediment load (for example, uncontrolled grazing, improper logging, or natural events such as forest fires) also can alter stream channel character. Most undesirable stream channel alteration can be avoided through careful management of uplands and riparian areas, in conjunction with rigorous control of in-channel activities.

C. WATER RIGHTS AND WATER REGULATION

1. WATER LAW

The State Engineer's office was established in 1905 and administered a voluntary program of water right registration. In 1909, Oregon asserted mandatory control over the right to use water through enactment of a unified water code. Before the code was passed, water users were left to their own devices to defend their rights from other users. This rather informal system broke down when faced with the needs of a growing state. The unified code, drawn up to address the chaotic situation, was founded on the doctrine of prior appropriation -- first in time is first in right. In other words, those who put a quantity of water to beneficial use first are entitled to its use without interference from subsequent water users. The priority date of a right establishes the seniority of the user. For rights perfected before passage of the state's water law, the date of first use is the priority date of the water right. The priority date of a right established since 1909 is the date on which the user filed an application with the state for a water right.

The 1909 water laws sought to define existing rights and enforce state regulations. Those water users who could prove they had applied water to a beneficial use before 1909 were granted rights under specific rules adopted by the courts. Water rights defined in this manner are adjudicated, or vested, rights.

In 1955, the Legislature established the State Water Resources Board to formulate a coordinated program for the use and control of all the water resources of the state. Water use classifications and minimum perennial streamflows were provided as tools to implement the program. In addition, the Legislature passed Oregon's first comprehensive ground water law. The Water Resources Department was given responsibility for managing ground water use to protect the resource and to ensure the availability for supplies to users. Every person must obtain a water right before using ground water except for certain statutorily exempt uses.

Today, water laws are administered by the Water Resources Department under the authority of the Water Resources Commission, a seven-member body appointed by the governor.

2. WATER POLICY

The Water Resources Commission is responsible for setting policy and making long-range plans for the use and control of the state's water resources. It is directed by statute to formulate policy based on the principle that all the state's waters belong to the public. The Commission is empowered to promote water conservation and prevent wasteful uses. The Commission's determinations regarding the appropriate use and control of water, consistent with the public interest, are in the basin water resources programs. The programs delineate specific basin problems and prescribe any restrictions on water uses.

3. REGULATION OF WATER USE

The Water Resources Department is responsible for administering state water laws. The Department issues permits to use water where the proposed uses are consistent with the policies adopted by the Water Resources Commission. The Department also maintains streamflow gaging stations and inspects diversions for permit compliance. The Department distributes water according to the doctrine of prior appropriation whenever shortages arise. That is, use of water by junior water right holders is curtailed as necessary to provide remaining water to those with older rights.

The Water Resources Department also has responsibilities to insure the wise use and conservation of water. The Department may not approve applications for more water than can be applied to a beneficial use. Under law, watermasters control waterworks to prevent the waste of water. The Department may curtail the use of wells that cause waste of ground water. During a severe drought, the Department also has emergency powers to order agencies and political subdivisions within any basin or subbasin to file a water conservation plan.

Section III

BASIN OVERVIEW

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BASIN OVERVIEW

A. PHYSICAL DESCRIPTION

1. GEOGRAPHY

The John Day River Basin (see Figure 1 and Plate 1) drains nearly 8,100 square miles of an extensive interior plateau lying between the Cascade Range and the Blue Mountains in northeastern Oregon. It is the fourth largest basin in the state and the third largest east of the Cascades. Elevations range from about 200 feet at the confluence of the John Day River with the Columbia River to over 9,000 feet in the Strawberry Range.

The basin includes portions of two major physiographic provinces: the Deschutes-Umatilla Plateau and the Blue Mountains. The Deschutes-Umatilla Plateau Province is a broad upland plain formed by floods of molten basalt overlain with wind-deposited loess. In contrast, the Blue Mountains Province is a diverse assemblage of older sedimentary, volcanic, and metamorphic rock which was uplifted, tilted and faulted to form rugged hills and mountains. These two physiographic provinces roughly divide the basin in half near Service Creek; the mountainous upper basin lies to the south and east and the plateau-like lower basin to the north and west.

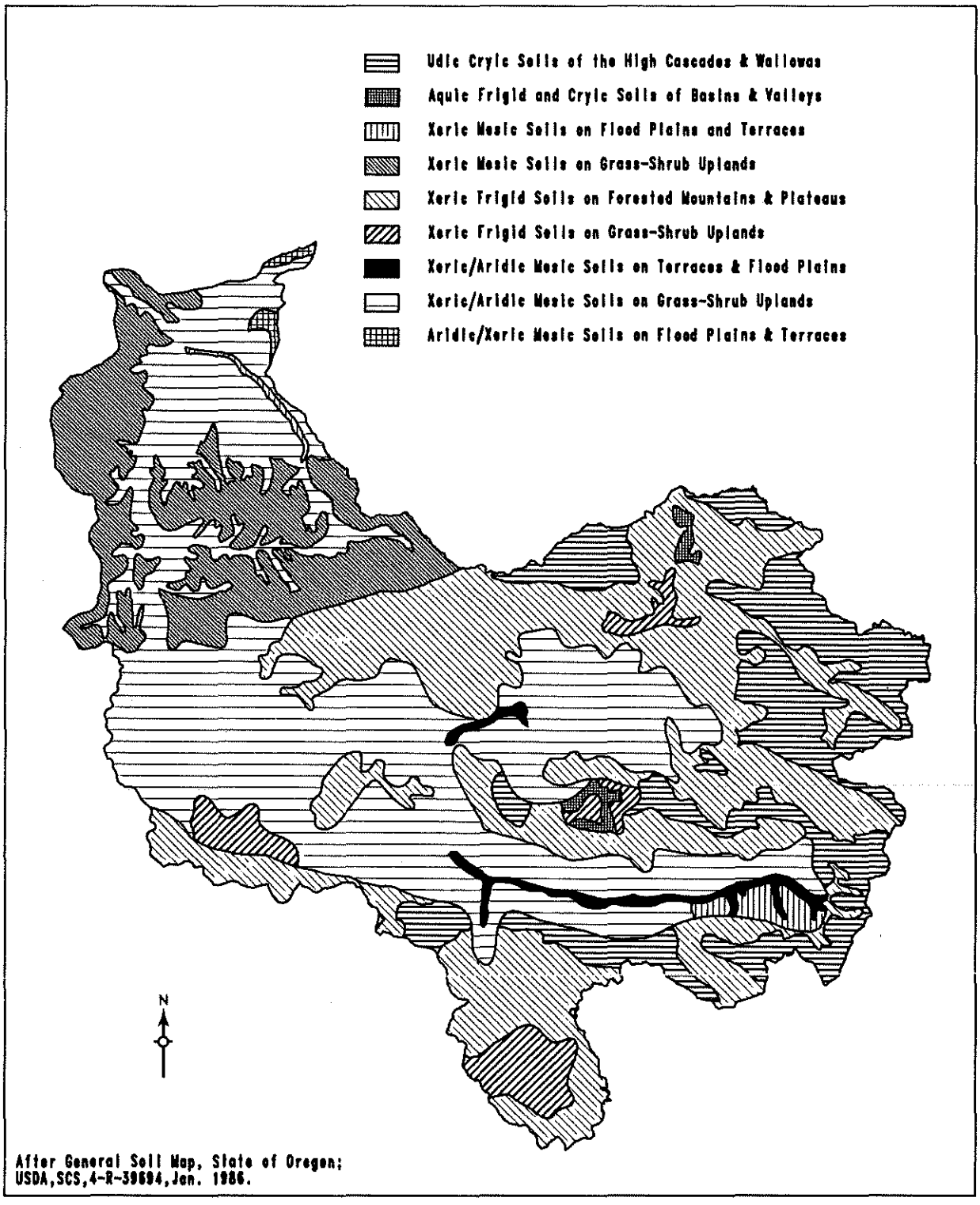
The crest of the Blue Mountains to the east and the Aldrich Mountains and Strawberry Range to the south define the crescent-shaped upper John Day Basin. A plateau-like ridge and the Ochoco Mountains form the divide between the basin and the Deschutes River Basin to the west. The Blue Mountain anticline, a broad up-arching of the earth's crust, forms part of the divide between the John Day Basin and Columbia River tributaries to the north.

The upper basin is one of Oregon's most physiographically diverse regions, containing mountains, rugged hills, plateaus cut by streams, alluvial basins and valleys. Soils (see Figure 4) are equally diverse and support a number of vegetation types. Coniferous forests and meadows are prevalent above 4,000 feet. Below 4,000 feet, the plant community generally is made up of grasses, sagebrush, and juniper trees, except on north-facing slopes where higher moisture levels support vigorous perennial grasses. Many alluvial stream bottoms and adjacent benchlands are suitable for irrigated agriculture.

In contrast to the upper basin, the lower basin is a plateau of nearly level to rolling, loess-covered Columbia River basalt deeply dissected by the John Day River and tributaries. Some irrigated agriculture is practiced in the canyon bottoms, but dryland farming and stock grazing on the plateau are the most prevalent agricultural activities. The lower basin's vegetation was essentially a bunchgrass climax community with some timber at higher elevations, but the introduction of livestock grazing and farming altered its character.

Figure 4

SOILS OF THE JOHN DAY BASIN



2. GEOLOGY

The John Day Basin has a complicated geologic history which has resulted in a complex and diverse assemblage of rocks. These rocks include masses of oceanic crust, marine sediments, a wide variety of volcanic materials, ancient river and lake deposits, and recent river and landslide deposits. Distribution of the basin's major geologic units largely has been controlled by the structural evolution of the basin. Figure 5 shows the stratigraphic sequence of the basin's major geologic units.

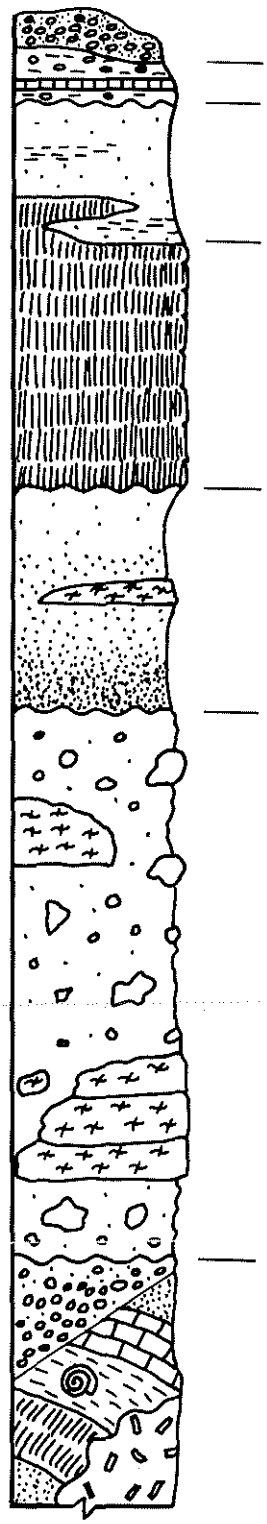
More than 65 million years ago, during pre-Tertiary geologic time, sediments and volcanic rocks of the oceanic crust were contorted, uplifted and eroded. Roughly 54 to 37 million years ago, a series of widespread volcanic eruptions produced the lavas, mudflows and tuffs of the Clarno Formation. As this activity waned, new eruptions in the area of the present-day Cascade Range began depositing thick layers of volcanic ash which form the John Day Formation. During a period approximately 19 to 12 million years ago, the region (along with much of northern Oregon, southern Washington and western Idaho) experienced volcanic eruptions which resulted in a series of flood basalts known collectively as the Columbia River Basalt Group. Sometime after these basalt flows blanketed the region, fine-grained volcanic sediments of the Mascall Formation were deposited locally atop the basalts. Finally, the Rattlesnake Formation, a thick sequence of sand and gravel, was deposited in the ancestral John Day Valley.

The distribution of these formations was controlled largely by the presence of topographic and structural features which developed during the pre-Tertiary period. Some of these older features, such as the Strawberry Range and Aldrich Mountains, Blue Mountains, and the Blue Mountain Anticline, persist and still influence the basin. The Blue Mountain Anticline is a long structural upwarping in the earth's crust and should not be confused with the mountain range known as the Blue Mountains (see Figure 6).

An east-west fault zone occurs along the base of the Aldrich Mountains and Strawberry Range. This fault zone, which includes the John Day fault, probably controls the location of the John Day River upstream of Picture Gorge. This area probably has been the location of a major valley since 1.5 to 13 million years ago, as evidenced by the thick accumulation of fragmented debris represented by the Rattlesnake Formation. The Rattlesnake Formation is largely confined to this long, low east-west trending feature now occupied by the upper John Day River and Mountain Creek.

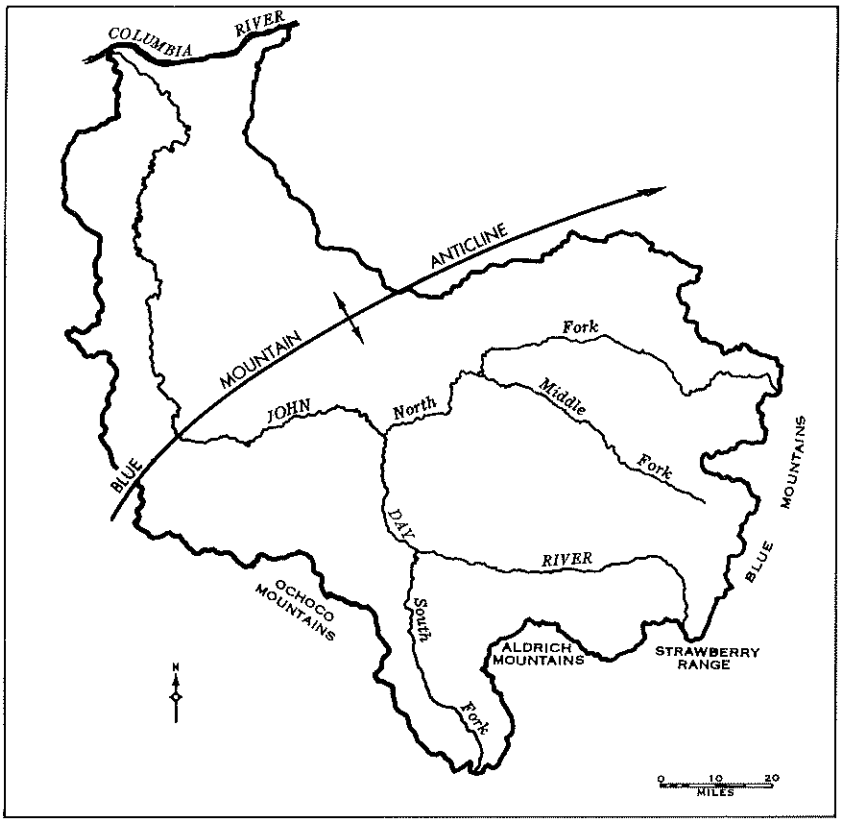
Figure 5

GENERALIZED STRATIGRAPHIC SEQUENCE OF MAJOR GEOLOGIC UNITS IN THE JOHN DAY BASIN



QUATERNARY ALLUVIUM 0-2 million years ago	Predominantly unconsolidated silt, sand and gravel
RATTLESNAKE FORMATION 2-5 million years ago	Conglomerate, sandstone, and mudstone with interbedded ash flow tuff, ± 630 ft. thick
MASCALL FORMATION 5-12 million years ago	Waterlaid tuff, tuffaceous sandstone, and conglomerate with local diatomite, ± 1,000 ft. thick
COLUMBIA RIVER BASALT 12-19 million years ago	Multiple flows of dark gray, fine grained crystalline basalt, ± 3,000 ft. thick
JOHN DAY FORMATION 19-37 million years ago	Primary tuffaceous claystone, air fall tuff, and ashflow tuff, ± 2,300 ft. thick
CLARNO FORMATION 37-54 million years ago	Inhomogeneous assemblage of andesitic lava flows, volcanic breccia, mudflows, tuff, and tuffaceous sediment; locally intruded, ± 5,800 ft. thick
PRE-TERTIARY SEQUENCE 65 million years ago and older	Diverse assemblage of marine sediments and volcanics, their variably metamorphosed equivalents, and intrusives, ± 45,000 ft. thick

Figure 6
MAJOR PHYSIOGRAPHIC FEATURES OF THE JOHN DAY BASIN



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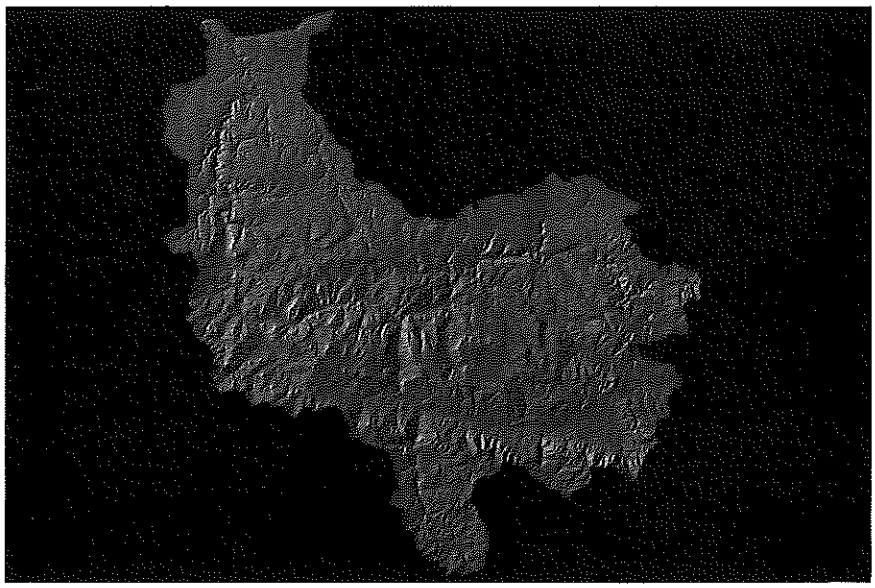

Digital elevation model of the John Day Basin showing physiographic features. Image produced with a U.S. Geological Survey geographic information system.

3. CLIMATE

The John Day Basin has a continental climate characterized by low winter and high summer temperatures, low average annual precipitation, and dry summers. Most precipitation occurs between late fall and spring. However, convectional summer storms create sporadic and scattered thunderstorms which produce most summer precipitation. Climate is closely related to the basin's two physiographic provinces, differing significantly between the Deschutes-Umatilla Plateau and the Blue Mountains.

Winters are cold on the Deschutes-Umatilla Plateau, but the Rocky Mountains partially shield the area from frigid arctic air masses. In summer, days generally are hot and nights are cool. Moist Pacific air drops most of its precipitation on the Coast Range and Cascade Mountains before reaching the Deschutes-Umatilla Plateau. Precipitation is low over the whole plateau (see Figure 7).

The Blue Mountains, on the other hand, exhibit a great range of climates because of the diversity of the region. While lower elevations generally are warmer and receive less precipitation than higher elevations, physical features create micro-climates which may deviate from this pattern. Eastern Oregon's precipitation is strongly influenced by elevation. Highlands such as the Blue Mountains which rise above the general plateau receive more precipitation. Tables 1 and 2 provide average temperatures and precipitation values for selected locations in the basin.

John Day Basin daily temperatures range from well below 0°F at Ukiah and Austin in the winter to over 100°F at Arlington in the summer. Mean annual temperatures vary inversely with elevation and range between 41°F at Austin and 54°F at Arlington. Inflows of moist Pacific air somewhat moderate extreme winter temperatures.

Precipitation increases with elevation. Mean annual precipitation is as low as 9 inches at Arlington and exceeds 40 inches in the mountains. Much of the precipitation in the mountains falls as snow.

Mean annual values can mask seasonal precipitation patterns and variability. While the John Day Basin receives less precipitation than many other locations in the state, the seasonal precipitation pattern in the basin is similar to the statewide pattern.

Seventy percent of annual precipitation occurs in the cooler months of November through May, mostly as snow. Less than 10 percent falls as rain during the summer growing season in July and August (see Figure 8).

Figure 7

JOHN DAY BASIN AVERAGE ANNUAL PRECIPITATION

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Table 1

AVERAGE TEMPERATURE AT SELECTED SITES
(degrees Fahrenheit)

SITE	ELEVATION	YEARS	ANN.	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT
Arlington	285	64	54.3	54.3	42.1	36.5	33.0	39.1	46.5	53.5	61.7	68.7	75.8	74.6	66.2
Moro	1838	66	48.9	50.0	38.8	33.3	29.8	35.3	41.4	47.3	54.6	61.5	68.7	67.5	60.1
Monument	1995	22	50.1	50.2	40.3	32.8	31.5	38.3	42.3	47.6	55.4	63.6	69.6	69.0	60.6
Dayville	2400	64	50.4	50.6	40.9	35.0	33.5	38.3	43.2	48.8	55.4	62.5	69.3	67.5	59.6
Mitchell	2645	76	49.0	50.4	38.2	35.0	33.2	37.2	41.1	46.8	53.7	61.0	68.2	65.3	58.5
Antelope	2680	60	48.6	49.9	39.7	33.9	30.9	35.9	40.4	46.0	53.0	60.1	67.6	66.5	59.1
Condon	2880	76	47.5	48.6	38.3	32.3	29.2	34.1	39.7	47.0	52.2	59.2	66.7	65.6	57.3
John Day	3063	32	48.8	49.7	39.7	33.6	30.8	36.2	40.1	45.7	53.5	61.4	68.6	67.2	59.7
Ukiah	3355	59	43.5	45.4	35.2	30.0	24.2	30.2	35.8	42.5	48.4	55.2	61.7	60.1	53.3
Long Creek	3720	29	45.8	47.3	37.4	31.9	29.7	35.3	37.5	42.4	49.5	57.2	63.6	62.9	55.7
Austin	4213	64	41.1	43.1	31.9	24.8	21.2	26.9	32.2	40.3	43.4	54.3	61.9	59.8	52.3

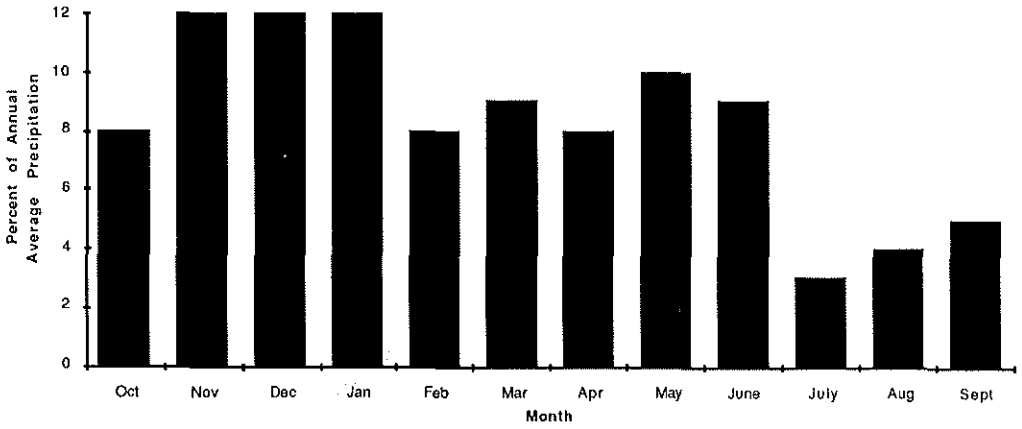
Table 2

AVERAGE PRECIPITATION AT SELECTED SITES
(inches)

SITE	ELEVATION	YEARS	ANN.	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT
Arlington	285	74	9.07	.71	1.34	1.59	1.47	.97	.66	.52	.54	.47	.17	.22	.41
Moro	1838	75	11.28	.84	1.66	1.69	1.77	1.14	.97	.75	.88	.54	.19	.27	.59
Monument	1995	22	13.42	.98	1.58	1.66	1.49	.90	1.14	1.20	1.34	1.27	.46	.66	.74
Mitchell	2645	46	11.36	.85	.89	1.10	1.00	.86	1.06	1.10	1.69	1.26	.53	.41	.61
Dayville	2400	77	11.41	.84	1.12	1.34	1.21	1.00	1.06	1.02	1.54	1.25	.42	.48	.55
Antelope	2680	61	12.60	.90	1.56	1.61	1.54	1.11	1.02	.79	1.35	1.02	.28	.49	.77
Condon	2880	80	12.70	1.07	1.57	1.54	1.43	1.14	1.11	.97	1.28	1.14	.39	.39	.68
John Day	3063	30	10.33	.78	1.12	1.12	1.08	.60	.77	.96	1.09	1.09	.38	.69	.65
Ukiah	3355	60	17.60	1.36	1.94	2.19	1.95	1.43	1.43	1.38	1.63	1.61	.53	.70	.91
Long Creek	3720	29	15.65	1.14	2.10	1.40	1.40	1.21	1.72	1.26	2.03	1.63	.47	.55	.74
Austin	4213	64	20.40	1.44	2.15	2.97	2.88	2.05	2.30	1.33	1.68	1.42	.58	.68	.92

Figure 8

DISTRIBUTION OF AVERAGE ANNUAL PRECIPITATION BY MONTH IN THE JOHN DAY RIVER BASIN



4. LAND COVER

Land cover (see Plate 2) in the John Day Basin is predominately forest and rangeland, with a small amount of cropland. Original grasslands were dominated by wheatgrass, bunchgrass, bluegrass, and fescue. Sedges and moisture-loving grass species grew on bottom lands. Forbs and shrubs such as bitterbrush were prevalent. Mountain mahogany and juniper flourished on dry, rocky sites.

Grass, shrub, and juniper communities predominate in the valleys but give way to ponderosa pine, lodgepole pine, Douglas fir, and white fir communities at higher elevations.

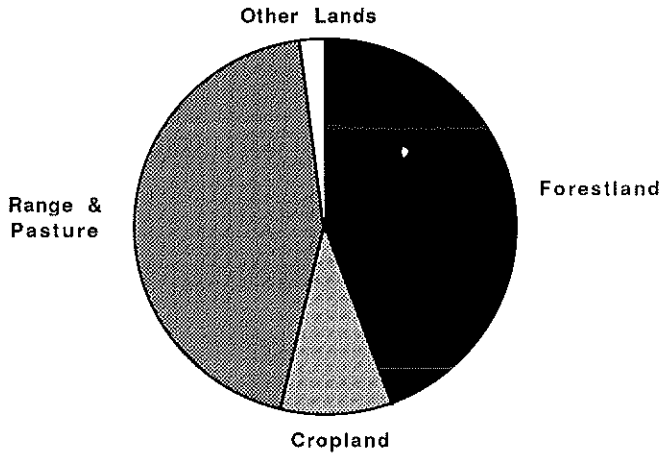
Much of the agricultural land in the basin is found on the loessal plateaus of Gilliam and Sherman Counties. These cultivated lands generally are not irrigated but are dryland-farmed in a grain/summer-fallow rotation. Irrigation is used to a greater extent in the upper subbasins, generally on alluvial bottomlands and irrigable benchlands, to grow alfalfa, meadow hay, and some specialty crops such as fruit and mint. Figure 9 shows land classification types by percentage based on a 1984 inventory by the Oregon Department of Agriculture.

An earlier land cover inventory of the John Day Basin in which high-elevation aerial photographs and satellite imagery were used was completed in 1979. The results of that inventory are in Table 3. The only significant difference

between the two inventories is the categorization of lands as range or forest -- two cover types that form a continuum in certain elevation bands. Transitional forest and rangeland was classified differently in each inventory, largely accounting for the classification discrepancies between the two.

Figure 9

JOHN DAY BASIN LANDCOVER



The introduction of livestock into the basin and the suppression of wildfires has changed the species composition of the original grasslands. More desirable grass species have decreased in many areas of the basin, particularly on spring and fall range and in big-game wintering areas. Desirable brush species also have decreased and unpalatable shrubs such as sagebrush, rabbitbrush, and matchweed have invaded many range sites.

Weed species have invaded forest, range and cropland. Weed control on cultivated cropland is more an economic problem than a watershed problem. Invading species compete with crops and may be unpalatable as forage but in many cases form good ground cover.

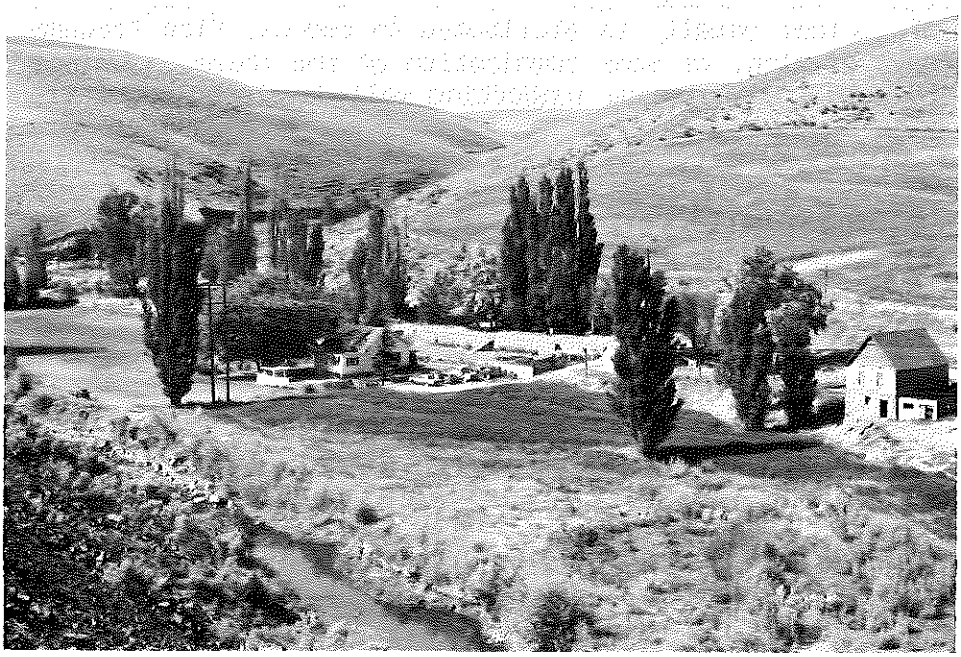
Since the turn of the century, juniper has invaded rangelands in central and eastern Oregon. Many stands appear to be relatively young and uniform. The expansion of juniper usually is attributed to reduced fire frequency, climatic changes, heavy grazing, or some combination of the three. Juniper establishes itself rapidly in areas already supporting well-developed vegetation.

Increasing juniper density and size apparently reduces understory plant cover and productivity, with forage grasses being most severely reduced. Studies conducted by Oregon State University also suggest that erosion is significant in areas associated with juniper. Water infiltration rates are reduced while sediment yield is increased. Preliminary research indicates that juniper transpire a large amount of the total moisture a site receives. If these preliminary findings are correct, juniper-control programs could improve the basin's water resources.

Table 3

LAND COVER CLASSIFICATION BY COUNTY IN ACRES

County	Irrigated Agri.	Non-Irr. Agri.	Range	Forest	Urban	Water	Other	Total
Crook		45	3,697	16,098				19,840
Gilliam	3,476	251,034	417,997	1,037	738	9,992	2,446	686,720
Grant	40,277	14,480	1,072,363	1,186,238	2,819	355	5,388	2,321,920
Harney			8,451	9,469				17,920
Jefferson	194	607	103,615	10,116		28		114,560
Morrow	2,940	16,741	81,979	149,098	51	58	13	250,880
Sherman	428	165,899	123,701	12,406	361	572	1,273	304,640
Umatilla		765	112,145	197,949	105	9	2,627	313,600
Union			2,103	3,017				5,120
Wasco	823	3,298	107,650		56	126	47	112,000
Wheeler	11,965	24,813	735,726	254,888	436	280	7,412	1,035,520
Total	60,103	477,682	2,769,427	1,840,316	4,566	11,420	19,206	5,182,720
% Total	1.2	9.2	53.4	35.5	.1	.2	.4	100



The area around the town of Olex on Rock Creek exemplifies many of the landcover types of the John Day Basin.

5. HYDROLOGY

a) Surface Water

The John Day River flows over 280 miles from its source southeast of Prairie City to its confluence with the Columbia River east of Rufus. The John Day and tributaries are typical of streams of semi-arid regions which tend to exhibit extreme variations in seasonal flows and annual discharges. On the average, the John Day discharges nearly 1.5 million acre-feet annually. Statistics describing flows in the John Day River and major tributaries are in Table 4.

The first stream gaging station in the basin was installed at McDonald Ferry near the mouth of the John Day River. It has provided continuous streamflow information since 1906. Two other gages on the mainstem John Day, at Service Creek and Picture Gorge, have been operating since 1929 and 1926, respectively. The upper John Day has been gaged between John Day and Prairie City since 1925.

There are numerous other gaging stations in the basin, including the North Fork John Day at Monument with a 60-year record, and the Middle Fork John Day at Ritter with 56 years. Appendix B contains information on past and present gaging stations in the basins. Figure 10 shows the locations of active stations in the basin.

Table 4

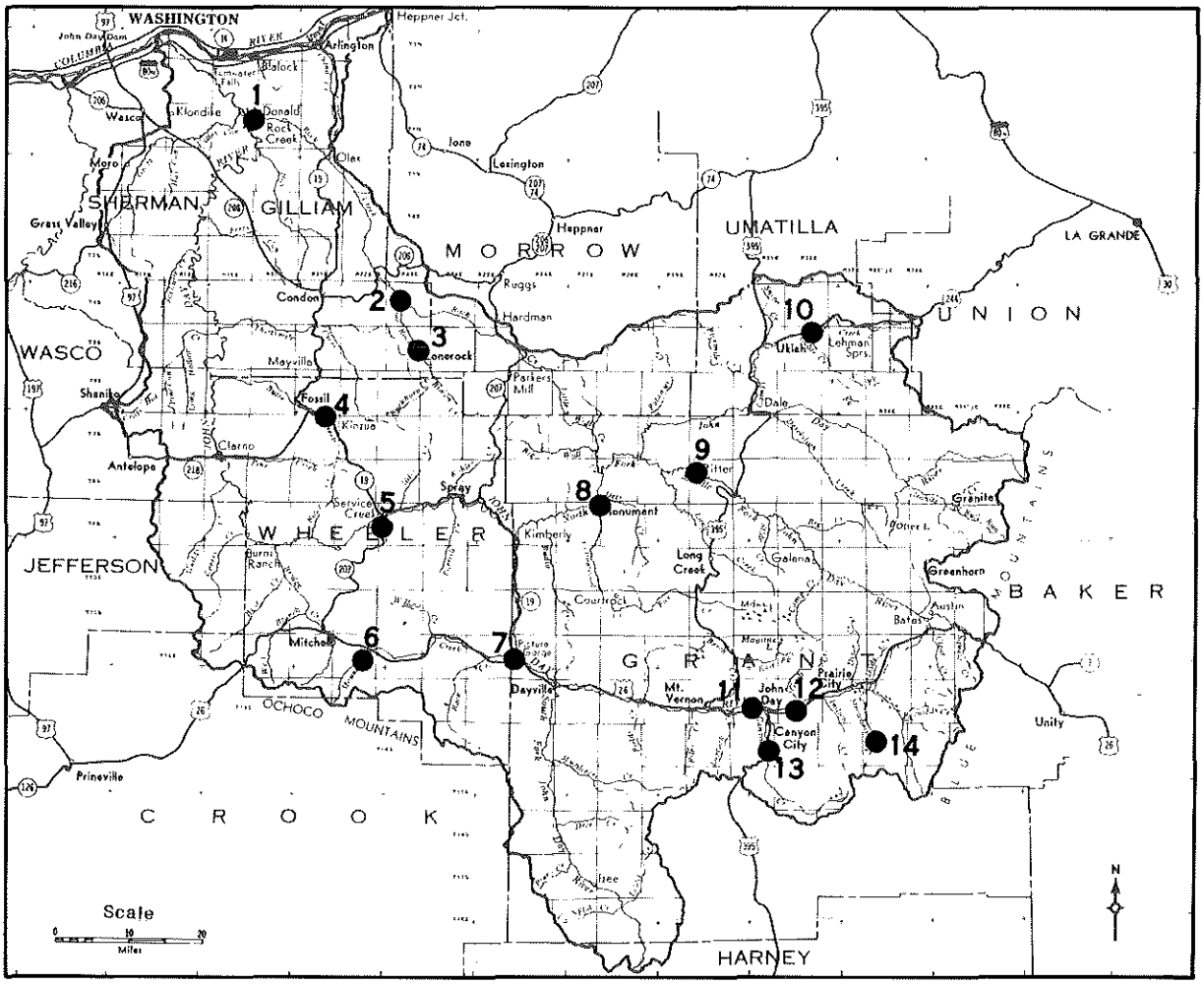
SELECTED STREAM STATISTICS BY GAGING STATION

Stream Name & Gage Location (miles from mouth)	Drainage Area (sq. mi.)	Mean Basin Elevation (ft.)	Average Yearly Discharge[1] (acre-feet)	Years of Record	Maximum Yearly (acre-feet)	Minimum Year (acre-feet)
John Day R. @ McDonald Ferry (21)	7580	3880	1,475,000	81	2,787,000	436,500
John Day R. @ Service Creek (157)	5090	4400	1,350,000	56	2,523,000	448,000
John Day R. @ Picture Gorge (204)	1680	4580	346,300	59	630,000	90,100
John Day R. near John Day (251)	386	5064	150,000	17	267,900	53,220
North Fork John Day R. @ Monument (15)	2520	4580	904,200	60	1,658,000	319,000
Middle Fork John Day R. @ Ritter (15)	515	4800	179,000	56	327,200	61,590
South Fork John * Day R. nr Dayville (1)	590	4780	123,800[2]	12	194,800	45,300
Rock Cr. abv Cayuse Canyon nr Condon (34)	350	3375	30,854	20	82,530	4,470
Desolation Cr. nr Dale * (1)	108	5204	73,100	9	104,600	42,510

* Station no longer operating.
1 / Average yearly discharge as of 1982; does not represent streams' total discharge, as gages not located at mouths.
2 / South Fork gaged sporadically from two stations; discharge calculated from combined record.

Figure 10

JOHN DAY BASIN GAGING STATIONS



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GAGING STATION KEY

1 John Day at McDonald Ferry
2 Rock Creek above Whyte Park
3 Lone Rock Creek near Lonerock
4 Butte Creek near Fossil
5 John Day River at Service Creek
6 Mountain Creek near Mitchell
7 John Day River at Picture Gorge
8 North Fork John Day River at Monument
9 Middle Fork John Day River at Ritter
10 Camas Creek near Ukiah
11 Enterprise Ditch near John Day
12 John Day River near John Day
13 Canyon Creek near Canyon City
14 Strawberry Creek above Slide Creek

The gage at McDonald Ferry measures runoff from 95 percent of the basin. The average annual discharge measured at the gage is 1,475,000 acre-feet. The highest annual discharge was 2,787,000 acre-feet in 1982, and the lowest was 436,000 acre-feet in 1977.

About 60 percent of average annual basin discharge comes from the North Fork. The average annual discharge of the 2,520-square-mile area drained by the North Fork, as measured at Monument, is 904,200 acre-feet. This subbasin has an average annual yield of 378 acre-feet per square mile. The average annual discharge of the 5,090-square-mile area above the gage at Service Creek is 1,350,000 acre-feet, or 265 acre-feet per square mile. The 2,490-square-mile drainage area below Service Creek contributes 125,000 acre-feet to average annual basin discharge -- 50 acre-feet per square mile. The difference in upper and lower basin contributions to average annual discharge is a reflection of the climatic and topographic difference between the two areas. The upper basin is more mountainous and receives more precipitation. Consequently, the upper basin produces more runoff per unit area as illustrated in Figure 11.

Stream discharge in the John Day Basin is marked by extreme variability in both timing and quantity. For example, the hydrograph of discharge for McDonald Ferry in Figure 12 depicts the wide variation in annual basin discharge and the extreme range of monthly discharge recorded at McDonald Ferry. The John Day River at McDonald Ferry has reached a peak instantaneous discharge of over 42,000 cubic feet per second (December 24, 1964). The John Day at McDonald Ferry also has essentially stopped flowing some years in August and September (see Figure 13).

Basin discharge not only varies seasonally and from year to year but also exhibits broad cycles of change over the course of decades. The 10-year running average shows that recently the basin has been experiencing an increase in annual discharge. However, even with 80 years of record from the gage at McDonald Ferry, data are insufficient to determine whether the recent increase represents a long-term change.

Another change in the discharge of the John Day Basin is in the seasonal pattern of runoff. Analysis of monthly discharges shows a trend of increased contributions to annual discharge of flows during the months from October to February and decreasing contributions for March, April, and July through September.

Frequency of peak flows also has changed. The number of flows exceeding 6,900 cfs (defined by the USGS as a peak flow for the gage at McDonald Ferry) was greater from 1980 to 1985 than for any other five-year period since 1948 (the date when peak flows first were tabulated). Of the 5 flows exceeding 25,000 cfs, all have occurred since 1965. The flows during the 1964 flood exceeded any other flow before or since by 50 percent. (See Appendix C for additional information on the 10-year running monthly discharge trends and peak flows.)

Changes in basin discharge may be caused by climatic variation or watershed alteration. Stream gaging stations were installed relatively recently in comparison with the length of major climatic cycles and even the length of time during which European civilization has been present in the basin. As a result, baseline data are not available to determine precisely which of the two variables have had the greatest effect on discharge.

Basin discharge is derived largely from melting snowpack. Historically, flood flows have occurred in December through February as a result of rain and snowmelt on frozen soil. Peak runoff generally occurs in the spring months, with timing dependent upon the elevation of stream basins. For example, Rock Creek (near Condon) has a mean basin elevation of about 3,400 feet, and flows peak during the period of January through April (see Figure 14). Strawberry Creek, with a much higher mean basin elevation of 6,900 feet, reaches maximum discharge later -- during May through July (see Figure 14). High flows also may occur briefly in summer as a result of local thunderstorms.

The upper John Day River in late summer is subject to very low flows.

Figure 11

MEAN ANNUAL RUNOFF
(inches)

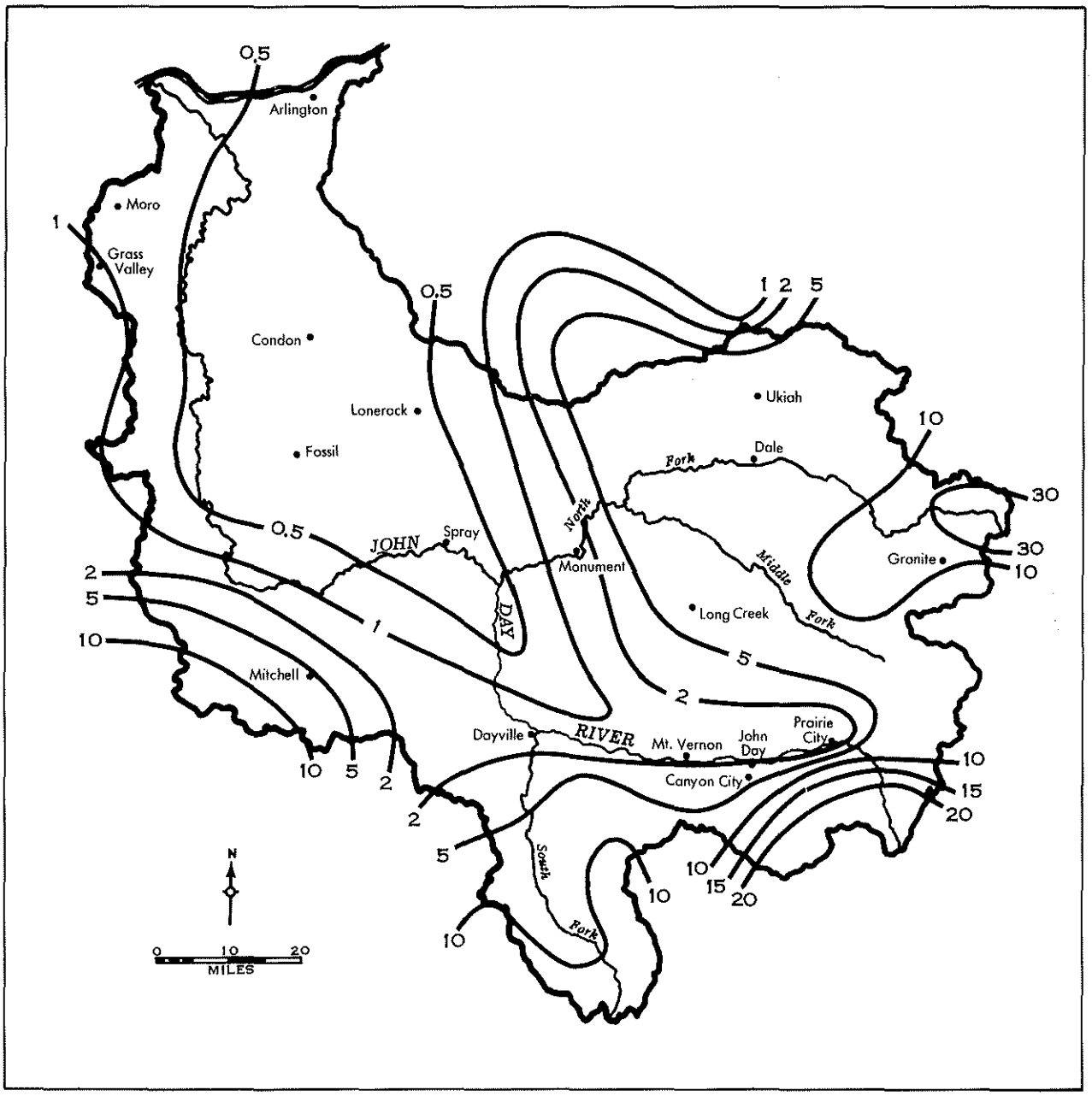

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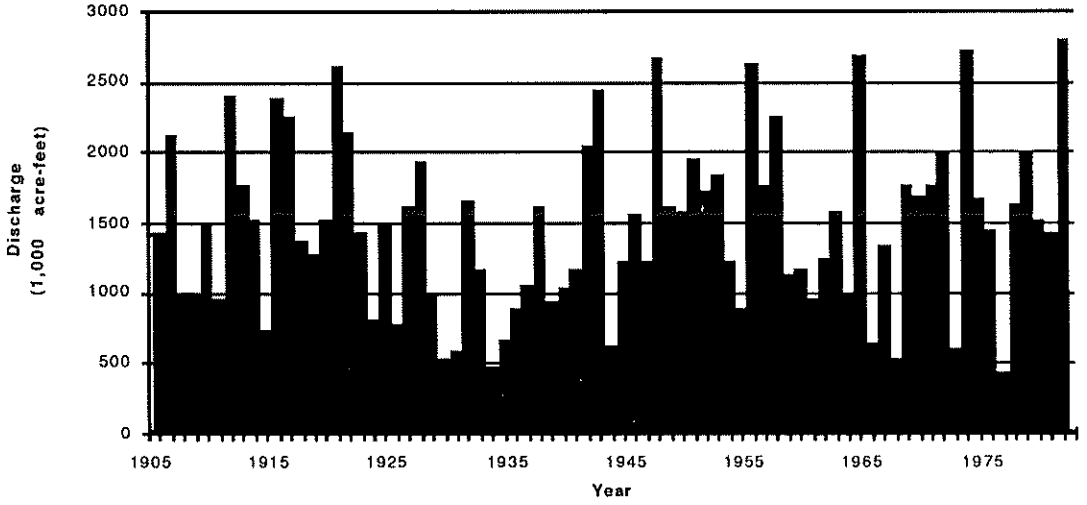
Figure 12

JOHN DAY RIVER FLOW VARIABILITY AT McDONALD FERRY



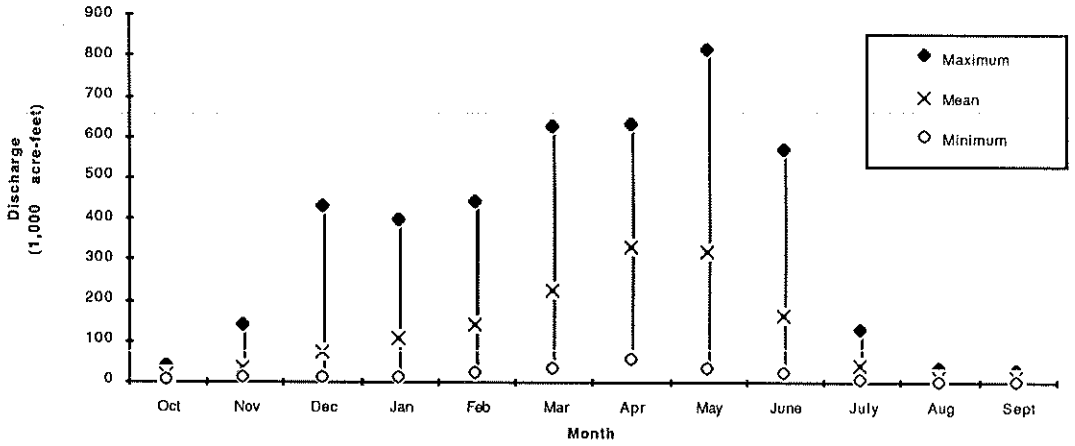


Figure 13

JOHN DAY RIVER BASIN 1973 LOW STREAMFLOWS

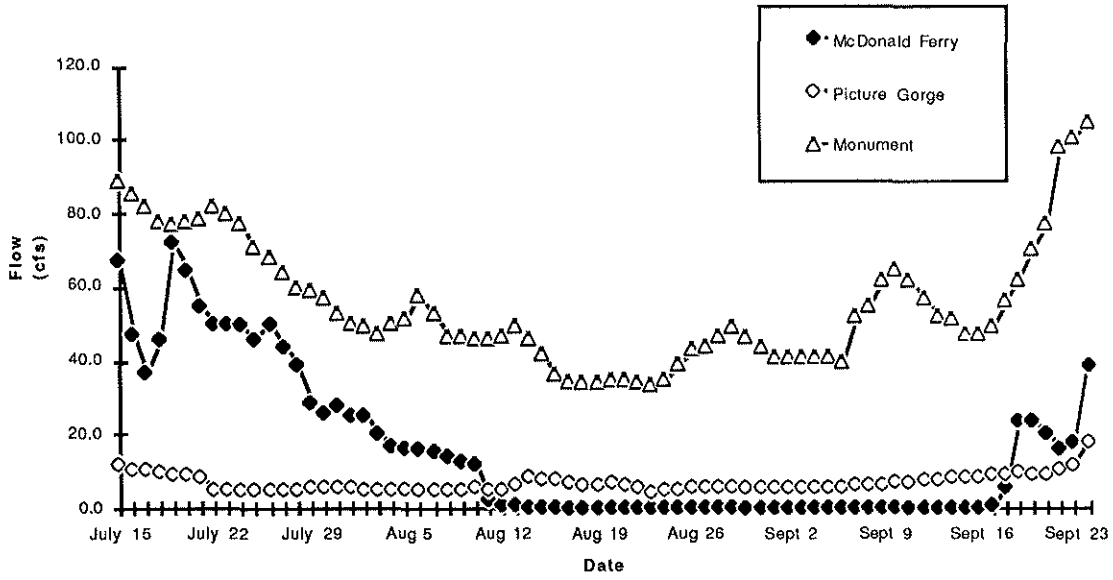
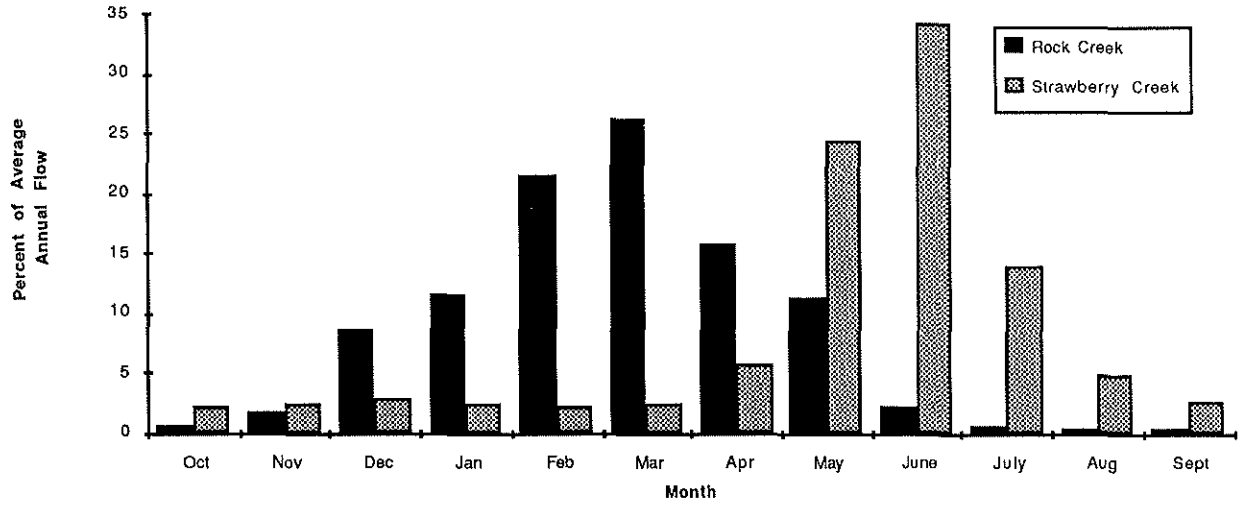


Figure 14

COMPARISON OF STRAWBERRY CREEK AND ROCK CREEK RUNOFF



Lowest flows occur in August and September throughout the basin once snowpacks melt. Ground water discharge makes up most late-season streamflow. There are no reservoirs of significant size in the John Day Basin, so streamflows largely reflect ground water discharge and surface flows altered by watershed conditions and out-of-stream water diversions. Flows also are low in winter at higher elevations as a consequence of freezing temperatures.

Appendix D illustrates average monthly discharge for selected gaging stations in the John Day Basin.

b) Ground Water

An estimate of the ground water potential of many areas can be generated using existing geologic information and ground water data. The level of confidence placed in a ground water assessment based on existing data will be a function of the amount and quality of that data. The availability of basic ground water data is generally proportional to development. In all cases, a detailed or quantitative determination of ground water potential is only possible after extensive field investigation.

The main sources of available information in the John Day Basin are published geologic maps, water well reports, and climatological and streamflow data. Published geological maps are used to define major geo-hydrological units, the overall physical characteristics of the units, and the capability of the units to store and transmit water. Geologic maps also display information on the geographical distribution, horizontal and vertical structure and setting of aquifer units, which is important in understanding recharge mechanisms and boundary conditions. Field reconnaissance has been used to field-check maps and to address unresolved questions. Water well reports are the only existing source of compiled information on water levels, saturated thickness and well performance in the various units. Geological information and well test data from these reports were used for determining ground water potential of the major units. Climatological and streamflow information was used for estimating where recharge occurs and the total volume of water moving through the ground in an area on an annual basis.

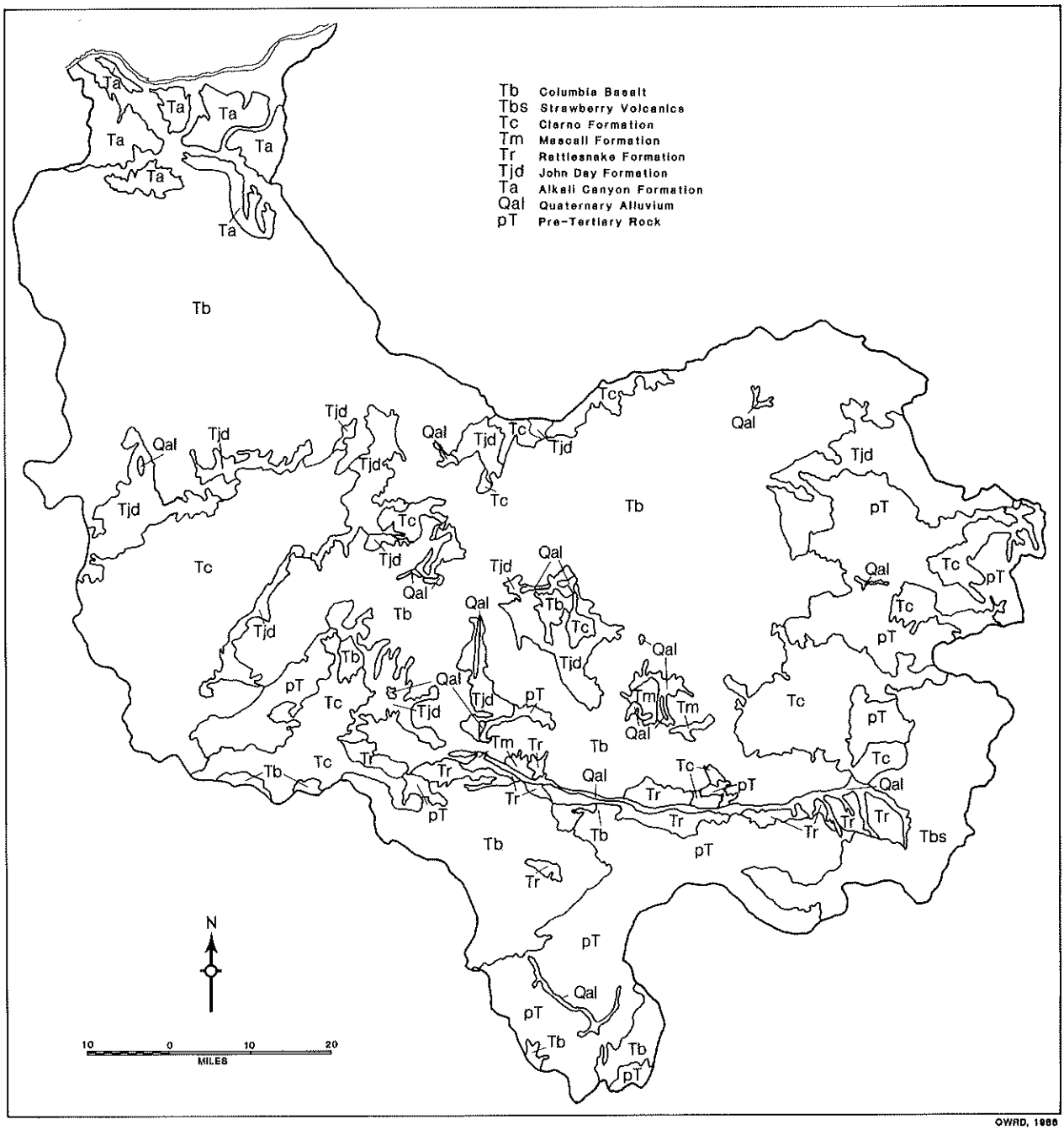
1) Geohydrologic Units

The major geo-hydrologic units present in the John Day Basin are Pre-Tertiary rocks, Clarno Formation, John Day Formation, Columbia River Basalt Group, Strawberry Volcanics, Mascall Formation, Rattlesnake Formation, Alkali Canyon Formation, and Quaternary Alluvium (see Figure 15).

Pre-Tertiary Units - The Pre-Tertiary units in the basin comprise a diverse assemblage of deformed and metamorphosed marine sediments and volcanic rocks. Outcrops of these rocks are present over large areas in the southern and eastern parts of the basin. These units are structurally complex and little hydrologic data from the units are available. However, ground water potential appears to be low.

Figure 15

MAJOR GEO-HYDROLOGIC UNITS IN THE JOHN DAY BASIN



The three major areas of pre-Tertiary rock in the basin are near Mitchell, south of the John Day River in the Aldrich Mountains and upper South Fork Subbasin, and in the Blue Mountains along the eastern edge of the basin in the headwaters of the North Fork Subbasin and in the Dixie Butte area.

None of the pre-Tertiary units in the basin are considered to be major ground water resources. The areas of pre-Tertiary rock generally are very rugged and sparsely settled. The potential for producing ground water in amounts necessary for domestic or stock use is variable and dependent upon the complex local geology.

Clarno Formation - The Clarno Formation largely consists of lava flows, mudflows, sediment, ashflow, clay, siltstone and conglomerate. Units generally are discontinuous and exhibit a high degree of lateral and vertical variability. The locations of major areas of Clarno Formation are presented in Figure 15.

The large amount of clay and fine-grained volcanic sediments restrict water movement in the formation. Overall permeability is generally quite low. However, local isolated units within the formation can have relatively good permeability and storage potential. The discontinuous geometry of these units and the probable confinement of the units by material of low permeability severely limit recharge. This makes large-scale development of these aquifers unlikely.

Even though the well data from the Clarno Formation indicate a low ground water potential, it is considered somewhat important hydrologically due to its large area. The Clarno Formation is exposed to the land surface over about 14 percent of basin area. Despite its low ground water potential, many people in the basin rely on the formation as their sole source of water. Obtaining adequate well yields for domestic or stock use is extremely difficult in many cases.

John Day Formation - The John Day Formation primarily is composed of volcanic material including claystone, air fall ash, and ash flows. The permeability of the formation generally is extremely low because of its fine-grained materials. Isolated units within the formation, such as sequences of flows or domes, may have relatively good permeability and storage locally. However, these are scarce and the probable confinement of the units by low permeability material greatly restricts recharge potential. Because of the very low potential and limited exposure, the formation is not considered an important geo-hydrologic unit.

Columbia River Basalt Unit - The Columbia River Basalt Group is the most extensive and hydrologically important unit in the John Day Basin. The Columbia River Basalt Group comprises a thick sequence of flood basalt covering large areas of northern Oregon, southeastern Washington, and western Idaho. The sequence is more than 3,000 feet thick near the Columbia River and is composed of extensive lateral flows ranging in thickness from 10 to 200 feet.

The John Day River cuts through flows of Columbia River Basalt in Picture Gorge near the town of Dayville.

