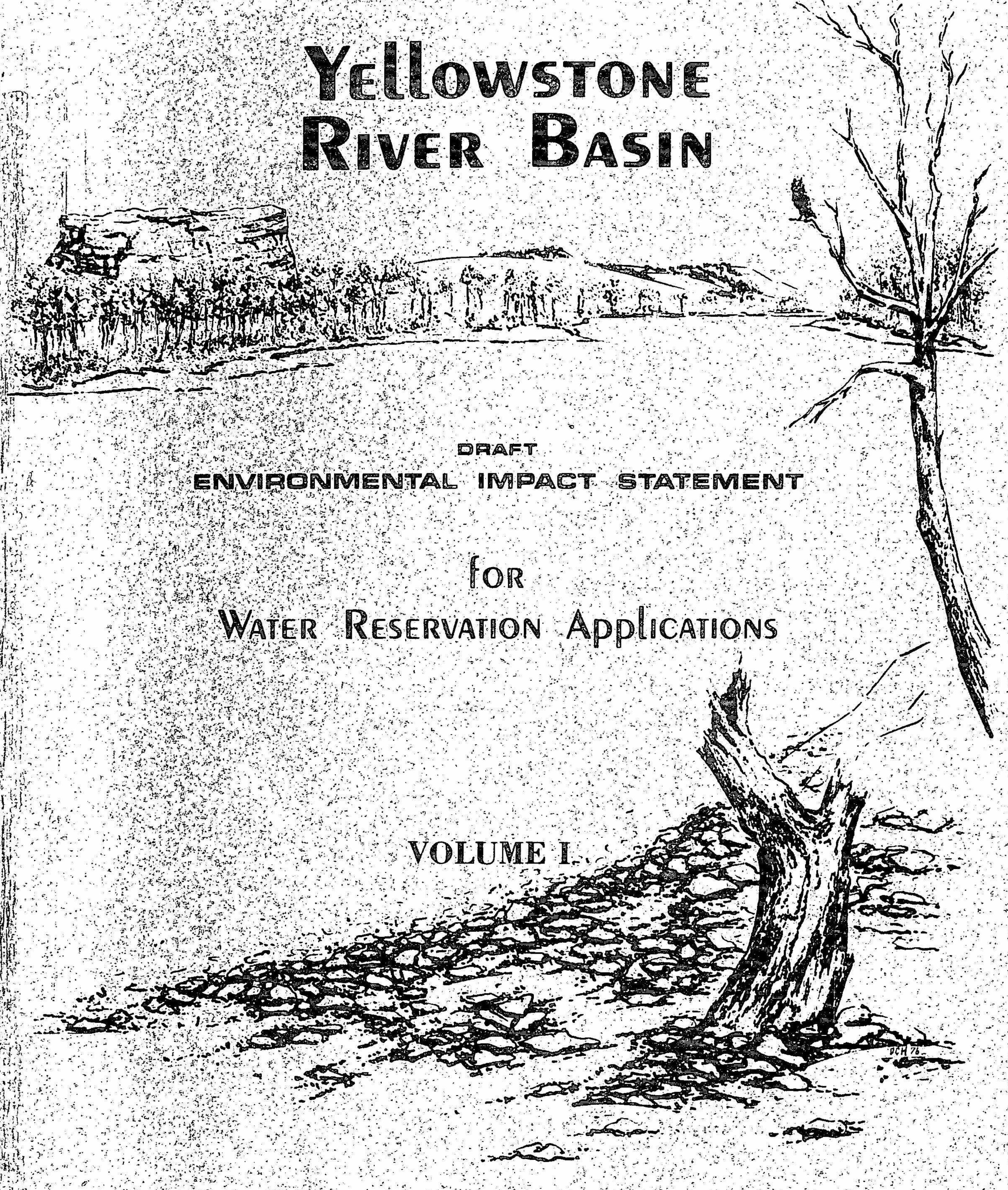
Yellowstone River Basin



DRAFT

ENVIRONMENTAL IMPACT STATEMENT

for

Water Reservation Applications

VOLUME I

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

DNRC

WATER RESOURCES DIVISION

DECEMBER 1976

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

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December 13, 1976

Enclosed is the Draft Environmental Impact Statement (EIS) concerning water reservation applications in the Yellowstone River Basin. All applications were received prior to November 5, 1976, and have been processed together.

In accordance with the Montana Water Use Act, the entire set of applications was announced in newspapers throughout the state, concentrating on those in the Yellowstone Basin, during the three weeks beginning November 8, 1976. At the same time, individuals whose water rights may be affected, according to Department records, were also notified of the applications. The 30-day objection period under the Water Use Act ends on December 31, 1976, for most applications; the objection period extends to January 10, 1977, for applications regarding the Powder and Tongue rivers, their tributaries, and Rosebud Creek. Hearings will then be held as shown in the following schedule; a complete listing of the applications to be considered appears at the end of this letter.

Community	Dates	Water Reservation Applications Considered
Livingston	January 3 & 4	Group 1
Billings	January 5 & 6	Group 2
Miles City	January 11 & 12	Group 3
Glendive	January 13 & 14	Group 4

When the exact times and locations of the hearings have been determined, objectors will receive written notice, and announcements will also be made through the news media.

Concurrently, the EIS process required by Montana Environmental Policy Act and its guidelines involves preparation of this draft, followed by a 30-day review period to receive written comments. Comments on this draft EIS will also be received before and during the same hearings mentioned above. The law allows for a 15-day extension of the comment period; however, in this case, severe time constraints preclude an extension, and written comments must be received by January 11, 1977.

A final EIS will then be prepared by this Department and distributed for another 30-day public review. The final EIS will consider public and agency comments and include Department recommendations for action by the Board of Natural Resources and Conservation on the applications. The Board will then consider adoption of an order on each water reservation application prior to the end of the Yellowstone Moratorium on March 10, 1977.

Sincerely,

Wayne Wetzel

WAYNE WETZEL
ENVIRONMENTAL COORDINATOR

WW:bjh

GROUP 1

Park Conservation District
Sweet Grass Conservation District
Montana Department of State Lands
City of Livingston
City of Big Timber
Montana Fish and Game Commission
Montana Department of Health and Environmental Sciences

GROUP 2

Stillwater Conservation District
Carbon Conservation District
Yellowstone Conservation District
Big Horn Conservation District
Huntley Irrigation Project
Montana Department of State Lands
City of Columbus
City of Laurel
City of Billings
Montana Fish and Game Commission
Montana Department of Health and Environmental Sciences

GROUP 3

Treasure Conservation District
Rosebud Conservation District
North Custer Conservation District
Powder River Conservation District
Montana Department of State Lands
City of Miles City
Town of Broadus
Montana Department of Natural Resources and Conservation
Montana Fish and Game Commission
Montana Department of Health and and Environmental Sciences

GROUP 4

Prairie County Conservation District
Dawson County Conservation District
Richland County Conservation District
Buffalo Rapids Irrigation Project
Montana Department of State Lands
City of Glendive
Montana Department of Natural Resources and Conservation
Montana Fish and Game Commission
Montana Department of Health and and Environmental Sciences

VOLUME I

DRAFT

ENVIRONMENTAL IMPACT STATEMENT

FOR

WATER RESERVATION APPLICATIONS

IN THE

YELLOWSTONE RIVER BASIN

December 1976

Water Resources Division
MONTANA DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
32 S. Ewing
Helena, Montana 59601

CONTENTS

Volume I

Volume II

MAPS

FIGURES

FIGURES, continued

TABLES

TABLES, continued

TABLES, continued

TABLES, continued

INTRODUCTION

LEGAL BASIS FOR WATER RESERVATIONS

MONTANA WATER USE ACT

Under the 1973 Montana Water Use Act (Section 89-865 et seq. R.C.M. 1947), state and federal agencies, as well as political subdivisions of the state, may apply to the Board of Natural Resources and Conservation (called the "Board" throughout this Environmental Impact Statement) to reserve water for existing or future beneficial uses, or to maintain a minimum flow, level, or quality of water. Before an order reserving water may be adopted, the applicant must establish to the Board's satisfaction:

1) the purpose of the reservation
2) the need for the reservation
3) the amount of water necessary for the purpose of the reservation
4) that the reservation is in the public interest.

A water reservation, when adopted, becomes a water right. However, if objectives of the reservation are not being met, the Board can later modify that water right. In addition, if the use of the reserved water requires diversion or storage, progress must be shown, over time, towards completion of those facilities. Such progress is to follow a previously submitted plan.

YELLOWSTONE MORATORIUM

Under the Montana Water Use Act, new water rights are established through the issuance of permits by the Department of Natural Resources and Conservation (DNRC). However, the Yellowstone Moratorium (Section 89-8-103 et seq. R.C.M. 1947), enacted in 1974, suspended all large applications (diversions of over 20 cfs or storage of over 14,000 af) for water use permits in the Yellowstone Basin until March 10, 1977. In addition, the Moratorium excluded reservations in the basin by federal agencies for three years.

A substantial number of applications, all of which are primarily for industrial water use, were suspended. The language of the Moratorium emphasized the need for reserving water in the Yellowstone Basin for the protection of existing and future beneficial water uses; particular emphasis was given to the reservation of water for agricultural and municipal needs, as well as guaranteed minimum flows for the protection of existing rights, future uses, water quality, and aquatic life.

By law, water use permits now pending will begin to be processed by DNRC on March 16, 1977. The priority date of any new water right subsequently approved will reflect the original date of application. However, any water reservation approved by the Board prior to the approval of these permits will have a preference of use over the permits.

WATER RESERVATION REQUESTS

Thirty reservation requests have been received for waters of the Yellowstone Basin.

Water for future irrigation consumption was requested by 13 conservation districts, two irrigation districts, and the Department of State Lands (three applications); water for domestic or municipal consumption was requested by eight municipalities. Some uses under multipurpose requests by DNRC in applications on the Tongue and Powder rivers would also be consumptive. The levels of consumptive use requested would involve the total diversion of 391,500 af/y for municipal/domestic, 1,600,000 af/y for multipurpose (DNRC requests), and 986,900 af/y for irrigation. (Approximately 29,000 acres, a relatively small portion of the whole, have been duplicated among applications from different irrigation applicants).

Non-consumptive uses, i.e. instream flow purposes, are requested in two major applications. They were submitted by the Montana Fish and Game Commission and the Department of Health and Environmental Sciences. In addition, instream flow purposes are mentioned in all the conservation district applications, although a specific figure was given only by North Custer Conservation District.

The applications are listed in Table 1.

SIGNIFICANCE OF WATER RESERVATIONS

The significance of water reservations cannot be overestimated; their impacts will be felt long after the decisions are made.

Because of the magnitude of the water reservation requests, the wide variety and magnitude of potential water uses, and their basinwide scope, action on these applications could establish future patterns of water use in the Yellowstone Basin.

By affecting both water availability and relative cost, the reservations may determine comparative future roles of irrigated agriculture and energy development. This, in turn, could profoundly affect the economy and future growth of the area. The relationship of consumptive uses of such beneficial instream uses as maintenance of aquatic habitats and water quality could also be defined.

The 1967 Legislative Assembly directed that a state water plan be developed for Montana to guide future water use. That water plan, not yet completed for the Yellowstone Basin, is scheduled to be finished by mid-1978. However, many of the options available under the water plan may be accomplished or foreclosed through the decisions on reservation requests. Hence, the Board's action may, at least in part, constitute the framework of the state water plan.

TABLE 1

APPLICATIONS FOR RESERVATIONS OF WATER IN YELLOWSTONE BASIN

Applicant	Source	Amount	Use
Park Conservation District	Yellowstone & Shields River	752 cfs/108,143 acre feet per year (af/y)	Irrigation (36,570 acres)
Sweet Grass Conservation District	Yellowstone River, Boulder River & various tributaries	438.7 cfs/55,822 af/y	Irrigation (18,510 acres)
Stillwater Conservation District	Yellowstone River & Stillwater River	122.1 cfs/16,755 af/y	Irrigation (5,290 acres)
Carbon Conservation District	Yellowstone River, Clarks Fork, Rock Creek, Red Lodge Creek	274.2 cfs/47,557 af/y	Irrigation (21,015 acres)
Yellowstone Conservation District	Yellowstone River	378.2 cfs/62,900 af/y	Irrigation (26,785 acres)
Big Horn Conservation District	Big Horn River, Tongue River	151 cfs/21,200 af/y	Irrigation (9,645 acres)
Treasure Conservation District	Yellowstone & Big Horn Rivers, Sarpy & Tullock Creeks	129 cfs/19,978 af/y	Irrigation (7,645 acres)
Rosebud Conservation District	Yellowstone, Tongue Rivers, Armell's & Rosebud Creeks	585 cfs/94,129 af/y	Irrigation (37,360 acres)
North Custer Conservation District	Yellowstone River, Tongue River & Powder River	732.4 cfs/104,237 af/y	Irrigation (36, 965 acres)
Powder River Conservation District	Powder River, Tongue River, & various tributaries	583.2 cfs/83,060 af/y	Irrigation (30,245 acres)
Prairie County Conservation District	Yellowstone River	512.9 cfs/63,127 af/y	Irrigation (20,646 acres)
Dawson County Conservation District	Yellowstone River	325 cfs/45,149 af/y	Irrigation (17,897 acres)
Richland County Conservation District	Yellowstone River	354.2 cfs/45,620 af/y	Irrigation (21,710 acres)

TABLE 1 continued

Applicant	Source	Amount	Use
Huntley Project Irrigation District	Yellowstone River	92 cfs/27,372 af/y	Irrigation (4,000 acres)
Buffalo Rapids Irrigation Project	Yellowstone River	167 cfs/124,434 af/y	Irrigation (41,306 acres)
Department of State Lands	Numerous tributaries in Yellowstone Basin	15,078 af/y	Irrigation (10,270 acres)
Department of State Lands	Numerous tributaries in Yellowstone Basin	143.64 cfs/21,429 af/y	Irrigation (7,143 acres)
Department of State Lands	Numerous tributaries in Yellowstone Basin	218.03 cfs/30,898 af/y	Irrigation (10,376 acres)
City of Livingston	Yellowstone River	20.8 cfs/15,060 acre feet per year (af/y)	Domestic, Municipal
City of Big Timber	Yellowstone River	6.19 cfs/4,483 af/y	Domestic, Municipal
City of Columbus	Yellowstone River	3.6 cfs/2,606 af/y	Domestic, Munidipal
City of Laurel	Yellowstone River	23.2 cfs/16,830 af/y	Domestic, Municipal
City of Billings	Yellowstone River	1,190 cfs/317,456 af/y	All Beneficial Uses
City of Miles City	Yellowstone River	30 cfs/21,720 af/y	Municipal
Town of Broadus	Ground Water	0.84 cfs/605 af/y	Municipal
City of Glendive	Yellowstone	17.62 cfs/12,756.9 af/y	Domestic, Municipal
Department of Natural Resources and Conservation	Tongue River	450,000 acre-feet (af)	Irrigation, Industrial, Fish & Wildlife
Department of Natural Resources and Conservation	Powder River & tributaries	1,150,000 af	Irrigation, Industrial, Fish & Wildlife
Montana Fish and Game Commission	Yellowstone Basin and numerous tributaries	Variable monthly flows; 8,206,723 af/y for Yellowstone River at Sidney	Water Quality, Fish & Wildlife, Recreation
Department of Health and Environmental Sciences	Yellowstone River	6,643,000 af/y for Yellowstone River at Sidney	Water Quality

These are some of the major issues to be dealt with by the Board:

1) How should the water be shared between consumptive and instream uses?

2) Should preference be given to some uses over others, by approving different priority dates for each use?

3) For how long should water be reserved? To the year 2000? Beyond?

4) Should some flow be left unreserved?

5) Should the amount of the instream flow reservations be variable--based on the runoff available each year?

Because of the relatively scarce water supply and the high projected demands, the Tongue and Powder river basins will be the primary focus of water resource allocation in the Yellowstone Basin. Plans are under consideration by private, state, and federal entities for providing storage facilities; potential exists for joint projects with the state of Wyoming as well.

It appears that water quality and high costs could be significant constraints on the type of development that occurs in these two subbasins. In the event that Tongue and Powder storage is impractical for economic, environmental, or institutional reasons, other alternatives could be considered -- such as use of Yellowstone mainstem water through offstream storage and aqueducts.

EXISTING WATER RIGHT IMPLICATIONS

There is not enough water physically in the basin to satisfy all water reservation requests that have been filed. In addition, due to legal difficulties, it is not presently known exactly how much unappropriated water is available.

At present, rights to the use of certain water in the Yellowstone Basin legally belong to established entities, and that water may not be available to other users.

First, there are existing water rights of individuals. Because of a lack of documentation concerning historical and existing water use, procedures for the determination and adjudication of these existing water rights can not be quantified until the adjudication process is complete, several years hence.

Second, there is water that originates on, passes through or adjacent to Indian lands. It is claimed that water was impliedly reserved with historically reserved lands for Indian use. However, the actual amount of water is in dispute, and will be settled in court. Similarly, water rights associated with certain federal lands have not yet been determined. Further litigation is pending on all the above rights.

Finally, the governments of Montana, Wyoming, and North Dakota entered into an agreement in 1950 allocating Yellowstone Basin water. This agreement, known as the Yellowstone Compact, expressed the amounts of water as a percentage of the total flow. Unfortunately, several assumptions must be agreed to by all parties involved before these percentages can be applied.

All existing water rights, whether quantified or not, are protected under the law. However, several of the water reservations, if fully granted, might adversely affect existing rights. Implementation of conservation district applications in the Shields River and Sweet Grass Creek, for example, would have to be carefully monitored to ensure that prior rights were protected. Adjudication of these streams, under the 1973 Water Use Act, would have to be completed, and water commissioners appointed by the court, before complete protection of those rights could be assured.

One purpose of the water reservation hearings, to be held under the Water Use Act, is to solicit information regarding the effect of water reservations on existing water rights. However, it is beyond the scope of this document to examine those effects in detail.

THE IMPACT STATEMENT

In many ways this document is unique, partly because the water reservation process itself is unique. Both the Board and DNRC are presented with the possibility of an entirely new kind of action, affecting or preserving Montana's resources and environment in ways not possible in the past.

Whenever a proposed action is major and may significantly affect the quality of the human environment, or is controversial, the Montana Environmental Policy Act (MEPA), guidelines adopted by the Montana Environmental Quality Council, and rules adopted by both the Board and DNRC require preparation of an environmental impact statement (EIS). The purpose of the EIS is to examine the potential consequences of the proposed action, present alternatives, inform the public, and guide the Board in its deliberations.

It is possible that certain individual water reservations, as proposed, will result in significant environmental impacts. In addition, allocating Yellowstone Basin water through a combination of these reservations would have basin-wide, cumulative effects which must be identified. Consequently, this EIS examines not only the anticipated impacts of each proposed reservation, but also the generalized regional impacts that could occur through approval of such a combination.

Because thirty applications are involved, and because each may be granted, modified, or denied, the number of these possible combinations is extraordinary. Action on any one proposal will limit possible actions on at least some of the others. The interrelationships are highly complex, and the impacts will be cumulative. Therefore, unlike any EIS prepared by DNRC in the past, this document is more programmatic in nature than a detailed analysis limited to a specific project.

The scale of possible consequences represented by the requests is imposing. The extent and variation of land areas involved, the quantities of water requested, the number of streams and tributaries potentially affected, and the development time periods required make analysis very complex. In addition, most of the applications present general proposals for the future, and specific project data are not available. In some cases, preparation of a more detailed impact statement, specific to that single project, may be required.

Much of the analytic data presented was made possible through an Old West Regional Commission grant to DNRC for the Yellowstone Impact Study, an investigation into impacts of water withdrawals from the middle and lower Yellowstone Basin. The Departments of Fish and Game and Health and Environmental Sciences also contributed to the Yellowstone Impact Study, as well as to the preparation and review of this EIS.

SUMMARY

PART I--EXISTING ENVIRONMENT

Part I describes the existing natural and cultural environments in Montana's portion of the Yellowstone Basin. From alpine crags to semiarid plains, the basin exhibits a wide variety of land, vegetation, climate, wildlife, and water resources.

The Yellowstone River is unique among the nation's major rivers. Two tributaries, the Tongue and Bighorn rivers, are regulated; but the Yellowstone mainstem is virtually unimpounded for its entire 670-mile length. Headwaters of the basin are in the high mountains of southcentral Montana and northwestern Wyoming. Winter accumulation and summer melting of this variable snowpack give the Yellowstone River its basic characteristics of high spring runoff and low flows through the fall and winter.

Streamflow records, adjusted to reflect the 1970 level of development, show that the average annual runoff from the Yellowstone Basin is 8.8 million acre-feet (mmaf). Most of this water originates in the Yellowstone mainstem and the Bighorn River. The maximum and minimum recorded annual basin outflows were 15.4 and 3.4 mmaf, respectively.

The major use of water in the basin (including Wyoming's portion) is irrigation, which consumes up to 3.5 million acre-feet per year. Amounts consumed in municipal and industrial uses are comparatively much smaller.

A major instream use of Yellowstone water is recreation. Because of the region's sparse population and somewhat limited access to the river, the actual use is much less than the potential.

With only a few impoundments and a variability in seasonal and yearly flow, water availability is a problem in some parts of the basin--especially in the Tongue and Powder rivers, both lower basin tributaries.

The basin's water quality is generally good, especially in the upper basin. In the lower basin, water quality is altered by increases in temperature, total dissolved solids, and turbidity.

The Yellowstone mainstem has a predominantly braided channel. This channel form, with its islands, bars, and backwaters, sustains many terrestrial and aquatic wildlife species. In its headwaters, the Yellowstone is a nationally renowned trout stream. In the lower part of the basin, the system sustains a productive warm-water fishery of nonsalmonid species. A more extensive discussion of these fisheries is included in the aquatic wildlife section of Part I.

The region's economy is basically agricultural, although coal mining and conversion are rapidly increasing in importance. Montana leads the nation in strippable coal reserves with over 50 billion tons. In recent years, interest in this coal has highlighted the importance of water to energy production.

SUMMARY, PART II--METHODOLOGY FOR EVALUATION OF IMPACTS

Because of the vastness and diversity of the basin, analysis and planning were done on the basis of the nine hydrologic subbasins.

The hydrology of each planning subbasin was analyzed by computer, taking into account such natural and human influences as precipitation, wind, snowmelt, evapotranspiration, ground-water storage, and irrigation. The computer model was used to predict monthly subbasin outflows for conditions that could occur in connection with water reservations. In addition, the model has been modified to include calculations for predicting concentrations of total dissolved solids (TDS).

Monthly subbasin outflows and TDS concentrations predicted by the model provided the basis for assessing environmental impacts, which are considered to be either "primary" or "secondary." Primary impacts are those on the river system itself, considering such features as monthly streamflows, water quality, channel form, and aquatic and riparian wildlife habitats. Secondary impacts, which are not necessarily of lesser importance, are the effects associated with the use of water.

SUMMARY, PART III--WATER RESERVATION APPLICATIONS AND ASSOCIATED IMPACTS

The applications for Yellowstone water reservations, discussed individually in Part III, may be grouped as either consumptive or instream.

Because there is not enough water, physically or legally, in the Yellowstone River and its tributaries to fully satisfy all water reservation applicants, conflicts arise between uses. Although the amounts of water involved in the legal committments have not yet been quantified, it is probable that neither of the two large requests for instream flows can be satisfied without modification. However, most consumptive applications could be. Therefore, the major water availability conflicts are between instream and consumptive use applicants.

CONSUMPTIVE USE APPLICATIONS

IRRIGATION RESERVATION REQUESTS

Conservation Districts

Each of the conservation districts shown in Table 1 has applied for reservation of water for irrigation. The 13 applications are for a total diversion of 757,700 af/y to irrigate 290,000 acres.

Projects identified in the conservation district requests are not necessarily firm commitments for future development. In most cases individual landowners are not even aware that their lands are included. Each conservation district application is based on a reconnaissance soil survey, which involves a general evaluation of land features for preliminary planning of irrigation development. As such, each survey's applicability should be restricted to a determination of the general extent, location, and quality of irrigable areas.

Farm budget analysis was used to determine economic feasibility of conservation district projects. These budgets compute the costs and returns associated with crop production and generalized farm costs, including investment, maintenance, and repairs. According to data submitted in the applications, benefits exceed costs in all cases.

Economic benefits, in the form of increased profits, would accrue to those engaged in irrigation development (the applications foresee $18,775,000 in increased annual profits if all projects were completed). Although it would be spread over a number of years, there would also be secondary income and employment benefits resulting from the installation of new irrigation systems.

Environmental impacts considered in Part III are those that would result from the granting of each application alone, without considering the effects of granting more than one application. If a combination of requests was granted, cumulative impacts would start to occur. Effects of these cumulative development levels are discussed in Part IV, "Alternatives and Associated Impacts."

Most of the conservation district applications, if each were implemented alone, would have only minor impacts on the environment. No immediate physical impacts would result, and the minor impacts of each taken alone would occur gradually as the reserved water was put to use over a period of years. Similar impacts might occur if each application were denied, because irrigation could still be developed under water use permits.

However, there are exceptions. In the upper part of the basin, the applications would call not only for storage, but also for dewatering in a few small streams. The loss of these to migratory (spawning) and resident fish would have an adverse effect on the upper basin fishery. The Shields River and Sweet Grass Creek would be seriously dewatered. Other exceptions are in the Tongue and Powder rivers, where further significant water development would require additional storage. In the Tongue River, the productive fishery would be adversely affected by stream dewatering and degradation of water quality.

Irrigation Districts

Both applications, shown in Table 1, request water from the Yellowstone mainstem. Neither application by itself would significantly affect the river system.

Montana Department of State Lands

In the process of identifying lands that should be included in requests, the conservation districts found that state and federal lands were intermingled with their potential projects. These lands were subsequently excluded from the applications, and the Department of State Lands has applied for a reservation for future irrigation of most of the state land involved.

The farm budget analysis, used for estimating the economic feasibility of this irrigation, found the projects to be feasible. The three requests ask for water from the Yellowstone mainstem and many tributaries. Most of the applications, if implemented alone, would have little effect on the flows of the larger streams. However, storage may be required on the Shields, Powder, and Tongue rivers as well as many smaller streams to avoid late-season supply and water quality problems.

MUNICIPAL RESERVATION REQUESTS

With the exception of Billings, the amounts requested are very small compared to the flow of the Yellowstone River. The Billings request totals 317,456 af/y, with a peak demand of 1,190 cfs. No population projections were given in the application, but the requested quantity could serve a city of about 1,500,000. During January, the request would equal about 37 percent of the 90th-percentile low flow and 18 percent of the median flow. Although half or more of the requested water would probably be returned to the river, making the flow reductions less serious, much of the returned water is likely to be treated wastewater, even if dependably treated by a secondary treatment plant, would adversely affect the river.

MULTIPURPOSE RESERVATION REQUESTS

DNRC has filed two applications for the reservation of water for future storage projects. These would involve storage of 450,000 af on the Tongue River and 1,150,000 af on the Powder River. Construction of the High Tongue Dam (with a firm annual yield of 112,000 af) on the Tongue River and Moorhead Dam (with a firm annual yield of 124,000 af, 75,000 of which is assumed for use in Montana) on the Powder River would be required in order to provide those amounts of storage. In effect, these applications request all unused and unappropriated water in these subbasins upstream of the dam sites.

The water reserved for these multipurpose projects would be for all legally defined beneficial uses. Specifics are not stated because detailed engineering and economic studies are necessary to determine the combination of uses that would maximize benefits.

The impacts of granting these applications would be similar to those discussed in Part IV under the No Action Alternative for the Tongue and Powder subbasins. Industrial use would probably receive the largest allocation, partly because irrigation interests alone may not be able to repay the cost.

The Moorhead Reservoir would have both beneficial and adverse effects. The Powder's fishery, predominately migrant, could change to a resident warmwater type. On the other hand, the reservoir and associated depletions would cause major increases in the total dissolved solids of an already saline river.

<u>INSTREAM FLOW APPLICATIONS</u>

FISH AND GAME COMMISSION

The Commission requested instream flows to protect fish and wildlife, water quality, and recreation values on the Yellowstone and all of the major tributaries, as well as many smaller tributaries. Culminating in a request of 8.2 mmaf/y at Sidney, sizable portions of the average monthly flows were also requested in the four major interstate tributaries.

Requests for many of the smaller streams listed had no specific quantities attached. Generally, the unquantified applications were for the instantaneous flows during late summer, fall, and winter months and the dominant discharge for a brief period during spring months. Instantaneous flows year round were also requested on four spring creeks in the Upper Yellowstone Subbasin.

If this overall request were approved, large benefits would accrue to water quality, fish and wildlife, and recreation values. Although very difficult to quantify in dollars, these benefits also have substantial economic value.

The Yellowstone River and its tributaries presently support a diverse population of fish and wildlife in a nearly natural environment, representing a biologic evolution that cannot be reproduced by man. If future appropriations consume water without regard to the minimum needs of fish and wildlife, these populations will be deprived of habitat requirements.

Minimum instream flows have a cumulative benefit because water retained in the channel serves a variety of uses, such as recreation, fish and wildlife habitat, water quality, aesthetics, effectiveness of diversion structures, and downstream water rights. The value of instream flows must be considered as the sum of all instream benefits, whereas diverted water usually fulfills a single purpose.

Because the major consumptive user in the Yellowstone Basin is agriculture, the costs of instream flows would be the profits foregone by the irrigators denied water to expand because of those reservations. These costs vary with the magnitude of streamflows. When runoff is high, there may be enough water to satisfy both instream flows and agriculture, but when runoff is low more water must remain in the stream, and losses to agriculture would be greater. If it is assumed that instream flow guarantees are the only constraints to irrigation expansion and the full instream requests were implemented, then potential losses to irrigators have been estimated at $7,700,000 for the year 2000. Due to the various factors, this estimate should be considered quite tentative.

If the Fish and Game Commission request was granted in full, energy interests would probably have to meet the expense of building storage facilities or developing ground water for use in low streamflow periods. However, many industrial water permit applications have indicated the willingness of energy-related companies to invest in water storage, diversion, and conveyance facilities.

MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

The purpose of this application, for an instream flow of 6,643,000 af/y in the Yellowstone at Sidney, is to prevent significant degradation and assure Montana water quality standards.

For water quality purposes, the majority of the river's reach considered in this application is classed B-D3. In the request's justification, it is asserted that, by virtue of the B-D3 water quality classification of the Yellowstone, the water cannot legally be allowed to exceed recommended limits for dissolved solids and sulfates. Thus, any flow level below the amount necessary to maintain established limits would be prohibited by law. Based on these criteria, the requested flows were determined by various methodologies included in the application.

This request, if implemented, would maintain existing water quality in the Yellowstone River downstream of Laurel. This request would benefit existing irrigators as well as other users.

Costs of this reservation, if implemented, would be similar to those of the Fish and Game Commission request.

SUMMARY, PART IV--ALTERNATIVES

The alternatives, chosen to represent a range of options, are based on the four major uses to which the water would be put: irrigation, municipal, energy conversion, and instream flows. In addition, a "no-action" situation is considered. Specific impacts in each subbasin are discussed at length in Part IV. However, only very generalized impacts are summarized here.

THE NO ACTION ALTERNATIVE

The No Action Alternative, which would occur if reservations were either denied or not acted upon, attempts to answer the question: "What will happen without water reservations in the Yellowstone Basin?"

ASSUMPTIONS

Diversion Uses

Irrigated agriculture would probably continue to expand and the availability of a dependable water supply would have to be determined on a project-by-project basis. Since a secure water supply would not be reserved, it is expected that an intermediate level of irrigation development would occur, along with a high level of energy development.

Table 2 shows the consumptive water use requirements for the No Action Alternative, based on the needs for the levels of development assumed.

Instream Uses

Under the No Action Alternative, no special provision is made for instream flows, with two exceptions.

In the Upper Yellowstone Subbasin, instream flows would presumably be protected by the Department of Fish and Game filing on the "blue ribbon" reach of the Yellowstone mainstem from Gardiner to Big Timber. In the Tongue Subbasin, very minimum flows were assumed (by operation of the proposed High Tongue Dam), because of the especially diverse and productive fishery. However, no legal obligation currently exists for this protection.

TABLE 2

THE INCREASE IN WATER DEPLETION
FOR THE NO ACTION ALTERNATIVE
IN THE YEAR 2000

Subbasin	Increase in Depletion, afy			
	Irrigation	Energy	Municipal	Total
Upper Yellowstone	50,780	0	0	50,780
Clarks Fork	2,880	0	0	2,880
Billings Area	25,880	0	3,900	29,780
Bighorn	17,380	28,150	480	46,010
Mid-Yellowstone	33,640	139,410	3,840	176,890
Tongue	29,260	118,030	780	148,070
Kinsey Area	6,320	0	0	6,320
Powder	100,280	28,150	1,140	129,570
Lower Yellowstone	50,200	13,000	480	63,680
TOTAL	316,620	326,740	10,620	653,980

IMPACTS

The No Action Alternative demands the diversion of 812,290 af/y and the consumption of 653,980 af/y of water throughout Montana's Yellowstone Basin.

Primary

Although this alternative would place heavy water demands on the system, the supply would generally be adequate. However, water availability problems would occur in the Tongue and Powder rivers and the lower Yellowstone mainstem.

Water quality would remain near its current high level in the upper basin. The natural degradation of the lower basin, particularly in the Tongue and Powder subbasins, would be amplified, however.

With the major exception of the Powder River, changes in channel morphology in most subbasins would not be noticeable. Some localized sedimentation and erosion would occur, but most could be mitigated. In many cases conversion or overgrazed rangelands or dry croplands to irrigated croplands would reduce erosion and sedimentation, by improving the vegetation cover.

Aquatic ecosystems would suffer varying impacts, ranging from minor on the upper basin mainstem to severe in the Tongue and Powder subbasins. Riparian ecosystems in general would also suffer, but to a lesser degree; in fact, increasing numbers of migratory waterfowl might be attracted to the new irrigated fields.

Secondary

Under this alternative, water would generally be available for consumptive uses, such as irrigation, municipal-domestic, and industrial. Much of the time water would also be available in most subbasins for instream uses, such as fish and wildlife habitat and recreation. However, in the lower Yellowstone, and especially in the Tongue, existing aquatic and riparian ecosystems would be degraded significantly. Accompanying this degradation would be a loss of recreation potential.