Lateral permeability is moderate to high because water can move easily through contact zones between flows. Vertical permeability usually is quite low because of the dense centers of most flows. Recharge is limited by the very low vertical permeability of the flows but will occur where interflow zones are exposed to precipitation and surface water. The lateral continuity of interflow zones can be disrupted by faults and anticlines.

The Columbia River Basalt is the most important aquifer unit, covering over one-half the basin area (see Figure 15). It will supply adequate water for domestic and stock-watering uses at reasonable depths in most places throughout the basin and can supply water for municipal use and irrigation in some locations. The potential for extensive development of basalt aquifers for large-scale irrigation generally is limited, however, because of the very low recharge resulting from poor vertical permeability.

Strawberry Volcanics - The Strawberry Volcanics are layered basalt flows which erupted from vents in the Strawberry-Lookout Mountain area and are found in the headwaters of the John Day River (see Figure 15). Layered basalt flows such as the Strawberry Volcanics typically exhibit poor vertical permeability

but relatively good lateral permeability because of the rubble between individual flows. Numerous small, discontinuous flows from scattered vents which comprise the Strawberry Volcanics may, unlike the extensive flows of the Columbia River Basalt Group, limit lateral permeability.

Permeability and storage potential are considered to be low to moderate. Well data are insufficient to assess accurately the hydrologic characteristics. The Strawberry Volcanics are not considered an important hydrologic unit because of the relatively small size of the formation and the sparse population in the area.

Mascall Formation - The Mascall Formation is a unit of limited extent occurring along the John Day River near Picture Gorge and in Fox Basin (see Figure 15). It consists mostly of sandstone layers, conglomerate and diatomite. The formation near Picture Gorge is rich in clay and probably has very low hydraulic conductivity, whereas in Fox Valley the formation appears to be much more sandy, with gravel and basalt interbeds.

The ground water potential of the formation is variable from place to place. In the Fox Basin, the unit has good potential for domestic and stock-watering purposes. Limited recharge due to low precipitation in the area precludes pumping for extensive, large-scale irrigation.

Rattlesnake Formation - The Rattlesnake Formation consists of poorly consolidated and fragmented remains of gravels, sands, and mudstones which were deposited in the John Day River and Mountain Creek valleys from adjacent highlands. The coarse, poorly consolidated nature of the formation suggests good permeability and storage potential. However, field reconnaissance and well data indicate otherwise. Outcrops in the upper John Day valley reveal fine-grained clay mixed with the sandstone and conglomerate. This clay acts to cement the sediments, fill void spaces, and impede water flow. A welded ash flow in the middle of the formation probably has low permeability and may act as a hydrologic barrier between the upper and lower profiles of the formation.

The formation encompasses a relatively small area in the basin. However, because this formation is located along the John Day River in the most densely populated area of the basin, it is widely used and is considered an important aquifer. The formation generally will yield water in amounts adequate for domestic or stock uses but not for large-scale irrigation.

Alkali Canyon Formation - The Alkali Canyon Formation occurs in the very northern portion of the basin to the south and west of Arlington. It consists primarily of basaltic cobble gravel with lesser but variable amounts of fine volcanic sediments. The predominance of fragmented gravel suggests that the formation has moderate to high permeability and storage potential. The fine volcanic sediments may perch water. Recharge is limited to percolation of precipitation in the immediate area, as most surface water flows in canyons cut through the gravels into underlying formations.

Very little well data are available for the formation. Nearly all the wells penetrate through the formation and are producing from the underlying Columbia River Basalt. The reasons for this are unclear, but it may be that the gravels do not have a sufficient saturated thickness, or higher yields are obtained from the basalt. The Alkali Canyon Formation is not considered an important aquifer unit.

Quaternary Alluvium - Quaternary Alluvium, specifically as deposited in rivers and stream valleys, is one of the most important aquifer units in the basin. In terms of usage, the unit is second only to the Columbia River Basalt. Significant volumes of alluvium have been deposited along the upper John Day River, on the North Fork between Monument and Kimberly, and in some of the lower basin tributaries such as Rock and Hay Creeks. Below Clarno, where the John Day River becomes deeply incised in the Columbia River Basalt, there are fewer large areas of alluvium than in the upper basin.

The nature of the alluvium varies with location, and its characteristics reflect the stream dynamics, topography, and geology of adjacent areas. Typically, alluvium consists of an unconsolidated series of interbedded gravel, sand, and silt in beds a few inches to several feet thick. The total thickness of the Quaternary Alluvium varies from a few inches to several hundred feet. Alluvial deposits in stream and river valleys typically have high porosity and permeability. Stream channel deposits generally are considered good aquifers due to their ability to store and transmit relatively large amounts of water to relatively shallow wells. In addition, alluvial deposits in valleys are readily recharged from surface sources.

2) Ground Water Potential

The most productive aquifer units in the John Day Basin are the Columbia River Basalt Group and the Quaternary Alluvium. The Mascall and Rattlesnake Formation can produce moderate quantities locally. Yields adequate for domestic and stock use probably can be obtained in most of the basin, except in localized areas of the Clarno and John Day Formation and locally in Pre-Tertiary rocks.

Ground water yields from the Columbia River Basalt appear adequate in some places for small scale irrigation purposes, but, because of very low recharge, the potential for intensive large-scale development is limited. Alluvial deposits at many locations in the river valleys provide sufficient ground water for irrigation. However, these deposits generally are very permeable, and pumping can divert ground water which normally would be discharging to the river or even induce water flow from the river into the alluvium. Therefore, pumping large amounts of water from the alluvium in river or stream valleys can cause a commensurate decrease in streamflow.

3) Recharge

Ground water recharge is difficult to quantify. Estimates of recharge can provide some information on the total amount of water moving through a ground water system each year. Recharge and discharge estimates, when combined with

other information, indicate the rate at which geohydrologic units transmit water, and how wells might be expected to perform. Recharge estimates also can provide an indication of the total amount of water available for development in an entire aquifer each year. If annual pumpage far exceeds annual recharge, it will lead to water-level declines and depletion of the aquifer.

There are a number of ways to estimate recharge. The ground water recharge estimates displayed in Table 5 were developed using a slightly modified version of the method employed by Robison in his 1968 USGS open file report on estimated existing and potential ground water storage in major Oregon drainage basins. This method provides an initial approximation of development potential.

Table 5

ESTIMATED GROUNDWATER RECHARGE BASED ON LOW STREAMFLOW STATISTICS

Gaging Station	Drainage Area (sq. mi.)	Estimated Recharge (acre-feet/year)	Estimated Recharge (inches/year)
Strawberry Creek	7	1,665 - 2,098	4.46 - 5.62
John Day River at Prairie City	231	18,850 - 34,742	1.53 - 2.82
John Day River near John Day	386	15,852 - 44,879	0.77 - 2.18
John Day River at Picture Gorge	1,680	14,336 - 51,072	0.16 - 0.57
Camas Creek near Lehman	61	809 - 1,360	0.25 - 0.42
Camas Creek near Ukiah	121	2,581 - 4,195	0.40 - 0.65
Middle Fork John Day River at Ritter	515	14,557 - 24,720	0.53 - 0.90
North Fork John Day River near Dale	525	34,160 - 46,200	1.22 - 1.65
North Fork John Day River at Monument	2,520	63,168 - 95,424	0.47 - 0.71
John Day River at Service Creek	5,090	73,296 - 160,165	0.27 - 0.59
John Day River at McDonald Ferry	7,580	80,853 - 169,792	0.20 - 0.42

During the low-flow months, when precipitation and runoff are negligible, streamflow is due almost entirely to ground water discharge. If the rate of ground water discharge during the low-flow period is extrapolated over the entire year, it can be taken to represent the amount of ground water discharge to the stream from the drainage area above the gaging station. The results of the method are highly dependent on elevation, topography, geology, and diversions and return flows upstream of the gage. Ideally, gaging stations are selected which represent drainage from one geo-hydrologic unit or rock type. The results can be presented as acre-feet. An alternative is to divide the discharge volume by the drainage area and represent recharge simply as "inches." This is a simple method which provides rough estimates. However, the results generally compare favorably with other non-direct methods.

B. CULTURAL FEATURES

1. HISTORY

The John Day Basin once was home to nomadic bands of Northern Paiute, Tenino, Umatilla, Cayuse and Walla Walla Indians. The Umatilla, Cayuse, Tenino and Walla Walla ranged southward into the John Day Basin from the Columbia River and Blue Mountains in search of the relatively sparse populations of wildlife. These bands rarely traveled south of the upper John Day River valley because of the terrain, aridity, lack of resources, and because this was the extreme northern boundary for hostile Northern Paiute bands. During seasonal migrations in search of food, traditional tribal boundaries often overlapped. By the 1800s, all these groups except the Northern Paiutes came to share numerous campsites in the upper subbasins and along the North Fork John Day River and its tributaries east of present-day Monument.

The John Day River was named after a member of the Wilson Price Hunt expedition of 1811-12 who visited the basin while trapping furs for John Jacob Astor's North West Company. Expeditions of Hudson's Bay Company and North West Company trappers traversed the region prior to the arrival of settlers and miners. A trail through the upper John Day Basin linked Columbia River trading posts with trappers in the Snake River country. The region was bypassed by Oregon Trail pioneers in favor of the Willamette Valley. Settlement of the region generally did not begin until the 1860s.

Pioneer migration across Central Oregon was difficult and made more so by hostility of Indians to the intrusion by white settlers. In the 1850s, treaties were signed by the Cayuse, Walla Walla, Umatilla and Tenino Tribes, settling them on reservations along the Umatilla and Deschutes Rivers. In these treaties, the tribes ceded lands to the United States but retained hunting and fishing rights in some areas of the John Day Basin. By treaty, the tribes reserved the right to take fish, "at all usual and accustomed grounds and stations ..." The basin contains many usual and accustomed fishing sites, especially in the North Fork and Lower Subbasins.

Gold was discovered in 1862 near Canyon City. As prospectors flocked to the area, the population rose to more than 6,000. Hundreds of Chinese immigrants entered the area in the 1870s and 1880s. They profitably reworked abandoned diggings and provided most of the labor used in building roads and water diversion ditches.

Canyon City was founded in 1862 and became the county seat in 1864. Scattered farms sprang up along the John Day River and its tributaries near the present-day towns of John Day and Prairie City. Irrigation was introduced into the basin at this time to help grow food for the lucrative mining market. This early farming helped reduce the need to transport food overland from The Dalles, the nearest service center. The basin's first sawmill was constructed near John Day in 1862 to supply lumber to the growing communities.

In observance of the American Bicentennial, a wagon train fords the John Day River while retracing the route of the Oregon Trail.

At the height of the gold rush, Canyon City supported a population of 10,000. Gold mined in the Canyon City district was shipped overland to The Dalles, transported by boat down the Columbia River to Astoria, and shipped to San Francisco for minting. After a few years, the high-yield mines and gold-bearing gravels were worked out and most inhabitants of Canyon City moved on to richer gold fields. When a fire destroyed nearly all of Canyon City in 1937, most businesses relocated to John Day. Gold extraction from stream gravels of the district continued until 1946 when the basin's last commercial gold dredge ceased operating in the John Day-Mt. Vernon area. Between 1862 and 1970, gold worth roughly $26,000,000 was extracted from the Canyon City mining district. Industrial minerals and precious metals have been mined in the basin ever since the 1860s.

Gold, although not discovered in the lower basin, played an important role in its development. The principal route to the gold fields of the upper John Day passed through what is now Wheeler County. Henry H. Wheeler, for whom the county is named, operated the first commercial stage line between The Dalles and Canyon City. Mitchell, Twickenham, and Spray developed along transportation routes between the Columbia River and Canyon City.

The lower basin was settled by farmers and ranchers during the 1860s and 1870s. In 1866, Andrew Clarno established one of the first central Oregon ranches at the site bearing his name. Other stockmen followed and located their operations in areas such as lower Rock Creek where their cattle grazed on the virgin bunchgrass range. Sheep were introduced into the region in the 1880s. Herds were driven to summer range in the mountains of the upper basin and wintered in the lower basin. Shaniko became one of the world's largest wool shipping centers upon arrival of the railroad in 1900. Range wars between sheepmen and cattlemen commonly occurred throughout the West in the late nineteenth and early twentieth centuries. The Eastern Oregon range country witnessed its share of the violence between 1902 and 1906. The Forest Service helped end the range war in 1906 by establishing range allotments and assigning Blue Mountain Forest Reserve grazing rights to stockmen.

Ranch scene in Gilliam County near Condon, circa 1880.

In the 1870s and 80s, farmers migrated from the Willamette Valley to the basin and settled in the areas along Rock and Thirtymile Creeks. The native bunchgrass was plowed under and replaced with wheat in a crop/fallow rotation. Most crops were consumed locally until 1905 when a railroad was constructed between Condon and Arlington, linking the area to outside markets.

In 1906, the federal government created the Blue Mountain Forest Reserve which included most of the forestland now contained within the present National Forests of northeast Oregon. Until 1921, the United States Forest Service's primary concerns were fire control, watershed protection, and range management. However, during the 1920s, timber production became commercially important. By the end of the decade, private contractors were harvesting federal timber on a largescale and had established several lumber mills in the basin. The developing market for federal timber brought with it a change in Forest Service management priorities. Timber harvest now is one of the Forest Service's major activities. In the 1960s and 70s, environmental land resource protection for endangered species, wilderness and roadless areas, wild and scenic rivers, and natural areas were added to its management objectives.

2. POLITICAL DIVISIONS

Parts of eleven counties are included in the drainage area of the John Day River (see Table 6). Gilliam, Grant, and Wheeler Counties make up most of the basin. Portions of Sherman, Crook, Harney, Jefferson, Morrow, Umatilla, Union, and Wasco Counties round out the remainder of the basin.

Table 6

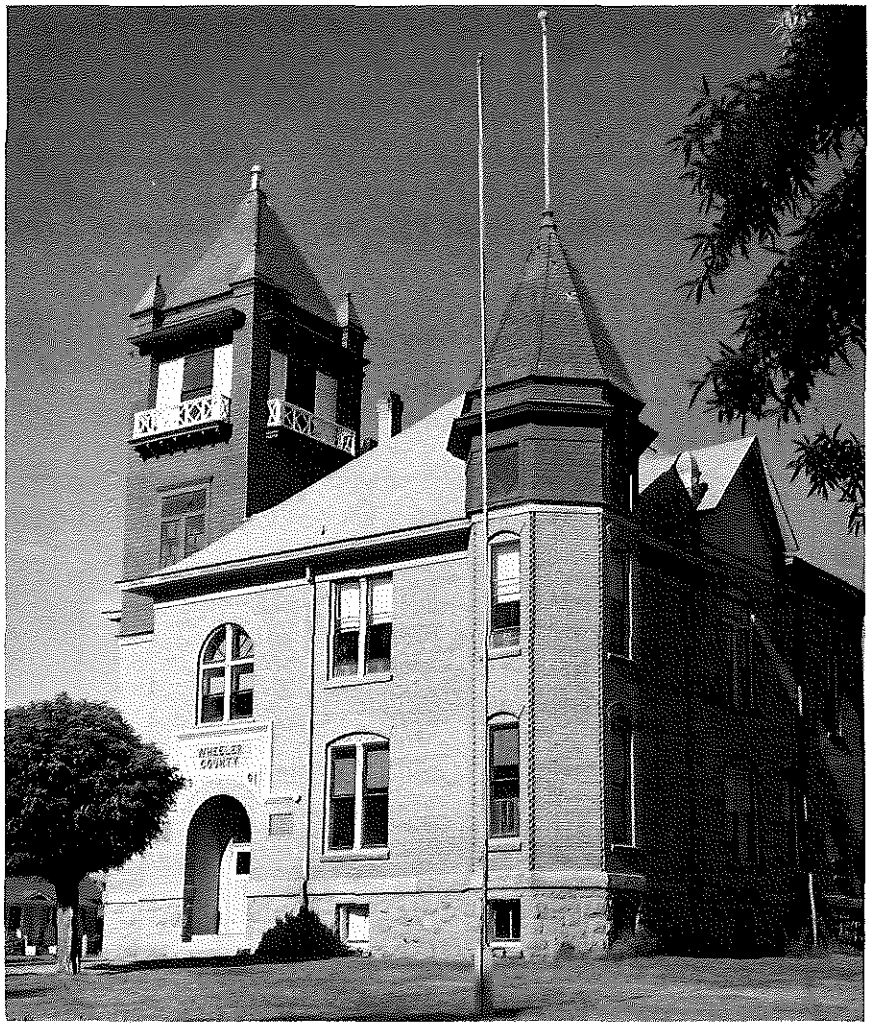
JOHN DAY BASIN LAND AREA BY COUNTY

County	Acres (in basin)	Percent of Basin in County	Percent of County in Basin
Crook	19,840	*	1.0
Gilliam	686,720	13.3	87.7
Grant	2,321,920	44.8	80.1
Harney	17,920	*	**
Jefferson	114,560	2.2	10.0
Morrow	250,880	4.8	19.1
Sherman	304,640	5.9	57.3
Umatilla	313,600	6.1	15.2
Union	5,120	*	**
Wasco	112,000	2.2	7.3
Wheeler	1,035,520	20.0	94.5

* Indicates less than 1 percent of basin area is in the county.
** Indicates less than 1 percent of county area is the basin

3. POPULATION AND AREA

The basin has a population of approximately 14,000 people. Most of the upper basin population of 9,000 is in Grant and Wheeler Counties. Most people in the lower basin live in Gilliam and Sherman Counties. The total populations of these four counties account for most of the population of the basin. Tables 7 and 8 show populations for the four major counties and for all incorporated cities in the basin.



Wheeler County courthouse in Fossil, built in 1901.

Table 7

COUNTY POPULATIONS
(actual and projected)

County	1950	1960	1970	1980	1984	1990	2000
Gilliam	2,817	3,069	2,342	2,057	1,950	2,100	2,200
Grant	8,329	7,726	6,996	8,210	8,050	8,500	9,400
Sherman	2,271	2,446	2,139	2,172	2,200	2,300	2,500
Wheeler	3,313	2,722	1,849	1,513	1,400	1,500	1,500
	16,730	15,963	13,326	13,952	13,600	14,400	15,600

Source: U.S. Bureau of Census
Portland State University, Center for Population Research and Census

Table 8

CITY POPULATIONS
(actual and projected)

City, County	1950	1960	1970	1980	1984	2000
Arlington, Gilliam	686	643	375	521	440	-
Canyon City, Grant	508	654	600	639	615	1,114
Condon, Gilliam	968	1,149	973	783	710	1,250
Dayville, Grant	286	234	197	199	205	275
Fossil, Wheeler	645	672	511	535	485	503
Granite, Grant	40	3	4	17	15	-
Grass Valley, Sherman	195	234	153	164	175	-
Greenhorn, Baker/Grant	-	-	-	0	3	-
John Day, Grant	1,597	1,520	1,566	2,012	1,985	3,950
Lonerock, Gilliam	38	31	12	26	20	-
Long Creek, Grant	288	295	196	252	245	497
Mitchell, Wheeler	415	236	196	183	170	240
Monument, Grant	228	214	161	192	190	291
Moro, Sherman	359	327	290	336	320	300
Mt. Vernon, Grant	451	502	423	569	610	835
Prairie City, Grant	822	801	867	1,106	1,115	1,757
Shaniko, Wasco	61	39	58	30	40	-
Spray, Wheeler	-	194	161	155	195	240
Ukiah, Umatilla	-	-	-	249	315	-

Source: U.S. Bureau of Census
Portland State University, Center for Population Research and Census
Department of Land Conservation and Development

4. LAND OWNERSHIP AND ZONING

Over 60 percent of the John Day River Basin is privately owned. Of the remainder, 30 percent is managed by the U.S. Forest Service, 7 percent by the Bureau of Land Management, and less than 1 percent by the State of Oregon. The lower basin is predominately privately owned. Private land in the upper basin coincides mostly with stream valleys. National Forest lands are located in the higher elevations of the upper subbasins in the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests. National Forest lands are important to the watershed and yield large quantities of runoff. The Bureau of Land Management administers widely scattered parcels throughout the basin. However, most BLM lands are along the lower John Day River below Service Creek, adjacent to the river between Kimberly and Dayville, and along the lower reaches of the South Fork. State-owned lands consist mostly of wildlife management areas in the vicinities of Bridge and Murderers Creeks. In addition, small areas in the basin are managed by the National Park Service, the Army Corps of Engineers, the Oregon Forestry Department, and the Oregon State Land Board. Table 9 shows land ownership in the basin.

Over 95 percent of the basin lands are zoned for agriculture and forestry uses. Urban lands comprise only 0.3 percent. Table 10 shows zoning types, by county, for the basin.

Table 9

LAND OWNERSHIP

Land Holder	Area (sq. mi.)	Percent of Basin
Private	5,027	62
U. S. Forest Service	2,396	30
Bureau of Land Management	587	7
National Park Service	20	*
Corps of Engineers	2	*
Oregon Dept. Fish & Wildlife	50	*
Oregon State Land Board	13	*
Oregon Forestry Dept.	4	*

* Indicates less than 1 percent.

Table 10

ZONING OF THE JOHN DAY BASIN *
(acres)

County	Agri-culture	Forestry	Public/ Park	Rural Ser. Centers	Rural Resident	Rural Indust.	Urban	TOTAL
Crook		18,950						18,950
Gilliam	687,385		27	196		3,158	2,518	693,284
Grant	918,554	1,383,999		1,500	13,457	141	7,540	2,325,191
Harney		19,111						19,111
Jefferson	105,049	8,112						113,161
Morrow	63,055	184,830		91				247,976
Sherman	299,732						800	300,532
Umatilla		148,696	163,518[1]		267		205	312,686
Union		4,532						4,532
Wasco	111,627						3,182[2]	114,809
Wheeler	765,194	276,040					1,643	1,042,877
TOTAL	2,950,596	2,044,270	163,545	1,787	13,724	3,299	15,888	5,193,109

1. National Forest Lands zoned public by Umatilla County.
2. Includes 2,800 acres in Rajneeshpuram.

* Acreage figures do not exactly match other estimates of basin area. Total acreage figures for the basin shown here is within 0.2 percent of that used in the 1979 land cover inventory.

Source: Department of Land Conservation and Development

5. TRANSPORTATION AND COMMUNICATIONS

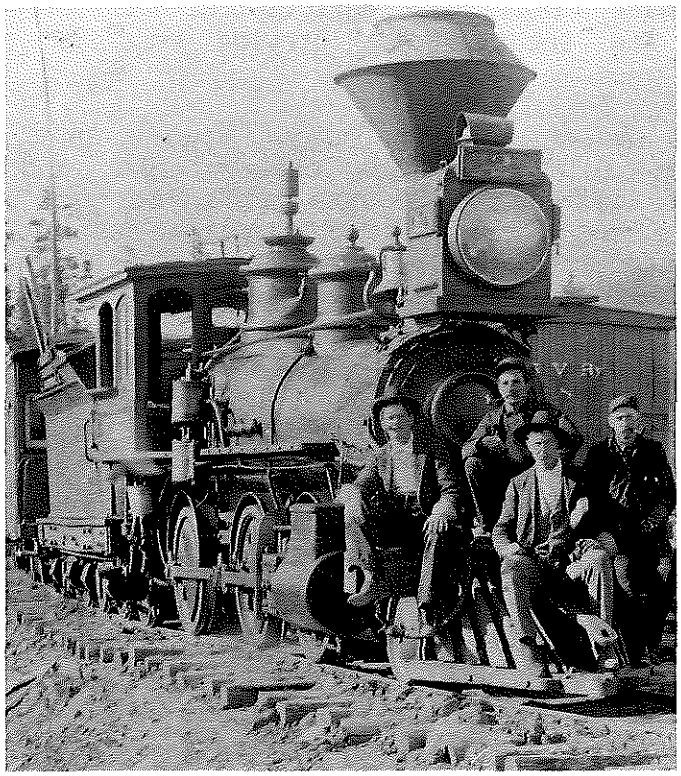
The highway transportation network in the John Day Basin includes one interstate highway, two federal highways, and five state routes. Interstate 84 crosses the John Day River at its mouth and thus affects only a small portion of the basin. U.S. Highway 26 passes through the southern part of the basin, connecting Mitchell, Dayville, Mt. Vernon, John Day, and Prairie City. U.S. Highway 395, which runs north and south through the eastern portion of the basin passes through Canyon City, John Day, Long Creek, and Ukiah. State routes provide connections between the basin's major communities.

Interstate 84 carries the largest traffic volume with an average daily vehicle count of nearly 6,000. This volume, however, is atypical for basin highways. The other federal highways carry about 680 vehicles per day, while state highways handle less than half that amount. Highest traffic volumes occur in late summer. The major traffic components (based on 1983 data) are passenger cars (37%), pickup trucks (39%), and heavy vehicles such as campers, trucks, and buses (16%).

In addition to state and federal routes, the John Day Basin has an extensive network of county and forest roads. Grant County maintains about 500 miles of county roads, Gilliam County another 500 miles, and Wheeler County almost 300 miles.

The basin has 22 airports and one heliport. Airports at John Day, Monument, and Condon are state-operated. Arlington has a municipal airport. The remainder are private, with the exception of a state Forestry Department airstrip in Wheeler County. No national or regional airlines serve the basin, though charter services are available.

Rail service is very limited in the John Day Basin and is restricted to the northern portion. Formerly, rail transportation extended to Shaniko and Kinzua. Currently, service is available only along the Columbia River and along a line running from Arlington to Condon. The basin was served by the Sumpter Valley Railroad from 1909 until abandonment in the 1930s. The railroad ran from Baker through Sumpter to Prairie City.



Logging engine on the Sumpter Valley Railroad in the early 1900s.

The Port of Arlington serves the extreme northern portion of the John Day Basin as a grain shipment terminal. An annual average of between 3 and 6 million bushels of grain has been shipped from the port during the past decade.

The following three newspapers are published in the basin (approximate circulation figures in parentheses): the Condon Times-Journal (1,400); the [Grant County] Blue Mountain Eagle (3,700); and the Sherman County Journal (900). The single radio station broadcasting from the basin is in John Day. Television and radio broadcasts from Oregon and Idaho are received by means of both regular transmission and cable.

C. RESOURCES

Agriculture, service industries, retail trade and the manufacture of forest products constitute the basin's economic base (see Table 11). Diversification of the economy is constrained by location, transportation, distance from markets, and a small population. Agriculture, the forest products industry (manufacturing), and retail trade provide most of the private sector employment.

Gilliam County is one of only two Oregon counties, both located in the John Day Basin, which lost population between 1970 and 1980. Employment opportunities are limited in the non-agricultural sector. An increase in average farm size and increased mechanization has reduced the number of farmers and farm laborers. However, in 1982 Gilliam County was ranked seventh among Oregon counties in per capita personal income.

Because of its excellent land resources, Sherman County's economy is agricultural. Fifty-five percent of its land is classified as tillable, compared to the state average of eight percent. The county's population is stable and modest growth is projected to the year 2000.

Wheeler County has the smallest population and the lowest growth rate of any Oregon county. It is the one other Oregon county which experienced a population decline between 1970 and 1980. Closure of the Kinzua Corporation sawmill at Kinzua in 1978, then the county's largest employer, was the major factor contributing to the population decline. Between 1977 and 1982 the labor force declined 27 percent. The agricultural sector now is the largest employer and accounts for 30 percent of county employment. Services and retail trade are the other major categories of employment. Wheeler County ranks eleventh among Oregon counties in per capita personal income. Income levels are closely tied to sale of agricultural products.

Grant County ranks 29th out of Oregon's 36 counties in population and, in 1982, ranked 29th in per capita personal income. The stability of Grant County's labor force and income levels largely follow the economic cycles of the lumber market. In 1980, 490 people were employed in lumber manufacturing. By 1982 employment had fallen to 280. Employment in the lumber manufacturing sector is rebounding slowly. Grant County's major employment sources are general services, agriculture, retail trade, and manufacturing.

Table 11

COUNTY EMPLOYMENT BY INDUSTRY
(percent of labor force)

Industry	Grant 3120*	Sherman 934*	Wheeler 510*	Gilliam 790*	Oregon 1,188,000*
Agriculture	16.9	29.3	30.0	28.8	5.0
Forestry & Fishing	7.4	--	3.5	--	5.4
Mining	0.5	1.0	0.4	--	0.2
Construction	5.2	11.2	9.1	4.6	5.8
Manufacturing	14.6	8.7	6.8	2.8	21.5
Transportation & Communications	4.2	3.0	7.2	7.6	8.0
Wholesale Trade	1.8	4.9	0.4	2.6	
Retail Trade	15.8	14.7	14.9	15.3	22.1
Finances, Insurance & Real Estate	2.5	1.4	1.9	5.6	5.1
Services	22.4	20.7	19.7	23.2	27.7
Public Administration	8.6	4.9	6.9	8.7	4.3

* Total labor force in respective jurisdiction.

Source: U.S. Department of Commerce, Bureau of Census (1983).

1. AGRICULTURE

Agriculture is the basin's primary private sector economic activity. Table 12 shows that the dominant crop grown in the basin are non-irrigated grain (mostly dryland wheat and small grains). The 380,000 acres devoted to these crops are located almost entirely below Clarno in the northern half of the basin where topography and water availability limit irrigated agriculture. Most irrigation in the northern half of the basin occurs along narrow stream bottoms for hay and alfalfa production. The water is applied primarily by sprinkler systems. Recent ground water development has led to some irrigation of lands that were formerly devoted to dryland crops.

The potential for increased agricultural production on the plateau depends more on economic conditions than the land base. Much of the land classified as suitable for dryland agricultural production already has been developed. Expansion is linked to factors such as soil productivity, land prices, fixed production costs, and commodity prices. Gilliam and Sherman County farm production (harvested acres) for the 1979-1984 five-year period peaked in 1982 and has declined since. Total gross farm income increased during this period, but production costs increased substantially as well.

Table 12

JOHN DAY BASIN CROP TYPES

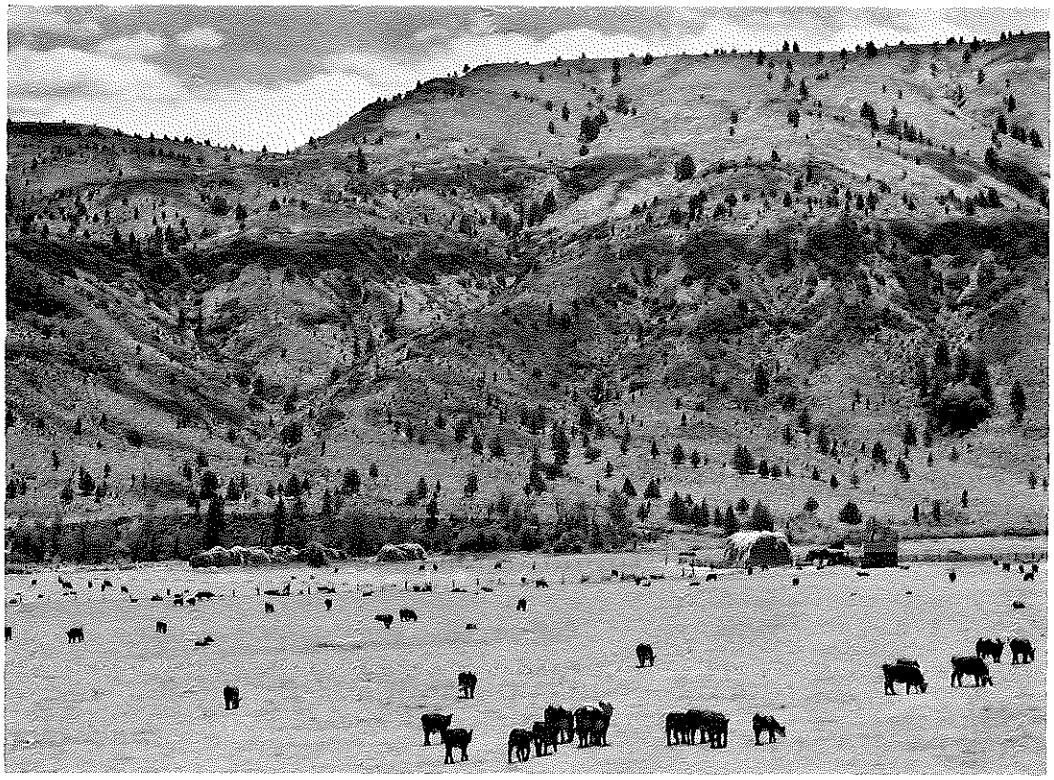
Irrigated Crops	Acres	Non-irrigated	Acres
Alfalfa Hay	25,010	Grain Hay and Pasture	37,850
Meadow Hay	24,300	Pasture and Grass	25,000
Hay and Pasture	12,550	Grain and Summer Fallow	379,700
Grain and Row Crops	2,050		
Corn and Corn Silage	90		
Orchards	290		
Mint	500		

Source: Oregon Department of Agriculture Small Watershed Study

The potential for an increase in irrigated acreage in the northern half of the basin currently is constrained by capital costs and fixed production costs. Farm land suitable for irrigation would be irrigated mostly by ground water. The irrigation systems recently installed in Grass Valley and Shutler Flat rely on ground water. Rapid increases in pumping costs coupled with initial system capitalization and falling commodity prices have significantly slowed irrigation expansion.

The primary agricultural products of the basin above Service Creek are alfalfa, meadow hay and beef cattle. Dryland farming generally is not practiced. Hay, as well as some specialty crops, fruit, and pasture are all irrigated (see Table 13). Irrigation is confined to valley and stream bottoms and productive benchlands. Surface water provides nearly all irrigation water. Flood irrigation is the most common method of field application (see Table 14).

While over one million acres in the basin are classified as suitable for irrigation, delivery of water to most of this land is not economical. Currently a little over 900 acres of land are irrigated with ground water compared to over 60,000 acres irrigated with surface water. Projections for Eastern Oregon indicate that areas irrigated by ground water could increase significantly by 1990. Relatively small increases in surface water use are projected. The same projections indicate that by the year 2000, ground water could be used to irrigate 57 percent more area than in 1984. Surface water only would be used to irrigate 6 percent more area. Table 15 lists various estimates of past irrigation in the basin as well as projections of possible irrigated acreages.



Beef cattle and hay crops, seen here on a ranch near Spray, are important agricultural products of the John Day Basin.

Table 13

IRRIGATED AREAS (1983 acres)

County	Hay & Pasture	Small Grains	Field Corn	Potatoes	Mint, Hops, & Dill	Fruits & Berries	Golf Courses & Parks	Other	Totals
Gilliam	3,600	4,148	74	50	--	30	--	--	8,438
Sherman	235	774	--	--	--	30	--	--	1,039
Wheeler	9,000	--	--	100	--	--	50	50	9,200
Grant	40,200	2,000	--	--	500	200	100	--	43,000

Source: Oregon State University, Extension Economic Information Office, 1984.

Table 14

IRRIGATION METHODS
(1983 acres)

County	Center Pivot	Hand Line	Side Roll	Solid Set	Big Gun	Gravity Flood	Drip	Total
Gilliam	2,180	1,000	2,653	250	500	1,825	30	8,438
Sherman	360	500	1,010	5	60	0	0	1,935
Wheeler	0	950	2,500	0	0	5,750	0	9,200
Grant	450	3,500	7,000	200	300	31,500	0	43,000

Source: Oregon State University, Extension Economic Information Office, 1984.

Table 15

ESTIMATED IRRIGATION ACREAGE BY YEAR
(1,000 acres)

Year	Acreage	Year	Acreage
1909	44.6	1970	65-65.7
1919	44.4	1975	56.5
1925	45.3	1980	57.8-59
1928	47.1	1984	64.8
1948/50	50.3	1990	66.3
1960	49.0	2000	69.1
1964	59.7	2020	70.6
1966	56.4		

Sources:
Oregon Water Resources Department, Oregon's Long-Range Requirements for Water, 1969.

Oregon Water Resources Department, John Day River Basin report, 1962.

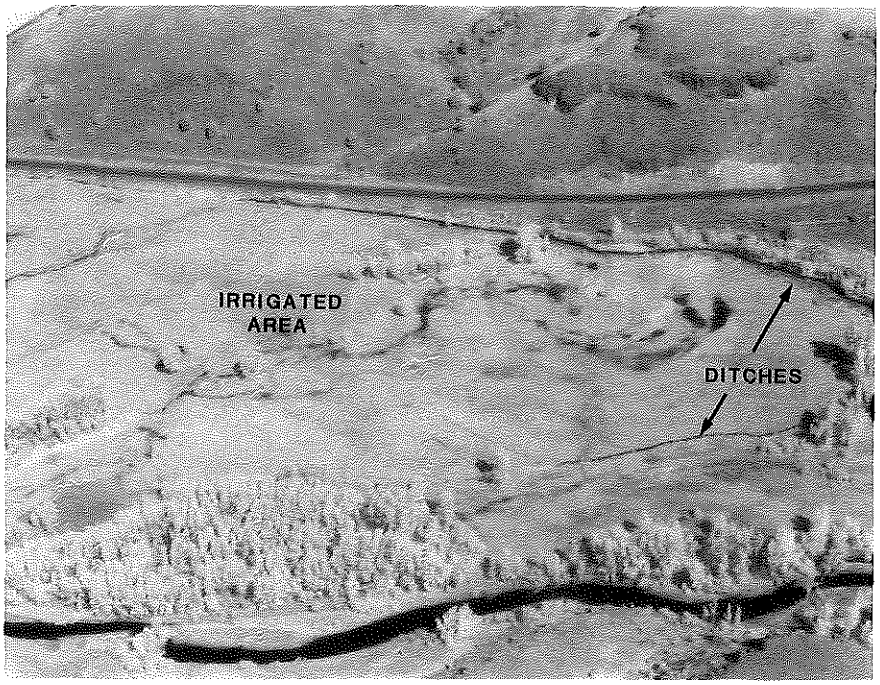
Pacific Northwest River Basins Commission, Projections of Irrigated Land in the Pacific Northwest, 1981.

Pacific Northwest River Basins Commission, Compilation of Information in Salmon and Steelhead Losses in the Columbia River Basin, 1985.

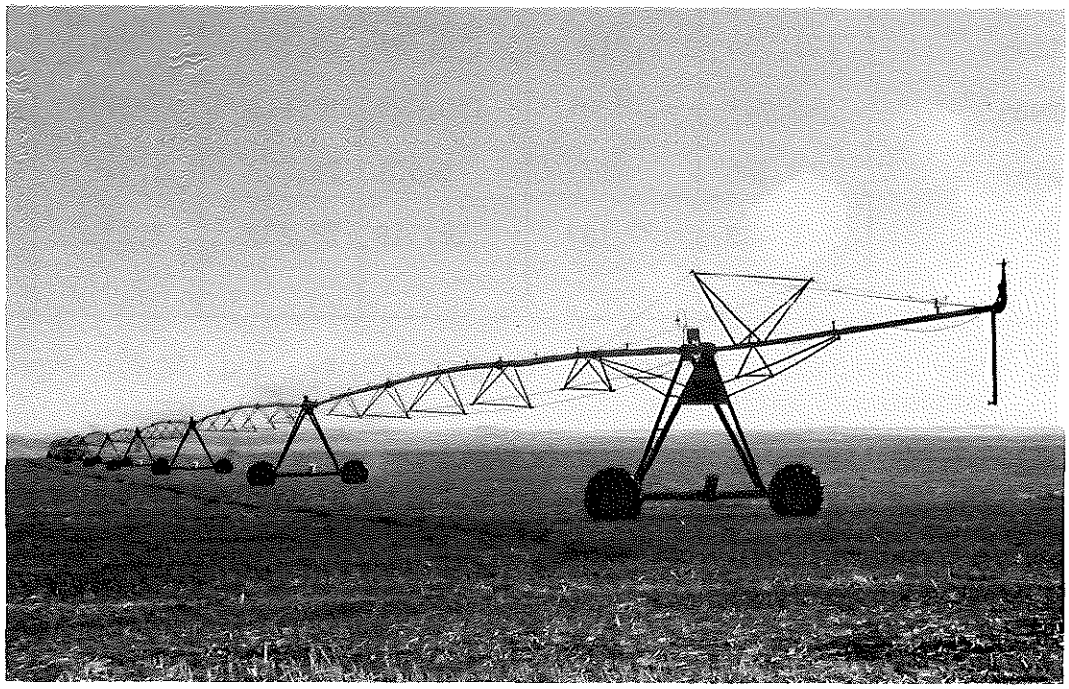
Oregon Department of Agriculture, unpublished report prepared under the Strategic Water Planning process.

Bonneville Power Administration, unpublished projections of irrigated acreages in Eastern Oregon.

Flood irrigation, shown in the first photograph below, is practiced mostly in the Upper Subbasin. Sprinkler irrigation is more common in the North Fork, Middle Mainstem, and Lower Subbasins. The bottom photo shows a circle pivot irrigation system near Arlington.



In flood irrigation, water is carried to fields by ditches such as these east of John Day.



In this field near Arlington, water is applied with a sprinkler irrigation system.

Beef cattle, meadow hay, and alfalfa production are important to the agricultural economy of the upper subbasins. Although hay and alfalfa are sold commercially, a large amount is retained and used by ranchers to feed wintering cattle. Annual yields generally range from 3 to 5 tons per acre, with operators normally getting 2 to 3 cuttings depending upon elevation and seasonal conditions. Between 1979 and 1985, hay sales comprised about 6 percent of Grant County's gross agricultural sales and 2.5 percent of Wheeler County's sales.

Cattle production, during the seven years between 1979 and 1985, comprised 74 percent of Grant County's agricultural production (gross sales) and about 78 percent of Wheeler County's production. In contrast, roughly 77 percent of Gilliam County's gross sales, and 91 percent of Sherman County's gross sales, were derived from grains, mostly dryland wheat and barley (see Table 16).

Table 16

COUNTY CROP AND ANIMAL SALES
1979-85
(thousands of dollars)

County	Grains	Hay and Silage	All Crops	Cattle and Calves	Other Animals	Total Gross Sales
Gilliam	121,524	2,017	126,791	29,495	974	157,260
Sherman	148,943	500	150,072	13,113	817	164,002
Wheeler	3,268	797	5,501	26,252	1,710	33,463
Grant	1,463	7,187	18,519	73,205	7,171	98,895

Source: OSU Extension Service. "Oregon County and State Agricultural Estimates," 1979-1985.

Range forage, the range grasses and vegetation on which cattle feed, provides 53 percent of the year-round cattle feed in Grant County. Hay and improved pasture provide the remainder. Access to range forage is important to operators since an animal unit month (AUM) of range forage, the amount of forage required to feed one cow and calf for one month, costs less than an AUM of hay.

Roughly 50 percent of the Grant County cattle operations use BLM or Forest Service range on a rental or permit basis. Table 17 illustrates the pattern of forage use by ranchers who graze cattle on federal rangeland. Federal range provides about 48 percent of the summer forage and is important to a large segment of Grant County ranchers. Privately owned range also provides a significant amount of forage, except during the winter months when hay provides over 90 percent of cattle feed.

Table 17

SEASONAL FORAGE USE BY FEDERAL PERMITTEES IN GRANT COUNTY (percent use)

Use	Apr	May	June	July-Sept	Oct-Nov	Dec-Mar
Private Range	39.5	85.2	45.1	39.3	53.5	3.8
BLM Range	11.2	7.9	8.2	3.9	2.9	1.3
USFS Range	-----	2.1	40.0	44.9	11.0	0.3
Pasture (irrigated)	0.9	1.9	5.5	7.7	6.8	0.1
Pasture (post-hay harvest)	-----	1.3	1.2	4.2	20.4	2.6
Hay (feedlot)	48.4	1.6	----	----	5.4	91.8

Source: Oregon State University, Agricultural Experiment Station (1984).

2. FOREST RESOURCES

Income from forestry and forest products ranks second to agriculture in the economy of the John Day Basin. Forest lands occupy a large portion of the basin area. About 1.6 million acres of forest lands in the basin are classed as commercial -- lands available for and capable of producing marketable timber. These lands contain approximately 13.8 billion board feet of commercial timber.

About 196,700 acres of timber are classified as commercial-reserved -- lands capable of, but reserved from, production of marketable timber. These lands are primarily in streamside and roadside protective zones, campgrounds, administrative sites, and in national forest wilderness areas which include Strawberry Mountain, North Fork John Day, and Black Canyon Wilderness Areas.

The remaining forest lands are classified as noncommercial-unproductive -- land not capable of producing marketable timber. These lands consist of low-elevation stands of juniper, steep rocky areas, and small areas of subalpine timber just below timberline. Most of this land is outside national forests.

The forests are composed almost exclusively of softwoods and generally do not occur below 4,000 feet in elevation because of low precipitation. Exceptions are hardwoods along the river bottoms. Western juniper extends from within the forest zone into the grassland zone.

Ponderosa pine is the predominant forest tree species constituting about 60 percent of the commercial forest acreage and about 63 percent of the commercial saw-timber volume. It often occurs in stands at lower elevations. As elevation increases, moisture conditions become more favorable for other species such as Douglas fir, white fir, western larch, lodgepole pine, and western white pine.

On the cool, moist upper slopes, generally above 6,000 feet in elevation, fir and lodgepole pine predominate with Englemann spruce and subalpine fir also present. Extensive stands of lodgepole pine are found where catastrophic agents such as fire or insects have destroyed timber stands.

There are 1,603,300 acres of commercial forest land in the basin. The USFS manages 957,200 acres and the BLM manages 24,100 acres, while 62,800 acres are in private and other ownership. About 62 percent of the commercial forest land and more than 67 percent of the commercial saw timber is in public ownership and as Table 18 illustrates, most of it is within the Ochoco, Malheur, Wallowa-Whitman and Umatilla National Forests. Timber productivity is relatively low in comparison to western Oregon timberlands. Productivity could be increased by more intensive management.

Table 18

COMMERCIAL FOREST VOLUMES
(million board feet)

National Forest	Bureau of Land Management	Private	Other	Total
8,986	123	4,583	59	13,751

Source: Oregon Forestry Department, U.S. Forest Service, and the Bureau of Land Management (1984).

Primary insect pests are the larch casebearer, the mountain pine beetle, the moth, and the western budworm. In 1983, the Malheur, Umatilla, and Ochoco National Forests chemically treated over 931,100 for budworm infestation. Casebearer, pine beetle and budworm infestations are expected to significantly reduce future timber harvests but, in the short term, may increase salvage sales.

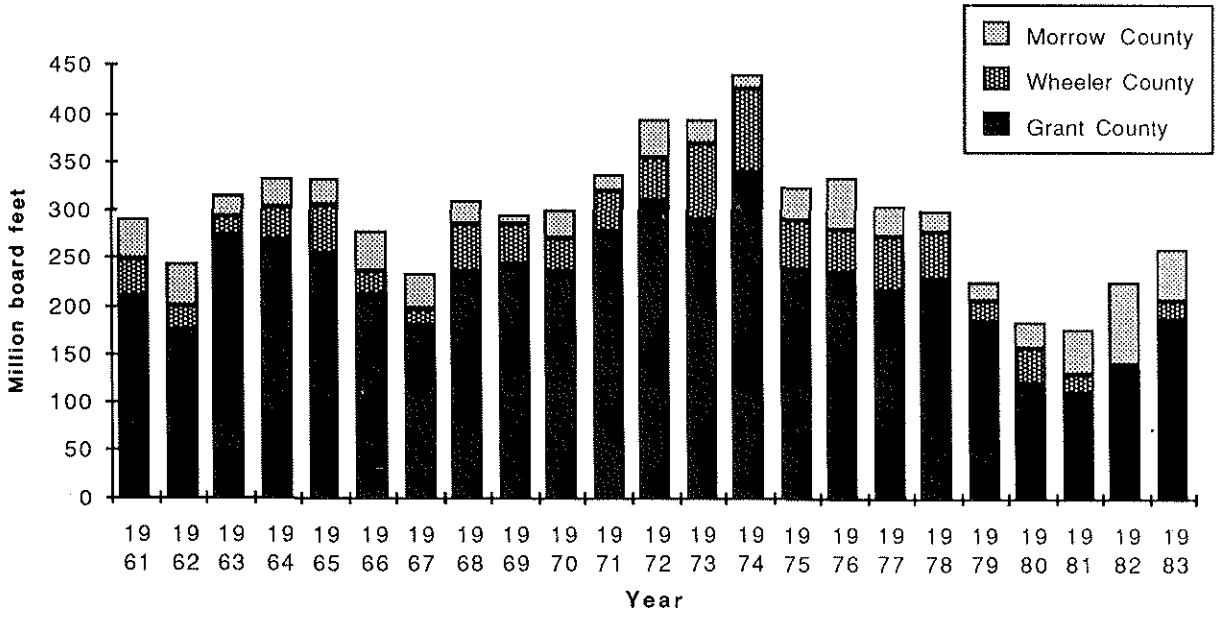
Future timber harvest from National Forest lands is being reviewed. Each Forest currently is preparing a land management plan which will allocate forest lands to various uses and which will set timber harvest schedules. Such factors as the amount of wood utilization, rate of regeneration of cutover land, degree of intensive management, and accessibility of salvageable dead timber will change the allowable cut figures.

Large volumes of timber have been harvested from private lands. During the near term, harvests from private land may drop while present young stands are attaining marketable size. During this period, the timber supply for the basin will be largely from public land.

Figure 16 shows log production trends of Grant, Wheeler and Morrow Counties since 1961. The dominance of Grant County production is a function of the federal timber base. Forests in Wheeler County are predominantly privately owned, but in Grant County the forests are predominantly federally owned.

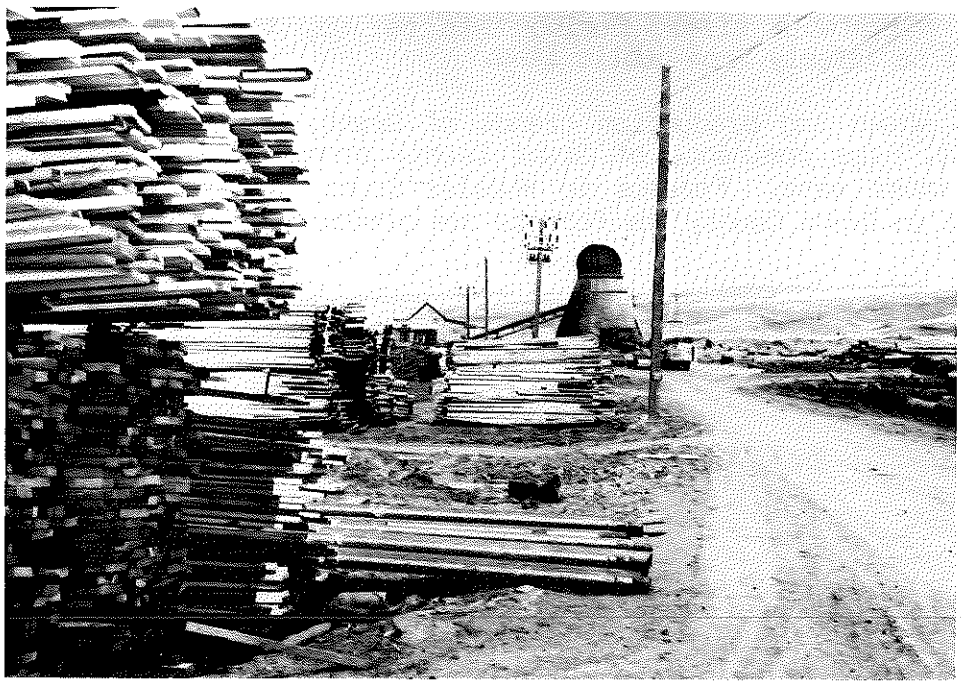
Figure 16

COUNTY LOG PRODUCTION
(million board feet)



Local county governments depend in part on forest receipts as a source of revenue. Between 1976 and 1984 the Umatilla National Forest returned an average of $537,815 in annual receipts to Grant County and about $64,000 to Wheeler County. Malheur National Forest fund payments to Grant County over the same period averaged $562,808 annually. These monies are dedicated to schools and roads.

Almost all the timber from the basin is milled into lumber. Sawmills are located at Prairie City, Long Creek, Ukiah, Mt. Vernon, and John Day. Timber is also exported to out-of-basin mills. These mills have a combined annual production of 185 million board-feet and employ approximately 450 people. Forest economy employment in counties comprising and contiguous to the basin totals about 4,800 people.



Lumber mill at Long Creek.

There is some potential for improved use of the basin's timber resource. Electrical cogeneration plants are producing energy at Long Creek and Prairie City. Additional opportunities exist to use dead lodgepole and logging residue for more electrical generation plants, firewood, and chips but, because of remoteness from existing and potential plant sites and population centers and lack of cheap transportation, opportunities to better use this resource may be limited.

3. FISH AND WILDLIFE RESOURCES

a) Fish Production

The John Day Basin contains one of the few remaining wild fish runs in the Columbia River drainage. The John Day River and tributaries historically have provided desirable spawning and rearing habitat for fall and spring chinook, summer steelhead and resident fish populations. Recently, anadromous populations have been declining. Historical data, while sketchy, indicate that over 6,000 spring chinook and 35,000 steelhead once traveled to the John Day Basin to spawn. Today, adult populations range from 1,000 to 2,500 spring chinook and 2,250 to 20,000 steelhead. The distribution of spring chinook and steelhead is displayed in Table 19 and Plate 3. Recent declines are generally attributed to high adult and juvenile mortality at the Columbia River dams combined with high egg and smolt mortality in the basin as a result of habitat degradation. Fall chinook probably were also present in the basin at one time. However, current runs are now estimated at 150 and few have been sighted in recent years.

The John Day Basin supports one of the few remaining wild anadromous fish runs in the entire Columbia River drainage.

The John Day Basin maintains wild runs for three primary reasons: (1) fish passage is almost totally uninhibited from the river's mouth to the headwaters, (2) runs have not experienced the gene pool alterations which have occurred in other basins because of hatchery supplementation, and (3) habitat diversity needed to support spawning and rearing populations continues to exist in many parts of the basin during most years. Because of these conditions, fishery interests are committed to protecting anadromous fish populations in the basin. Oregon Department of Fish and Wildlife seeks to maintain completely wild anadromous runs and to achieve long-range future escapement levels of approximately 5,700 spring chinook and 20,500 summer steelhead annually through habitat protection and restoration. The purpose of this type of management is to preserve genetic diversity for maximum habitat use and fisheries production.

Table 19

ESTIMATED SPAWNING DISTRIBUTION OF SALMON AND STEELHEAD IN THE JOHN DAY BASIN (percent)

Subbasin	Spring Chinook	Fall Chinook	Steelhead
Upper Mainstem	18	--	16
South Fork	--	--	7
Middle Mainstem	--	--	4
Middle Fork	24	--	30
North Fork	58	--	40
Lower Mainstem	--	100	3

Source: Department of Fish and Wildlife, 1985.

b) Habitat Conditions

General time periods for anadromous fish migration, spawning, egg incubation and rearing in the John Day basin are shown in Table 20. The timing of each stage changes according to conditions within individual subbasins.

Migrating adult summer steelhead enter the John Day Basin in late August or September when stream temperatures drop and streamflows increase. The adult steelhead reach spawning and rearing grounds between March and May while passage is relatively unrestricted. Spring chinook adults migrate into the drainage in April and reach resting pools near spawning grounds by late June. During low-water years, fish may encounter passage and spawning difficulties in upper basin streams. Flows necessary for migration may be unavailable during early summer months. For example, in the spring of 1985, passage for

migrating adult steelhead was restricted on Indian, Pine, Fields, Cottonwood and other creeks where naturally low flows were further reduced by irrigation diversions. Juvenile steelhead and spring chinook move out of the basin during freshets when water quality and quantity improve. While spring chinook smolts generally migrate during the spring, steelhead may migrate any time from spring to fall with peak movement usually occurring in June and October.

Table 20

LIFE HISTORY STAGES FOR ANADROMOUS FISH IN THE JOHN DAY BASIN

Species	Life History Stage	J	F	M	A	M	J	J	A	S	O	N	D
Summer Steelhead	Adult Migration	---	---	---	---	---			---	---	---	---	---
	Adult Spawning			---	---	---	---						
	Egg Incubation			---	---	---	---	---					
	Juvenile Rearing	---	---	---	---	---	---	---	---	---	---	---	---
	Smolt Migration			---	---	---	---	---					
Spring Chinook Salmon	Adult Migration				---	---	---						
	Adult Holding						---	---	---				
	Adult Spawning								---	---			
	Egg Incubation	---	---	---	---								
	Juvenile Rearing	---	---	---	---	---	---	---	---	---	---	---	---
	Smolt Migration		---	---	---	---	---						

Source: Department of Fish and Wildlife, 1986.

Adult steelhead spawn from March through the middle of June and adult spring chinook in late August or September, depending on water conditions. The small population of fall chinook spawns in the lower mainstem from September through November. During normal water years, spawning habitat generally is available in the upper basin. During low-water years, water depth may be inadequate for spawning adults to use all potential gravel bar habitat. Gravel is necessary for both redd (spawning nest) construction and fry emergence. Gravel size and depth requirements vary by species. Not only must streamflow be high enough for adults to reach gravel, it must be of relatively low velocity to allow egg deposition. In some stream reaches, particularly in the lower portions of the mainstem and tributaries, water diversions, gravels smothered by sediment, and poor water quality in general may preclude successful spawning. Such conditions likely have contributed to the decline of fall chinook in the lower mainstem.

Steelhead eggs incubate for approximately one month and spring chinook eggs for approximately five months. Time required for incubation varies significantly with water temperature. Alevins (newly hatched fish) may spend another month or so in the gravel before they absorb their yolk sacs and

emerge as free-swimming fry. During this time, adequate streamflow is needed to maintain low turbidity, cool temperatures, high oxygen concentrations, and favorable conditions for egg, embryo and alevin development.

Juvenile steelhead grow for two to three years and chinook for one year in the John Day Basin before migrating to the ocean as smolts. During this time, fish size and number are determined largely by the physical space available in pools and riffles, food abundance, clean water, and cover. In the John Day Basin, anadromous fish production is limited primarily by existing rearing conditions.

A healthy fish-producing stream has cool, clean water, has an even sequence of pools and riffles, and is bordered by healthy vegetation. Cover also is available for fish in the form of boulders, submerged logs, undercut banks, overhanging vegetation and similar features needed for resting and escape from predators. Lastly, a fish-producing stream is characterized by adequate late-summer streamflows.

Today, streams with these characteristics are not predominant in the basin. Many streams have been affected by a variety of activities which have caused streambank degradation, erosion, very low late-summer flows and very high spring flows. Recovery from damage caused by such activities is slow in arid areas such as the John Day Basin. These streams are not as resilient as streams in areas which receive more precipitation.

c) Wildlife Production

Deer, elk, bighorned sheep, cougar, waterfowl, upland game birds, furbearers, and other wildlife are present in the John Day Basin. Research has shown that of the terrestrial species known to live in the Blue Mountains, 75 percent are either directly dependent on riparian zones or use them more than other habitats. Consequently, riparian areas are one of the most critical wildlife habitats.

d) Habitat Improvement

The Department of Fish and Wildlife, Bonneville Power Administration, the Forest Service, Bureau of Land Management, Soil Conservation Service, Northwest Power Planning Council, Indian tribes, landowners, and others are working to improve stream conditions in the basin. From 1973 to 1986, over $3,129,000 has been spent on habitat improvement projects in the upper John Day system. Areas improved are expected to show near-optimum spawning and rearing conditions for spring chinook and summer steelhead within ten years of project completion. A majority of this work is being completed under the Northwest Power Planning Council's Fish and Wildlife program to mitigate for fish and wildlife losses from hydroelectric developments.

Instream habitat improvement structures on Camp Creek, a tributary of the Middle Fork John Day River.

During the next five years, improvements are scheduled for 55.6 miles of the John Day River and tributaries above Prairie City and on the North Fork and its tributaries. (For a complete listing of needed stream improvements, see Appendix E). Both areas are important for anadromous fish production, especially spring chinook, and contain big-game range and other critical wildlife habitat. The work is intended to rehabilitate natural spawning and rearing grounds and migrating corridors to increase fish production. Improvements are being made to increase water quality and quantity and to restore bank stability, natural streamside vegetation and other physical conditions necessary for stream integrity which enhance habitat diversity for fish and wildlife.

4. MINERALS AND ENERGY

a) Minerals

The basin contains a wide variety of metallic and non-metallic minerals. Metallic minerals include antimony, chromium, cobalt, copper, gold, nickel, mercury, molybdenum, silver, and tungsten. The major deposits are concentrated in the eastern part of the basin. Non-metallic minerals, which include asbestos, clay, diatomite, limestone, building stone, and zeolite, are distributed throughout the basin. At the present time, most of these deposits are not considered economically feasible for development, either because of their low grade, small quantity or high transportation costs.

The increase in precious metals prices since 1978 has led to increased exploration and mining activity. Gold continues to be mined from placer and small hardrock mines near the heads of the North Fork and Upper Mainstem Subbasins. A small quantity of silver is being mined on an annual basis from Granite Boulder Creek in the Middle Fork Subbasin.

Exploration efforts have focused mainly on previously known deposits on Granite Creek and headwaters of the North Fork and Middle Fork. It is estimated that more than $20 million has been spent on major exploration programs in the basins since 1975.

Other metallic and non-metallic mineral deposits probably will be discovered elsewhere in the John Day Basin. Recent exploration has focused largely in the geologically better-known areas in the basin that have had past production. Many areas in the basin have not been fully explored. Expansion of exploration to unexplored areas probably would expose additional deposits.

b) Energy

Approximately 10 geothermal springs have been located in the John Day Basin. These springs indicate the presence of isolated low-temperature resources. Use of the geothermal energy in this area to date has been limited to resort space and pool heating, e.g., Ritter Hot Springs. Both the low temperatures and isolated nature of the springs -- even relative to towns in the basin -- generally preclude increased use of the resource. In the lower basin, warm ground water underlies most of the Columbia Plateau. Water-source heat pumps can use this ground water. The rural nature of the area has precluded any uses to date and will continue to be the limiting factor for future development.