IRRIGATION-EMPHASIS ALTERNATIVE

In the Yellowstone Basin some 650,000 acres are now either fully or partially irrigated, consuming annually about 1.9 mmaf of water. Since 1971, irrigated agriculture in the Yellowstone Basin has been increasing, primarily through the expansion of sprinkler systems.

Agriculture, more than just an important economic activity in the Yellowstone Basin, molds the lifestyle of the region. To protect and expand agriculture, it may prove desirable to reserve a quantity of water for increased future irrigation. However, irrigation development does not depend exclusively on an adequate water supply. It also depends on the availability of irrigable lands, financial feasibility, markets, and other less quantifiable factors.

ASSUMPTIONS

DNRC's reconnaissance land classification survey identified 2.2 million acres of irrigable land in the basin; a subsequent economic feasibility evaluation reduced it to 237,000 acres.

To present a range of possible irrigation futures, considering the diversity of influences, three irrigation development levels and associated water demands were projected. The lowest includes one-third; the intermediate, two-thirds; and the highest, all of the 237,000 feasibly irrigable acreage. Table 3 shows the three levels in irrigated acreage, water diversions, and water depletions by the year 2000. To analyze the effects of these levels, the irrigation diversion rate was assumed to be three acre-feet per acre. One acre-foot per acre would be returned, on a delayed basis, to the streams.

TABLE 3

THE INCREASE IN WATER DEPLETION FOR IRRIGATED AGRICULTURE BY 2000
BY SUBBASIN

Subbasin	Increase in acreage	Increase in diversion (af/y)	Increase in depletion (af/y)
Low level of development			
Total	79,170	237,510	158,340
Intermediate level of development			
Total	158,310	474,930	316,620
High level of development			
Upper Yellowstone	38,080	114,240	76,160
Clarks Fork	2,160	6,480	4,320
Billings area	19,410	58,230	38,820
Bighorn	13,040	39,120	26,080
Mid-Yellowstone	25,230	75,690	50,460
Tongue	21,950	65,850	43,900
Kinsey area	4,740	14,220	9,480
Powder	75,200	225,600	150,400
Lower Yellowstone	37,670	113,010	75,340
Total	237,480	712,440	474,960

The applications for irrigation water use taken together propose reserving irrigation water for 360,000 acres, more than the high level of irrigation development (237,480 acres) predicted here.

IMPACTS

Primary Impacts

Although there are some significant exceptions, the Yellowstone mainstem and its tributaries have an adequate water supply for the high projected level of future irrigation, with little or no impact on the environment.

The first exception is the mainstem from the Billings subbasin downstream. Under high irrigation it would, in about one year in ten, experience fall flows low enough to cause environmental stress. Other exceptions are in the Tongue and Powder river subbasins, where water supply problems would persist even if additional storage were provided.

The channel formation processes are not expected to be affected by the projected depletions in the mainstem and most tributaries. The Tongue River channel has already undergone change following construction of Tongue River Dam; further impoundment should have little effect. There would be major changes in the Powder River channel, if that stream were impounded.

A potential for water quality degradation exists in the middle and lower basin, becoming greater as the Yellowstone progesses downstream. For the high level of development, salinity would not be a problem in the upstream subbasins (including the Clarks Fork Yellowstone and Bighorn), because the streamflows would be adequate to dilute the saline return flows. In the downstream mainstem subbasins, however, high TDS concentrations would be an occasional problem.

In the Tongue and Powder subbasins, where salinity is already troublesome, any irrigation development beyond present levels will aggravate that problem. Depletion for irrigation, even at the low projected level, would result in significant water temperature increases.

The conversion of rangeland to cultivated, irrigated fields may tend to increase erosion and sedimentation, especially if soils are not carefully managed. However, erosion and sedimentation could be reduced due to improved vegetation cover on converted irrigated fields.

Any new cultivation in the basin could attract migratory waterfowl, and would probably increase the number of geese and ducks stopping to feed along the rivers. Decreased flow and degraded water quality would cause significant impacts to the aquatic ecosystems of the Tongue and Powder rivers, with major effects on the Tongue River fishery.

Secondary Impacts

Water availability would be a problem only on the Tongue and Powder rivers, where increased storage is the only way enough water could be made available to satisfy the depletion assumed in those basins. On the Powder, even with storage, only about half of the high irrigation development projection can be satisfied.

In the three lower mainstem subbasins (Mid-Yellowstone, Kinsey Area, and Lower Yellowstone), during some years TDS concentrations would be high enough during low-flow months at the high level of development to require careful application of water to avoid salt accumulation in the root zone.

ENERGY EMPHASIS ALTERNATIVE

It was concluded during the course of the impact study that an energy emphasis alternative would, for all practical purposes, be the same as that predicted under the No Action Alternative. Refer to that section for a discussion of the impacts.

INSTREAM FLOW EMPHASIS ALTERNATIVE

An Instream Flow Emphasis Alternative would, by precluding major depletions in the future, serve to preserve the basins's diverse and productive aquatic and riparian ecosystems.

Such an alternative, if chosen, would be very similar to the situation wherein the instream flow requests by the Montana Fish and Game Commission and the Department of Health and Environmental Sciences are granted. These impacts are largely addressed in the section discussing the Fish and Game application. It should be noted here, however, that the Department of Health's application asks for higher flows during the winter months than does the Fish and Game Commission's. If both applications were satisfied, then, water availability for other uses would be lower during the winter than anticipated by the Fish and Game Commission's request.

Not only would basin ecosystems be protected by this alternative, but water quality and levels would also be maintained. This would benefit current irrigators, although there may be a cost to future irrigators in terms of development opportunities foregone.

SUMMARY, PART V--EFFECTS OF WATER RESERVATIONS ON PENDING WATER APPROPRIATIONS

The priority date of a water reservation is established at the time the Board approves the application. This reservation, which can be regarded as a water right, then has priority over rights with later priority dates, and is junior in status to water rights with earlier priority dates. As described earlier, however, this general rule is affected by granting a preferred use to reservations under the Yellowstone Moratorium. Water reservations adopted before approval of suspended permit applications will have preference of water use.

Montana, unlike most western states, has not had a preference system for water uses until this enactment of a partial preference system in the Yellowstone Moratorium.

Approval of water reservations could therefore have significant and adverse effects on large industrial water right applications held pending by the moratorium. If all water reservation requests were adopted, industrial applicants on the Tongue and Powder rivers could not implement their applications. However, industrial applicants for Yellowstone River water could still obtain a firm supply of water through offstream storage, with the possible exception of full approval of the instream flow requests.

It should also be noted that commitments of water made through reservations would probably have the effect of discouraging speculative permit applications in the future, regardless of the specific beneficial use involved.

SUMMARY, PART VI--RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

AGRICULTURAL PRODUCTIVITY

The granting of significant instream flow requests would severely limit the expansion of irrigation. The denial of all reservation requests would allow gradual continued increases in irrigation under water use permits; however, other users may move first to secure the use of unappropriated waters by permit. This is particularly true in basins where water shortages are apparent, where coal reserves are located, and/or where expensive storage facilities will be needed.

The highest benefit to agricultural productivity would result from granting all requests from conservation districts, irrigation districts, and the Montana Department of State Lands. Although other users could obtain the use of reserved water through temporary permits, the approval of such reservations would insure that sufficient water is available to allow the greatest possible eventual increase in irrigation.

Costs of providing water for irrigation would include investments in storage facilities and water delivery systems. Energy and labor costs would increase. Other opportunity costs would be incurred, through the reluctance of possible water users to invest in facilities dependent upon the temporary use of water reserved for another purpose.

WATER FOR MUNICIPAL USE

Communities with reserved water gain the benefit of securing a future water supply. A municipal water reservation could reduce the future cost of obtaining water, particularly if possible alternative sources (such as ground water) are expensive to develop and/or treat.

WATER FOR ENERGY

If a water reservation is made for multiple purposes, or if all reservations are denied, water will be readily available for energy development. Energy conversion plants require large quantities of water, particularly if they do not use the more expensive dry cooling systems. In certain subbasins, notably the Powder and Tongue rivers, insufficient water is available to provide for high levels of both energy and irrigation development. Energy development would accrue economic and employment benefits to the areas involved, and would require the utilization of coal, a non-renewable fossil fuel.

Energy development, especially if conversion plants are constructed, would have an impact on social and cultural systems as sparsely populated, agrarian areas become transformed into populated, industrial centers. Negative impacts to the natural environment, some of which may be extensive and long-term, would also result.

ENVIRONMENTAL QUALITY

Water remaining in the stream provides a public benefit by providing natural flow regimes to maintain amenity values like ecosystem productivity, water quality, wildlife habitat, and recreation.

The public benefits provided by waters of the Yellowstone Basin could become incrementally diminished by numerous individual appropriations. At present, instream flow reservations provide the only available mechanism to prevent further dewatering.

The difficulty in the case of instream flows is in trying to determine the optimal quantity of water to leave in the river, i.e., the marginal amount at which the public benefit begins to outweigh the private gain. If natural instream flows are allowed to diminish to this limit, environmental productivity will decrease as natural flow regimes are altered, water quality lessens, habitat is lost, biological diversity diminishes, and water temperatures increase.

SUMMARY, PART VII--IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

WATER

Unappropriated surface water is the primary resource being considered in this EIS. Instream flow reservations, if approved, would be implemented immediately. Most of the consumptive-use reservations, if approved, would be implemented over the next few years, as projects were built and water diverted.

Water reservations would be reviewed periodically, and can be modified or revoked by the Board if the purpose of the reservation is not being met. Furthermore, future water use plans or expectations may be withdrawn or changed voluntarily. In both respects, water reservation decisions cannot be considered absolutely irreversible and irretrievable.

LAND

Reservation requests could substantially influence irreversible commitment of the land resource. Water reserved for irrigation, for example, may help provide for the conversion of rangeland and dry cropland to irrigated cropland; water reserved for multiple uses, including energy, might be a factor in the conversion of agricultural land to such uses as mines, plant sites, roads, pipelines, and urban development.

Conversely, as the amount of water reserved for instream flows increases, the amount of land that can receive irrigation decreases. Similarly, the reservation of water for instream flows may inhibit energy-related development.

Any storage reservoirs would flood certain lands, thereby precluding other surface use options and possibly irreversibly commiting mineral resources such as coal.

ENERGY AND MATERIALS

An irretrievable commitment of energy and materials could indirectly result from the granting of applications for other than instream flow purposes, or from the denying of reservation requests. Energy and materials are required in the construction and operation of either irrigation or energy facilities.

Water developed for energy will help commit Montana's coal reserves to extraction, an irreversible commitment of a non-renewable resource. The instream flow applications, on the other hand, might reduce the water available for energy development, slowing the growth rate,and extending the lifetime of the basin's coal reserves.

PART I

EXISTING ENVIRONMENT

CONTENTS

INTRODUCTION

About one-half of the Yellowstone Basin is in Montana; a small piece lies in North Dakota, and the rest is in Wyoming. Only Montana's portion of the basin is described in this impact statement.

The basin has been divided into nine hydrologic planning subbasins, as shown in Map I-1, to facilitate use of a mathematical model and to identify variations in water supply and demand. Description of these nine planning subbasins is included below.

1. Upper Yellowstone - the Yellowstone mainstem and all its tributaries, including the Shields, Boulder, and Stillwater rivers, down to its confluence with the Clarks Fork Yellowstone.

2. Clarks Fork Yellowstone - the Clarks Fork Yellowstone and its tributaries, including Rock and Red Lodge creeks.

3. Billings Area - the Yellowstone mainstem and its tributaries, including Pryor Creek, from the mouth of the Clarks Fork Yellowstone to the mouth of the Bighorn River.

4. Bighorn - the Bighorn and Little Bighorn rivers and their tributaries, including Tullock and Lodge Grass creeks.

5. Mid-Yellowstone - the Yellowstone mainstem and its tributaries, including Sarpy, Armells, and Rosebud creeks, from the mouth of the Bighorn River to the mouth of the Tongue River.

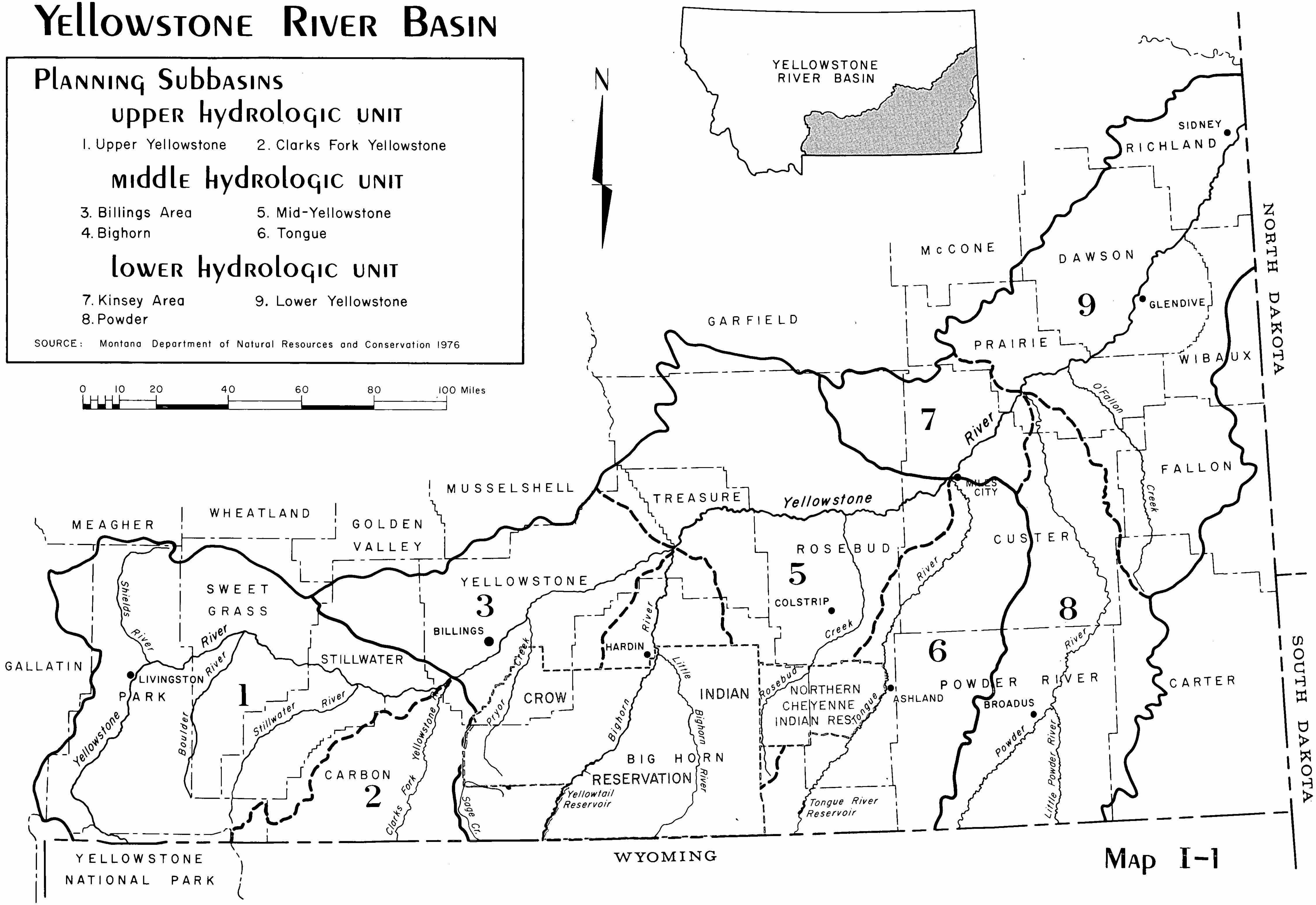
6. Tongue - the Tongue River and its tributaries, including Hanging Woman, Otter, and Pumpkin creeks.

7. Kinsey Area - the Yellowstone mainstem and its tributaries, including Sunday Creek, from the mouth of the Tongue River to the mouth of the Powder River.

8. Powder - the Powder River and its tributaries, including the Little Powder River and Mizpah Creek.

9. Lower Yellowstone - the Yellowstone mainstem and its tributaries, including O'Fallon Creek, from the mouth of the Powder River to the North Dakota state line.

Note that the Departments of Fish and Game and Health and Environmental Sciences each define different portions of the basin as upper, middle, and lower. In Department of Fish and Game terminology, the upper Yellowstone is the Yellowstone mainstem and its tributaries, including the Shields River, but not including the Boulder River, from Gardiner to Big Timber. The middle Yellowstone is the Yellowstone mainstem and its tributaries, including the Boulder, Stillwater, and Clarks Fork Yellowstone rivers, but not including the Bighorn River, from Big Timber to the mouth of the Bighorn River. The lower Yellowstone is the Yellowstone mainstem and its tributaries, including the Bighorn, Tongue, and Powder rivers, from the mouth of the Bighorn River to the North Dakota state line. The Department of Health and Environmental Sciences defines the upper Yellowstone as the Yellowstone mainstem and its tributaries, including the Shields, Boulder, Stillwater, and Clarks Fork Yellowstone rivers, but not including Pryor Creek, from Gardiner to the mouth of Pryor Creek. The middle Yellowstone is the Yellowstone mainstem and its tributaries, including the Bighorn and Tongue rivers from the mouth of Pryor Creek to the mouth of the Tongue River. The lower Yellowstone is the Yellowstone mainstem and its tributaries, including the Powder River, from the mouth of the Tongue River to the North Dakota state line.



Yellowstone River Basin
Planning Subbasins
upper hydrologic unit
1. Upper Yellowstone
2. Clarks Fork Yellowstone
middle hydrologic unit
3. Billings Area
4. Bighorn
5. Mid-Yellowstone
6. Tongue
lower hydrologic unit
7. Kinsey Area
8. Powder
9. Lower Yellowstone
SOURCE: Montana Department of Natural Resources and Conservation 1976
0 10 20 40 60 80 100 Miles
N
YELLOWSTONE RIVER BASIN
SIDNEY
RICHLAND
McCONE
DAWSON
GLENDIVE
GARFIELD
PRAIRIE
WIBAUX
NORTH DAKOTA
O'Fallon
FALLON
Creek
River
MILES CITY
MUSSELSHELL
TREASURE
Yellowstone
WHEATLAND
GOLDEN VALLEY
MEAGHER
ROSEBUD
CUSTER
SWEET GRASS
YELLOWSTONE
Shields River
River
BILLINGS
COLSTRIP
Creek
GALLATIN
STILLWATER
HARDIN
Little
LIVINGSTON
PARK
River
Rosebud
NORTHERN CHEYENNE INDIAN RES
Tongue
ASHLAND
POWDER RIVER
BROADUS
CARTER
SOUTH DAKOTA
Stillwater River
Pryor
Creek
CROW
INDIAN
Bighorn
Bighorn River
Yellowstone
Boulder
CARBON
Clarks Fork
Yellowstone
Sage Cr.
BIG HORN
RESERVATION
Yellowtail Reservoir
Tongue River Reservoir
Powder
Little Powder River
YELLOWSTONE NATIONAL PARK
WYOMING
1
2
3
5
6
7
8
9

Map I-1

NATURAL ENVIRONMENT

PHYSICAL ENVIRONMENT

PHYSIOGRAPHY

The western third of the Yellowstone Basin in Montana is a land of mountain ranges, high plateaus, and deeply entrenched valleys. The Crazy, Absaroka, Beartooth, Gallatin,and Bridger Mountain ranges all have peaks extending to over 10,000 feet. The Beartooth Plateau, straddling the Montana-Wyoming border, extends well above timberline. Paradise Valley, cut by the Yellowstone River upstream from Livingston, is several miles wide and averages about 4,800 feet above sea level. Alpine glaciation reached ice cap proportions in this area during the Ice Age and glacial deposits are extensive. The Pryor and Bighorn mountains are isolated ranges south of Billings; the Bighorns range to over 9,000 feet.

The eastern portion of the Yellowstone Basin is a large dissected upland, ranging in elevation from about 2,000 feet near the Montana-North Dakota border to 6,000 feet near the western mountains. Nearly flat beds of shale and sandstone are present which, near major rivers, are eroded into breaks or more intricate badland topography. The landscape in this area is dominated by plains, low-lying hills, and tablelands, with a few isolated uplands and buttes. Benchlands, alluvial terraces, and bottomlands occur adjacent to the Yellowstone and its major tributaries. Additional generalized characterization of land forms, with associated climate, vegetation, and human activities, is available in the Montana Environmental Quality Council's First Annual Report (1972).

GEOLOGY

In the mountainous southwestern portion of the basin, intricate geologic structure results from the folding, faulting, intrusion of granitic rocks, and volcanic activity that accompanied mountain building. Mountain uplifts, generally more susceptible to erosion than surrounding lower areas, often have igneous and metamorphic core rocks or older sedimentary rocks exposed near the axes of these uplifts. This occurs in the Absaroka, Beartooth, Crazy, Pryor and Bighorn mountains.

Broadly folded and flat-lying sedimentary rocks occupy the eastern portion of the basin. Erosion on domes or upfolded sediments has exposed older underlying rocks, while younger sediments tend to be present at the surface in structural basins. Stratigraphic relations of some major rock units are illustrated in Table I-1.

MINERAL RESOURCES

Resources derived from geologic formations fall into three categories: metallic, nonmetallic, and fuel.

METALLIC

Metallic ore deposits in the Yellowstone Basin are primarily limited to igneous and metamorphic rocks in the Absaroka, Beartooth, and Crazy mountains. The most important and well known deposit of metal ore-bearing rocks in the Yellowstone basin is the Stillwater Complex in Park, Sweetgrass, and Stillwater counties on the north face of the Beartooth Mountains. The Stillwater Complex is noted for the presence of chromium, nickel, platinum group metals, and copper.

The Stillwater Complex has been most important in the past as a source of chromite, an ore of chromium. Approximately 900,000 long tons of chromium concentrate had been produced by 1968, principally from two mines. Recent exploration indicates known or inferred reserves of chromite to be in the 10 million to 100 million ton range. The Stillwater Complex contains between 70 and 80 percent of the known chromium reserves and approximately 20 percent of the platinum reserves in the United States.

NONMETALLIC

Materials such as limestone, gypsum, clay, sand, and gravel are mined or quarried from both consolidated and unconsolidated sedimentary rocks in the Yellowstone Basin.

TABLE I-1

GENERALIZED STRATIGRAPHY OF THE YELLOWSTONE BASIN

ERA	Time Interval (million years before present)	Predominant Formations	Rock Type	Approximate % Surface Area	Areas of Outcrop
CENOZOIC Quaternary	present - 2	Alluvium, Terraces, Glacial Deposits	unconsolidated sediments	8%	Adjacent to Yellowstone, major, and minor tributaries
Tertiary	2 - 65	Fort Union Formation	shale, sandstone, coal	30	Big Timber to Red Lodge; most of basin east of Little Bighorn River
		Livingston Formation	conglomerate, sandstone, shale	8	North of Livingston
		Intrusive Igneous Rocks	granitic rocks	1	Crazy Mtns, Absaroka & Beartooth Ranges
		Volcanic Igneous Rocks	basalt & andesite lava	5	South of Big Timber, Gallatin & Absaroka Ranges
MESOZOIC Cretaceous	65 - 135	Montana Group	sandstone, shale, minor coal	20	Exposed in uplifts from Livingston to Forsyth & south to Bighorn Mtns; Porcupine Dome North of Forsyth, east side of the Powder River Basin & southeast of Glendive
		Colorado Shale	shale, siltstone	15	
Jurassic Triassic	135 - 180 180 - 225	Undifferentiated	conglomerate, sandstone, shale, limestone	2	
PALEOZOIC Undifferentiated	225 - 600	Madison Group Jefferson Limestone Bighorn Dolomite	limestone, shale, sandstone, quartzite, dolomite	5	Bighorn, Pryor, Beartooth, & Absaroka mtns.
PRECAMBRIAN	more than 600	Stillwater Complex	gabbro, periodite, gneiss, schist	1	Northern periphery of Beartooth Mtns.
		Pre-Belt Metamorphics	gneiss, schist	6	Beartooth, Absaroka & Bighorn mtns.

SOURCE: DNRC 1976

Limestone is used for many purposes, but that quarried in the Yellowstone Basin primarily provides decorative building stone and a raw material for sugar processing. Water is necessary to wash limestone for both of these uses. Outcrops of potentially usable limestone are abundant in the mountainous area in southwestern Big Horn County but market, transportation, and quality limitations have precluded extensive development of this resource.

Gypsum is very widespread in the subsurface formations of the Powder River Basin and is present in sedimentary formations in southwestern Big Horn County. At present, these deposits are economically unimportant because of low demand, inaccessibility, and low value.

Clay suitable for bricks and tiles, as well as bentonitic clays used for heavy muds and light-weight aggregate for concrete, are found and mined in the basin. Bentonite pits occur at scattered locations in Carter, Rosebud, and Treasure counties. Future growth of the clay industry is closely tied to population growth and/or the need for building materials.

Perhaps the most valuable nonfuel mineral commodity produced in the Yellowstone Basin is sand and gravel. Ninety percent of the material is used for road construction, and the remainder is used for railroad ballast, fill, and building construction. These deposits are generally found along the major drainage systems and their terraces.

FUELS

Mineral fuel resources of the Yellowstone Basin are widespread and economically important. Oil and coal are extracted in the basin, and some uranium deposits have been identified.

Oil and natural gas reserves have been developed for many years in the Yellowstone Basin. However, many of these fields are small and are declining in production. In some areas, such as the Cedar Creek anticline, water flooding has been used for secondary recovery of petroleum. Most water used for this is either recovered from oil-bearing formations or is ground water taken from other formations. Drilling for new oil usually involves only minor amounts of water.

Coal resources of the Yellowstone Basin are extensive. Coal occurs in several formations with the thickest and most important deposits found in the Tertiary Fort Union formation. This formation covers extensive areas of the eastern part of the Yellowstone drainage, as shown in Map I-2. Development of coal reserves in this formation is increasing (see Table I-18).

There are several low-grade uranium deposits in the Yellowstone Basin. Most of these occur in uranium-bearing lignites. In order to be economically viable, either the lignite must be valuable as fuel, allowing the production of uranium as a byproduct, or it must be rich enough in uranium to be mined for the metal itself. At present no Montana lignites satisfy either of the above requirements, and no uranium is mined in the basin.

CLIMATE

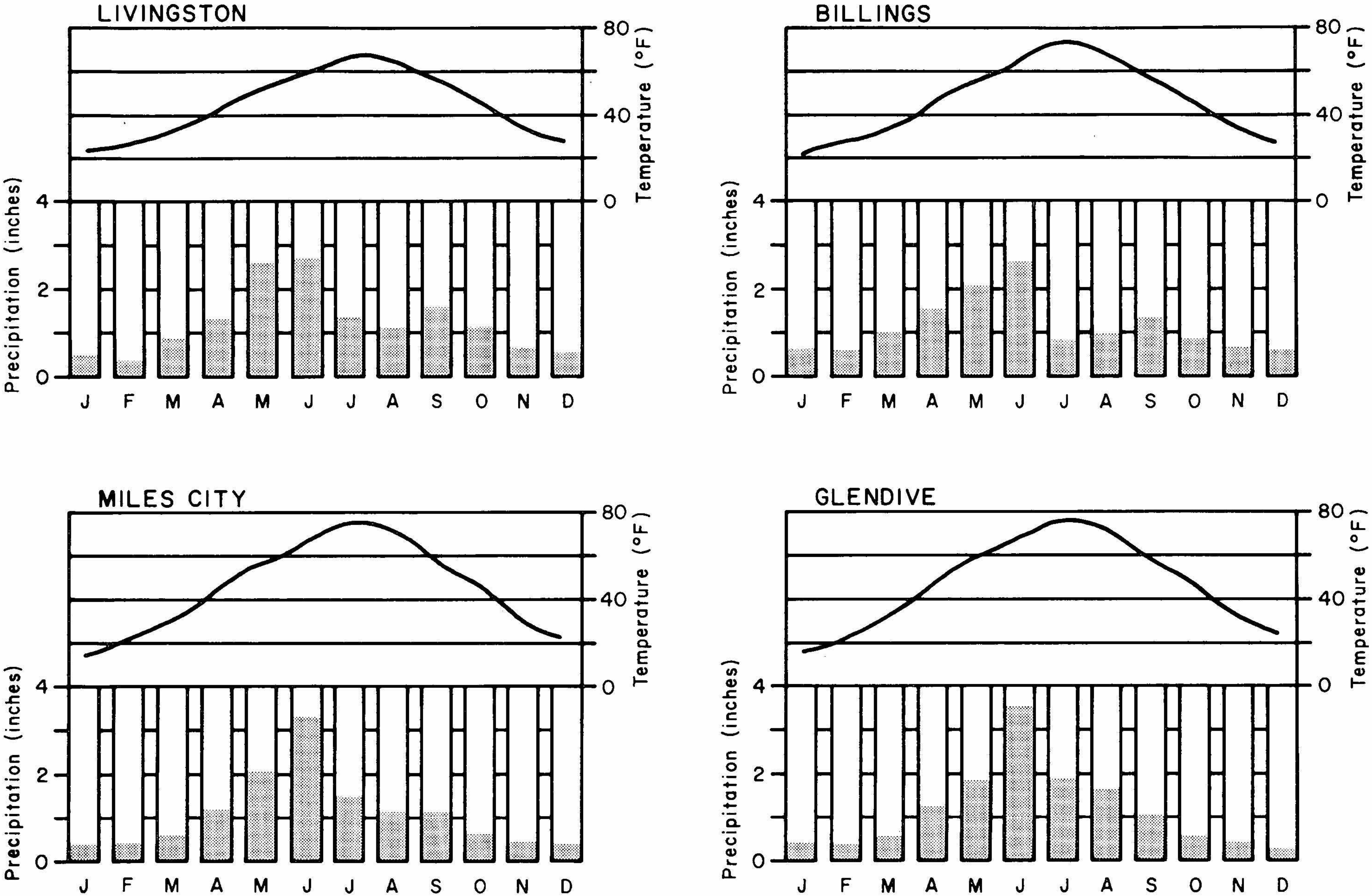
Montana's climate is influenced by the combination of its interior continental position, movement and mixing of air masses, northerly latitude, and mountain barriers producing orographic precipitation and lee-side rain shadow effects. Because the Yellowstone Basin extends from high mountainous headwaters to low dissected plains, considerable local variation in climate is experienced.

Winter precipitation is normally from storms originating in the North Pacific Ocean. Although local convectional thunderstorms provide rainfall during the growing season, summer rainfall is generally inadequate for some cultivated agriculture without supplemental irrigation. Dryland farming, which is fairly widespread, is successful in non-drought years. Most of the arable land has about four frost-free months (Map I-3). In early summer extended length of day and maximum precipitation combine to allow cultivation of some crops not normally grown in semiarid climates. Average temperature and precipitation graphs for four stations along the Yellowstone are shown in Figure I-1.

AIR QUALITY

Air quality in the Yellowstone Basin is generally considered good, although localized pollution from suspended particulates in urban areas and coal strip mining sites may be a problem. Only rudimentary estimates of ambient air quality in the Yellowstone Basin are possible at this time, due to the small number of monitoring stations in operation. Data on total suspended particulates (TSP) is the most complete. Monitoring stations are located at Laurel, Billings, (four stations), Forsyth, Miles City (two), Glendive, and Sidney. In addition, rural monitors for TSP are located near Poplar, Linsay (two), Fort Peck, Broadus, Scobey, Glendive, Ekalaka, and Lame Deer.

The ambient TSP can be estimated for eastern Montana by examination of recent (1973, 1975-76) data for the rural stations listed above. These data range from a high of 29 micrograms per cubic meter (ug/m^3) at the rural Glendive station to a low of six ug/m^3 at Lame Deer. The mean (15.4) and standard deviation (7.0) enable an estimate of normal TSP. By subtracting values of background air quality from values obtaned in urban or industrialized environments, an assessment of air quality reduction attributable to urban-industrial sources can be derived. This has been done for TSP or urban monitors in the Yellowstone Basin. (Table I-2).

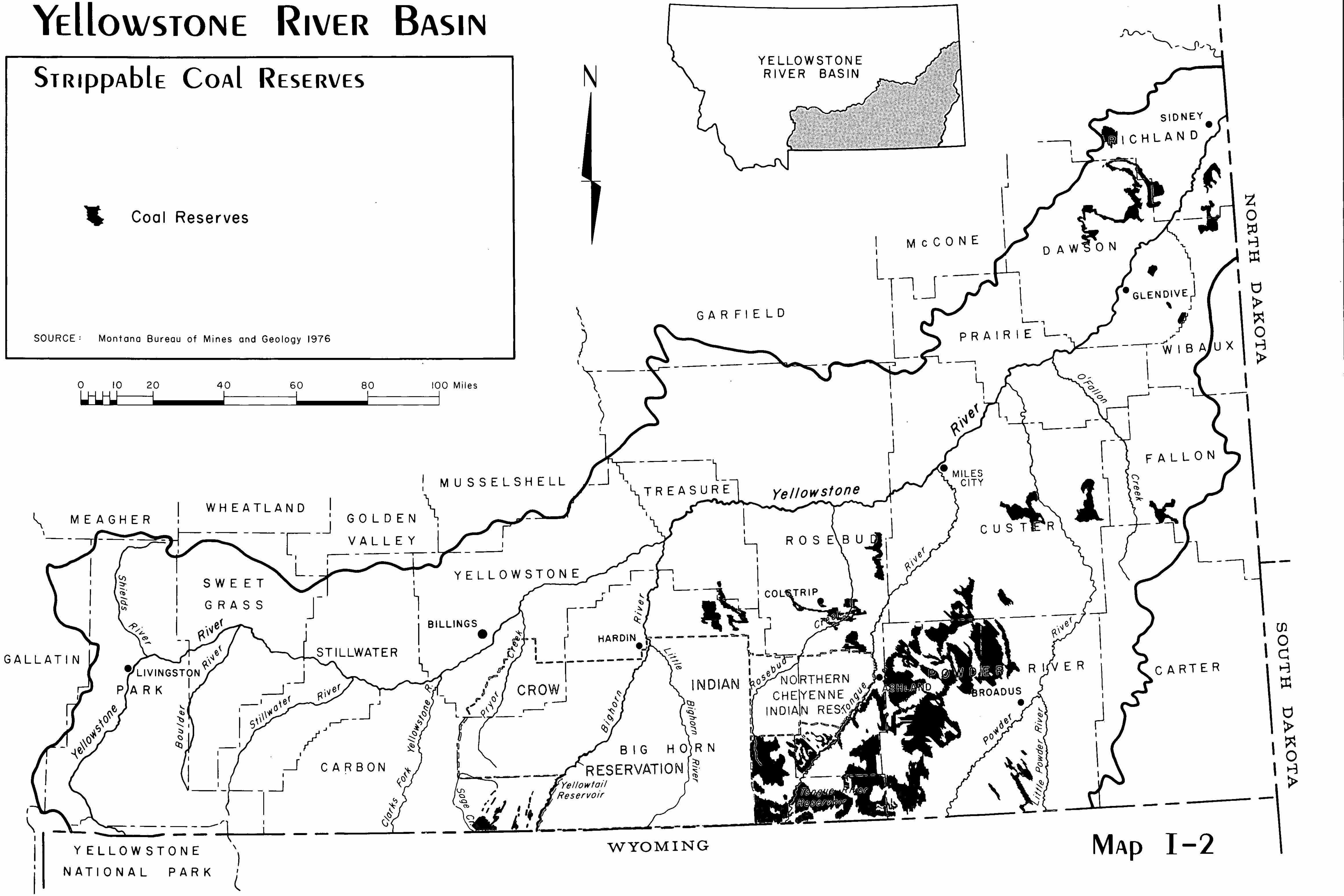


SOURCE: Taylor, Edie, Gritzner 1974

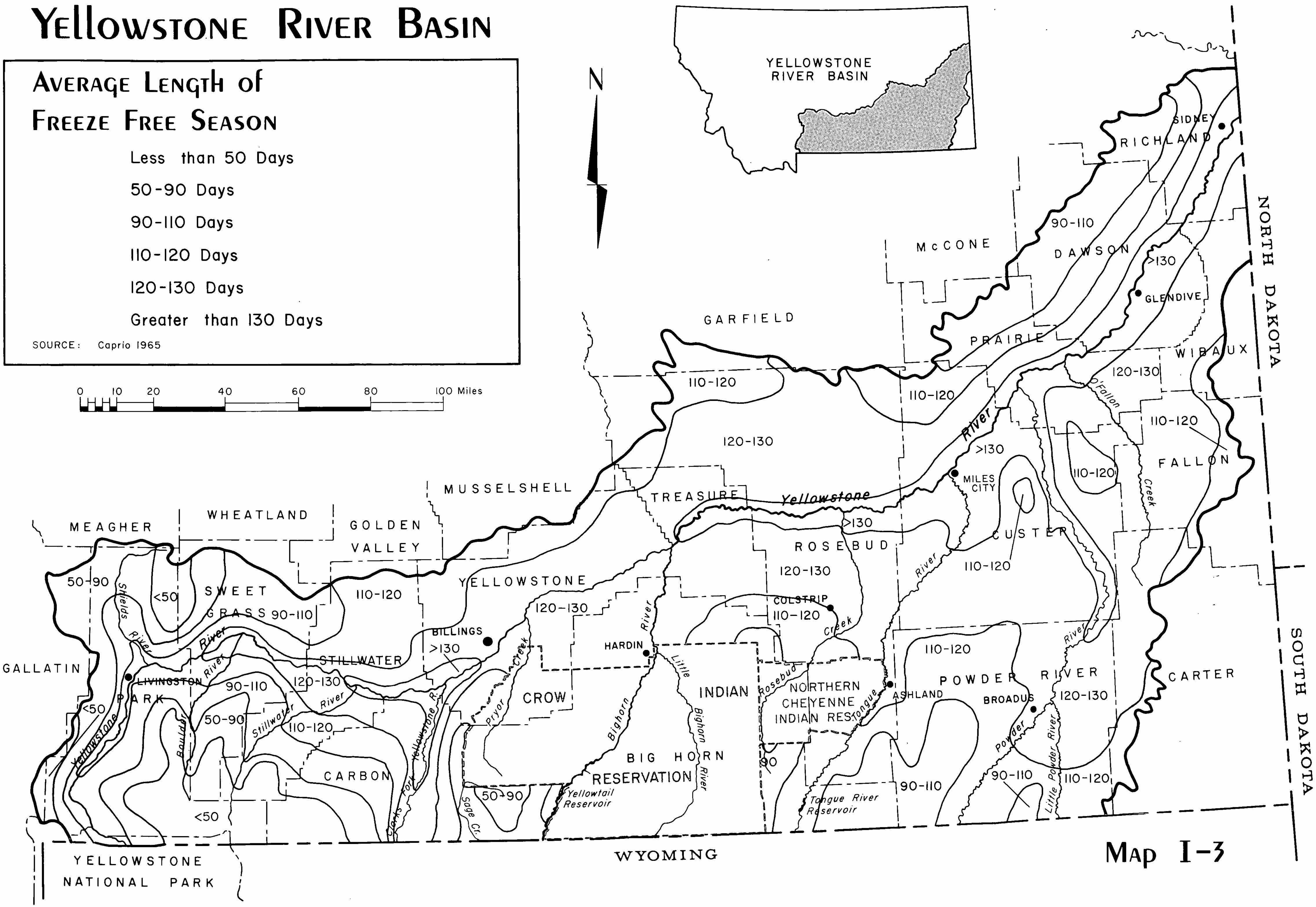
TEMPERATURE AND PRECIPITATION DATA FOR SELECTED STATIONS

FIGURE I-1

Yellowstone River Basin



Map I-2



Yellowstone River Basin
Average Length of Freeze Free Season
Less than 50 Days
50-90 Days
90-110 Days
110-120 Days
120-130 Days
Greater than 130 Days
SOURCE: Caprio 1965
0 10 20 40 60 80 100 Miles
N
YELLOWSTONE RIVER BASIN
GARFIELD
McCONE
RICHLAND
SIDNEY
DAWSON
GLENDIVE
PRAIRIE
WIBAUX
NORTH DAKOTA
SOUTH DAKOTA
FALLON
CUSTER
MILES CITY
CARTER
POWDER RIVER
BROADUS
ROSEBUD
COLSTRIP
ASHLAND
NORTHERN CHEYENNE INDIAN RES.
TREASURE
MUSSELSHELL
GOLDEN VALLEY
WHEATLAND
MEAGHER
SWEET GRASS
STILLWATER
YELLOWSTONE
BILLINGS
HARDIN
CROW INDIAN RESERVATION
BIG HORN RESERVATION
CARBON
PARK
LIVINGSTON
GALLATIN
YELLOWSTONE NATIONAL PARK
WYOMING
Yellowstone River
O'Fallon Creek
Powder River
Little Powder River
Tongue River
Tongue River Reservoir
Rosebud Creek
Bighorn River
Little Bighorn River
Yellowtail Reservoir
Pryor Creek
Sage Cr.
Clarks Fork Yellowstone R.
Stillwater River
Boulder River
Shields River
Map I-3

TABLE I-2

ESTIMATED URBAN-INDUSTRIAL TSP CONTRIBUTIONS[a]

City	Actual Annual Total Suspended Particles	- Background[b] =	Urban-Industrial Contributions
Laurel	33	15	18
Billings	68	15	53
Forsyth	36	15	21
Miles City	85	15	70
Glendive	31	15	16
Sidney	26	15	11

SOURCE: Montana Department of Health and Environmental Sciences 1976a

[a]All values are average annual geometric means measured in ug/m^3. The state standard (maximum allowable) is 75 μg/m^3.

[b]These values should be considered mean values that may vary according to local background air quality. One standard deviation variance would include values within $\pm$7ug/m^3 of each value.

In addition to TSP, carbon monoxide (CO) hydrocarbons (HC), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and total fluorides (F) are monitored in the urban-industrial locations above. In Table I-3, quantitative data are expressed as a fraction showing actual values over the appropriate allowable standard. Qualitative remarks reflect "best guess" estimates supplied by the Air Quality Bureau of the Montana Department of Health and Environmental Sciences.

Automobiles and petroleum refineries are generally the major contributors to carbon monoxide and hydrocarbon levels respectively, and sulphur dioxide is normally the result of oil refining and thermo-electric generation. Except for total suspended particulates, pollutants in other cities of the Yellowstone Basin are generally moderate to low in comparison to state air quality standards.

Perhaps the most significant standards are the recently adopted Environmental Protection Agency standards for prevention of "significant deterioration". Standards in effect for Montana would allow a maximum average annual increase above 1974 recorded ambient levels of 10 ug/m^3 for TSP and 15 ug/m^3 for SO_2.

TABLE I-3

LEVELS OF OTHER POLLUTANTS

City	CO	HC	NO_x	SO_2	TF
Laurel	Low	exceeds standard	moderate	.31/.25[a] (1 hr. max) .2/.5 (3 hr.) .08/.14 (24 hr.)	High
Billings	2.5/35 (average) 26.5/35 (max. 1 hr.) 15.1/9[a] (max. 8 hr.)	1.29/.24[a] (6-9 a.m.)	$\frac{.039}{.05}$ (max)	.15/.25 (1 hr. max)	Moderate
Forsyth	Nil	Nil	Nil	Nil	Nil
Miles City	Low	Nil	Nil	Nil	Nil
Glendive	Nil	Nil	Nil	Nil	Nil
Sidney	Nil	Nil	Nil	Nil	Low

SOURCE: Montana Department of Health and Environmental Sciences 1976a

[a]Exceeds those standards adopted May 7, 1967 by the Montana Clean Air Act (Section 69-3909, et seq. R.C.M. 1947)

This means that significant deterioration would occur at pollution levels well below the maximum allowable under the Montana Clean Air Act.

SOILS

Irrigable soils have been identified by a reconnaissance-level land classification. Lands with soils, topography, and drainage features necessary to support sustained irrigated agriculture are divided into suitability classes (high-Class 1, medium-Class 2, low-Class 3) on the basis of estimates of increased productivity after irrigation occurs. Descriptions of irrigable lands in this section include information on general location, predominant landform, and soil characteristics.

Irrigable lands in the Upper Yellowstone Subbasin (see introduction to this section) typically occur on benchland terraces having medium to light textured soil with high to moderate lime content and low salt content. Gravelly substratum is normally present from depths of 12 to 30 inches, overlying sandstone or shale bedrock. Good internal drainage and low salt content of irrigation return flows encourages irrigation of these lands.

Soils in the Clarks Fork Yellowstone Subbasin generally consist of loams, clay loams, and silt loams formed in alluvium or wind deposits over alluvium. These soils occur on the bottomlands and terraces of the Clarks Fork Yellowstone and its tributaries and are typically deep and well drained. Some irrigable soils are found on benchlands along the lower Clarks Fork. Extensive areas of shallow, poorly drained, or alkaline soils are also present.

Along the Yellowstone mainstem from approximately Laurel to Miles City irrigable land is generally on benchland terraces of alluvial fans. A typical soil series consists of well-drained clay loams formed from alluvium, 20 to 40 inches deep over sand and gravel. Soil drainage or irrigable terrace and benchlands along the Yellowstone mainstem and the lower Bighorn River is generally adequate; a minimum of drainage construction would be required.

Irrigable lands along the Tongue River have variable soils with loamy sand to clay textures located on terraces and alluvial fans near the river. Some areas with localized drainage and salinity problems have been identified, but these areas are not extensive.

The Yellowstone Valley below the Tongue River is one of the most productive irrigated areas in Montana. Undeveloped irrigable land consists of benchlands, terraces, and alluvial fans above the Yellowstone floodplain. Soils vary from clay to loam with moderate permeability and are typically deep and well-drained, being formed in old alluvium. Some large tracts may have restricted permeability, requiring special drainage systems for effective irrigation.

The Powder River is the only major tributary of the Yellowstone with large acreages of irrigable land on the floodplain that are not presently irrigated. Low streamflows coupled with high silt loads in July and August limit the use of Powder River water for irrigation. Recently, new pump designs have allowed for pumping silty water with minimal pump repairs, permitting some increase in irrigation along the Powder. Surface soils are variable loams (sandy, clay, and silt loams) of alluvial origin, with sand and loamy sand subsoils providing good sub-drainage in most areas.

Medium and heavy textured soils near escarpment and outer valley areas have medium to high salt content. Irrigation of the soils may result in some leaching problems. A portion of the Powder River water used for irrigation must be allocated to leaching and diluting salts. This will require careful water management to avoid excessive salt concentrations in ground water and downstream return flows, as well as root zone salt accumulation.

WATER RESOURCES

SURFACE WATER

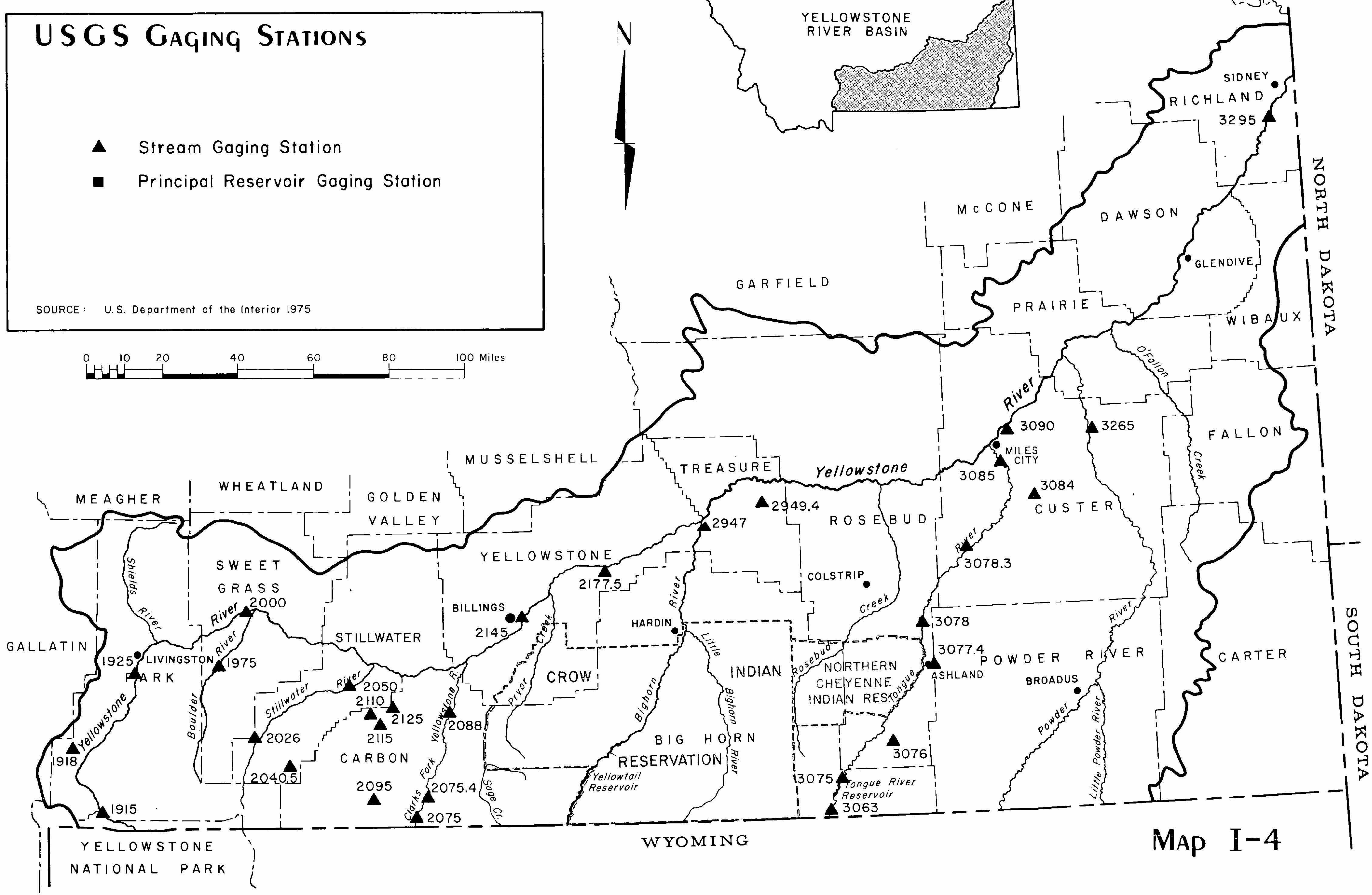
Channel Morphology

Yellowstone Basin streams, as they exist today, are the results of dynamic, ongoing channel formation and adjustment processes--erosion, runoff, streamflow, and sediment transport--as well as the geology of the basin. Changes in any of these processes will change the morphology of the channel, which will subsequently affect other things, such as the stream-bottom habitat for aquatic insects and other invertebrates, the fish which feed on those invertebrates, the islands used by geese and other migratory waterfowl, and the beavers or other furbearing mammals which utilize vegetation adjacent to the river.

Though it has undergone changes, the Yellowstone mainstem exhibits a braided form much like that viewed by Captain Clark in 1805. This braided form, characterized by multiple channels, islands, and extensive backwater areas, is exemplified best by stretches of the river above Forsyth and below Glendive. Although it is susceptible to change, it provides the habitat necessary for the diversity and abundance of wildlife along the river.

The Bighorn River was once also a highly braided river. Since the construction of Buffalo Bill, Boysen, and Yellowtail dams, however, the river has consolidated and eliminated islands, tending toward a single channel with no backwater areas. Between 1939 and 1974, in the reach from the present Yellowtail Dam site to the mouth, the area of the riparian bank increased 38 percent, the total river area (including water, islands, and gravel bars) decreased 25 percent, the vegetated island area decreased 23 percent, and the area of gravel bars decreased 70 percent. A similar, but undocumented, change probably took place on the Tongue River, now essentially a single channel, following the construction of Tongue River Dam.

Yellowstone River Basin



Map I-4

The Clarks Fork Yellowstone exhibits a meandering channel pattern with numerous mid-channel bars and stabilized islands. Side and mid-channel bars are more frequent in the lower reaches, due to increased sediment loads from tributaries.

The Powder River is characterized by a single channel with many mid-channel bars, but few islands. Because bed materials are usually sand to silt-sized, depositional features such as gravel bars tend to be ephemeral and channel changes are frequent.

The impact of several decades of water diversion on the morphology of the Yellowstone mainstem has been small, pricipally because the mainstem is still essentially free-flowing. The natural phenomenon having the most effect on the river channel is the dominant discharge, which occurs during the June peak. However, less than 10 percent of the total June flow is diverted for irrigation. Therefore, neither the dominant discharge nor, consequently, the channel morphology have yet been seriously affected.

The major influence on channel morphology has been riprap, which stabilizes the banks and limits the operation of natural processes.

Quantity

The Yellowstone River has a drainage area of 70,115 square miles, which is divided nearly equally between Montana and Wyoming. The river rises in northwestern Wyoming, runs into Yellowstone Lake, flows in a northerly direction to Livingston, turns eastward to Laurel, turns northeastward to Sidney, and joins the Missouri River a few miles east of the Montana-North Dakota border.

Flows for the 1970 level of development in Montana's portion of the basin are shown on Table I-4. These flows are averages, calculated from historical records and modified to show the effects of 1970-level depletions. For the Yellowstone mainstem at Sidney, this flow is 8.8 million af/y and the unmodified historical flow is about 9.5 million af/y. At their confluence, the Yellowstone yields 22 percent more average flow than the Missouri, although it drains 14 percent less area. Flow data and other hydrologic information presented in this report are from records gathered at U.S. Geological Survey gaging stations located throughout the basin. (Map I-4).

The Yellowstone River receives more than one-half of its total flow from waters rising in mountain ranges upstream of Billings. The majority of flow entering the mainstem below Billings is from the Bighorn, Tongue, and Powder rivers.

Hydrologic characteristics vary within the basin, primarily between the mountain and plains regions. Water yield from the high mountain region ranges up to 40 inches, while there is almost no runoff from the semiarid plains. Although perennial streams occur in the mountainous areas, the only streams that normally flow all year in the semiarid regions are the large interstate tributaries. Seasonal distribution of runoff also varies from west to east

TABLE I-4

HYDROLOGIC CHARACTERISTICS OF MAJOR STREAMS
(acre-feet)

Stream	Location of Station	Average Annual Runoff		Maximum Recorded Annual Runoff	Minimum Recorded Annual Runoff
		1970 Level of Development[a]	Historical[b]		
YELLOWSTONE RIVER	near Livingston	2,687,000	2,722,000	5,250,000	2,190,000
BOULDER RIVER	Big Timber	unknown	441,200	611,600	269,600
STILLWATER RIVER	near Absarokee	unknown	695,500	1,029,000	368,100
CLARKS FORK YELLOWSTONE RIVER	near Silesia	767,000	908,500	1,015,000	708,100
YELLOWSTONE RIVER	Billings	4,920,000	5,008,000	7,396,000	2,915,000
BIGHORN RIVER	Bighorn	2,550,000	2,828,000	3,967,000	1,175,000
TONGUE RIVER	Miles City	304,000	309,400	532,100	41,440
YELLOWSTONE RIVER	Miles City	8,102,000	8,274,000	12,060,000	4,446,000
POWDER RIVER	near Locate	416,000	446,300	1,178,000	57,500
YELLOWSTONE RIVER	near Sidney	8,800,000	9,420,000	15,400,000	3,400,000

SOURCES: NGPRP 1974a and unpublished, Montana DNRC unpublished, USDI 1974.

[a]1970-level-of-development flows are averages calculated from historical records that have been modified to show the effects of 1970-level depletions in each year of study.

[b]The periods of record vary for these stations.

in the basin. In the Yellowstone Basin, most of the annual runoff occurs in spring and early summer, with flow dropping sharply as the snowpack is depleted. Flow is then modified primarily by irrigation diversions and rains. Annual low flow generally occurs in winter.

In the plains region much of the runoff is derived from low elevation snowpack melted by chinook winds in late winter and spring months, while a second period of early summer high flow is due to higher elevation snowmelt. Lowest flows usually occur in early winter. Large variation in flow is shown by plains streams, with high flows of short duration contrasted with flows approaching and reaching zero at other times of the year.

For a more detailed description of the basin's water resources, the basin has been divided into planning subbasins, as explained in the introduction to this section. Hydrographs, as well as 1-, 30-, and 90-day low-flow duration curves for selected gaging stations in the basin are shown in Figures A-1 through A-15 of the Appendix.

Upper Yellowstone and Clarks Fork Yellowstone Subbasins

These subbasins include the Yellowstone River mainstem from the Yellowstone National Park boundary to the confluence of the Clarks Fork Yellowstone River, as well as the Shields, Boulder, Stillwater, Clarks Fork Yellowstone rivers, and Sweet Grass Creek.

Streamflow records indicate that peak flows in these two subbasins generally occur from mid-June to mid-July, and are caused by snowmelt from mountain snowpack. This mountain snowpack is the major contributing factor to the stable and plentiful runoff experienced in most years.

The maximum flow recorded for the mainstem near Livingston was 36,300 cfs on June 17, 1974; the lowest was 590 cfs on January 22, 1940. Extreme flows from the Clarks Fork Yellowstone near its mouth were 10,900 cfs on June 7, 1936, and 36 cfs on April 22, 1961.

Table I-5 lists the major reservoirs located in these two subbasins.

TABLE I-5

UPPER YELLOWSTONE AND CLARKS FORK YELLOWSTONE SUBBASINS
RESERVOIRS WITH TOTAL CAPACITY EXCEEDING 5,000
ACRE-FEET

Name	Stream	Total Storage (af)	Active Storage (af)	Surface Area (acres)	Purpose
Cooney	Red Lodge Creek	24,190	24,070	790	Irrigation
Lake Adam	Sweet Grass Creek	11,000	11,000	585	Irrigation
Lake Walvoord	Sweet Grass Creek	14,000	14,000	768	Irrigation
Mystic Lake	West Rosebud Creek	20,800	20,800	400	Hydropower

SOURCE: Montana Department of Natural Resources and Conservation 1976

These reservoirs, together with stock ponds, can influence small streams by reducing peak flows and increasing low flows--in effect, stabilizing the stream. Due to their small size, reservoirs in these upper subbasins influence the mainstem only to a minor degree.

Billings Area, Bighorn, Mid-Yellowstone, and Tongue Subbasins

These subbasins include the Yellowstone River mainstem from the Clarks Fork Yellowstone to the mouth of the Tongue River, Rosebud, and Pryor creeks and the Bighorn and Tongue rivers.

The streams of these basins which originate in the mountains display different hydrologic characteristics than those with plains or lowland sources. Extreme variations in daily, monthly, and annual flow for streams originating in the prairie are common. The spring runoff in these streams generally occurs between March and May, and may create a minor peak flow in the Yellowstone River. Peak flows can occur in mid-winter due to the rapid melting of snow cover by chinook winds. The major peak flow period for the Yellowstone mainstem and tributaries originating in mountainous areas is usually between mid-June and mid-July, and is due to snowmelt runoff.

The maximum discharge recorded for the Yellowstone River at Billings was 69,500 cfs on June 19, 1974; the minimum was 430 cfs on December 12, 1932. The Tongue River has been regulated by Tongue River Reservoir since 1939; the maximum flow recorded was 13,500 cfs on June 15, 1962; no flow was recorded on July 9-19, August 13-14, and September 28, 1940, due to closures of the Tongue River dam. The Bighorn River has been regulated by Yellowtail Reservoir since November 3, 1965; the maximum flow recorded was 26,200 cfs on June 24, 1942; the minimum was 275 cfs on November 15, 1959.

Reservoirs in these subbasins are listed in Table I-6.

TABLE I-6

BILLINGS AREA, BIGHORN, MID-YELLOWSTONE AND TONGUE SUBBASIN RESERVOIRS WITH TOTAL CAPACITY EXCEEDING 5,000 ACRE-FEET

Name	Stream	Total Storage (af)	Active Storage (af)	Surface Area (acres)	Purposes
Tongue River	Tongue River	69,439	68,040	3,497	Irrigation & Industrial
Willow Creek	Lodge Grass Creek	23,000	28,000	750	Irrigation
Yellowtail	Bighorn River	1,375,000	1,356,000	17,300	Irrigation Flood Control Hydropower Fish & Wildlife Industrial

SOURCE: Montana Department of Natural Resources and Conservation 1976

The Tongue River Dam substantially modified the natural hydrologic characteristics of the Tongue River, altering island and bar formation, bank vegetation, and other channel characteristics. These effects, however, are little noticed on the relatively larger Yellowstone mainstem. Yellowtail Reservoir, because of its large storage capacity and the water yield of the Bighorn River, exerts some stabilizing influence on the Yellowstone mainstem. The extreme low flows recorded on the mainstem downstream of the Bighorn's mouth would not have been as low if Yellowtail Reservoir had existed at that time.

Kinsey Area, Powder, and Lower Yellowstone Subbasins

These subbasins include the Yellowstone mainstem from the mouth of the Tongue River to the Montana-North Dakota border, the Powder River, and O'Fallon Creek.

Streamflow records show that for many small tributaries in these subbasins the major portion of the annual flow comes during March; flows diminish to zero by summer. Although the peak flows generally occur in June, high flows also occur in the Powder River in March. Peak flows for the Yellowstone mainstem generally occur from mid-June to mid-July; December and January flows are generally the lowest of the year.

The maximum flow recorded for the Yellowstone River at Sidney was 159,000 cfs on June 2, 1921; the minimum was 470 cfs on May 17, 1961. This minimum will probably never again be approached because of the stabilizing effect releases from Yellowtail Reservoir have on the lower Yellowstone mainstem. Flow extremes for the Powder River near Locate were 31,000 cfs on February 19, 1943; zero flow occurred from January 16 to February 12, February 22-24, 1950, July 27, September 17-21, October 1, 1960, and September 4-8, 1961.

No reservoirs with capacity of over 5,000 acre-feet occur in these subbasins.

Quality

The Yellowstone River in Montana experiences a distinct downstream change in the quality of its waters from its entrance into the state in Yellowstone National Park near Gardiner to its exit to North Dakota near Fairview, Montana. This downstream change in water quality, a feature common to many streams, is due to the cumulative natural chemical and physical interaction between water and soils and many activities of man, including waste water discharges and agricultural practices. Figures A-16 and A-17 of the Appendix demonstrate this change for six recently measured water quality parameters.

In general, the quality of water in the Yellowstone River is best at upstream sites and at high flow periods, although the concentration of suspended sediments increases during this period. There is a general degradation in the river downstream to Sidney; dissolved solids, sulfate, and suspended sediment levels appear to be the prime detractors from its quality (Montana DHES 1976). However, there is no evidence of extensive pollution inputs to the river through most of its length. The quality of the river is generally good above Miles City, and its waters are suitable for most uses. Below Miles City, sediment, dissolved solids, and sulfate levels might restrict some uses.

Total dissolved solids (TDS) is a measure of the salinity of water. In the Yellowstone Basin, TDS is one of the few water quality parameters for which substantial data exist. Furthermore, TDS is a water quality parameter which is expected to change with changing streamflows and dilution of irrigation return flows. Therefore, TDS is the water quality parameter of most intense interest in the Yellowstone Basin, especially the lower and middle portions of the basin.

There is no absolute upper limit in TDS for water used as a domestic supply. The U.S. Public Health Service (1961) recommends that waters with TDS in excess of 500 mg/l not be used for drinking if other, more potable supplies are available.

Livestock are much less sensitive to salts than are humans. Most domestic animals can tolerate TDS levels in excess of 2,000 mg/l (McKee and Wolf 1974).

Plants are variable in their tolerance to salts, but are, in general, much more sensitive than animals. It is difficult to generalize about plants because:

1) different plants exhibit different salt tolerances;

2) salt tolerance depends on the presence of specific ions such as sodium, calcium, and boron, and the ratios of the concentrations of these ions;

3) salt tolerance depends on the chemical and physical characteristics of the soil; and

4) salt sensitivity can be mitigated by careful water application.

Nevertheless, a guide to the salinity hazard of waters used for irrigation is offered in Table I-7.

TABLE I-7

SALINITY HAZARD FOR IRRIGATION WATERS

TDS, mg/l	Salinity Hazard
<700	Low; water suitable for most plants under most conditions.
700 - 1,000	Medium; suitable for tolerant and semi-tolerant plants (e.g. barley, sugar beets, wheat, oats, corn).
1,000 - 2,500	High; unsuitable for most crops unless careful management is employed.
>2,500	Severe; unsuitable under most conditions.

With respect to aquatic organisms, it is also difficult to generalize about the tolerance to salts. Indeed, marine organisms thrive in water with TDS concentrations on the order of 35,000 mg/l. Freshwater organisms, however, have evolved osmotic mechanisms for salt and water balance which are sensitive to much lower salinities. Table I-8 shows some guidelines for the sensitivity of freshwater communities to salinity.

TABLE I-8

SALINITY HAZARD FOR FRESHWATER COMMUNITIES

TDS, mg/l	Hazard
<400	Low; healthy, mixed aquatic communities.
400 - 700	Moderate; some organisms suffer competitive disadvantage.
700 - 1,350	High; threshold range for success of many communities; avoidance by migratory species.
>1,350	Severe; detrimental to most freshwater systems; metabolic difficulties with eggs and fry.

Comparing tables I-7 and I-8, it may be seen that the salt sensitivities of irrigated crops and aquatic ecosystems are similar.

Water Quality Upstream From Billings

The quality of water in Yellowstone River above Billings appears to be suitable for most potential uses. Localized problems in the headwaters involve erosion, sedimentation, heavy metals, and acidity. Water chemistry begins to change from sodium-bicarbonate to calcium-bicarbonate in the vicinity of Corwin Springs. There is no evidence of marked pollution inputs to the stream. Concentrations of none of the common constituents exceed recommended levels for human consumption and use, stock water, or irrigation. Dissolved oxygen concentrations are typically near saturation, and levels of biochemical oxygen demand (BOD) are not indicative of organic pollution. None of the dissolved metals appear to be present in toxic concentrations, and the critical nutrients are not at levels characteristic of eutrophy. Temperatures are typical of a cold water fishery. Of the various water quality parameters, only fecal coliforms and (possibly) phenols are at concentrations that would indicate pollution problems; distinct concentrations of these parameters become evident in the vicinity of Billings, which has a number of industrial wastewater discharges.

The municipal and industrial discharges at Billings once caused a distinct dissolved oxygen drop and an abrupt change in the aquatic ecosystem to pollution-tolerant species. Improved treatment of these discharges, however, has resulted in a marked improvement in recent years.

Water Quality, Billings to Miles City

The degradation of water quality is most pronounced below the mouth of the Bighorn River. The water tends to become progressively more sodium-sulfate, except during high flow (May - July) periods. The quality of water in this lower river remains generally good, although a few parameters reach potential problem levels.

Temperature increases below Billings induce a warm water fishery habitat. Dissolved oxygen levels remain very close to saturation, but at lower concentrations than observed upstream. BOD levels are again indicative of an absence of organic pollution and fecal coliform concentrations are low. Dissolved metals do not approach toxic levels, and there is no evidence that the waters become eutrophic through this segment. As a result, water in the river appears to be suitable for most beneficial uses.

Water Quality Downstream From Miles City

In the segment of river below Miles City, median total dissolved solids and sulfate concentrations exceed recommended criteria for drinking water (500 mg/l and 250 mg/l, respectively) during the November to April low-flow period of the year. Thus, domestic use might be restricted in the lower river.

High levels of total suspended solids (TSS) and turbidity could pose an additional problem to water use in the lower river below Miles city. A distinct increase in TSS occurs downstream during the high flow period. At periods of low flow, however, TSS concentrations are typically less than 80 mg/l in the river below this point through all seasons, and median suspended sediment concentrations exceed 100 mg/l through most of the year below the mouth of the Powder River. Such high levels of TSS in the lower river could restrict certain beneficial water uses, e.g., as a source of domestic supply.

GROUND WATER

Although all water reservation applications but one are for surface water, ground-water resources are briefly described here. In many cases surface water is linked to ground water; however, very little is known about this relationship in the Yellowstone Basin. For descriptive purposes ground water has been divided between "near-surface aquifers" and "deep aquifers."

Near-Surface Aquifers (Montana Bureau of Mines and Geology 1968)

The upper Yellowstone Basin is a mountainous region with intermontane valleys. Mountains are composed principally of crystalline and igneous rocks, with some Paleozoic and Mesozoic age sedimentary rocks. These rocks are not sources of ground water, but serve as catchment areas for precipitation. Part of this later enters the pervious fill of the intermontane valleys to become ground water.