Two biomass-fired cogeneration facilities are operating in the John Day Basin. The facilities are:

Prairie Wood Products in Prairie City with a capacity of 7.5 megawatts. The facility will use about 70,000 bone dry tons of mill residue per year and 120 gpm of ground water.

Blue Mountain Forest Products in Long Creek with a capacity of 5 megawatts. The facility will use about 46,000 bone dry tons of mill residue per year and 80 gpm of water.

These two facilities likely will consume most of the available wood residue in the eastern half of the basin. A one-year-old facility in Heppner (20 miles outside of the basin) will use much of the available residue in the western half of the basin.

There have been three Federal Energy Regulatory Commission preliminary permits issued for hydroelectric projects in the basin. All are located in Grant County -- two are on the North Fork and one is on the South Fork at Izee Falls. Currently, only the project at the site of the historic Fremont Power Project is being pursued. An application for a right to divert 20 cfs from Lost and Lake Creeks to produce 2.5 megawatts of power has been approved. Outflow would return to Congo Creek, a tributary of Clear Creek.

The Water Resources Commission has approved the license application for the Fremont Power Project but has yet to issue a state license to construct and operate the project. Four additional state operating licenses have been issued for projects of less than 100 theoretical horsepower.

5. RECREATION AND TOURISM

Recreation and tourism also are important to the basin's economy. The John Day Fossil Beds National Monument, the Strawberry Mountain, Black Canyon, and North Fork John Day River Wilderness Areas, and abundant federal and state lands open to public hunting, fishing, camping and sightseeing attract thousands of visitors to the basin each year. For example, 43,051 hunters spent 225,368 hunter days in the basin during the 1983 big-game seasons. In the same year, an estimated 37,400 angler-days were spent fishing for steelhead, trout, and other species.

Between Service Creek and Tumwater Falls, the 147-mile segment of the lower John Day River is a state-designated Scenic Waterway. Canoeists and rafters are floating the waterway in increasing numbers, especially the stretch between Service Creek and Clarno because of its good public access. A boater survey indicated 3,000 people floated the lower John Day River during 1984.

Tourism, travel expenditures for food, lodging, transportation, costs, etc., contributed an estimated $6,200,000 to the economy of the four major John Day basin counties in 1983. Up to 168 temporary and full-time jobs serviced the tourism industry. About $64,000 in local tax receipts were generated through tourism. However, the economic importance of tourism is small in comparison to agriculture, forest products and service sectors of the John Day Basin economy.

Drift boat on lower John Day River.

D. WATER USE AND CONTROL

The current John Day Basin Program, adopted May 24, 1962, and last modified December 2, 1985, establishes a program for the use and control of the water resources of the basin. Recognized beneficial water uses for the basin include, domestic, municipal, livestock, irrigation, industrial, mining, power development, recreation, pollution abatement, wildlife and aquatic life uses.

1. WATER RIGHTS

Water has been appropriated in the basin since the early 1860s. Since that time, over 4,500 water right certificates have been issued. Figure 17 traces water rights issuance in cubic feet per second (cfs) by decade and general use. The figures are based on all rights granted per decade according to priority date, and do not reflect cancellations. It appears, however, that of the 4,500 rights representing 6,200 cfs, about 800 have been cancelled, accounting for around 3,600 cfs.

Figure 17

WATER APPROPRIATIONS BY DECADE

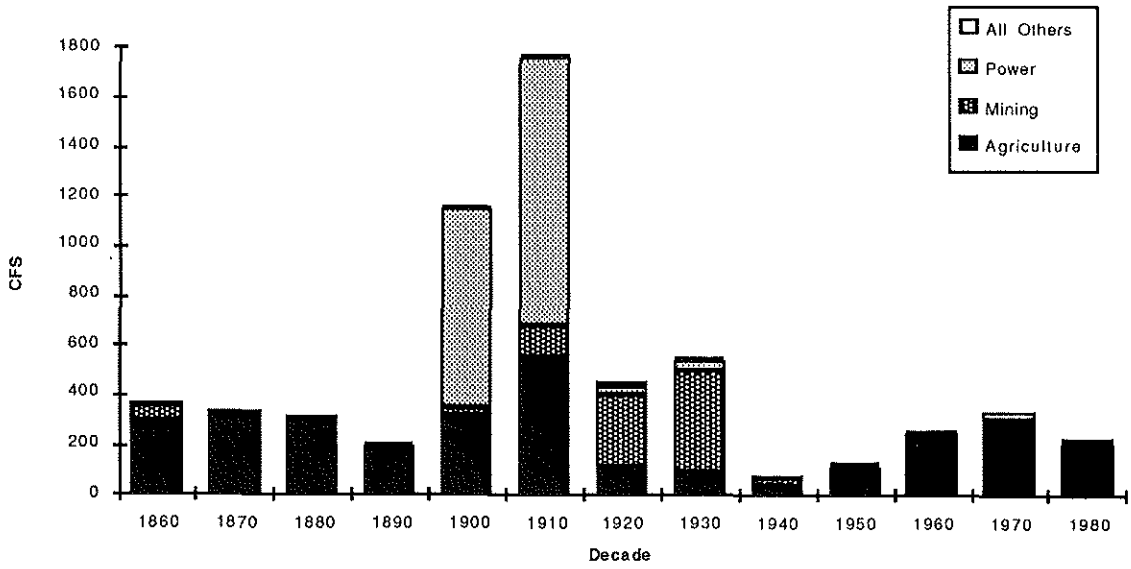


Figure 17 reveals about 60 percent of historical appropriations occurred between 1860 and 1920. This corresponds to the basin's early economic and social development. During this period, slightly less than 73 percent of the appropriation was for irrigation. The 50 years between 1920 and 1970 was a period of moderate water development. During the 1970s, the basin experienced an increase in water allocation. Most recently, the number of water use applications has been declining. The total quantities of water (in cfs) applied for in each of the years between 1980 and 1985 were 74, 36, 40, 64, 5, and 30. Seventy to 95 percent of the water requested was for irrigation.

Water diverted and applied to benefical use in the basin under conditions predating the state permit system were adjudicated by four court decrees: Cochran Creek in the North Fork Subbasin in 1910; Cherry Creek and its tributaries in 1922; Bridge Creek and its tributaries in 1937; and the remainder of the basin in 1956. The resulting decrees clarified and validated beneficial uses, and established an irrigation season and rate of water use for each adjudicated right (see Table 21).

Table 21

ADJUDICATION SEASONS, RATES AND TOTAL ALLOWABLE USE

	Irrigation Season	Irrigation Rate (per season)	Total Duty (use not to exceed)
1) John Day River	Apr. 1-Sep. 30		
A. Mainstem John Day R. above Picture Gorge		1/40 cfs per acre 1 af/ac/mo to July 1 .75 af/ac/mo thereafter	5 af/ac per season
B. Mainstem John Day R. below Picture Gorge and North and Middle Fks.		1/40 cfs per acre 1 af/ac/mo per month	5 af/ac per season
C. S. Fork John Day River and tributaries, and all tributaries of Mainstem, N. Fork and Middle Fork		1/40 cfs per acre 1 af/ac to June 1 1/80 cfs per acre thereafter	4 af/ac per season
2) Cochran Creek	Apr. 1-Oct. 1	1/50 cfs per acre	
3) Bridge Creek, all tributaries except Gable Creek	Mar. 1-Oct. 1	1/40 cfs per acre to June 15 1/80 cfs per acre thereafter	
Gable Creek		1/80 cfs per acre to June 15 1/100 cfs per acre thereafter	
4) Cherry Creek and all tributaries	As needed for irrigated beneficial use	1/80 cfs per acre 1/40 cfs per acre to July 1 1/80 cfs per acre thereafter	3 af/ac per season

af = acre-feet
ac = acre

A summary of basin water rights is presented in Table 22. Water rights information for the John Day Basin was derived from a computerized database. The data are provisional in nature, not having been subjected to rigorous verification. Data are current to August 1984. Water rights issued after this date are not taken into account.

The water rights information that follows represents all rights which have been perfected and have not been cancelled. Many of the rights may no longer be used. According to Oregon water law, if a right is not exercised for five consecutive years, it is considered forfeited and ceases to exist. However, such rights remain on the records until officially cancelled. Because of its nature, little information is available on water right forfeiture. Thus, rights that have been forfeited but not cancelled would appear as valid in the database.

Table 22

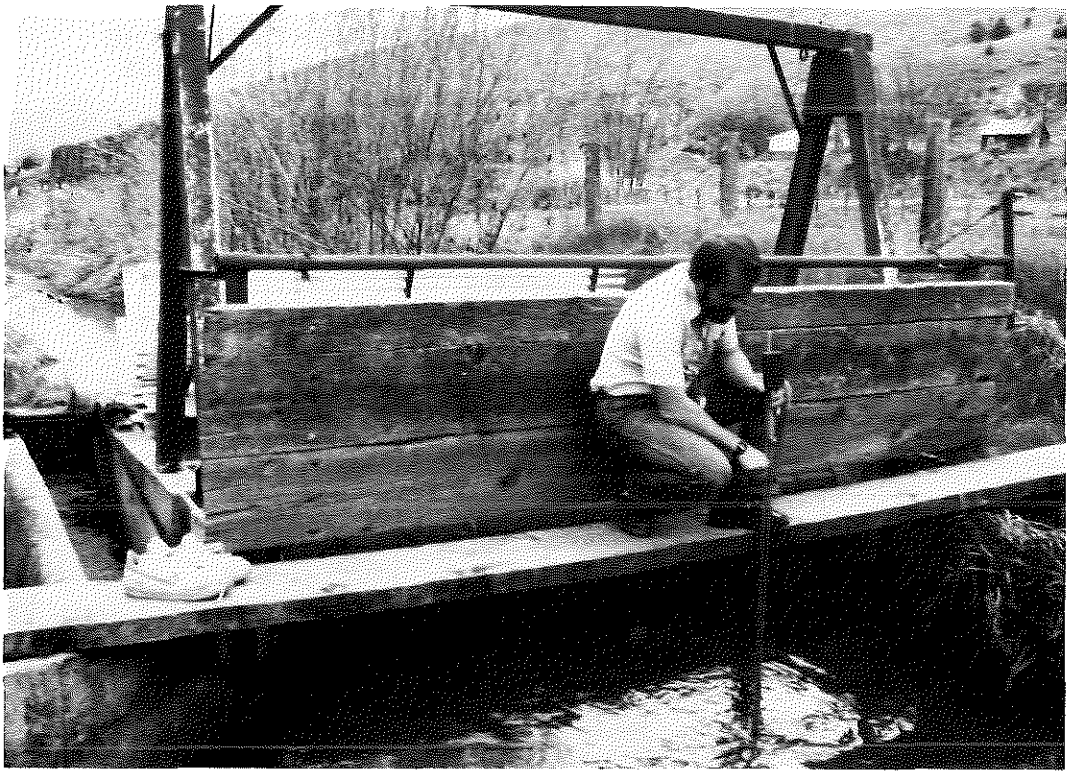
SUMMARY OF EXISTING WATER RIGHTS FOR THE JOHN DAY BASIN BY CFS AND BENEFICIAL USE

Beneficial Use	Lower John Day	Middle Mainstem	Upper Mainstem	North Fork	Middle Fork	South Fork	Total[1]
Agriculture			*				*
Commercial				3.7			3.7
Domestic (lawn & garden)	0.2	0.2	0.2	0.1	*		0.7
Domestic	0.1	1.3	1.6	1.2	1.8	0.1	6.1
Fish life	0.1	0.7	12.8	2.0			15.6
Fire Protection		*	0.2		0.1		0.3
Industrial/Manufacturing	0.8		7.3	2.1	2.2		12.4
Irrigation[2]	229.0	495.5	927.0	291.5	88.5	97.5	2,129.0
Livestock	4.0	0.6	0.9	1.7	0.8	0.3	8.3
Mining		30.8	40.5	202.2	49.5		323.0
Municipal	15.4	5.4	9.3	3.9	3.1	5.1	42.2
Power			13.9	25.0	0.8		39.7
Quasi-Municipal	2.5	2.8					5.3
Recreation	.2		*	2.0	*		2.3
Storage [3]	(129)	(5,215)	(681)	(1,898)	(82)	(377)	(8,382.0)
Temperature Control	3.3						3.3
Wildlife		*	*				*
Other [4]	9.6	6.8	4.3	0.7			21.4
Total[1]	265.2	544.1	1,018.1	536.1	146.7	103.0	2,613.0 (1,549.0)

* Less than 0.1 cfs.
1 Totals may not agree due to rounding.
2 CFS allowed during 6-month irrigation season. (CFS adjusted for entire year in parenthesis)
3 Storage is in acre-feet. Storage rights allow no diversion. Use of stored waters requires a separate right under the specified use. Storage figures are not included in the grand totals.
4 Represents those rights with uncoded use in provisional database.

There are two measures of the water quantity allocated by an irrigation water right. The first allows an irrigator to use water at a rate no greater than that specified on the certificate. For most of the John Day Basin this rate is 1/40th of a cubic foot per second for each acre irrigated during the season. The second measure governs the total volume that can be used over the entire season. This quantity varies within the basin but never exceeds 5 acre-feet per acre irrigated. Thus, a right to irrigate 100 acres may permit application of up to 2.5 cfs throughout the season with a total allowable use of 500 acre-feet.

Table 22 arrays beneficial uses by subbasin. It reveals that throughout the basin, there are certain common denominators of water use. For example, domestic, irrigation, livestock, municipal, and storage uses occur in each of



Watermaster measuring flow in irrigation ditch.

the subbasins. Quantities for uses other than irrigation, mining, and power generally are very limited. Agricultural uses dominate, though there are a diversity of uses represented in the basin. Water listed for fish life represents mostly private, out-of-stream use and should not be confused with instream uses or minimum flows.

Table 22 shows that the use of water for irrigation accounts for over 69 percent (by volume) of all water appropriated in the basin. Mining is the next most dominant use, with 12 percent by volume. Given the current low level of mining activity, many of the mining rights probably have been abandoned. Similarly, although irrigation is undoubtedly the dominant water use, the figures arrayed in Table 22 probably overestimate current use. There are rights to apply irrigation water to about 100,000 acres in the John Day basin. Only about 60,000 acres, however, are currently irrigated according to recent estimates (see Table 12). Of the remaining 40,000 acres, many probably were never irrigated due to overestimates of acreages and overlaps with existing rights. Some have also been abandoned.

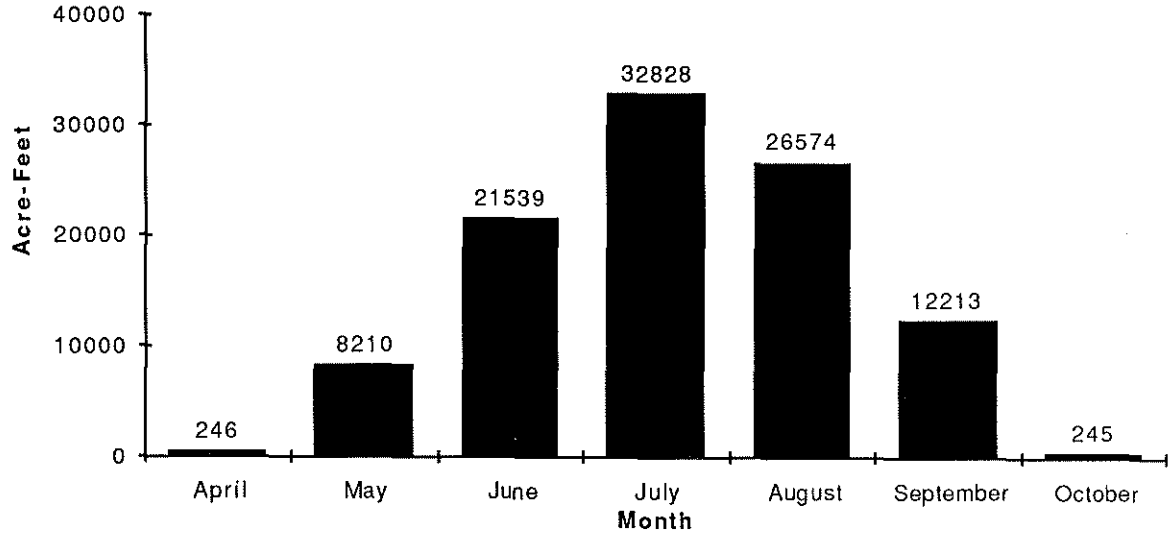
Irrigation water consumption estimates were developed based on the crop type, crop acreage, and locale. These estimates are shown in Figure 18.

Over the irrigation season, the crops grown in the basin require an estimated 102,000 acre-feet of water. This translates into approximately 280 cubic feet per second from April through September. These figures were derived using the SCS Blaney-Criddle method. Under this method, monthly water requirements for specific crops are calculated based on the plant's physiology, the mean monthly air temperature, the monthly percentage of daytime hours, and other climatic considerations. In other words, it is a measure of the amount of water transpired by an actively growing plant plus the water evaporated from the soil surface surrounding the plant, less rainfall and a soil moisture storage coefficient.

The estimates of consumption are conservative in at least two respects. First, according to a 1985 study, the Blaney-Criddle method can underpredict crop consumptive use at arid, high-elevation locations. Secondly, the estimates identify the water requirements at the point of application. The estimates do not take into account transporting water to the site and any consequent conveyance losses.

Figure 18

JOHN DAY RIVER BASIN
ESTIMATED IRRIGATION WATER REQUIREMENTS



A recent U.S. Geological Survey study underscores the conservative nature of the estimates. In 1984, the USGS estimated that, absent irrigation, the John Day River at Picture Gorge would have an average July flow of 700 cfs. The actual flow measured at that point, however, was 400 cfs, indicating a consumption of 300 cfs through the month. This is equivalent to about 18,000 acre-feet. The crop water requirements, as predicted by the Blaney-Criddle method, amount to approximately 13,000 acre-feet.

Thus, the quantity of water used for irrigation is certainly less than the 2,100 cfs (760,000 AF) indicated in Table 22 but higher than the 102,000 AF indicated by crop requirements alone. The actual quantity is dependent upon the crop, the method and efficiency of application, climate, and the number of users -- all of which vary with time. Basinwide, irrigation requirements amount to about seven percent of the John Day River's average annual discharge.

Total basin permitted diversions (1,100,000 AF or 1,549 cfs) are 76 percent of the John Day Basin's annual discharge (1,475,000 AF or 2,036 cfs). However, actual consumption undoubtedly is less than that permitted. Basin discharge is adequate to satisfy all water rights on an average annual basis, even in a critically low-flow year. However, because of the wide variance in seasonal distribution of runoff, there is insufficient streamflow on many streams during late summer to satisfy all water rights.

2. WATER USE RESTRICTIONS

a) Statutory

Chapter 324 of Oregon Laws, 1939, grants the Morrow County Court the authority to divert and store an unquantified amount of water from Ditch Creek, a tributary of the John Day North Fork, for irrigation purposes. ORS 538.010 states that the waters of Ditch Creek, which are diverted via an interbasin transfer into Willow Creek of the Umatilla Basin, have a priority of July 10, 1939, and are subject to the same rights of use and appropriation as the original waters of Willow Creek. The Smith Ditch conveys 7 to 10 cfs of John Day water into the Umatilla Basin during the irrigation season.

ORS 390.825 designates 147 miles of the John Day River from Service Creek to Tumwater Falls as a State Scenic Waterway. No dam, reservoir, water impoundment facility, or placer mining is permitted on waters within the scenic waterway. No water diversion facility can be constructed or used in the scenic waterway except by previously established right.

b) Administrative

1) Withdrawals

In 1915, the State Engineer withdrew and withheld from appropriation 2,000 cfs of the John Day River and its tributaries, supplemented by 250,000 acre-feet of storage in the then proposed Dayville Reservoir and 150,000 acre-feet in the proposed Carty Reservoir, for irrigation, power and domestic purposes

(applications 4707 and R-4708). The withdrawal is for the purpose of providing a water supply for a proposed John Day project, which was studied cooperatively by the State of Oregon and U.S. Bureau of Reclamation. The project envisioned irrigating about 300,000 acres on the Umatilla Plateau between Alkali Canyon and the Umatilla River, using the waters of the John Day River. The withdrawal has not been rescinded even though funding for the project never materialized.

2) Reservations

In 1930, the State Engineer ordered that no subsequent applications for permits should be accepted to appropriate the waters of Long Gulch or its tributary springs in order to protect the municipal water supply of the City of John Day. Long Gulch is a tributary of Canyon Creek.

Guyon Springs on Conner Creek, a tributary of the South Fork John Day River, was reserved by the State Engineer in 1932 to protect Dayville's municipal water supply.

Bly Creek, and the springs at the head of Bly Creek, were reserved by the State Engineer in 1934 for municipal use by the City of Long Creek, including domestic use and fire protection.

3) Minimum Streamflows

Currently, the John Day Basin has 17 minimum perennial streamflow points and reaches which are identified in Figure 19 and Table 23. The establishment of minimum perennial streamflows is one tool the Water Resources Commission may use to protect instream water uses. Under Oregon law, these minimum flows are treated as natural flow rights and are regulated in essentially the same manner as water rights -- that is, according to priority.

Five minimum streamflows were established in 1962 on the John Day River and on the North and Middle Forks. These flow levels do not vary seasonally. The other 12 flow points and reaches were established in 1985 and include most of the John Day River above Picture Gorge. The flow levels specified for these vary by month. Minimum streamflows in the John Day Basin were requested primarily for maintenance of fish life. Water for domestic and livestock uses, as well as water released from storage, is not subject to minimum streamflow restrictions. In addition, there are special exemptions for some other uses in specific minimum streamflow reaches.

4) Hydroelectric Standards

Administrative rules governing hydroelectric applications on Oregon rivers and streams affect hydroelectric development in the John Day Basin. The rules do not permit construction of hydroelectric projects within the John Day River Scenic Waterway. Furthermore, state hydroelectric standards place stringent requirements on projects which are on streams supporting anadromous fish, wild game fish, or important recreational opportunities.

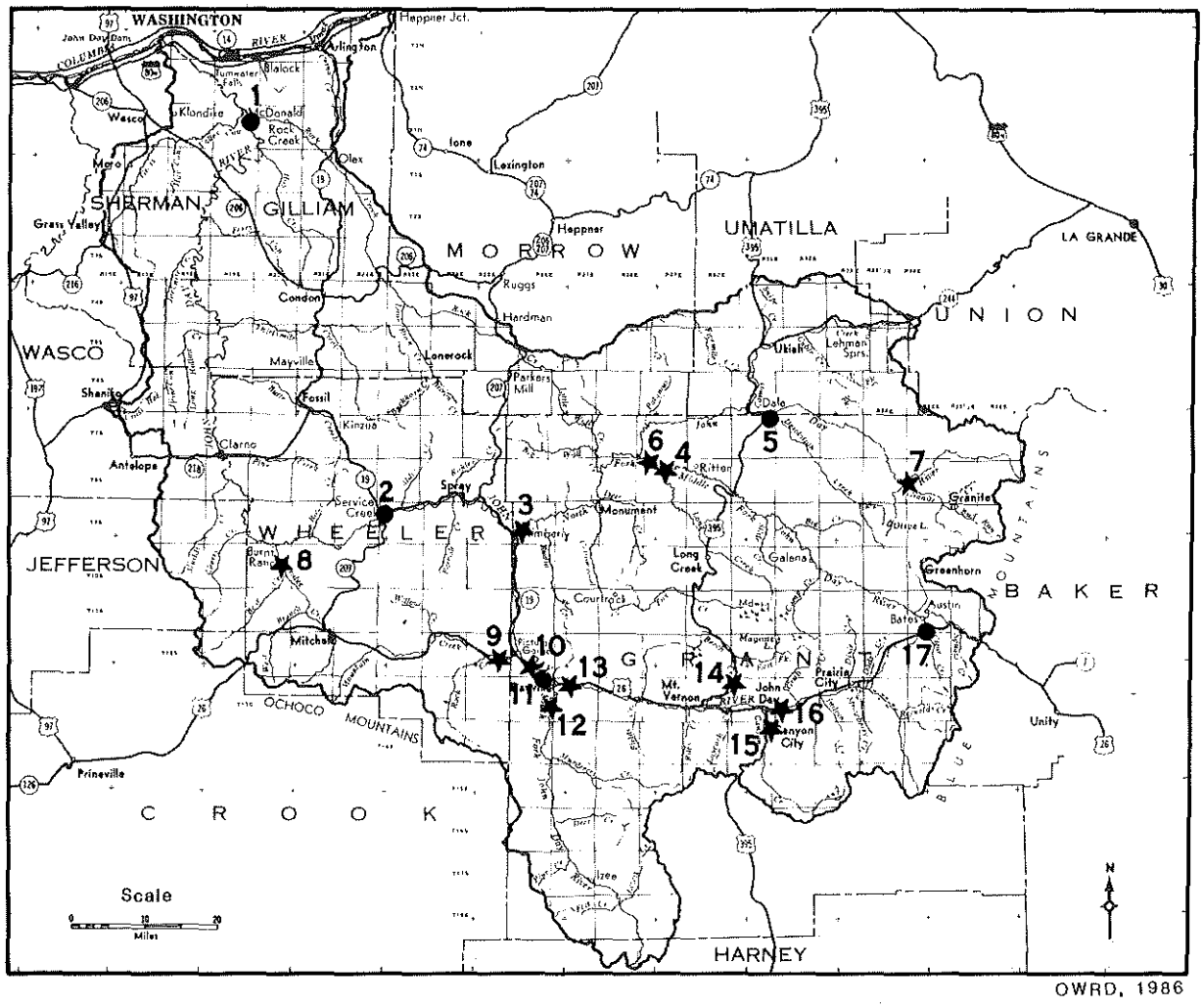
Table 23

JOHN DAY RIVER BASIN
MINIMUM PERENNIAL STREAMFLOWS
(cfs)

	OCT	NOV	DEC	JAN	FEB 1-15	FEB 16-29	MAR	APR	MAY	JUN	JUL 1-15	JUL 16-31	AUG 1-15	AUG 16-31	SEPT 1-15	SEPT 16-30	Priority Date
John Day River in the reach between the mouth of Rail Cr. and USGS gage 14-038530 (Sec. 19, T13S, R32E).	25	25	25	25	25	25	24	24	24	25	15	15	15	34	34	34	11/03/83
John Day River in the reach between USGS gage 14-038530 (Sec. 19, T13S, R32E) and the mouth of the South Fork John Day River.	50	80	80	80	80	118	118	118	118	80	50	30	30	30	30	30	11/03/83
John Day River in the reach between the mouth of the South Fork John Day River and the mouth of the North Fork John Day River.	60	120	120	120	120	160	160	160	160	120	60	60	60	60	60	60	11/03/83
John Day River above USGS gage 14-046500 at Service Creek (Sec. 18, T9S, R23E) as measured at the gage.	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	05/24/62
John Day River above its mouth as measured at USGS gage 14-048500 at McDonald Ferry (Sec. 11, T1N, R19E).	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	05/24/62
Canyon Creek in the reach between the mouth of East Fork Canyon Creek and the mouth of Canyon Creek (Sec. 23, T13S, R31E).	9	15	25	25	25	34	34	34	34	25	15	9	9	9	9	9	11/03/83
Beech Creek in the reach between the mouth of East Fork Beech Creek and the mouth of Beech Creek (Sec. 28, T13S, R30E).	8	15	30	30	30	44	44	44	44	30	15	8	8	8	8	8	11/03/83
South Fork John Day River in the reach between the mouth of Black Canyon Creek and the mouth of the South Fork John Day River.	25	50	100	100	100	133	133	133	133	100	50	25	25	25	25	25	11/03/83
Cottonwood Creek above its mouth as measured at the mouth (Sec. 28, T12S, R26E).	3	10	10	10	10	15	15	15	15	10	7	3	3	3	3	3	11/03/83
Rock Creek in the reach between the mouth of Mountain Creek and the mouth of Rock Creek (Sec. 17, T12S, R26E).	10	20	35	35	35	50	50	50	50	35	20	10	10	10	10	10	11/03/83
Bridge Creek in the reach between the mouth of Bear Creek and the mouth of Bridge Creek (Sec. 3, T10S, R20E).	6	25	25	25	25	40	40	40	40	25	15	6	6	6	6	6	11/03/83
Granite Creek in the reach between the Clear Creek and the mouth of Granite Creek (Sec. 13, T8S, R34E).	30	30	55	55	35	35	71	71	71	55	30	30	30	71	71	30	11/03/83
North Fork John Day River above former USGS gage 14-0415 near Dale (Sec. 35, T6S, R31E) as measured at the site of the gage.	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	05/24/62
North Fork John Day River above its mouth as measured at USGS gage 14-0460 at Monument (Sec. 2, T6S, R27E).	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	05/24/62
Clear Creek above its mouth as measured at the mouth (Sec. 34, T11S, R35E).	10	10	18	18	18	18	25	25	25	18	10	4	4	25	25	10	11/03/83
Middle Fork John Day River above its mouth as measured at USGS gage 14-0440 at Ritter (Sec. 8, T8S, R30E).	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	05/24/62
Middle Fork John Day River in the reach between USGS gage 14-0440 (Sec. 8, T8S, R30E) at Ritter and the mouth of the Middle Fork John Day River.	50	80	80	80	80	125	125	125	125	80	50	25	25	125	125	50	11/03/83

Figure 19

JOHN DAY BASIN
MINIMUM PERRENNIAL STREAMFLOW LOCATIONS



● MINIMUM FLOW POINT ★ MINIMUM FLOW REACH

1 John Day River at McDonald Ferry
2 John Day River at Service Creek
3 North Fork John Day River from Monument to mouth
4 Middle Fork John Day River from Ritter to mouth
5 North Fork John Day River at Dale
6 Middle Fork John Day River from Ritter to mouth
7 Granite Creek from Clear Creek to mouth
8 Bridge Creek from Clear Creek to mouth
9 Rock Creek from Mountain Creek to the mouth
10 John Day River from South Fork to North Fork
11 Cottonwood Creek at mouth
12 South Fork John Day River from Black Canyon to mouth
13 John Day River from John Day gage to South Fork
14 Beech Creek from East Fork to mouth
15 Canyon Creek from East Fork to mouth
16 John Day River from Rail Creek to John Day gage
17 Clear Creek at the mouth

c) Classification

In accordance with the public interest, the Water Resources Commission has classified the water resources of the John Day Basin for domestic, livestock, municipal, irrigation, power development, industrial, mining, recreation, pollution abatement, wildlife and fish life uses. The use of the waters of natural lakes is limited to domestic, livestock, irrigation of lawn or noncommercial gardens not to exceed one-half acre in size, power development not to exceed 7.5 theoretical horsepower, recreation, wildlife and fish life uses. Use of the John Day River within the scenic waterway is limited to domestic, livestock, municipal, irrigation, industrial, mining, recreation, wildlife and fish life uses.

3. WATER QUALITY

Water quality generally is satisfactory for most uses in the John Day Basin. The most serious water quality problems are high sediment loads and turbidity in spring runoff and high water temperatures in late summer. Localized problems with community sewer systems or individual septic tanks exist, but bacteria and nutrient loading do not pose serious concerns basinwide. Phosphorus concentrations exceed Department of Environmental Quality standards periodically in some reaches of the mainstem John Day.

In addition to domestic wastes, the basin also contains one of the few licensed hazardous waste disposal sites in the Northwest. The Chem-Security Systems, Inc. site, located southwest of Arlington on Alkali Canyon, is a disposal site for hazardous and toxic materials. No radioactive waste disposal is allowed at the site. Non-hazardous industrial wastes are disposed of in local landfills.

4. STORAGE

There are no major impoundments in the John Day Basin. Over the years, many studies have examined potential storage and irrigation projects. Other potential sites probably could be identified. The Corps of Engineers completed two preliminary studies of the John Day Basin in 1982. A reconnaissance report dated April 1982, discussed the potential for several large storage facilities on the mainstem John Day River and the lower North Fork John Day River. All of these sites are considered to have a significant adverse impact on anadromous fish runs. None of the sites were found to be economically justified under the criteria used by the federal agencies. The report recommended that "no further study of major water storage projects in the John Day River basin be undertaken at this time."

A second reconnaissance report, dated September 1982, was prepared to fulfill a request by the Oregon Water Resources Department. The report presents a preliminary assessment of 14 potential damsites on the John Day River and several of its tributaries but does not include any recommendations for action or further study.

The Bureau of Reclamation completed a study of the basin above Service Creek in 1985. The study was authorized primarily to aid in the rehabilitation of anadromous fish habitat. In addition, the investigation identified other water-related needs such as irrigation, recreation, flood control, and power production. Fifty-nine potential headwater storage sites were identified. Of these, five were chosen for further investigation in the North and Middle Fork Subbasins. The most promising of these, the 10,000 acre-foot Phipps Meadow site on the Middle Fork, was selected for intensive study. It was found to have a high degree of environmental acceptability. However, based on Bureau of Reclamation criteria, the benefit-cost ratio was found to be .88 to 1. Estimated annual costs exceeded annual benefits by $178,000. No further action was recommended.

Storage could solve many of the water problems identified in the John Day Basin, particularly in the North Fork and Middle Fork Subbasins where the least costly storage sites are located. However, concerted action by state, federal, and local governments and basin residents likely will be necessary for a storage project to proceed in the current economic climate.

Altogether, 132 possible reservoir sites have been studied in the John Day Basin. These sites and their characteristics may be found in the subbasin sections that follow this overview.

Over 8,400 acre-feet of storage is under permit in the basin. Small farm impoundments and livestock watering ponds account for the majority of stored volume. Impoundments range from 0.1 to 2,300 acre-feet. Of the 478 permitted reservoirs, only 22 are greater than 50 acre-feet.

5. FUTURE WATER REQUIREMENTS

The demands which will be placed on water resources in the John Day Basin depend on economic trends. Apart from agriculture, mining, and the forest products industry, large-scale water-consuming industries have not located in the basin. In all probability, the economy in the basin will continue to depend on agriculture, forestry, and tourism.

Estimates of per capita water use for domestic and municipal water use range from 100 to 430 gallons per person per day. Based on an expected population growth of 2,000 persons during the next 15 years, the increased water requirement will be less than 1,000 acre-feet per year, or an average of 1.5 cfs. The small amount of industrial growth likely will be served by municipal water systems and can be included within these estimates. While expansion or modification of municipal systems could have significant effects on flows in smaller streams, future domestic, municipal, and industrial withdrawals will not be measurable in the John Day River or its major tributaries.

Agricultural uses account for most of the water rights established since 1940. Based on the assumptions that expansion of irrigation will follow projections shown in Table 15 and that crop pattern in the basin will remain roughly the same as in 1984, and, barring any significant change in growing

season and climate, the long-range irrigation requirements will be similar to those arrayed in Table 24. These estimates are based on the Blaney-Criddle crop-water requirement method and do not reflect conveyance losses. Agricultural uses other than irrigation are small and will not result in significant new water requirements.

Instream uses of water, especially for water quality maintenance, also account for significant future water needs of the basin. Due to low streamflows during late summer and fall, water quality in many areas of the basin is degraded. Additional quantities of water are needed during these seasons to protect the instream uses, especially fish life and other aquatic life forms. Larger flows would reduce water temperatures which in turn would increase dissolved oxygen levels for aquatic life. Larger flows also would ensure that any pollutants reaching the streams are not concentrated to undesirable levels.

Table 24

JOHN DAY RIVER BASIN
ESTIMATED FUTURE IRRIGATION WATER REQUIREMENTS
(acre-feet)

Year	May	June	July	August	September
1990	9,840	22,558	34,072	27,790	12,769
2000	10,258	23,515	35,517	28,969	13,311
2020	10,473	24,009	36,262	29,577	13,590

E. PROBLEMS

The major water resource problem in the John Day River basin is the seasonal distribution of discharge. Like other semi-arid river basins in Eastern Oregon, the John Day naturally experiences the highest runoff in later winter and early spring during snowmelt. The lowest flows occur during late summer.

Activities in the last 125 years may have had a significant impact on the basin's capacity to retain water and release it later in the season. Analysis of historical flow data suggests that more precipitation falling in the basin during winter now runs off immediately instead of staying in the basin. The use of the watershed's resources to satisfy consumer demand for forest products, cattle, grains, minerals, and other commodities probably has increased winter runoff and decreased spring runoff.

Past uses of natural resources had particularly severe effects. The healing process is slow in the John Day's semi-arid environment, and some areas are adversely affected by activities that ceased long ago. In other cases, poor management practices still continue.

Mining seriously affected many streams in the John Day Basin. In this photograph from the late 1800s, hydraulic mining wastes (lower right) can be seen entering Canyon Creek.

Watershed degradation, in turn, has created secondary problems. It has intensified out-of-stream versus instream use conflicts, as well as seasonal water quality problems in the basin.

Although on the average the John Day Basin annually discharges about 1.5 million acre-feet of water, only four percent of the flow takes place in the critical July through September period. This is the period of peak water requirements for irrigation. Water also is needed at this time for the support of juvenile anadromous and resident fish. These, then, become the major water use conflicts in the basin. These activities conflict only insofar as water supply is concerned. The water supply during summer has been altered by activities beyond the control of either irrigators or fisheries interests.

Water quality, on the whole, is acceptable for most uses in the John Day Basin. But it, too, suffers from existing watershed conditions and the imbalance in seasonal flows. Water from rains and snowmelt runs off to

streams more quickly. Soil erosion increases. As the winter's store of water is lost from the basin, flooding occurs. The increased velocity and volume of water erodes streambanks, resulting in further erosion. In many streams tributary to the John Day, excessive water volumes are deepening channels, thus lowering water tables in immediate proximity. In the mainstem of the John Day, residents have observed widening of the stream channel which is believed to be a consequence of high flows and bank collapse. Land area is lost and spawning gravels are covered.

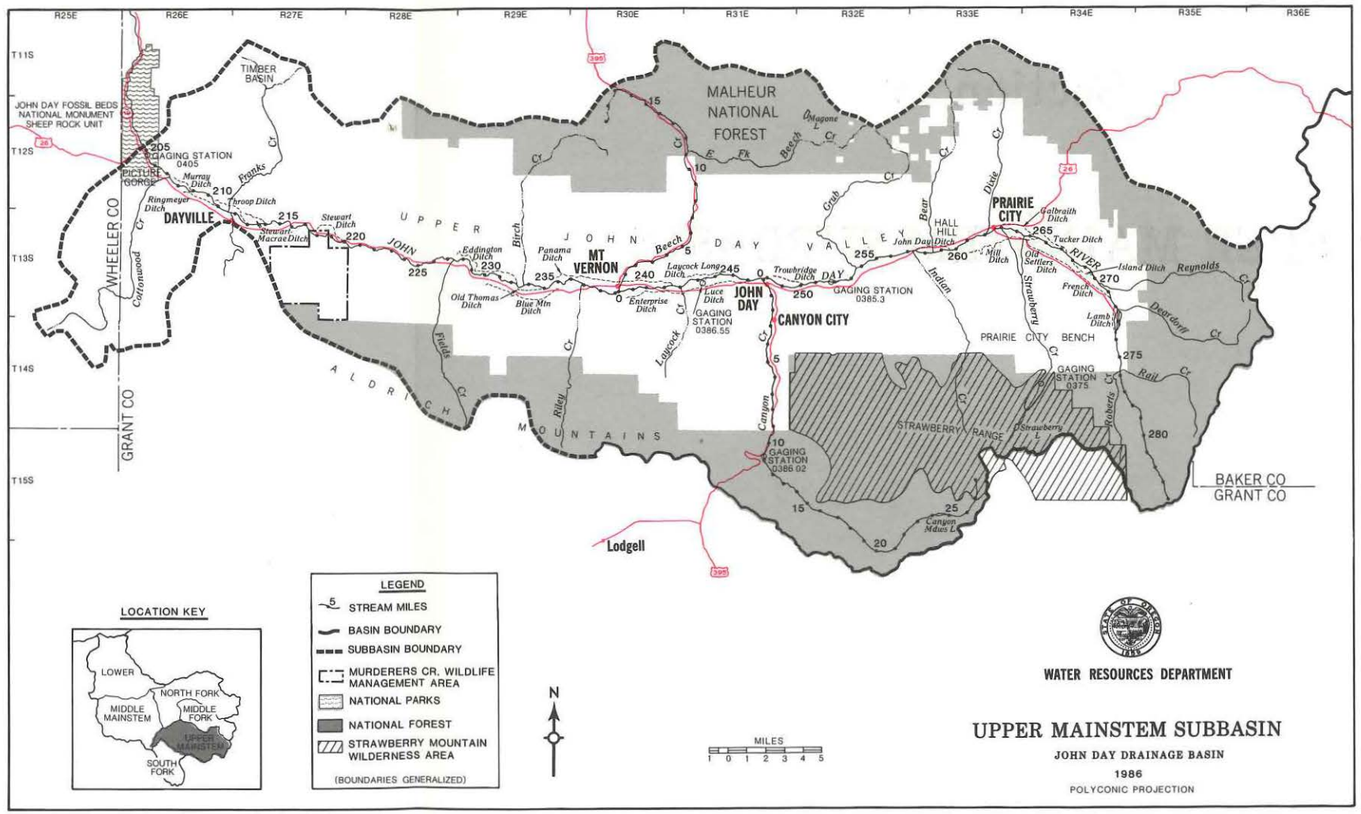
The water that is left to run off in summer is relatively clean. However, because there is little of it, water use affects it more. Diversions from streams in late summer can result in total dewatering of channels. The small amounts of water in remaining channels is subject to heating from a variety of sources. Elevated water temperatures pose serious problems to aquatic life in the basin.

Section IV

UPPER MAINSTEM SUBBASIN

Figure 20

MAP OF THE UPPER MAINSTEM SUBBASIN



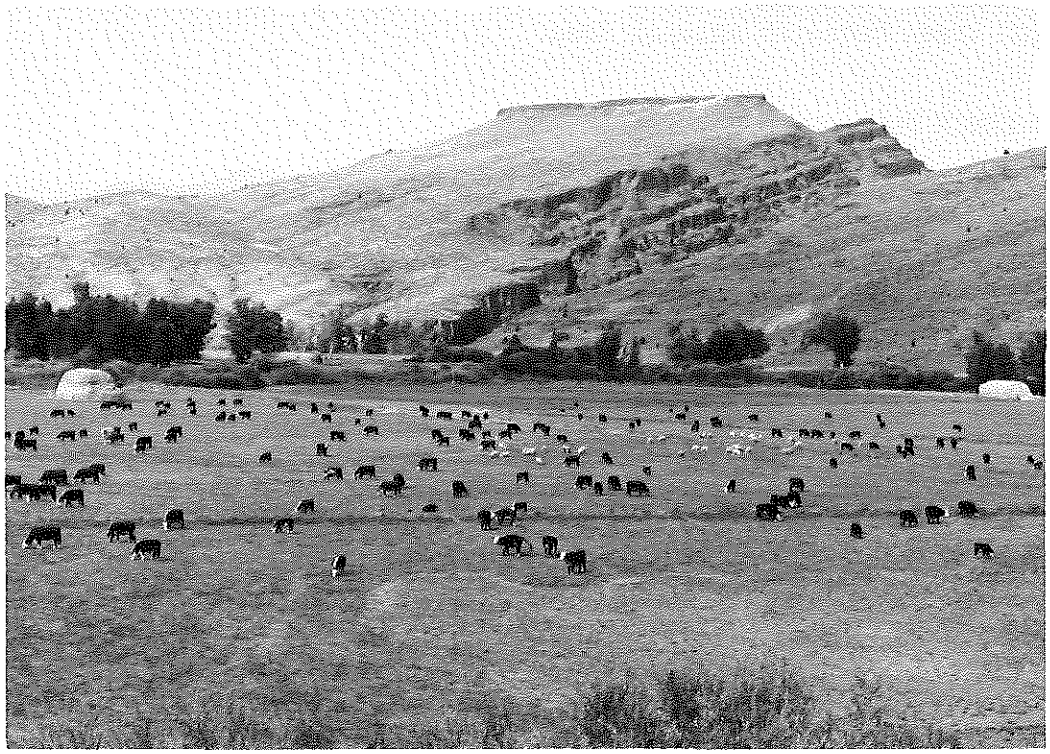
SECTION IV

UPPER MAINSTEM SUBBASIN

A. LOCATION AND DESCRIPTION

The Upper Mainstem Subbasin (see Figure 20) is located almost entirely within Grant County. It drains an area of approximately 1,070 square miles above Picture Gorge. The mainstem John Day River flows west out of the Blue Mountains through a valley of irrigated stream bottoms and benchlands for over 75 miles before reaching Picture Gorge. Lower elevation agricultural land gives way to range and forest land at higher elevations. Most headwater areas are on lands managed by the Malheur and Ochoco National Forests in the Blue, Aldrich, Ochoco Mountains and Strawberry Range. Elevations range from about 2,230 feet at Picture Gorge to above 9,000 feet in the Strawberry Range. The subbasin contains few naturally occurring lakes.

The largest concentration of population in the John Day Basin is in the Upper Mainstem between Dayville and Prairie City. The inhabitants of Mt. Vernon, John Day, Canyon City, and Prairie City comprise about 52 percent of Grant County's estimated population. The subbasin also is the location of much of the John Day Basin's industry.



An important feature of the Upper Mainstem Subbasin is the John Day Valley, shown here near Picture Gorge.

1. CLIMATE

The climate is semi-arid. Annual precipitation averages between 10 and 12 inches in the river valley. The headwater areas receive as much as 40 inches of precipitation per year. Most of this precipitation falls as snow. Temperature patterns are typical for the region. John Day has an average annual temperature of 49°F while the average temperature at Dayville is 50°F. Frost-free days number about 100 at an elevation of 3,400 feet.

2. LAND OWNERSHIP

The federal government is the largest landowner in the subbasin (see Figure 21). The Bureau of Land Management administers mostly low-elevation grass/juniper rangeland, while the USFS manages higher elevation conifer forests and juniper/grass rangeland. Private lands generally are concentrated at lower elevations along streams and at intermediate upland elevations (mostly rangeland). A checkerboard pattern of private and federal ownership characterizes the Upper Mainstem Subbasin above Deardorff Creek. These are mostly timberlands.

The Division of State Lands, Department of Forestry and Department of Fish and Wildlife manage scattered parcels throughout the subbasin. One large block of ODFW's Murderers Creek Wildlife Area is located above Dayville along the mainstem John Day River.

Special federal management areas are the Strawberry Mountain Wilderness Area and Canyon Creek Research Natural Area.

3. LAND COVER AND LAND USE

Land cover in the Upper Mainstem Subbasin is mostly range and forest (see Figure 21). Most of the forested headwater areas are managed by federal agencies. Private rangeland dominates below treeline. Upland soils, outside of the relatively flat alluvial valley floor, have a medium-to-high erosion potential and medium-to-high sediment yield.

About 38 percent of the subbasin is range and pastureland. Winter and spring grazing practices at lower elevations have disturbed natural vegetation and compacted soils. Vegetation and range condition on these sites is poor. According to the SCS, Upper Mainstem range conditions are more the result of historic use than of present grazing practices. Range condition improves with elevation. The SCS considers most of the low-elevation range downstream from the City of John Day to be in poor condition. Between John Day and Prairie City, roughly 33 percent is in poor condition. Above Prairie City, about 25 percent or less is in poor condition.

Local ranchers rely on forestland for summer grazing. Nearly 260,000 acres of forestland are grazed (see Table 25). Forest covers about 56 percent of the subbasin.

Figure 21

UPPER MAINSTEM SUBBASIN LAND OWNERSHIP AND LAND COVER

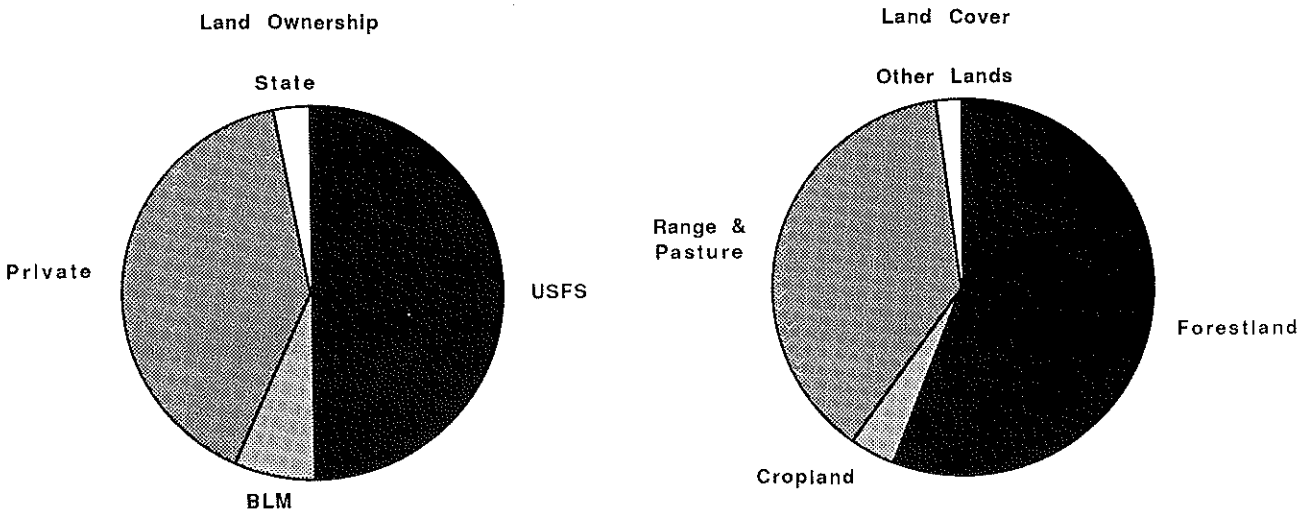


Table 25

UPPER MAINSTEM SUBBASIN LANDCOVER (acres)

Type	Acres
Range and pastureland	262,200
Forestland (grazed)	258,000
Forestland (not grazed)	131,400
Cropland	26,300
Other	14,000
	691,900

Source: Oregon Department of Agriculture Small Watershed Reconnaissance Study, 1984.

The amount of irrigated and non-irrigated land is small (see Table 27 and Figure 21). Irrigated cropland is confined largely to the valley, mostly on alluvial fans and flood plains of the mainstem and its tributaries. Despite this, these croplands represent the greatest concentration of irrigated acreage in the entire John Day Basin.

The upper John Day has most of the basin's rural residential developments and a majority of its urban areas. Urban population and land-use information is displayed in Table 26.

B. RESOURCES

The economy of the Upper Mainstem is heavily resource-based. Forest products, ranching, and retail trade are the primary private-sector industries. Federal, state, and local governments also are major employers.

1. AGRICULTURE

Ranching is the primary agricultural activity in the subbasin. Grant County gross livestock sales, mostly beef cattle, averaged $11,482,000 per year between 1979 and 1985.

Table 26

UPPER MAINSTEM SUBBASIN
POPULATION AND URBAN LAND-USE DATA

City	Population			Size (acres)		Water Use	
	1980 Census	PSU est.	Projected 2000	City	UGB	Water Source	Pumping Capacity
Mt. Vernon	569	530	835	436	637	Ground water	170 gpm
John Day	2012	1985	3950	2667		Surface	100 gpm
						Ground water	1200 gpm (2 wells)
Canyon City	639	615	1114	944	1213	Surface	115 gpm
						Ground water	69 gpm
Prairie City	1106	1100	1757	627	875	Surface and	900 gpm
						Ground water	

Source: Department of Land Conservation and Development, 1985.

Grant County gross crop sales averaged $2,634,000 per year for the period 1979 to 1985. Cropland, both irrigated and non-irrigated, makes up a small percentage of the subbasin land area (see Figure 21).

The 25,000 acres of irrigated cropland make up about 95 percent of the cropped area. The primary crops are grass hay and alfalfa (see Table 27). SCS crop production values for hay and alfalfa on arable valley soils are 5.0 to 6.5 tons per acre for alfalfa and 2.5 to 3.5 tons per acre for grass hay. An acre of irrigated pasture can produce 6 to 15 Animal Unit Months of forage. These values assume the use of common management practices and that the water requirements of the crops are satisfied throughout the irrigation season. Crop production on lands receiving less water will be less.

Table 27

UPPER MAINSTEM SUBBASIN
CROP TYPES

Crop	Acres
Irrigated	
Alfalfa hay	11,300
Meadow hay	13,700
Hay and pasture	0
	25,000
Non-Irrigated	
Grain hay and pasture	600
Pasture and grass	600
Grain	100
	1,300

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

Non-irrigated land yields significantly less production. Grass hay production is about 1.5 tons per acre. Winter wheat in a summer-fallow rotation produces between 20 and 30 bushels per acre.

2. FOREST PRODUCTS

The lumber and wood products sector is a major contributor to the economic well-being of the subbasin. In recent years, high interest rates, excess inventories, and decreased demand have depressed the timber market. However, ponderosa pine lumber, the basin's major forest product, is not closely tied to the housing market and the market for pine has not dropped significantly. Thus, forest products work force in Grant County has been more stable than in many other Oregon counties.

National Forests provide much of the ponderosa pine processed at subbasin sawmills. Between 1964 and 1984, the average cut from the entire Malheur National Forest was 175 million board feet (MMBF) per year. Timber contracted to be harvested, but uncut, averaged 426 MMBF until 1981 when economic conditions substantially raised the uncut amount. The 1985-1988 Malheur National Forest timber sales plan projects selling about 34 MMBF of subbasin timber per year. Most probably will be bought by local timber companies.

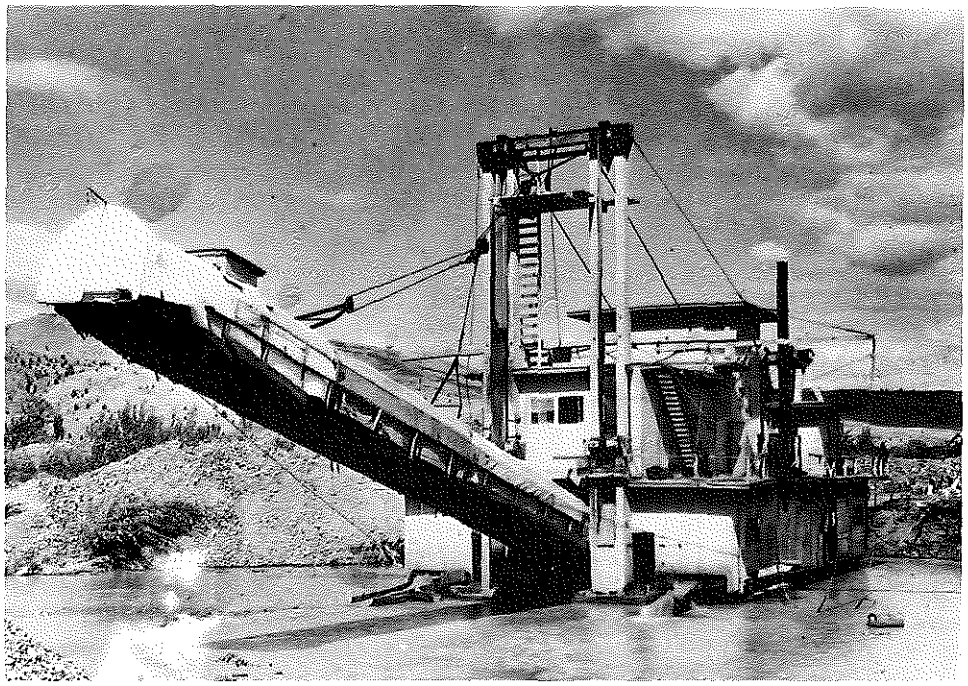
The Malheur National Forest is an important source of revenue for Grant County. Payments by the national forest to the county account for 35 to 40 percent of Grant County's total budget.

3. MINERALS AND ENERGY

a) Minerals

The Upper Mainstem Subbasin has a rich and varied mining heritage. The subbasin has produced gold, precious metals and industrial minerals. Besides large amounts of gold, 27,000 tons of valuable chromite ores were mined from the rock outcrops along the north slope of the Strawberry Range. Mineral production is tied to commodity price and demand. Decreasing prices for gold and other minerals over the past several years have depressed the mining economy.

The Miller Mountain gold mine in the Canyon Creek drainage has an active exploration program but is not currently in production. The Prairies Diggings lode operation above Prairie City is inactive at this time. According to Department of Geology and Mineral Industries, placer mining (gold) on Canyon Creek from the mouth upstream is expected to continue at current levels. The bench gravels between Mt. Vernon and Prairie City have the potential to support medium-sized gold mines if prices improve.



This gold dredge operated in the upper John Day Valley until 1946.

b) Energy

Prairie Wood Products in Prairie City has constructed a biomass-fired cogeneration facility on its mill site. This facility will use 70,000 bone dry tons per year of mill residue to generate 7.5 megawatts of energy. The mill is expected to use about 120 gallons per minute (gpm) in the process of generating energy. In February 1986, Prairie Wood Products applied for the right to pump 300 gpm of ground water from two deep wells.

The Upper Mainstem contains a number of low-temperature geothermal energy resources. They are Mt. Vernon Hot Springs (49°C), Limekiln Hot Springs (21°C), Blue Mountain Hot Springs (58°C), and Joaquin Miller Hot Springs (48°C). Low-temperature geothermal energy is best suited to space heating, not generating electricity. The lack of large populations at these sites limits this use.

There are a few micro-hydroelectric installations generating household electricity. There probably are additional sites capable of generating domestic energy supplies.

4. FISH RESOURCES

As many as 575 adult spring chinook salmon and 3,200 adult summer steelhead return each year to the Upper Mainstem Subbasin to spawn. The subbasin produces about 18 percent of the John Day Basin's total spring chinook and about 16 percent of its summer steelhead population. The subbasin contains 15.5 miles of existing spring chinook spawning and rearing habitat and about 350 miles of summer steelhead habitat. The subbasin also supports a healthy resident trout population.

Summer steelhead migrate to the headwater areas between March and May and may spawn as late as June. Steelhead fry emerge from spawning gravels after two to three months and remain in the subbasin for up to three years before migrating out of the basin.

Spring chinook migrate into the drainage in early spring but do not reach spawning grounds until late June. Adult chinook rest in pools until spawning in late August or early September. Fry emerge from the spawning gravels after an incubation period of up to five months and rear for one year in the basin before migrating to the ocean as smolts.

The Upper Mainstem Subbasin contains the highest quality water found in the mainstem John Day River. Anadromous fish populations are lower than historical levels but appear to have stabilized. Improved ocean survival, passage at Columbia River dams, instream and streambank conditions, fish screening, and higher-than-average streamflows are believed to be responsible.

The mainstem above the City of John Day generally has sufficient flow and water quality to support anadromous fish populations. However, during low-water years, populations are damaged when streamflows drop and water temperatures reach or exceed 70°F for extended periods of time. The mainstem river between Hall Hill and Roberts Creek contains 15.5 miles of spring chinook spawning and rearing habitat. Spring chinook production has shown a slow, steady increase during recent years.

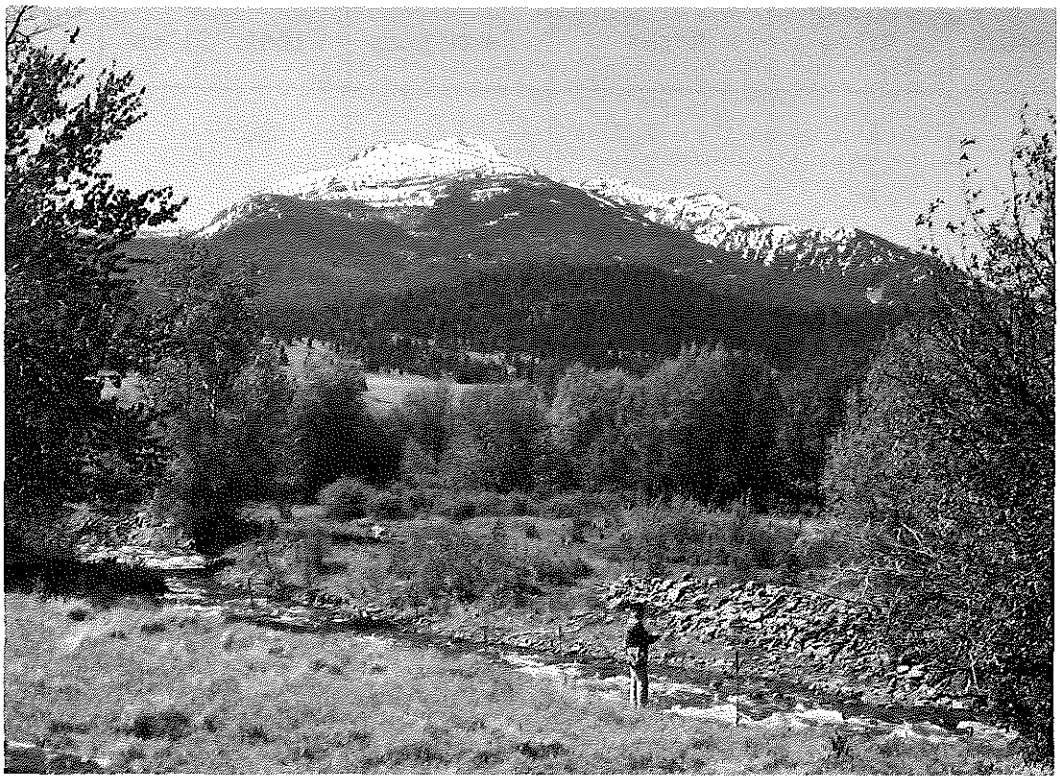
Key steelhead and trout streams identified by ODFW are Cottonwood, Canyon, Beech, Strawberry, Reynolds, Deardorff, McClellan, Fields, Belshaw, Dog, Little Pine, Moon, Laycock, Grub, Indian, Bear, Dixie, Roberts and Rail Creeks.