The fill underlying many of these intermontane valleys can be several thousand feet thick and composed of alluvium. This alluvium is very permeable and forms vast ground water reservoirs. Recharge of ground water is by precipitation in the valleys, seepage from irrigation, and seepage from streams. During periods of low flow in major streams, a base flow is provided when ground water is discharged to the streams.

The middle Yellowstone is a area of high plains, broken by isolated mountain ranges. Here most of the area is underlain by stratified rocks of Paleozoic and Mesozoic age, containing permeable sandstone and limestone formations containing large quantities of ground water. Many of the water-bearing rocks outcrop at the edge of isolated mountains, and thus are favorably situated to receive recharge from precipitation and mountain streams. Isolated areas of the Fort Union formation and high terrace gravels are present and, where thick enough, provide a source of ground water.

The lower Yellowstone Basin is a high plain devoid of mountains but incised by the Yellowstone River. Ground water recharge to the shallow aquifers in the lower Yellowstone is by local precipitation, and is considered small.

Ground-water quality varies in chemical characteristics depending upon the local geology and precipitation. Sedimentary rocks of the lower Yellowstone yield water of poorer quality than the water from the upper intermontane valleys. Water obtained from sources near the mountains tends to be more uniform in chemical character, whereas water from the lower basin varies considerably depending on the location and depth of supply. The Cenozoic and Mesozoic rocks of the lower Yellowstone are less dense than bedrock of the mountainous areas, and as a consequence soluble minerals are readily leached and contribute greatly to the mineralization of ground water.

<u>Deep Aquifers</u> (Swenson 1974)

The Madison geologic group is the major deep-water aquifer east of Billings. This limestone group underlies the entire Powder River Basin, and is exposed on the flanks of surrounding mountains. This group and underlying carbonate rocks are hydrologically connected, transmitting water as a unit.

The group dips sharply off the flanks of the Bighorn Mountains and more gently away from the Black Hills. The top of the Madison Group in Montana is between 4,000 and 5,000 feet below sea level and is about 1,400 feet thick near the Yellowstone River. Major recharge comes from the Black Hills, and the Bighorn and Pryor mountains. This water generally moves in a north-northeasterly direction. Because of the thickness of the group and the occurrence of fractures and caverns, high water yields are possible in some areas.

Total dissolved solids vary from 1,000-2,000 mg/l. Although suitable for industrial use, the water is considered marginal-to-unsatisfactory for uses demanding good water quality. Where major development of the Madison aquifer has occurred, mineralization has increased over time.

Major ground-water development of the Madison group may mine the water resource; use may exceed recharge. For this reason, additional data are needed before large scale development of the Madison should occur. The present use of the aquifer is small; however, large scale development could affect flows from existing springs and streams near the formation.

BIOLOGICAL ENVIRONMENT

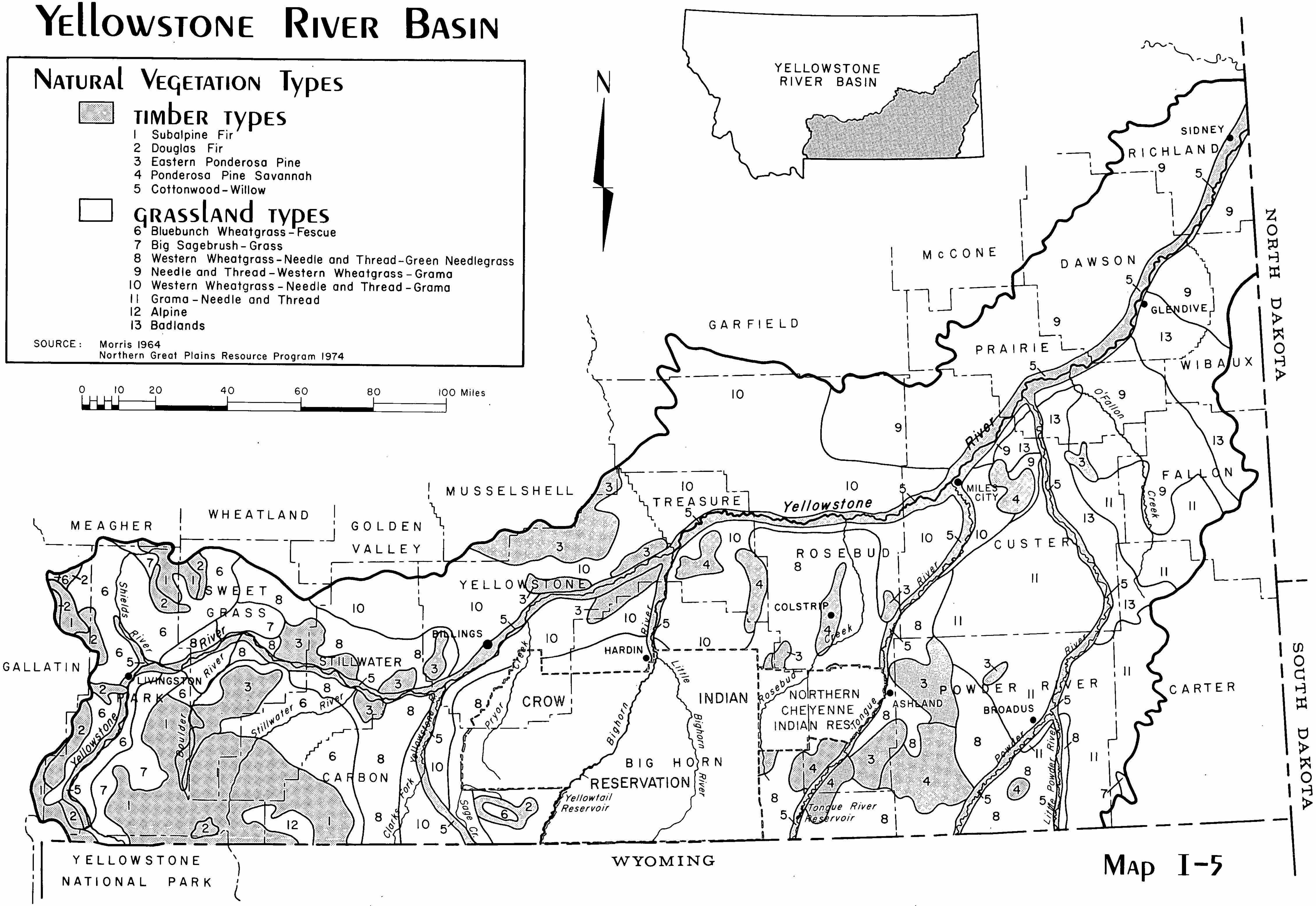
VEGETATION

Vegetation communities result from interactions over time among topography, soils, and climate. In addition, existing vegetation represents the product of disruption and adaptation through natural (fires, drought, wildlife grazing) and man-caused (domestic grazing, agriculture, urban sprawl, pollution) disturbance. Existing vegetative communities are complex, and may change rapidly with natural or man-caused environmental changes.

Although grazing, farming, and other land uses may have recently altered or eliminated the indicated vegetation types from some areas, the vegetation map (Map I-5) shows distribution for existing natural vegetation types. There are 13 vegetation types in the study area, classified according to dominant (and in some cases major subdominant) species. Environmental associations for the timber and grassland vegetation types are shown in Tables I-9 and I-10.

Rainfall, as related to elevation, is a major factor in determining whether grasses or trees are the dominant vegetation. Grasslands (with the exception of alpine grassland) generally occur where annual average precipitation is less than 14 inches. Ponderosa pine savannah occurs when precipitation is slightly above 14 inches, and timber/grassland ratios increase rapidly with increasing precipitation. The 14-inch isohyet, used here to separate timber and grassland vegetative types, represents a dividing value that varies considerably. Regional factors such as evaporation and drought frequency, and local factors such as slope, exposure, and soil water capacity have a bearing on the proportion of precipitation actually available for plant use. Thus, 18 inches of precipitation may support timber at one site and grass, sagebrush, or prickly pear cactus at another.

Yellowstone River Basin



Map I-5

TABLE I-9

TIMBER VEGETATION TYPES

Principal Associated Species	No. 1 Subalpine	No. 2 Douglas Fir	No. 3 Eastern Ponderosa Pine	No. 4 Ponderosa Pine Savanna	No. 5 Cottonwood-Willow
TREES	Subalpine fir Lodgepole pine Spruce complex Douglas fir Whitebark pine Limber pine	Douglas fir Ponderosa pine Lodgepole pine Limber pine Engelmann spruce Subalpine fir	Ponderosa pine Rocky Mountain juniper Common juniper	Ponderosa pine Rocky Mountain juniper	Cottonwoods Willow
SHRUBS	Grouse whortle-berry Red mountain heath Menziesia Blue huckle-berry	Ninebark Oregon grape Fringed sage-wort Snowberry Big sagebrush	Skunkbrush sumac Western snowberry	Western snowberry Skunkbrush sumac	Rose Buffaloberry Snowberry Chokecherry Serviceberry
GRASSES & GRASSLIKE	Idaho fescue Bluegrass Elk sedge Pine grass	Bluebunch wheatgrass Idaho fescue Elk sedge	Bluebunch wheat-grass Idaho fescue Spike fescue	Bluebunch wheat-grass Western wheat- Blue grama Native bluegrass	Sedges Wirerush
FORBS	Aster Bluebell Lupine Arnica	Arrowleaf-balsamroot Arnica False Solo-mon's seal	Phlox Arrowleaf-balsamroot	Phlox Lupine	Lambsquarter-goosefoot Stickseed
TOPOGRAPHY	rough; mountains	mountainous	rough broken land along Yellowstone river & rocky hills rising from plains	rolling to hilly on breaks to terraces	bottomland, river & creek bottoms
MAJOR RESOURCE USES	watershed timber wildlife recreation range wilderness	timber recreation wildlife watershed range	range watershed wildlife recreation	watershed range wildlife	streambank stab-ilization wildlife

SOURCE: Montana DNRC 1974

TABLE I-10

GRASSLAND VEGETATION TYPES

Principal Associated Species	No. 6 Bluebunch Wheat-grass Fescue	No. 7 Big Sagebrush-Grass	No. 8 Western Wheatgrass-Needle & Thread-green Needlegrass	No. 9 Needle & Thread-Western Wheatgrass-Grama	No. 10 Western Wheatgrass-Needle & Thread-Grama	No. 11 Grama-Needle & Thread	No. 12 Alpine	No. 13 Badlands
TREES	Limber pine Common juniper							Rocky Mountain juniper Ponderosa pine
SHRUBS	Shrubby cinquefoil Big sagebrush Fringed sagewort Skunkbush sumac	Big sagebrush Rubber rabbitbrush Fringed sagewort Prickly pear Broom snakeweed	Fringed sagewort Big sagebrush	Broom snakeweed Prickly pear	Big sagebrush Pricklypear Silver sagebrush Fringed sagewort	Fringed sagewort	Snow willow Summill willow Western ledum Red mountain heath	Greasewood Nuttail saltbrush Shadscale saltbrush Fringed sagewort Winterfat Big sagebrush
GRASSES & GRASSLIKE	Western wheatgrass Prairie junegrass Threadleaf sedge Needle and thread Kentucky bluegrass Side-oats grama	Native bluegrass Priaire junegrass Blue grama Bluebunch wheatgrass Idaho fescue Plains muhly Needle and thread Western wheatgrass	Prairie junegrass Threadleaf sedge Canada bluegrass Blue grama Native bluegrass	Threadleaf sedge Native bluegrass Prairie junegrass Plains reedgrass Bluebunch wheatgrass Needleleaf sedge	Native bludgrass Green needlegrass Prairie junegrass Plains muhly Threadleaf sedge	Native bluegrass Prairie junegrass Bluebunch wheatgrass Needleleaf sedge Threadleaf sedge	Sheep fescue Timber oatgrass Bentgrass Alpine bluegrass Alpine timothy Sedge	Alkali sacaton Squirreltail Bluebunch wheatgrass Indian ricegrass Little bluestem Blue grama Buffalograss Tumblegrass Prairie sandreed Western wheatgrass Red three-awn
FORBS	Lupine Yarrow Wild onions Arrowleaf balsamroot	Pussytoes Phlox Locoweed Lupine	Yarrow Lupine Phlox Clubmoss	Scarlet globemallow Lambsquarter goose-foot Stickseed	Phlox Wild buckwheat Scarlet globemallow	Phlox Lupine Clubmoss	Lupine Bluebell Alpine forget-me-not	Silverleaf scurfpea Russian thistle Hoods phlox
TOPOGRAPHY	rolling hills-steep; from edge of timber in mountains to plains	foothills	gently sloping to rolling	rolling	plains to rolling & rough	gently sloping to rolling	rolling to very steep; above timberline	rough breaks
MAJOR RESOURCE USES	range wildlife recreation	watershed wildlife range	range cultivation	range wildlife	range wildlife	range wildlife	recreation summer sheep range	wildlife limited range; recreation

SOURCE: Montana DNRC 1974

AQUATIC LIFE

From the Yellowstone's headwaters to its mouth, the river changes from an alpine, salmonid-type fishery to a diverse, non-salmonid aquatic ecosystem. A longitudinal profile of the Yellowstone is presented in Figure I-2 (Peterman and Haddix 1975).

Based on current knowledge of fish distribution, the Yellowstone may be generally divided into three zones. The "headwaters zone," roughly running from Gardiner to Big Timber, covers 103 miles of river and roughly corresponds to the western half of the Upper Yellowstone Subbasin.

The second zone, or "transition zone," runs 160 miles from Big Timber to the mouth of the Bighorn River. This zone corresponds to the eastern half of the Upper Yellowstone Subbasin and all of the Clarks Fork Yellowstone, Billings Area, and Bighorn subbasins.

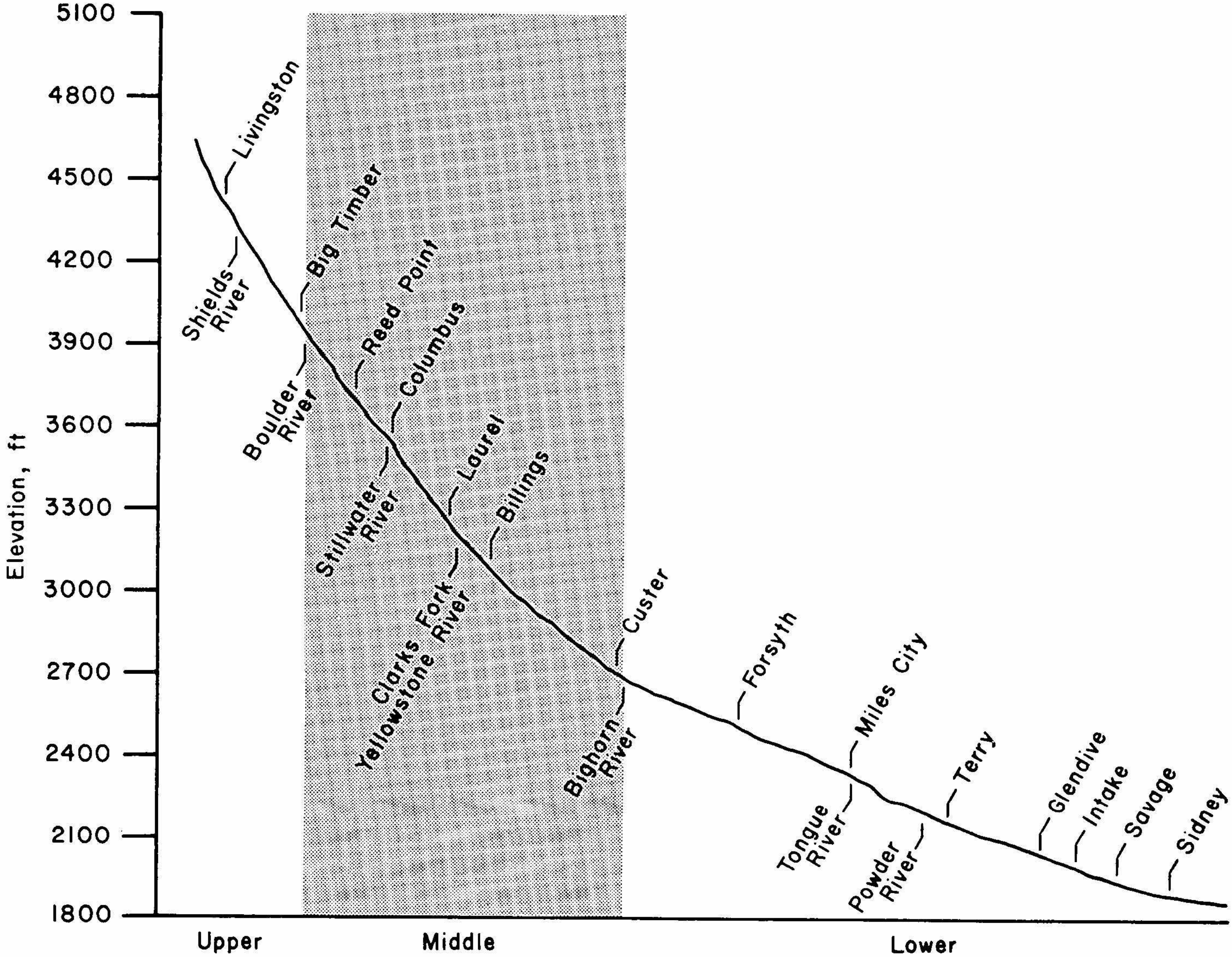
The third fishery zone, or "plains zone," runs approximately 295 miles from the mouth of the Bighorn River to the Yellowstone's confluence with the Missouri. This zone corresponds to the Mid-Yellowstone, Tongue, Kinsey Area, Powder, and Lower Yellowstone subbasins.

Montana's portion of the Yellowstone is of great importance as a sport fishery. A total of 50 species, representing 13 fish families, has been recorded in the river (Table I-11). Although data are too limited to show distributions of 17 species, the probable distribution of the remaining 33 is illustrated in Figure I-3 (Peterman and Haddix 1975).

HEADWATERS ZONE

The headwaters zone supports a cold-water fishery of national significance and has been classified as a "blue ribbon" trout stream by the Stream Classification Committee (1965). Large populations of a relatively few species characteristic of clear, cold waters occur in this portion of the basin. The stream reach from Gardiner to the mouth of the Boulder River at Big Timber represents the longest single reach (103 miles) of blue ribbon trout stream in Montana and comprises 23 percent of the state's 452 total miles of blue ribbon water.

An excellent fishery exists in the entire headwaters zone for rainbow, brown, and Yellowstone cutthroat trout, as well as mountain whitefish. Rainbow and brown trout are the most sought-after species, and provide excellent fishing opportunities. Although not native to the area, they currently provide the bulk of the trout harvest. The Yellowstone cutthroat trout is a unique and highly prized species. Found only in the headwaters of the Yellowstone Basin, its range appears to be quite restricted. Mountain whitefish are several times more abundant than trout and provide an important winter fishery.



LONGITUDINAL PROFILE OF THE YELLOWSTONE RIVER

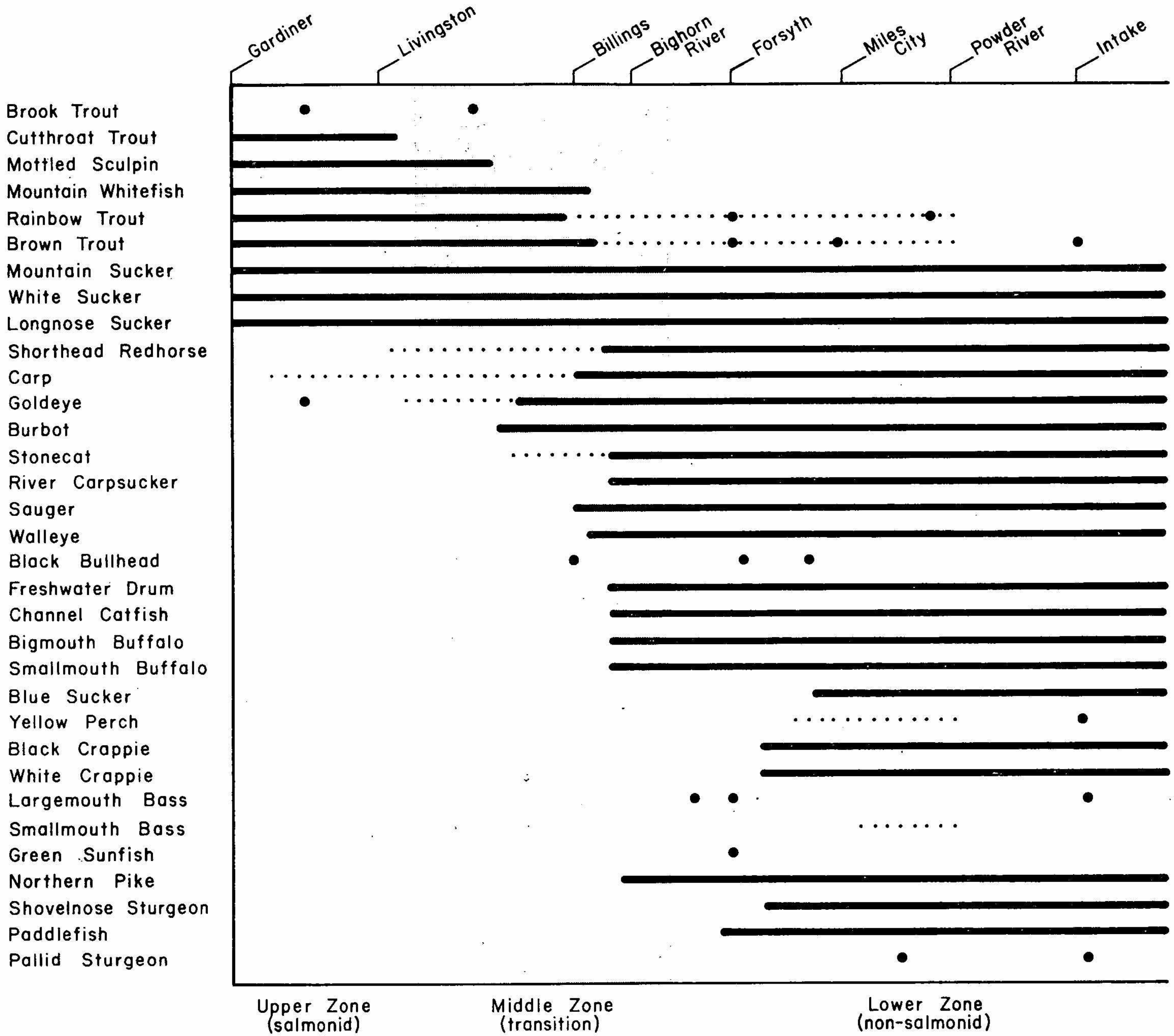
FIGURE I-2

TABLE I-11

FISH SPECIES RECORDED FOR THE YELLOWSTONE RIVER

Family	Species
Sturgeon family	Pallid sturgeon Shovelnose sturgeon
Paddlefish family	Paddlefish
Mooneye family	Goldeye
Trout family	Mountain whitefish Cutthroat trout Rainbow trout Brown trout Brook trout
Pike family	Northern Pike
Minnow family	Carp Goldfish Golden Shiner Pearl dace Creek chub Flathead chub Sturgeon chub Lake chub Emerald shiner Sand shiner Brassy minnow Plains minnow Silvery minnow Flathead minnow Longnose dace
Sucker family	River carpsucker Blue sucker Smallmouth buffalo Bigmouth buffalo Shorthead redhorse Longnose sucker White sucker Mountain sucker
Catfish family	Black bullhead Channel catfish Stonecat
Codfish family	Burbot
Sunfish family	Green sunfish Pumpkinseed Bluegill Smallmouth bass Largemouth bass White crappie Black crappie Rock bass
Perch family	Yellow perch Sauger Walleye
Drum family	Freshwater drum
Sculpin family	Mottled sculpin

SOURCE: Peterman and Haddix 1975



SOURCE: Peterman and Haddix 1975

▬ reproductive success
······ occasional occurrence
● occurrence of a few individuals

LONGITUDINAL DISTRIBUTION OF FISH SPECIES IN THE YELLOWSTONE RIVER

FIGURE I-3

As shown in Table I-12, a total of 17 species, representing seven families of fish, is known to occur in the upper Yellowstone-Shields River drainages above Springdale. Only ten species (four families) are considered common or abundant. Cutthroat, rainbow, brown, brook trout, and mountain whitefish are the most common game fish. Common nongame fish species include longnose, white and mountain suckers, longnose dace, and mottled sculpin.

TABLE I-12

FISH SPECIES RECORDED FOR THE YELLOWSTONE RIVER DRAINAGE IN MONTANA ABOVE SPRINGDALE

Family	Species	Family	Species
Mooneye family	Goldeye[a]	Sucker family	Shorthead redhorse[a] Longnose sucker White sucker Mountain sucker
Trout family	Mountain whitefish Cutthroat trout Rainbow trout Brown trout Brook trout Kokanee[b]	Codfish family	Burbot[a]
		Perch family	Yellow perch[b]
Minnow family	Carp[a] Lake chub[a] Longnose dace	Sculpin family	Mottled sculpin

SOURCE: Montana Department of Fish and Game 1975a

[a]Rare

[b]Limited to Dailey Lake

The headwaters zone is characterized by its clean, cold, highly productive water. Streambed materials, predominantly round cobbles in riffle and run areas, provide excellent substrate for primary and secondary producers. Spaces between the cobbles provide shelter for young trout and small forage fish such as sculpin. Adult fish security is provided mostly by instream cover such as large rocks, debris, deep water, and surface roughness.

In many parts of the headwaters zone, introduced rainbow have hybridized extensively with native cutthroat. This hybridization, common in tributary streams in this zone, has resulted in a decline of genetically pure cutthroat.

The cutthroat population in the mainstem of the Yellowstone River appears to be a pure strain which migrates from the river into tributary streams to spawn. Significant in the cutthroat's decline in the mainstem is the complete diversion of many tributaries for irrigation after spring runoff, leaving only a few that are suitable for maintenance of spawning runs.

Small Tributary Creeks

The upper Yellowstone River derives much of its water and bedload material from the numerous mountain tributary streams. These creeks, which originate in high mountain areas, contribute cold, high-quality water to the mainstem. They independently support self-sustaining resident populations of rainbow, cutthroat, rainbow-cutthroat hybrid, brown, and brook trout, and mountain whitefish. Tributary streams generally exhibit high gradients and cobble and boulder channels. Fish cover is provided primarily by surface roughness, streambank vegetation, and instream boulders.

Armstrong Spring and Nelson Spring creeks are the best examples of the several important spring-fed streams in this area. Spring-fed creeks are characterized by fairly constant flows and temperature, and are rich in aquatic vegetation and insect life. Flows originate almost entirely in underground aquifers and are independent of surface water sources. Their high productivity is reflected in excellent trout populations (Elser and Marcoux 1970; Workman 1972, 1973), of which brown and rainbow trout are the dominant species. Fish cover consists primarily of stream bank vegetation, undercut banks, debris, and instream vegetation.

Cutthroat trout are the most widely distributed of the fish species, occuring in 13 of 21 tributaries surveyed. Cutthroat trout are most abundant in the headwater areas but normally are distributed throughout the length of the drainages where they occur.

Brown and rainbow trout have been found to select only spring creek tributaries for spawning. Armstrong, Nelson, McDonald,and Emigrant spring creeks contain brown and rainbow spawning runs,and tagging studies indicate that some fish migrate several miles up or downstream in the Yellowstone mainstem to reach a spring creek to ascend for spawning. Migrant brown trout were taken from early November to early December; rainbow trout appeared from early April to early May.

The two native salmonid fish, Yellowstone cutthroat trout and mountain whitefish, appear to be particularly dependent on the tributary streams for spawning. Cutthroat trout move as far as 14 miles in the Yellowstone River to utilize tributary streams of their birth; there is no evidence that cutthroat spawn in the mainstem itself. Mountain whitefish also exhibit extensive movements to reach spawning tributaries.

Mountain whitefish spawning runs have been monitored in six tributaries: Mol Heron, Tom Miner, Big, Eightmile, Fridley, and Mission creeks. Tremendous numbers of migratory whitefish were found spawning in the tributaries from October 15 to December 5, 1974, peaking in early November. No migratory whitefish were found in limited sampling conducted on Rock, Cedar, Billman, Mission, Dry, Eightmile, Pine, Sixmile, or Deep creeks. Due to limited sampling on these latter tributaries, it is not possible at this time to determine the presence or absence of a cutthroat spawning run.

Shields River

The watershed in the headwaters of the Shields River has been extensively logged; in the lower reaches of the drainage livestock grazing and other agricultural activities are the major land use. Nevertheless, waters in the Shields drainage offer sport fishing for cutthroat, rainbow, brown, and brook trout, as well as mountain whitefish. Brown trout and mountain whitefish are most abundant in the Shields mainstem below the headwaters basin, while cutthroat trout are mainly found in the headwaters basin and in the tributary streams.

Fish population inventories detected 11 species in 15 survey sections along the Shields River during the summer of 1974. The longitudinal distribution of these species is illustrated in Figure I-4. Cutthroat trout and mottled sculpin are the most widespread species in the Shields River, each occurring throughout the 62-mile length of stream. Cutthroat trout are the most abundant in the upper Shields, with only an occasional specimen found on the lower 25 miles of river. Mountain whitefish and brown trout are common in the river below the confluence of the South Fork.

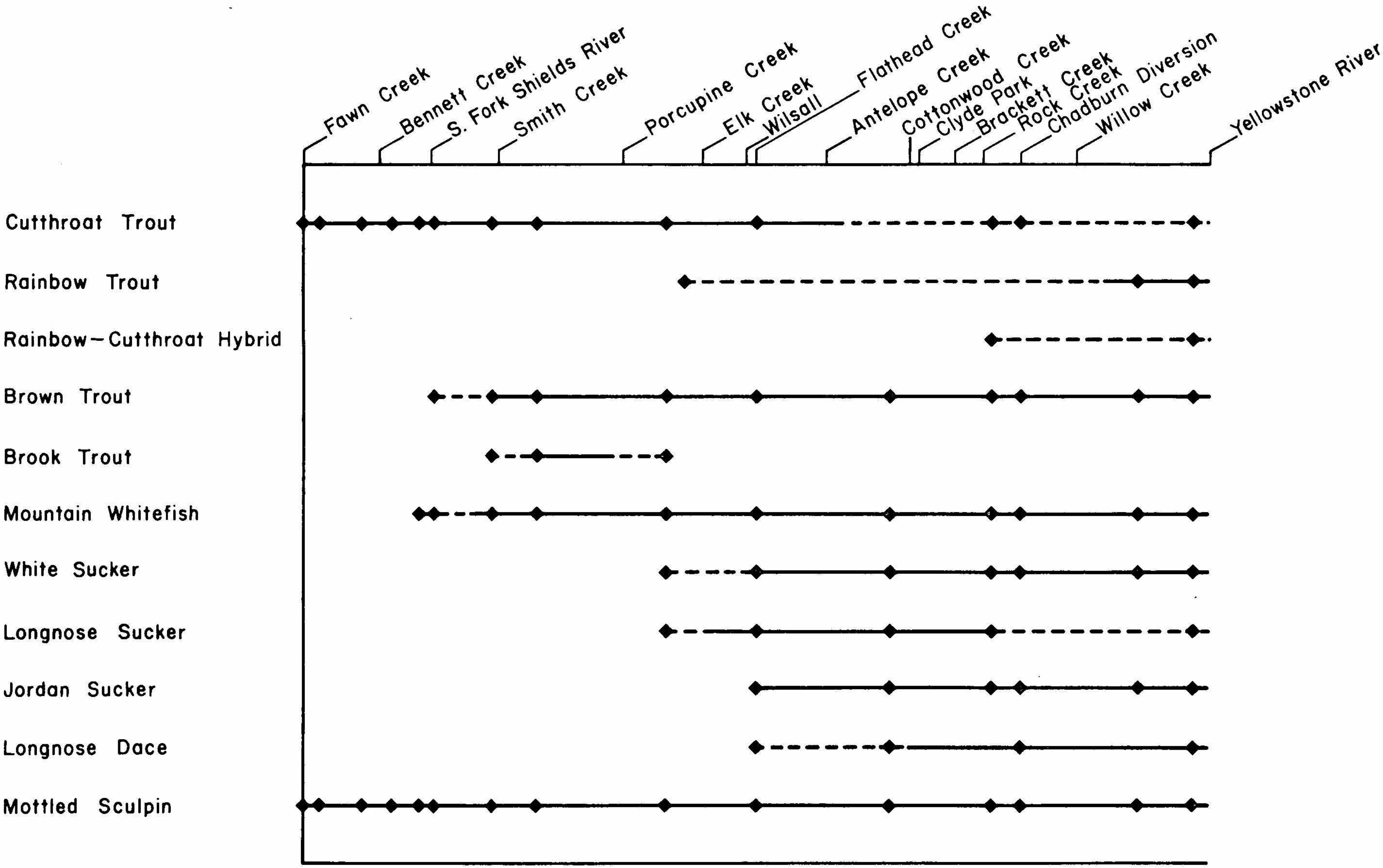
Brook trout distribution is limited to a 10-15 mile reach of the Shields immediately upstream from Wilsall. This portion of the Shields normally experiences severe dewatering during the irrigation season. Rainbow trout distribution is essentially limited to the lower five to ten miles of the Shields.

Macroinvertebrates

Seventy-eight macroinvertebrate species have been identified on the Yellowstone River (Newell 1976). Fifty-eight are members of the mayfly, stonefly, and caddisfly orders, primarily gill-breathing forms indicative of clean, unpolluted water. Species diversity represented in Figure I-5 indicates healthy macroinvertebrate communities in the upper Yellowstone (Berg 1975). Stonefly and caddisfly species decline significantly from the headwaters zone to the plains zone.

Periphyton

As in the other zones, algae are responsible for the major share of primary production in the upper Yellowstone River aquatic ecosystem. Based on preliminary observations, the cosmopolitan green algae Cladophora is the dominant genus in the river, purifying water and serving as an attachment site for aquatic invertebrates and other algae.