Canyon Creek has good water quality. It has flow and temperature characteristics which encourage steelhead spawning and rearing throughout its entire length. An estimated 22,100 smolts and 500 adult spawners are produced there each year.

Beech Creek is a productive steelhead stream, producing an estimated 7,000 wild smolts and 200 adult spawners in an average year. During low-water years, water needed for steelhead migration on lower Beech Creek often is unavailable because of irrigation diversions. A major diversion on the Panama Ditch can take all the lower Beech Creek flow.

Cottonwood Creek provides annual habitat for an estimated 1,900 smolts and 40 adult spawners. The upper drainage has very high water quality and good spawning habitat. Production, however, often is restricted during low-water years. Low streamflows coupled with irrigation diversions in the lower reaches has limited upstream migration in two of the last ten years.

Approximately $1 million has been invested in the subbasin to improve and restore anadromous fish habitat. Plans include improvement of chinook spawning and rearing habitat on the John Day River between John Day and Blue Mountain Hot Springs. Improvements also are needed on Indian, Strawberry, Canyon, Pine, Beech, and other productive fish streams (see Appendix E). Fish screens have been installed on irrigation diversions to prevent fish from entering the canals. Approximately 300 fish screens and 29 trap-boxes are maintained by ODFW at an annual cost of $242,000. In addition, minimum perennial streamflows adopted in 1985 for the upper mainstem John Day River, and Canyon, Beech and Cottonwood Creeks should aid in maintaining anadromous fish habitat.



The creeks draining the northern flanks of the Strawberry Mountains provide many fishing opportunities.

5. RECREATION AND TOURISM

The Upper Mainstem Subbasin contains most of the urban development and industry in the John Day drainage. This subbasin offers a variety of recreational opportunities. The Strawberry Mountain Wilderness provides numerous recreational experiences, such as camping, hiking, fishing, horseback riding, and sightseeing. Malheur National Forest campgrounds are located in the subbasin. Steelhead and trout fishing account for approximately 3,600 angler-days along the river. Many other trout fishing opportunities are available in tributary streams. Steelhead fishing is available from October through April with a peak in the spring. Trout fishing peaks in June and again in September as water temperatures become cooler. Table 28 lists recreational facilities in the subbasin.

Table 28

UPPER MAINSTEM SUBBASIN
RECREATIONAL FACILITIES

Ownership	No. of Sites	Acres	Campsites	Picnic Sites	Boat Ramps
City	4	7.3		20	
County	1	2	30	5	
State	3	8	30	15	
BLM					
USFS	15	463	79	33	2
NPS					
Private*	2	3000	Yes	Yes	
TOTALS	25	3480.3	139	73	2

* Blue Mountain Hot Springs

Source: Oregon Parks and Recreation Division, 1985.

Hunting for deer, bear, and elk is the single largest recreational pursuit in the basin and peaks during the fall months.

A limited amount of drift-boating and canoeing occurs when water levels permit during the spring and early summer.

C. WATER RESOURCES

1. SURFACE WATER

The South Fork, Beech Creek, Canyon Creek, Strawberry Creek, and Dixie Creek are major tributaries which contribute to the John Day River flow recorded by the Picture Gorge gage.

The John Day River has been gaged at Picture Gorge since 1926. Annual average discharge at Picture Gorge is 346,000 acre-feet. The South Fork, a separate subbasin, contributes about 100,000 acre-feet per year. The Malheur National Forest estimates that 661 square miles of land it manages in the Upper Mainstem and South Fork Subbasins contribute 196,000 acre-feet to the average annual flow of the John Day River at Picture Gorge.

Other gaged streams in the subbasin are Strawberry Creek, the John Day River near John Day, and Canyon Creek (since 1980). Beech Creek previously was gaged but only for a few years during the 1930's.

The distribution of subbasin discharge is uneven. Peak discharge generally occurs between March and early June, and lowest flows occur during the months of August and September (see Appendix D).

The Upper Mainstem contains most of the basin's natural slack water resources -- Strawberry, Little Strawberry, Magone, Slide and Little Slide Lakes, and Canyon Meadows Reservoir near the head of Canyon Creek.

2. GROUND WATER

The ground water resources of the Upper Mainstem Subbasin are better defined than those in other, less populated subbasins because there are more and deeper wells (municipal) from which to gather data. The major geo-hydrologic units are Quaternary Alluvium, Rattlesnake Formation, Columbia River Basalt, Pre-Tertiary rocks, and Strawberry Volcanics. The Mascall and Clarno Formations also are present but only in minor amounts.

Significant deposits of Quaternary Alluvium stretch along the John Day River from Picture Gorge upstream to Deardorff Creek above Prairie City. Thickness varies from a few feet to several hundred feet. Alluvial deposits typically have high porosity and permeability. Yields from subbasin wells range from 3 to 193 gpm. The ground water potential of the alluvium is good.

The Rattlesnake Formation is a potentially important aquifer because of its location relative to subbasin population. Wells between Mt. Vernon and Prairie City yield from 2 to 1,200 gpm. The 1,200 gpm well is 1,210 feet deep and is anomalous and not a true indicator of ground water potential. Wells drilled into the formation usually yield water in amounts adequate for domestic and stock uses, but the formation generally will not yield water sufficient for large-scale irrigation development.

Because of the limited extent in a sparsely populated area, the Strawberry Volcanics are not considered to be an important hydrologic unit.

Columbia River Basalt is concentrated to the north of the Upper John Day River. The Columbia River Basalt will supply adequate water for domestic and stock watering uses at reasonable depths in most of the subbasin and can locally supply large quantities of water suitable for municipal and irrigation use. Canyon City and John Day each have deep, large-diameter, high-yield municipal wells producing 1,000 and 876 gpm, respectively. Well yields range from 1.3 to 1,000 gpm. The potential for large-scale irrigation use is limited, however, because of the very low recharge due to poor vertical permeability.

The Pre-Tertiary rocks in the subbasin generally are located south of the John Day River and include the Aldrich Mountains. This is the largest area of Pre-Tertiary rock in the John Day Basin, but the formation is not considered to be hydrologically important. The potential for producing ground water in amounts necessary for domestic or stock use exists but is highly variable and dependent upon the local geology.

3. WATER QUALITY

Water quality generally exhibits satisfactory chemical, physical and biological quality except during high-runoff events or periods of low streamflow. Most streams exhibit higher than normal temperatures when flows are low and higher than normal turbidities during high flows.

The tributary streams to the Upper Mainstem John Day only exhibit high temperatures if they originate in, and drain, relatively low-elevation areas. The small tributaries originating at higher elevations in the Strawberry Range and Aldrich Mountains have less serious temperature problems. Depending upon soils, geology and land use, some tributaries exhibit erosion and sedimentation problems. The temperature and sediment problems interfere with mpact some of the beneficial uses of water, particularly cold-water fish use (see Appendix F).

The Upper Mainstem John Day River reflects the problems created in the tributaries as well as some specific to the river. Temperature and turbidity patterns in the river are similar to those in the tributaries. In addition, high bacteria levels from the City of John Day downstream threaten swimming.

Water quality for irrigation is acceptable. However, irrigation return flows present possible nutrient nonpoint source pollution problems during summer months. The return flows also may increase the salinity of the river during the same period.

There are no municipal sewage point source discharges to the streams of the subbasin. A description of municipal sewage treatment facilities is included in Table 29. Mt. Vernon has a discharge permit for its sewage treatment facility, but there has been enough evaporation and seepage from the lagoons

so that a discharge to the John Day River has not been necessary. According to DEQ, the facility is in good condition and should be operational for many years.

The John Day sewage treatment plant is well maintained, but seepage could contaminate ground water in the vicinity of the lagoon. A failure in the raw sewage pipeline supplying the lagoon could discharge wastes into the John Day River.

Table 29

UPPER MAINSTEM SUBBASIN SEWAGE TREATMENT PLANTS

Source	Type of Facility	Year Built	Design Population	Connected Population	Design Flow (MGD)	Connected Flow (MGD)	Current Raw Waste (#POD) Load (Day)	Current Treated Waste (#POD) Load (Day)	Current Permitted Waste (#POD)
John Day (Canyon City is connected to John Day)	Trickling Filter and Lagoon	1978	4300	2500	0.6	0.23	350	No Discharge	No discharge, treated effluent discharged to seepage lagoon.
Mt. Vernon	Lagoon	1981	1000	610	0.1	0.04	103	No Discharge	45, permit allows discharge to John Day River.
Prairie City	Lagoon	1983	1400	1150	0.2	0.27	196	No Discharge	No discharge, spray irrigation occurs on a dedicated irrigation site.

Source: Department of Environmental Quality, 1985.

Prairie City has a relatively new sewage treatment facility. However, DEQ suggests the facility was designed with inaccurate flow information. Excessive subsurface infiltration into the system comes close to overloading the lagoons and disinfection facility. Removing the infiltration problem will extend the life of the system.

Cattle feedlots along subbasin streams also have been identified as point sources of pollution. They are located on:

Stream	River Mile
Riley Creek	0.1
Dixie Creek	4.3
Fields Creek	0.5
Upper Mainstem	255.5

D. WATER USE AND CONTROL

1. WATER RIGHTS

Irrigation is the dominant water use in the Upper Mainstem Subbasin, accounting for over 90 percent of the total appropriated water volume (see Table 30). Although mining and power represent the next largest quantities of use, it is unlikely that the rights are regularly exercised. For example, about 66 percent of the mining rights are quite old. Municipal use, although a very small quantity, is an essential component of the subbasin's economy and overall water-use pattern.

Table 30

UPPER MAINSTEM SUBBASIN WATER RIGHTS
(cfs)

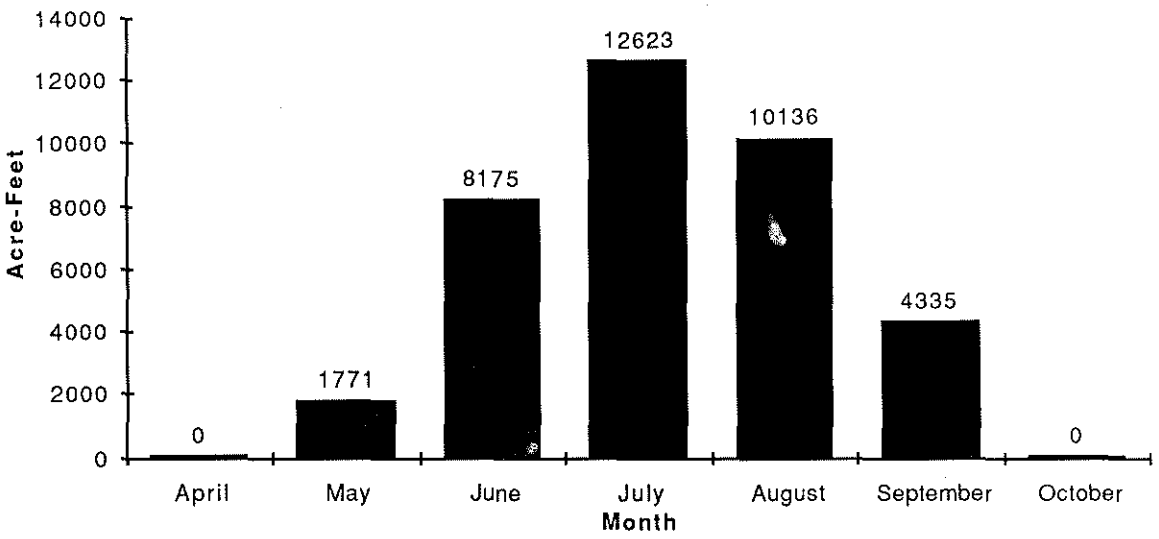
SUBBASIN or REACH	Irrigation[1]	Livestock	Mining	Power	Indust./ Munic.	Fish and Wildlife	Residential	Storage[2]	Other[3]	Total
John Day abv Rail Cr.	0.3	*								0.3
John Day, Rail Cr. to gage	125.6	0.1		10.0				47.1		135.7
John Day, gage to S. Fork	185.7		1.8		11.4	1.0	0.1	16.0	2.3	202.3
John Day, S. Fork to Picture G.	7.8	0.1								8.0
Strawberry Cr.	56.1						*			56.1
Indian Cr.	97.3			0.8		*				98.2
Canyon Cr.	27.8	*	15.6	*	1.6	11.4	0.6	401.5		57.0
Laycock Cr.	9.8	*	1.0	0.1			*	5.4		10.9
Beech Cr.	18.5	0.2		1.0	0.3	0.3	0.1	1.0		20.4
Riley Cr.	13.0	*					0.1	0.4	2.0	15.1
Fields Cr.	7.1	*					*			7.2
Cottonwood Cr.	9.8	*								9.8
Remainder of Subbasin	368.0	0.3	22.2	2.1	3.3	0.2	1.2	210.0	*	397.3
TOTAL	927.0 (463.5)[4]	0.9	40.5	13.9	16.6	12.8	2.1	681.4	4.3	1,018.2

1. Rate for irrigation season.
2. Figures in acre-feet; not included in grand total.
3. Rights in database with uncoded uses.
4. Rate adjusted for entire year.
* Less than 0.05 cfs.

Although there are rights to apply over 900 cfs of water for irrigation, it appears that the quantity actually used is less. According to the estimates of irrigated crop acreage, irrigation water requirements follow the pattern shown in Figure 22 and total 37,000 acre-feet, or about 100 cfs through the irrigation season.

Figure 22

UPPER MAINSTEM SUBBASIN
ESTIMATED IRRIGATION WATER REQUIREMENTS



In the upper portion of the subbasin, most water is delivered using flood irrigation. Below Mt. Vernon, however, there is more use of sprinkler systems. Sprinkler systems usually are used on higher value crops such as alfalfa. Flood irrigation is used on grass and meadow hay.

There are over 80 ditches diverting water from the mainstem John Day River. All are equipped with headgates as a regulation mechanism. Four major ditches in the basin are operated by ditch companies. Information on these is listed in Table 31.

The watermaster normally begins water distribution on tributaries to the John Day in June and July. Regulation of water taken directly from the river begins in late July or early August. Some users denied access to river water by such action are able to irrigate again late in the season when flow begins to increase, usually in mid-September.

Ground water use in the subbasin is greater than in most other subbasins. Use is principally municipal and domestic and does not significantly impact streamflows. Domestic wells are developed in bedrock material and ground water supply appears adequate for domestic use. The formations generally yield water slowly and large quantities commonly are not available. The majority of John Day and Canyon City municipal supply is derived from deep wells. The water source for Mt. Vernon is infiltration wells along the John Day River. Mt. Vernon has experienced problems with its water source which has led to some rationing.

Table 31

COMPANY-OPERATED DITCHES OF THE UPPER MAINSTEM SUBBASIN

Name	Head of Diversion	Length (miles)	Volume (cfs)	Ditch Company
Blue Mtn.	S. bank John Day R., river mile 238.2	7	9.0	Blue Mountain (organized 1916)
Panama	N. bank John Day R., river mile 242.5	6	19.5	Mt Vernon Irrigation and Power (organized 1912)
Enterprise	S. bank John Day R., river mile 243.5	4	24.5	Enterprise (organized 1889)
Cummings	E. bank S. Fork John Day R., river mile 5	5	3.2	Cummings (organized 1958)

2. WATER USE RESTRICTIONS

a) Administrative

1) Withdrawals and Reservations

On December 31, 1915, the State Engineer withdrew from appropriation 2,000 cfs of John Day River and tributary water, and 400,000 acre-feet of potentially stored water, for the proposed John Day Project. This withdrawal has not been modified or revoked. If the project is constructed, subsequent junior water rights would be subject to regulation according to this priority.

Long Gulch, a tributary to Canyon Creek, and its tributary springs were closed to further appropriation by order of the State Engineer in 1930. This protects the City of John Day's municipal surface water supply. The present source for most of John Day's municipal water is deep ground water wells.

2) Minimum Perennial Streamflows

In 1985, the Water Resources Commission established six minimum streamflows to protect instream water uses in the Upper Mainstem Subbasin. These minimum streamflows are regulated essentially the same as water rights -- according to priority. The priority date for all six is November 3, 1983.

On the mainstem John Day River, three minimum streamflows cover the entire river reach from Rail Creek to Picture Gorge, a distance of about 70 miles. Three additional minimum streamflows are located on Canyon Creek from the East Fork Canyon Creek to the mouth; Beech Creek from the East Fork Beech Creek to the mouth; and Cottonwood Creek at the mouth.

3) Hydroelectric Standards

Administrative rules governing hydroelectric applications generally prohibit development of hydroelectric projects on the Mainstem John Day River. Furthermore, state hydroelectric standards place stringent requirements on projects which are on streams supporting anadromous fish, wild game fish, or important recreational opportunities.

b) Classification

The use of subbasin streams is limited to domestic, livestock, municipal, irrigation, power development, industrial, mining, recreation, fish and wildlife beneficial water uses. The beneficial use of natural lakes is limited to domestic, livestock, lawn and garden irrigation, power development of no more than 7 1/2 theoretical horsepower, recreation, fish and wildlife.

3. STORAGE

A number of reservoir sites have been identified in the subbasin. Feasibility studies were performed by the Bureau of Reclamation and Corps of Engineers on several of the sites (see Table 32). Based on the criteria in use by the agencies at the time of the studies, none of the sites were found to be both environmentally and economically acceptable. Many of the proposed reservoirs would inundate anadromous fish spawning and rearing habitat and block migration. Projects may be available on tributaries which would not adversely affect fish and which could meet the economic criteria of other possible public or private developers.

Table 32

IDENTIFIED RESERVOIR SITES IN THE UPPER MAINSTEM SUBBASIN

Site Name	Stream Name	River Mile	Potential Storage (acre-feet)	Drainage Area (sq. mi.)
Bridge Creek	John Day River	221.0	N/A	N/A
Canyon Creek	John Day River	247.2	N/A	N/A
Hall Hill	John Day River	258.9	40,000	252
Deardroff	John Day River	272.0	N/A	155
Rail Creek	John Day River	275.6	7,500	37
Call Creek	John Day River	278.0	2,500	16
Little Meadow	John Day River	279.5	1,500	9
Mt. Vernon	Beech Creek	3.8	13,000	94
Beech Creek	Beech Creek	5.4	600	87
Birch Creek	Birch Creek	12.0	155	1
Magone Lake	Lake Creek	1.3	1,200	2
East Gulch	Canyon Creek	12.5	13,600	68
Big Canyon	Canyon Creek	19.4	5,000	22
Grub Creek	Grub Creek	3.3	4,000	22
Bear Creek	Bear Creek	1.7	4,000	16
Strawberry Lake	Strawberry Creek	12.0	800	N/A
Reynolds Creek	Reynolds Creek	2.7	2,475	27

N/A = not available

E. PROBLEMS

The seasonal distribution of runoff and discharge is a problem in the Upper John Day subbasin just as it is throughout most of the basin. There generally is enough streamflow early in the summer to satisfy most uses. As the summer progresses and the snowpack and ground water supplies are depleted, streams carry less water and generally cannot satisfy all the demands for instream and out-of-stream uses.

Water needs are not met during the summer months in the Upper Mainstem Subbasin. Low late summer flows create conflicts among out-of-stream users and between out-of-stream and instream uses.

Not all water rights are satisfied during the irrigation season. Water use usually is regulated on tributaries and frequently is regulated on the mainstem. Mainstem regulation normally is required when the flow at the John Day gage near John Day reaches 30 cfs. At such times, the watermaster usually finds it necessary to shut off users with priority dates after 1950. Currently, over 90 mainstem water users have post-1950 priority dates and have rights to irrigate about 3,800 acres. The John Day River reached or dropped below 30 cfs at the gage nine of the eleven years between 1973 and 1983.

Instream needs frequently also are not satisfied. On the average, the August and September minimum perennial streamflows at Picture Gorge are not met. The volume for these months as measured by the Picture Gorge gage is nearly 1,300 acre-feet short of meeting the minimum flows. Instream water shortages are also evidenced by dewatered stream reaches and elevated water temperatures.

Based on irrigation water requirements and minimum flows, about 5,000 acre-feet is needed during the irrigation season to satisfy subbasin needs.

Demand by both out-of-stream and instream uses, however, pales in comparison to the total water supply that flows out of the basin annually. For example, the irrigation water requirements of the Upper Subbasin account for only 11 percent of the total annual flow at Picture Gorge. Similarly, the minimum flow in the Picture Gorge reach amounts to 23 percent of the annual gaged flow. Annual average volumes, then, are well in excess of present and expected future needs.

Water quality is generally good. Water quality suffers during high-and low-flow periods. The major water-quality conflict centers on fisheries impacts.

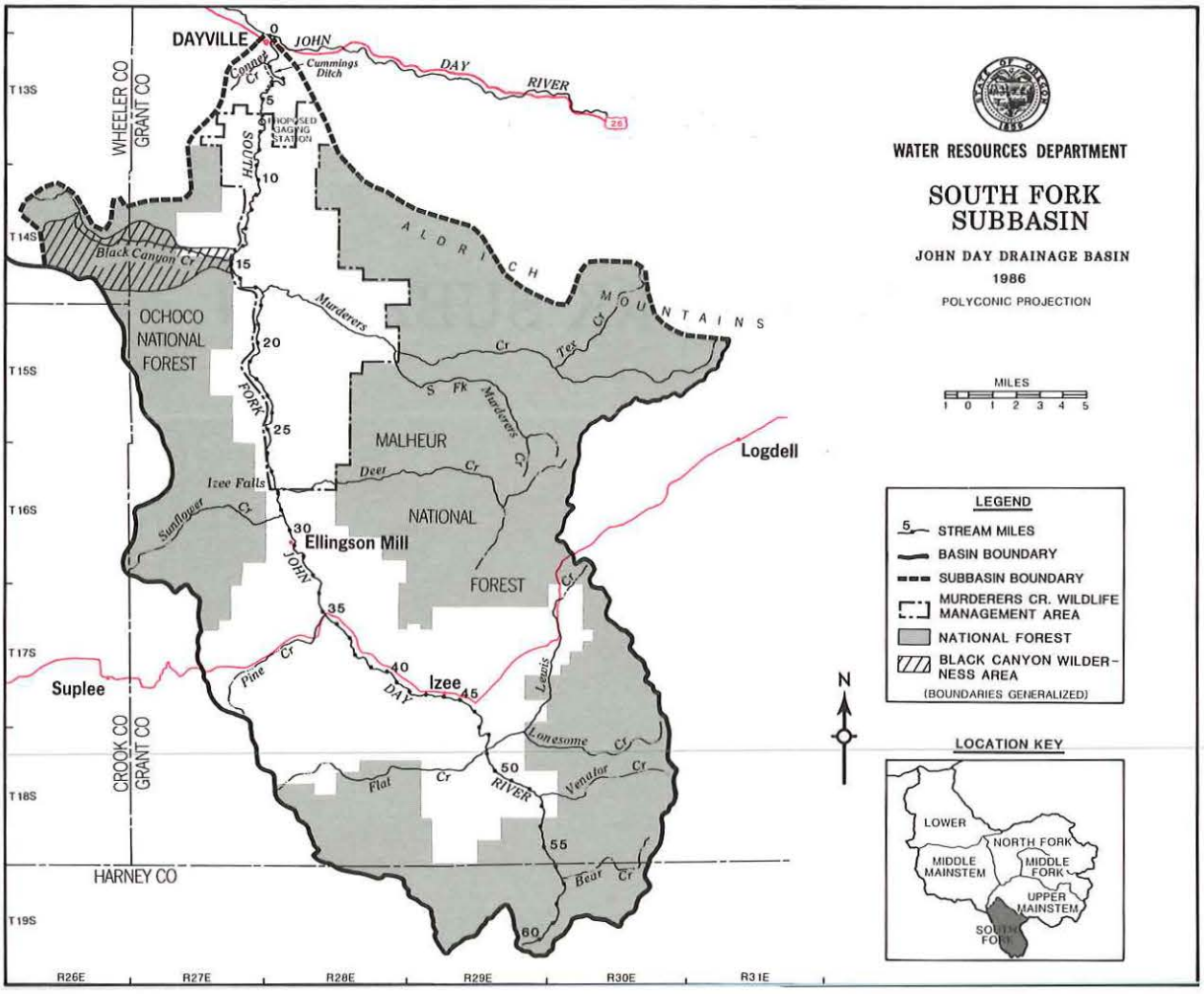
Watershed conditions may have contributed to discharge variability. Disturbance of soils and vegetative cover by domestic and wild animal foraging, road building, and timber harvesting have altered the watershed. Soils have been compacted and vegetative cover has been reduced. This has the effect of increasing soil erosion potential, decreasing precipitation infiltration and ground water storage, and speeding runoff.

Section V

SOUTH FORK SUBBASIN

Figure 23

MAP OF THE SOUTH FORK SUBBASIN



SECTION V

SOUTH FORK SUBBASIN

A. LOCATION AND DESCRIPTION

Flowing northward from the Ochoco and Aldrich Mountains, the South Fork John Day River drains an area of approximately 607 square miles and enters the mainstem John Day at Dayville. Subbasin elevation ranges between about 2,300 feet to 7,400 feet above sea level. Most of the subbasin is located in Grant County (see Figure 23).

Dayville is the only incorporated city in the subbasin. There are three major transportation routes in the subbasin: Highway 26 in the extreme northern part of the subbasin; a road that parallels the South Fork John Day River from Dayville to the headwaters; and a federal aid secondary highway that connects Prineville with Highway 395 and crosses the southern portion of the basin.

The South Fork John Day River flowing through well-vegetated riparian area south of Dayville.

1. CLIMATE

The climate is semi-arid with precipitation ranging from 10 to 20 inches per year. Precipitation at Dayville averages about 12 inches per year. Peak precipitation occurs between November and January as snowfall, with a secondary peak of rain in May and June as a result of localized thunderstorms. The annual average temperature at Dayville is 50°F. The coldest average monthly temperature (34°F) occurs in January and the warmest (69°F) occurs in July.

2. LAND OWNERSHIP

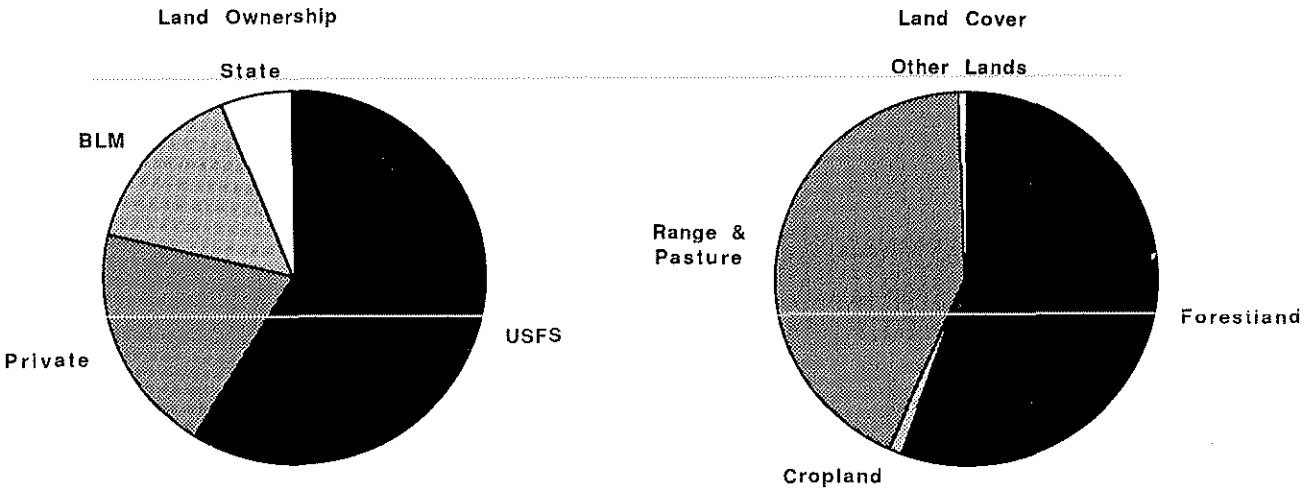
The federal government manages most of the land in the subbasin (see Figure 24). Private lands tend to be concentrated at lower elevations along streams and at intermediate upland elevations. The Murderers Creek Wildlife Management Area comprises most of the state lands in the South Fork drainage.

3. LAND COVER AND LAND USE

The two major landcover types are coniferous forest and rangeland (see Figure 24). The few agricultural areas in the subbasin generally are located adjacent to streams on loamy soils with frost-free periods of 90 to 150 days. Forestland consists mostly of ponderosa and lodgepole pine with western larch and fir at higher elevations. Although some forestland is in private ownership, most is under Malheur and Ochoco National Forest management.

Figure 24

SOUTH FORK SUBBASIN
LAND OWNERSHIP AND LAND COVER



Rangeland largely is a mixed grass, sage and juniper community. According to the SCS, range conditions vary from poor to good and in general are improving. Higher zones, accessible only in summer, are grazed less and thus have a greater density of desirable perennial grasses. Lower elevations (below 3,500 feet), used heavily as fall, winter, and spring range, are characterized by poor range conditions. Between the mouth and the confluence of Black Canyon Creek, about 75 percent of the low-elevation range is in fair to poor condition. Above Black Canyon Creek, conditions are better with 50 percent of the lower elevation rangeland in fair to poor condition.

Table 33 indicates that all forestland in the subbasin is grazed. Grazing is the major subbasin land use.

The BLM, USFS, and ODFW have documented watershed damage in the Upper South Fork Subbasin, especially to riparian areas. In the past, riparian and fragile range areas were not managed much differently from upland areas which could sustain greater grazing pressure.

Photographs which were taken before and after the 1964 flood indicate that the high waters scoured the South Fork River channel. Stream channel conditions still have not recovered fully from the flood damage. The channel is wider and less stable in some places than before.

Table 33

SOUTH FORK SUBBASIN LANDCOVER

Type	Acres
Forestland (grazed)	216,300
Forestland (not grazed)	0
Cropland	5,200
Range/pasturelands	164,800
Other	3,300
	389,600

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

There is very little urban land in the subbasin. Dayville, the only city in the subbasin, has a population of 205 (1983 estimate) and an area of 297 acres. Izee, located in the upper South Fork drainage, is a crossroads community located on the South Fork at the junction of the Post-Paulina Highway and the Dayville-Hines Road. Settlement throughout the remainder of the subbasin is sparse. Ranching and support services are the primary economic activities.

The South Fork Subbasin contains a number of special wildlife, vegetation, and geologic areas. The 26,000-acre Murderers Creek Wildlife Management Area is owned and managed by ODFW. The Murderers Creek Wild Horse Herd Management Area (143,000 acres), composed partially of this ODFW land, adjacent USFS and BLM and private land, is administered jointly by the two federal agencies. The current management plan calls for a three-year control cycle to maintain the herd's population at about 100 head.

According to the 1977 Oregon Natural Heritage Program inventory conducted by The Nature Conservancy, the Shake Table Mountain and Jackass Creek areas possess unique vegetation communities and protected plant species. The 13,400-acre Black Canyon Wilderness, in the Black Canyon drainage, is managed by the Ochoco National Forest.

B. RESOURCES

1. AGRICULTURE

Agriculture is practiced on only a very small amount of the subbasin land area near Dayville and Izee. Irrigated agriculture, primarily pasture and hay production, comprises more than half the agricultural acreage, with the remainder devoted to non-irrigated hay, pasture and grain production (see Table 34). All irrigation water is derived from surface sources.

Table 34

SOUTH FORK SUBBASIN CROP TYPES

Type	Acres
Irrigated	
Alfalfa hay	1,100
Meadow hay	2,700
	3,800
Non-irrigated	
Grain hay and pasture	1,100
Pasture and grass hay	200
Grain	100
	1,400

Source: Department of Agriculture Small Watershed Reconaissance Study, 1984.

2. FOREST RESOURCES

Most of the forestlands in the subbasin are managed by the Malheur and Ochoco National Forests. These Forest manage the forest resources according to policies formulated for the South Fork Planning Unit. The Unit boundaries coincide closely with the South Fork Subbasin but also enclose some small drainages that are in the Upper Subbasin. About 25 square miles of USFS land are in these other drainages.

According to the Draft Environmental Statement for the South Fork Planning Unit (Malheur National Forest, 1976), there are nearly 170,000 acres of commercial forest within the Unit. Forty-nine percent of this total is climax ponderosa pine, 43 percent mixed pine and fir, 7 percent white fir, Douglas fir, and western larch, and 1 percent sub-alpine fir and lodgepole pine. Timber harvest began in the early 1920s, mainly on private lands within the subbasin. Much of the timber was processed at mills at Izee and Dayville. As private timberland was logged out, harvest began on the National Forests. The Izee mill closed in the mid-1960s. Today, timber is transported to John Day, Hines, and Prineville.

In 1976, the USFS estimated the Unit yielded about 25 million board feet per year. At that time, the Unit forest plan called for more intensive forest management. Between 1985 and 1988, the USFS has scheduled timber sales of 127 million board feet to be harvested from approximately 65,000 acres. These sales call for the construction of over 60 miles of new road.

The Unit's forestlands also are used for range and have been since about 1900. The National Forest provides about 9,700 animal-unit months of cattle grazing annually. Sheep grazing reached its peak on USFS lands in the area in the early 1940's and has almost ceased since.

3. ENERGY AND MINERALS

a) Energy

Waterfall Electric Company applied for and received a state preliminary permit for a hydroelectric project at Izee Falls. However, no further action was taken and no further interest in developing the site has been expressed by Waterfall Electric Company.

b) Minerals

Deposits of chromium, mercury, and gold occur in the subbasin, but there are no active mines currently, nor have there been many in the past. Some exploratory oil wells have been drilled a few miles west and south of the subbasin, but no commercial quantities of oil or gas have been found.

4. FISH RESOURCES

The South Fork Subbasin currently produces approximately 7 percent of the total John Day steelhead populations as well as a substantial resident trout fishery. Annually, between March 15 and June 30, as many as 1,400 adult steelhead spawners migrate into the South Fork drainage where approximately 95 miles of spawning and rearing habitat exist. Juveniles rear in the subbasin for two to three years before migrating out. Resident trout populations generate 3,000 to 5,000 recreation days annually with a sport catch of over 10,000 fish. Wild rainbows are supplemented each year with the stocking of legal and fingerling rainbows. The subbasin does not support a spring chinook population.

Generally, fish production in the South Fork is maintained by good water quality, streamflow, and habitat diversity, particularly in the middle reaches. In the lower reaches of the subbasin, however, fish production declines when problems due to low flows and channel instability increase during low-water years. Steelhead runs are restricted to habitat below Izee Falls at River Mile 27.5. Sunflower, Indian, Flat, Lewis, Corral and Venator Creeks enter the South Fork above Izee Falls. These streams are important to the maintenance of wild trout populations in the subbasin.

Fish screens, such as this one on the South Fork, keep migrating anadromous fish from being trapped in irrigation ditches.

Major steelhead production streams in the drainage are Murderers, Tex, Deer, Wind and Black Canyon Creeks. These streams characteristically have good stream flows, low water temperature, well-vegetated streambanks and evenly-spaced pools and riffles. Habitat in the upper subbasin above the Izee Falls could potentially support steelhead production if access around the falls was provided. Much of this habitat, however, is currently degraded and would require enhancement work.

Since 1975, BPA, USFS, ODFW and BLM have worked cooperatively to improve fish and wildlife habitat conditions on several miles of the South Fork as part of a multi-agency Murderers Creek Coordinated Resource Plan. Much of this work has been funded by the NWPPC fish and wildlife program. Currently, over $386,000 has been invested. Future plans being considered to enhance production include construction of a fish ladder around Izee Falls and riparian and instream restoration work on the South Fork and tributaries above that point.

5. RECREATION AND TOURISM

The South Fork Subbasin is an area that has seen relatively little recreational development (see Table 35). This area contains three National Forest campgrounds and the Black Canyon Wilderness providing recreational opportunities such as hiking, camping, hunting, horseback riding, sightseeing and fishing. Deer and elk hunting account for the largest number of recreation user-days in the subbasin with a peak in the fall. Trout fishing accounts for 2,500 angler-days on the South Fork of the river with an equal number on the tributary streams. Fishing peaks during June with another substantial surge during early fall.

C. WATER RESOURCES

1. SURFACE WATER

The headwaters of the South Fork John Day River are in the Ochoco and Aldrich Mountains. The stream gradient over the 60-mile course of the river is a relatively gentle 47 feet per mile. Major tributaries are Murderers Creek, Black Canyon Creek, and Deer Creek.

The South Fork near Dayville was gaged intermittently for 10 years between 1910 and 1930. Average annual discharge at the mouth is an estimated 100,000 acre-feet. A permanent gaging station is scheduled to be installed on the Lower South Fork in 1986.

Subbasin discharge is greatest during the winter months. Discharge generally peaks in late April, which coincides with maximum snowmelt runoff and is lowest in September. During the low-flow period of July through October, demands for irrigation use, fisheries maintenance, and water quality are greatest.

Table 35

SOUTH FORK SUBBASIN
RECREATIONAL FACILITIES

Ownership	Sites	Acres	Campsites	Picnic sites
City				
County				
State				
BLM				
USFS	3	13	15	1
NPS				
Private				
TOTALS	3	13	15	1

Source: Oregon Parks and Recreation Division, 1985.

2. GROUND WATER

The subbasin geology is comprised mostly of basalt and complex pre-Tertiary rock. There are essentially no well data for the area and, as a result, estimates of ground water storage are not available. However, significant amounts of ground water probably are stored in the basalt. Topographic maps indicate springs are fairly common in the area.

3. WATER QUALITY

On an annual basis, the surface water of the South Fork Subbasin generally exhibits satisfactory chemical, physical and biological quality. Seasonal high and low streamflows create periodic surface water quality problems (see Appendix F). The primary problems are sediment loading during high-flow periods and extreme water temperatures during lowflow periods. These may be partly the result of vegetation disturbances and riparian zone degradation.

High sediment loads are present in the subbasin's streams during peak runoff and as result of intense thunderstorms. The major impacts of sediment loading affect fisheries resources. Sediment alters the material composition of the stream channel by smothering spawning gravels and by filling pools used for rearing. No individual factor is solely responsible for producing the conditions leading to vegetation removal, erosion, and sediment loading. According to ODFW, livestock grazing has had a significant impact. However, timber removal, road construction, farm practices, stream channel disturbance (dredge- and fill-type activities), and natural conditions also have contributed.

Headwater areas of the Upper South Fork have severe to moderately severe sheet, gully and streambank erosion, and resultant sedimentation problems. The most severe problems are in the Lewis Creek, Corral Creek, and Flat Creek areas.

Water temperatures as high as 76°F have been recorded in the South Fork Subbasin near Izee and are the result of low streamflows and lack of streamside shade. Livestock grazing and noxious weed spraying in the upper watershed has reduced the vegetation which provides streambank stability and shades the water. Excessively high water temperatures deplete the dissolved oxygen content in the water and seriously affect fish rearing, particularly of salmonids. High water temperatures are conducive to the growth of disease-causing bacteria.

There are no permitted treated waste discharges in this subbasin.

D. WATER USE AND CONTROL

1. WATER RIGHTS

Presently, subbasin water rights total approximately 105 cfs for all uses. Out-of-stream water use is almost entirely for irrigation (95 percent by appropriated volume). Table 36 shows that most of the remainder is for municipal use by Dayville.

Approximately 6,000 acre-feet of water is required for the crops grown in the subbasin. The monthly distribution of this need is in Figure 25. From May through September, the need is about 17 cfs.

There are 141 water rights with an allowable rate of 99.4 cfs to irrigate about 4,400 acres. In the northern portion of the subbasin irrigation is applied primarily to pasture and hay fields. Roughly one-half is by sprinklers and one-half through flood irrigation. In the Izee area, flood irrigation is dominant. Most domestic water supplies are derived from shallow wells. The upper part of the South Fork drainage has the only domestic surface right in the subbasin. Domestic water use is not a major consumptive use.

The City of Dayville has the right to divert 5.05 cfs from Conner Creek, a tributary stream entering the South Fork about two miles above the mouth, and the South Fork John Day River. The city water system is supplied by a series of springs at the rate of 23 gallons per minute (0.05 cfs). In 1985, the city of Dayville applied for an additional 0.3 cfs from the South Fork Subbasin in order to improve its water system.

There are rights to store about 45 acre-feet of water in the subbasin. Most of these are small stock-watering impoundments. There are no industrial, mining or hydropower rights in the subbasin.

Table 36

SOUTH FORK SUBBASIN WATER RIGHTS
(cfs)

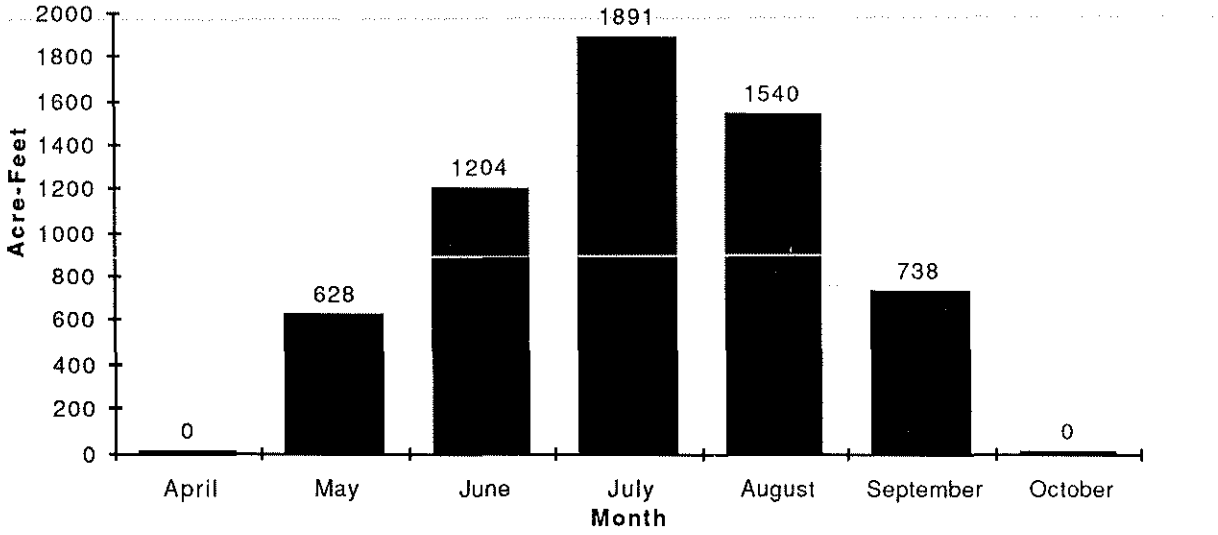
SUBBASIN or REACH	Irrig-ation[1]	Live-stock	Indust./ Munic.	Residen-tial	Storage[2]	Total
South Fork (mainstem only)	29.5	*		0.1	9.4	29.7
Murderer's Cr.	15.6	0.2		*	8.6	15.8
Black Canyon Cr.	1.0					1.0
Deer Cr.	0.3	*			3.4	0.3
Remainder of subbasin	51.2	*	5.1		355.7	56.3
TOTAL	97.5 (48.8)[3]	0.3	5.1	0.1	377.1	102.9

1. Rate for irrigation season.
2. Figures in acre-feet; not included in grand total.
3. Rate adjusted for entire year.
* Less than 0.05 cfs.

Ground water use in the subbasin is low and is primarily domestic. The geologic formations generally yield water slowly and large quantities are not commonly available, but supply appears adequate for domestic use. One non-domestic well is located about three-quarters of a mile above the mouth. There are no legal restrictions on groundwater use.

Figure 25

SOUTH FORK SUBBASIN
ESTIMATED IRRIGATION WATER REQUIREMENTS



2. WATER USE RESTRICTIONS

a) Administrative

1) Reservations

Guyon Springs, tributary to Conner Creek which flows into the South Fork, was reserved by order of the State Engineer in 1932 for municipal use by the City of Dayville.

2) Minimum Perennial Streamflows

The ODFW and ODEQ requested, and the Water Resources Commission adopted, a minimum stream flow with a November 3, 1983, priority on the South Fork from the confluence of Black Canyon Creek to the mouth. Municipal, storage, domestic, and livestock uses are exempt from the minimum flow.

3) Classification

The use of subbasin streams is limited to domestic, livestock, municipal, irrigation, power development, industrial, mining, recreation, fish and wildlife beneficial water uses. The beneficial use of natural lakes is limited to domestic, livestock, lawn and garden irrigation, power development of no more than 7-1/2 theoretical horsepower, recreation, fish and wildlife.

3. STORAGE

The subbasin has a large amount of unappropriated winter and spring streamflow which could be applied to beneficial use if it could be stored for release during the summer and fall. Studies conducted by the Bureau of Reclamation and the Corps of Engineers have identified many potential storage sites in the subbasin (see Table 37). None of the sites were found economically feasible based on the criteria used by the agencies at the time of the studies.

An engineering design prepared by the Bureau of Reclamation for the Falls storage site located above Deer Creek on the South Fork called for a 140-foot-high dam, creating a 140-acre reservoir containing 5,800 acre-feet of water. This project could maintain a base flow of 50 cfs in an average year at the mouth of the South Fork, meeting recommended late-season fish flows. The project also would provide 4,200 acre-feet of water for irrigation and power production. The estimated cost of the project was $22,000,000 in 1980.

Some of the riparian improvement projects carried out by ODFW, BLM, and the Malheur National Forest in the South Fork Subbasin are designed not only to improve fisheries habitat but add to late-season flows by improving the streamside water table. Riparian zone restoration and improvement has been performed on five miles of Murderers Creek, three miles of Tex Creek and three miles of Deer Creek, and more work is planned. However, the contribution of non-structural storage to late-season streamflow is unquantified and requires further investigation.

Table 37

IDENTIFIED RESERVOIR SITES IN THE SOUTH FORK SUBBASIN

Site Name	Stream Name	River Mile	Potential Storage (acre-feet)	Drainage Area (sq. mi.)
Fourmile	S. Fk. John Day	6.2	16,000	590
Black Canyon	S. Fk. John Day	15.0	82,000	540
Falls	S. Fk. John Day	29.3	5,800	245
Pine Creek	S. Fk. John Day	29.7	50,500	260
Mill	S. Fk. John Day	30.1	5,800	244
Little Pine	S. Fk. John Day	33.6	5,800	235
Morgan	S. Fk. John Day	35.5	5,800	201
Sheep Creek	S. Fk. John Day	42.0	N/A	188
Blackhorse	S. Fk. John Day	49.0	6,000	143
John Day S. Fk.	S. Fk. John Day	52.2	2,500	35
Murderers Creek	Murderers Creek	2.2	N/A	113
Thorn Creek	Murderers Creek	6.2	N/A	72
Stewarts Cabin	Murderers Creek	11.8	4,200	38
Tex	Murderers Creek	14.2	3,600	29
John Young	S. Fk. Murderers	7.1	N/A	5
Beaver Dam	Beaver Dam Creek	0.4	N/A	2
Deer Creek	Deer Creek	4.9	N/A	34
Sunflower Creek	Sunflower Creek	2.8	2,000	18
Lewis Creek	Lewis Creek	0.1	5,800	44
Lonesome Creek	Lonesome Creek	0.9	1,300	13
Venator Creek	Venator Creek	1.4	1,200	13
Bear Creek	Bear Creek	4.4	250	3

N/A = not available

E. PROBLEMS

The seasonal distribution of stream discharge is a problem in the South Fork just as it is throughout the John Day Basin. Late-season low streamflows are common and affect water quality and fisheries resources. Peak runoff carries high amounts of sediments which have adverse effects on water quality and fish habitat. Flood flows, extreme events such as occurred in 1964, and, to a lesser extent, annual high flows alter stream structure.

Historic and current human activities altered the South Fork watershed. Watershed alteration has led to decreased precipitation infiltration, increased sediment loads, and decreased riparian vegetation. Resource management activities which improve the watershed will help alleviate not only the water quality problems but the seasonal distribution of stream discharge. However, the damage has accumulated over a long period of time and likely will require extensive rehabilitation efforts.

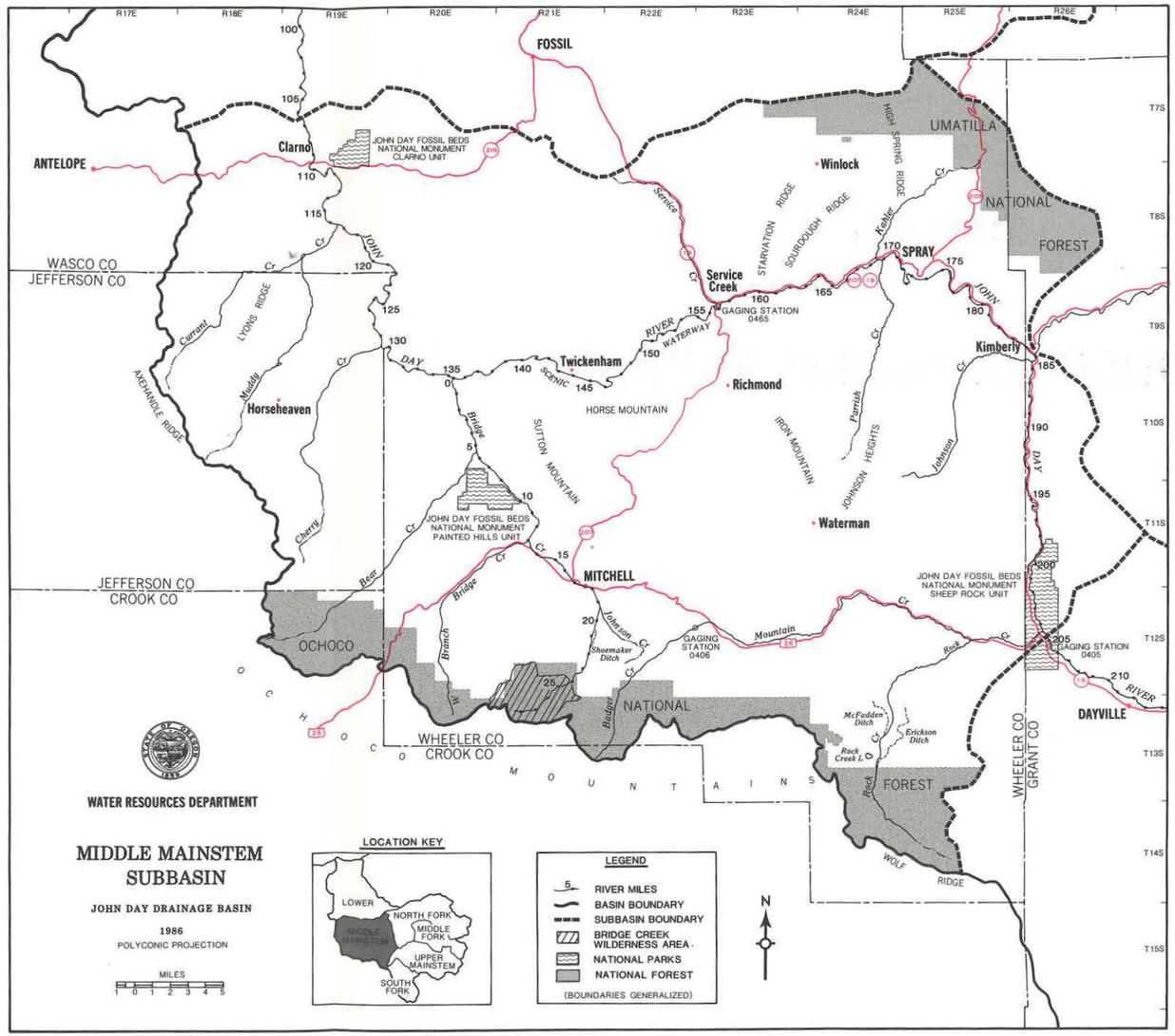
Storage reservoirs, both large- and small-scale, are the most reliable means of keeping water from escaping the subbasin. However, the construction costs and fisheries impacts have precluded development to date. Benefits from alternative non-structural storage techniques in the riparian zone are unquantified.

Section VI

MIDDLE MAINSTEM SUBBASIN

Figure 26

MAP OF THE MIDDLE MAINSTEM SUBBASIN



SECTION VI

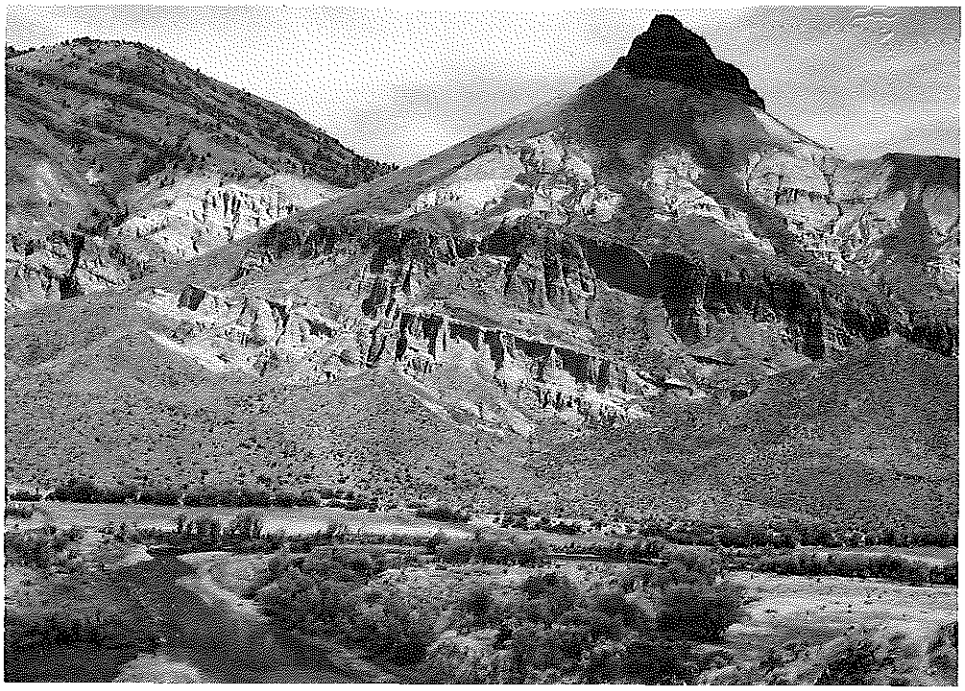
MIDDLE MAINSTEM SUBBASIN

A. LOCATION AND DESCRIPTION

The Middle Mainstem Subbasin (see Figure 26) includes the 99-mile reach of the John Day River between Clarno and Picture Gorge and encompasses an area of about 1,431 square miles. The subbasin is a relatively rugged region with steep canyons and high mountains. Elevations range from 1,300 feet at Clarno to over 6,000 feet in the Ochoco Mountains. Units of the John Day Fossil Beds National Monument are in the subbasin.

The cities of Mitchell, Spray, and Rajneeshpuram are the subbasin's incorporated cities. The legality of Rajneeshpuram's incorporation, however, has been the subject of litigation.

There are four major transportation routes in the subbasin: Highway 26 which runs through the southern portion of the subbasin; Highway 218 connecting Antelope with Fossil in the northwestern corner of the subbasin; Highway 19 which follows Service Creek and the John Day River and intersects Highway 26 at Picture Gorge; and Highway 207. Highway 207, a north-south route with one terminus at Mitchell, passes through Spray before it exits the subbasin on the route to Heppner.



The John Day River flows by Sheep Rock in the John Day Fossil Beds National Monument.

1. CLIMATE

The climate is semi-arid with annual precipitation averaging about 10 to 12 inches at Service Creek and similar low elevations. Precipitation in the mountains is considerably higher and may reach 30 inches. Temperature ranges are typical for the region which is characterized by hot summers and cold winters.

2. LAND OWNERSHIP

The predominance of private land ownership distinguishes the Middle Mainstem Subbasin from the upper subbasins. Federal ownership is about equally divided between the USFS and the BLM. About 10 square miles of the Sheep Rock Unit of the John Day Fossil Beds are included in the drainage area. Lands managed by BLM are concentrated in the John Day River corridor and in the lower Service Creek, upper Rock Creek, Johnson Creek, and Parrish Creek drainages. Forest Service lands are located in the uplands of the northern and southern divides which form the subbasin boundary. Less than one percent of the area is state-owned land (see Figure 27).

3. LAND COVER AND LAND USE

Much of the subbasin is steep canyon country with relatively shallow soils. A 1980/81 unpublished soil survey by the BLM identified the steep dissected uplands and canyon areas located between Service Creek and Picture Gorge and Clarno and Bridge Creek as having relatively fragile soils susceptible to erosion. Additionally, the Muddy, Currant, Cherry and Bridge Creeks drainages have severe erosion potential due to shallow soils and steep slopes.

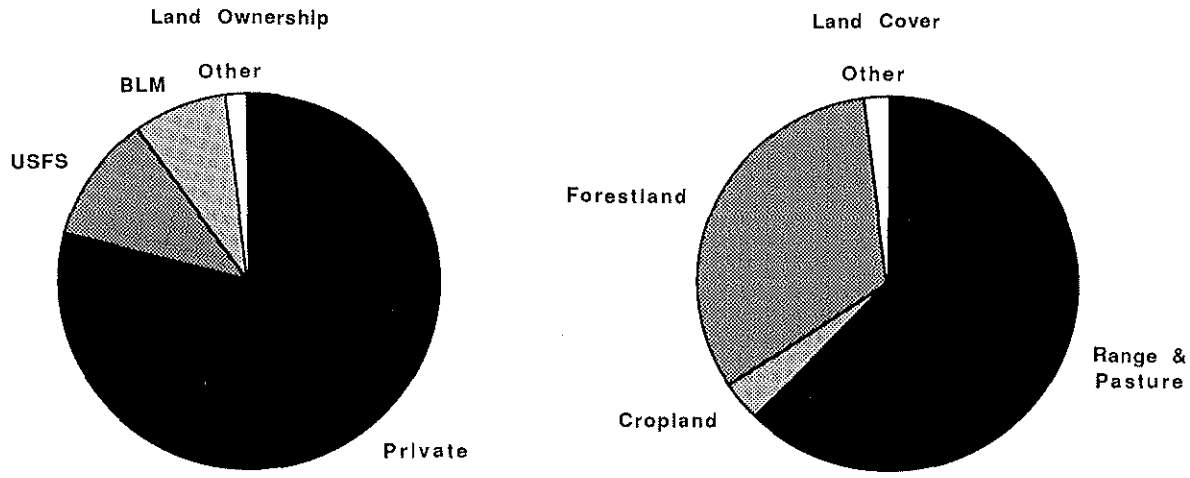
Over 60 percent of the subbasin is range and pastureland (see Figure 27). The majority of rangeland is privately owned. Range conditions vary from site to site and, by SCS standards, much is in poor or fair ecological condition. BLM and USFS public range allotments are used for spring, summer and fall grazing. The majority of subbasin BLM rangeland is in fair to poor condition.

Ochoco National Forest rangeland on the other hand is in fair to good condition. Portions of four range allotments and one full allotment provide 929 AUMs. On the northern edge of the subbasin, the Umatilla National Forest manages four range allotments covering about 33,100 acres. Range condition varies with two percent in very poor condition, 14 percent in poor condition, 72 percent in fair condition, and eight percent in good condition. None of the range is rated as being in excellent condition and four percent of land classified as range is not in an allotment program.

Forest covers about 32 percent of the subbasin. Most of the forestland is federally owned and managed by the Ochoco and Umatilla National Froests. The BLM has some commercial forestland on the eastern subbasin divide between the North Fork and Picture Gorge and in Johnson Heights. Nearly all the forestland is used for grazing (see Table 38).

Figure 27

MIDDLE MAINSTEM SUBBASIN
LAND OWNERSHIP AND LAND COVER



Cropland, urban areas, and other land types comprise only about 5 percent of the subbasin (see Table 38). Spray (population 170), situated along the John Day River, and Mitchell (population 195) are the only subbasin urban areas. Spray encompasses an area of 185 acres with an urban growth area of 15 acres. Mitchell is considerably larger covering 820 acres with a 350 acre urban growth area. Rajneeshpuram, located along Muddy Creek, was the largest and most developed subbasin urban area prior to its depopulation in 1985. Many of the urban improvements remain.

Table 38

MIDDLE MAINSTEM SUBBASIN LANDCOVER
(acres)

Type	Acres
Range and Pastureland	661,639
Forestland (grazed)	340,800
Forestland (not grazed)	500
Cropland	34,660
Other	21,950
	1,059,549

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

The 1980 census indicated Spray had a population of 155 and Mitchell 185 inhabitants. The 1983 population of Spray remained the same while Mitchell decreased to 170 inhabitants. Portland State University population projections suggest the cities will each have a population of 240 in the year 2000.

The scenic waterway portion of the John Day River includes basalt formations and agricultural lands.

B. RESOURCES

1. AGRICULTURE

Non-irrigated agricultural land is scattered throughout the subbasin. However, these acreages are concentrated in the general area north of the John Day River between Service Creek and Kimberly, in an arc extending between Service Creek, Richmond and Mitchell, and in the upper reaches of Mountain and Bridge Creeks.

Irrigated acreage is concentrated along the mainstem John Day River near Spray, Twickenham, Clarno and the mouth of Bridge Creek. Concentrations of irrigated land also are found in Upper Rock, Mountain and Bridge Creeks and in the Waterman Flat area.

Table 39 shows subbasin acreage by crop type. Hay and pasture acreages provide forage and winter feed for the cattle industry. Beef cattle production is an important economic activity in the subbasin.

Table 39

MIDDLE MAINSTEM SUBBASIN
CROP TYPES

Crop	Acres
Irrigated	
Alfalfa hay	5,710
Meadow hay	1,400
Hay and pasture	6,300
Grain/Grain hay	900
	14,310
Non-Irrigated	
Grain hay and pasture	6,250
Pasture and hay	1,500
Grain	12,600
	20,350

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

2. FOREST RESOURCES

During the past ten years, the Ochoco National Forest has harvested 55.9 million board feet of timber from 6,000 acres of land located in the Ochoco Mountains along the southern boundary of the subbasin. Road construction during this period added about 40 miles to the forest transportation system. The Forest Service plans to sell an additional 85 million board feet of timber over the next ten years, affecting 6,670 acres. Associated road construction is expected to add 28.5 miles of road to the system. The Forest Service intends to close half of this road mileage to public access.

No significant timber sales or harvesting took place on Umatilla National Forest lands during the past ten years. The five-year timber harvest plan for the period 1985-1989 indicates that 23.6 million board feet of timber will be sold in the area to the north and northeast of Spray. Roughly 21 million

board feet will be removed by tractor logging and 2 million board feet through skyline logging. The plan calls for 712 acres to be cut, using shelterwood techniques and 210 acres to be clearcut. No new roads will be constructed, but 13 miles of road will be rebuilt.

Additional timber will be harvested from sales which extend into the North Fork Subbasin. A portion of the 18 million board feet to be sold will come from the Middle Mainstem subbasin, with 6.7 million board feet to be removed from roadless areas. About 17 million board feet will be removed by tractor logging and 1 million board feet by skyline logging. Shelterwood cut will encompass 431 acres and 380 acres will be clearcut. An additional 4.8 miles of road will be constructed and 17.2 miles will be rebuilt.

Little or none of the timber harvested from the subbasin's Ochoco National Forest land is processed at sawmills in the John Day Basin. Much of the Umatilla National Forest timber is milled outside the basin at Heppner.

3. FISH RESOURCES

The Middle Mainstem Subbasin produces approximately four percent of the John Day basin summer steelhead. As many as 800 adult summer steelhead return annually to spawn. The mainstem serves primarily as a migration corridor for anadromous runs to spawning and rearing habitat in the upper subbasins.

Populations of rainbow trout, smallmouth bass and channel catfish also exist in the subbasin. Good habitat conditions for steelhead and resident trout exist in Bridge, Horseshoe, Service, Kahler, Parrish, Rock, Alder, Johnson, Cherry and Mountain Creeks. Production within these streams is restricted only in low-water years when flow and quality may be inadequate to support spawning or rearing.

Habitat conditions for fish production in the mainstem of the John Day River are limited. The river is wide and shallow in this reach. Flow and water quality characteristics are marginal for fish production. Riparian conditions and instream structure frequently provide inadequate cover and food to support significant numbers of fish. However, streamflow between fall and spring is adequate to support migration to tributary spawning and rearing areas and to quality habitat in the upper subbasins.

The mainstem and tributaries need improvements to channel structure and other habitat conditions to maintain fish production. Little in the way of habitat improvement has been carried out in the subbasin. BPA has budgeted funds for future instream and riparian habitat improvement on Rock and Bridge Creek and the mainstem John Day River (see Appendix E).

4. RECREATION AND TOURISM

The Middle Mainstem Subbasin has only a few developed recreational sites (see Table 40). These include the Sheep Rock and Painted Hills Units of the John Day Fossil Beds National Monument, Shelton Wayside State Park, and three Ochoco National Forest campgrounds. Sightseeing, camping, horseback riding, fishing and hunting are the primary recreational pursuits in this sub-drainage. Drift-boating, canoeing, and rafting on the John Day River are popular between Service Creek and Clarno when water levels are sufficient during the spring and early summer. Use of the John Day Scenic Waterway for recreation activities such as this is increasing. Steelhead fishing accounts for approximately 1,500 angler-days through the winter months, and trout fishing on the river and its tributaries accounts for around 1,700 angler-days in the early summer and fall. This subbasin also receives heavy hunting pressure for deer and elk during the fall seasons. The entire river in this subbasin is designated as a potential National Wild and Scenic River.

C. WATER RESOURCES

1. SURFACE WATER

The Middle Mainstem Subbasin drains an area of about 1,431 square miles. Peak discharge occurs from late March to early June and can account for as much as 70 percent of the annual discharge. Low flows occur from July through November. Major subbasin tributaries are the North Fork John Day River and Rock, Parrish, Bridge, Muddy, Cherry, Alder, Kahler, Service, Rowe and Pine Creeks.

The Middle Mainstem Subbasin is characterized by fairly dry conditions. Streams in the subbasin are likely to stop flowing in the late summer and fall. For example, on Mountain Creek between 1966 (the first year of record) and 1978 (year of last published record), flow stopped at some time during seven of the thirteen years. Periods of no-flow can begin as early as July and can be quite protracted. In 1977, for example, Mountain Creek did not flow from June 26 to October 5. Flows for late summer months on Mountain Creek average about 0.5 cfs. Monthly average minimum flows for July through August drop to zero.

Outflow is ungaged since there is no recording station at Clarno. However, major inflow from upstream subbasins is measured by gages at Picture Gorge on the Upper Mainstem John Day and at Monument on the North Fork John Day. The gage at Service Creek, which is roughly the midpoint of the subbasin, provides a good record of water production for the subbasin above that point. Flow data indicate that the subbasin above the gage produces about 100,000 acre-feet of water per year, or roughly 120 acre-feet of water per square mile.

The maximum discharge, or flood flow, recorded at Service Creek was 40,200 cfs on December 23, 1964. The minimum recorded flow was 6.0 cfs on August 23 and 24, 1973.

Table 40

MIDDLE MAINSTEM SUBBASIN
RECREATIONAL FACILITIES

Ownership	No. of Sites	Acres	Campsites	Picnic sites	Boat Ramps
City					
County					
State	1	180	26	5	
BLM					
USFS	4	16	16	5	1
NPS	1				
Private					
TOTALS	6	196	42	10	

Source: Oregon Parks and Recreation Division, 1985.

In eight out of ten years the estimated annual discharge at Clarno, using standard U.S. Geological Survey methodology, is predicted to equal or exceed 1,106,450 acre-feet. However, using the same methodology, August discharge is estimated to be 9,570 acre-feet, or 13.2 cfs.

The basin has experienced a wet cycle in the climatic pattern over the past few years. Runoff has been higher than normal. High peak flows have more erosive power and can change the stream profile. Evidence suggests that streambanks have suffered more undercutting than normal.

Ice scouring also appears to be a problem in the Middle Mainstem John Day River in the area above Spray. Ice has gouged and destabilized streambanks, leaving them more exposed to the erosive force of the river during peak runoff.

2. GROUND WATER

Limited data are available regarding subbasin ground water resources. Quaternary Alluvium is the most developed hydrologic unit. Deposits of Quaternary Alluvium are present in the John Day stream channel around Spray. Alluvial deposits in the stream channel vary in thickness and are thin where the river is deeply incised through the plateau. Alluvial deposits generally have high porosity and permeability. They are considered good aquifers because of their ability to store and transmit relatively large amounts of water and their high potential for recharge from surface sources.

3. WATER QUALITY

Water quality of the mainstem in the subbasin is primarily the result of upstream quality from the Upper John Day and South Fork John Day watersheds. Water quality generally exhibits satisfactory chemical, physical and biological quality except during water flow extremes. Turbidity, erosion and sedimentation problems occur during high flows and higher temperatures with concurrent lower dissolved oxygen occur during the low-flow periods.

Tributaries in the subbasin also exhibit high temperatures during the summer months. These tributaries carry high sediment loads during heavy rain storms. Portions of the basin contain soils of the fossil formations. When heavy rains occur, stream turbidity increases because these are very fine soils and they remain in suspension, giving the appearance of a more serious sediment loading problem. Streams with identified turbidity and erosion problems are listed in Appendix F.

High temperatures create the most serious threat to beneficial uses of the water. Fecal bacteria in the main river occasionally threaten the safe use of the main river for water contact recreation (see Appendix F). Bacteria are most prevalent after rain storms.

Water quality is acceptable for irrigation use at the present time. Total nitrogen levels in this part of the John Day basin are elevated, indicating an increasing input of nutrients into the river as the water travels toward the Columbia River. Nitrate and nitrite levels are well within safe limits for domestic use, although the water should be disinfected before drinking.

There are no permitted source discharges to the streams of the subbasin. The towns of Spray and Mitchell have no municipal sewage treatment facilities and rely on individual septic systems to dispose of domestic wastes.

Ground water quality is unknown for this subbasin due to lack of water quality information. The landfills at Spray (Ives Creek drainage), Mitchell (Bridge Creek drainage) and Rajneeshpuram (Currant Creek drainage) could cause future ground water problems.

D. WATER USE AND CONTROL

1. WATER RIGHTS

Over 85 percent of the appropriated water volume in the Middle Mainstem Subbasin is for irrigation (see Table 41). Another nine percent is for mining. All mining rights date from before 1940 and probably are not used. There also are rights for about 4 cfs for municipal use, the majority of which takes place in Spray.

About 22,000 acre-feet of irrigation water is required for the crops grown in the subbasin. The monthly distribution of the requirement is displayed in Figure 28. The total seasonal volume required is approximately 60 cfs from May through September, or about 12 percent of the total allowed by right.

Ground water use is principally municipal and domestic and does not appear to significantly impact streamflow even though the municipal water source for Spray is shallow wells drilled in alluvium. Spray has the capacity to pump 175 to 240 gpm, but its current use is about 19 gpm. Spray appears to have adequate supplies for current and future use.

Table 41

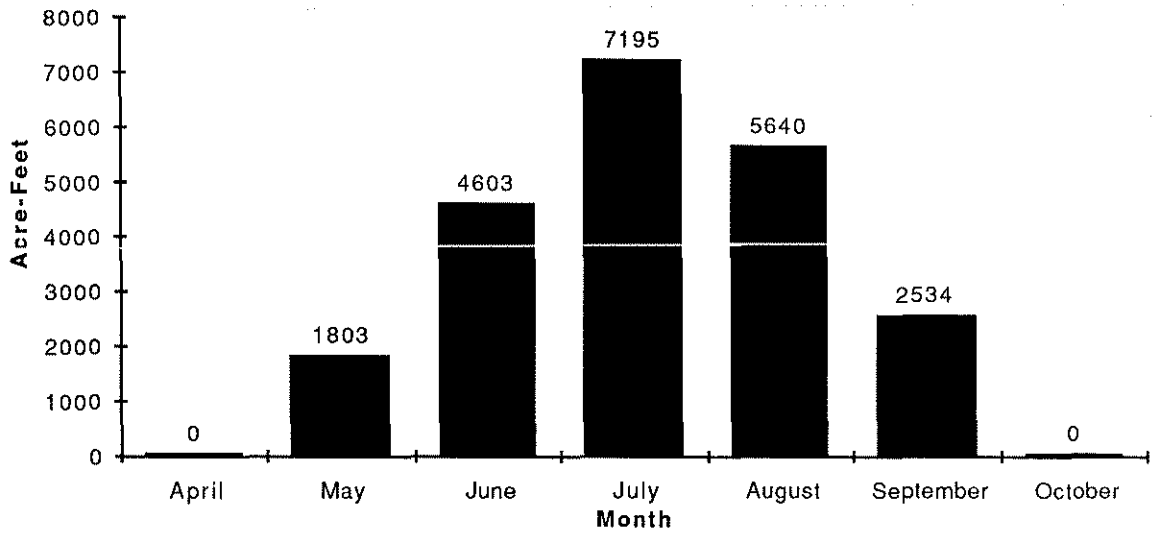
MIDDLE MAINSTEM SUBBASIN WATER RIGHTS
(cfs)

SUBBASIN or REACH	Irrigation[1]	Livestock	Mining	Indust./ Munic.	Fish and Wildlife	Residential	Storage[2]	Other[3]	Total
John Day, Pict. G. - Service Cr.	160.3	*		3.7		*	0	4.3	168.3
Rock Cr. (ex. Mtn. Cr.)	116.0	0.1	30.8			*	2299.8	2.2	149.0
Mountain Cr.	29.6	0.2				*	874.0		29.9
Parrish Cr.	6.5						0		6.5
Kahler Cr.	13.0					*	4.7		13.1
Alder Cr.	12.0	*			0.2	0.1	96.5		12.3
Bridge Cr.	85.1	0.1		1.0	0.5	1.1	337.4	*	87.7
Muddy Cr.	6.2			1.9			1079.0	0.2	8.3
Remainder of subbasin	66.7	0.1		1.7	*	0.3	523.6	1.3	70.1
TOTAL	495.4 (247.7)[4]	0.6	30.8	8.2	0.7	1.5	5215.0	8.1	545.2

1. Rate for irrigation season.
2. Figures in acre-feet; not included in total.
3. Rights in database with uncoded uses.
4. Rate adjusted for entire year.
* Less than 0.05 cfs.

Figure 28

MIDDLE MAINSTEM SUBBASIN
ESTIMATED IRRIGATION WATER REQUIREMENTS



2. WATER USE RESTRICTIONS

a) Statutory

The John Day River from Service Creek to Clarno is designated as a state Scenic Waterway (ORS 390.825). No dam, reservoir, water impoundment facility or placer mining is permitted on waters within the scenic waterway. No water diversion facility can be constructed or used except by previously established right.

b) Administrative

1) Minimum Perennial Streamflows

The Middle Mainstem Subbasin has four minimum perennial streamflows. A 30 cfs minimum streamflow was established at Service Creek in 1962. In 1985, the Water Resources Commission established three additional minimum streamflows, with 1983 priority dates to protect instream water uses. These minimum streamflows are regulated essentially the same as water rights -- according to priority.

The 1962 minimum streamflow at Service Creek is for 30 cfs. A 20 mile reach of the John Day River between Picture Gorge and the mouth of the North Fork John Day River is subject to a 1983 minimum streamflow. Two additional 1983 minimum streamflows are located on Bridge Creek from Bear Creek to the mouth, and on Rock Creek from Mountain Creek to the mouth.

2) Hydroelectric Standards

Administrative rules governing hydroelectric applications generally prohibit development of hydroelectric projects on the Mainstem John Day River. Furthermore, state hydroelectric standards place stringent requirements on projects which are on streams supporting anadromous fish, wild game fish, or important recreational opportunities.

3) Classifications

The use of subbasin streams is limited to domestic, livestock, municipal, irrigation, power development, industrial, mining, recreation, fish and wildlife beneficial water uses. The beneficial use of natural lakes is limited to domestic, livestock, lawn and garden irrigation, power development of no more than 7 1/2 theoretical horsepower, recreation, fish and wildlife.

3. STORAGE

The Bureau of Reclamation, Corps of Engineers, and Soil Conservation Service have studied many of the subbasin's potential reservoir sites. A number of suitable sites have been identified (see Table 42). However, according to the criteria used by the agencies to evaluate the projects, none were found to be environmentally or economically acceptable at the time the studies were done.

Table 42

IDENTIFIED RESERVOIR SITES IN THE MIDDLE MAINSTEM SUBBASIN

Site Name	Stream Name	River Mile	Storage (acre-feet)	Drainage Area (sq. mi.)
Clarno	John Day R.	106.0	115,000	N/A
Hicks	John Day R.	119.4	N/A	N/A
Twickenham	John Day R.	136.3	N/A	N/A
Hoogie Doogie	John Day R.	162.4	N/A	N/A
Alder Cr.	John Day R.	164.0	600,000	4,960
Berry	John Day R.	172.0	592,000	4,880
Kimberly (Spray)	John Day R.	182.9	162,000	4,820
Kimberly	John Day R.	183.3	N/A	N/A
Humphrey Ranch	John Day R.	199.9	N/A	N/A
Bear Cr. (Lower)	Bear Cr.	1.7	6,570	81
Bear Cr. (Upper)	Bear Cr.	4.6	7,180	73
Currant Cr.	Currant Cr.	2.4	140	30
Sorefoot Cr.	Sorefoot Cr.	2.8	100	12
Alder Cr.	Alder Cr.	5.2	2,205	30
Horseshoe Cr.	Horseshoe Cr.	10.1	740	4
Kahler Cr. (Lower)	Kahler Cr.	2.9	900	38
Kahler Cr. (Upper)	Kahler Cr.	6.4	153	16
Henry Cr.	Henry Cr.	3.7	582	5
Rock Cr.	Rock Cr.	6.0	2,420	83
Mountain Cr.	Mountain Cr.	24.6	4,200	24
Willow Cr.	Willow Cr.	3.1	2,333	32
Sixshooter Cr.	Sixshooter Cr.	2.2	800	4
Fort Cr.	Fort Cr.	0.3	1,165	9

N/A = Not Available

E. PROBLEMS

The Middle Mainstem subbasin experiences periodic water shortages for both out-of-stream and in-stream uses. Water use is regulated at such times both for irrigation use and for preservation of instream flows.

Low summer flows in the subbasin result in high water temperatures and low dissolved oxygen contents. Fish habitat consequently is degraded. Most fish habitat is marginal. The minimum flows on Rock Creek and Bridge Creek probably are infrequently met in August and September. The lower reaches of Bridge Creek are frequently dewatered. As described more fully in the Upper Mainstem Subbasin, the minimum flows on the John Day River from the South Fork to the North Fork are usually not met in August and September. The minimum flow of 30 cfs on the John Day River at Service Creek is probably satisfied, except during August and September in very dry years.

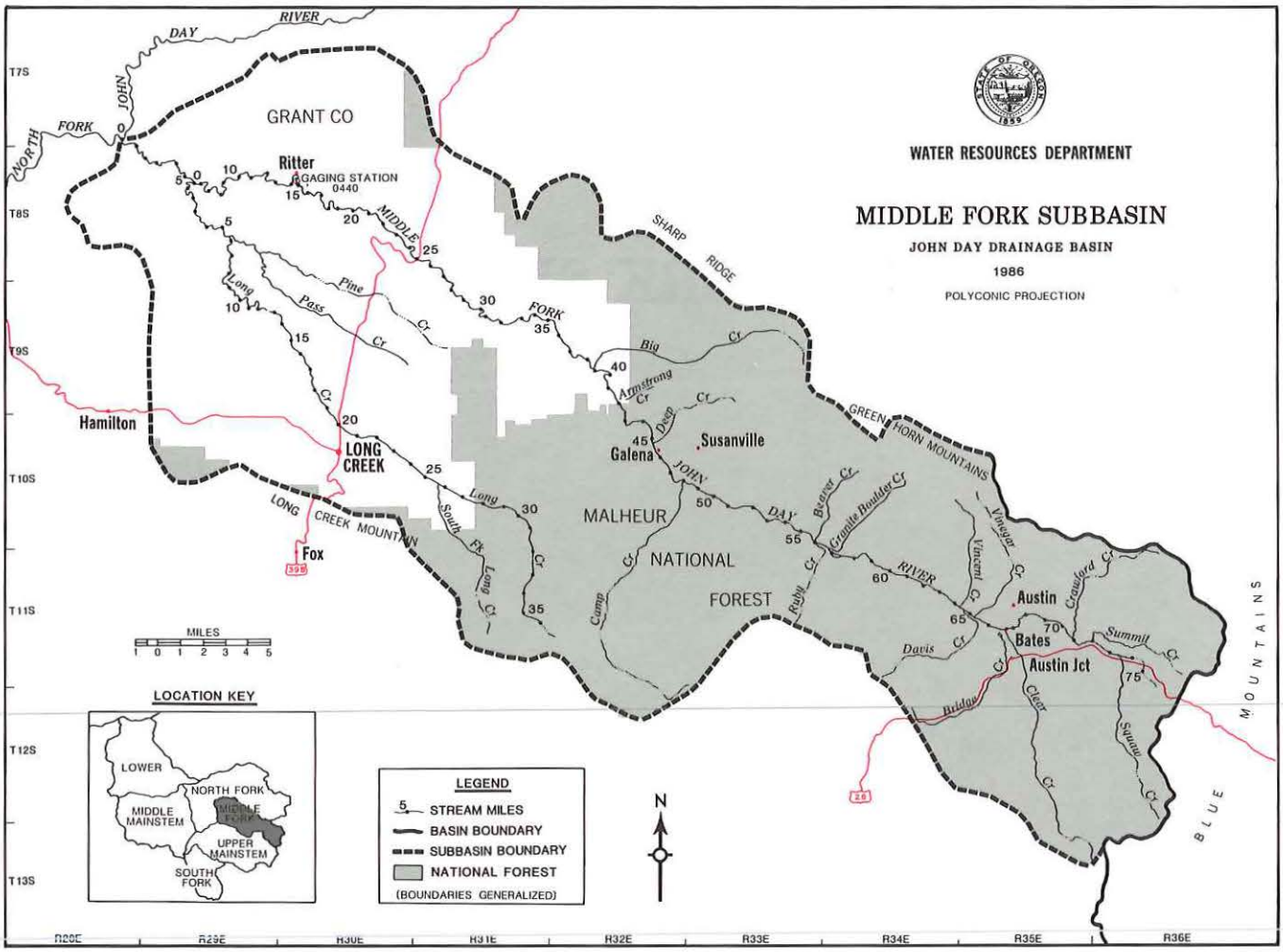
The City of Mitchell municipal water supply periodically suffers from poor quality. The city is in the process of improving its facilities. Most of the subbasin is rangeland, much of which is in poor condition. Erosion potential is high in the Muddy, Currant, Cherry, and Bridge Creek subbasins. Streams throughout the Middle Mainstem have turbidity, sedimentation, and erosion problems. At times, fecal bacteria in the mainstem John Day River can pose health problems.

Section VII

MIDDLE FORK SUBBASIN

Figure 29

MAP OF THE MIDDLE FORK SUBBASIN



SECTION VII

MIDDLE FORK SUBBASIN

A. LOCATION AND DESCRIPTION

The Middle Fork John Day River, a tributary of the North Fork John Day River, is located entirely within Grant County. The subbasin (see Figure 29) is an area of approximately 806 square miles. The Middle Fork flows northwest from its source in the Greenhorn and Elkhorn Ranges of the Blue Mountains for over 75 miles before entering the North Fork at river mile 32.2. Most of the headwaters of the Middle Fork are on the Malheur and Umatilla National Forests. The subbasin has highly variable terrain with elevations ranging from about 2,200 feet near the mouth to over 8,100 feet in the headwater areas.

The major city within the subbasin is Long Creek, with a population of 245. Other communities include Ritter, Austin, and Bates. Highway 395 passes north-to-south through the western portion of the subbasin and Highway 26 through the southeastern headwater area. In addition, a road parallels the Middle Fork for nearly its entire length.

The Middle Fork John Day River Subbasin is characterized by high - elevation, forested lands.

1. CLIMATE

The climate is semi-arid with average annual precipitation of about 10 inches near the mouth of the Middle Fork. The City of Long Creek, at an elevation of 3,750 feet receives an average of 16 inches of precipitation annually. Higher in the Blue Mountains, precipitation occurs mostly as snow and can reach 40 inches per year. At Long Creek the coldest average monthly temperature occurs in January (30°F) and the warmest occurs in July (64°F).

2. LAND OWNERSHIP

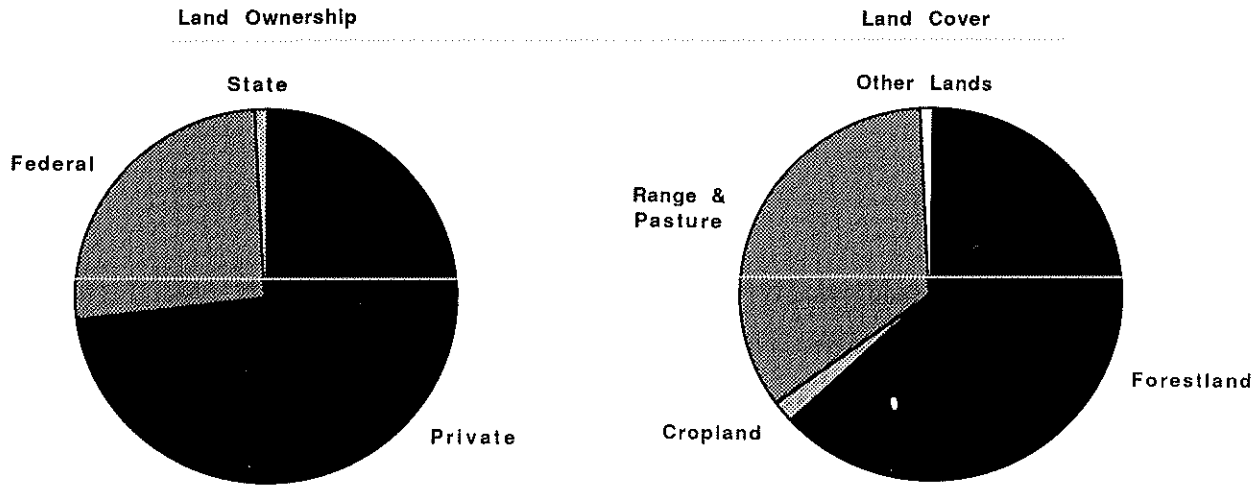
The federal government is the largest landowner in the subbasin (see Figure 30). Nearly all federal land is managed by the Malheur National Forest, although about 30 square miles is managed by the Umatilla National Forest. Small, widely distributed parcels of land adjacent to the lower and middle reaches of the Middle Fork and Long Creek are managed by the Bureau of Land Management. Most of the Middle Fork below Slide Creek is privately owned.

3. LAND COVER AND LAND USE

Range and forestland are the predominant land cover types in the subbasin. Most of the forestland is federally managed. Over 75 percent of it is grazed. Most range is privately owned or managed by the USFS. Agricultural land makes up less than two percent of the subbasin (see Figure 30 and Table 43).

Figure 30

MIDDLE FORK SUBBASIN
LAND OWNERSHIP AND LAND COVER



Long Prairie, north of the City of Long Creek, is a rolling, hilly, non-forested steppe area notable for the excellent condition of its native bunchgrasses. It was cited by the Nature Conservancy under the Oregon Natural Heritage Program as an outstanding example of the native Blue Mountain steppe community. The combination of long winters and careful grazing practices by ranchers has preserved the quality of rangeland. Under present grazing practices the quality of Long Prairie vegetation likely will remain high.

Urban areas occupy only a small portion of the subbasin. Long Creek, the only incorporated city in the subbasin, covers about 600 acres. Rural service centers such as Austin Junction account for less than 200 acres.

The subbasin also includes about 20 square miles of the Vinegar Hill-Indian Rock Scenic Area which the USFS manages for protection of scenic and backcountry resources.

Table 43

MIDDLE FORK SUBBASIN LANDCOVER
(acres)

Type	Acres
Range/pasturelands	167,300
Forestland (grazed)	240,000
Forestland (not grazed)	70,000
Cropland	10,600
Other	5,500
	493,400

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

Roughly two thirds of the watershed and nearly all headwater areas are located on forestland managed by the USFS. Forest Service management regarding timber harvesting, road construction, cattle grazing, wildlife habitat, mining, and roadless areas have had, and will continue to have, the greatest influence on watershed conditions in the upper Middle Fork Subbasin. While most headwater areas are under federal management, private ownership of rangeland is dominant in the lower subbasin.

Shallow soils dominate the forested uplands of the upper Middle Fork and Long Creek. Outside of a few relatively flat alluvial segments along the Middle Fork above Galena, soils have a medium to high erosion potential and sediment yield. According to the SCS, historic winter and spring grazing at lower

elevations along the lower Middle Fork and lower Long Creek have disturbed natural vegetation and compacted the soils. Vegetation and range conditions on these sites are poor. On higher elevation sites, range condition is usually good.

B. RESOURCES

1. AGRICULTURE

Only a very small amount of the subbasin is farmed. Irrigated agriculture, primarily hay and pasture production (see Table 44), is limited to the upper Middle Fork John Day River above Galena and to upper Long Creek. Irrigation on Long Creek is located in the general vicinity of the City of Long Creek. All irrigation water is from surface sources. Non-irrigated crop acreage is double the irrigated acreage, and is located mostly along the streams and benchlands of the lower Middle Fork below Ritter, the lower to middle reaches of Long Creek, and tributary drainages such as Pass and Pine Creeks. The dominant crops are hay and pasture which support the area's cattle ranching.

Table 44

MIDDLE FORK SUBBASIN CROP TYPES
(acres)

Type	Acres
Irrigated	
Alfalfa hay	1,600
Meadow hay	500
Hay and pasture	1,400
	3,500
Non-Irrigated	
Grain hay and Pasture	2,900
Pasture and grass hay	2,300
Grain	1,900
	7,100

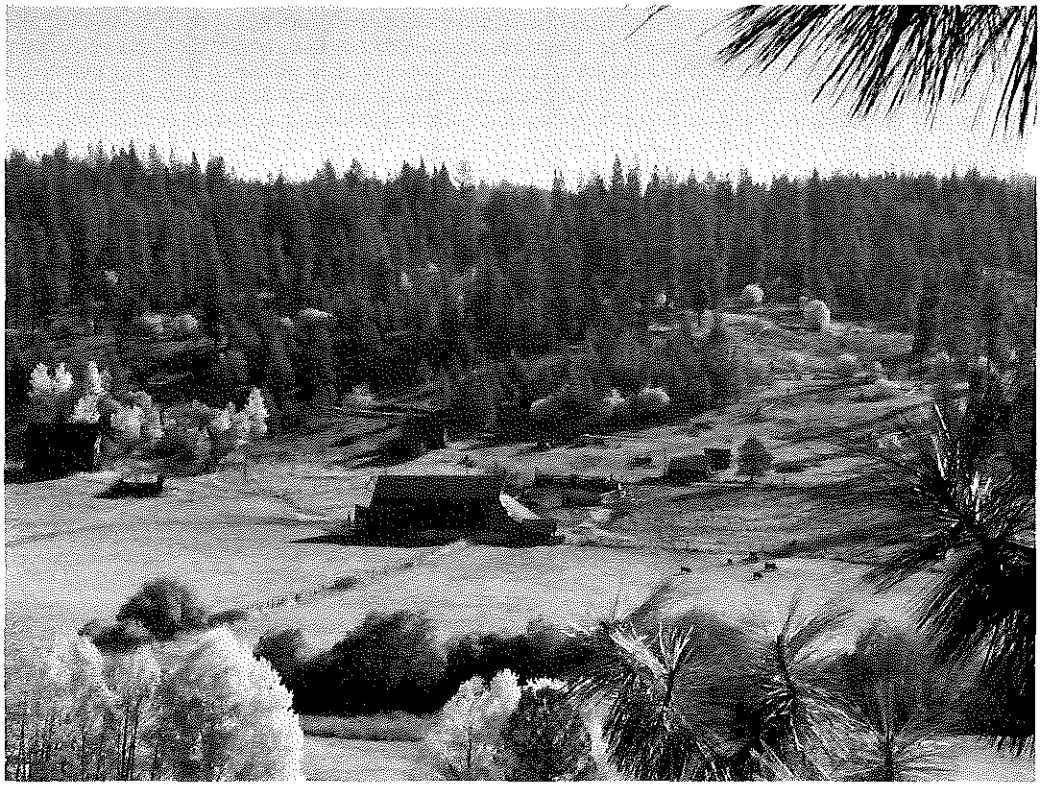
Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

2. FOREST RESOURCES

The forestland of the Middle Fork Subbasin is administered almost entirely by the Malheur National Forest. About 30 square miles are managed by the Umatilla National Forest. The Middle Fork's forests are included in the USFS John Day Planning Unit. The commercial forest-type composition of the Unit is: 42 percent mixed pine and fir; 25 percent white fir, Douglas fir, and larch; 24 percent climax pine; 5 percent lodgepole pine; and 4 percent subalpine fir.

Between 1976 and 1985 the Umatilla National Forest harvested over 40 million board feet of timber from 7,200 acres in the subbasin. Over the same period, about 1,500 acres were reforested. About 1,600 acres on the Umatilla within the subbasin are scheduled for sale in 1989.

The Malheur National Forest plans timber sales in the subbasin amounting to over 135 million board feet by 1988. The timber will be harvested on approximately 23,000 acres. These sales call for the construction of nearly 130 miles of new road.



Forests and agricultural lands, shown here near Long Creek, are typical of the subbasin.

3. ENERGY AND MINERALS

The upper Middle Fork is a mineralized area where lode and placer mining has been an ongoing activity. Decreasing prices for minerals over the past several years have depressed the mining economy. Mineral production is tied to commodity price and demand. When demand increases, so will prices, which will lead to greater production.

Placer mining occurs between Susanville and Bates. DOGAMI has rated the placer mining potential in the subbasin by potential future size of operation (see Table 45). DOGAMI expects placer mining to increase as commodity prices increase. Lode mines mostly are gold and silver operations. The status of lode mining is shown in Table 46.

Table 45

MIDDLE FORK SUBBASIN
PLACER MINING POTENTIAL

Location	Small	Medium
Susanville		X
Granite Boulder Creek		X
Vinegar Creek	X	
Vincent Creek	X	
Davis Creek	X	
Ruby Creek	X	

Source: Department of Geology and Mineral Industries, 1985.

Table 46

STATUS OF LODE MINING IN THE MIDDLE FORK SUBBASIN

Site Name	Location	Status	Potential Size
Tempest	T10S, R34E, Sec. 10	Active Production	Small
Susanville	T10S, R33E, Sec. 8	Active Exploration	100-300 ton/day
Dixie Meadows	T11S, R33E, Sec. 23	Active Exploration	100 ton/day
Vinegar Hill	T10S, R34E, Sec. 2	Inactive	-

Source: Department of Geology and Mineral Industries, 1985

4. FISH RESOURCES

The Middle Fork subbasin produces 24 percent of the total spring chinook and 30 percent of the total summer steelhead populations in the John Day basin. Currently as many as 770 adult spring chinook and 6,000 adult steelhead migrate into the subbasin to spawn annually. The Middle Fork also supports a productive trout fishery. A healthy resident trout population is supplemented yearly with 3,000 legal hatchery rainbows. Trout and steelhead provide 2,000 to 3,000 and 300 to 500 annual recreational angling days respectively on the Middle Fork.

In recent years habitat for salmon and steelhead has improved, primarily because of the removal of a diversion dam and the Bate's sawmill which were blocking fish passage and causing water pollution. Consequently, anadromous production, particularly that of spring chinook, has increased as fish now are able to use the upper Middle Fork system. Approximately 30 miles of spawning and rearing habitat for spring chinook are available in the Middle Fork between Armstrong and Summit Creeks. An estimated 295 miles of spawning and rearing habitat also are available in the Middle Fork and tributaries to support steelhead production. Major steelhead producing streams in the drainage include Camp, Indian, Granite Boulder, Deep, Beaver, Clear, Big Boulder, Deerhorn, Vinegar, Vincent, Davis, Long, Granite, Butte, Big, Huckleberry, and Slide Creeks.

In low water years, both salmon and steelhead production in the subbasin are affected by low flows and high stream temperatures on the Middle Fork below Highway 395. These conditions restrict passage to and limit the amount of usable habitat within potential spawning, rearing and adult holding areas. For example, in Clear Creek, one of the major producing streams in the subbasin containing both salmon and steelhead, rearing for spring chinook is often limited during low water years. Clear Creek supports annual production of 40 to 80 adult steelhead and 6 to 15 adult spring chinook spawners as well as a wild trout population.

BPA, USFS, BLM, and ODFW are administering programs to restore salmon and steelhead habitat in the subbasin. Through 1986, over $312,000 will have been spent in the subbasin to improve anadromous habitat. Most of this work is being completed through the NWPPC's fish and wildlife program. Planned work includes improving spawning and rearing habitat on 30 miles of the upper Middle Fork and on 9 miles of Clear Creek to increase smolt production.

5. RECREATION AND TOURISM

The Middle Fork Subbasin has a few widely dispersed developed recreational sites, most of which are maintained by the Malheur National Forest. The subbasin is used recreationally for hiking, camping, hunting, fishing, horseback riding, and sightseeing. The peak for trout and steelhead fishing is in the spring and early summer with another surge occurring in early fall.

A total of over 5,000 angler days are spent annually in this subbasin on the river and its tributaries. A road which parallels the Middle Fork for nearly its entire length provides excellent recreational access to the river.

Hunting for big game including deer, elk, and bear accounts for many thousands of hunter days during the fall. Table 47 contains recreation facility information.

Table 47

MIDDLE FORK SUBBASIN
RECREATIONAL FACILITIES

Ownership	No. of Sites	Acres	Campsites	Picnic sites
City	1	1		2
County				
State				
BLM				
USFS	5	26	20	8
NPS				
Private	2	63	Yes	Yes
TOTALS	8	90	20	10

Source: Oregon Parks and Recreation Division, 1985.

C. WATER RESOURCES

1. SURFACE WATER

The stream gradient of the Middle Fork John Day River averages 40 feet per mile, but steeper gradients are present in the upper reaches and in tributaries. Long Creek is the major tributary. Other tributaries include Big, Vinegar, Bridge, Camp, Clear, and Squaw Creeks.

The Middle Fork has been gaged at Ritter since 1929. Annual average discharge at Ritter is 168,464 acre-feet. The discharge at the mouth, which would measure the contribution of Long Creek and the 200 square miles of drainage below Ritter, is not gaged. Estimated discharge at the mouth is about 268,000 acre-feet annually. This accounts for about 25 percent of the estimated flow of the North Fork. Based on the Ritter gage, peak discharge generally occurs between March and early June, and lowest flows occur during the months of August and September (see Appendix D).

2. GROUND WATER

The ground water resources of the Middle Fork Subbasin are not well defined. However, data from wells in the vicinity of Long Creek indicate good production. The subbasin is a rugged, sparsely populated area and has few wells from which to acquire ground water data. The subbasin is comprised of fairly complex geology in four primary formations: Columbia River Basalt, Clarno Formation, Pre-Tertiary rock, and Strawberry Volcanics.

Columbia River Basalt underlies most of the lower Middle Fork and Long Creek drainages, or about half of the subbasin. This formation will supply adequate water for domestic and livestock purposes at reasonable well depths, and locally can supply large quantities of water suitable for municipal and irrigation use. The potential for development of basalt aquifers for large scale irrigation is limited due to very low ground water recharge due to poor vertical permeability.

The Clarno Formation is one of the major geologic units of the subbasin, although less extensive than Columbia River Basalts. The Clarno Formation has low permeability. The discontinuous structure of the unit and the low permeability limits recharge.

The geology of the Blue Mountain headwater areas consists of complexly folded and metamorphosed Pre-Tertiary rocks. There are few well data for this unit because most of the headwater areas are not inhabitated. It is unlikely that these Pre-Tertiary rocks have any significant permeability because of their fine grained nature. There is limited ground water potential in quantities necessary to satisfy domestic and stock use. Distribution of ground water is highly variable and dependent on the specific local geology.

A small area of Strawberry Volcanics occurs in the southeast headwater portion of the subbasin. The formation is not considered to be an important hydrologic unit because of its limited extent. Permeability and storage potential are considered to be low to moderate. Well data are insufficient to accurately assess hydrologic characteristics.

3. WATER QUALITY

Water quality in the Middle Fork Subbasin generally exhibits satisfactory chemical, physical and biological quality except when flows are extremely high or low. The most serious water quality problem in the subbasin is elevated temperatures. Sediment and erosion problems generally are not serious although localized streambank erosion does occur in some meadow areas where streams meander.

Most tributaries of the subbasin drain higher elevations and are shaded. Thus, high temperatures are not extensive and do not represent long term problems. The mainstem Middle Fork of the John Day, however, occasionally exhibits high temperatures that threaten optimum use by cold water fish (see

Appendix F). The main cause is riparian habitat degradation. Higher than optimum temperatures for salmonids will continue to occur as a result of natural low flows and irrigation withdrawals in the late summer. Past mining and dredging of the main river also has created some damage to riparian vegetation. Dredge tailings limit the rate of revegetation.

Some tributaries exhibit elevated fecal bacteria counts during summer months, probably as a result of use of surrounding areas for cattle grazing. Water-contact recreation or use of these streams for domestic purposes poses potential health risks.

Water quality throughout the subbasin is adequate for irrigation use. Total nitrogen levels in the main river are acceptable.

The town of Long Creek has the only municipal sewage treatment facility in the subbasin. However, discharge to surface waters is not permitted. Built in 1977, the lagoon facility is designed to serve a population of 342. It currently serves a population of 200. It was designed to allow irrigation use of treated discharge. DEQ considers it to be a well built and operated facility which should last for many years.

Ground water quality for this subbasin is unknown due to lack of water quality data. The landfill at Long Creek (Paul Creek drainage) may cause some surface water contamination but is not likely to affect ground water.

D. WATER USE AND CONTROL

1. WATER RIGHTS

Over 90 percent of the appropriated water in the Middle Fork Subbasin is for irrigation and mining (see Table 48). About half of the mining rights are fairly recent -- 1970 or later. These rights, however, generally are for smaller quantities of water than earlier mining rights. The more recent rights only account for 30 percent of the mining total.

Irrigation is mostly through flood irrigation on lands near Long Creek and above Galena. The crops grown in the subbasin require about 5,100 acre-feet of water from May through September (see Figure 31). This translates to approximately 14 cfs during the irrigation season.

Ground water use in the subbasin is low. Use is principally domestic and does not significantly impact streamflows. Domestic wells are developed in bedrock material and ground water supply appears adequate for domestic use. The formations generally yield water slowly and large quantities commonly are not available. The majority of Long Creek's municipal supply is derived from ground water, but there are few other permitted wells in the subbasin.

Table 48

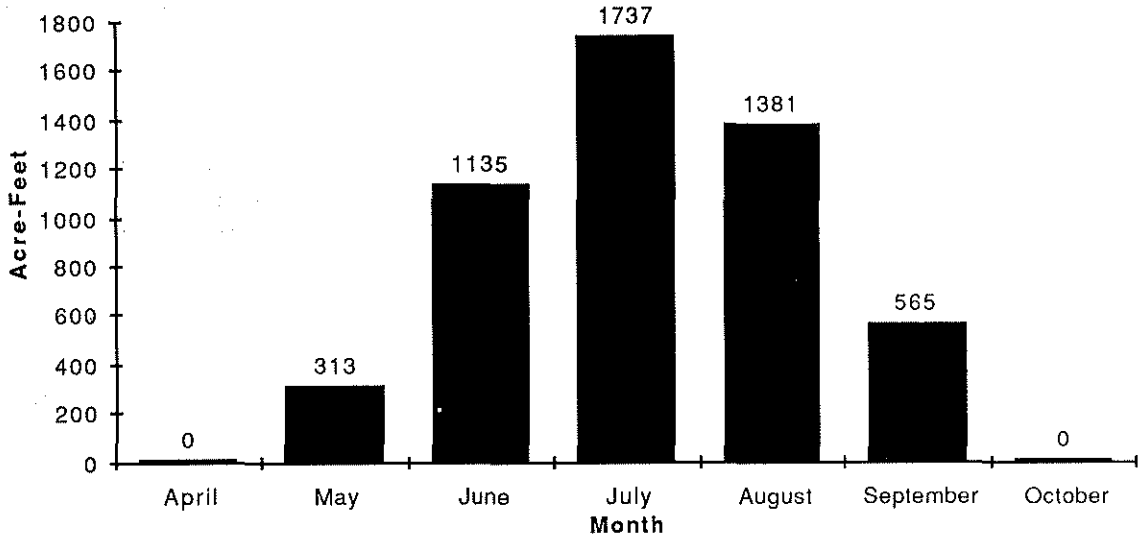
MIDDLE FORK SUBBASIN WATER RIGHTS
(cfs)

SUBBASIN or REACH	Irrig-ation[1]	Live-stock	Mining	Power	Indust./ Munc.	Residen-tial	Storage[2]	Total
Middle Fork (mainstem only)	35.0	*			1.0	1.3	79.2	37.3
Clear Cr.	2.2	*			2.2	0.1		4.5
Camp Cr.	1.9							1.9
Big Cr.	0.3		8.5					8.8
Long Cr.	19.8	0.7			1.9	0.2	0.5	22.7
Remainder of subbasin	29.3	0.6	41.0	0.8	0.2	0.4	2.0	71.7
TOTAL	88.5 (44.2)[3]	0.8	49.5	0.8	5.3	2.0	81.7	146.7

1. Rate for irrigation season.
2. Figures in acre-feet; not included in total.
3. Rate adjusted for entire year.
*. Less than 0.5 cfs.

Figure 31

MIDDLE FORK SUBBASIN
ESTIMATED IRRIGATION WATER REQUIREMENTS



2. WATER USE RESTRICTIONS

a) Administrative

1) Reservations

In 1934, the State Engineer reserved Bly Creek (a tributary of Long Creek) and its tributaries for municipal use by the City of Long Creek.

2) Minimum Perennial Streamflows

A minimum streamflow of 10 cfs on the Middle Fork at Ritter was established in 1962 to support aquatic life. Minimum flows with 1983 priority dates have since been adopted for Clear Creek at the mouth and on the Middle Fork from the gage near Ritter to the mouth. The latter flows were established to support aquatic life (specifically chinook salmon, steelhead, and resident trout) and for the assimilation of treated wastes.

3) Hydroelectric Standards

State hydroelectric standards place stringent requirements on projects which are on streams supporting anadromous fish, wild game fish, or important recreational opportunities.

4) Classification

The use of subbasin streams is limited to domestic, livestock, muncipal, irrigation, power development, industrial, mining, recreation, fish and wildlife beneficial water uses. The beneficial water use of natural lakes is limited to domestic, livestock, lawn and garden, irrigation, power development of no more than 7 1/2 theoretical horsepower, recreation, fish and wildlife.

3. STORAGE

Storage reservoirs, both large and small scale, are the most reliable structural means of keeping water from escaping the subbasin. Non-structural improvements in watershed conditions, although less reliable, also have the potential to store large amounts of water.

The Corps of Engineers and Bureau of Reclamation have studied many of the potential reservoir sites in the subbasin for flow augmentation (see Table 49). Phipps Meadow (river mile 71) proved to be one of the most promising sites considering public preference, needs, water supply, availability, storage capability, ability to protect flows, impacts to

Table 49

IDENTIFIED RESERVOIR SITES IN THE MIDDLE FORK SUBBASIN

Site Name	Stream Name	River Mile	Storage (acre-feet)	Drainage Area (sq. mi.)
Long Creek	M. Fk. John Day	8.5	106,000	565
Ritter	M. Fk. John Day	15.2	100,000	514
Sugarloaf Mtn.	M. Fk. John Day	21.6	N/A	N/A
Porter	M. Fk. John Day	23.4	90,000	470
Johnson	M. Fk. John Day	27.0	97,800	465
Indian Creek	M. Fk. John Day	35.8	90,000	400
Galena	M. Fk. John Day	45.8	N/A	N/A
Bates (DS)	M. Fk. John Day	62.2	28,000	125
Bates	M. Fk. John Day	66.3	10,000	117
Austin	M. Fk. John Day	68.3	10,000	58
Austin (Bates)	M. Fk. John Day	69.5	18,000	57
Phipps Meadow	M. Fk. John Day	72.0	10,000	53
Flood Meadow	Long Creek	33.9	N/A	4
Clark Meadows	S. Fk. Long Creek	8.0	500	3
Clark Meadow	S. Fk. Long Creek	7.0	N/A	2
Onion Gulch	Big Creek	4.8	5,200	16
Camp Creek	Camp Creek	1.6	13,400	59
Crawford Creek	Unnamed tributary	1.3	400	1
Squaw Creek	Squaw Creek	5.1	N/A	6

N/A = not available

fisheries, and economics. An initial engineering design for the site called for an impoundment of about 8,000 acre-feet from a 53 square mile drainage area which would augment streamflows from the damsite downstream to Monument. Roughly 2,000 acre-feet of water would be available annually to supplement the water supply to irrigated lands between Monument and Clarno. The increased flows would provide desireable water temperatures and enhance fisheries habitat. The project would not block steelhead runs and would eliminate only a very small chinook salmon spawning area. Based on the economic criteria

used, the Bureau concluded that the costs of construction of a dam exceeded the benefits. An associated riparian improvement project was found to be cost effective. Other sites may be available which could meet another sponsor's feasibility criteria.

E. PROBLEMS

The seasonal distribution of stream discharge follows the general John Day Basin pattern. The major surface water problems are high winter and low summer streamflows. Serious erosion and sedimentation problems are localized and not basin wide. Periodic high flows carry sediment, affecting water quality and fish habitat. Low summer flows and lack of protective vegetation canopy cause high water temperatures. Fecal bacteria cause localized water quality problems.

There are few water use conflicts in this subbasin and consequently little regulation by the watermaster. Streamflow is normally adequate to meet existing needs, rarely dropping below minimum flow levels adopted in 1962. The 1983 minimum flow on the Middle Fork probably will not be met at times during late summer months. Minimum flow requirements on the North Fork John Day or on the John Day at Service Creek could trigger regulation.

Historic and current land use activities have altered the Middle Fork watershed. Mining, specifically dredging, has modified the stream channel and stream side vegetation. Timber harvest, road construction and livestock grazing contribute to the uneven distribution of subbasin discharge.

A storage reservoir which would help distribute subbasin discharge to low flow periods is not economic by federal standards. The economic benefits of non-structural, or a series of small scale structural improvements, have not been quantified.

SECTION VIII

NORTH FORK SUBBASIN

A. LOCATION AND DESCRIPTION

The North Fork Subbasin (see Figure 32) encompasses an area of about 1,800 square miles in Wheeler, Morrow, Umatilla, and Grant Counties. The North Fork John Day River flows westward from the Blue Mountains for over 100 miles before entering the John Day River at Kimberly (river mile 184.2). Subbasin elevations range from about 1,900 feet near the mouth to over 8,000 feet in the Blue Mountains. Incorporated cities within the subbasin are Monument, Ukiah, and Granite. The major transportation route is the north and south Highway 395. Highway 244, connecting Ukiah and LaGrande, intersects Highway 395 at Ukiah. Major local roads run between Kimberly and Monument eventually intersecting Highway 395 at Long Creek. Granite, in the headwaters of the North Fork, is an isolated community with difficult road access.

North Fork John Day River near the mouth of Potamus Creek.

1. CLIMATE

The climate varies from semi-arid conditions near the mouth of the North Fork to relatively moist conditions at higher elevations. Monument, located near the mouth at an elevation of 1,995 feet averages slightly more than 13 inches of precipitation annually. Ukiah, at 3,335 feet, averages almost 18 inches annually. Precipitation, occurring mostly as snow, can exceed 40 inches annually at high elevations in the Blue Mountains.

Temperatures follow the general regional pattern. Lower average annual temperatures occur at higher elevations. Monument averages 50° F with January being the coldest month at 32° Fahrenheit and July the hottest at 70° Fahrenheit. Ukiah averages only 44° Fahrenheit annually. January is the coldest month averaging 24° Fahrenheit and August is the warmest month at 60° Fahrenheit.

2. LAND OWNERSHIP

The federal government manages most of the land in the North Fork Subbasin (see Figure 33). Private lands tend to be concentrated at lower elevations and at intermediate upland elevations. Patented mining claims form small private enclaves within the boundaries of federally managed land. State owned lands are minimal.

3. LAND COVER AND LAND USE

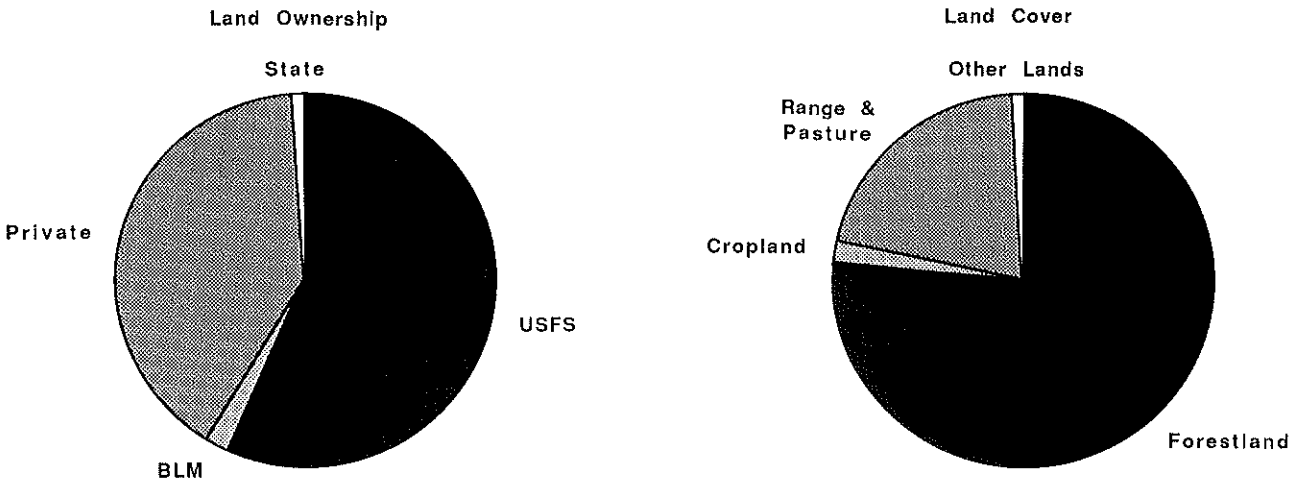
Forestland comprises nearly 77 percent of the subbasin area, and range and pasture accounts for another 20 percent (see Figure 33). Cropland comprises slightly more than one percent of the subbasin.

Although some forestland is in private ownership, most falls under the management of the Umatilla and Wallow-Whitman National Forests, and includes most of the subbasin headwater areas.

According to the SCS, the area of range immediately below the timber zone generally is in fair to good ecological condition. The intermediate zone generally is in poor to fair ecological condition with the lowest elevation areas in poor ecological condition. As ecological condition declines the relative density of annual grasses, sagebrush and junipers increases. The better the ecological condition, the more the vegetation consists of a mix of perennial grasses. The present ecological condition in the North Fork Subbasin is a result of historic use patterns by both domestic livestock and wildlife. In recent years, ecological condition has been improving slowly.

Figure 33

NORTH FORK SUBBASIN
LAND OWNERSHIP AND LAND COVER



Roughly 95 percent of the subbasin (1,127,300 acres) is used for livestock grazing. The forest zone provides about 78 percent of the land area used for grazing (see Table 50). The Umatilla National Forest manages 33 cattle and sheep allotments in the North Fork Subbasin. Over 200,000 acres (43 percent) of the nearly 500,000 acres of potential grazing land is not included in the allotment system. A summary of range conditions on Umatilla National Forest range allotments is as follows:

Condition	Acres
Very Poor	452
Poor	71,005
Fair	190,789
Good	20,194
Excellent	2,605

The Wallowa-Whitman National Forest manages three range allotments for a total of 3,880 AUMs. Range condition is fair to good. Forage conditions in timber zones is slightly better than in the meadows. Beaver Meadows northeast of Greenhorn provides 1,000 AUM's for two months and is rested one out of every four years.

The Wheeler, Grant, Jefferson, Crook and Monument Soil and Water Conservation Districts have established a four county range emphasis area. The purpose of the emphasis area is to identify critical resource problem areas and undertake

action to resolve those problems. Priorities within each district have been established by their respective Boards of Directors.

On Deer Creek, BPA riparian improvement funds were used to fence and establish a riparian grazing system. The effects of grazing on vegetation has been monitored toward establishing a baseline of shrub and grass response to short period, high intensity grazing. The baseline data is being analyzed.

Table 50

NORTH FORK SUBBASIN LANDCOVER (acres)

Type	Acres
Forestland (grazed)	887,000
Forestland (not grazed)	19,200
Range and Pasturelands	240,300
Cropland	23,850
Other	11,800
	1,182,150

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

Cottonwood Creek was chosen as a program site because of its degraded condition and the presence of heavy, erodable, shrink/swell clays which contribute heavy sediment loads to the North Fork. A nursery has been planted on similar soil types in order to learn which plant species establish themselves best in these heavy clay soils. The most adaptable and beneficial species then can be used to rehabilitate other similar sites. Riparian fencing was prescribed in order to exclude all grazing for five years to be followed by controlled winter grazing thereafter.

Urban/residential use is a very small percentage of the subbasin land area. Monument, Ukiah, and Granite are the only incorporated cities in the subbasin. Granite has no land use plan. Population data are in Table 51.

The North Fork Subbasin contains a number of special management areas. The 122,000 acre North Fork John Day Wilderness was created as part of the Oregon Wilderness Act of 1984. It actually is four separate units representing nearly all the remaining National Forest roadless areas in the North Fork drainage. The wilderness was established in part to prevent further changes in the watershed which could adversely affect anadromous fish runs.

Table 51

NORTH FORK SUBBASIN
POPULATION AND LAND USE DATA

City	Population			Land Use		Water System			
	1980 Census	1983 PSU	Projected	Acres City	Acres UGB	Pumping Capacity	Use	Storage	Source
Monument	192	190	291	361	181	-	-	100,000 gallons	Ground-water
Ukiah	249	275	380	154	202	700,000 gpd	80,000 gpd	-	Ground-water
Granite	17	-	-	-	-	-	-	-	-

Source: Department of Land Conservation and Development, 1985.

The North Fork John Day River was inventoried for inclusion in the federal Wild and Scenic Rivers system. Over 24 miles within the North Fork Wilderness are being considered for Wild River status, 10.5 miles for inclusion as a Scenic River, and 3.9 as a Recreational River.

The Vinegar Hill - Indian Rock Scenic Area was established on the Umatilla and Malheur National Forests in 1966. The area was expanded to 29,285 acres and renamed the Greenhorn Mountains Scenic Area. It is managed to maintain its scenic qualities. The 20 square mile Bridge Creek Wildlife Management Area north of Dale along Camas Creek is managed by ODFW.

B. RESOURCES

1. AGRICULTURE

Agriculture is fairly evenly divided between irrigated and non-irrigated farming. The major crops (based on acreages) are grain hay and pasture. The second most dominant crop is irrigated meadow hay. Irrigated agriculture is confined largely to the North Fork bottom land and benchlands between Kimberly and Monument. Scattered land parcels are irrigated along Rudio Creek, Cupper Creek, and Cottonwood and Fox Creeks. The majority of non-irrigated acreage (see Table 52) is located in Fox Valley.

Favorable growing conditions have led to a significant amount of the farmland between Kimberly and Monument being placed in higher value orchard and mint production. However, alfalfa still is the predominant crop. Essentially all the irrigation between Kimberly and Monument is by sprinkler systems.

Table 52

NORTH FORK SUBBASIN CROP TYPES
(acres)

Type	Acres
Irrigated	
Alfalfa hay	3,660
Meadow hay	5,500
Hay and pasture	1,500
Corn	40
Orchards	250
Mint	500
	11,450
Non-Irrigated	
Grain hay and pasture	7,200
Pasture and grass hay	4,600
Grain and summer fallow	600
	12,400

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

2. FOREST RESOURCES

Between 1976 and 1985 about 530 million board feet of timber were harvested from 127,000 acres of National Forestland in the subbasin. About 6,200 acres of land were reforested on the Umatilla National Forest.

The 1985-1989 Umatilla National Forest timber sale plan calls for timber to be harvested from 5,675 acres using shelterwood techniques and 6,410 acres by clearcutting. The vast majority of timber would be removed by tractor logging with a small percentage removed through skyline logging. The Wallowa-Whitman National Forest projects its planned timber sales for the next ten years will affect 4,540 acres of land within the subbasin.

The forest transportation network is extensive. Currently, the Wallowa-Whitman National Forest transportation system contains 325 miles of roads; 231 miles of which are local roads. Road closures exist for 78 miles of road, and an additional 230 miles of mostly local roads are to be closed to travel. Only 24 miles of road construction is planned, most in association with proposed timber sales. Under the Umatilla National Forest's timber sale plan, 139 miles of new road construction would be added to the existing system and 155 miles of road would be rebuilt.

3. ENERGY AND MINERALS

a) Energy

A Federal Energy Regulatory Commission (FERC) application has been submitted for hydroelectric development at the site of the Fremont Powerhouse near Olive Lake. The powerhouse is on the National Register of Historic Places. The proposed project would divert 20 cfs from Lost and Lake Creeks downstream of Olive Lake. The water would be conveyed through an existing woodstave and steel pipeline for 5.5 miles to the existing powerhouse, which will be refurbished, located on Congo Gulch in the Clear Creek drainage. The project is designed as a year round, run-of-river facility which would produce about 2.5 megawatts. Project flows would range from 1.5 cfs in low streamflow months of August, September and October to 20 cfs in May and June.

The hydroelectric license application for the project received the approval of the Water Resources Commission. However, issuance of a license is conditioned upon receiving a special use permit from the U.S. Forest Service, ODFW approval, and maintaining at least 0.5 cfs of instream flow in Lost and Lake Creeks below the diversions.

The U.S. Forest Service has not issued a special use permit. Lost and Lake Creeks originate on and flow through a unit of the North Fork John Day Wilderness. A recent judicial decision in Colorado declared waters arising in wilderness areas are subject to the federal reserved rights doctrine. The reservation of water dates from the establishment of a wilderness area, in this case 1984, but does not interfere with preexisting water rights. Until the decision is clarified, the U.S. Forest Service will not issue a special use permit for the project.

Besides hydroelectric potential, the North Fork Subbasin contains a number of low temperature geothermal energy resources at Lehman Hot Springs (61° C) and Hidaway Springs (38°C) which provides limited potential for space heating, but not for power generation.

b) Minerals

Mining historically has been an important economic activity in the subbasin. Gold continues to be mined from placer and small bedrock mines near the head of the North Fork. Exploration activities continue and focus mainly on previously known gold and silver deposits on Granite Creek and the headwaters of the North Fork. (See Tables 53 and 54.)