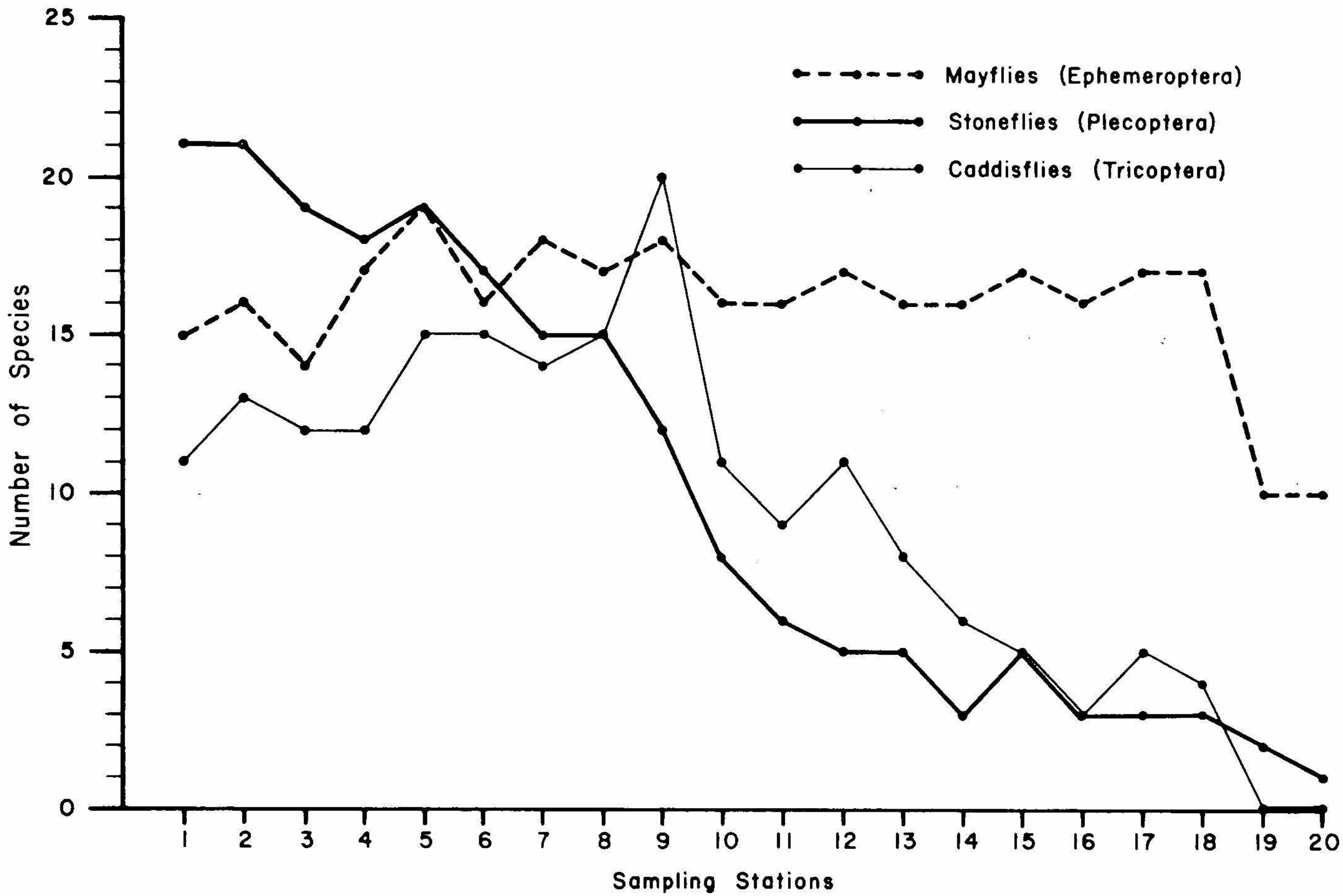


SOURCE: Montana Department of Fish and Game 1975a

——— common distribution
- - - limited distribution
◆ fish species capture site

LONGITUDINAL DISTRIBUTION OF FISH SPECIES IN THE SHIELDS RIVER

FIGURE I-4



		River Mile
1	Corwin Springs	549
2	Mallard Rest Access	515
3	Above Livingston	501
4	Above Shields River	497
5	Grey Bear Access	468
6	Below Grey Cliff	444
7	Columbus	411
8	Laurel	391
9	Duck Creek Bridge	360
10	Huntley	349
11	Custer	300
12	Below Bighorn River	296
13	Meyers	279
14	Forsyth	234
15	Miles City	184
16	Terry	138
17	Glendive	93
18	Intake	71
19	Sydney	30
20	Cartwright, N. D.	9
	Mouth	0

SOURCE: Newell 1976

LONGITUDINAL DISTRIBUTION OF THE THREE MAJOR ORDERS OF MACROINVERTEBRATES IN THE YELLOWSTONE RIVER

FIGURE I-5

Diatoms are the most diverse and perhaps the most important algae group. They are functionally important in purifying water and are grazed by aquatic macroinvertebrates. Dozens of diatom genera and over 100 species have been identified in preliminary investigations (Bahls 1975, cited in Montana Department of Fish and Game 1975a).

TRANSITION ZONE

The transition zone extends 160 miles from Big Timber to the mouth of the Bighorn River. Although both cold and warm-water species are present, their distribution and population dynamics are poorly understood. Trout are the principle species from Big Timber to the Clarks Fork Yellowstone; the primary change to warm-water species occurs below the mouth of the Clarks Fork Yellowstone.

Species known to occur in the vicinity of Reedpoint include rainbow and brown trout, mountain whitefish, longnose, white and mountain suckers, stonecat, shorthead redhorse, burbot, longnose dace, and mottled sculpin (Peterman 1974). Sampling from Laurel downstream to the Bighorn River produced, in addition to 13 other species, a small number of brown and rainbow trout, which became less numerous in the lower reaches.

The Stillwater River enters as a major tributary of the middle Yellowstone at Columbus. The Stillwater is a cold-water stream originating high in the Beartooth Mountains. Although water quality is generally good in the Stillwater region, past mining activities have adversely affected portions of a few streams and reduced fish populations in those reaches. Game fish populations are composed of rainbow, cutthroat, brown, and brook trout, as well as mountain whitefish and rainbow-cutthroat hydrids. Nongame species include longnose sucker, mountain sucker, and longnose dace. In smaller tributaries fish populations are lacking, except near the mouth (Stewart 1975). Fish populations are maintained almost entirely by natural reproduction.

A total of 136 species of macroinvertebrates have been collected from the Yellowstone within the transition zone, indicating a rich and diverse community. Regression analyses indicate that the number of organisms and genera are correlated with water velocity and depth, and that reduced discharge could decrease abundance and richness of the present communities (Schwehr 1976).

PLAINS ZONE

The lower Yellowstone, stretching 295 miles below the mouth of the Bighorn River, supports a diverse aquatic ecosystem with a wide variety of non-salmonid, warm-water species. Important game species include the paddlefish, shovelnose sturgeon, sauger, walleye, channel catfish, northern pike, and burbot. These species, as well as a large population of nongame fish, are a lightly utilized but potentially valuable resource.

Sampling near Forsyth in 1974 produced 4,698 fish of 19 species. Goldeye accounted for 55.4 percent of the total, with carp, river carpsucker, shorthead redhorse, and longnose sucker making up the balance of the catch. Goldeye are abundant in the lower Yellowstone from Billings downstream and have been taken as far upstream as Pine Creek above Livingston (Brown 1971). Estimated populations of goldeye computed in 1973 showed 9,170 fish per mile of stream for a section of river below Armells Creek. Although the estimate is not statistically reliable, it is indicative of the large number of goldeye in the river.

Bighorn River

With water releases from the Bighorn Reservoir at Yellowtail Dam, a substantial cold-water fishery has developed in the river from the Afterbay Dam to about ten miles below St. Xavier. Transition to a diverse warm-water fishery occurs below that point to the mouth of the Bighorn River. Important species in the upper portion are brown and rainbow trout, while walleye, burbot, and channel catfish are important in the lower reaches.

During a 1973 sample taken in the upper section of the river, eight species were taken: rainbow trout, brown trout, carp, longnose sucker, mountain sucker, shorthead redhorse, flathead chub, and burbot. The lower section of river was dominated by longnose sucker (30.1 percent) and carp (26.3 percent), although twelve species were present.

Tongue River

The Tongue River provides one of the most diverse sport fisheries in the state. Popular game fish in the Tongue include: rainbow trout, brown trout, smallmouth bass, northern pike, rock bass, sauger, walleye, channel catfish, and shovelnose sturgeon. Predominant non-game fish species are goldeye, longnose sucker, flathead chub, shorthead redhorse, and stonecat. The Tongue River supports the only rock bass population in Montana. The sturgeon chub, rare in Montana, is also found in the Tongue.

The Tongue River is important as a Yellowstone spawning area for several species including sauger, shovelnose sturgeon, and blue suckers.

Powder River

Due to the extremely turbid nature and seasonally low water conditions of the Powder River, only a limited sport fishery is provided. Shovelnose sturgeon are taken as far upstream as Broadus, and channel catfish are also commonly caught along most of the river.

River habitat is typical of a prairie stream. The river is silt-laden and subject to erratic fluctuations in flow, with much of its substrate constantly shifting as bed load. The river develops shallow pools only and lacks aquatic vegetation. The extreme turbidity limits light penetration, severely reducing primary productivity and, therefore, aquatic invertebrate populations.

Sampling in the Powder during the summer of 1973 produced seven species, including flathead chub, sturgeon chub, channel catfish, goldeye, river carpsucker, carp, and stonecat. More recent sampling (Rehwinkle et al. 1976) produced the following additional species: lake chub, shorthead redhorse, longnose dace, sauger, burbot, brassy minnow, green sunfish, sand shiner, plains minnow, silvery minnow, and creek chub. Sturgeon chub, a murky-water fish, is common only in the Powder River and Mizpah Creek (Rehwinkle et al. 1976).

Reservoirs

Game fish in southeastern Montana are supported by a large number of ranch and farm ponds. These ponds vary in size from under one acre to over 100 acres, but are generally between five and 20 acres. The primary consideration in pond construction is livestock watering, but sport fishing constitutes a secondary benefit.

Most of these ponds are managed for warm-water species, usually including northern pike, walleye, and largemouth bass. Some ponds are suitable for rainbow trout and are planted on a regular basis (Elser 1974). The physical nature of these ponds and their fish populations are constantly changing; therefore, they are under intense management to provide quality fishing.

One large impoundment, the Tongue River Reservoir (3,500 surface acres), provides a variety of warm-water fishing for walleye, northern pike, smallmouth bass, and crappie.

Periphyton

The lower Yellowstone's most abundant algae, by volume, is Cladophora, a common sessile green algae. However, as a group, diatoms are the most abundant and diverse. A total of 23 genera of diatoms, six genera of green algae, two genera of blue green algae, and one genus of red algae has been identified.

Plankton samples collected near Armells Creek in 1973 produced 39 species of algae (37 diatom species and two species of green algae) (Bahls 1974).

In the lower portion of the Yellowstone River, the plankton consist of sessile algae and bottom fauna dislodged from the substrate. Therefore they are not true plankton, and their production area is primarily the riffle sites where a suitable clean substrate exists. The lack of true plankton is a common characteristic of cool, fast flowing rivers (Hynes 1970). Within such rivers, the periphyton is the primary producer.

Other Aquatic Vertebrates

Three turtle species have been found in the lower Yellowstone: the common snapping turtle, the western spiny soft-shelled turtle, and the western painted turtle. Amphibians in or near the Yellowstone include the toad, the tiger salamander, and the leopard frog.

TERRESTRIAL WILDLIFE

A diversity of game and nongame wildlife populates the entire Yellowstone Basin. Habitat areas for major species have been mapped, and are included in the Appendix. Close study of the maps will give a broad understanding of major species identification, as well as where in the basin they are encountered. The maps delineate habitat areas for: bighorn sheep and mountain goat, white-tailed deer and moose, elk, pronghorn, mule deer, chukars and turkey, mountain grouse, ducks (fall distribution), sharptail grouse, gray (hungarian) partridge, geese, sage grouse, and pheasant.

In order to describe terrestrial wildlife, the basin has been divided into three zones: the upper, or "headwaters zone," the middle, or "transition zone," and the lower, or "plains zone." For a discussion of the zone locations in relation to the nine planning subbasins, see page 30.

HEADWATERS ZONE

Big Game

The upper Yellowstone and Shields river drainage support abundant populations of elk, mule and white-tailed deer, pronghorn antelope, mountain goats, bighorn sheep, and black bear. A few grizzly bear also inhabit the area. Over 1,500 resident elk and 3,000 migratory elk (from Yellowstone Park) winter in the area.

Elk and mule deer spend summers at high elevations and winter at lower elevations. White-tailed deer live yearlong in the river bottoms, with major concentrations along the Shields River. Pronghorn usually remain yearlong in the foothills, with major concentrations in the Shields River drainage and along the Yellowstone mainstem from Livingston to Springdale. Black bears are scattered throughout the study area, and grizzly bears are found primarily adjacent to Yellowstone Park.

Upland Game and Waterfowl

Principal upland game birds found in the headwaters zone include sage, sharp-tailed, blue, and ruffed grouse; Hungarian and chukar partridge; pheasant; and Merriam's turkey.

Sage grouse are found exclusively in the Shields River drainage. They are associated with a sagebrush-grassland habitat type which occurs primarily north of Wilsall. Sharp-tailed grouse are limited to the Shields River drainage and (to a lesser extent) the Yellowstone River downstream of Livingston. They are usually associated with a grassland habitat type on the benchlands east and west of the Shields River and north of the Absaroka Mountains.

The blue grouse is the major upland game bird found in the headwaters zone. During spring they breed in lower foothill areas. Females and young remain at these lower elevations for brood rearing, while males begin an upward migration in late summer. Autumn finds the birds at intermediate elevations in the forest; the birds winter on higher ridges. Ruffed grouse, although not as abundant as blue grouse, are found in aspen parks and deciduous drainage bottoms within several mountain ranges as well as brushy areas along the Shields and Yellowstone rivers. Increased agricultural brush removal and heavy livestock use have resulted in the deterioration of ruffed grouse habitats in many areas.

The ring-necked pheasant has a marginal population in the area, restricted to the bottom lands of the Yellowstone and Shields river drainages. The population trend for pheasants, apparently downward for a number of years, will probably continue as agricultural and other development activities on these bottomlands intensify and expand.

Gray (Hungarian) partridge are found throughout nonforested portions of the area from Yellowstone Park to the sagebrush-grasslands north of Wilsall. They are locally abundant on the agricultural benchlands along the Shields River and south of Livingston along the Yellowstone River.

Because Park County lies on the eastern edge of the Pacific Flyway, it does not receive as great a use by migratory waterfowl as other parts of Montana in the Pacific and Central Flyways. However, 21 species have been found using the area: pintail, shoveller, canvasback, redhead, mallard, gadwall, baldpate, lesser scaup, whistling swan, common merganser, redbreasted merganser, common goldeneye, Barrow's goldeneye, bufflehead, ruddy duck, blue-winged teal, green-winged teal, cinnamon teal, coot, ringnecked duck,and Canada goose. Geese are usually seen in association with islands.

Nongame Birds

Sixteen species of raptors have been reported in the area. The bald eagle is commonly found wintering along the entire length of the upper Yellowstone River and is occasionally observed along the Shields River. The golden eagle, another major raptor, makes extensive use of the sagebrush-grassland habitat type in the upper Shields for hunting.

Endangered Wildlife

Peregrine falcons migrate through the area, and grizzly bear, a threatened species, inhabit some areas of the headwaters zone.

TRANSITION ZONE

Big Game

Game species in the transition zone, between Big Timber and the Bighorn River, are similar to those of the headwaters zone; included are elk, mule and white-tailed deer, moose, black and grizzly bear, mountain goats, and bighorn sheep. Due to the change in habitat from mountainous to prairie types, pronghorn antelope populations are higher and more widely dispersed.

Mule and white-tailed deer are commonly range over the entire area. Elk are less abundant, occupying only a small area southwest of Custer. Other mammals found in the middle Yellowstone include beaver, muskrat, marten, coyote, fox, bobcat, and lynx. Mink, beaver, and muskrat are the major fur-bearing animals of the region.

Upland Game and Waterfowl

Upland game birds include Merriam's turkey, ring-necked pheasant, and Hungarian partridge, as well as sage, sharp-tailed, blue, ruffed, and Franklin's grouse. Sage and sharp-tailed grouse are found mostly in prairie regions, whereas blue, ruffed and Franklin's grouse are confined to higher elevations. Pheasants are found along river bottoms in agricultural areas. Populations of Hungarian partridge, chukar, and turkey are small.

Waterfowl species and habitats are found along the Yellowstone River, lowland lakes, streams, irrigation canals, stock ponds, and marshes. Canada geese migrate through the area in spring and fall, and goose nesting occurs on islands of the Yellowstone. The year-round open water of the Bighorn River below Yellowtail Dam is also an important Canada goose wintering area.

Nongame Birds

Golden eagles are abundant in the region, and whistling swans as well as sandhill cranes migrate through the easternmost portion.

Endangered Wildlife

A threatened species is the grizzly bear, limited to small regions of the Beartooth Mountains. The black-footed ferret, western burrowing owl, ferruginous hawk, and American osprey all may inhabit the area, but are rarely seen and their status is presently classified as undetermined. Bald eagles are known to depend on the Bighorn and Yellowstone rivers for winter habitat.

PLAINS ZONE

Big Game

The plains zone, which extends along the Yellowstone River from the mouth of the Bighorn to the confluence with the Missouri, contains mule deer, white-tailed deer, pronghorn antelope, and a small number of bighorn sheep.

Mule deer are found throughout the area, and are generally nonmigratory, although there is a seasonal change of habitat types due to changes in weather and available food. White-tailed deer are common along bottomlands, usually associated with deciduous vegetation and agricultural areas. The Yellowstone, Tongue, and Bighorn river bottoms support major populations; Rosebud Creek has a substantial population; and smaller populations may exist along Armells and Sarpy creeks.

Pronghorn antelope are abundant in the plains zone, particularly north of the Yellowstone River and south of the river between the Tongue River and North Dakota. They are less frequent south of the river between the Bighorn and Tongue rivers; however, a number of areas in this region are considered important antelope habitat. There are seasonal changes in distribution.

A very small bighorn sheep population occurs east of Miles City, resulting from a transplant of 11 sheep in 1958. The population is presently estimated at 75 to 100 sheep.

Upland Game and Waterfowl

Major upland game birds in the plains zone include Merriam's turkey, sage grouse, sharp-tailed grouse, pheasants, and gray partridge. Turkeys are not numerous, but can be found east of Miles City, south of Forsyth, in the Sarpy Basin, and in the Custer National Forest between the Tongue and Powder rivers.

Sage grouse are abundant in the rolling sagebrush-grassland plains of Powder River, Custer, and Rosebud counties north of the Yellowstone River. Sharp-tailed grouse, found throughout the area, are the most abundant game birds in the southeastern Montana. The Great Plains sharptail remains seasonally abundant in the more moist upland areas where mixed-prairie rangelands have been maintained in reasonably good condition.

Pheasants occur along most of the drainage bottoms, especially in cultivated lands with a mixture of herbs, shrubs and trees for cover. Pheasant populations were high in the early 1960's, but they declined drastically after the severe winter of 1964-65. Since then populations appear to have slowly increased and are approaching the original levels. Gray (Hungarian) partridge are found throughout the area, but not in abundance.

The number of breeding pairs of Canada geese along the Yellowstone appears to be increasing and is currently estimated at over 800 pairs. Goose production for the Yellowstone River has been estimated at 2,300 young per year, brooded in the early summer in backwaters of the river, riverside meadows, and hayfields. Geese along the river prefer to nest on islands.

The river has also become a stopover for large numbers of spring migrants. An aerial census from Sidney to the Bighorn River in March of 1974 revealed a total of nearly 9,600 geese. The number of geese along the river and its larger tributaries grows throughout the fall, and appears to be increasing from year to year. The higher use by geese in the fall is believed to be related to an increase in acreage of irrigated grain along the rivers, coupled with a possible increase of goose numbers in the Central Flyway.

Other known nesters in the plains zone include mallard, blue-winged teal, wood duck, and merganser. Double-crested cormorants and eared grebes are also believed to nest there. Summer use of the Yellowstone by ducks, particularly mallards, closely parallels that by Canada geese; heavy use of open islands and bars is made once the molt is completed. By fall many large flocks of ducks concentrate on the Yellowstone and its largest tributaries, with ultimate numbers reaching an estimated 60,000 ducks on the lower Yellowstone alone. Field-feeding ducks, which commonly frequent riverside cornfields, have been estimated to number up to 15,000 in a single flock. In winter the mallard is still a common species along the river, but common goldeneyes, Barrow's goldeneyes, and mergansers sometimes outnumber the mallards.

Nongame Birds

Great blue herons are the most common large wading birds of the Yellowstone River during warm periods, with spring arrival of herons occurring in early April. Nine rookeries are known between Livingston and Miles City, although more are probably present. A high number of herons use the river until mid-fall. A smaller number of herons has also been observed on the Bighorn, Tongue, and Powder rivers. White pelicans also occur along the Yellowstone River, notably in spring and early summer. One flock of 40 to 80 pelicans has been observed each spring between Glendive and Sidney, and small flocks have been sighted in the Armells Creek area and near the Powder River's mouth.

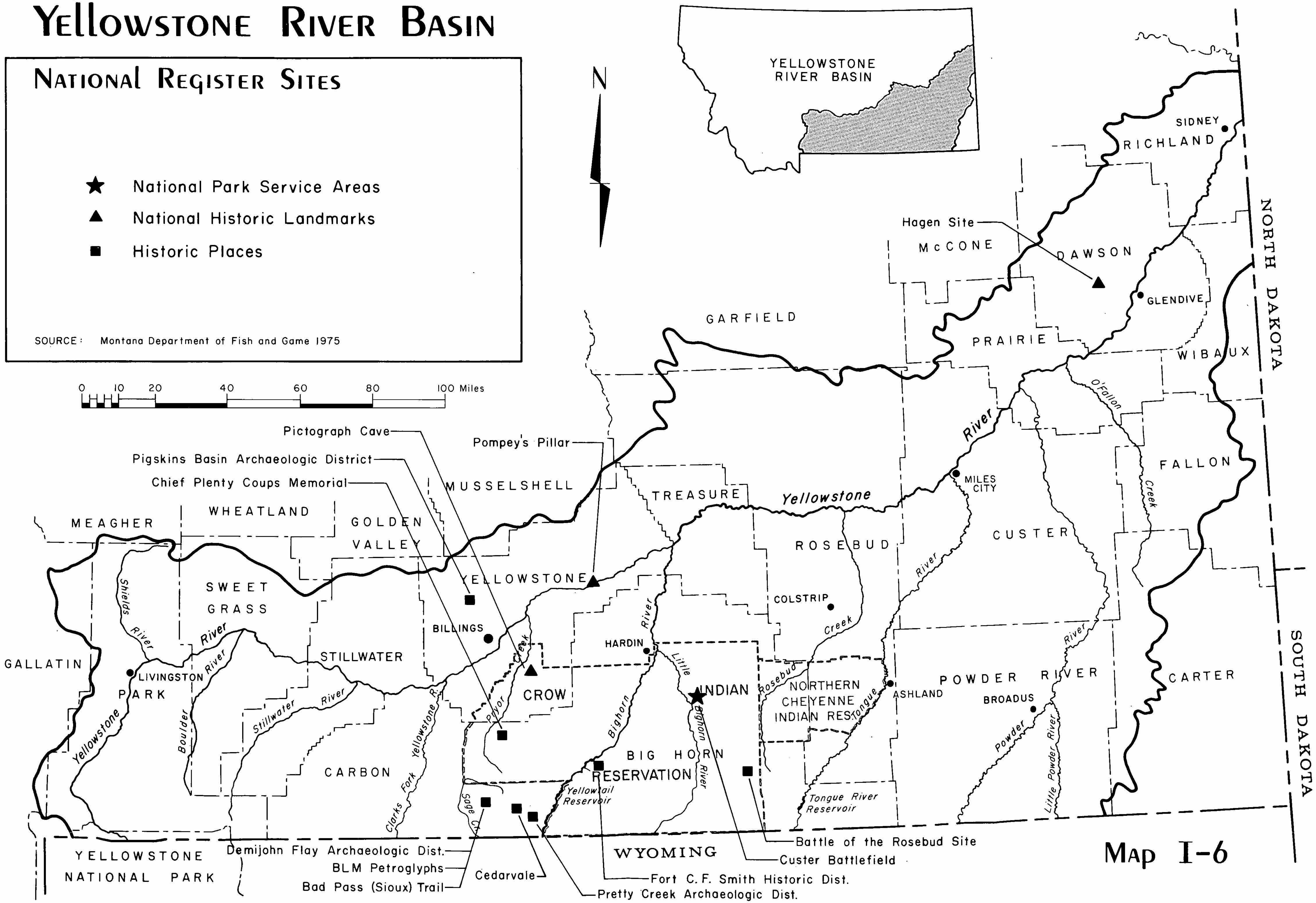
Raptorial birds known to breed in the plains zone include the marsh hawk, red-tailed hawk, golden eagle, prairie falcon, American kestrel, ferruginous hawk, and great horned owl. With the exception of the prairie falcon and ferruginous hawk, all are common throughout the area.

Other common species in spring and fall migration periods include the rough-legged hawk, Swainson's hawk, bald eagles, members of the Accipiter group, and short-eared owls. Several of these species may also breed within the area. Bald eagles concentrate along the Yellowstone during spring migration. The highest recorded count was made in 1974, when 298 eagles were counted from Yankee Jim Canyon to Sidney. None of these birds are believed to breed along the lower Yellowstone, although some may nest along the upper reaches. Eagle distribution in winter seems to coincide with areas of open water where waterfowl congregate. Winter records include one in January of 1970, when 13 bald eagles were counted from Bighorn to Miles City.

Endangered Wildlife

Two species of endangered wildlife are known to occur in the plains zone. Peregrine falcons, although not known to breed in the area, are occasionally observed and can be expected throughout the zone. Whooping cranes occasionally rest in the area during fall and spring migrations.

YELLOWSTONE RIVER BASIN



Map I-6

CULTURAL ENVIRONMENT

ARCHAEOLOGY

The Yellowstone Basin in Montana contains twelve sites listed in the register of national historic or archaeologic sites (Map I-6), as well as many locales of state or local interest. Most of these sites contain remains or artifacts of post-Columbian native American cultures or events concerning them; some represent pre-Columbian or even BCE (before current era) time spans. The sites listed in the register are shown in Table I-13.

TABLE I-13

YELLOWSTONE BASIN SITES LISTED IN THE NATIONAL REGISTER OF HISTORIC PLACES

Name of Site	Official Status, If Any	County	Era
Demijohn Flat Archaeological District		Carbon	pre- and post-Columbian
Petroglyph Canyon		Carbon	BCE[a], pre- and post-Columbian
Bad Pass (Sioux) Trail		Carbon	post-Columbian
Pretty Creek Archaeological Site		Carbon	BCE[a], pre- and post-Columbian
Chief Plenty Coups Monument	A Memorial State Monument	Big Horn	post-Columbian
Ft. C.F. Smith Historic District	A Part of the Bighorn Canyon National Recreation Area	Big Horn	post-Columbian
Pictograph Cave	A State Monument	Yellowstone	BCE[a], pre- and post-Columbian
Battle of the Rosebud Site		Big Horn	post-Columbian
Custer Battlefield	A National Monument	Big Horn	post-Columbian
Pompey's Pillar	A National Historic Landmark	Yellowstone	post-Columbian
Hoskin's Basin Archaeological District		Yellowstone	pre- and post-Columbian
Hagen Site		Dawson	pre-Columbian

SOURCE: U.S. Department of the Interior 1973

NOTE: The location of each of these sites is shown on Map I-6

[a]BCE=before current era

RECREATION AND AESTHETICS

Outdoor recreation opportunities and aesthetics in the Yellowstone are primarily a consequence of the basin's expanse of undeveloped landscape, unique natural features, open space, and pristine wildlands. Descriptions in this section will focus on the natural beauty and recreational opportunities of the Yellowstone Basin, and will identify the human activities which have most altered this natural beauty.

Montana Environmental Quality Council's Fourth Annual Report (1976) presents a map (Map I-7) showing the state's environmental regions. Delineations on this map are well suited to aesthetic interpretation and descriptions will conform to these environmental regions and sub-regions. Photographs 1-4 typify some of the varied character of the Yellowstone landscape.

YELLOWSTONE ROCKIES

Paradise Valley, the east side of the Gallatin Range, the Beartooth Plateau, and the Absaroka Range all fall within the Yellowstone Rockies Environmental Region. This area, immediately north of Yellowstone Park, provides excellent opportunities for back-country or wilderness experiences; for example, the North Absaroka proposed wilderness study area has one of the highest wilderness quality ratings of any National Forest area. The Absaroka and Beartooth Primitive Areas and contiguous lands, including the North Absaroka area, consist of some 900,000 acres of undesignated wildland with potential for inclusion in the National Wilderness Preservation System.

The outstanding scenic quality of this region can be seen in its majestic mountains; more than 25 peaks reach above 12,000 feet, including Granite Peak, Montana's highest. Vast reaches of wild, secluded land lie within the Beartooth, Absaroka, Crazy, and Gallatin mountain ranges. Glaciers and snow fields flank the highest peaks; their waters feed hundreds of streams and lakes. Wild flowers, meadows, and alpine tundra blanket the extensive alpine and subalpine plateaus of the Yellowstone Rockies.

The excellent cold-water fishery provided by the upper Yellowstone and its tributaries is highly rated and of national significance. Hunting in the Yellowstone Rockies is the preeminent recreational activity in the autumn. Hiking, ski touring, horseback riding and other forms of mountain travel and recreation provide pleasures to many, including increasing numbers of out-of-state visitors.

Although this area offers high quality aesthetic experiences, the natural landscape of the Yellowstone Rockies has been somewhat modified by human activities. Some of these activities include elimination of large predators, preemption of winter game range by human settlement, off-road vehicle use, livestock overgrazing, clearcutting, and mining.

ROCKY MOUNTAIN FORELAND

BEARTOOTH FORELAND

Although the portion of this region within the Yellowstone Basin does not include any existing or potential wilderness areas, it does have a number of significant historic sites and includes the Crow Indian Reservation. In addition, streams such as the Bighorn River, Clarks Fork Yellowstone River, Yellowstone mainstem, Rock Creek, Rosebud Creek, and Pryor Creek provide contrast to the grassy plateaus and rocky, sparsely timbered hills. This gives the Beartooth Foreland an unusual diversity of open space. Remnants of the Rockies blend eastward with rolling hills, dissected plains, and dry benchlands.

Residents of Billings, the major urban-industrial center in the basin, contribute to heavy recreational use in this environmental subregion. Most recreational pursuits are water-based: fishing, boating, sunbathing, swimming and agate hunting. The fishery is transitional between the cold headwaters fishery and the warm-water fishery further downstream. Hunting, picnicking and camping, sightseeing, hiking, and motorcycling are the major land-based recreational activities.

The natural character of this landscape has been partly altered by urban sprawl and industrial development in the Billings-Laurel area, overgrazing and irrigation development of rangeland, and extensive transportation-communication facilities.

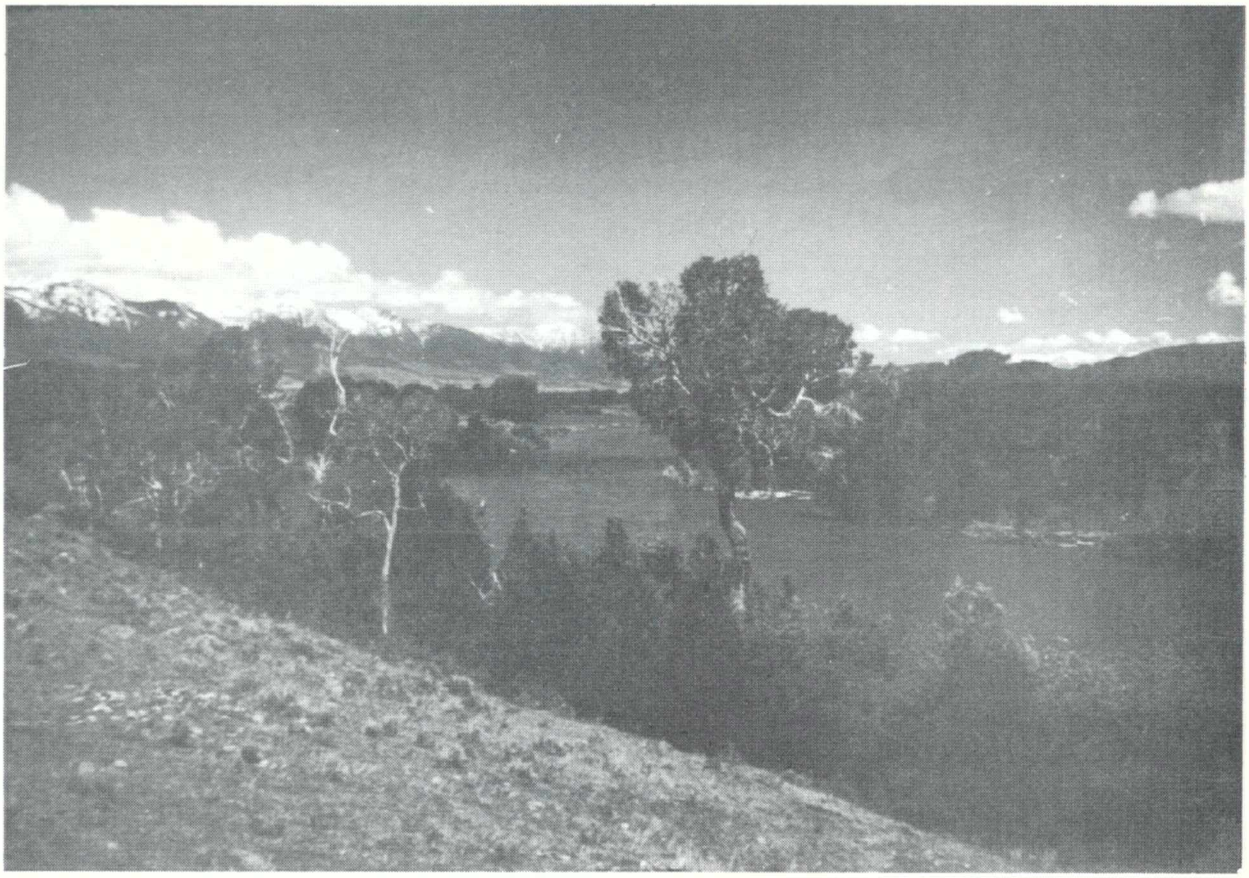
BIGHORNS

Although the Bighorns subregion is smallest in both population and size, it is perhaps one of the richest archeological areas on the continent with a concentration of diverse sites of the Northwest Plains Indians. Yellowtail Reservoir, while inundating several thousand acres of winter game range in the Bighorn Canyon, provides a variety of water-based recreation on the reservoir and an excellent trout fishery downstream. Because of abrupt elevational changes in this subregion, vegetation types range from true desert shrub to subalpine forest and meadow.