Table 53

NORTH FORK SUBBASIN
PLACER AREAS

Stream	Area	Comments
North Fork	From Dale upstream to Thornburg Placer	Small operations at current or reduced levels*.
Granite Creek	From mouth upstream	Medium-size operation on Boulder Creek at current or increased level.
Clear Creek	From mouth upstream	Small operations at current or reduced levels*.

* Reduced activity possible as result of inclusion within North Fork Wilderness.

Source: Department of Geology and Mineral Industries, 1985.

Table 54

NORTH FORK SUBBASIN
LODE MINES

Name	Drainage	Production Status	Tons/day	Mineral
Elk Haven	North Fork	Active	Small	Gold/Silver
Ibex	Granite Creek	Explore	300-500	Gold/Silver
Buffalo	Granite Creek	Inactive	30-50	Gold/Silver
Cougar-Ind.	Granite Creek	Inactive	30-50	Gold/Silver
Pyx	Clear Creek	Active	Small	Gold/Silver

Source: Department of Geology and Mineral Industries, 1985.

3. FISH RESOURCES

The North Fork Subbasin is the major producer of wild spring chinook and summer steelhead in the John Day Basin. Approximately 58 percent of the total basin spring chinook population and 43 percent of the total summer steelhead population are produced in this drainage. In recent years, as many as 1,855 adult spring chinook and 8,000 adult summer steelhead have returned annually to the subbasin to spawn. In addition, the North Fork John Day is the migratory route for runs traveling to and from the Middle Fork Subbasin. The North Fork drainage also supports warmwater and coldwater resident fish populations. Warmwater smallmouth bass and channel catfish reside in the North Fork below RM 22.6 and coldwater resident trout are found throughout the subbasin. It also supports healthy wildlife populations, including deer and elk herds which winter along the stream corridor.

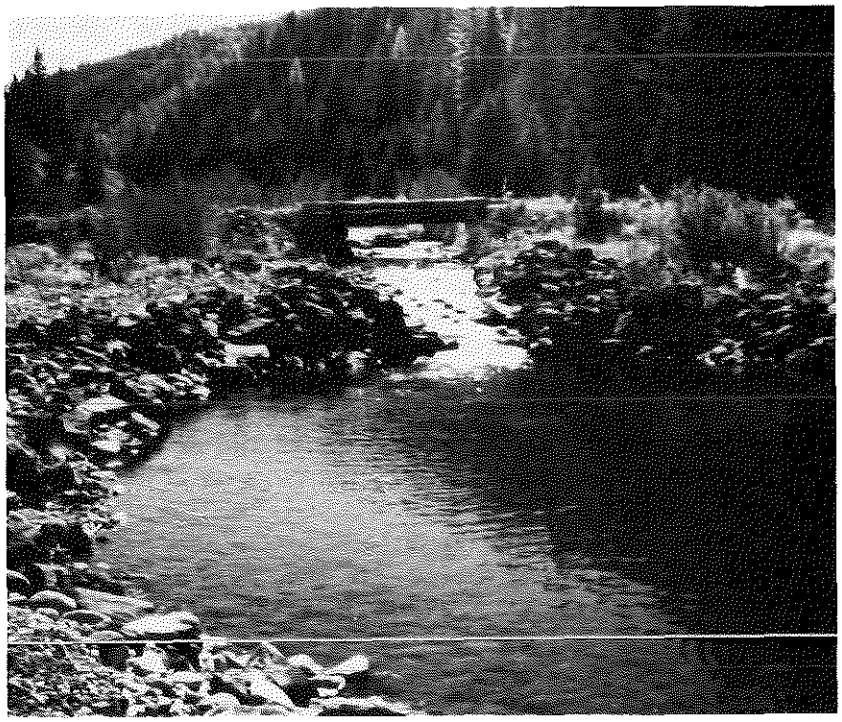
Steelhead, resident trout and smallmouth bass populations provide a substantial recreational fishery for anglers. Annually, about 10,000 recreation days are spent fishing for steelhead on the North Fork. Trout and bass fishing generate another 2,500 to 5,000 angler recreation days each year. The warmwater fishery is recovering from a species control program which accidentally destroyed game fish as well as the targeted undesireable species.

Streams in the middle and upper North Fork drainage generally have good channel structure, riparian and instream cover, and water quality and quantity. Consequently, the subbasin contains approximately 72 miles of spring chinook spawning and rearing habitat and 700 miles of steelhead habitat. Spring chinook habitat lies between Camas and Baldy Creeks on the North Fork, and in the Granite Creek system. Per mile, Granite Creek produces more spring chinook than any other area in the John Day Basin. Located in the North Fork headwaters, this system which includes Clear and Bull Run Creeks, produces 42 percent of the total John Day spring chinook population. Major steelhead producing streams in the North Fork Subbasin are Cottonwood, Rudio, Deer, Wall, Potamus, Desolation, Granite, Ditch, Mallory, Trout, Meadow Brook, Trail, Olive, Clear, Bull Run, Camas, Beaver and Big Creeks.

Recently, spring chinook and steelhead production has decreased in the North Fork Subbasin. Increased logging, road building and poaching activities in the forested uplands probably have contributed to the declining populations. Between 1969 and 1973, biologists counted an annual average of 32 spring chinook redds (spawning beds) per mile in the system. Counts for the last five years, 1981 to 1985, show spawning density decreased to an average level of 10 redds per mile. Summer steelhead production also has declined slightly. Declines in spring chinook production are primarily attributable to dam mortality. The degradation of spawning and rearing habitat has also had a major impact. High summer water temperatures limit juvenile spring chinook distribution.

In the Granite Creek system, past mining operations have left their imprint. Water quality continues to be affected by leaking and leaching of toxic effluent from inactive mines. Some historically productive spawning and rearing habitat remains degraded from dredging which took place in the 1930s. ODFW has attempted to restore spawning conditions by opening blocked passage and providing additional spawning gravels.

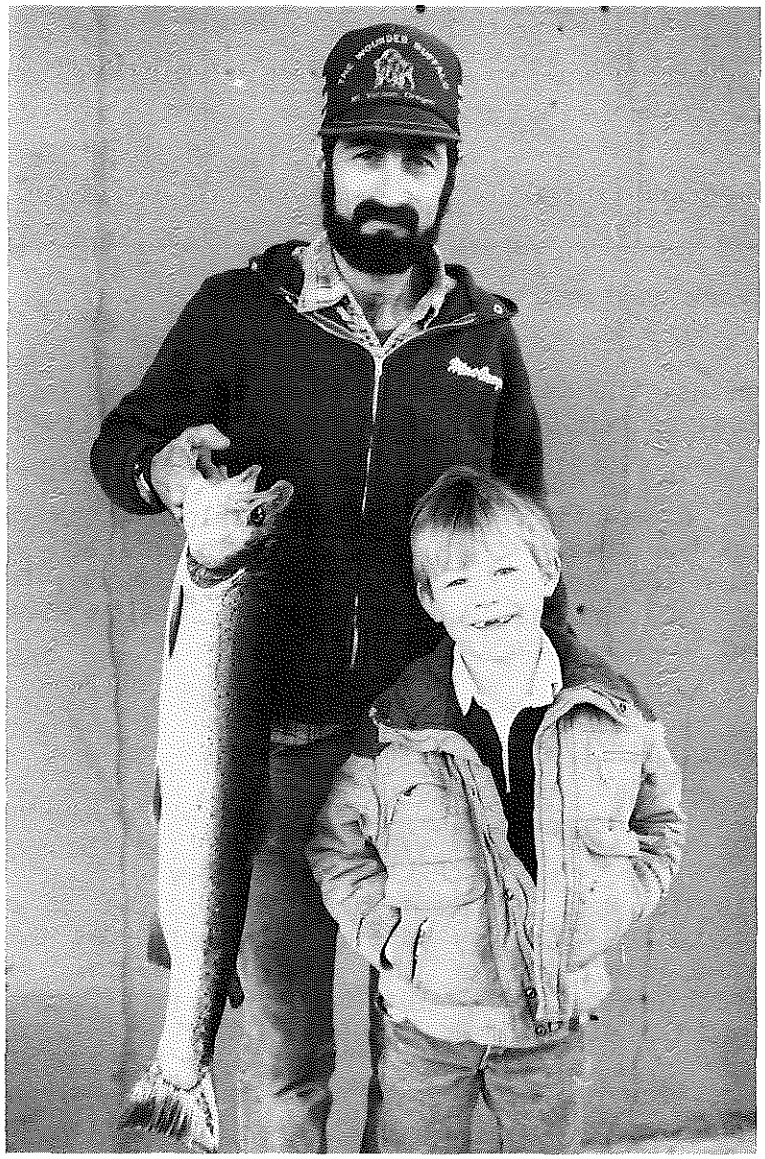
The North Fork Subbasin has been identified as a high priority area for habitat restoration work. To date, BPA, USFS, BLM, and ODFW have invested $1,443,000 on riparian and instream improvement in the drainage, primarily as part of the NWPPC fish and wildlife program. In 1987, projects will be implemented to improve riparian and instream conditions on 25 stream miles. During the following five years, additional improvements will be implemented on 16 stream miles. Additional investments are projected for the North Fork Subbasin in the next five years. As part of this investment, additional habitat improvements will be undertaken on the mainstem, on Desolation Creek and in the Granite Creek system to eliminate passage problems and increase smolt production, particularly for spring chinook.



This resting pool on Clear Creek, a tributary of Granite Creek, was constructed for migrating chinook salmon.

4. RECREATION AND TOURISM

There are numerous USFS campgrounds scattered throughout the North Fork Subbasin as well as one state and a few BLM campgrounds. National Forest multiple use lands and wilderness areas provide good opportunities for dispersed recreation. North Fork Subbasin recreation facilities are listed in Table 55. The subbasin is the most heavily fished for steelhead with around 10,000 angler days annually. Considering the remoteness of the area, the North Fork and its tributaries is a very popular trout fishing drainage receiving approximately 16,000 angler days per year. The peak for both types of fishing occurs in the spring with another peak for trout fishing in early fall.



Steelhead, such as this one caught near Kimberly, are an important recreational resource.

Table 55

NORTH FORK SUBBASIN
RECREATIONAL FACILITIES

Ownership	No. of Sites	Acres	Campsites	Picnic sites	Boat Ramps
City	1	2	3	3	
County					
State	1	2986	25		2
BLM	2	80	8	4	1
USFS	23	142	70	106	3
NPS					
Private	1	476	344		
TOTALS	28	3686	450	113	6

Source: Oregon Parks and Recreation Division, 1985.

Of all the subbasins, the North Fork is the most heavily hunted for elk. The subbasin also receives considerable hunting pressure for deer and bear during the fall seasons.

Boating in rafts, canoes and kayaks between Dale and Monument occurs to a limited extent on the lower North Fork in the spring and early summer when flows are between 500 and 800 cfs. The entire North Fork John Day is recognized in the 1980 National Park Services Nationwide River Inventory as a potential National Wild and Scenic River.

C. WATER RESOURCES

1. SURFACE WATER

The North Fork is the most important subbasin in terms of water quality and flow contribution to the John Day River. It contributes over 60 percent of the average annual discharge of the John Day Basin. Major North Fork tributaries are Cottonwood, Fox, Big Wall, Potamus, Camas, Desolation and Granite Creeks, and the Middle Fork John Day River.

The North Fork has been gaged at Monument since 1925, and was gaged upstream near Dale from 1929 to 1958. Additional gaged tributaries include Camas, Fox and Desolation Creeks. Average annual discharge at Monument is 904,200 acre-feet. Peak discharge occurs between March and early June, and lowest

flows generally are during July, August, and September (see Appendix D). Records indicate flows can get below 10 cfs on North Fork tributaries, but only Fox Creek experiences periods of no flow.

National Forestlands are important watershed features. Forest canopy, soils, slope, elevation and land use help determine how much water is produced in the subbasin. Gaging stations located in the upper watershed, largely surrounded by Forest Service managed lands, provide a good indication of water yield from the National Forests. The average annual water yield for the subbasin above Monument is 359 acre-feet per square mile. The estimated water yield from National Forestland, calculated from stream gage records and drainage area, is depicted in Table 56. Average annual water yield is considerably greater in the upland forest areas than for the entire subbasin.

Table 56

ESTIMATED WATER YIELD FROM NATIONAL FOREST LAND
(acre-feet per square mile)

Gage Station	Annual Average	Low Flow	Peak Runoff
North Fork at Dale	557	8.1	200
Desolation Creek	677	8.3	240
Camas Creek at Lehman	517	1.4	163
Camas Creek at Ukiah	574	2.5	166

2. GROUND WATER

Outside of the Kimberly to Monument corridor, the ground water resources of the sparsely populated North Fork Subbasin are poorly defined because there are few wells from which to acquire data. The subbasin geology is composed of five primary formations: Columbia River Basalts, Clarno, John Day, Quarternary Alluvium, and pre-Tertiary rock.

The Columbia River Basalt Group is the most extensive and hydrologically important formation in the North Fork Subbasin. The basalt flows generally are uniform, and interbeds are not common. However, in a departure from the norm, the uppermost flows are interbedded with the Mascall Formation in Fox Basin. The Columbia River Basalt will supply adequate water for domestic and stockwatering purposes at reasonable depths in most places, and can supply large quantities of water suitable for municipal or irrigation use in some locations.

The Clarno Formation is found in the upper reaches of the drainage near Granite. Obtaining adequate well yields for domestic or stock use is difficult in many cases. Regardless of its low ground water potential, the Clarno Formation serves as the source of water for a number of residences. The best prospects for ground water production are fractured crystalline rock, such as lava flows or domes within the unit.

The John Day Formation occurs beneath the Columbia River Basalt throughout portions of the subbasin. Isolated units within the formation may have relatively good permeability and storage potential locally, but rock with low permeability greatly restricts recharge potential. Most of the water well reports are from wells located near the river and many may be recharging directly from the river. Yields from these wells range from 0.5 to 100 gpm with most well yields being from 5 to 30 gpm.

Quaternary Alluvium deposited in the North Fork stream bottom between Kimberly and Monument is one of the most important basin aquifer units. Alluvium typically consists of unconsolidated, interbedded gravel, sand, and silt. The deposits also have a high potential for recharge from surface streams. Wells yield from 3 to 193 gpm.

The pre-Tertiary rocks are found in the upper reaches of the North Fork and largely consist of complexly folded and variably metamorphosed fine grained marine sediments and volcanics. Very little well data are available from these rocks. The pre-tertiary rocks are not considered to be hydrologically important.

3. WATER QUALITY

The North Fork Subbasin has the best chemical, physical, and biological water quality in the John Day Basin. Water quality problems occur in localized areas. Elevated water temperatures occur during low flows and sedimentation and erosion occur during high flows. The additional problem of toxic mine effluent leaching into Granite Creek is a localized problem. The problem is being addressed by ODFW, USFS, and BPA in a fish habitat restoration project.

Camas Creek above Ukiah exhibits continually high nitrate levels regardless of the time of year. The source is unknown.

According to DEQ, the lower North Fork tributaries of Rudio, Fox, upper Big Wall, and Cottonwood Creeks have periodic water quality problems in various stream segments. The elevated temperatures, low dissolved oxygen, low flows, siltation, bank erosion, and debris accumulation in these streams can be partially attributed to grazing, channelization, logging practices, road construction, and irrigation withdrawals. Overall, the North Fork and its upper tributaries of Camas, Granite, and Clear Creeks have moderate problems, and the remainder of the subbasin's streams are in good condition.

Water quality is adequate for most beneficial uses. Elevated water temperatures and the sediment problems, however, threaten or impair use by cold water fish (see Appendix F).

Monument has no municipal sewage treatment facility and is serviced by individual septic systems. The Ukiah and Dale sewage treatment facilities are well-maintained and-operated. (See Table 57)

Ground water quality is unknown in this subbasin due to the lack of water quality data. The landfill at Monument currently has no impact on surface or ground water.

Table 57

NORTH FORK SUBBASIN
SEWAGE TREATMENT PLANTS

Source	Type of Facility	Year Built	Design Population	Connected Population	Design Flow (MGD)	Connected Flow (MGD)	Current Raw Waste (#POD) Load (Day)	Current Treated Waste (#POD) Load (Day)	Current Permitted Waste (#POD) Load (Day)
Ukiah	Lagoon	1978	600	270	0.065	0.03	50	No Discharge	No discharge, irrigation in Pine Creek drainage basin.
U.S. Forest Service (Dale Ranger Station	Lagoon	1981	250	150	0.025	0.015	30	No Discharge	No discharge, irrigation adjacent to lagoons in Desolation Creek drainage.

Source: Department of Environmental Quality, 1985.

D. WATER USE AND CONTROL

1. WATER RIGHTS

Irrigation and mining dominate water use in the subbasin (see Table 58). The major water use in the subbasin occurs along the North Fork from just above Monument to the mouth. Irrigation in the subbasin is almost totally by sprinkler systems. Nearly 17,800 acre-feet of water are required for the

crops grown in the basin (see Figure 34). Regulation is infrequent, but has been required on occasion to meet the 1962 minimum flow on the mainstem at Service Creek. The North Fork John Day dropped below minimum flow levels in 1966, 1973, and 1977.

Water is diverted out of the basin from Ditch Creek and Five Mile Creek for irrigation and municipal use in the Umatilla Basin. The Sayler-Madison Ditch conveys 17.95 cfs of water from Five Mile Creek for irrigation use in the Buttercreek area. Approximately 1,200 to 1,300 acre-feet has been diverted annually. Seven to ten cfs is conveyed via the Smith Ditch from Ditch Creek into the Umatilla Basin during the irrigation season. The Pete Mann Ditch conveys water from the headwaters of Clear Creek to the North Fork Burnt River in the Powder River Basin. A water right of 22 cfs allows diversion for irrigation and mining. Current diversions primarily are for irrigation.

Table 56

NORTH FORK SUBBASIN WATER RIGHTS
(cfs)

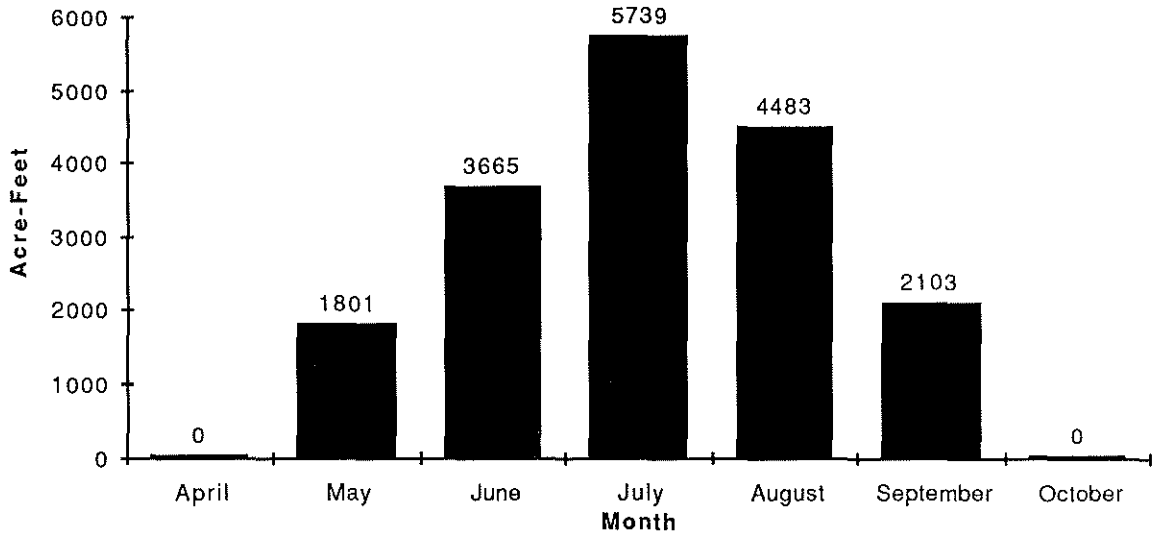
SUBBASIN or REACH	Irrigation[1]	Livestock	Mining	Power	Indust./ Munic.	Fish and Wildlife	Residential	Storage[2]	Other[3]	Total
On North Fork (mainstem)	76.4	*	10.0		1.7		2.1	175.3		90.2
Cottonwood/Fox Cr.	129.2	0.5	3.5				0.5	1.0		133.7
Big Wall Cr.	15.2	*				2.0	0.1	32.9		17.3
Camas Cr.	23.5	0.7			3.8		*	69.1		28.0
Snipe Cr.	4.2	0.2						7.5		4.4
Desolation Cr.	0.1						*			0.1
Granite Cr. (ex. Clear Cr.)	1.7		9.4		3.0		0.2			14.3
Clear Cr.			144.3		1.0		*			145.3
Remainder of subbasin	41.2	0.3	35.0	25.0	0.2		0.4	1612.3	0.7	102.6
TOTAL	291.5 (145.8)[4]	1.7	202.2	25.0	9.7	2.0	3.2	1898.1	0.7	536.0

1. Rate for irrigation season.
2. Figures in acre-feet; not included in grand total.
3. Rights in database with uncoded uses.
4. Rate adjusted for entire year.
* Less than 0.05 cfs.

Ground water use in the subbasin is low and is principally for domestic purposes. The ground water supply appears adequate for domestic use. The formations generally yield water slowly and large quantities are not commonly available. A number of permitted and domestic wells are in alluvium and are hydrologically connected to the river.

Figure 34

NORTH FORK SUBBASIN
ESTIMATED IRRIGATION WATER REQUIREMENTS



2. WATER USE RESTRICTIONS

a) Statutory

The Morrow County Court has the authority to divert and store the waters of Ditch Creek for irrigation purposes. ORS 538.010 states that water diverted from Ditch Creek into the Umatilla Basin is regulated as if it were Willow Creek water.

b) Administrative

1) Withdrawals

On December 31, 1915, the State Engineer withdrew from appropriation 2,000 cfs of John Day River and tributary water, including the North Fork John Day River, for the proposed John Day Project. This withdrawal has not been modified or revoked. If the project is constructed, subsequent junior water rights would be subject to regulation according to this priority.

2) Minimum Perennial Streamflows

In 1962, two minimum streamflow points were established on the North Fork John Day River at Monument and Dale to protect instream water uses. The set flows were 55 and 30 cfs respectively. In 1985, the Water Resources Commission approved an additional minimum streamflow on Granite Creek from Clear Creek to the mouth with a priority date of November 3, 1983. These minimum streamflows are regulated essentially the same as water rights -- according to priority.

3) Hydroelectric Standards

Administrative rules governing hydroelectric applications generally prohibit development of hydroelectric projects on the North Fork John Day River. Furthermore, state hydroelectric standards place stringent requirements on projects which are on streams supporting anadromous fish, wild game fish, or important recreational opportunities.

4) Classification

The use of subbasin streams is limited to domestic, livestock, municipal, irrigation, power development, industrial, mining, recreation, fish and wildlife beneficial water uses. The beneficial use of natural lakes is limited to domestic, livestock, lawn and garden irrigation, power development of no more than 7 1/2 theoretical horsepower, recreation, fish and wildlife.

3. STORAGE

The Corps of Engineers and Bureau of Reclamation have identified 24 potential major reservoir sites within the subbasin. Eight are located on the North Fork mainstem (see Table 59) and would interfere with anadromous fish migration and spawning. None of the 24 sites have met economic and environmental criteria in use at the time of the feasibility studies.

There are 199 permitted reservoirs capable of storing 1,433 acre-feet of water, but only four permits are for greater than 50 acre-feet of storage. Almost 95 percent are for livestock and/or wildlife uses, mostly located in U.S. Forest Service lands, and have 1980 or later priority dates.

Table 59

IDENTIFIED RESERVOIR SITES IN THE NORTH FORK SUBBASIN

Site Name	Stream Name	River Mile	Potential Storage (acre-feet)	Drainage Area (sq. mi.)
Lower Monument	N. Fk. John Day R.	14.7	6,8000	2,520
Upper Monument	N. Fk. John Day R.	22.0	236,000	2,220
Two Mile Can	N. Fk. John Day R.	30.0	N/A	N/A
Dale	N. Fk. John Day R.	62.4	152,000	415
Granite Creek	N. Fk. John Day R.	86.9	N/A	N/A
Thornburg	N. Fk. John Day R.	94.4	N/A	90
Trail	N. Fk. John Day R.	100.5	9,100	56
Baldy	N. Fk. John Day R.	103.8	7,000	29
Bird	Cottonwood Creek	3.9	700	N/A
Canyon	Cottonwood Creek	4.7	15,000	205
Canyon	Cottonwood Creek	5.2	N/A	N/A
Big Wall Creek	Big Wall Creek	10.7	6,900	67
Swale Creek	Swale Creek	7.4	N/A	19
Lower Camas Creek	Camas Creek	10.4	24,000	318
Camas Creek	Camas Creek	17.5	12,390	105
Mud Creek	Camas Creek	19.2	31,000	121
Nelson Meadows	Camas Creek	26.1	24,100	59
Snipe	Snipe Creek	3.2	8,500	32
Howard Meadows	E. Fk. Meadowbrook	0.7	3,900	28
Lost Lake	Desolation Creek	1.0	N/A	2
Starveout	Desolation Creek	10.7	5,300	67
Forks	Meadow Creek	3.0	6,200	28
Trout Meadows	Trout Creek	2.3	6,400	13
Fox	Fox Creek	3.8	11,000	99

N/A = not available

E. PROBLEMS

The major problems of the North Fork Subbasin are high volumes of runoff, low summer streamflows, and localized degraded water quality. Seasonal streamflow is unevenly distributed throughout the year.

Large volumes of runoff erode streambanks and soil and increase stream sediment loads. Severe streambank erosion is a problem on some of the major streams in the subbasin. The force of high flow is responsible for the loss of streamside agricultural lands. Upland soil erosion during runoff is severe in some drainages. Although erosion is a natural process in some parts of the subbasin, it also can be attributed to watershed conditions. Stream sedimentation and turbidity, often the result of erosion, degrade fish habitat and affect other water uses.

Ice scouring of streambanks is a problem on the lower North Fork. It contributes to denuded riparian zones and streambank instability. Land use practices and watershed conditions may lead to ice scouring.

The North Fork Subbasin is the most important subbasin for anadromous fish production in the John Day system. The river between Monument and Kimberly, a highly productive agricultural area, is primarily a migratory corridor for anadromous fish. Conflicts between out-of-stream and instream waters uses are greatest during low flow periods, especially in dry years. For example, in 1973 and 1977 some out-of-stream water use was restricted in order to meet minimum flows.

Low summer flows, out-of-stream diversions, and poor riparian vegetation cause high water temperatures in some stream reaches. Elevated stream temperatures and low dissolved oxygen levels, coupled with sediment effects on fish habitat, hinder anadromous and game fish production and growth.

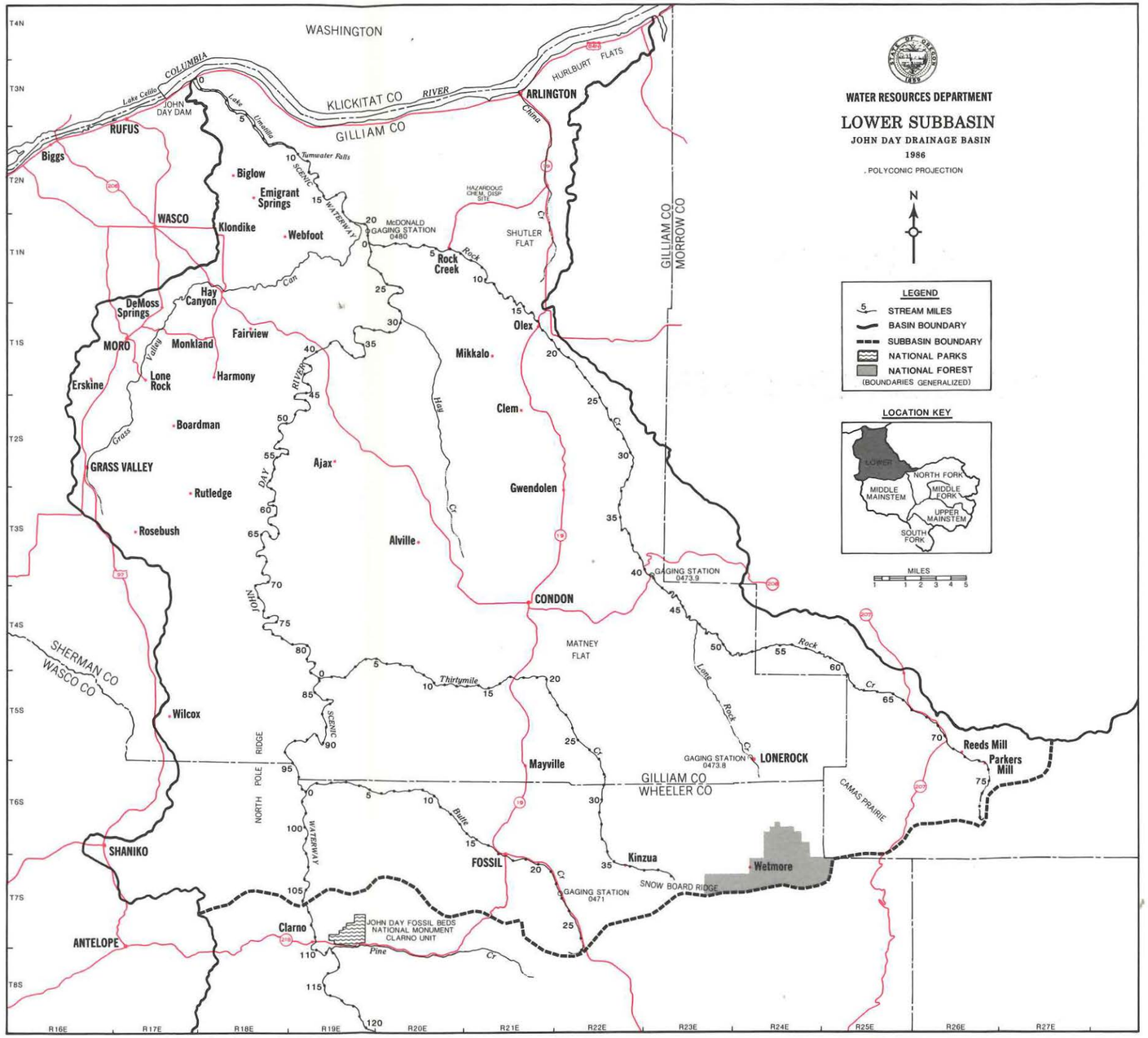
Site specific water quality problems exist on Granite Creek and Camas Creek. Localized toxic mine effluent continues to be a concern on Granite Creek, especially as it affects anadromous fish production. Camas Creek exhibits high nitrate levels throughout the year. This could indicate potential ground water problems. Shallow domestic wells could experience similar nitrate levels. However, no data currently suggest this is the case.

Section IX

LOWER SUBBASIN

Figure 35

MAP OF THE LOWER SUBBASIN



SECTION IX

LOWER SUBBASIN

A. LOCATION AND DESCRIPTION

The Lower Subbasin (see Figure 35) drains an area of about 2,030 square miles below Clarno and is located in Wheeler, Gilliam, Sherman, Morrow, and Wasco Counties. It is an area which is physiographically different from the upstream subbasins. The subbasin generally lacks the mountainous terrain and elevations which accumulate significant snowpack. Elevations range from about 200 feet at the mouth of the John Day River, to over 5,700 feet south of Heppner. The Lower Subbasin is a nearly level to rolling, loess covered plateau of Columbia River Basalt which is deeply dissected by the John Day River and its tributaries. Unlike the rest of the basin, it is a major dryland farming area and includes some large scale irrigation, using ground water.

The Lower Subbasin has a well developed transportation network. Interstate 84 and a rail line in the extreme north parallel the Columbia River. State routes 19, 206, and 218 connect subbasin communities such as Fossil, Condon, and Arlington. The Columbia River provides the Port of Arlington with a transportation route to the Pacific.

Small streams, such as Rock Creek, are important water sources in the dry Lower Subbasin.

1. CLIMATE

The climate is semiarid. Precipitation is low and the subbasin exhibits small daily ranges in both summer and winter temperatures. The length and character of summer and winter extremes are influenced by the rain shadow effect of the Cascade Mountains, and the wind tunnel effect of the Columbia River Gorge.

Precipitation ranges from slightly more than 9 inches annually at Arlington and 13 inches at Condon, to about 40 inches in the mountains. Annual average temperatures are 54° F at Arlington and 48° F at Condon.

2. LAND OWNERSHIP

Like the Middle Mainstem Subbasin, the predominance of private land ownership sets the Lower Subbasin apart from the other subbasins. Federal ownership (mostly BLM) accounts for only about 11 percent of the land area (see Figure 36). BLM-managed lands are concentrated along the John Day River canyon, and in Hay and Thirtymile Creeks. About 40 square miles of Umatilla National Forest lands are located in the uplands around Kinzua in Wheeler County. The Corps of Engineers manage a small amount of land near the mouth of the John Day River along the Columbia River.

The 100 miles of the John Day River between Clarno and Tumwater Falls are part of the designated State Scenic Waterway. The John Day River State Wildlife Refuge, from the mouth upriver for 84 miles to Thirtymile Creek, provides a resting area for ducks and geese and provides habitat for various raptor species and other wildlife.

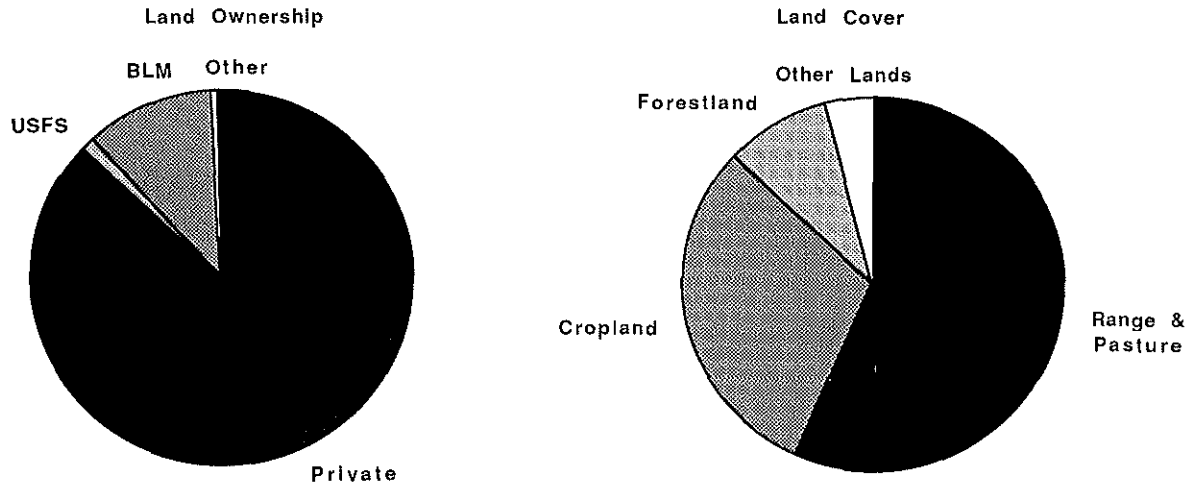
3. LAND COVER AND LAND USE

Rangeland comprises about 57 percent of the subbasin area (see Figure 36 and Table 60). Most range is in private ownership although there is extensive use made of public range allotments on BLM land. There are 636,765 acres of private rangeland in Wheeler County alone. According to the SCS, deteriorated range is a major resource problem in Wheeler County, with 80 percent of privately owned range in poor (222,868 acres) or fair (286,544 acres) condition. The BLM has rated the majority of the public range in the Lower Subbasin as fair to poor. The condition of private rangeland is similar. Only 20 percent of privately owned range is in good or excellent condition.

About 30 percent of the subbasin is cropland, but less than 1 percent of the subbasin is irrigated. Dryland wheat farming is practiced on over 350,000 acres of loessal plateau soil. Loess is a materail formed from deposits of wind-transported silt. Loessal soil can be eroded easily by both wind and water. Conservation tillage practices such as contour plowing, terracing, no-till, and crop residue management have been encouraged to minimize erosion. The practice of clean cultivation during the fallow year continues to contribute to erosion and sedimentation. Erosion hazard for these plateau soils range from slight to severe with annual soil losses ranging from 2.5 to 15 tons per acre.

Figure 36

LOWER SUBBASIN
LAND OWNERSHIP AND LAND COVER



Riparian areas make up less than 1 percent of subbasin area, yet are often the most heavily used for recreation, grazing, agriculture, and wildlife habitat. A riparian inventory conducted on public land by the BLM in 1981 indicates that most areas under its management are in stable condition. Only a small fraction of riparian areas are deteriorating.

Table 60

LOWER SUBBASIN LANDCOVER
(acres)

Type	Acres
Range and Pasturelands	758,911
Forestland (grazed)	116,600
Forestland (not grazed)	0
Cropland	405,740
Other	54,400
	1,335,651

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

Although the amount of urban area is small, the subbasin contains the basin's largest concentration of population outside of the upper basin. The towns in the subbasin are: Arlington, Lonerock, Moro, Grass Valley, Shaniko, Condon, and Fossil. Pertinent urban information for each town is in Table 61.

The subbasin also contains the Chem-Security System site, one of the few licensed hazardous waste disposal sites in the Pacific Northwest. It is located southwest of Arlington near Alkali Canyon. A number of kinds of non-radioactive wastes are accepted for disposal at the site. These include acidic and caustic substances, heavy metals, and solid PCB's. Solid wastes are placed in a landfill. Liquid wastes are placed in plastic-lined ponds. Ground water quality is monitored at 39 wells around the facility. There has been no evidence of ground water contamination during the ten years of operation of the disposal site.

Table 61

LOWER SUBBASIN
POPULATION AND URBAN LAND USE DATA

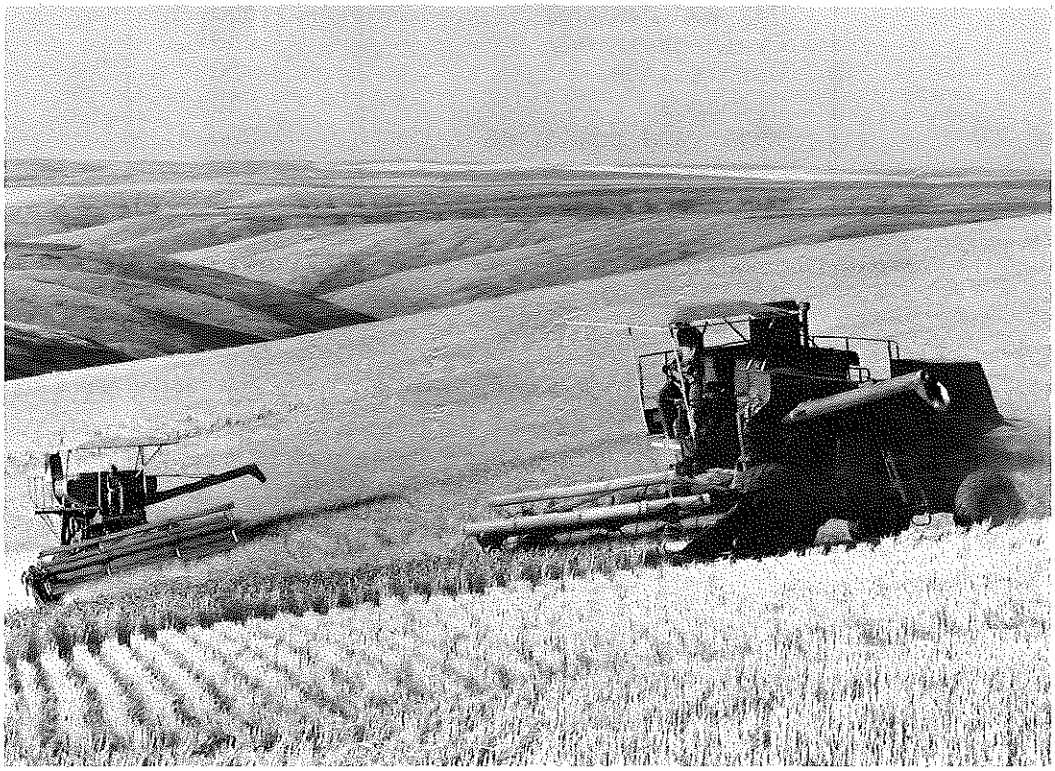
	Population			Land Use		Water Use			
	Census 1980	PSU 1983	Projected 2000	City Acres	UGB Acres	Source	Pump Capacity	Current Use	Additional Capacity Needed
Arlington	521	450	1250	225	-	Ground water Surface	1,500,000 gal/day	-	-
Moro	335	320	300	610	-	Ground water	180,000 gal/day	-	-
Grass Valley	170	175	-	330	-	Ground water	-	-	-
Shaniko	30	25	-	-	-	Surface	-	-	-
Lonerock	26	25	-	640	-	Surface	-	-	-
Condon	780	725	-	-	-	Ground water	345,000 gal/day	-	-
Fossil	535	490	503	420	-	Ground water Surface	350 gal/min	39 gal/min	-

Source: Department of Land Conservation and Development, 1985.

B. RESOURCES

1. AGRICULTURE

About 90 percent of the agricultural land in the Lower Subbasin is devoted to dryland grain (winter wheat and spring barley) production on the loess covered plateau (see Table 62). Irrigated land is located along the mainstem John Day River above Butte Creek, upper Butte Creek, Rock Creek and its tributaries, Hay Canyon Creek, and Grass Valley. There also is an area of large scale ground water irrigation south of Arlington near Rock Creek and on Shutler Flat. The major irrigated crops in the subbasin are alfalfa hay, pasture grass, and annual wheat. The area has a frost-free season of between 180 and 200 days.



Dryland farming, especially the cultivation of wheat and barley, is the major agricultural activity in the Lower Subbasin.

Table 62

LOWER SUBBASIN
CROP TYPES

Type	Acres
Non-Irrigated	
Grain, hay and pasture	14,300
Pasture and grass	15,800
Grain and summer fallow	364,400
	394,500
Irrigated	
Alfalfa hay	1,640
Meadow hay	500
Hay and pasture	3,350
Grain/grain hay	250
Corn silage	50
Orchards	40
Wheat and row crops	900
	6,730

Source: Department of Agriculture Small Watershed Reconnaissance Study, 1984.

According to the 1984 Gilliam County Soil Survey, the Columbia River provides little irrigation water in the Lower Subbasin. The soils suitable for irrigation are at elevations and distances that currently preclude economic pumping of Columbia River water. Most of the land bordering the Columbia between Arlington and Willow Creek, however, has been developed for irrigation. When irrigated, the soils in this strip are well suited for vegetables, small grains, hay, and specialty crops. Without irrigation, the area was suitable only for limited winter grazing.

The soils north of State Route 206 are used mostly for dry-farmed small grain. Large areas of these soil units, however, are well suited to irrigation and offer good potential for a large variety of crops. Irrigation development is constrained by costs, however. South of State Route 206, arable soils are used in a grain fallow rotation. This use probably will continue, absent water for irrigation.

Cattle and sheep ranching was the dominant agricultural activity in the subbasin earlier this century. In recent years, its importance has diminshed. Currently, some sheep are raised in the northern subbasin and cattle are dispersed in small herds throughout the subbasin.

2. ENERGY AND MINERALS

The Lower Subbasin is not heavily mineralized and there is no record of production from this area. There are some deposits of volcanic ash that could be used for industrial purposes and some semiprecious gem beds. USFS historical files indicate the presence of bauxite in the vicinity of Wilson Prairie. In addition, some coal was mined about eight miles east of the subbasin, in the Rhea Creek drainage. Lastly, some exploratory oil and gas wells have been drilled in the vicinity of Clarno, Fossil, and Condon.

3. FISH RESOURCES

The lower John Day River serves primarily as a migration corridor for all adult and juvenile anadromous fish using the upper mainstem and tributaries. In addition, it contains approximately 290 miles of potential summer steelhead spawning and rearing habitat. Currently this habitat supports production of approximately two percent of the basin's total summer steelhead population. As many as 600 adult steelhead spawn in the subbasin annually. The subbasin supports a small fall chinook run and contains a limited cold-water and warm-water resident fish population.

The majority of habitat in the subbasin is only marginally productive for anadromous fish compared to habitat in the upper watershed. The mainstem stream channel is largely undefined, wide and shallow. Low flows, gravel sedimentation, minimal instream and riparian cover, and high summer stream temperatures are conditions which frequently exist. The most productive steelhead tributaries are Butte, Thirtymile, and Rock Creeks. However, production is often restricted by low flows, particularly during dry years.

Habitat protection and improvement is needed in the Lower Subbasin to support juvenile and adult anadromous fish during migration. Adequate streamflows, food, cover, and resting pools are needed to aid use of the river. Rehabilitation work in potentially productive tributaries such as Thirtymile, Rock, and Butte Creeks would improve spawning and rearing habitat for steelhead.

4. FOREST RESOURCES

The Lower Subbasin has limited forest resources. About 40 square miles of the subbasin to the east of Kinzua are managed by the Umatilla National Forest. Forest stands in this area consist of grand fir, Douglas fir, western larch and lodgepole pine, intermixed with minor amounts of sub-alpine fir and Engelmann spruce at the highest elevations. National forest timber harvesting began in the Heppner area in the late 1930's. In 1909, Kinzua Pine Mills (currently named Kinzua Corporation) acquired 50,000 acres in the vicinity and built a small mill in 1927 at what is now known as Kinzua. The mill closed in 1978.

5. TOURISM AND RECREATION

The Lower Subbasin offers many widely dispersed recreational opportunities, including golf courses, the John Day Scenic Waterway, city, county, and state campgrounds and a few private fishing lakes (see Table 63). Drift- and power-boating, canoeing, rafting and kayaking are popular on the lower John Day River. This use accounts for approximately 95 percent of the boating use of the entire John Day River and peaks in early summer before water levels drop below 1,000 cfs. Power-boating is not allowed between Clarno and Cottonwood between May 1 and October 30. Steelhead fishing statistics indicate around 5,500 angler-days, peaking during the fall months on the lower river. Tributary streams contribute 3,300 angler-days for trout fishing, and bass fishing is a popular recreational pursuit on this portion of the river.

Hunting for deer is a leading recreational pursuit in the fall with a lesser amount of elk hunting occurring as well.

Table 63

LOWER SUBBASIN
RECREATIONAL FACILITIES

Ownership	No. of Sites	Acres	Campsites	Picnic sites	Boat Ramps
City	9	119	20	20	1
County	5	15	34	24	3
State	5	10.3	28	6	3
BLM					
USFS	2	4	5		
NPS	2				
Private	3				
TOTALS	25	148.3	87	50	6

Source: Oregon Parks and Recreation Division, 1985.

C. WATER RESOURCES

1. SURFACE WATER

The McDonald Ferry stream gage records discharge for over 95 percent of the John Day Basin. It has been in operation since 1905 and provides an excellent record of streamflow variability. The average annual flow of the John Day at

McDonald Ferry is 1,475,500 acre-feet. Peak flow for the period of record occurred on December 24, 1964, when discharge reached 42,800 cfs. On other occasions, such as in 1966, 1973, and 1977, the river ceased flowing. There are also gages on Rock Creek, Lone Rock Creek, and Butte Creek.

Peak discharge occurs from late March to early June, with 22 percent of runoff occurring in April and 21 percent in May. Low flows occur from July through November.

The Lower Subbasin can be characterized as an area that receives water, as opposed to one that produces it. Most streams in the subbasin are nearly ephemeral, almost ceasing to flow in summer.

Of the three gaged streams, Rock Creek is the largest. The mean monthly flows range from 120 cfs in March to less than 1 cfs in September. Both Butte Creek and Lone Rock Creek (a tributary of Rock Creek) average less than 1 cfs from July through October. Mean monthly minimum flows average 0.2 cfs or less on Butte Creek throughout the entire year. On Rock and Lone Rock Creeks, mean monthly minima drop to zero July through September.

All three streams have stopped flowing completely at times. Lone Rock Creek stopped flowing at some time at least 10 out of the 13 years between 1966 (first year of record) and 1978 (last year of published record). Rock Creek's flow stopped at some point nine years of the same period. Butte Creek dropped to zero flow four of the seven years between 1972 (first year of record) and 1978. Generally, no-flow conditions last from August through September. In especially dry years, flows can stop as early as July and do not resume until October.

2. GROUND WATER

Columbia River Basalt, Alkali Canyon Formation, Clarno Formation, and Quaternary Alluvium are the major hydrogeologic units in the subbasin. The Columbia River Basalt Group is a sequence of basalt flows more than 3,000 feet thick in the vicinity of the Columbia River. Data from 57 wells producing from basalt in Sherman County west of the John Day River show a range of production between 4 and 300 gpm. Usable data from 38 wells producing from basalts within Gilliam County indicate wells yielded from less than 1 to 1,500 gpm. Pump tests from 13 large-diameter wells (greater than 12 inches in diameter) in the northeastern part of Gilliam County showed well yields to be from 50 to 2,000 gpm. These deep, large-diameter wells may more accurately represent the hydrologic potential of the basalt. However, it is not known if recharge is adequate to sustain a great number of these wells.

The Alkali Canyon Formation occurs to the south and west of Arlington. Negligible data are available from wells pumping from the formation. Nearly all wells drilled in the area penetrate through the formation and tap the Columbia River Basalt. The Alkali Canyon Formation is not considered an important aquifer.

The Clarno Formation occupies the general area between Fossil and Mitchell. Eighteen wells are drilled in the formation near Fossil. Reported pumpage rates range from 1 to 230 gpm, but the 230 gpm well is anomalous. The median yield is 6 gpm. Even though well data from the Clarno Formation indicate low ground water potential, the formation is considered hydrologically important because it is the sole domestic source in many areas. Obtaining adequate well yields for domestic or stock use is difficult in many cases.

Deposits of Quaternary Alluvium are present in the mainstem John Day stream channel around Clarno. Alluvial deposits in the stream channel vary in thickness and are thin in the subbasin where the river is deeply incised through the plateau. Alluvial deposits generally have high porosity and permeability. They generally are good aquifers because of their ability to store and transmit relatively large amounts of water and their high potential for recharge from surface sources.

3. WATER QUALITY

Water quality problems in the Lower Subbasin are the result of an accumulation of pollutants carried into the subbasin and locally-produced bacteria and sediment. Data on the main river near McDonald Ferry indicate severe turbidity, temperature, and fecal bacteria problems occur in the lower river. These problems impair cold-water fish use and threaten safe use of the river for water contact recreation.

There are little water quality data for the tributaries in the subbasin. However, the DEQ nonpoint source assessment maps, (August 1978) identify severe streambank erosion and sedimentation on some of the major tributaries to the main river. This information suggests a threatened use of these streams for cold-water fish (see Appendix F).

Water quality poses no problems for irrigation use. Total nitrogen levels in the main river are elevated but acceptable.

There are five municipal sewage treatment facilities located in the subbasin. Two of the facilities discharge to the surface waters of the basin (see Table 64). The DEQ recently conducted discharge mixing zone studies for the facilities at Condon and Fossil. The Condon plant was found to be discharging very poor-quality effluent into a small stream. The Fossil plant also was found to be inadequately treating sewage prior to discharging to Butte Creek. The DEQ is pursuing correction of problems at both facilities.

Agricultural activities in the subbasin are primarily dryland wheat operations that have high potential for soil erosion by water and wind. The Soil and Water Conservation Districts and farmers in the area are actively involved in erosion control. They are developing plans based on problem assessment projects funded in the late 1970s, using the Clean Water Act Section 208 pollution control funds. This effort and others by the agricultural community continue to improve erosion control in the dryland wheat areas.

The extensive environmental quality monitoring activities around the Chem-Security Systems, Inc., hazardous waste storage site near Arlington have identified no pollution problems for surface or ground water. Outside of this area, ground water quality is unknown due to lack of water quality data.

Table 64

LOWER SUBBASIN
SEWAGE TREATMENT PLANTS

Source	Type of Facility	Year Built	Design Population	Connected Population	Design Flow (MGD)	Connected Flow (MGD)	Current Raw Waste (#POD) Load (Day)	Current Treated Waste (#POD) Load (Day)	Current Permitted Waste (#POD) Load (Day)
Arlington	Activated Sludge and Sand Filter	1974	1000	455	0.125	0.04	62	4	31, discharge to Columbia River.
Condon	Activated Sludge and Lagoon	1971	1200	950	0.15	0.10	160	40	25, discharge to Thirty Mile Creek via Condon Canyon.
Fossil	Trickling Filter	1952	1000	535	0.15	0.05	90	20	38, discharge to Butte Creek.
Moro	Lagoon	1970	430	250	0.045	0.035	43	No Discharge	No discharge, irrigation near Barnum Canyon Creek.

Source: Department of Environmental Quality, 1985.

D. WATER USE AND CONTROL

1. WATER RIGHTS

Irrigation accounts for about 87 percent of the appropriated water in the Lower Subbasin. Over 40 percent of the irrigation water use is in the Rock Creek drainage. Municipal uses by the communities of Condon, Fossil, and Arlington also are important. Table 65 summarizes water rights in the subbasin.

Regulation of water use by the watermaster normally begins in May and June. The Rock Creek drainage, until recently, was the area of most intensive regulation. In the last 10 years, many Rock Creek water users have begun pumping from newly drilled wells for use as supplemental irrigation water supplies, reducing the need for regulation by the watermaster. Generally, streams tributary to the John Day are already dry or nearly dry by the time regulation for minimum flows is required. As a result, use of tributary waters generally is not affected by regulation for minimum streamflows.

Based on the crop patterns in the subbasin, irrigation water requirements total over 14,000 acre-feet, or about 39 cfs through the irrigation season (see Figure 37).

Table 65

LOWER SUBBASIN WATER RIGHTS (cfs)

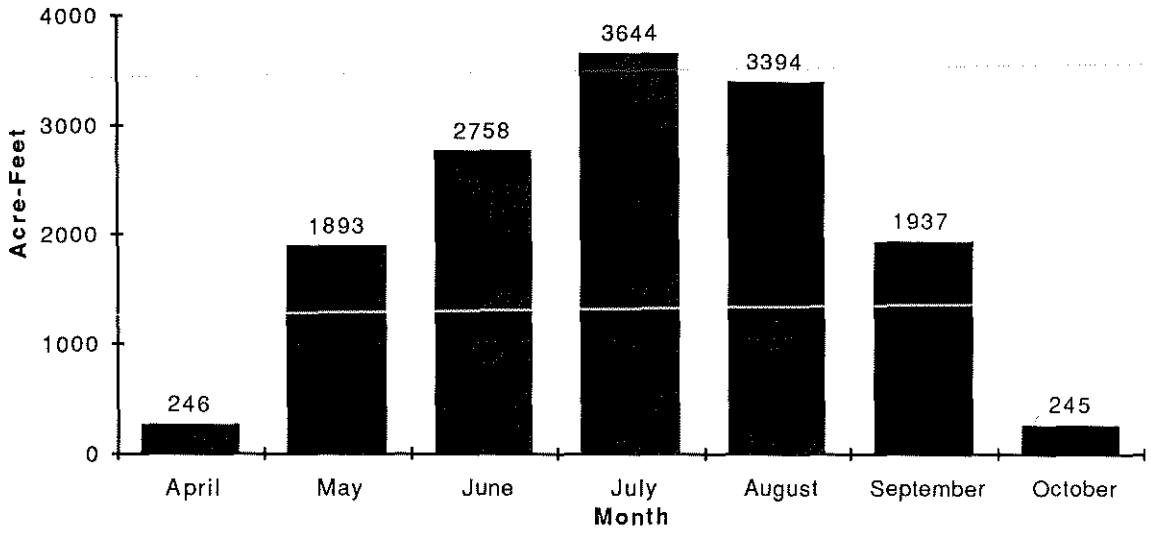
SUBBASIN or REACH	Irrigation[1]	Livestock	Indust./ Munic.	Fish and Wildlife	Residential	Storage[2]	Other[3]	Total
John Day River	29.2				0.2	63.1	0.1	29.5
Butte Cr.	35.9	0.1	1.2		0.2	15.4		37.5
Thirtymile Cr.	11.7	0.9	0.9		*	32.0		13.5
Hay Cr.	19.4		2.1					21.6
Rock Cr.	99.0	0.5		0.1		8.2	7.9	107.6
Grass Valley Canyon	13.1		1.5		0.1	8.0	1.2	15.9
Remainder of Basin	20.6	0.5	12.9		3.4	2.8	0.4	37.7
TOTAL	229.0 (114.5)[4]	2.0	18.7	0.1	3.9	129.4	9.6	263.3

1. Rate for irrigation season.
2. Figures acre-feet; not included in grand total.
3. Rights in database with uncoded uses.
4. Rate adjusted for entire year.

* Less than 0.05 cfs.

Figure 37

LOWER SUBBASIN ESTIMATED IRRIGATION WATER REQUIREMENTS



2. WATER USE RESTRICTIONS

a) Statutory

The John Day River from Clarno to Tumwater Falls is designated a state scenic waterway (ORS 390.825). No dam, reservoir, water impoundment facility, or placer mining is permitted on water within the scenic waterway. No water diversion facility can be constructed or used except by previously established right.

b) Administrative

1) Minimum Perennial Streamflows

A minimum perennial streamflow of 20 cfs on the mainstem John Day River at the McDonald Ferry gage was established in 1962 to support aquatic life.

2) Hydroelectric Standards

Administrative rules governing hydroelectric applications generally prohibit development of hydroelectric projects on the John Day River. Furthermore, state hydroelectric standards place stringent requirements on projects which are on streams supporting anadromous fish, wild game fish, or important recreational opportunities.

3) Classification

The use of subbasin streams is limited to domestic, livestock, municipal, irrigation, power development, industrial, mining, recreation, fish and wildlife beneficial water uses. The beneficial use of natural lakes is limited to domestic, livestock, lawn and garden irrigation, power development of no more than 7-1/2 theoretical horsepower, recreation, fish and wildlife.

3. STORAGE

The Bureau of Reclamation, Corps of Engineers, and Soil Conservation Service have studied many of the subbasin's potential reservoir sites (see Table 66). Most of the sites have failed to meet economic and environmental standards in use by the agencies at the time of the studies.

Reservoir construction is prohibited on the mainstem of the river in the subbasin because of the scenic waterway status. In addition, a project on the river would interfere with anadromous fishery uses. Nonstructural storage opportunities in the form of watershed improvements may offer the most economical means of stabilizing and distributing streamflow while yielding multiple benefits.

Table 66

IDENTIFIED RESERVOIR SITES IN THE LOWER SUBBASIN

Site Name	Stream Name	River Mile	Potential Storage (acre-feet)	Drainage Area (sq. mi.)
Tenmile Falls	John Day R.	11.0	N/A	N/A
Bull Basin	John Day R.	66.4	4000	N/A
Butte Cr. (Clarno)	John Day R.	93.5	850,000	N/A
Rosebush	Rosebush Can.	5.9	407	16
Dry Fork	Rock Cr.	31.7	N/A	356
Cemetery	Rock Cr.	35.2	N/A	327
Devils Gap	Rock Cr.	36.1	N/A	N/A
Ghost Camp	Rock Cr.	36.8	14,430	323
Eightmile	Rock Cr.	45.2	10,000	261
Murtha	Rock Cr.	46.9	N/A	271
Rock Cr (Buttermilk)	Rock Cr.	53.8	15,000	166
Rock Cr (Upper)	Rock Cr.	62.5	11,700	67
Parkers Mill	Rock Cr.	73.4	N/A	15
Butte Cr. (Lower)	Butte Cr.	18.0	332	31
Butte Cr. (Upper)	Butte Cr.	21.9	1,450	19
Lone Rock	Lone Rock Cr.	12.6	1,820	66
Buckhorn	Buckhorn Cr.	1.6	1,638	36
Thirtymile Cr.	Thirtymile Cr.	9.1	7,190	210
Hoover Cr.	Hoover Cr.	3.0	68	6
Straw Fork	Straw Fork	0.7	124	5

N/A = Not Available

E. PROBLEMS

The seasonal distribution of runoff and discharge is highly variable. There generally is enough streamflow early in the summer to satisfy most uses. However, once peak runoff has passed, there often is insufficient streamflow, especially in tributary streams, to satisfy all instream and out-of-stream uses.

The major problems of the Lower Subbasin are high winter and low summer streamflows and erosion. Soils of the subbasin are particularly susceptible to erosion and are easily carried to streams where sedimentation takes place. This process is compounded poor range conditions common in the subbasin. Severe streambank erosion is a problem on some of the major streams in the subbasin. Stream sedimentation and turbidity degrade fish habitat and affect other water uses.

Low summer flows in concert with degraded riparian areas cause high water temperatures. High temperatures combined with sedimentation, turbidity, and a lack of instream cover result in marginal fish habitat throughout the subbasin. Although by comparison to other subbasins there is little irrigation, this use also is limited by inadequate supplies in summer.

High streamflows in the winter and spring are a major source of streambank erosion. Winter high flows are chiefly responsible for the loss of streamside agricultural lands. In addition, eroding streambanks are important sediment sources the remainder of the year.

Water quality is impaired by the aforementioned streambank erosion and sedimentation. On the John Day River near McDonald Ferry, fecal bacteria can pose health problems. In addition, inadequate sewage treatment by the cities of Condon and Fossil is a problem currently being investigated by the DEQ.

Section X

REFERENCES

SECTION X

REFERENCES

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Section XI

APPENDICES

APPENDIX A

STATUTORY AUTHORITY

APPENDIX A

STATUTORY AUTHORITY

536.300 Formulation of state water resources program; public hearing in affected river basin. (1) The Water Resources Commission shall proceed as rapidly as possible to study: Existing water resources of this state; means and methods of conserving and augmenting such water resources; existing and contemplated needs and uses of water for domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, and fish life uses and for pollution abatement, all of which are declared to be beneficial uses, and all other related subjects, including drainage, reclamation, flood plains and reservoir sites.