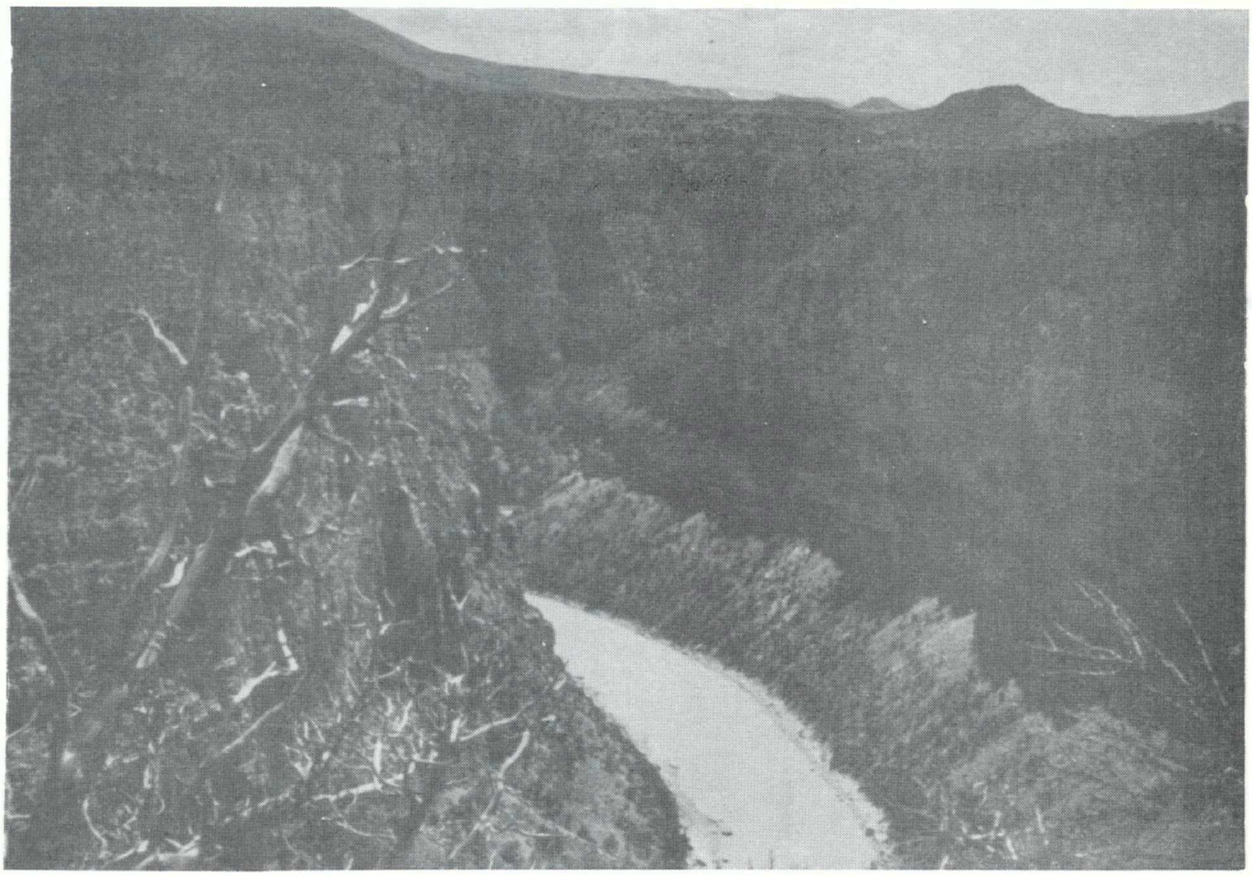
Yellowtail Reservoir, rangeland overgrazing, and damage to soils and vegetation by off-road vehicular use are the major human-induced changes in this natural landscape.

PINE PARKLANDS

Part of Custer National Forest comprises a major portion of the subregion, with public domain, state, and private land and the Northern Cheyenne Indian Reservation making up the remainder. The topography consists of broad rolling uplands, angular sandstone-capped buttes and spurs, and deeply dissected badlands where shale beds have been exposed to running water. The northern and southeastern portions are characterized by low hills covered with dense growths of ponderosa pine. Elsewhere, trees are generally restricted to the coarse, poorly developed soils associated with sandstone outdrops. To the south, coal begins to appear in outcrops and the colorful clinker-capped ridges, rock-fused or baked by heat rising from smoldering coalbeds, become the distinguishing feature of the landscape. These thermally altered rocks more effectively resist erosion than most unaltered sediments, and thus remain topographically high when exposed. This region provides excellent cover for deer and other game and nongame species, so hunting is a major recreational pursuit. Some fishing occurs along the Yellowstone, Lower Bighorn and Tongue rivers. The Tongue River Reservoir, while inundating 3,500 acres of land, provides a source of varied recreation that is heavily used in accessible areas. Human instrusions that disrupt the ecological integrity of this subregion include coal strip mining,



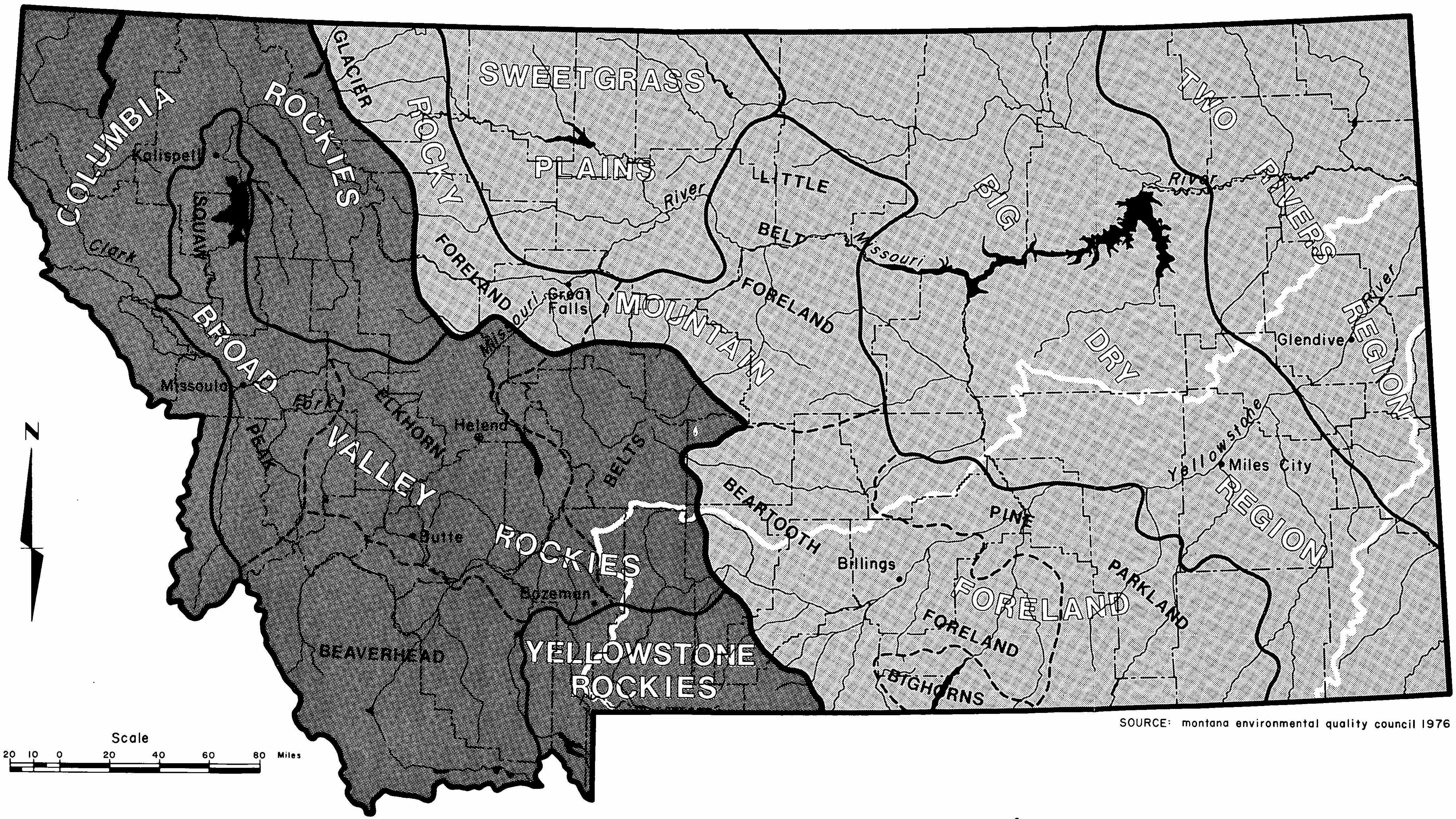
1. Paradise Valley in the Yellowstone Rockies



2. Bighorn Canyon in the Rocky Mountain Foreland prior to flooding by Yellowtail Dam

3. Badlands near Miles City in the Big Dry Region

4. Cottonwood-Willow habitat along the braided channel of the Yellowstone



SOURCE: montana environmental quality council 1976

Environmental Regions **Map I-7**

overgrazing, logging, and highway construction.

BIG DRY REGION

Today the Big Dry remains largely unsettled, even by Montana standards, with the average population for the counties of Carter, Custer, and Prairie about one person per square mile. This plains region includes a portion of the Yellowstone, with Miles City at its center, and a good part of the lower Tongue and Powder river basins. While subject to weather extremes and a shortage of natural rainfall, the area is productive as rangeland and supports dryland wheat farming.

Fishing for sauger, pike, paddlefish, and other warm water game fish is the favored recreational activity on this section of the Yellowstone and lower Tongue rivers. The Powder River supports a limited and little-utilized fishery. Agate hunting is a very popular pastime, and some boating occurs. In autumn, hunting is very popular in this region.

Overgrazing can be a serious problem, as many areas have highly erosive soils. Localized urban build-up, transportation facilities, and irrigated cropland are other major disruptions affecting the natural landscape.

TWO RIVERS REGION

This plains region includes portions of Dawson, Richland, and Wibaux counties in the Yellowstone Basin. Paddlefishing is the primary recreation in this area, followed closely by hunting. Also of economic and recreational importance are rockhounding, fishing for northern pike, sauger, catfish, and walleye, agate hunting, waterskiiing, swimming, and boating.

The open prairies, river bottoms, brushy draws, and wetlands in the Two Rivers Region provide a wide variety of habitat for game birds and mammals; however, much of this habitat has been altered by intensive agriculture. Dust from agricultural cropping practices and low precipitation is also a problem throughout much of the region.

YELLOWSTONE RIVER

The Yellowstone River and its unique habitats are a major aesthetic entity, deserving separate mention. The Yellowstone River has survived as one of the last large, free-flowing rivers in America. Lack of mainstem impoundments allows spring peak flows and fall and winter low flows to influence a unique ecosystem and aesthetic resource. From the clear, cold-water cutthroat trout fishery in Yellowstone National Park to the warmer-water habitat at its mouth, the river supports a variety of aquatic environments that remain relatively undisturbed. The adjacent terrestrial environment, through most of the 550 Montana miles of river, is an impressive cottonwood-willow bottom land, as shown on Map I-5.

Riprap, sewage effluent, urban sprawl, cottonwood clearing, and diking have modified the river and adjacent land but it continues to provide a tranquil repast for those who take the time to float the riffles or walk the bank. The river has also been a major factor in the settlement of southeastern Montana, and retains much cultural and historical significance.

ECONOMICS

Agriculture, the basin's largest industry, is declining in relative importance. Coal mining is growing rapidly; so is manufacturing. Population increases and employment trends indicate that a new surge of economic growth is replacing the recent period of relative decline, although rural population levels are still decreasing.

Growth rates basin-wide compare with national averages, though Billings and Colstrip are developing rapidly. Decreases in rural population and employment opportunities, related to agriculture, are spread throughout the region.

EMPLOYMENT

Employment in the basin has risen in all counties, but growth has been quite slow in some areas. Table I-14 shows employment levels by county for 1968, 1971, and 1974.

Agriculture, mining, manufacturing, and railroads are considered the basic industries in the basin. A "basic industry" is one that primarily produces goods and services to be exported from the local economy. As such, income and employment levels in the basic industries are subject to influences outside the region.

"Derivative industries," on the other hand, provide goods or services to the local area. The level of income and employment in derivative industries depends directly on income and employment in the basic industries.

Table I-15 shows the number of persons employed in each basic industry for 1950, 1960, and 1970. Table I-16 shows the relative employment levels of the basic industries in Yellowstone County, and Table I-17 shows this for all counties in the basin except Yellowstone County.

TABLE I-14

EMPLOYMENT LEVELS BY COUNTY

County	1968	1971	1974
Park	4,216	4,363	4,963
Sweet Grass	1,282	1,425	1,500
Stillwater	1,711	1,806	1,923
Carbon	2,819	3,000	3,085
Yellowstone	35,940	38,241	44,981
Big Horn	3,424	3,742	4,047
Treasure	494	498	498
Rosebud	2,544	2,782	3,511
Custer	5,301	5,331	5,824
Powder River	1,410	1,202	1,249
Prairie	827	861	952
Dawson	4,569	5,041	5,515
Richland	3,820	4,276	4,592

SOURCE: U.S. Bureau of Economic Analysis unpublished.

TABLE I-15

EMPLOYMENT IN THE BASIC INDUSTRIES IN THE YELLOWSTONE BASIN 1950, 1960 AND 1970

	Employment			Percentage of Total[a]		
	1950	1960	1970	1950	1960	1970
Total Basin Employment	21,846	18,971	15,382	100.0	100.0	100.0
Agriculture, Forestry and Fisheries	14,214	10,177	7,853	65.0	53.6	51.0
Mining	611	1,024	852	2.8	5.4	5.6
Manufacturing	2,834	4,757	4,414	12.9	25.0	28.7
Railroads	4,187	3,013	2,253	19.1	15.8	14.6

SOURCE: U.S. Department of Commerce 1952, 1961, 1971

NOTE: The U.S. Census Bureau classifies agriculture, forestry, and fisheries together. In the Yellowstone Basin, employment in forestry and fisheries is very small, making these figures an adequate measure of agricultural employment.

[a] Percentages may not add to 100 because of rounding

TABLE I-16

EMPLOYMENT IN THE BASIC INDUSTRIES IN YELLOWSTONE COUNTY 1950, 1960 AND 1970

	Employment			Percentage of Total[a]		
	1950	1960	1970	1950	1960	1970
Total Basin Employment	5,784	6,798	5,424	100.0	100.0	100.0
Agriculture, Forestry and Fisheries	2,400	1,928	1,410	41.5	28.3	26.0
Mining	78	404	249	1.3	5.9	4.6
Manufacturing	2,026	3,360	2,880	35.0	49.4	53.1
Railroads	1,280	1,106	885	22.1	16.2	16.3

SOURCE and NOTES same as Table I-15

TABLE I-17

EMPLOYMENT IN THE BASIC INDUSTRIES IN THE YELLOWSTONE BASIN EXCLUDING YELLOWSTONE COUNTY 1950, 1960 AND 1970

	Employment			Percentage of Total[a]		
	1950	1960	1970	1950	1960	1970
Total Basic Employment	16,062	12,173	9,688	100.0	100.0	100.0
Agriculture, Forestry and Fisheries	11,814	8,249	6,443	73.5	67.7	66.5
Mining	533	620	613	3.3	5.0	6.3
Manufacturing	808	1,397	1,264	5.0	11.5	13.0
Railroads	2,907	1,907	1,368	18.1	15.6	14.1

SOURCE: Derived from Tables I-15 and I-16

NOTE: The U.S. Census Bureau classifies agriculture, forestry, and fisheries together. In the Yellowstone Basin, employment in forestry and fisheries is very small, making these figures an adequate measure of agricultural employment.

[a] Percentages may not add to 100 because of rounding

Although the number of jobs in agriculture is still larger than the number in other sectors, a steady decline is apparent. New jobs in basic industries have occurred primarily in mining and manufacturing. However, data on basic employment should be interpreted cautiously because both statewide and nationally, the employment level in basic industries has been falling relative to derivative employment. This is partially because worker productivity, due to improved technology, has increased rapidly in many basic industries.

New mining jobs with the basin are primarily located at the coal mines in Sarpy Creek, Colstrip and Decker, while most of the new manufacturing jobs have been in the Billings area. It is important to note that these new basic jobs are occurring in a few specific locations, primarily in the coalfields and at Billings.

Table I-18 illustrates the rapid growth of coal mining in Montana, and Table I-19 shows the relative number of jobs at each mine site. From 1971 to 1974, employment in Rosebud County, site of substantial coal development, increased 26 percent, while employment in the basin went up by 13%. However, some portion of this rapid growth may be temporary, and employment will probably be reduced upon completion of existing electrical generating facilities at Colstrip. Table I-20 shows 1972 employment levels for agriculture in the basin, by county. As previously indicated, agriculture in the basin is experiencing a decline in employment levels. Agricultural employment in the basin has fallen from 65 percent to 51 percent of total employment between 1950 and 1970. The impact of this loss in jobs occurred primarily outside Yellowstone County, reflecting a drop in agricultural jobs of 40 percent. While the loss of 990 agricultural jobs in Yellowstone County was partially compensated by an increase of 854 manufacturing jobs, the basin outside Yellowstone County lost 5,371 jobs in agriculture and gained only 456 manufacturing jobs.

TABLE I-18

COAL EXTRACTED IN MONTANA 1960-1975

Year	Tons Extracted
1960	301,273
1961	358,848
1962	365,850
1963	336,548
1964	344,636
1965	377,248
1966	415,410
1967	364,509
1968	555,271
1969	1,024,885
1970	3,517,158
1971	7,097,127
1972	8,264,405
1973	10,729,019
1974	13,555,150
1975	22,087,188

SOURCE: Montana Energy Advisory Council 1976

TABLE I-19

COAL MINES IN YELLOWSTONE BASIN IN 1975

Mine Name	Location County and Town	Number of Employees	Tons Mined
Long Construction Western Energy	Rosebud County Colstrip	283	6,432,344
Coal Creek Mine	Powder River County Ashland	2	1,865
Knife River Coal	Richland County Savage	28	298,324
MK Mining Co.	Big Horn County	110	4,048,082
Decker Coal Co.	Big Horn County	248	9,208,752
Peabody Coal Big Sky Mine	Rosebud County Colstrip	64	2,080,412
Totals		735	22,065,778

SOURCE: Montana Energy Advisory Council 1976.

TABLE I-20

1972 EMPLOYMENT LEVELS FOR AGRICULTURE, BY COUNTY

County	1972 Number of Farm Proprietors	1972 Number of Non-Farm Proprietors	1972 Number of Farm Employees	1972 Number of Non-Farm Employees
Park	437	628	230	3,034
Sweet Grass	305	241	150	631
Stillwater	497	295	161	880
Carbon	810	342	242	1,425
Yellowstone	1,224	3,652	538	34,585
Big Horn	590	375	500	2,277
Treasure	138	55	119	188
Rosebud	410	324	286	1,889
Custer	397	667	214	3,991
Powder River	389	195	142	462
Prairie	248	137	93	423
Dawson	619	559	170	3,624
Richland	817	585	316	2,680

SOURCE: U.S. Bureau of Economic Analysis unpublished.

POPULATION

Table I-21 shows population trends in the Yellowstone Basin by county. It can be seen that nearly half of the basin's population lives in Billings, and over half lives in the two regional centers of Billings and Miles City.

From 1960 to 1970 the overall population remained about the same, but the number of urban dwellers (defined as those living in towns of at least 2,500 persons) increased eight percent, while the number of rural dwellers fell by ten percent. The population of Billings during this time increased 15.8 percent. Out-migration has been moderate to high in the rural areas, and lack of employment opportunities is believed to be a major cause of this rural population decline.

However, job opportunities began increasing in the late 1960's and from 1970 to 1974 the population in the basin began to grow again. From 1908 to 1971 employment opportunities increased six percent, but from 1971 to 1974 they increased 13 percent (U.S. Bureau of Economic Analysis unpublished). The largest increase in population was in Rosebud County (29.3 percent), due to the developments at Colstrip.

INCOME

Personal income in the basin is growing faster than that for the nation. This increase is primarily due to the increased earnings from coal mining. Incomes from manufacturing and railroads are also above the state average, while the increases in farm earnings are down relative to the rest of the state and nation. From 1970 to 1974 personal income in Rosebud County increased 68 percent, while personal income in the Yellowstone Basin as a whole increased 47 percent. Table I-22 shows 1973 levels of per capita income by county, as well as 1972 levels of total personal income. In addition, the table shows what percentage of that income was directly generated by agriculture.

Table I-23 shows cash receipts and average farm size in the basin; 38 percent of the cash receipts come from sale of crops, and 63 percent come from sale of livestock.

TABLE I-21

POPULATION TRENDS IN THE YELLOWSTONE BASIN
BY COUNTY 1960, 1970, AND 1974

County	1960			1970			Percentage Change 1960-1970			July 1 1974	Percentage Change 1970-1974
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	
Park	13,168	8,229	4,939	11,197	6,883	4,314	-15.0	-16.4	-12.7	11,900	7.9
Sweet Grass	3,290	-0-	3,290	2,980	-0-	2,980	- 9.4	-0-	- 9.4	3,000	0.7
Stillwater	5,526	-0-	5,526	4,632	-0-	4,632	-16.2	-0-	-16.2	5,100	10.1
Carbon	8,317	-0-	8,317	7,080	-0-	7,080	-14.9	-0-	-14.9	7,700	8.8
Yellowstone	79,016	65,313	13,703	87,367	76,651	11,716	10.6	15.8	-14.5	95,600	9.4
Big Horn	10,007	2,789	7,218	10,057	2,733	7,324	0.5	- 2.0	1.5	10,400	3.4
Treasure	1,345	-0-	1,345	1,069	-0-	1,069	-20.5	-0-	-20.5	1,200	2.3
Rosebud	6,187	-0-	6,187	6,032	-0-	6,032	- 2.5	-0-	- 2.5	7,800	29.3
Custer	13,227	9,665	3,562	12,174	9,023	3,151	- 8.0	- 6.7	-11.5	12,100	- 0.6
Powder River	2,485	-0-	2,485	2,862	-0-	2,862	15.2	-0-	15.2	2,300	- 7.4
Prairie	2,318	-0-	2,318	1,752	-0-	1,752	-24.4	-0-	-24.4	1,800	2.7
Dawson	12,314	7,058	5,256	11,269	6,305	4,964	- 8.5	-10.7	- 5.6	10,900	3.3
Richland	10,504	4,564	5,940	9,837	4,543	5,294	- 6.3	- 0.5	-10.9	9,900	0.6
TOTAL	167,704	97,618	70,086	168,308	105,138	63,170	0.3	7.7	- 9.8	179,700	6.7

SOURCE: U.S. Department of Commerce, 1961 and 1971; U.S. Bureau of Economic Analysis unpublished.

[a] Urban dwellers live in a community with more than 2,500 inhabitants

TABLE I-22

SELECTED INCOME DATA, BY COUNTY

County	1973 Per Capita Income ($)	1972 Total Personal Income ($)	1972 Farm Earnings Expressed As Percentage of Total
Park	4,172	41,657,000	19
Sweet Grass	5,205	14,410,000	53
Stillwater	4,857	19,106,000	47
Carbon	4,568	27,672,000	43
Yellowstone	4,685	402,737,000	6
Big Horn	4,550	38,884,000	49
Treasure	5,785	5,730,000	71
Rosebud	4,724	24,191,000	33
Custer	4,745	49,790,000	14
Powder River	5,990	10,295,000	61
Prairie	6,726	7,283,000	52
Dawson	5,195	40,794,000	16
Richland	5,097	38,978,000	35

SOURCE: U.S. Bureau of Economic Analysis unpublished.

TABLE I-23

CASH RECEIPTS AND FARM SIZE IN THE YELLOWSTONE BASIN

County	Cash Receipts by County 1973		Average Farm Size in Acres, 1969 (Farms with sales greater than $2500)
	Livestock and Livestock Products $	Crop $	
Park	9,618,000	2,570,400	2,549
Sweet Grass	9,199,600	2,014,600	2,909
Stillwater	14,055,700	5,639,400	2,289
Carbon	14,408,000	6,800,300	1,097
Yellowstone	30,419,000	14,930,500	1,925
Big Horn	18,002,900	9,377,800	4,832
Treasure	4,821,600	3,200,200	5,085
Rosebud	15,075,400	4,475,500	7,928
Custer	15,147,400	3,683,400	7,676
Powder River	12,948,900	4,675,700	5,085
Prairie	7,730,100	5,905,300	3,378
Dawson	7,871,700	17,392,300	2,717
Richland	12,151,100	17,019,600	1,928
BASIN	164,360,100	97,685,000	

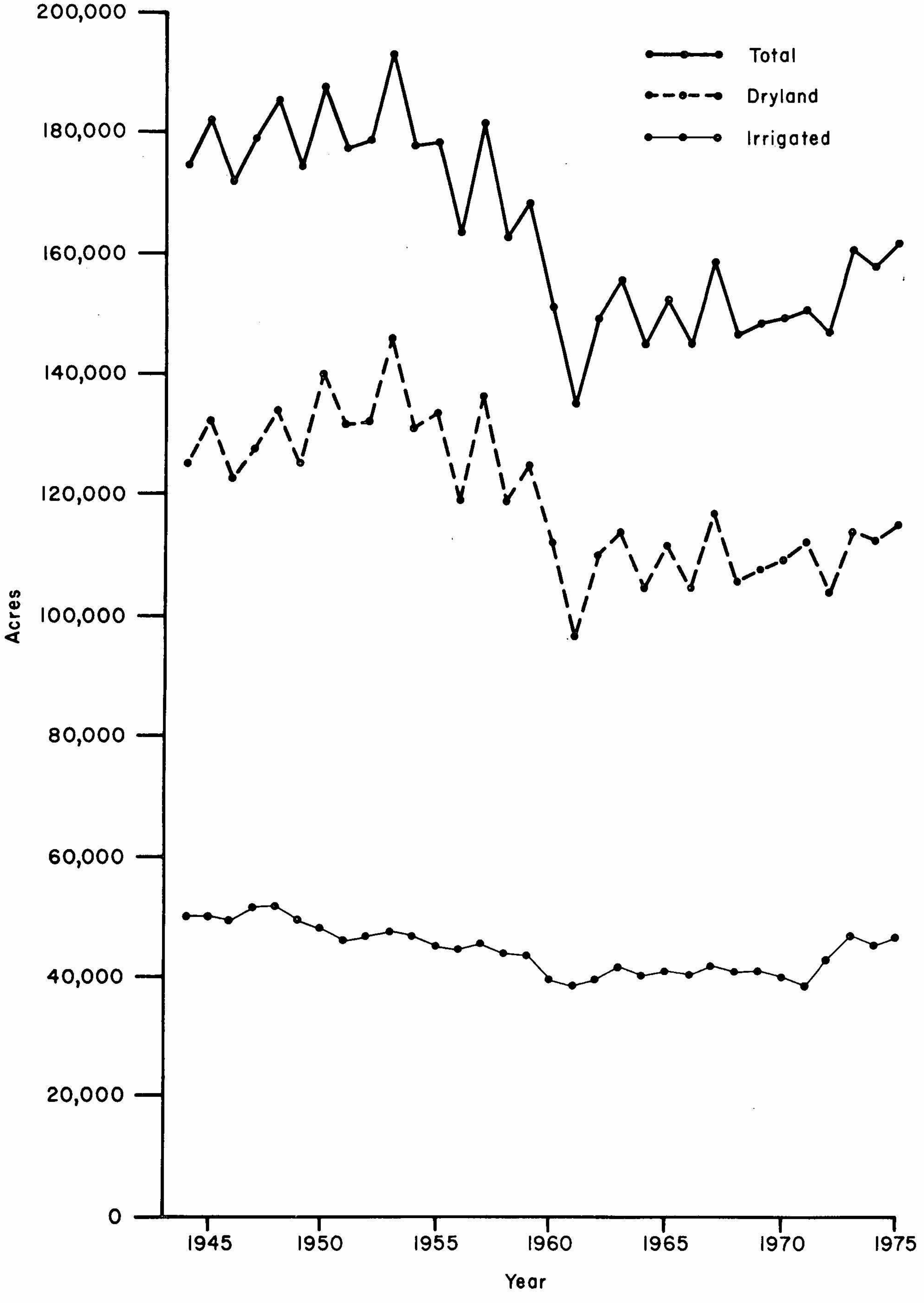
SOURCE: U.S. Department of Agriculture, 1972, 1973; U.S. Department of Commerce 1974.

AGRICULTURE

Farms and ranches within the basin are generally much larger than the statewide average. Major grain crops are wheat, barley, and oats; these are usually grown on non-irrigated land. Although sugar beets and dry beans are grown only on irrigated land, most irrigated land is devoted to hay.

Figure I-6 shows the downward trends in irrigated cropland, non-irrigated cropland, and total cropland harvested; although 1971, 1972 and 1973 showed a sharp increase. There was no increase in 1974 or 1975. However, irrigation is important to the basin's economy because it permits valuable cash crops such as sugar beets, and it increases the yields per acre for hay and grain.

An additional consideration which potentially affects the agricultural economy is the price of water. Many irrigators presently fear that they would not be able to outbid the energy industry if water is sold competitively. Water costs have historically been a relatively small part of the costs of mining and electrical generation, but consitutute a major input to irrigated farming. Thus farmers are very sensitive to changes in water costs and prices, while the energy industries are comparatively less sensitive.



CROPLAND HARVESTED YELLOWSTONE BASIN 1945-1975

FIGURE I-6

WATER USE

In this section, water use will be segregated into withdrawal and instream uses.

INTRODUCTION

WITHDRAWAL USES

A withdrawal use is any which requires removal of water from a source such as a stream, reservoir, or well. Withdrawal use of water can be classified as either nonconsumptive or consumptive. Nonconsumptive withdrawal use occurs when water is taken from its source, used, and eventually returned to the same or another source where it is again available for use (further uses may be limited, however, if water quality is changed by previous use). Consumptive use precludes further use of the water because it is evaporated, incorporated into products or crops, consumed by man or animals, or otherwise removed from the immediate environment.

Withdrawal uses include: irrigation, self-supplied industry, municipal and livestock, and rural domestic. Water used for irrigation is applied to the land in an effort to sustain or increase crop yields. Basin-wide, water for irrigation use accounts for more than 95 percent of the total amount withdrawn. Water obtained directly from a source by industry, as opposed to that provided by a municipality, is referred to as self-supplied industrial water. Municipal and industrial water is water provided by a public water supply system which may be publicly or privately owned. DHES defines a public water supply as one supplying 10 users or 25 persons. This use includes water for residential purposes, sanitation, public institutions, industrial processes, and other private and public uses. Livestock water use is estimated, based on farm animal populations and per capita water consumption of various animals. Montana water law is unclear on whether stock watering establishes an existing water right (rights established prior to July, 1973). Rural domestic water is that used by persons not served by a public or minicipal water supply system.

INSTREAM USES

Instream uses of water are those which do not require removal of water from the source of supply. Important instream uses in Montana are hydroelectric power generation, recreation, fish and wildlife, aquatic habitats, and dilution of wastes.

Hydroelectric power generation is considered an instream use, even though water is diverted momentarily for passage through turbines. When considering other uses for water, it should be remembered that a certain water level must be maintained in reservoirs for hydroelectric generation. There is additional evaporation resulting from that storage. Recreation users, as well as fish and wildlife, presently make use of almost all Montana's water, although the actual instream water requirements for those uses are difficult to quantify.

WATER USE BY SUBBASIN

Subbasin delineations in Map I-1 are used to facilitate water use description here.

UPPER YELLOWSTONE AND CLARKS FORK YELLOWSTONE SUBBASINS

As is true with the rest of the state, water used for irrigation comprises the vast majority of water diverted and consumed in these subbasins. Table I-24 shows acres irrigated as well as water diverted and consumed.

TABLE I-24

UPPER YELLOWSTONE AND CLARKS FORK YELLOWSTONE SUBBASINS
WATER USE FOR IRRIGATION

Subbasin	Acres	Diversion (af/y)	Net Depletion (af/y)	Return Flow (af/y)
Shields River	35,440	209,100	98,280	110,820
Boulder River	8,640	50,980	23,960	27,020
Sweet Grass Creek	15,880	93,700	44,040	49,660
Stillwater River	26,350	155,470	73,070	82,400
Clarks Fork Yellowstone River	93,220	550,000	258,500	291,500
Yellowstone River	90,590	534,480	251,210	283,270
TOTAL	270,120	1,593,730	749,060	844,670

SOURCE: Montana Department of Natural Resources and Conservation 1976

Irrigation development in these subbasins is almost entirely the result of private enterprise, although Cooney Reservoir was constructed by the Montana Water Resources Board in 1936 and provides a total storage capacity of 24,190 acre-feet for irrigation use. The primary irrigated crop grown is hay, with some corn, sugar beets, and beans. Gravity irrigation systems predominate, but recent years have brought increased use of sprinkler irrigation.

Other water uses account for only 5 percent of the water withdrawn for use in the subbasins. Community water systems in the basin withdraw 4.8 million gallons per day (mgd), or 5390 acre-feet per year (af/y), of which about half is surface water, the other half ground water. Rural domestic use accounts for about 1.1 mgd or 1220 af/y. Livestock water use totals about 2.4 mgd or 2800 af/y.

The only hydropower reservoir is Mystic Lake on West Rosebud Creek, where almost all of the annual flow (average 93,460 af/y) is used to generate up to 10 megawatts of electricity.

Water remaining in or returning to streams of the subbasins receives heavy use by recreationists for fishing, hunting, picknicking, camping, and boating. These streams also support a high quality, diverse fish and wildlife resource.

BILLINGS AREA, BIGHORN, MID-YELLOWSTONE, AND TONGUE SUBBASINS

Here also, irrigation accounts for nearly all water diverted and consumed. Water use estimates presented in Table I-25 are based on the number of acres irrigated, taking into consideration typical cropping patterns, water diverted and depleted by crops, and water lost by inefficient management. While the irrigation season normally extends from April until October, over half the required water is used in July and August.

TABLE I-25

BILLINGS AREA, BIGHORN, MID-YELLOWSTONE AND TONGUE SUBBASINS
WATER USE FOR IRRIGATION

Subbasin	Acres	Diversion (af/y)	Net Depletion (af/y)	Return Flow (af/y)
Pryor Creek	3,360	20,160	9,475	10,685
Sage Creek	1,650	9,900	4,650	5,250
Little Bighorn River	18,670	112,020	56,010	56,010
Bighorn River	49,350	296,100	139,170	156,930
Rosebud Creek	1,810	10,860	5,105	5,755
Tongue River	31,180	187,080	87,930	99,150
Yellowstone River	136,700	820,200	385,500	434,480
TOTAL	242,720	1,456,320	687,840	768,480

SOURCE: Montana Department of Natural Resources and Conservation 1976.

Almost 27,500 acres of irrigated land are in the Huntley Project, constructed by the Bureau of Reclamation in the early 1900's. The project is now maintained and operated by the Huntley Project Irrigation District, which has since upgraded several project facilities. The Tongue River Reservoir, 7 miles northeast of Decker, provides about 64,000 acre-feet of storage for downstream irrigation. The dam was constructed in 1939 by the Montana Water Resources Board and is now owned by the State of Montana through the Department of Natural Resources and Conservation and operated by the Tongue River Water Users Association.

Community water systems require about 20.1 mgd or 27,520 af/y, most of which is used in the Billings area. Water withdrawals from the Yellowstone mainstem for once-through cooling of thermoelectric generating plants at

Billings total 132 mgd or about 148,000 af/y. Only a very small portion of the amount diverted from the river (less than 1 percent) is consumed. Colstrip units 1 and 2, 350-megawatt coal-fired generating plants, divert and consume a total of about 16,000 af/y. Self-supplied industries use 48.5 mgd or 54,870 af/y, mostly in the Billings area. Rural domestic and livestock uses are relatively minor, accounting for only about 4,400 af/y.

Yellowtail Dam, on the Bighorn River, completed by the Bureau of Reclamation in 1965, houses a powerplant that includes four 62.5-megawatt generating units that produce an average of about 1 billion kilowatt hours each year. Almost all of the flow of the Bighorn River (average 2.5 million af/y) is routed through the turbines to produce this power.

As in the other subbasins, most, if not all, streams, ponds, and lakes provide for recreation, fish, and wildlife use.

KINSEY AREA, POWDER, AND LOWER YELLOWSTONE SUBBASINS

Again, most of the water withdrawn in these subbasins is used to irrigate crops. Table I-26 shows the acres irrigated along with estimates of the water diverted and consumed.

TABLE I-26

KINSEY AREA, POWDER, AND LOWER YELLOWSTONE SUBBASINS
WATER FOR IRRIGATION

Subbasins	Acres	Diversion (af/y)	Net Depletion (af/y)	Return Flow (af/y)
Little Powder River	6,785	40,710	19,135	21,575
Powder River	34,055	204,330	96,035	108,295
O'Fallon Creek	4,840	20,040	13,650	15,390
Yellowstone Mainstem	53,330	319,980	150,390	169,590
TOTAL	99,010	549,060	279,210	314,850

SOURCE: Montana Department of Natural Resources and Conservation 1976.

Bureau of Reclamation projects include the Savage and Intake Units of the Lower Yellowstone Project, and the Buffalo Rapids Project. The Lower Yellowstone Project, operated by a board of commissioners, extends between Intake and the mouth of the Yellowstone River. The Intake Unit lies astride the main canal of the Lower Yellowstone Project about 2 miles from Intake. The Savage Unit is west of the Main Canal of the Lower Yellowstone Project in the vicinity of Savage. The Buffalo Rapids Project occupies a bench on the north side of the Yellowstone River between Fallon and Glendive, as well as benchland south of the river near Terry. The Buffalo Rapids Board of Commissioners maintains and operates the water supply system.

The Sidney Irrigation Project, built by the Montana Water Resources Board in 1939, irrigates about 3,200 acres east of Sidney. The facilities were upgraded by the Soil Conservation Service in 1969 to provide full water supply for those lands.

The natural gas- or oil-fired plant at Glendive can divert up to 1.0 mgd, but only operates about 50 days a year. The Lewis and Clark coal-fired thermo-electric plant at Sidney diverts 30 mgd or 33,660 af.y. Community water systems in the lower basin withdraw 2.9 mgd, or 3,250 af/y mainly for the cities of Miles City, Glendive, and Sidney. Rural domestic use totals 1.1 mgd or 1,200 af/y. Livestock use amounts to almost 2.1 mgd or 2,375 af/y. Self-supplied industry uses about 12.0 mgd or 1,370 af/y.

As in the other basins, water is used instream for recreation, fish and wildlife, and water quality purposes.

LAND USE AND OWNERSHIP

Tables I-27 to I-33 present a brief overview of land use in the Yellowstone Basin. An overwhelming majority of agricultural acreage is being used for rangeland. Yellowstone, Powder River, and Custer counties each contain over one million acres of range; Big Horn and Rosebud counties contain over two million each. Although urban and built-up areas are increasing in most counties, they currently represent a very small percentage of the total land area; the highest is three percent in Yellowstone County.

By percentage, the upper Yellowstone is generally devoted to forests, range, and cropland, in that order. The portion of each county devoted to rangeland increases downstream, reaching a peak of 80-90 percent in Big Horn, Treasure, Rosebud, Powder River, Custer, and Prairie counties.

Irrigated cropland harvested, shown in Table I-30, ranges from a low of 14,310 acres in Prairie County to a high of 60,200 acres in Sweet Grass County. Other significant irrigated acreages occur in Carbon (59,620 acres), Big Horn (53,200 acres), Yellowstone (51,620 acres), Park (47,400 acres), and Richland (45,500 acres) counties.

Land ownership by percentage is shown in Table I-31. The majority of acres are privately owned, with a large federal ownership in Park and Carbon Counties, and a large Indian ownership in Big Horn County.

For comparison purposes, percentages of land ownership and agricultural use for Montana as a whole have been presented in Tables I-32 and I-33.

TABLE I-27

LAND USE, BY COUNTY, IN 1967
(acres)

County	Total land area	Federal non-cropland	Urban & built-up	Agriculture				
				Cropland	Pasture	Range	Forest	Total
Park	1,681,280	887,969	18,856	125,000	35,000	457,329	147,272	770,803
Sweet Grass	1,181,440	299,040	7,630	84,507	41,899	640,970	103,994	874,230
Still-water	1,150,080	192,870	10,456	247,078	14,681	610,785	68,474	945,891
Carbon	1,324,800	519,872	8,979	179,274	19,704	539,074	42,594	790,949
Yellow-stone	1,686,400	85,230	44,333	284,816	71,000	1,101,889	78,501	1,556,337
Big Horn	3,217,626	32,062	11,979	286,480	42,430	2,501,257	10,997	3,172,885
Treasure	629,760	11,694	4,115	37,768	8,127	523,289	38,603	612,766
Rosebud	3,220,480	337,995	5,208	128,303	27,388	2,483,906	220,690	2,874,173
Custer	2,409,600	344,689	14,307	92,185	27,600	1,857,135	56,500	2,041,520
Powder River	2,102,400	604,101	6,200	150,970	30,000	1,218,201	85,528	1,490,499
Prairie	1,105,280	450,078	8,818	113,030	15,000	510,041	1,785	645,356
Dawson	1,509,120	67,968	20,515	406,848	19,675	975,967	8,435	1,418,959
Richland	1,321,600	53,262	12,755	458,811	37,000	716,829	14,223	1,251,183

SOURCE: Montana Department of Planning and Economic Development 1970.

TABLE I-28

GENERAL LAND USE BY COUNTY IN 1972 (PERCENTAGE OF TOTAL)[a]

County	Federal Non-Cropland	Urban and Built-up	Private, State, and Indian Agricultural
Sweet Grass	25	1	74
Stillwater	17	1	82
Carbon	39	1	60
Yellowstone	5	3	92
Big Horn	1	0	99
Treasure	2	1	97
Rosebud	11	0	89
Powder River	29	0	71
Custer	14	1	85
Prairie	41	1	58
Dawson	5	1	94
Richland	4	1	95

SOURCE: U.S. Department of Interior 1972.

TABLE I-29

AGRICULTURAL LAND USE BY COUNTY IN 1972 (PERCENTAGE OF TOTAL)[a]

County	Cropland	Pasture	Range	Forest
Sweet Grass	10	5	73	12
Stillwater	26	2	64	8
Carbon	23	2	68	7
Yellowstone	18	5	71	6
Big Horn	9	1	79	11
Treasure	6	11	86	7
Rosebud	5	1	86	8
Powder River	10	2	82	6
Custer	5	1	91	3
Prairie	18	2	79	1
Dawson	29	1	69	1
Richland	37	3	57	3

SOURCE: U.S. Department of Interior 1972.

[a] Park County data not available

TABLE I-30

IRRIGATED CROPLAND HARVESTED BY COUNTY IN 1975

County	Irrigated Cropland Harvested (acres)
Park	47,400
Sweet Grass	60,200
Stillwater	27,520
Carbon	59,620
Yellowstone	51,190
Big Horn	53,200
Treasure	14,420
Rosebud	37,780
Powder River	15,900
Custer	23,630
Paririe	14,310
Dawson	16,110
Richland	45,500

SOURCE: Montana Department of Agriculture 1976

TABLE I-31

LAND OWNERSHIP BY COUNTY IN 1972 (PERCENTAGE OF TOTAL)[a]

County	Private	Federal	State	Indian
Sweet Grass	71	24	5	0
Stillwater	79	17	4	0
Carbon	54	43	3	0
Yellowstone	82	5	4	9
Big Horn	34	14	3	49
Treasure	80	14	3	0
Rosebud	67	11	6	7
Powder River	63	28	9	0
Custer	77	17	6	0
Prairie	53	41	6	0
Dawson	90	4	6	0
Richland	90	4	6	0

SOURCE: U.S. Department of Interior 1972

[a] Park County data not available

TABLE I-32

MONTANA LAND AREA, 1974

	Percentage of Total
Private	59.1
Forest Service	17.8
BLM	8.9
National Parks	3.0
State	5.7
Indian	5.5

SOURCE: Montana Department of Agriculture 1974.

TABLE I-33

MONTANA LAND IN FARMS, 1974

	Percentage of Total
Pasture and Rangeland	68.3
Harvested Cropland	13.5
Cultivated Summerfallow	10.2
Other Cropland	3.5
Woodland	2.6
All Other	1.9

SOURCE: Montana Department of Agriculture 1974.

INSTITUTIONAL FRAMEWORK

Until 1885 water rights in Montana were appropriated and used in accordance with rules of mining districts first adopted during the gold-rush days in California. In 1885 the legislature enacted an optional statutory procedure for appropriating water, accomplished by posting notice at the point of diversion and filing similar notice with the county clerk and recorder, followed by diligent development of the water claim. Thereafter, until July 1, 1973, one could appropriate water by either this statutory method or by the actual use of water on "unadjudicated" streams. In complying with the statutory method, one would acquire a water right with a priority date which related back to the date of posting the notice; otherwise, the priority date would be the date of first use.

Disputes over the use of water normally would be "adjudicated", with the nature of the rights spelled out in a court decree. After 1921, all water appropriations from adjudicated streams required district court approval.

MONTANA WATER USE ACT

The Water Use Act (Section 89-865 *et seq.*, R.C.M. 1947), effective on July 1, 1973, recognized and confirmed all existing water rights. This includes rights in existence and established under past statutes, adjudications, and customs.

The Department of Natural Resources and Conservation is charged with the responsibility and authority to administer the act and its provisions. To accomplish this, DNRC has initiated action to adjudicate existing water rights in the Yellowstone Basin, established a centralized record system for water rights, and implemented a permit system for all new water appropriations.

Water reservations for future beneficial uses are also permitted under the Water Use Act.

Because of the size of the Yellowstone Basin, the large number of water right filings, and the field work involved in investigating water right claims, adjudication of the entire basin will probably take many years. Therefore, water reservations acted upon by the Board will be subject to the eventual adjudication of all prior existing rights.

WATER RIGHTS LITIGATION

Indian reserved water rights were first clearly established in *Winters v. United States*, 207 U.S. 564 (1908), and the reserved water right doctrine was subsequently extended to lands held by the federal government such as national parks and forests, *Arizona v. California*, 373 U.S. 546 (1963). Reserved water rights attach, expressly or by necessary implication to lands which are reserved or withdrawn from the public domain. The permissable uses and extent of the reserved right is determined by the purpose of the reservation of land as for a national forest or for a homeplace for an Indian tribe. Reserved water rights, whether Indian or federal, are not created by or dependent upon state law, but rather are derived from the treaty, executive order, or federal statute establishing the reservation. State courts may, however, adjudicate federal reserved rights and non-federal reserved rights held in trust by the federal government, United States v. Akin, U.S. Supreme Court, (1976).

There are currently three pending lawsuits in federal District Court in Billings concerning reserved water rights in the Yellowstone River Drainage for federal lands such as the Custer National Forest, and for the Crow and Northern Cheyenne Indian Tribes. Two of the actions were brought by the United States in its own behalf and as trustee for the Tribes, and the third was brought by the Cheyenne Tribe itself. The reserved rights are claimed in the Tongue and Bighorn Rivers, Rosebud Creek, and several other smaller adjacent drainages. There are several thousand persons claiming water rights under state law named as defendants, along with the State of Montana. The major question presently before the Court is whether these water right claims should be determined in federal court, or whether they should be determined in state court proceedings pursuant to the Montana Water Use Act. Until this and other procedural questions are resolved, there will be no final determination of the extent of the reserved water rights claimed.

YELLOWSTONE RIVER COMPACT

The Yellowstone River Compact, adopted by Montana, Wyoming, and North Dakota, and ratified by the United States Congress in 1951, was designed to allocate water of the Clarks Fork Yellowstone, Bighorn, Tongue, and Powder rivers. The compact recognizes water rights prior to 1950, those rights designated to provide supplemental water supplies to land irrigated prior to 1950, and water rights for irrigation projects started before 1950. The compact divides the remaining water according to percentages of the flow at the mouths of the streams as shown in Table I-34.

TABLE I-34

DIVISION OF WATERS UNDER THE YELLOWSTONE RIVER COMPACT

Tributary	Wyoming	Montana
Clarks Fork Yellowstone	60%	40%
Bighorn	80%	20%
Tongue	40%	60%
Powder	42%	58%

SOURCE: Montana Department of Natural Resources and Conservation 1976.

Article X of the compact prohibits diversion of water out of the Yellowstone Basin without the unanimous consent of the signatory states. This article has recently become controversial because industrial interests and Wyoming would like to divert water out of the basin for energy conversion uses. Montana's position at this time is to withhold approval of such diversions until the two states can agree on quantification of the percentages of tributary flows. Wyoming has published its estimates of these quantities, presented in Table I-35. Montana does not necessarily agree and intends to independently calculate compact shares.

TABLE I-35

WYOMING'S YELLOWSTONE COMPACT ESTIMATES (ACRE-FEET)

	Wyoming	Montana
Clarks Fork Yellowstone	429,000	285,000
Bighorn	1,800,000	400,000
Tongue	96,400	144,700
Powder	120,700	166,600
TOTAL	2,446,100	996,300

SOURCE: Wyoming State Engineer's Office 1973

PART II

METHODOLOGY FOR EVALUATION OF IMPACTS

CONTENTS

The State Water Planning Model, described below, calculated the depleted subbasin streamflows that would result from implementation of reservation requests or alternative levels of irrigation or energy use; it was also used to compute, by subbasin, the water which would be surplus to the instream flow requests. The primary, secondary, and cumulative effects of these water withdrawals or flows left instream were then evaluated. Where possible, these impacts have been identified by planning subbasin (see Map I-1).

PRIMARY, SECONDARY, AND CUMULATIVE IMPACTS

The monthly subbasin outflows and TDS concentrations produced by the model provided the basis for predicting the environmental impacts of the hypothetical situations considered in Parts III and IV of this EIS.

Impacts reported here are considered to be either "primary" or "secondary." Primary impacts, defined as changes to the river system itself, include alterations in monthly streamflows, water quality, channel form, and aquatic, and riparian fish and wildlife habitats.

Secondary impacts are the effects that a situation might have on the use of water, for example, for irrigation, domestic consumption, recreation, and energy conversion. Included are economic effects.

The use of the terms "primary" and "secondary" in no way implies that primary impacts are any larger or any more important than secondary impacts. In fact, the opposite is often the case. The terms merely provide a convenient way of structuring the impact analyses.

It is conceivable, but unlikely, that only one of the reservation applications would be implemented. For that reason, the impacts of individual applications are considered. More likely, some combination of reservations will be adopted and implemented. Such situations are considered and called "cumulative." For example, the cumulative effect of enactment of all the consumptive-use applications is discussed. Likewise, the cumulative impact of granting all instream applications is considered.

FORMAT

Some of the impacts which would result from granting one or more of the reservation applications or from implementing one of the alternatives would be minor or would be relatively uniform throughout the Yellowstone Basin. These effects, whether primary or secondary, are discussed in a generalized impact section for each application or alternative without regard to spatial (geographic) differences across the basin. Other impacts are unique, either in magnitude or in quality, in one or more subbasins. These effects are discussed in sections for each subbasin which follow the generalized impact section.

STATE WATER PLANNING MODEL

The hydrology of each of the nine planning subbasins was analyzed using the State Water Planning Model. The output of the model is monthly subbasin outflows over the period of historical hydrologic record, either for historical conditions (calibration phase) or hypothetical conditions (simulation phase). The model accounts for such natural and human influences as precipitation, wind, snowmelt, evapotranspiration, ground-water storage, and irrigation.

The model was first calibrated so that it reproduced accurately the historical subbasin outflows. Then, for each hypothetical situation, for example one of the water reservation applications presented in Part III or one of the alternatives described in Part IV, the water diversions and depletions were assumed to have existed over the period of hydrologic record. The simulation then produced monthly subbasin outflows assuming the hypothetical situation had actually existed for the past 30 years or more. In many cases, simulation of a subbasin required the concurrent simulation of upstream subbasins.

A necessary input to the model is subbasin inflows. For the four Yellowstone Compact tributaries (Clarks Fork Yellowstone, Bighorn, Tongue, and Powder rivers), the proper allocations of water between Montana and Wyoming are not exactly known, nor is it known how much of its share Wyoming will deplete at certain dates in the future. For the simulation of hypothetical situations, water diversion and depletion figures from the Wyoming State Water Plan (Wyoming State Engineer's Office, 1973) were assumed to be appropriate.

In addition, the model has been modified to include mass balance calculations for predicting concentrations of total dissolved solids on a monthly basis.

The State Water Planning Model assumes that each subbasin is spatially homogeneous; that is, it cannot account for variations in physical characteristics or hydrological phenomena from one place in a subbasin to another. The model reports subbasin outflows, which, for lack of better information, are assumed to be the streamflows through the subbasin. In actuality, streamflows would often be higher than those reported by the model to be outflows. For example, in the Tongue Subbasin, the largest existing diversion is near the mouth. That diversion would not be a part of the outflow calculated by the model, yet that diverted water would be flowing in the river through much of the subbasin. Likewise, the model does not report other diversions and tributary inflows within the subbasin.

Specific physical and biological impacts in all the subbasins except the Upper Yellowstone and Clarks Fork Yellowstone were provided through the Yellowstone Impact Study funded by the Old West Regional Commission. That study is performed in part and coordinated by the Department of Natural Resources and Conservation. Other major participants were the Water Quality Bureau of the Department of Health and Environmental Sciences and the Department of Fish and Game.

PART III

WATER RESERVATION APPLICATIONS AND ASSOCIATED IMPACTS

CONTENTS

INTRODUCTION

In Part III, each of the applications for reservation of Yellowstone Basin water received to date is described in detail and its primary and secondary impacts evaluated. For convenience, those applications for future consumptive use (that is, those uses for which water is diverted and consumed) are discussed first; applications for instream use (those uses for which water is left in the stream) second.

Table III-1 lists all applications received for the reservation of Yellowstone Basin water for both consumptive and instream uses. An examination of that table reveals the variety and magnitude of these requests. Consumptive use applications were received from conservation districts, irrigation districts, municipalities, and state agencies; application for instream flow reservations were received from conservation districts and state agencies.

The last section of Part III, Cumulative Applications, is a discussion by subbasin of the feasibility of granting all requests received.

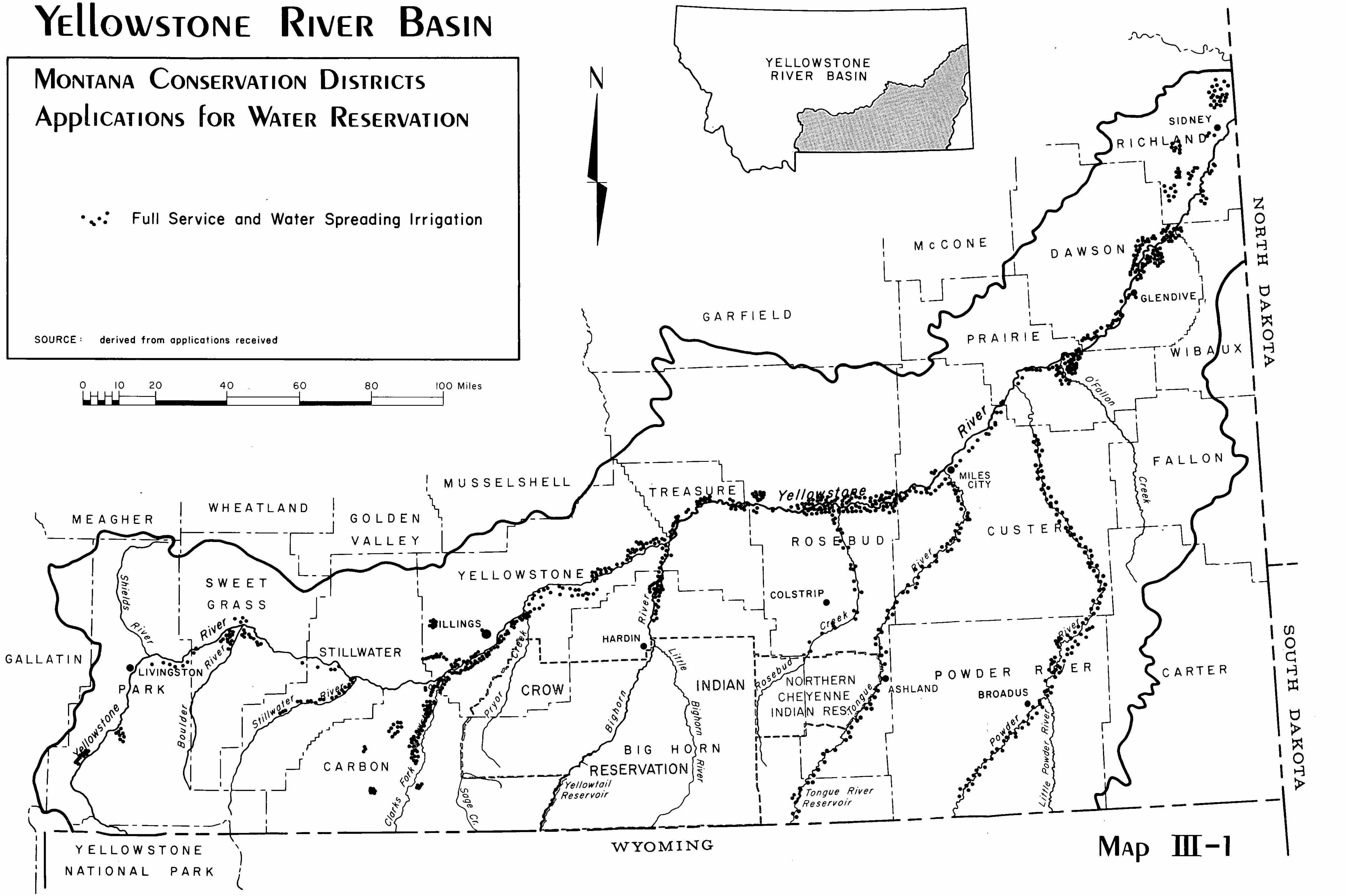
TABLE III-1

APPLICATIONS FOR RESERVATIONS OF WATER IN YELLOWSTONE BASIN

Applicant	Source	Amount	Use
Park Conservation District	Yellowstone & Shields River	752 cfs/108,143 acre feet per year (af/y)	Irrigation (36,570 acres)
Sweet Grass Conservation District	Yellowstone River, Boulder River & various tributaries	438.7 cfs/55,822 af/y	Irrigation (18,510 acres)
Stillwater Conservation District	Yellowstone River & Stillwater River	122.1 cfs/16,755 af/y	Irrigation (5,290 acres)
Carbon Conservation District	Yellowstone River, Clarks Fork, Rock Creek, Red Lodge Creek	274.2 cfs/47,557 af/y	Irrigation (21,015 acres)
Yellowstone Conservation District	Yellowstone River	378.2 cfs/62,900 af/y	Irrigation (26,785 acres)
Big Horn Conservation District	Big Horn River, Tongue River	151 cfs/21,200 af/y	Irrigation (9,645 acres)
Treasure Conservation District	Yellowstone & Big Horn Rivers, Sarpy & Tullock Creeks	129 cfs/19,978 af/y	Irrigation (7,645 acres)
Rosebud Conservation District	Yellowstone, Tongue Rivers, Armell's & Rosebud Creeks	585 cfs/94,129 af/y	Irrigation (37,360 acres)
North Custer Conservation District	Yellowstone River, Tongue River & Powder River	732.4 cfs/104,237 af/y	Irrigation (36, 965 acres)
Powder River Conservation District	Powder River, Tongue River, & various tributaries	583.2 cfs/83,060 af/y	Irrigation (30,245 acres)
Prairie County Conservation District	Yellowstone River	512.9 cfs/63,127 af/y	Irrigation (20,646 acres)
Dawson County Conservation District	Yellowstone River	325 cfs/45,149 af/y	Irrigation (17,897 acres)
Richland County Conservation District	Yellowstone River	354.2 cfs/45,620 af/y	Irrigation (21,710 acres)

TABLE III-1 continued

Applicant	Source	Amount	Use
Huntley Project Irrigation District	Yellowstone River	92 cfs/27,372 af/y	Irrigation (4,000 acres)
Buffalo Rapids Irrigation Project	Yellowstone River	167 cfs/124,434 af/y	Irrigation (41,306 acres)
Department of State Lands	Numerous tributaries in Yellowstone Basin	15,078 af/y	Irrigation (10,270 acres)
Department of State Lands	Numerous tributaries in Yellowstone Basin	143.64 cfs/21,429 af/y	Irrigation (7,143 acres)
Department of State Lands	Numerous tributaries in Yellowstone Basin	218.03 cfs/30,898 af/y	Irrigation (10,376 acres)
City of Livingston	Yellowstone River	20.8 cfs/15,060 acre feet per year (af/y)	Domestic, Municipal
City of Big Timber	Yellowstone River	6.19 cfs/4,483 af/y	Domestic, Municipal
City of Columbus	Yellowstone River	3.6 cfs/2,606 af/y	Domestic, Munidipal
City of Laurel	Yellowstone River	23.2 cfs/16,830 af/y	Domestic, Municipal
City of Billings	Yellowstone River	1,190 cfs/317,456 af/y	All Beneficial Uses
City of Miles City	Yellowstone River	30 cfs/21,720 af/y	Municipal
Town of Broadus	Ground Water	0.84 cfs/605 af/y	Municipal
City of Glendive	Yellowstone	17.62 cfs/12,756.9 af/y	Domestic, Municipal
Department of Natural Resources and Conservation	Tongue River	450,000 acre-feet (af)	Irrigation, Industrial, Fish & Wildlife
Department of Natural Resources and Conservation	Powder River & tributaries	1,150,000 af	Irrigation, Industrial, Fish & Wildlife
Montana Fish and Game Commission	Yellowstone Basin and numerous tributaries	Variable monthly flows; 8,206,723 af/y for Yellowstone River at Sidney	Water Quality, Fish & Wildlife, Recreation
Department of Health and Environmental Sciences	Yellowstone River	6,643,000 af/y for Yellowstone River at Sidney	Water Quality



Yellowstone River Basin
Montana Conservation Districts
Applications for Water Reservation
Full Service and Water Spreading Irrigation
SOURCE: derived from applications received
0 10 20 40 60 80 100 Miles
N
YELLOWSTONE RIVER BASIN
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
YELLOWSTONE NATIONAL PARK
GALLATIN
MEAGHER
WHEATLAND
GOLDEN VALLEY
MUSSELSHELL
GARFIELD
McCONE
RICHLAND
SIDNEY
DAWSON
GLENDIVE
PRAIRIE
WIBAUX
FALLON
CARTER
CUSTER
MILES CITY
TREASURE
ROSEBUD
COLSTRIP
POWDER RIVER
ASHLAND
BROADUS
NORTHERN CHEYENNE INDIAN RES.
CROW INDIAN
BIG HORN RESERVATION
HARDIN
YELLOWSTONE
BILLINGS
STILLWATER
SWEET GRASS
PARK
LIVINGSTON
CARBON
Yellowstone River
Shields River
Boulder River
Stillwater River
Clarks Fork
Pryor Creek
Sage Cr.
Bighorn River
Little Bighorn River
Yellowtail Reservoir
Rosebud Creek
Tongue River
Tongue River Reservoir
Powder River
Little Powder River
O'Fallon Creek
Map III-1

APPLICATIONS FOR FUTURE CONSUMPTIVE USE

There are three categories of consumptive water use for which applications for reservations were received: irrigation, municipal, and multipurpose.

IRRIGATION RESERVATION REQUESTS

Eighteen applications requested the reservation of waters for future irrigation. In this section, the action proposed under each application is described and the resultant impacts assessed. Although each application is considered individually, they are grouped as follows to facilitate discussion:

1) Conservation Districts-- 13 applications
2) Irrigation Districts--2 applications
3) Department of State Lands--3 applications

CONSERVATION DISTRICTS

A conservation district is a political subdivision of the state with broad powers to undertake plans and projects to conserve soil and water resources. Landowners organize a conservation district and elect the governing body, a board of supervisors. Cooperation of landowners with district programs is strictly voluntary.

Most of rural Montana is now included within conservation districts. In many cases, the boundaries of conservation districts coincide with those of counties. The newest conservation district is Prairie County Conservation District, formerly Prairie County Cooperative State Grazing District; its reorganization into a conservation district was not yet completed at the time the application was filed.

DESCRIPTION OF APPLICATIONS

The intent of each conservation district application is to identify potentially irrigable lands and related water supplies, then to set that water aside, through the reservation process, for development as a group or individual project. It should be emphasized that projects identified in the request are not firm commitments for future development, but only possibilities for water use. Individual landowners, in most cases, are not aware that their lands are included.

In the process of identifying lands that should be included in requests, the applicants determined that state and federal lands were intermingled with potential projects. These lands were excluded from the conservation district applications. The Department of State Lands has applied for a water reservation for future irrigation of almost all state lands involved, as identified in the description of each application. Because the federal government cannot reserve water in the Yellowstone Basin until after the end of the moratorium, no application was made for the reservation of water for the irrigation of federal lands.

Each conservation district application was based on a general reconnaissance soils survey, which involves a general evaluation of land features of conspicuous importance in preliminary planning of irrigation development in a particular region. The survey's applicability should be restricted to the following:

1) use on large areas where only general information on the extent of the irrigable land is required, and

2) determining the general extent, location, and quality of irrigable areas with the object of obtaining sufficient information to decide whether making more detailed investigations is justified.

Consequently, the use and interpretation of this reconnaissance-type classification is definitely limited. Because the extent of the irrigable area as determined by this type of survey could be erroneous by 15 to 30 percent, any actual project development should be based on a detailed study to pinpoint the exact location and limits of the land best suited for irrigation.

Farm budget analyses were used to determine the economic feasibility of potential conservation district projects. These budgets compute the costs and returns associated with crop production as well as generalized farm costs, including investment, maintenance, and repairs on buildings and fences. Since the budgets include all costs associated with a farm enterprise, the remaining profit may be used to pay irrigation costs. Comparison of these budgets and the expected irrigation costs indicate possibilities for profitable irrigation development.

The land proposed for future irrigation by each conservation district is illustrated on Map III-1. The legal description of all lands may be obtained from DNRC. Each conservation district's application is explained below.

Park Conservation District

As shown in Table III-2, Park Conservation District's application requests the reservation of a total of up to 108,143 af/y from the Yellowstone and Shields rivers for irrigation of 36,570 acres. Lands proposed to be irrigated (except those on the Shields River, which were not specifically identified in the application) are shown on Map III-1. The total depletion would be 70,315 af/y.

TABLE III-2

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: PARK CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Yellowstone River mainstem[b,c]	Flood	13,470	45,393	27,235
	Sideroll	3,770	7,540	6,786
	Center pivot	1,330	2,660	2,394
MAINSTEM SUBTOTAL		18,570	55,593	36,415
Shields River[d]	Flood	13,500	44,800	26,900
	Sprinkler	4,500	7,750	7,000
SHIELDS SUBTOTAL		18,000	52,550	33,900[d]
GRAND TOTAL		36,570	108,143	70,315

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Includes 250 acres of unspecified development within existing irrigation systems.

[c]Excludes 200 acres of federal land and 1,290 acres of state land within projects.

[d]Based on water availability study (Hurlbut, Kersich & McCullough 1976). Can be used for new acreage and/or supplementing existing acreage.

Along the Yellowstone mainstem, sixteen projects have been specified. Fourteen of these, to be located upstream from Livingston, would involve flood, center pivot, and sideroll irrigation of 11,900 acres. A proposed project north of the city concerns sideroll irrigation of 120 acres, and a major project in the Yellowstone Valley immediately downstream from Livingston would flood irrigate 6,550 acres.

Of the fourteen above-Livingston projects, one, located approximately 20 miles north of Gardiner, would utilize water from Yellowstone tributaries. Potential storage sites on Tom Miner, Big, Mill, Eightmile, and Elbow creeks are listed in the application.