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

(3) The commission may adopt or amend a basin program only after holding at least one public hearing in the affected river basin. After the commission itself conducts one public hearing in the affected river basin, the commission may delegate to the Water Resources Director the authority to conduct additional public hearings in the affected river basin. [1955 c.707 §10(1), (2); 1965 c.355 §2; 1985 c.673 §14]

536.310 Purposes and policies to be considered in formulating state water resources program. In formulating the water resources program under ORS 536.300 (2), the commission shall take into consideration the purposes and declarations enumerated in ORS 536.220 and also the following additional declarations of policy:

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

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

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

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

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

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

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

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

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

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

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

(12) When proposed uses of water are in mutually exclusive conflict or when available supplies of water are insufficient for all who desire to use them, preference shall be given to human consumption purposes over all other uses and for livestock consumption, over any other use, and thereafter other beneficial purposes in such order as may be in the public interest consistent with the principles of chapter 707, Oregon Laws 1955, under the existing circumstances; and

(13) Notwithstanding any other provision of this section, when available supplies of water are insufficient in the South Umpqua River to provide for both the needs of human consumption pursuant to a municipal water right and the maintenance of previously established minimum stream flows, preference shall be given to the municipal needs if the municipality adopts and enforces an ordinance restricting use of the water so obtained to direct human consumption uses.

537.525 Policy. The Legislative Assembly recognizes, declares and finds that the right to reasonable control of all water within this state from all sources of water supply belongs to the public, and that in order to insure the preservation of the public welfare, safety and health it is necessary that:

(1) Provision be made for the final determination of relative rights to appropriate ground water everywhere within this state and of other matters with regard thereto through a system of registration, permits and adjudication.

(2) Rights to appropriate ground water and priority thereof be acknowledged and protected, except when, under certain conditions, the public welfare, safety and health require otherwise.

(3) Beneficial use without waste, within the capacity of available sources, be the basis, measure and extent of the right to appropriate ground water.

(4) All claims to rights to appropriate ground water be made a matter of public record.

(5) Adequate and safe supplies of ground water for human consumption be assured, while conserving maximum supplies of ground water for agricultural, commercial, industrial, recreational and other beneficial uses.

(6) The location, extent, capacity, quality and other characteristics of particular sources of ground water be determined.

(7) Reasonably stable ground water levels be determined and maintained.

(8) Depletion of ground water supplies below economic levels, impairment of natural quality of ground water by pollution and wasteful practices in connection with ground water be prevented or controlled within practicable limits.

(9) Whenever wasteful use of ground water, impairment of or interference with existing rights to appropriate surface water, declining ground water levels, interference among wells, overdrawing of ground water supplies or pollution of ground water exists or impends, controlled use of the ground water concerned be authorized and imposed under voluntary joint action by the Water Resources Commission and the ground water users concerned whenever possible, but by the commission under the police power of the state when such voluntary joint action is not taken or is ineffective.

(10) Location, construction, depth, capacity, yield and other characteristics of and matters in connection with wells be controlled in accordance with the purposes set forth in this section. [1955

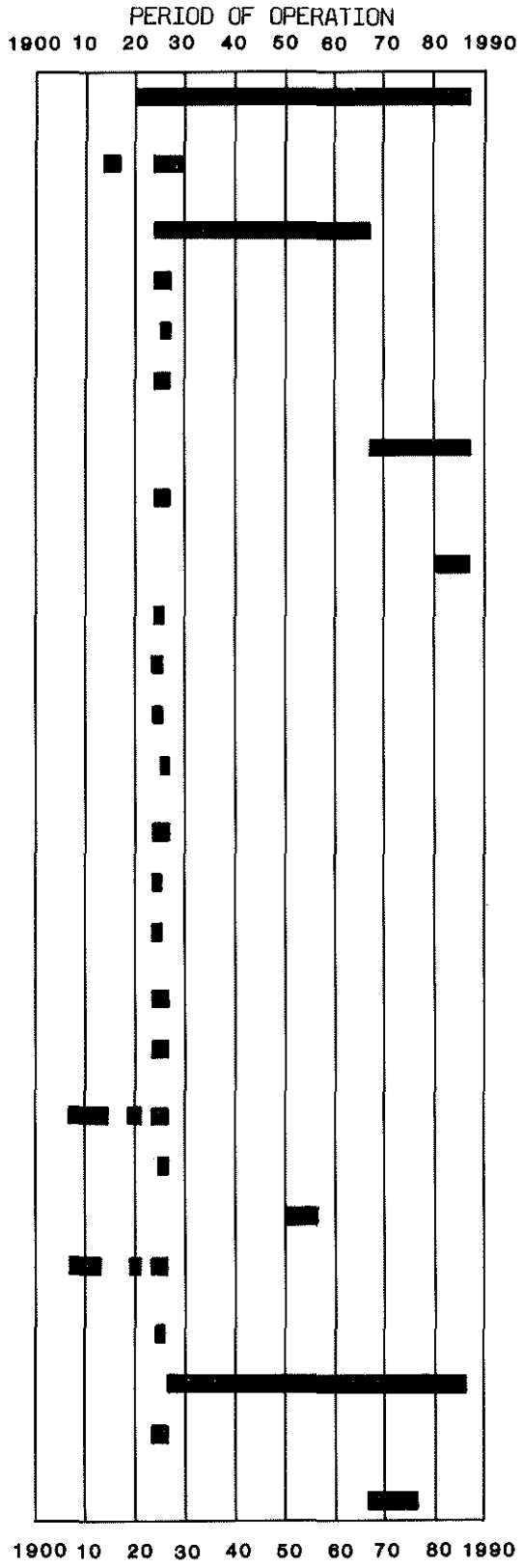
APPENDIX B

GAGING STATION INFORMATION

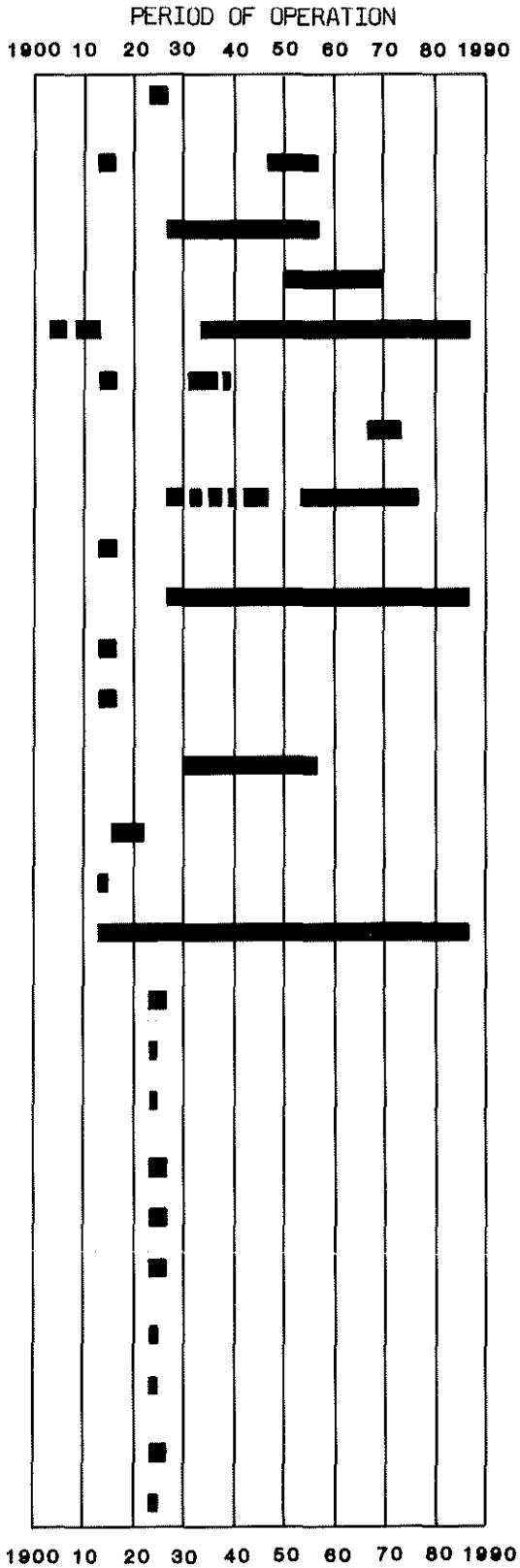
APPENDIX B

GAGING STATION INFORMATION

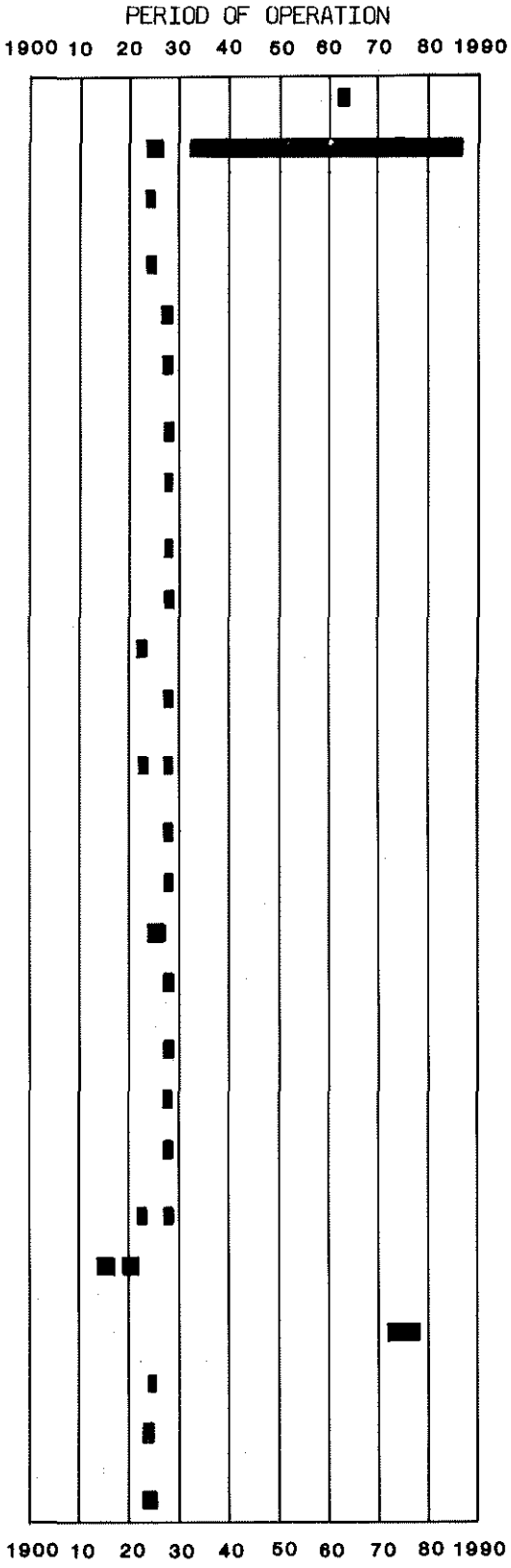
STATION NUMBER	STATION NAME
14037500	Strawberry Cr. nr Prairie City
14038000	Strawberry Cr. nr Prairie City
14038500	John Day R. at Prairie City
14038510	Indian Cr. nr Prairie City
14038515	Indian Cr. nr Prairie City
14038520	Pine Cr. nr Prairie City
14038530	John Day R. nr John Day
14038560	Canyon Cr. nr Canyon City
14038602	Canyon Cr. nr Canyon City
14038630	Canyon Cr. at John Day
14038656	Hanscombe Cr. nr John Day
14038657	Laycock Cr. nr John Day
14038658	Laycock Cr. nr John Day
14038690	Ingle Cr. nr Mt. Vernon
14038755	Beech Cr. nr Mt. Vernon
14038760	Beech Cr. nr Mt. Vernon
14038800	Belshaw Cr. nr Mt. Vernon
14038950	Fields Cr. nr mouth nr Mt. Vernon
14039000	John Day R. nr Dayville
14039300	S Fk John Day R. nr Izee
14039500	S Fk John Day R. nr Dayville
14040000	S Fk John Day R. at Dayville
14040450	Cottonwood Cr. nr Dayville
14040500	John Day R. at Picture Gorge
14040550	Rock Cr. at Antone Cr.
14040600	Mountain Cr. nr Mitchell



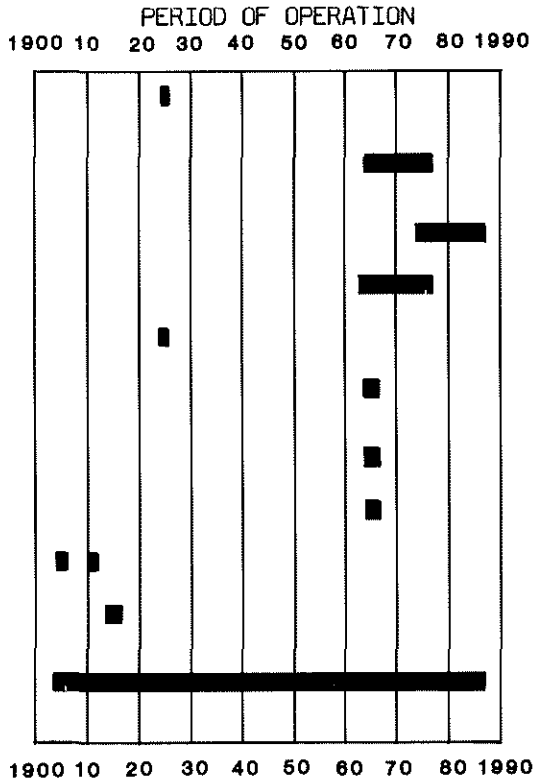
STATION NUMBER	STATION NAME
14040750	Mountain Cr. nr Dayville
14041000	Desolation Cr. nr Dale
14041500	N Fk John Day R. nr Dale
14042000	Camas Cr. nr Lehman
14042500	Camas Cr. nr Ukiah
14043000	Cable Cr. nr Ukian
14043560	Snipe Cr. nr Ukiah
14043700	Fivemile Cr. Diversion nr Gurdane
14043830	M Fk John Day R. nr Austin
14044000	M Fk John Day R. at Ritter
14044090	Long Cr. nr Long Creek
14044400	Fox Cr. abv Smith Cr.
14044500	Fox Cr. at Gorge nr Fox
14045000	Cottonwood Cr. nr Monument
14045500	Cottonwood Cr. nr Monument
14046000	N Fk John Day R. at Monument
14046260	Parrish Cr. nr Spray
14046265	Kahler Cr. abv Corncob Cr.
14046270	Corncob Cr. nr Spray
14046275	Kahler Cr. at John Day R. nr Spray
14046280	Alder Cr. abv Wheeler Cr.
14046282	Trib. of Alder Cr. nr Winlock
14046285	Alder Cr. abv Lake Cr. nr Service Cr.
14046290	Alder Cr. abv mouth nr Service Cr.
14046330	Service Cr. bel Big Service Cr.
14046355	Service Cr. at Service Cr.



STATION NUMBER	STATION NAME
14046400	Donnelly Cr. trib nr. Service Cr.
14046500	John Day R. at Service Cr.
14046525	Shoofly Cr. nr Richmond
14046535	Rowe Cr. nr Twickenham
14046540	Bridge Cr. nr Mitchell
14046550	Bridge Cr. nr Mitchell
14046555	Johnson Cr. nr Mitchell
14046605	Keyes Cr. at mouth nr Mitchell
14046610	Bridge Cr. nr Mitchell
14046615	Bridge Cr. abv Gable Cr.
14046617	Gable Cr. bel fork
14046618	Mud Cr. nr Mitchell
14046620	Bridge Cr. abv W Branch
14046655	W Branch Bridge Cr. bel Clover Cr.
14046658	W Branch Bridge Cr. nr Mitchell
14046660	Bridge Cr. bel W Branch
14046662	Meyers Gulch nr Mitchell
14046750	Bear Cr. nr Mitchell
14046770	Bridge Cr. abv Lockwood Can
14046780	Bridge Cr. abv Stephens Dam
14046800	Bridge Cr. at John Day R.
14047000	John Day R. at Clarno
14047100	Butte Cr. nr Fossil
14047120	Butte Cr. bel Straw Cr.
14047125	Cottonwood Cr. at Fossil
14047130	Butte Cr. bel W Fork



STATION NUMBER	STATION NAME
14047290	Thirtymile Cr. nr Fossil
14047380	Lone Rock Cr. nr Lonerock
14047390	Rock Cr. abv Whyte Park nr Condon
14047400	Rock Cr. abv Cayuse Can nr Condon
14047420	Rock Cr. abv Dry Cr. nr Gwendolyn
14047455	Rock Cr. abv Wolf Hollow
14047460	Rock Cr. bel Spring Hollow nr Olex
14047480	Rock Cr. at Marvel Farm nr Rock Cr.
14047500	Rock Cr. at Rock Cr. (nr Arlington)
14047800	Rock Cr. nr Rock Cr.
14048000	John Day at McDonald Ferry



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APPENDIX C

DISCHARGE TRENDS THROUGH TIME

APPENDIX C

HISTORICAL ANALYSIS OF DISCHARGE DATA

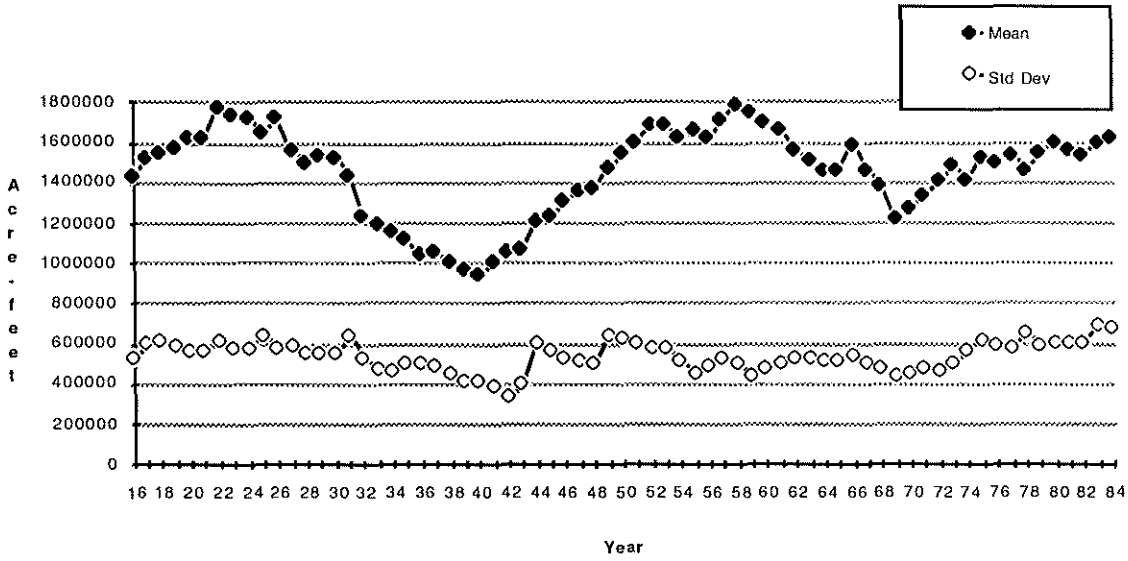
This Appendix consists of three graphic approaches to inspecting change in discharge patterns through time. Each is based on the U.S. Geological Survey gage at McDonald Ferry which has been operating since 1906.

The first approach displays the 10 year running average of discharge at McDonald Ferry. That is, the average annual discharge for water years 1907 to 1916 is the first value plotted on the y - axis. The second value represents the average annual discharge for the water years 1908 to 1917. The last value plotted is the average annual discharge for water years 1975 to 1984. The standard deviation is also displayed. The standard deviation is a measure of variability around the mean. When the standard deviation is large, it means the annual flows for that period have been highly variable. When the standard deviation is small, the flows have been more consistent.

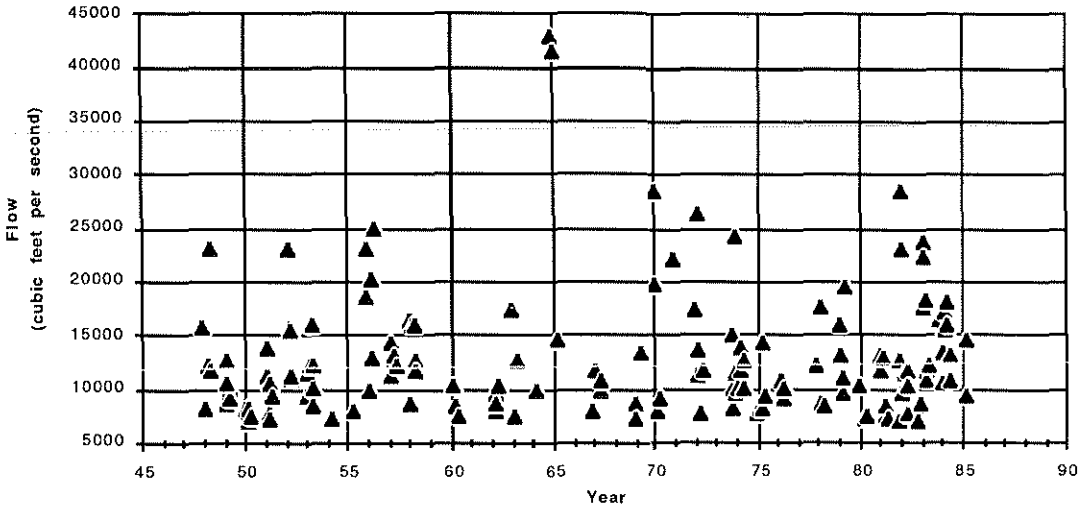
The second approach graphs peak flows from 1948 to 1985. The U.S. Geological Survey defines any flow at McDonald Ferry that is equal to or greater than 6,900 cfs as a peak flow. The USGS began recording such flows in 1948.

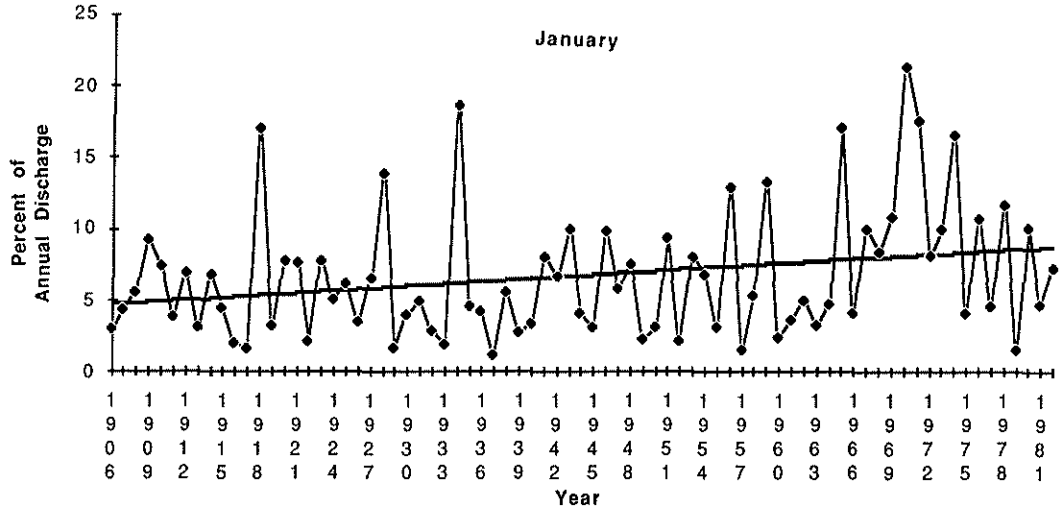
The third approach traces each month's percent contribution to annual flow for the water years 1906 through 1981. A trend line (a straight line fitted to the data points by least squares approximation) is plotted for each month.

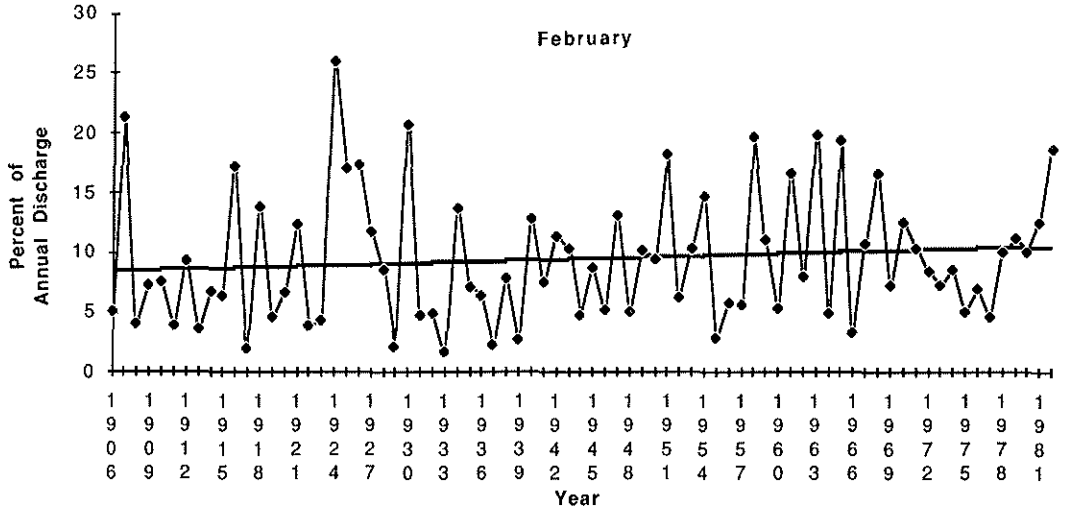
Annual Discharge
10-Year Running Average
John Day River at McDonald Ferry

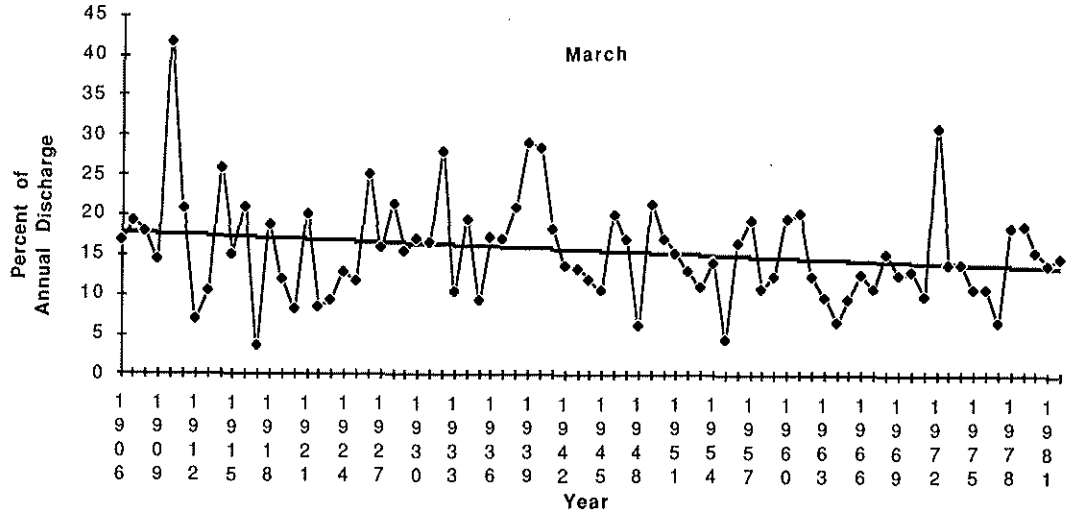


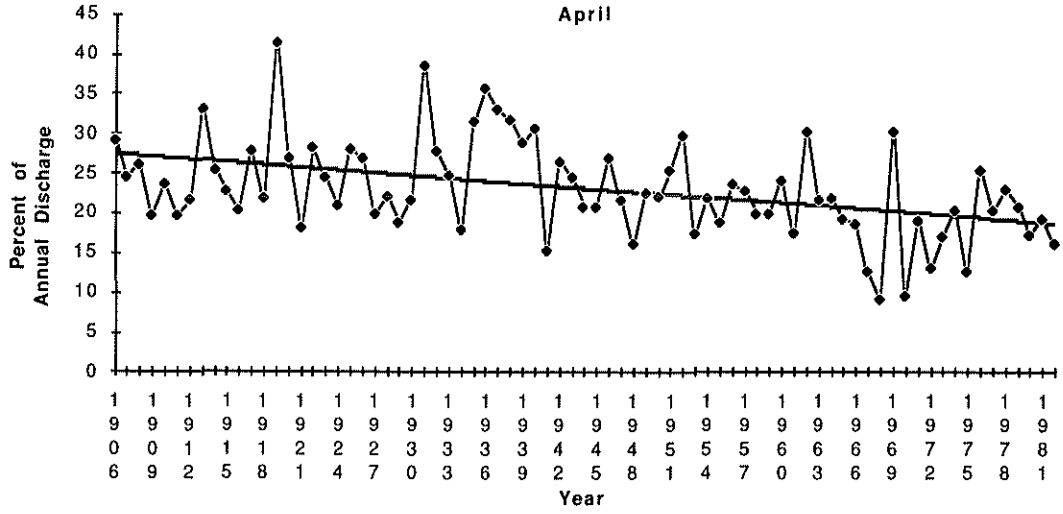
Peak Flows
John Day River at McDonald Ferry

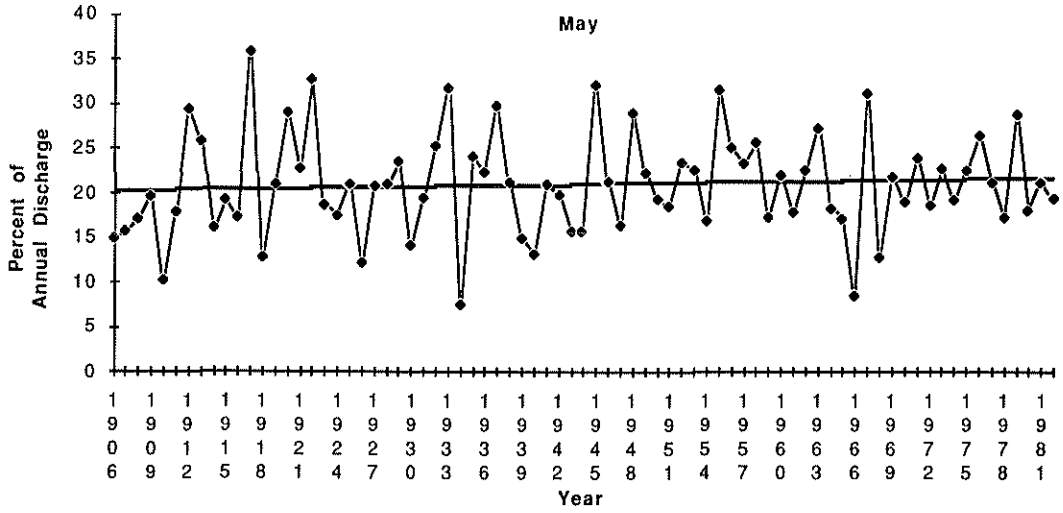


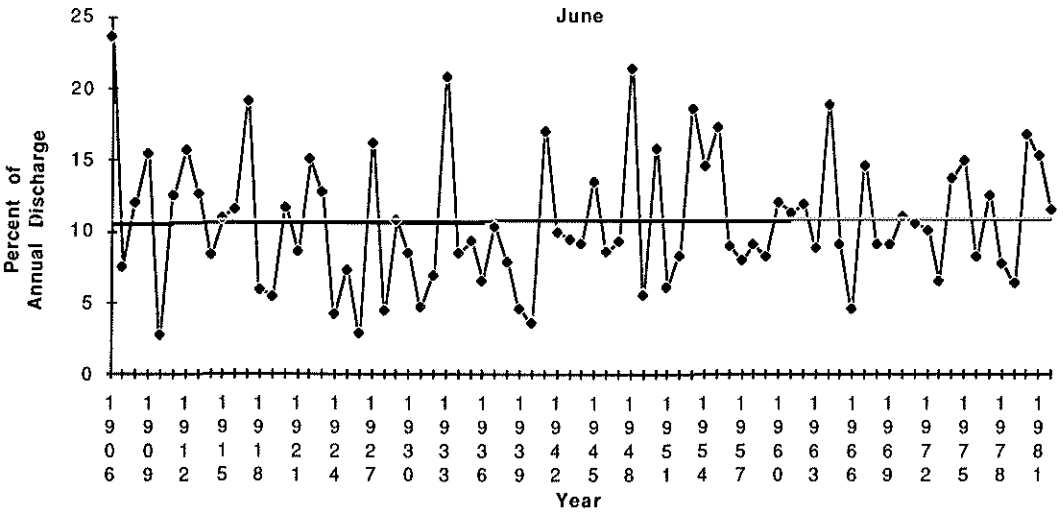

January
Percent of Annual Discharge
0
5
10
15
20
25
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

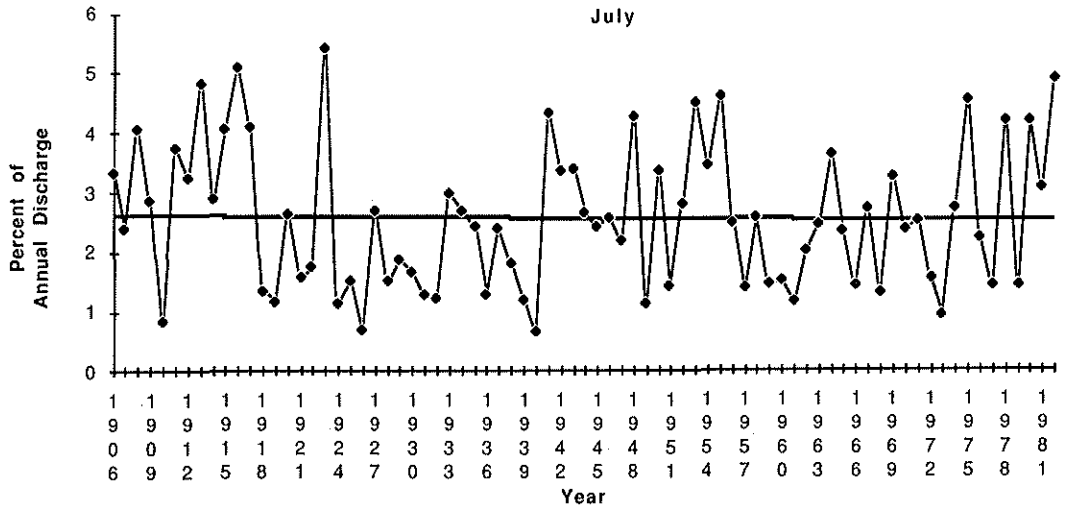

February
Percent of Annual Discharge
0
5
10
15
20
25
30
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

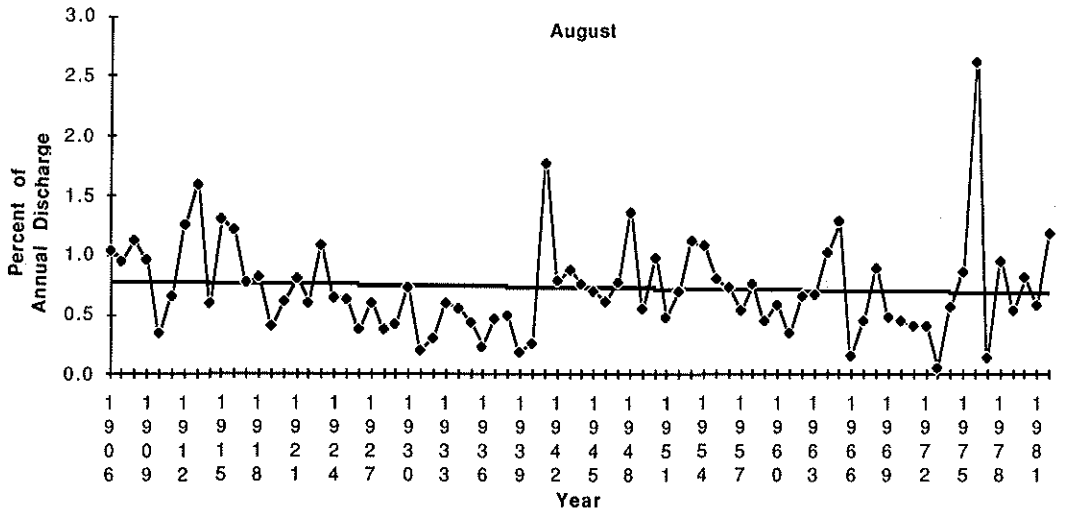

March
Percent of Annual Discharge
0
5
10
15
20
25
30
35
40
45
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

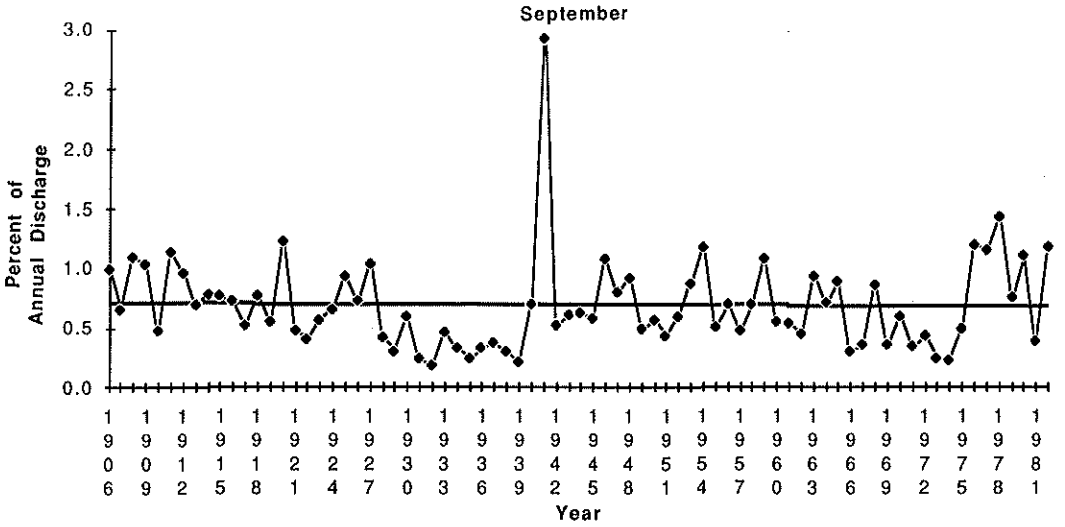

April
Percent of Annual Discharge
0
5
10
15
20
25
30
35
40
45
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

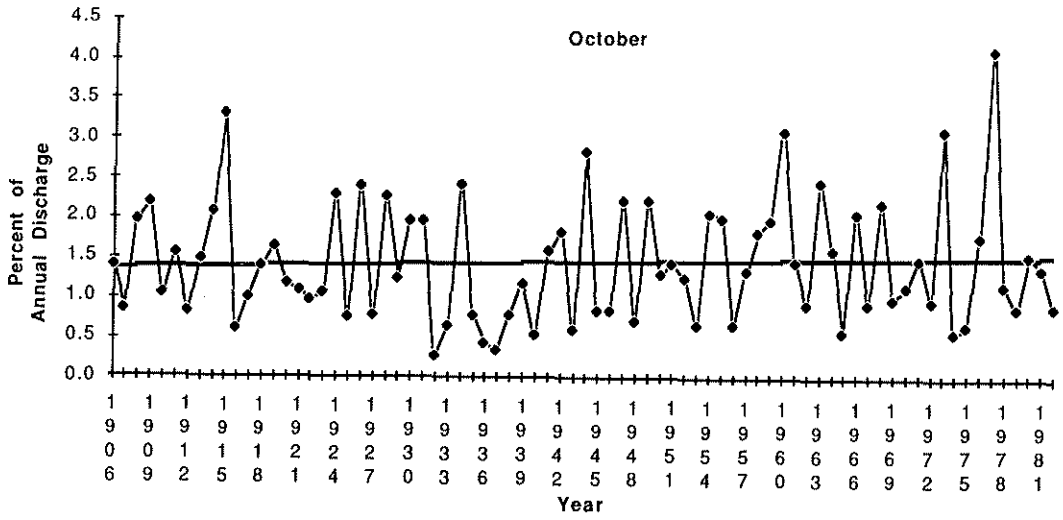

May
Percent of Annual Discharge
0
5
10
15
20
25
30
35
40
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

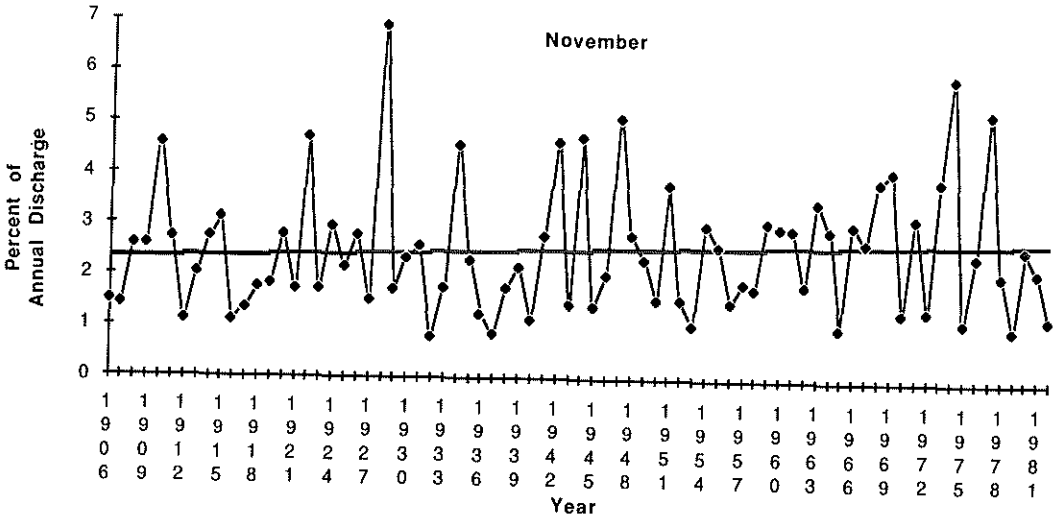

June
Percent of Annual Discharge
0
5
10
15
20
25
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

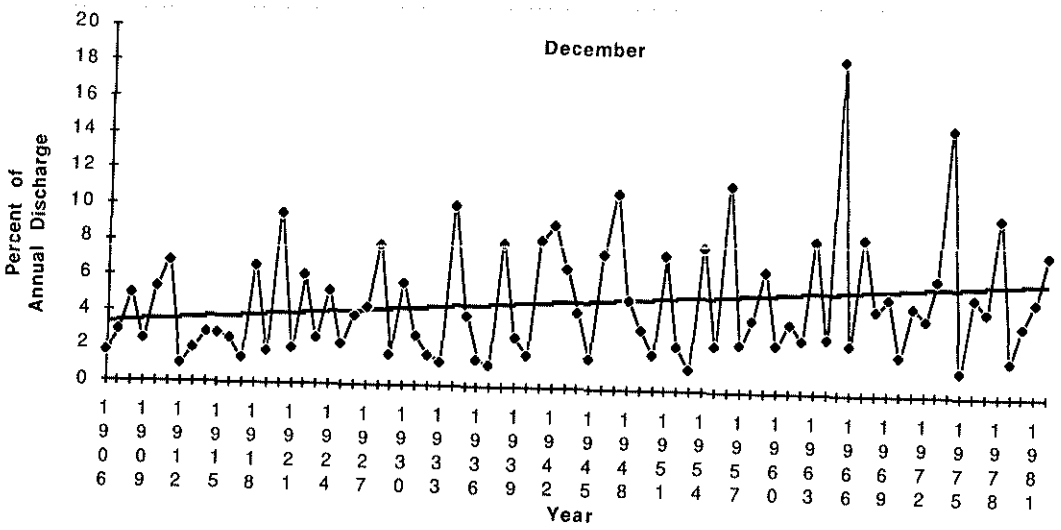

July
Percent of Annual Discharge
0
1
2
3
4
5
6
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year


August
Percent of Annual Discharge
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year


September
Percent of Annual Discharge
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year


October
Percent of Annual Discharge
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year


November
Percent of Annual Discharge
7
6
5
4
3
2
1
0
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

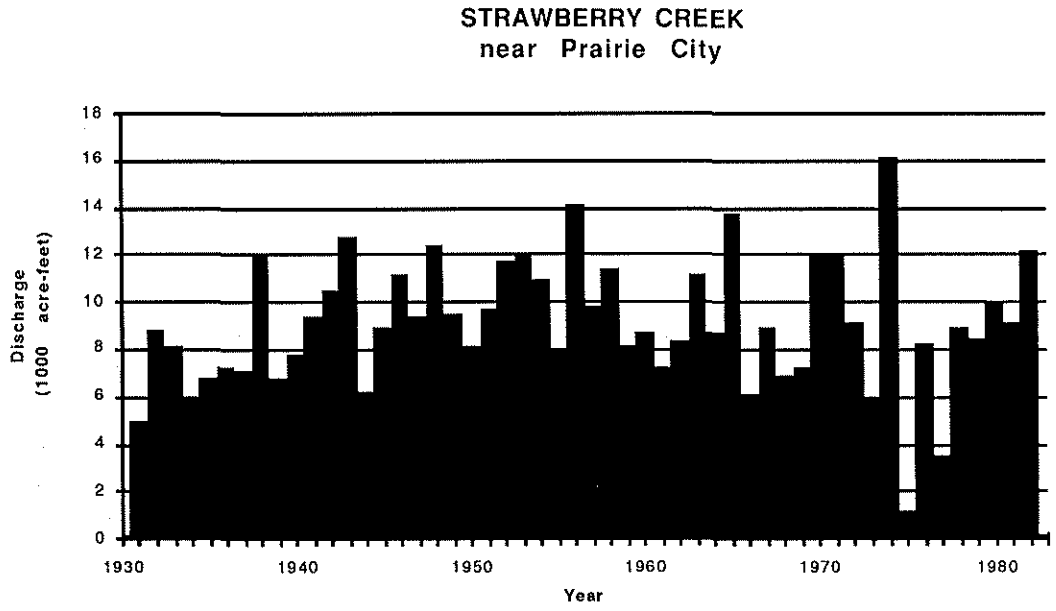

December
Percent of Annual Discharge
20
18
16
14
12
10
8
6
4
2
0
1906 1909 1912 1915 1918 1921 1924 1927 1930 1933 1936 1939 1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981
Year

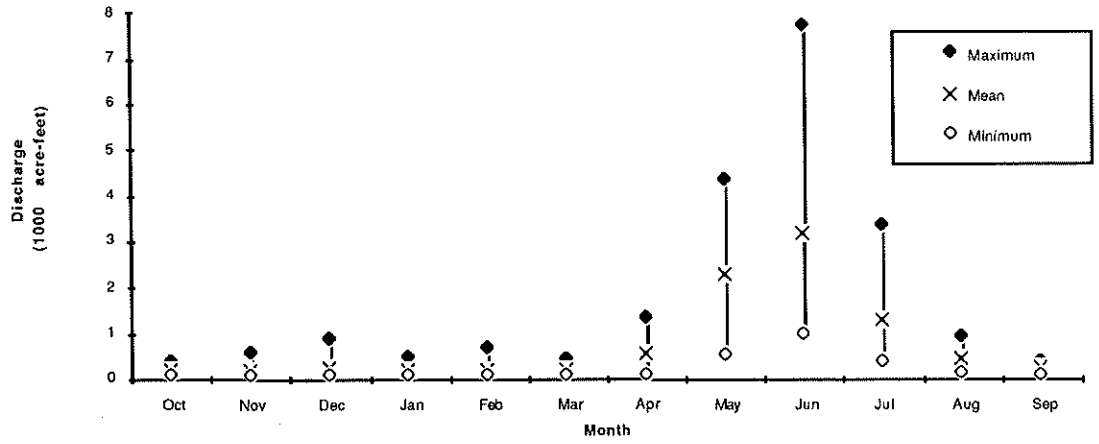
APPENDIX D

HYDROGRAPHS

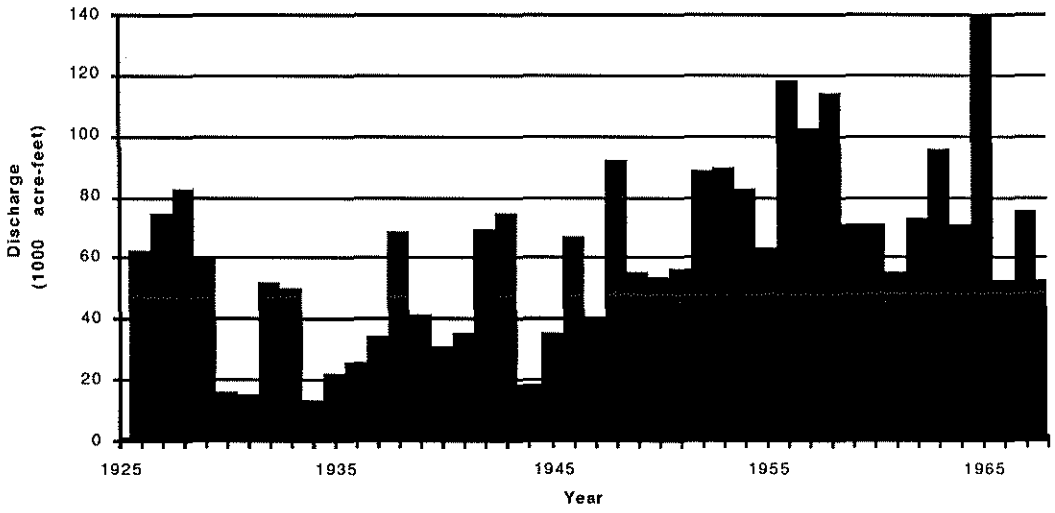
APPENDIX D

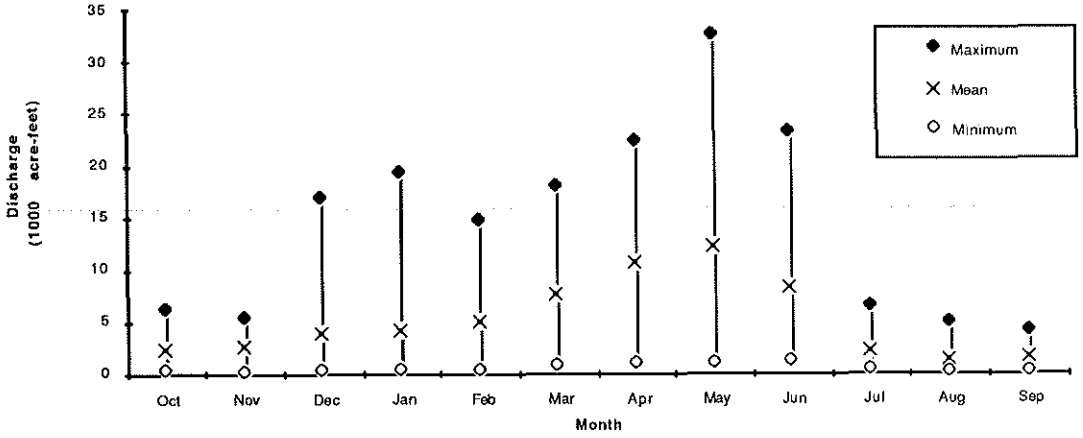
HYDROGRAPHS



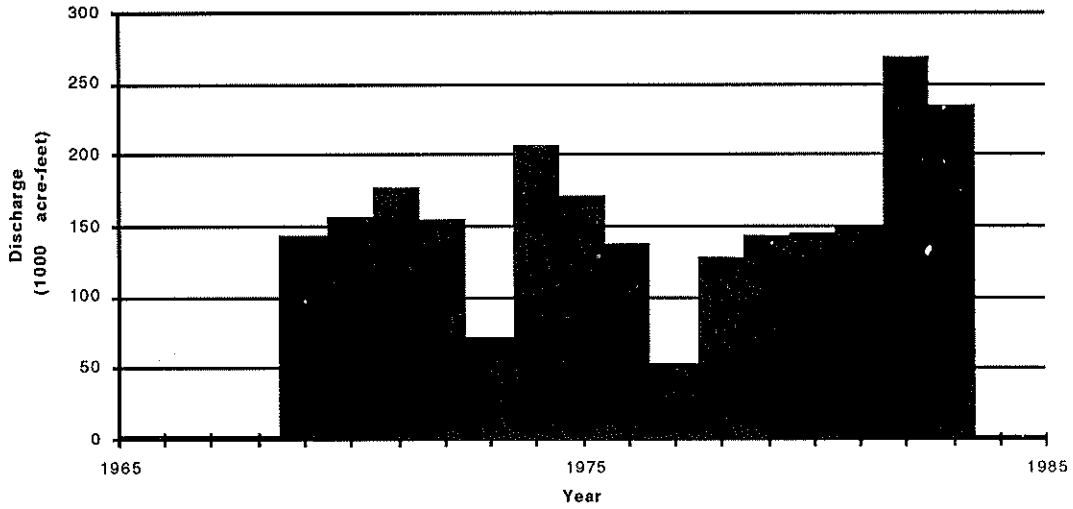


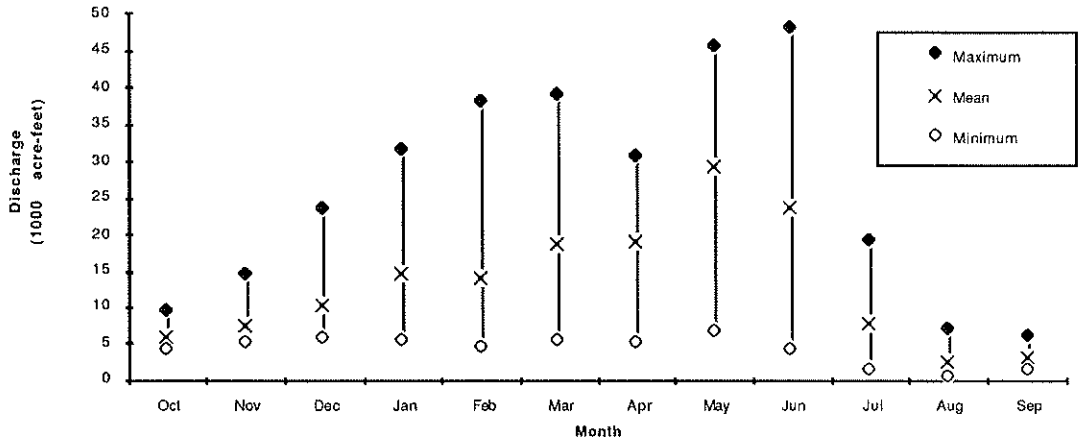
JOHN DAY RIVER
at Prairie City



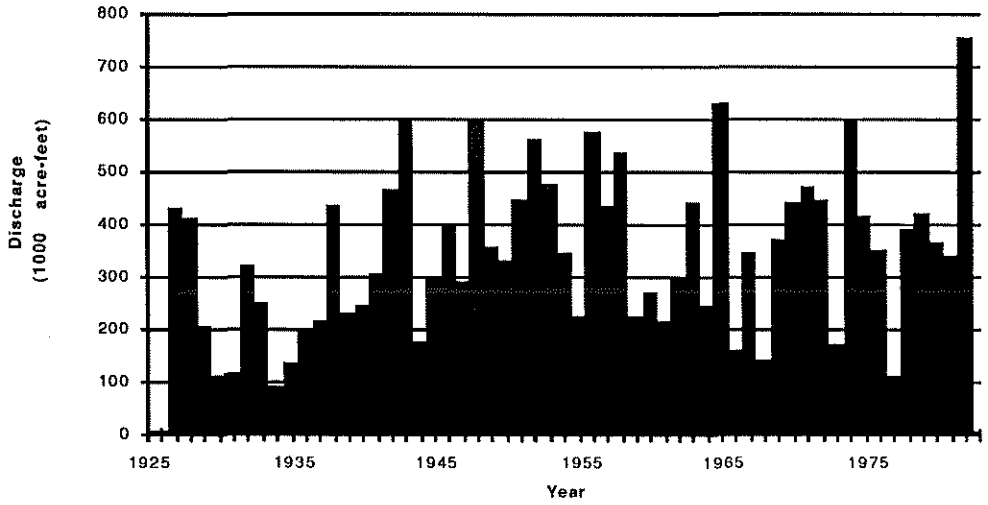


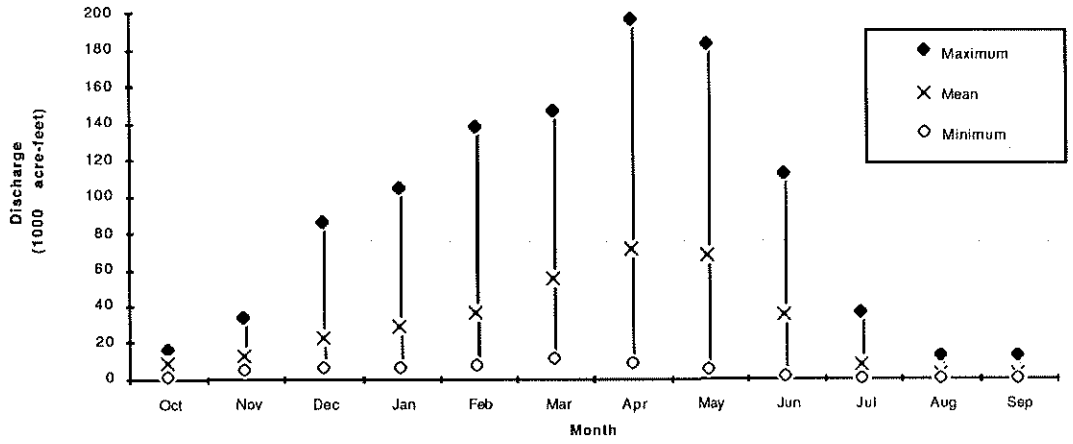
JOHN DAY RIVER
near John Day



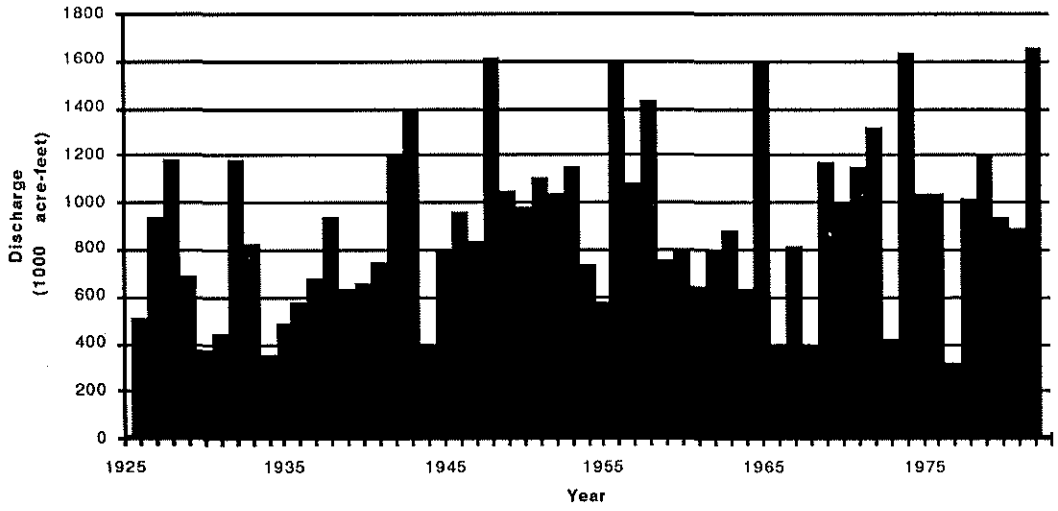


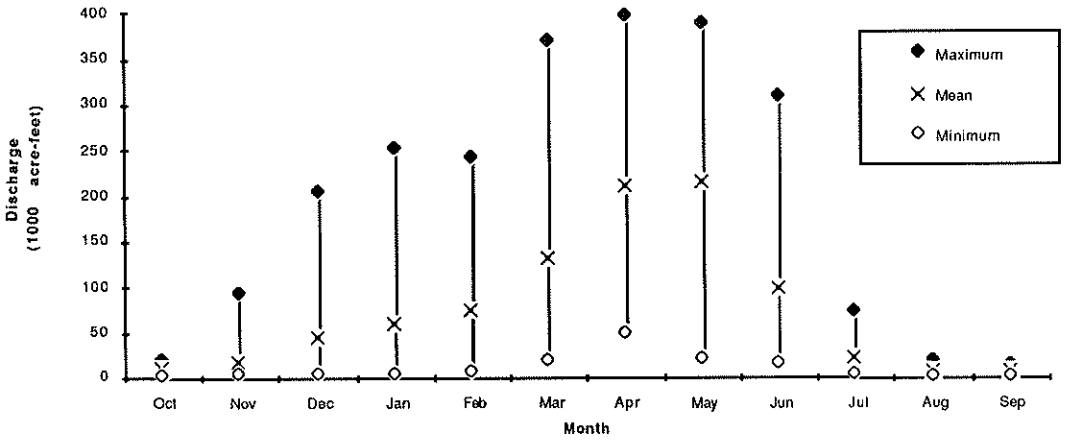
JOHN DAY RIVER
at Picture Gorge



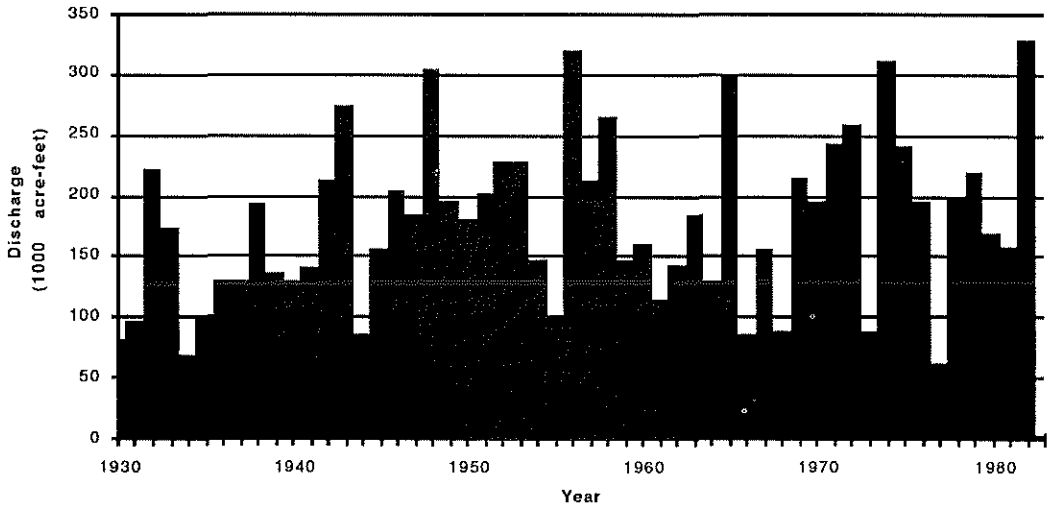


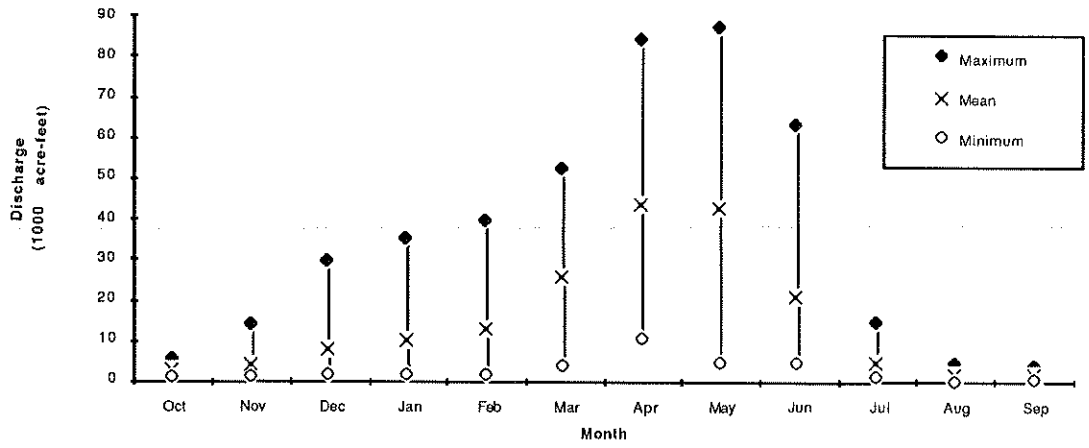
NORTH FORK JOHN DAY
at Monument



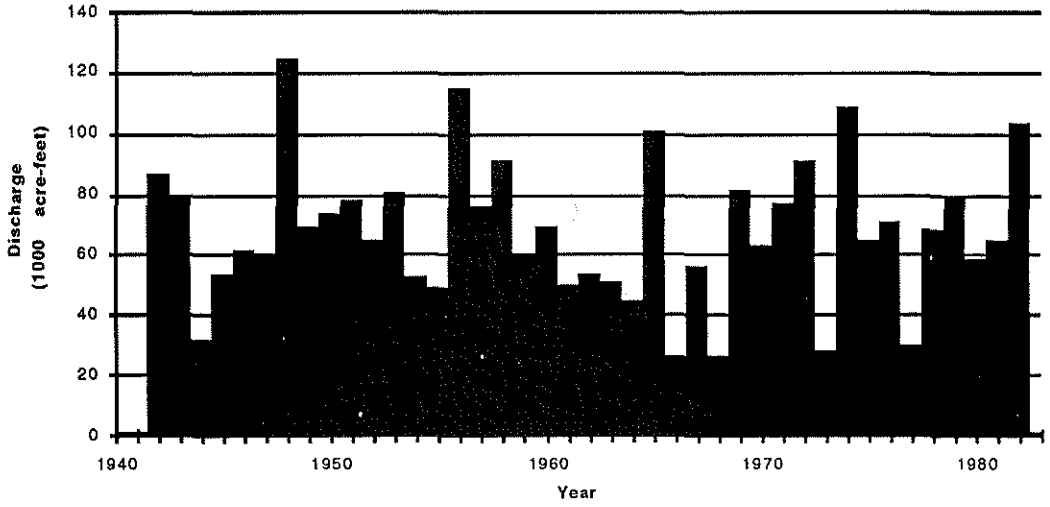


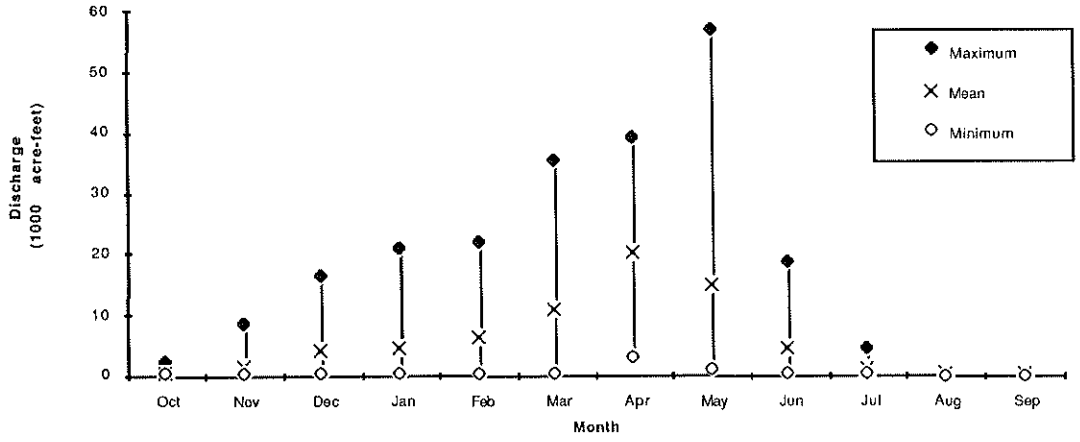
MIDDLE FORK JOHN DAY
at Ritter



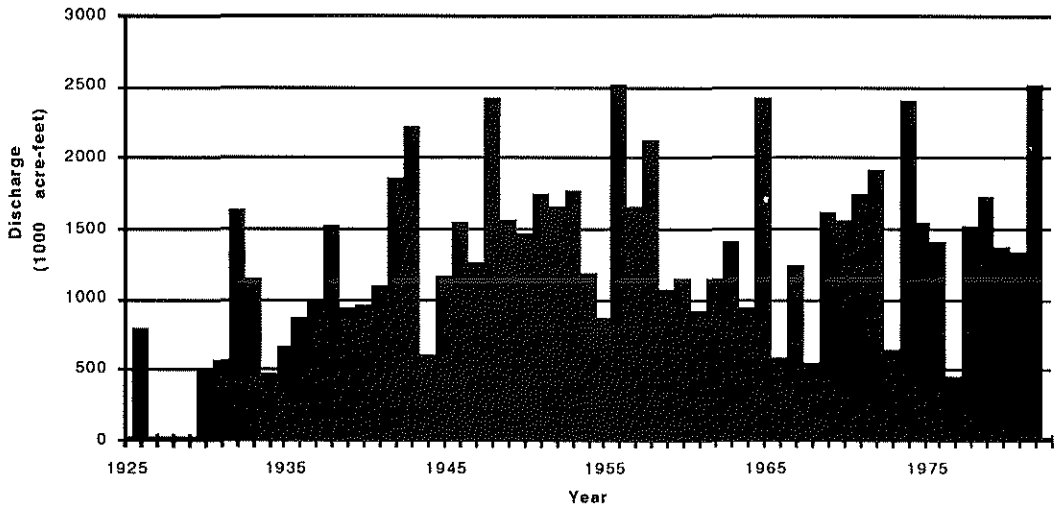


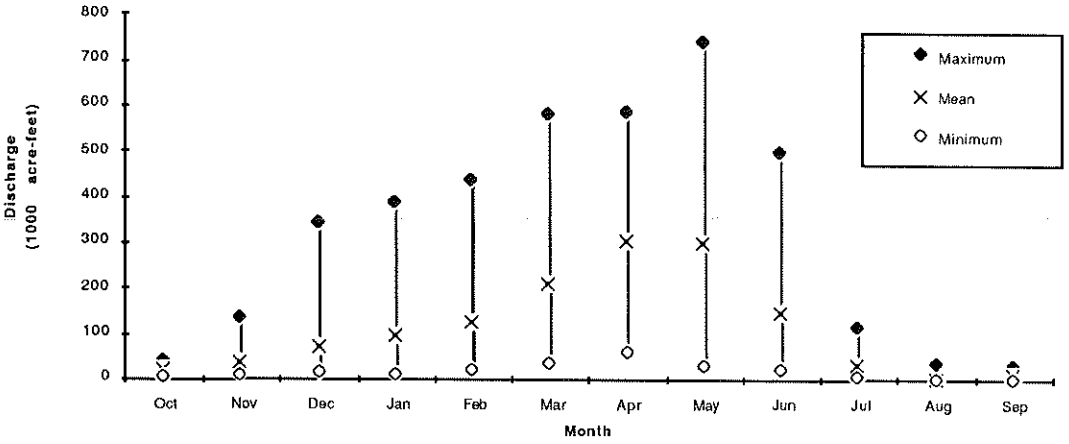
CAMAS CREEK
near Ukiah



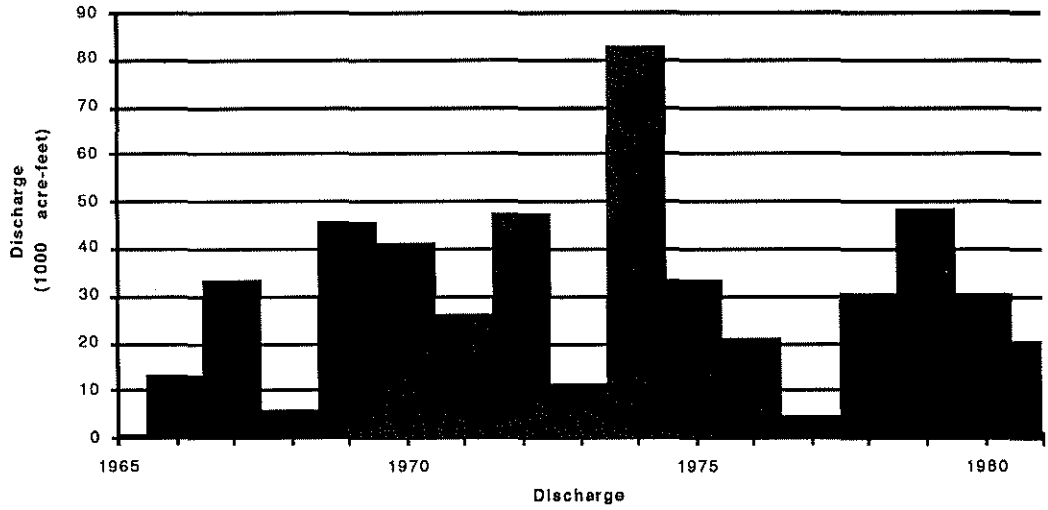


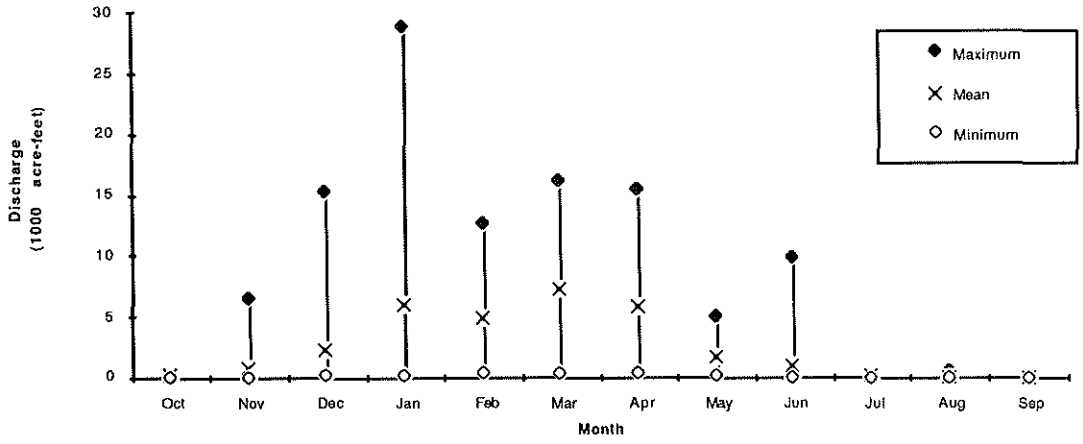
JOHN DAY RIVER
at Service Creek



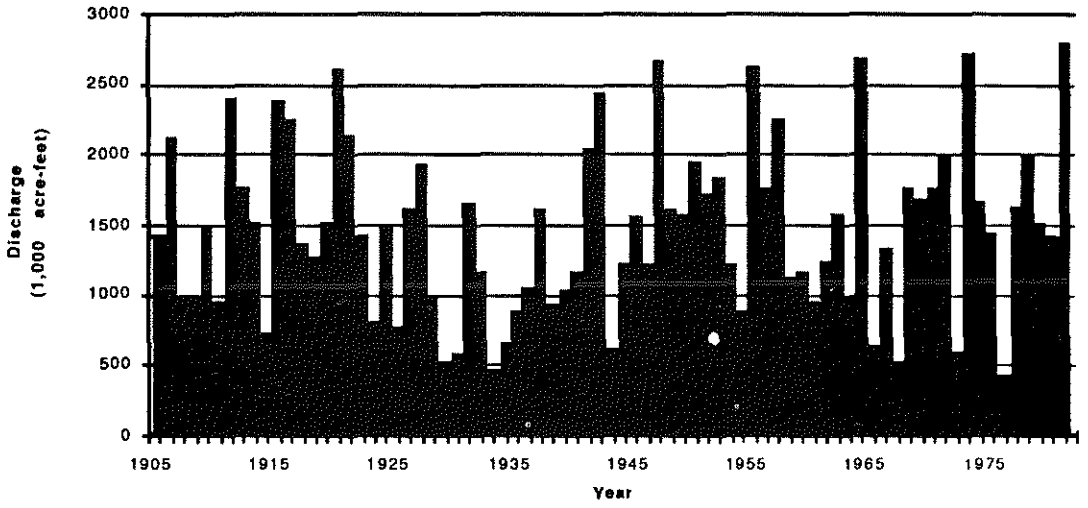


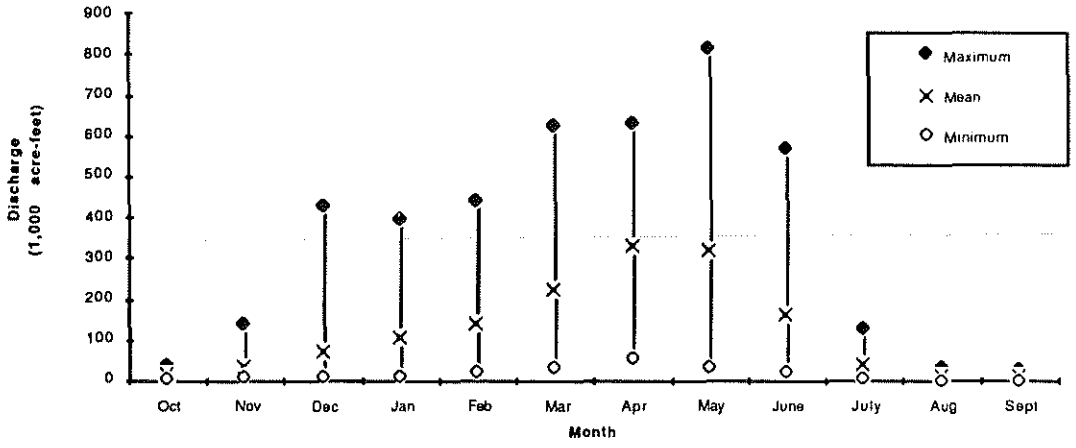
ROCK CREEK
above Cayuse Canyon





JOHN DAY RIVER
at McDonald Ferry





APPENDIX E

ANADROMOUS FISH HABITAT IMPROVEMENT PRIORITIES

ANADROMOUS FISH STREAMS IN THE JOHN DAY DRAINAGE WHICH HAVE THE HIGHEST PRIORITY FOR HABITAT IMPROVEMENT
Confederated Tribes of the Umatilla Indian Reservation and BPA (1984)

Stream	Species	Priority1/	Mi. Needing Work			Mi. Riparian Improvement		No. Instr. Struct.		Type of Work or Struct.4/	Cost Estimate by Land Ownership		
			Public	Private	Total	Protection2/	Bank Stab.3/	Boulders	Other		Public	Private	Total
Upper Main Stem Main Stem	Ch, St	1	3.0	23.0	26.0	9.0	2.0	5,200	275	BDWP	59,000	452,000	511,000
Cottonwood Cr.	St	2	5.5	7.0	12.5	6.0	1.0	1,250	125	BDW	109,500	139,000	248,500
Rock Cr	St	3	0	30.0	30.0	20.0	2.0	3,000	300	BDWR	0	654,000	654,000
Beech Cr.	St	2	6.0	9.0	15.0	7.0	2.0	1,500	150	BDW	107,000	160,000	267,000
East Fk. Beech Cr.	St	2	9.0	0	9.0	6.0	0.5	900	90	BDW	183,500	0	183,500
McClellan Cr.	St	2	3.5	0	3.5	3.5	0	350	35	BDW	73,500	0	73,500
Clear Cr.	St	2	3.0	0	3.0	3.0	0	300	30	BDW	63,000	0	63,000
Canyon Cr.	St	3	7.5	15.5	23.0	11.0	1.0	2,300	120	BDW	109,500	216,500	326,000
East Fk. Canyon Cr.	St	3	3.0	1.0	4.0	1.0	0.5	400	40	BDW	59,000	19,500	78,500
M. Fk. Canyon Cr.	St	3	5.0	0	5.0	0	0	500	50	BDW	75,000	0	75,000
Reynolds Cr.5/	St	4	3.5	2.0	5.5	0	0	550	55	BDW	52,500	30,000	82,500
Deardorff Cr.5/	St	4	3.0	2.0	5.0	0	0	500	50	BDW	45,000	30,000	75,000
Fields Cr.	St	5	5.0	3.0	8.0	3.0	0	800	80	BDW	86,000	52,000	138,000
Bear Cr.	St	6	0	6.0	6.0	5.0	0	600	60	BDW	0	120,000	120,000
Hall Cr.	St	6	1.0	0	1.0	1.0	0	100	10	BDW	21,000	0	21,000
Pine Cr.	St	7	1.5	4.5	6.0	6.0	0	600	60	BDW	31,500	94,500	126,000
Indian Cr.	St	7	1.0	6.0	7.0	5.0	0.2	700	70	BDW	20,000	120,000	140,000
Grub Cr.	St	8	1.0	7.0	8.0	5.0	0.5	800	80	BDW	23,000	139,500	162,500
Dixie Cr.	St	9	6.2	2.8	9.0	2.0	0	900	90	BDW	101,000	46,000	147,000
Roberts Cr.	St	10	2.0	0	2.0	0	0	200	20	BDW	30,000	0	30,000
Sub-Basin Totals			69.7	118.8	183.5	93.5	9.7	71,450	1,790		1,249,000	2,273,000	3,521,500

1/ Priorities based on opportunity for increased fish production; order of project implementation may vary depending on availability and opportunity (i.e. work loads of implementing agencies in various districts or completion time of pre-project design studies).

2/ Controlled livestock use needed by permanent or temporary riparian corridor fencing, riparian pasture system, or livestock exclusion.

3/ Bank stabilization refers to planting and rock or juniper rip-rap.

4/ Structure types are: W = Weirs; B = Boulder placement; D = Deflectors; R = Removal of barrier; P = Pool excavation; C = Channel restoration.

5/ Past riparian and/or instream work done; more is needed (projects with approved funding represented by*).

Stream	Species	Priority1/	Mi. Needing Work			Mi. Riparian Improvement		No. Instr. Struct.		Type of Work or Struct.4/	Cost Estimate by Land Ownership		
			Public	Private	Total	Protection2/	Bank Stab.3/	Boulders	Other		Public	Private	Total
South Fork	St	1	22.0	37.0	59.0	20.0	17.0	11,800	120	WBOR	1,597,500	1,423,500	3,021,000
South Fk.6/													
Murderers Cr.5/	St	1	28.0	2.0	20.0	8.0	0.2	2,000	200	WBD	318,000	35,000	353,000
Deer Cr.5/	St	1	10.0	0	10.0	5.0	2.0	1,000	100	WBD	230,000	0	230,000
Tex Cr.	St	2	4.8	0	4.8	3.0	0	480	48	WBD	90,000	0	90,000
Vester Cr.	St	3	2.0	1.0	3.0	1.0	1.0	300	30	WBD	47,000	23,000	70,000
Wind Cr.	St	4	6.5	2.5	9.0	3.0	0	800	80	WBD	105,000	48,000	153,000
S Fk Murderers Cr.6/	St	5	1.0	0	1.0	1.0	1.0	100	10	WBDR	48,000	0	48,000
Sunflower Cr.7/	St	6	3.5	2.5	6.0	3.0	0	600	60	WBD	63,000	45,000	108,000
Packwood Cr.7/	St	6	0	6.0	6.0	6.0	0	600	60	WBD	0	126,000	126,000
Pine Cr.7/	St	6	0	5.0	5.0	5.0	0	500	50	WBD	0	105,000	105,000
Rosebud Cr.7/	St	6	1.0	5.0	6.0	6.0	0	600	60	WBD	21,000	105,000	126,000
Utley Cr.7/	St	6	2.5	3.0	5.5	4.0	0	550	55	WBD	48,500	58,000	106,500
Alder Cr.7/	St	6	1.0	2.0	3.0	3.0	0	300	30	WBD	21,000	42,000	63,000
Spoon Cr.7/	St	6	1.0	1.5	2.5	2.5	0	250	25	WBD	21,000	32,000	53,000
Flat Cr.7/	St	6	2.5	3.0	5.5	5.5	0	550	55	WBD	52,500	63,000	115,500
Corral Cr.7/	St	6	1.5	4.5	6.0	6.0	0	600	60	WBD	31,500	94,500	126,000
Lewis Cr.7/	St	6	0	2.0	2.0	2.0	0	200	20	WBD	0	42,000	42,000
Lonesome Cr.7/	St	6	2.5	1.0	3.5	3.5	0	350	35	WBD	52,500	21,000	73,500
Venator Cr.7/	St	6	4.0	2.0	6.0	6.0	0	600	60	WBD	84,000	42,000	126,000
Bear Cr.7/	St	6	5.0	0	5.0	5.0	0	500	50	WBD	105,000	0	105,000
Sub-Basin Totals			88.0	80.0	168.8	98.5	21.2	22,680	1,208		3,019,500	2,305,000	5,324,500
Basin Totals			402.45	542.05	944.5	421.5	71.2	153,475	7,461		8,333,750	11,854,750	20,188,500

1/ Priorities based on opportunity for increased fish production; order of project implementation may vary depending on availability and opportunity (i.e. work loads of implementing agencies in various districts or completion time of pre-project design studies).

2/ Controlled livestock use needed by permanent or temporary riparian corridor fencing, riparian pasture system, or livestock exclusion.

3/ Bank stabilization refers to planting and rock or juniper rip-rap.

4/ Structure types are: W = Weirs; B = Boulder placement; D = Deflectors; R = Removal of barrier; P = Pool excavation; C = Channel restoration.

5/ Past riparian and/or instream work done; more is needed (projects with approved funding represented by*).

6/ Project requires removal of fish passage barrier/s.

7/ South Fork tributaries above passage barrier (RM 30).

Stream	Species	Priority1/	Mi. Needing Work			Mi. Riparian Improvement		No. Instr. Struct.		Type of Work or Struct.4/	Cost Estimate by Land Ownership		
			Public	Private	Total	Protection2/	Bank Stab.3/	Boulders	Other		Public	Private	Total
Middle Fork Middle Fork	Ch, St	1	10.0	30.0	40.0	25.0	2.0	8,000	415	BWDPC	261,000	684,000	945,000
Camp Cr.5/	Ch, St	2	11.8	2.0	13.8	2.0	0	1,380	69	BD	128,000	22,000	150,000
Lick Cr.5/	St	2	5.0	0	5.0	0	0	500	25	BD	50,000	0	50,000
W. Fk. Lick Cr.	St	2	2.0	0	2.0	0	0	200	10	BD	20,000	0	20,000
Bridge Cr.	St	3	9.0	0	9.0	0	0	900	90	BDW	135,000	0	135,000
Big Cr.	Ch, St	4	5.0	2.0	7.0	0	0	700	70	BDW	75,000	30,000	105,000
Big Boulder Cr.	Ch, St	5	5.0	5.0	0	0	0	500	50	BDW	75,000	0	75,000
Wray Cr.	St	5	1.6	0	1.6	0	0	160	16	BDW	24,000	0	24,000
Long Creek	St	6	6.0	14.0	20.0	10.0	0.5	2,000	200	BDW	112,000	260,500	372,500
Vinegar Cr.	St	7	6.5	0	6.5	0	0	650	65	BDW	97,500	0	97,500
Granite Boulder Cr.	Ch, St	8	4.0	4.0	0	0	0	400	40	BDW	60,000	0	60,000
Clear Cr.	Ch, St	9	8.0	1.5	9.5	1.5	0.5	950	95	BDW	138,000	26,000	164,000
Beaver Cr.	St	10	2.3	0	2.3	2.3	0	230	23	BDW	48,000	0	48,000
Ruby Cr.	St	11	2.0	0	2.0	1.0	0	200	20	BDW	36,000	0	36,000
Dear Cr.	St	12	2.0	0	2.0	0	0	200	20	BDW	30,000	0	30,000
Davis Cr.	St	13	3.0	0	3.0	0	0	300	30	BDW	45,000	0	45,000
Squaw Cr.	Ch, St	14	5.0	0	5.0	3.0	0	500	50	BDW	93,000	0	93,000
Indian Cr.	Ch, St	15	4.0	2.0	6.0	0	0	200	30	BDWP	10,000	30,000	40,000
Sub-Basin Totals			92.2	51.5	143.7	44.8	3.0	17,970	1,318		1,437,500	1,052,500	2,490,000

1/ Priorities based on opportunity for increased fish production; order of project implementation may vary depending on availability and opportunity (i.e. work loads of implementing agencies in various districts or completion time of pre-project design studies).

2/ Controlled livestock use needed by permanent or temporary riparian corridor fencing, riparian pasture system, or livestock exclusion.

3/ Bank stabilization refers to planting and rock or juniper rip-rap.

4/ Structure types are: W = Weirs; B = Boulder placement; D = Deflectors; R = Removal of barrier; P = Pool excavation; C = Channel restoration.

5/ Past riparian and/or instream work done; more is needed (projects with approved funding represented by*).

Stream	Species	Priority1/	Mi. Needing Work			Mi. Riparian Improvement		No. Instr. Struct.		Type of Work or Struct.4/	Cost Estimate by Land Ownership		
			Public	Private	Total	Protection2/	Bank Stab.3/	Boulders	Other		Public	Private	Total
North Fork North Fork2/*	Ch, St	1	16.5	27.0	43.5	5.0	0	5,050	115	WBDP	390,000	590,000	980,000
Granite/Clear5/*	Ch, St	1	8.0	4.0	12.0	0	0	1,225	65	BD	37,000	60,000	97,000
Desolation Cr.	Ch, St	2	12.0	8.0	20.0	4.0	0	1,600	380	BDWP	180,000	120,000	300,000
Fivemile Cr.6/	St	3	24.0	3.0	27.0	12.0	0	500	240	RBDWP	320,000	50,000	370,000
Camas Cr.	St	4	6.0	10.0	16.0	8.0	2.0	1,150	160	DWP	60,000	248,000	308,000
Owens Cr.	St	4	2.0	8.0	10.0	8.0	2.0	850	100	BDW	20,000	120,000	140,000
Big Wall Cr.	Ch, St	5	6.0	8.0	14.0	5.0	1.0	950	140	BDWP	60,000	175,000	235,000
Little Wall Cr.	St	5	4.0	4.0	8.0	2.0	0	500	80	BDWP	40,000	72,000	112,000
Wilson Cr.	St	6	3.0	3.0	6.0	3.0	0.5	375	60	BDWP	30,000	75,500	105,500
Cottonwood Cr.	St	7	2.0	14.0	16.0	14.0	5.0	1,600	160	BDW	56,000	393,000	449,000
Fox Cr.	St	7	6.0	12.0	18.0	15.0	1.0	1,800	180	BDW	127,000	258,000	385,000
Rudio Cr.	St	8	3.5	5.0	8.5	8.5	0.1	750	75	BDWR	78,000	111,000	189,000
Gilmore Cr.	St	8	0.5	5.0	5.5	5.5	0.1	500	50	BDWR	10,000	108,500	118,500
Potamus Cr.	Ch, St	9	12.0	3.0	15.0	8.0	0	600	150	BWDP	136,000	45,000	181,000
Mallory Cr.	Ch, St	10	5.0	2.5	7.5	1.0	0	375	75	BWDP	50,000	43,500	93,500
Ditch Cr.	Ch, St	10	8.0	5.5	13.5	3.0	0	750	135	BWDP	80,000	100,500	180,500
Stoney Cr.	Ch, St	10	0	6.0	6.0	0	0	600	60	BWDP	0	90,000	90,000
Deer Cr.6/	Ch, St	11	1.0	14.0	15.0	0	0	1,500	150	BWD	15,000	210,000	225,000
Sub-Basin Totals			119.5	142.0	261.5	102.0	9.7	20,675	2,375		1,689,000	2,870,000	4,559,000

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5/ Past riparian and/or instream work done; more is needed (projects with approved funding represented by*).

6/ Project requires removal of fish passage barrier/s.

Stream	Species	Priority1/	Mi. Needing Work			Mi. Riparian Improvement		No. Instr. Struct.		Type of Work or Struct.4/	Cost Estimate by Land Ownership		
			Public	Private	Total	Protection2/	Bank Stab.3/	Boulders	Other		Public	Private	Total
Lower John Day Main Stem	Ch, St	1	11.25	13.75	25.0	15.0	10.0	5,000	0	B	490,500	599,500	1,090,000
Parrish Cr.	St	4	0	12.0	12.0	10.0	1.0	1,200	120	BDW	0	265,000	265,000
Alder Cr.	St	5	2.0	2.0	4.0	4.0	0.1	400	40	BDW	43,250	43,250	86,500
Thirtymile Cr.	St	6	0	25.0	25.0	15.0	2.0	2,500	250	BDW	0	515,000	515,000
Rock Cr.	St	7	7.0	10.0	17.0	4.0	3.0	1,700	170	BDW	146,000	208,000	354,000
Bridge Cr.	St	8	4.0	16.0	20.0	4.0	10.0	2,000	200	BDW	115,000	459,000	574,000
Bear Cr.	St	8	0	6.0	6.0	6.0	1.0	600	60	BDW	0	151,000	151,000
Johnson Cr.	St	9	1.0	11.0	12.0	6.0	0	1,200	120	BDW	18,000	198,000	216,000
Squaw Cr.	St	9	2.5	7.5	10.0	5.0	0	1,000	100	BDW	45,000	135,000	180,000
Bologna Cr.	St	9	2.0	4.0	6.0	3.0	0	600	60	BDW	36,000	72,000	108,000
Horseshoe Cr.	St	10	0.5	6.5	7.0	5.0	0.5	700	70	BDW	10,500	137,000	147,500
Service Cr.	St	10	0	10.0	10.0	3.0	0	1,000	100	BDW	0	168,000	168,000
Kahler Cr.	St	11	2.0	6.0	8.0	3.0	0	800	80	BDW	34,500	103,500	138,000
Butte Cr.	St	12	0	20.0	20.0	0	0	2,000	200	BDW	0	300,000	300,000
Sub-Basin Totals			32.25	149.75	187.0	83.0	27.6	20,700	770		938,750	3,354,250	4,293,500

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3/ Bank stabilization refers to planting and rock or juniper rip-rap.

4/ Structure types are: W = Weirs; B = Boulder placement; D = Deflectors; R = Removal of barrier; P = Pool excavation; C = Channel restoration.

APPENDIX F

WATER QUALITY - BENEFICIAL USE IMPAIRMENT

APPENDIX F

BENEFICIAL USE IMPAIRMENT BASED ON WATER QUALITY

Beneficial use may be impaired by degraded water quality. The Environmental Quality Commission has adopted standards identifying water quality levels needed to support specified uses. Data Base Reliability levels used in the following table are:

1 enough data observations for one or more water quality parameters to make statistically significant conclusions.
2 less data available than that needed for statistical significance but observations are available for one or more water quality parameters covering more than one year.
3 not enough observations and only one year or less of data are available.

The suitability of specific streams for irrigation, animal watering, swimming, cold water fish use, and warm water fish use is represented as follows:

PROTECT use is protected by satisfactory water quality.
THREAT water quality is on a downward trend threatening continued use of the water by that use.
IMPAIR water quality is unsatisfactory to protect that use, the use may no longer be available, or the use is stressed to the point that the use is marginal at best.

The following COLD FISH CRITERIA symbols are used to the left of the semicolon (;) to identify specific water quality parameters affecting fish use:

T temperatures
S suspended solids
P pH

The following COLD FISH CRITERIA symbols are used to the right of the semicolon (;) to identify the extent to which sediment loading affects fish use:

S severe sediment impact on cold fish habitat
M moderate sediment impact on cold fish habitat.

4077D

SITE NAME	RIVER MILE	DATA BASE RELIABILITY	IRRIGATION	ANIMAL WATERING	SWIMMING	COLD WATER FISHERY	WARM WATER FISHERY	COLD FISH CRITERIA
UPPER MAINSTEM SUBBASIN		Level						
John Day R @ Picture Gorge	205.0	2	PROTECT	PROTECT		THREAT	PROTECT	T;M
John Day R @ Bl S Fk John Day	211.4	3	PROTECT	PROTECT	THREAT	THREAT	PROTECT	T;M
John Day R ab S Fk John Day	213.0	2	PROTECT	PROTECT	THREAT	THREAT	PROTECT	;M
John Day R ab Dayville	215.5	1	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	TS;M
John Day R nr Mt. Vernon	237.2	1	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TSP;M
John Day R @ John Day	247.0	1	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TSP;S
John Day R nr John Day @ Gage	251.0	3	PROTECT	PROTECT		THREAT	PROTECT	;M
John Day R @ Prairie City	262.6	2	PROTECT	PROTECT		THREAT	PROTECT	T;M
John Day R bl Rail Cr	275.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
Day Cr	1.8	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Belshaw Cr nr Mt. Vernon	0.2	2	PROTECT	PROTECT		IMPAIR	PROTECT	TSP;S
Beech Cr nr Mt. Vernon	0.1	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
E FK Beech Cr - Lower	6.0	3	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TPS;S
E FK Beech Cr - Upper	7.5	3	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TP;S
Lake Cr	2.2	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
Tinker Cr	2.8	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	PT;S
Lower Laycock Cr	2.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Upper Laycock Cr	3.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
Canyon Cr @ John Day	1.0	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Vance Cr	1.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	S;
East Gulch	0.3	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
M FK Canyon Cr	0.1	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
Hall Cr - Lower	2.1	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PS;M
Hall Cr - Upper	2.5	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PS;M
Dixie Cr ab Standard Cr	0.2	3	PROTECT	PROTECT		THREAT	PROTECT	S;M
Standard Cr	0.2	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Strawberry Cr nr Prairie City	0.4	3	PROTECT	PROTECT		PROTECT	PROTECT	;
N FK Reynolds Cr - Lower	2.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
N FK Reynolds Cr - Upper	5.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
SOUTH FORK SUBBASIN								
S FK John Day @ Dayville	0.2	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TSP;M
S FK John Day @ Dayville	0.4	3	PROTECT	PROTECT		THREAT	PROTECT	;M
S FK John Day nr Dayville	5.0	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
S FK John Day bl Black Canyon Cr	14.0	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	T;M
S FK John Day ab Black Canyon Cr	15.0	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	T;M
S FK John Day bl Murderers Cr	17.0	2	PROTECT	PROTECT	THREAT	THREAT	PROTECT	T;M
S FK John Day ab Murderers Cr	18.0	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	T;M
S FK John Day ab Ellingson Mill	30.7	2	PROTECT	PROTECT	IMPAIR	IMPAIR	PROTECT	S;S
S FK John Day ab L Pine Cr	35.2	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Black Canyon Cr	0.4	1	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	T;
Murderers Cr @ Mouth	0.1	2	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	T;M
Murderers Cr bl Cabin Cr	3.8	2	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	T;M
Murderers Cr ab Cabin Cr	4.2	2	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	T;M
Murderers Cr ab Thorn Cr	7.0	2	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	;M
Murderers Cr bl Tex Cr	14.6	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Murderers Cr ab Tex Cr	15.0	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Cabin Cr	0.1	2	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	;M
Todd Cr		2	PROTECT	PROTECT	IMPAIR	THREAT	PROTECT	;M
Duncan Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Thorn Cr	0.1	2	PROTECT	PROTECT	THREAT	THREAT	PROTECT	;M
S FK Murderers Cr @ Mouth	0.2	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
S FK Murderers Cr @ R-1537	3.8	2	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	;S
Tex Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Deer Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Vester Cr Lower	0.2	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PS;M
Vester Cr Upper	0.6	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PS;M
Indian Cr	0.1	3	PROTECT	PROTECT		THREAT	PROTECT	;M

@ = at
ab = above
nr = near
bl = below

SITE NAME	RIVER MILE	DATA BASE RELIABILITY	IRRIGATION	ANIMAL WATERING	SWIMMING	COLD WATER FISHERY	WARM WATER FISHERY	COLD FISH CRITERIA
MIDDLE MAINSTEM SUBBASIN		Level						
John Day R @ Clarno	109.3	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
John Day R @ Service Cr	156.7	1	PROTECT	PROTECT	THREAT	THREAT	PROTECT	TS;M
John Day R @ Horseshoe Cr	162.0	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
John Day R @ Spray	171.0	3	PROTECT	PROTECT		THREAT	PROTECT	;M
John Day R bl Kimberly	178.0	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
John Day R bl Kimberly	184.0	3	PROTECT	PROTECT	THREAT	THREAT	PROTECT	T;M
John Day R ab Kimberly	185.3	3	PROTECT	PROTECT		THREAT	PROTECT	
Pine Cr	12.7	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Muddy Cr	0.5	3	PROTECT	PROTECT		THREAT	PROTECT	TP;M
Currant Cr	6.5	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Nelson Cr	3.0	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Girds Cr	3.0	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Horseshoe Cr	0.1	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Kahler Cr	8.3	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Tamarack Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TP;
Left Hand Cr	2.4	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Indian Hollow Cr	3.2	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Johnson Cr	9.7	3	PROTECT	PROTECT		PROTECT	PROTECT	;
China Hat Cr	0.2	3	PROTECT	PROTECT		PROTECT	PROTECT	;
McGinnis Cr	0.3	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Squaw Cr	1.5	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Frank Cr	0.5	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Franks Cr	3.0	3	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	PS;S
Buckhorn Cr	0.3	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Indian Cr	0.1	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Indian Cr	2.1	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Rock Cr	1.8	3	PROTECT	PROTECT		THREAT	PROTECT	TP;M
Rock Cr	15.1	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Birch Cr	3.8	3	PROTECT	PROTECT		PROTECT	PROTECT	;
W FK Birch Cr	0.5	3	PROTECT	PROTECT		PROTECT	PROTECT	;
W FK Birch Cr	2.3	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Unnamed Trib to W FK Birch Cr	0.1	3	PROTECT	PROTECT		PROTECT	PROTECT	;
E FK Birch Cr	1.0	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Willow Cr	0.5	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
Fopiano Cr	0.2	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
MIDDLE FORK SUBBASIN								
M FK John Day @ Ritter	15.0	2	PROTECT	PROTECT		THREAT	PROTECT	T;M
M FK John Day ab Highway 395	23.7	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	T;M
M FK John Day @ Highway 395	25.0	2	PROTECT	PROTECT		THREAT	PROTECT	;M
M FK John Day nr Bates	66.7	2	PROTECT	PROTECT		THREAT	PROTECT	;M
M FK John D E of Austin Whitney Rd	68.5	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Long Cr @ Highway 395	20.1	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Flood Meadows	33.0	1	PROTECT	PROTECT	THREAT	IMPAIR	THREAT	TPS;M
Pass Cr	4.0	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TS;S
Keeney Meadows	6.8	1	PROTECT	PROTECT	THREAT	IMPAIR	THREAT	TPS;M
Indian Cr bl L Indian Cr	3.2	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Indian Cr ab L Indian Cr	3.5	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Indian Cr Bl S-876	4.0	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
Indian Cr Bl S-815	8.7	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	S;
L Indian Cr ab Indian Cr	0.1	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
L Indian Cr bl S-713C	1.2	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
L Indian Cr Bl S-815	2.8	2	PROTECT	PROTECT		PROTECT	PROTECT	;
Big Cr Lower	2.4	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Big Cr Upper	4.8	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Big Cr nr Onion Gulch	4.8	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Big Cr @ S-998	5.8	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Big Cr	10.0	1	PROTECT	PROTECT	PROTECT	THREAT	THREAT	P;M
Ragged Cr	1.0	1	PROTECT	PROTECT	THREAT	PROTECT	PROTECT	P;
Blackeye Cr	0.2	1	PROTECT	PROTECT	THREAT	THREAT	THREAT	P;M
E Little Butte Cr	0.1	1	PROTECT	PROTECT	THREAT	THREAT	THREAT	P;M
W Little Butte Cr	1.0	1	PROTECT	PROTECT	THREAT	THREAT	PROTECT	P;M
Little Boulder Cr	2.2	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
Caribou Cr	0.4	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TPS;M

@ = at
ab = above
nr = near
bl = below

SITE NAME	RIVER MILE	DATA BASE RELIABILITY	IRRIGATION	ANIMAL WATERING	SWIMMING	COLD WATER FISHERY	WARM WATER FISHERY	COLD FISH CRITERIA
NORTH FORK SUBBASIN		Level						
N FK John Day @ Kimberly	0.1	1	PROTECT	PROTECT	THREAT	THREAT	PROTECT	T;M
N FK John Day @ Monument	15.3	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
N FK John Day bl Camas Cr	56.0	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	T;M
N FK John Day	56.6	3	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TSP;M
N FK John Day	59.0	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	SP;
N FK John Day @ Highway 395	60.0	2	PROTECT	PROTECT		THREAT	PROTECT	S;M
N FK John Day bl Desolation Cr	60.2	3	PROTECT	PROTECT		THREAT	PROTECT	S;M
N FK John Day	73.2	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
N FK John Day	76.6	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
N FK John Day	102.0	1	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	PS;S
Cottonwood Cr @ Mouth	0.1	3	PROTECT	PROTECT		IMPAIR	PROTECT	S;S
E Donaldson Cr	1.6	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	P;S
W Donaldson Cr	0.1	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	P;S
Big Wall Cr	8.3	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PT;M
Big Wall Cr	13.0	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PT;M
Skookum Cr	5.6	1	PROTECT	PROTECT		PROTECT	PROTECT	T;
Swale Cr	12.3	3	PROTECT	PROTECT		PROTECT	PROTECT	;
Bull Prairie Res	2.2-2.4	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PT;
Bull Cr	2.8	1	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	T;
Bull Cr	3.8	1	PROTECT	PROTECT		PROTECT	PROTECT	T;
Penland Lk	10.8	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TPS;
Mallory Cr ab Penland Lk	12.5	2	PROTECT	PROTECT		PROTECT	PROTECT	S;
Potamus Cr @ S-543	9.7	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	T;M
Potamus Cr	14.4	3	PROTECT	PROTECT	PROTECT	THREAT	THREAT	P;M
Camas Cr nr Highway 395	0.1	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Camas Cr nr Ukiah	19.0	3	PROTECT	PROTECT		IMPAIR	PROTECT	T;S
Camas Cr nr Lehman Sprgs	29.0	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Camas Cr	33.5	2	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TSP;S
Fivemile Cr	3.2	1						
Fivemile Cr @ Guliford Xing	8.4	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Fivemile Cr @ Diversion Dam	11.2	3	PROTECT	PROTECT		THREAT	PROTECT	S;M
Silver Cr @ S-419	1.1	3	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	;M
Taylor Cr	1.6	3						
Owens Cr	0.5	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Snipe Cr 4.5 Mi NNW of Ukiah	3.2	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Cable Cr	6.8	1	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TPS;S
Hidaway Cr @ S-20	5.0	1	PROTECT	PROTECT		IMPAIR	PROTECT	T;S
Lane Cr	0.1	2	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	T;S
Line Cr	0.1	2	PROTECT	PROTECT		IMPAIR	PROTECT	S;S
Line Cr	0.4	3	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	S;S
Line Cr	1.5	3	PROTECT	PROTECT		IMPAIR	PROTECT	S;S
Bowman Cr	0.1	2	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	P;S
Rancheria Cr	0.1	2	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	SP;S
Hinton Cr	0.2	1	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	TPS;M
Meadow Brook	0.4	1	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	TSP;M
Meadow Brook	0.8	1	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	TSP;M
E FK Meadow Brook	0.1	1	PROTECT	PROTECT	THREAT	IMPAIR	THREAT	TSP;
Bully Cr ab Brush Cr	0.2	2	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	TSP;M
Brush Cr	2.5	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Smith Cr	0.2	2	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	TSP;M
W FK Meadow Brook	0.6	2	PROTECT	PROTECT	THREAT	IMPAIR	THREAT	TSP;m
W W FK Meadow Brook	6.8	2	PROTECT	PROTECT	PROTECT	THREAT	THREAT	SP;M
Desolation Cr	0.3	1	PROTECT	PROTECT	PROTECT	THREAT	THREAT	SP;M
Desolation Ford	3.0	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	PS;M
Desolation Cr	12.4	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	SP;M
Hog Cr	0.4	2	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TSP;M
Skinner Cr	0.2	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Snapp Sprg	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
Park Cr	0.1	2	PROTECT	PROTECT	THREAT	THREAT	PROTECT	PS;M
Bruin Cr	0.1	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	SP;M
Junkens Cr	0.1	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	SP;M
Welch Cr	0.1	1	PROTECT	PROTECT	PROTECT	IMPAIR	PROTECT	TSP;M
Beeman Cr	0.1	1	PROTECT	PROTECT	PROTECT	THREAT	THREAT	PS;M
Battle Cr	0.1	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	SP;M
Sponge Cr	0.1	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TPS;S
Howard Cr	0.1	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M

@ = at
ab = above
nr = near
bl = below

SITE NAME	RIVER MILE	DATA BASE RELIABILITY	IRRIGATION	ANIMAL WATERING	SWIMMING	COLD WATER FISHERY	WARM WATER FISHERY	COLD FISH CRITERIA
NORTH FORK SUBBASIN (continued)		Level						
S FK Desolation Cr	0.8	3	PROTECT	PROTECT		THREAT	PROTECT	;M
N FK Desolation Cr	1.0	2	PROTECT	PROTECT			PROTECT	P;M
N FK Desolation Cr	3.7	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
Trough Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	P;M
Oriental Cr	0.2	1	PROTECT	PROTECT	PROTECT	THREAT	THREAT	SP;M
Big Cr	0.2	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Big Cr	2.7	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
Winom Cr	4.8	1	PROTECT	PROTECT		PROTECT	PROTECT	S;
Meadow Cr bl S FK	2.7	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TP;
Meadow Cr ab S FK	3.0	2	PROTECT	PROTECT	THREAT	THREAT	PROTECT	TDP;
Meadow Cr N of Private Land	3.8	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TSP;
Meadow Cr	5.2	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TSP;
Meadow Cr	6.5	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	T;
Meadow Cr	6.9	2	PROTECT	PROTECT	PROTECT	THREAT	THREAT	TP;
Meadow Cr @ Trail 3021	7.7	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
S FK Meadow Cr	0.1	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TP;
White Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TP;
Squaw Cr	0.1	2	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TP;
Unnamed Cr Trib	0.1	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Olive Lake	7.2-8.0	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Lost Cr	1.2	1	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Tencent Leach Pad	1.0	3						
Rasmussen Mining	1.4	3						
Clear Cr	0.2	1	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Clear Cr	0.4	2	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	TP;S
Clear Cr	4.8	3	PROTECT	PROTECT	PROTECT	IMPAIR	THREAT	P;S
Clear Cr	6.6	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Congo Gulch	1.3	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;M
Congo Gulch	1.6	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Ruby Cr	0.2	1	PROTECT	PROTECT		THREAT	PROTECT	TS;M
Beaver Cr	0.8	2	PROTECT	PROTECT		THREAT	PROTECT	;M
Trout Cr	0.1	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	T;
Trout Cr	1.7	1	PROTECT	PROTECT	PROTECT	THREAT	PROTECT	TP;
Unnamed Stream	0.1	1	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
Unnamed Stream	0.5	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	;
Unnamed Stream	0.9	3	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
E FK Trout Cr	0.2	2	PROTECT	PROTECT	PROTECT	PROTECT	PROTECT	P;
LOWER SUBBASIN								
John Day R @ McDonald Ferry	20.9	1	PROTECT	PROTECT	THREAT	IMPAIR	PROTECT	TSP;S
John Day R @ Highway 206	39.7	1	PROTECT	PROTECT	THREAT	IMPAIR	THREAT	TSP;S
John Day R ab Thirtymile Cr	85.7	3	PROTECT	PROTECT		IMPAIR	PROTECT	TP;S
Grass Valley Canyon Cr	1.2	3	PROTECT	PROTECT		IMPAIR	THREAT	TP;S
Grass Valley Canyon Cr	8.2	3	PROTECT	PROTECT		IMPAIR	PROTECT	T;S
Rock Cr nr Mouth @ Highway 29+19	0.1	3	PROTECT	PROTECT		THREAT	PROTECT	S;M
Rock Cr ab Whyte Pk	39.7	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Rock Cr	48.3	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Hay Cr	9.6	3	PROTECT	PROTECT		IMPAIR	THREAT	TP;S
Hay Cr	12.7	3	PROTECT	PROTECT		IMPAIR	PROTECT	;S
Ferry Canyon Cr	0.3	3	PROTECT	PROTECT		IMPAIR	THREAT	TP;S
L Ferry Canyon Cr	0.2	3	PROTECT	PROTECT		IMPAIR	PROTECT	TP;S
Jacknife Canyon Cr	1.3	3	PROTECT	PROTECT		IMPAIR	PROTECT	T;S
Thirty Mile Cr	1.6	3	PROTECT	PROTECT		THREAT	THREAT	TP;M
Condon Cr	0.8	3	PROTECT	PROTECT		THREAT	PROTECT	TP;M
E Fk 30 Mile Cr	3.3	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Pine Hollow Cr	8.2	3	PROTECT	PROTECT		THREAT	PROTECT	T;M
Long Hollow Cr	0.7	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Brush Canyon Cr	4.5	3	PROTECT	PROTECT		THREAT	PROTECT	;M
Sorefoot Cr	1.2	3	PROTECT	PROTECT		THREAT	THREAT	TP;M

@ = at
ab = above
nr = near
bl = below

APPENDIX G

TABLES OF MEASURES

APPENDIX G

TABLE OF MEASURES

EQUIVALENTS

Linear Measurements:

1 inch	=	2.54 centimeters
1 foot	=	30.48 centimeters
1 meter	=	39.37 inches
1 mile	=	1.609 kilometers
1 kilometer	=	0.621 miles

Areal Measurements:

1 acre	=	43,560 square ft.
	=	4,047 square meters
	=	0.404 hectares
1 hectare	=	2.47 acres
1 square mile	=	640 acres
	=	258.998 hectares
	=	2.589 kilometers

Water volume measurements:

1 gallon	=	8.34 pounds
1 cubic ft.	=	62.4 pounds
	=	7.48 gallons
1 acre-foot	=	325,851 gallons
		43,560 cubic ft.

1 cubic foot per second (cfs) = 7.48 gallons per second
= 448.8 gallons per minute
= 646,272 gallons per day

1 inch of rain = 17.4 million gallons per square mile
27,200 gallons per acre
100 tons per acre

CONVERSIONS

(cfs) X (days in month) X 1.9835 = acre-feet per month

(acre-feet) / 1.9835 / (days in month) = cfs

Degrees centigrade = 5/9 X (degrees fahrenheit - 32)

4077D

APPENDIX H

TABLE OF ABBREVIATIONS

APPENDIX H

TABLE OF ABBREVIATIONS

AC-FT	acre-feet or acre foot; volume of 1 acre covered by 1 foot.
AF	acre-feet or acre-foot; volume of 1 acre covered by 1 foot.
ASCS	Agricultural Stabilization and Conservation Service
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
°C	Degrees centigrade
CFS	cubic feet per second
DEQ	(Oregon) Department of Environmental Quality
DOA	(Oregon) Department of Agriculture
DOGAMI	(Oregon) Department of Geology and Mineral Industries
°F	Degrees fahrenheit
FD	(Oregon) Department of Forestry
FT^3/SEC	cubic feet per second
GPM	gallons per minute
MBF	thousand board feet
MI^2	square miles
MMBF	million board feet
NPS	National Park Service
NWPPC	Northwest Power Planning Council
ODFW	Oregon Department of Fish and Wildlife
ORS	Oregon Revised Statutes
SCS	Soil Conservation Service
SQ.MI	square miles
SWCD	Soil and Water Conservation District
USDI	United States Department of Interior
USFS	United States Forest Service
USGS	United States Geological Survey
WRC	Water Resources Commission
WRD	Water Resources Department

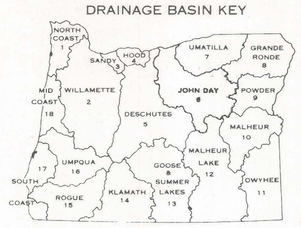
John Day Drainage Basin
FISH HABITAT
1986

KEY

- WARMWATER GAMEFISH HABITAT
- SPRING CHINOOK SPAWNING/REARING HABITAT
- MIGRATION WATERS FOR SPRING CHINOOK AND STEELHEAD. SPAWNING/REARING HABITAT FOR STEELHEAD ABOVE KIMBERLY
- SUMMER STEELHEAD SPAWNING/REARING HABITAT. HABITAT FOR RESIDENT TROUT POPULATION

SOURCE: ODFW

DRAINAGE BASIN KEY



JOHN DAY RIVER SCENIC WATERWAY MILE 10 TO MILE 157

LEGEND

INCORPORATED CITY
- OVER 1,000 ..... JOHN DAY
- UNDER 1,000 ..... MITCHELL

UNINCORPORATED COMMUNITY ..... Clarno
PLACE NAME ..... Mitchell
FORMER COMMUNITY ..... Prairieville
Includes place names of historical significance.
ROADS: PAVED, GRAVEL, DIRT
BOAT LANDING
PARK, CAMPGROUND, ETC.
Includes State parks and waysides, Forest Service camps, BLM camps, County and Municipal parks, Organizational camps, Resorts, and Hunter camps.
RANGER STA., GUARD STA., LOOKOUT
ELEVATION IN FEET: LAND, WATER, ROAD 3079 570 3278

PERENNIAL STREAM, LAKE
INTERMITTENT STREAM, LAKE
STREAM MILES (MILES ABOVE MOUTH) 15
CANAL OR DITCH Trowbridge Ditch
STREAM OR CANAL GAGE 0405
FALLS, RAPIDS Falls
SPRING Cedar Spr
MARSH, MEADOW Marsh Mdw
HYDRO POWER PLANT POWER PLANT
WATER PIPELINE, SIPHON, FLUME, TUNNEL Siphon
WATER TANK WT
MINE MINE
ROAD GATE

MILES 0 1 2 3 4 5
POLYCONIC PROJECTION

WATER RESOURCES DEPARTMENT
SALEM, OREGON
1974 Base

JOHN DAY DRAINAGE BASIN
OREGON

MAP NO. 6.6A

JOHN DAY BASIN

LAND USE CLASSIFICATION BY COUNTY IN ACRES

COUNTY	IRRIGATED AGRICULTURE	NON-IRRIGATED AGRICULTURE	RANGE	FOREST	URBAN	WATER*	OTHER	TOTAL
Crook		45	3,697	16,098				19,840
Gilliam	3,476	251,034	417,997	1,037	738	9,992	2,446	686,720
Grant	40,277	14,480	1,072,363	1,186,238	2,819	355	5,388	2,321,920
Harney			8,451	9,469				17,920
Jefferson	194	607	103,615	10,116		28		114,560
Morrow	2,940	16,741	81,979	149,098	51	58	13	250,880
Sherman	428	165,899	123,701	12,406	361	572	1,273	304,640
Umatilla		765	112,145	197,949	105	9	2,627	313,600
Union			2,103	3,017				5,120
Wasco	823	3,298	107,650		56	126	47	112,000
Wheeler	11,965	24,813	735,726	254,888	436	280	7,412	1,035,520
TOTAL	60,103	477,682	2,769,427	1,840,316	4,566	11,420	19,206	5,182,720
% TOTAL	1.2	9.2	53.4	35.5	.1	.2	.4	100

*Includes only natural and manmade lakes and impoundments.

IRRIGATED AGRICULTURE
Land improved by artificial applications of water through flood, row, sprinkler, drip or other irrigation techniques.

NON-IRRIGATED AGRICULTURE
Land cultivated and/or harvested without benefit of irrigation.

RANGE
Includes areas characterized by grasses, shrubs, meadows, unimproved pasture and scattered trees—especially juniper or oak.

FOREST LAND
Land primarily occupied by, or used to produce trees—both deciduous and conifer. Includes rural wood lots, regenerating cuts and burns as well as mixed and pure stands of merchantable or non-merchantable timber.

URBAN
Residential, commercial, industrial developments, including military installations, airports, or other transportation nuclei, schools, parks, golf courses, etc.

WATER
Natural and man-made waterways and impoundments measurable at the mapped scale.

OTHER
Includes highway interchanges, airstrips, cemeteries, and other developed areas when not adjacent to urban centers, marshes, snow-ice, lava flows, feed lots, quarries, etc.

The Oregon Statewide Land Use Inventory was conducted by the Oregon Water Resources Department for use in its river basin planning activities. Manual photointerpretive techniques were used to interpret 1:130,000 scale, U-2 color infrared photos taken from 1972-1980. Color composite, 1:1,000,000 scale, Landsat satellite imagery acquired during the summers of 1978-1980 was used to update the photos.

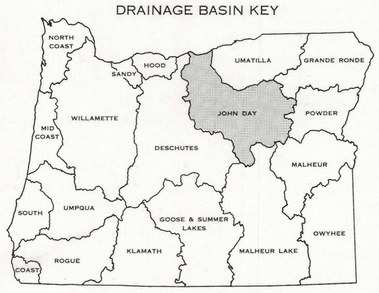
The inventory identifies seven broad land use categories: irrigated agriculture, non-irrigated agriculture, range, forest, urban, water and other. Forest-range and other transition zones were classified subjectively, based on visual similarity to pre-selected models. Descriptions of each category appear in the key.

County and basin land use statistics are shown in the table. Land use configurations, e.g., water courses, transportation routes, etc., whose areas are indeterminate at this scale, are not accounted for in the statistic l summary. Detailed work maps and additional basin statistics are available for public inspection at the Oregon Water Resources Department office at 555 13th Street NE., Salem, Oregon 97310.

This inventory was prepared and published in cooperation with the Environmental Remote Sensing Applications Laboratory at Oregon State University, through the Pacific Northwest Regional Commission's Landsat Applications Program.

The John Day Basin Inventory was completed in 1979 using 1975-78 U-2 photos updated with 1978 Landsat imagery.

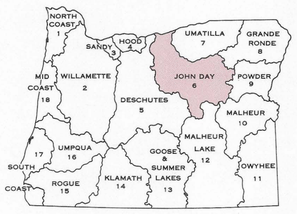
DRAINAGE BASIN KEY



POLYCONIC PROJECTION
MILES
0 1 2 3 4 5
SCALE 1:370,000

WATER RESOURCES DEPARTMENT
SALEM, OREGON

JOHN DAY DRAINAGE BASIN
OREGON
LAND USE
1978



JOHN DAY RIVER SCENIC WATERWAY MILE 10 TO MILE 157

LEGEND

INCORPORATED CITY
OVER 1,000 ..... JOHN DAY
UNDER 1,000 ..... MITCHELL
UNINCORPORATED COMMUNITY ..... Clarno
PLACE NAME ..... McDonald
FORMER COMMUNITY ..... (Francisville)
Includes place names of historical significance.
ROADS: PAVED, GRAVEL, DIRT
BOAT LANDING ..... LDG
PARK, CAMPGROUND, ETC. ..... PP CG PA R C
Includes State parks and waysides, Forest Service camps, BLM camps, County and Municipal parks, Organizational camps, Resorts, and Hunter camps.
RANGER STA., GUARD STA., LOOKOUT ..... RS GS LO
ELEVATION IN FEET: LAND, WATER, ROAD 8079 970 5279

PERENNIAL STREAM, LAKE
INTERMITTENT STREAM, LAKE
STREAM MILES (MILES ABOVE MOUTH) 15
CANAL OR DITCH ..... Trowbridge Ditch
STREAM OR CANAL GAGE 0405
FALLS, RAPIDS ..... Palisades Rapids
SPRING ..... Cutter Spr
MARSH, MEADOW ..... Swamp Mdw
HYDRO POWER PLANT ..... POWER PLANT
WATER PIPELINE, SIPHON, FLUME, TUNNEL ..... Siphon
WATER TANK ..... WT
MINE ..... MINE
ROAD GATE
WILDERNESS AREA (Boundaries Indefinite)

MILES 1 0 1 2 3 4 5
POLYCONIC PROJECTION

WATER RESOURCES DEPARTMENT
SALEM, OREGON
1986

JOHN DAY DRAINAGE BASIN
OREGON

MAP NO. 6.6