Along the Shields River, anticipated flood and sprinkler irrigation of 13,500 and 4,500 acres, respectively, would necessitate construction of storage facilities. A reservoir at the primary mainstem site (in the headwaters near the confluence with Smith Creek) could yield over 30,000 af/y, over half the total diversion requirement. Other possible sites have been identified on Potter and Flathead creeks in the upper watershed and Brackett, Cottonwood, and Rock creeks in the lower basin.

Because 1,290 acres of land managed by the Department of State Lands and 200 acres of federal land are also included in these proposed projects, the total irrigation proposed for Park County is 38,600 acres.

Sweet Grass Conservation District

As shown in Table III-3, Sweet Grass Conservation District's application requests the reservation of up to 55,822 af/y in the Yellowstone and Boulder rivers and their tributaries, including Sweet Grass and Big Timber creeks, for irrigation of 18,510 acres. The total depletion would be 35,940 af/y.

TABLE III-3

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: SWEET GRASS CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Yellowstone River mainstem	Flood	7,335	22,518	13,511
	Sideroll	720	1,620	1,458
	Center pivot	2,455	5,524	4,971
MAINSTEM SUBTOTAL[b]		10,510	29,662	19,940
Sweet Grass Creek	Flood	8,000	26,160	16,000[c]
GRAND TOTAL		18,510	55,822	35,940

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion for Yellowstone Unit.

[b]Excludes 2,250 acres of state land and 60 acres of federal land.

[c]Based on water availability study (Hurlbut, Kersich & McCullough 1976). Can be used for new acreage and/or supplementary existing acreage. Depletion estimated at 2 af/acre, based on complexity of irrigation system.

The irrigation projects identified would irrigate 20,820 acres. However, two projects include a total of 2,250 acres of state land, and one of these also includes 60 acres of federal land.

Several projects would involve flood irrigation of large tracts along the valley of the Yellowstone, both above and below Big Timber. However, the largest single project (nearly 3,000 acres situated on benchland extending southwest of the Big Timber airport) would include all three irrigation methods, as would another large development (1,270 acres) across the Boulder River to the east. Center-pivot irrigation, used on all or part of seven projects, would be used on only 13 percent of the total acreage. Six projects would require construction of new canal and lateral systems.

The reservation application did not include a map delineating the 8,000 acres expected to be flood irrigated in the Sweet Grass Creek drainage. However, because of late irrigation season flow deficits, storage would be necessary to expand agriculture in the north portion of the county. A site on Sweet Grass Creek offers the greatest single potential; other reservoir sites have been investigated in the Otter Creek and Big Timber Creek watersheds.

Stillwater Conservation District

As shown in Table III-4, Stillwater Conservation District's application requests up to 16,349 af/y from the drainages of the Yellowstone and Stillwater rivers for irrigation of 5,177 acres. The total depletion would be 10,307 af/y.

TABLE III-4

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: STILLWATER CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Stillwater River	Flood	3,505	11,460	6,875
	Sideroll	80	160	145
	Center pivot	130	260	235
STILLWATER SUBTOTAL		3,715	11,880	7,255
Yellowstone River mainstem[b]	Flood	897	3,229	1,937
	Center pivot	565	1,240	1,115
MAINSTEM SUBTOTAL		1,462	4,469	3,052
GRAND TOTAL		5,177	16,349	10,307

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Excludes 113 acres of state land.

A total additional irrigation of 5,290 acres is proposed. However, one of the projects (flood irrigation north of Columbus) would include, in addition to private land, 113 acres managed by the Department of State Lands.

Among the nine projects identified along the Yellowstone mainstem, the only center pivot irrigation, involving a total of 565 acres, would take place at two of the four projects located above Columbus. In the immediate Columbus vicinity, flood irrigation would be accomplished at one project to the north and another to the southwest. Three additional flood-irrigation projects are expected downstream. Construction of canal and lateral systems would be necessary at two projects.

Of the eleven projects in the Stillwater drainage basin, five would be situated along the mainstem and the others on Fishtail, West Rosebud, East Rosebud, Rosebud, and Antelope creeks. Flood irrigation would be used for the two largest projects, one of which extends north of the Stillwater County-Carbon County line along West Rosebud Creek; the other is situated on a bench paralleling Rosebud Creek to the immediate southeast of the town of Absarokee. All projects would require construction of canal and lateral systems.

The Yellowstone River is a firm water source in Stillwater County. Late-season flow records of the Stillwater River, Rosebud Creek, and its tributaries indicate that additional irrigation can be accommodated; however, storage will be necessary to develop all irrigable acreage in that basin. Federal and state studies have found substantial storage potential at sites on East and West Rosebud creeks, the West Fork and the mainstem of the Stillwater River, and Trout Creek.

Carbon Conservation District

As shown in Table III-5 Carbon Conservation District's application requests the reservation of a total of up to 47,557 af/y from the Yellowstone mainstem, Clarks Fork Yellowstone River, Rock and Red Lodge creeks, and their tributaries for irrigation of 21,015 acres. The total depletion would be 38,322 af/y.

TABLE III-5

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: CARBON CONSERVATION DISTRICT RESERVATION APPLICATION

Designation	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Lower region	Flood	1,660	5,462	3,277
	Sideroll	3,320	6,673	6,006
	Center pivot	11,610	23,336	21,002
LOWER REGION SUBTOTAL		16,590	35,471	30,285
Intermediate region	Flood	215	703	422
	Sideroll	130	312	281
	Center pivot	960	2,304	2,074
INTERMEDIATE REGION SUBTOTAL		1,305	3,319	2,777
Upper region	Flood[b]	3,120	8,767	5,260
GRAND TOTAL		21,015	47,557	38,322

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Excludes 850 acres of state land.

A total additional irrigation of 21,865 acres is proposed. However, two proposed projects in the immediate vicinity of Bridger would include, in addition to private land, sideroll and center-pivot irrigation of a total of 850 acres managed by the Department of State Lands.

A major portion of the proposed irrigation is along the Clarks Fork Yellowstone immediately south of its confluence with the Yellowstone mainstem. Three of the 32 projects, together comprising nearly two-thirds of the total proposed irrigable acreage in Carbon County, would be located here. These three projects, in addition to 15 others on the Clarks Fork Yellowstone, would be predominantly center-pivot and sideroll sprinkler-irrigation systems, although minor acreages of flood irrigation would be included. Two sprinkler-irrigation projects would be located along the Yellowstone mainstem southeast of Laurel. Four new sprinkler projects on Rock Creek north of Red Lodge, as well as expansion of existing systems to irrigate an additional 1,500 acres. Red Lodge Creek, Rosebud Creek, and other tributaries northwest of Red Lodge would supply six new flood-irrigation projects by diversions from existing canal systems. Four major projects (three on the Clarks Fork Yellowstone and one on the Yellowstone mainstem) would require construction of extensive new canal and lateral systems.

Large-scale irrigation development in Carbon County would require development of water-storage systems in all tributaries to provide firm water supplies during peak irrigation periods. Offstream-storage sites along the Clarks Fork Yellowstone include Bluewater and Sand creeks, which would store 14,000 and 25,000 acre-feet, respectively. Downstream water rights preclude full utilization of irrigable lands in Rock Creek; however, offstream storage on Elbow Creek has been investigated by the SCS. Excess off-season water diverted through an existing canal could provide an additional 11,000 acre-feet if a reservoir were built in Elbow Creek. Lower Red Lodge Creek has a firm water supply resulting from storage provided by Cooney Reservoir. Additional storage capabilities are proposed by building additional reservoirs on Red Lodge Creek or Willow Creek, or by importation of water from East Rosebud Creek.

Yellowstone Conservation District

As shown in Table III-6, Yellowstone Conservation District's application requests the reservation of up to 63,094 af/y from the Yellowstone, Clarks Fork Yellowstone, and Bighorn rivers for irrigation of 26,785 acres. Included in these totals are 5,725 acres within the conservation district adjacent to the Huntley Irrigation Project which would be supplied with 14,576 af/y through that project. The total depletion would be 53,130 af/y.

TABLE III-6

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: YELLOWSTONE CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage[a]	Diversion (af/y)	Depletion (af/y)[b]
Yellowstone	Flood	3,958	12,190	7,315
	Sideroll	5,588	12,461	11,215
	Center pivot	17,239	38,443	34,600
TOTAL		26,785	63,094	53,130
Huntley Irrigation District[c]	Flood	2,130	6,560	3,936
	Sideroll	1,680	3,746	3,371
	Center pivot	1,915	4,270	3,843
TOTAL		5,725	14,576	11,150

[a]Excludes 1,950 acres of potentially irrigable state lands.

[b]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[c]Tabulation of potentially irrigable land adjacent to Huntley Irrigation District within Conservation District.

A total additional irrigation of 28,735 acres is proposed. However, several of the proposed projects near Laurel include, in addition to private land, a total of 1,950 acres managed by the Department of State Lands.

Most of the proposed projects would be center-pivot or sideroll sprinkler-irrigation systems, with minor acreages of flood irrigation. With the exception of two proposed projects on the east side of the Clarks Fork Yellowstone and three proposals on the Bighorn River, all of the proposed 53 irrigation systems would divert Yellowstone mainstem water. Those along the Yellowstone would be on both the north and south sides of the river in the Billings-Laurel vicinity, but primarily south of the Yellowstone mainstem between Billings and Custer. Several of the proposals include construction of additional canal and lateral systems, and one proposal includes a storage reservoir in the Laurel area south of the Yellowstone mainstem.

Water availability during peak irrigation months presents few problems along the Yellowstone mainstem, which historically provides sufficient flows to irrigate the proposed acreage. The Bighorn River, regulated by Yellowtail Dam, also provides a firm water supply. Irrigation development in these areas will be generally limited by development economics.

Those projects in Yellowstone County along the Clarks Fork Yellowstone will depend on development of onstream or offstream storage to provide ample water during low-flow periods. Some proposed storage sites are discussed in Carbon County Conservation District's application. Pryor Creek also provides some potential for irrigation; however, it is almost entirely contained within the Crow Reservation, as are all potential onstream storage sites. Presumably, any development along Pryor Creek will be undertaken by the Crow Tribe for irrigation of Indian lands.

Big Horn Conservation District

As shown in Table III-7, Big Horn Conservation District's application requests the reservation of up to 21,200 af/y from the Bighorn and Tongue rivers for irrigation of 9,645 acres. The total depletion would be 17,939 af/y.

TABLE III-7

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: BIG HORN CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Bighorn River[b]	Flood	1,335	3,805	2,283
	Sideroll	2,950	6,165	5,544
	Center pivot	4,890	10,220	9,198
BIGHORN SUBTOTAL		9,175	20,190	17,030
Tongue River[c]	Center pivot	470	1,010	909
GRAND TOTAL		9,645	21,200	17,939

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Excludes 420 acres of state land within projects.

[c]Excludes 250 acres of state land within projects.

A total additional irrigation of 10,315 acres is proposed. However, several of the proposed projects include, in addition to private land, a total of 670 acres managed by the Department of State Lands.

Nearly 55 percent of the proposed irrigation would be by center-pivot sprinklers and 33 percent by sideroll sprinklers, leaving only 12 percent in flood irrigation. Only 470 acres of sprinkler irrigation are proposed in the Tongue River drainage; therefore, almost the entire reservation request concerns the Bighorn River. Irrigation development would be entirely outside the Crow Indian Reservation from Hardin northward to the confluence of the Bighorn and Yellowstone rivers. Many of the projects would require construction of extensive canal and lateral systems.

Water availability is not a problem on the Bighorn River because of regulation by Yellowtail Dam; however, because Indian water rights have not yet been determined, eventual water availability for conservation district irrigation projects cannot be determined. The Tongue River, partially regulated by the Tongue River Dam, also provides a firm water supply for Big Horn County; however, additional storage will be necessary to meet all irrigation demands downstream. Many small tributaries including Fly, Pryor, Tullock, Sarpy, Rosebud, Squirrel, and Hanging Woman creeks could provide irrigation potential if adequate storage, either onstream or offstream, could be provided. In almost every case, however, benefits of irrigation would probably not offset the cost of providing storage.

Treasure Conservation District

As shown in Table III-8, Treasure Conservation District's application requests the reservation of up to 19,978 af/y from the Yellowstone and Bighorn rivers and Sarpy and Tullock creeks for irrigation of 7,645 acres. The total depletion would be 16,063 af/y.

TABLE III-8

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: TREASURE CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Yellowstone	Flood	1,960	6,390	3,834
	Sideroll	1,440	3,442	3,098
	Center pivot	4,245	10,146	9,131
TOTAL		7,645[b]	19,978	16,063

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Excludes 1,040 acres of state land within projects.

Development of eighteen units irrigating a total of 8,685 acres is proposed. However, three of the proposed projects include, in addition to private lands, a total of 985 acres managed by the Department of State Lands; one project would include, in addition to private land, 55 acres managed by the Department of Fish and Game.

The three largest units each would involve irrigation of over 1,000 acres. Center-pivot irrigation would be utilized on all or part of the lands in seven units, including the three largest. Because over half (56 percent) of all new irrigation proposed in Treasure Conservation District's application is expected to be by the center-pivot sprinkler method, most of the water diverted would be depleted.

Two units are anticipated on the west side of an approximately three-mile stretch of the Bighorn River immediately above its confluence with the Yellowstone mainstem. No need for storage facilities is foreseen.

Of the sixteen units along the Yellowstone mainstem, nine would lie generally west of Hysham; one flood irrigation project would be located due north of Hysham on the north side of the river. The most easterly of the six remaining downstream projects would include lands within one-quarter mile of the Treasure County-Rosebud County line. Diversion points would include the Yellowstone mainstem, Ranger ditch, and the Main, Hysham, and

Yellowstone canals; again, construction of storage works is not thought necessary, but most of the projects would require construction of canal and lateral systems.

Rosebud Conservation District

As shown in Table III-9, Rosebud Conservation District's application requests up to 94,129 af/y from the Yellowstone and Tongue rivers and Rosebud and Armells creeks for the irrigation of 37,360 acres. The total depletion would be 78,510 af/y.

TABLE III-9

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: ROSEBUD CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage[a]	Diversion (af/y)	Depletion (af/y)[b]
Yellowstone	Flood	6,015	19,609	11,765
	Sideroll	2,195	5,246	4,721
	Center pivot	26,315	62,892	56,602
SUBTOTAL		34,525	87,747	73,088
Tongue	Flood	355	1,040	624
	Sideroll	2,040	4,386	3,947
	Center pivot	440	946	851
SUBTOTAL		2,835	6,372	5,422
GRAND TOTAL		37,360	94,119	78,510

[a]Excludes 1,330 acres of state land.

[b]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

A total additional irrigation of 38,690 acres is proposed. However, several of the projects would include, in addition to private land, a total of 1,330 acres managed by the Department of State Lands.

The proposed Rosebud County projects would be generally located along the Yellowstone River bottom, benches above the Yellowstone River, and along Yellowstone tributaries including Greasewood, Porcupine, Pine, Rosebud, Armells, and Battle creeks. These projects would utilize center-pivot, sideroll, and flood irrigation. Lands designated for flood irrigation are along the bottomlands of the mainstem and tributaries; high lands and benches would rely primarily on center-pivot and sideroll sprinkler systems. Not located on the map are 1,200 acres of unspecified lands proposed for irrigation within the Hammond Irrigation District. The Yellowstone mainstem and tributaries would be the main sources of water for these projects, many of which would require the construction of extensive canal and lateral systems.

There are 2,835 acres proposed in the Tongue River basin; the locations of these units have not been provided.

North Custer Conservation District

As shown in Table III-10, North Custer Conservation District's application requests the reservation of up to 104,237 af/y from the Yellowstone, Tongue, and Powder rivers for irrigation of 36,965 acres. The total depletion would be 74,568 af/y.

TABLE III-10

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: NORTH CUSTER CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Yellowstone[b,c]	Flood	1,210	3,960	2,374
	Sideroll	320	698	628
	Center pivot	4,680	10,202	9,182
SUBTOTAL		6,210	14,860	12,185
Tongue[c]	Flood	695	2,295	1,376
	Sideroll	680	1,496	1,322
	Center pivot	3,230	7,106	6,395
SUBTOTAL		4,605	10,897	9,093
Powder[d]	Flood	17,000	57,800	34,680
	Sideroll	1,850	4,180	3,760
	Center pivot	7,300	16,500	14,850
SUBTOTAL		26,150	78,480	53,290
GRAND TOTAL		36,965	104,237	74,568

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Excludes 290 acres of state land within projects.

[c]Includes 250 acres of unspecified development within Tongue and Yellowstone River Irrigation District.

[d]Excludes 1,400 acres of federal land and 950 acres of state land within projects.

A total additional irrigation of 39,605 acres is proposed. However, the projects would include, in addition to private land, 290 acres of state land in the Yellowstone drainage and 950 acres of state land in the Powder drainage. In addition, 1,400 acres of federal land are included among private lands in projects anticipated in the Powder drainage.

The projects which would rely on the Yellowstone River for water would utilize mainly center-pivot systems. The major portion of land to be irrigated consists of 3 projects (totaling 5,370 acres) on benches along banks of the Yellowstone River about 13 miles upstream from Miles City. One small project totaling 510 acres would be located about one mile north of Miles City; 5 other small proposed projects totaling 1,215 acres would be located along the river 10 to 20 miles downstream from Miles City. A firm yield of water, without storage, is expected in the Yellowstone River; however, construction of lateral and canal systems would be necessary.

The Tongue River projects would rely on the Tongue River for a water supply and would mainly utilize center-pivot systems, with some sideroll and flood systems. The lands are dispersed along the length of the Tongue River in Custer County. These irrigation projects would require additional water storage on the Tongue River.

A total of 26,150 acres are planned for irrigation in the Powder River subbasin. Water for these proposed projects would require additional storage in the Powder River.

Powder River Conservation District

As shown in Table III-11, Powder River Conservation District's application requests the diversion of up to 83,060 af/y from the Powder and Tongue rivers and/or their tributaries for irrigation of 30,245 acres. The total depletion would be 51,450 af/y for the acres of full-service irrigation; depletions which would result from irrigation by water spreading are unknown.

TABLE III-11

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: POWDER RIVER COUNTY CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Powder	Flood	20,200	68,680	41,200
	Sideroll	2,000	4,500	4,050
	Center pivot	3,045	6,880	6,200
SUBTOTAL		25,245	75,560	51,450
	Water Spreading	5,000	7,500	Unknown
GRAND TOTAL		30,245	83,060	

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

A total additional irrigation of 31,990 acres is proposed. However, the anticipated projects include, in addition to private land, 1,745 acres of state and federal land.

Over 80 percent of the proposed development would be by flood irrigation, with the remaining sprinkler irrigation divided approximately equally between center pivot and sideroll systems. Irrigable lands are almost exclusively on the floodplain of the Powder River, with developments being planned for almost the entire reach within Powder River County.

It was assumed for the purpose of this reservation application that substantial onstream storage will be provided in the future to meet the full potential for irrigation development. Historically, unpredictable flows, silt loads, and high sodium concentrations have hindered irrigation development. The Bureau of Reclamation has studied several sites for reservoir storage in the Powder; however, a considerable amount of carry-over and sediment storage is necessary to provide a firm water supply. No irrigation development or storage reservoirs are proposed by the Powder River Conservation District for the drainages of Mizpah, Pumpkin, or Otter creeks or the Little Powder River because of naturally existing water quality problems.

Prairie County Conservation District

As shown in Table III-12, Prairie County Conservation District's application requests the reservation of up to 63,127 af/y from the Yellowstone mainstem and its tributaries for irrigation of some 20,646 acres. Included in these totals are 3,316 acres in or adjacent to the Buffalo Rapids Irrigation District which would require a diversion of 10,180 af/y, 6,108 af/y of which would be depleted. The total watershed depletion under this application would be 38,087 af/y.

TABLE III-12

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: PRAIRIE COUNTY CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage[a]	Diversion (af/y)	Depletion (af/y)[b]
Yellowstone	Flood	20,334	62,425	37,455
	Sideroll	0	0	0
	Center pivot	312	702	632
TOTAL		20,646	63,127	38,087
Buffalo Rapids[c] Irrigation District	Flood	3,316	10,180	6,108
	Sideroll	0	0	0
	Center pivot	0	0	0
TOTAL		3,316	10,180	6,108

[a]Excludes 532 acres of state lands and 482 acres of federal lands.

[b]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler irrigation.

[c]Acreage included in Prairie County Conservation District reservation in or adjacent to Buffalo Rapids Irrigation District.

A total additional irrigation of 21,660 acres is proposed. However, five of the projects include, in addition to private land, a total of 532 acres managed by the Department of State Lands; three of the same projects would also include 482 acres of federal land.

All the lands proposed to be irrigated are located along the Yellowstone River bottom and adjacent benches. Flooding is proposed for 20,334 acres; center-pivot circles are planned for the remaining 312 acres. Canal and lateral construction would be needed for three projects.

Because the Yellowstone River is a firm water source, irrigation expansion is felt to be only a function of economics.

Dawson County Conservation District

As shown in Table III-13, Dawson County Conservation District's application requests the reservation of up to 45,149 af/y from the Yellowstone mainstem for irrigation of 17,897 acres. Included in Dawson County Conservation District's reservation request are 3,240 acres in or adjacent to the Buffalo Rapids Irrigation District which will be supplied with water through expansion of Buffalo Rapids facilities. The total depletion would be 35,152 af/y.

TABLE III-13

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: DAWSON COUNTY CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage[a]	Diversion (af/y)	Depletion (af/y)[b]
Yellowstone	Flood	5,952	18,273	10,964
	Sideroll	920	2,070	1,863
	Center pivot	11,025	24,806	22,325
TOTAL		17,897	45,149	35,152
Buffalo Rapids Irrigation District[c]	Flood	2,980	9,149	5,489
	Sideroll	-	-	-
	Center pivot	260	585	351
TOTAL		3,240	9,734	5,840

[a]Excludes 1,932 acres of state land.

[b]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[c]Acreage included on Dawson County Conservation District's reservation on or adjacent to Buffalo Rapids Irrigation District.

A total additional irrigation of 19,829 acres is proposed. However, eight of the projects would include, in addition to private land, a total of 1,932 acres managed by the Department of State Lands.

Center pivot sprinklers would irrigate 61 percent of the total acreage applied for in the reservation, 33 percent will be flood irrigated, and about 5 percent would have sideroll sprinklers. The Yellowstone River would provide virtually all of the water for the proposed irrigation developments. Proposed projects are concentrated on the floodplain and lower benchlands in two areas along the Yellowstone, upstream and downstream from Glendive. Of the 40 projects considered feasible, 14 will require construction of additional canal and lateral systems.

The Yellowstone is considered the only reliable water supply for irrigation development in that part of Dawson County in the Yellowstone Basin. Historic and recent flow regimes indicate that water supply would enable development of irrigation projects in Dawson County even with similar developments upstream. Minor tributaries north and south of the Yellowstone mainstem are not considered reliable irrigation development water sources, although storage systems on these tributaries may provide sufficient water for some industrial developments.

Richland County Conservation District

As shown in Table III-14, Richland County Conservation District's application requests the reservation of up to 45,620 af/y from the Lower Yellowstone for irrigation of 21,710 acres. The total depletion would be 38,565 af/y.

TABLE III-14

SUMMARY OF IRRIGABLE ACRES, WATER DIVERSION, AND WATER DEPLETION: RICHLAND COUNTY CONSERVATION DISTRICT RESERVATION APPLICATION

Drainage Basin	Type of Irrigation	Acreage	Diversion (af/y)	Depletion (af/y)[a]
Yellowstone	Flood	3,055	8,310	4,986
	Sideroll	2,240	4,480	4,032
	Center pivot	16,415	32,830	29,547
TOTAL		21,710[b]	45,620	38,565

[a]Assumed to be 60 percent of flood diversion and 90 percent of sprinkler diversion.

[b]Excludes 420 acres of state land.

A total additional irrigation of 22,130 acres is proposed. However, three of the projects include, in addition to private land, center-pivot and flood irrigation of a total of 420 acres managed by the Department of State Lands.

Well over 75 percent of the proposed irrigation development would consist of center-pivot irrigation systems with the acreage split nearly equally between side roll and flood irrigation. The Yellowstone mainstem is, for all practical purposes, the sole water supply for the proposed irrigation projects. Of 28 individual projects proposed, most large projects would be on benchlands north of the Yellowstone, principally upstream from Sidney. A significant portion of developments are proposed south of the mainstem, while only a few projects are intended for the floodplain, already extensively irrigated. Seven projects would require construction of canals and laterals in addition to pipeline supply systems.

The lower Yellowstone shows significant depletion by upstream use; however, water supply during the peak irrigation season is regarded as sufficient to meet the requirements of the proposed irrigation. Tributaries both north and south of the mainstem provide very little additional water. Development of storage capabilities to provide supplemental irrigation flows is not deemed feasible at this time.

ENVIRONMENTAL IMPACTS--CONSERVATION DISTRICT APPLICATIONS

This section considers the environmental impacts that would result from the granting of each conservation district application alone, without considering the cumulative effects of granting more than one application. The cumulative impacts of granting all the consumptive use reservation requests are discussed in the Irrigation Emphasis Alternative (page 253) of Part IV.

No immediate environmental impact would result from the Board's granting of any individual conservation district's reservation request. The impacts to the natural and cultural environments described in this section would occur, in time, as the reserved water is gradually put to irrigation use over approximately a 30-year period. The same impacts might result following denial of each application, since the same irrigation might eventually be developed under water use permits.

To avoid repetition, those effects common to all conservation district requests are identified as generalized impacts. Impacts peculiar, either in nature or in magnitude, to individual conservation districts are identified in the subsequent section. All impacts considered are categorized as either primary or secondary, as defined in Part II.

Generalized Impacts

Primary Impacts

Streamflow Alteration. The lands proposed to be irrigated in the applications of the Stillwater, Yellowstone, Big Horn, Treasure, Prairie County, Dawson County, and Richland County conservation districts would be served by the Yellowstone mainstem, the Stillwater River, or the Bighorn River. The water supply in each of these rivers would be adequate to serve any of these proposed projects without causing significant streamflow alterations. Several of the applications would result in substantial dewatering of Yellowstone tributaries, however. These situations are discussed in more detail below under "Impacts for Individual Conservation Districts."

Channel Form. On those unimpounded streams (e.g. the Powder River) which would require the construction of storage facilities in order to provide adequate water supplies for the developments proposed in individual applications, there would be changes in channel form as a result of implementing individual consumptive-use applications. These impoundments would reduce the streams' sediment loads and cause degradation (downcutting) below the dams. Islands, bars, and backwaters would tend to be eliminated, and vegetation would tend to encroach on the channels.

For an evaluation of the potential changes in the Powder River channel form resulting from the construction of Moorhead Dam, see page 281 in Part IV.

Water Quality. Conversion of rangeland to irrigated, cultivated fields may tend to increase erosion and sedimentation, especially if soils are not carefully managed. On the other hand, conversion of overgrazed rangeland or dry farmland to irrigated fields may decrease erosion and sedimentation due to improved vegetation cover. Irrigation return flows will be saline but will be adequately diluted by the flow of the larger streams.

In some tributaries, dewatering will result in water quality problems; these localized problems are discussed in the sections for individual applications, below.

Ecosystems. No impacts are expected on the aquatic ecosystem of the Yellowstone mainstem as a result of the implementation of individual applications, but significant impacts would occur on some tributaries, discussed below.

Increasing numbers of migratory waterfowl may be attracted to the new irrigated fields for feed, especially in the eastern portion of the Yellowstone basin, which lies in the important Central Flyway.

Secondary Impacts

Agricultural Water Use. The granting of any of the conservation district applications would have the effect of securing a water supply for future irrigation. Implementation of any one of these applications would mean the conversion of thousands of acres of rangeland or dry cropland to irrigated cropland, resulting in an increase in irrigation water use.

Trends in the amounts of irrigated acreage, current levels of development, and new irrigation proposed by conservation districts are summarized in Table III-15. In Park, Yellowstone, and Treasure counties, the recent trend has been a decrease in irrigated acreage. If the reservation requests were granted and projects implemented, this trend would be reversed. In the basin's other counties, the recent trend, a small increase in irrigated acreage, would greatly accelerate if the projects proposed in the applications were implemented.

According to the data submitted in the reservation applications, benefits would exceed costs of proposed projects in all cases; thus the proposals are economically feasible. Table III-16 summarizes project profit information, the trade centers which would primarily benefit from those profits, and the effects on county employment. Note that in Park, Powder River, and Prairie counties, the anticipated annual primary profits would equal a substantial portion of all personal income in 1972.

There would also be primary and secondary income and employment benefits resulting from the installation of new irrigation systems. Primary benefits would be the increased profits of firms that manufacture and install these systems and the increased job opportunities in these industries due to the increased activity. No estimate is available for the magnitude of these benefits, which would be spread over the 30 years or more needed to install the proposed irrigation systems.

TABLE III-15

CURRENT AND ANTICIPATED IRRIGATION

County and Conservation District	Past and Present Irrigation[a,b]			Future Irrigation Anticipated by Conservation Districts by the Year 2007			
	Average Annual Increase or Decrease in Irrigated Acreage		Irrigated Acreage 1975	On Private Land	On State Land	On Federal Land	Total
	1944 - 1975	1965 - 1975					
PARK Park Conservation District	-204	-41	47,400	36,570	1,290	200	33,060
SWEET GRASS Sweet Grass Conservation District	+192	+3,458	60,200	18,510	2,250	60	20,820
STILLWATER Stillwater Conservation District	-99	+49	27,520	5,177	113	--	5,290
CARBON Carbon Conservation District	-703	+46	59,620	21,015	850	--	21,865
YELLOWSTONE Yellowstone Conservation District (and Huntley Project Irrigation District)	-1,143	-1,848	51,190	26,785	1,950	--	28,735
BIG HORN Big Horn Conservation District	-704	+329	53,200	9,645	670	--	10,315
TREASURE Treasure Conservation District	-239	-16	14,420	7,645	1,040	--	8,685
ROSEBUD Rosebud Conservation District	+254	+1,505	37,780	37,360	1,330	--	38,690
CUSTER North Custer Conservation District	-105	+7	23,630	36,965	1,240	1,400	39,605
POWDER RIVER Powder River Conservation District	+340	+1,123	15,900	25,245	unknown[c]	unknown[c]	26,990
PRAIRIE Prairie County Conservation District (and Buffalo Rapids Irrigation District)	+44	+679	14,310	20,646	532	482	21,660
DAWSON Dawson County Conservation District (and Buffalo Rapids Irrigation District)	-18	+182	16,110	17,897	1,932	--	19,829
RICHLAND Richland County Conservation District	-480	+592	45,500	21,710	420	--	22,130

[a]Montana Department of Agriculture, 1944-75.
[b]Includes only irrigated cropland harvested.
[c]The Powder River Conservation District included in its proposed irrigation projects 1,745 acres of state and federal land. Because the application did not identify which lands were state and which federal, it is not known how much of each the district anticipates will be irrigated.

TABLE III-16

ECONOMIC IMPACTS--CONSERVATION DISTRICT IRRIGATION APPLICATIONS

Applicant	Average Annual Profit per Acre[a] ($)	Annual Profit[b] ($)	Annual Profit as Percentage of Personal Income in County[c]	Annual Secondary Benefits[d] ($)	Annual Total Benefits ($)	Trade Center: Local	Trade Center: Regional	Employment Benefits[e]	Farm Workers[f]	Off-Farm Workers[g]
Park Conservation District	31	1,100,000	14%	2,310,000	3,410,000	Livingston	Bozeman	1972	230	3,034
								New	91	127
								TOTAL	321	3,161
Sweet Grass Conservation District	15	320,000	2%	672,000	992,000	Big Timber	Billings	1972	150	631
								New	46	64
								TOTAL	196	695
Stillwater Conservation District	5	26,000	1%	54,600	80,600	Columbus	Billings	1972	161	880
								New	13	18
								TOTAL	174	898
Carbon Conservation District	17	350,000	1%	735,000	1,085,000	Red Lodge	Billings	1972	242	1,425
								New	48	64
								TOTAL	306	1,489
Yellowstone Conservation District and Huntley Project Irrigation District	67	1,900,000	0.1%	3,990,000	5,890,000		Billings	1972	538	34,585
								New	72	101
								TOTAL	610	34,686
Big Horn Conservation District	48	460,000	1%	966,000	1,426,000	Hardin	Billings	1972	500	2,277
								New	24	34
								TOTAL	524	2,311
Treasure Conservation District	26	250,000	8%	525,000	775,000	Hysham	Billings	1972	119	188
								New	19	27
								TOTAL	138	215
Rosebud Conservation District	61	1,500,000	6%	3,150,000	4,650,000	Forsyth	Miles City	1972	267	1,614
								New	93	130
								TOTAL	360	1,744
Powder River Conservation District	86	1,800,000	17%	3,780,000	5,580,000	Broadus	Miles City	1972	142	462
								New	75	105
								TOTAL	217	567
North Custer Conservation District	60	2,200,000	4%	4,620,000	6,820,000		Miles City	1972	214	3,991
								New	92	129
								TOTAL	306	4,120
Prairie County Conservation District and Buffalo Rapids Irrigation Project	78	1,600,000	33%	3,360,000	4,960,000	Terry	Miles City Glendive	1972	93	423
								New	54	76
								TOTAL	147	499
Dawson County Conservation District and Buffalo Rapids Irrigation Project	71	1,300,000	3%	2,730,000	4,030,000		Glendive	1972	170	3,624
								New	45	63
								TOTAL	215	3,687
Richland County Conservation District	46	1,000,000	5%	2,100,000	3,100,000		Sidney	1972	316	2,680
								New	53	74
								TOTAL	369	2,754

NOTE: Estimate of profitability, secondary benefits, and employment benefits can only be regarded as rough estimates because the studies were not sufficiently detailed to provide more exact ones.

[a]Per-acre profits are equal to the annual payment capacity per acre minus per-acre costs. The figure is an average computed from those units identified in the application for which cost information is available.

[b]This figure results from multiplying the average profit per acre by the total acres in the request. The primary benefits are enjoyed by the farmer who earns the profits from irrigation.

[c]Calculated from 1972 personal income data (U.S. Bureau of Economic Analysis unpub.).

[d]Secondary income benefits from agricultural income are estimated to be 2.1 times the primary income benefits (Haroldsen 1975). Secondary benefits are the increases in regional employment and income resulting from the increased spending and hiring done by those receiving the primary benefits. The secondary benefits go to the businessman who prospers because the farmer is spending more.

[e]Jobs shown here as "new" are those that would result from implementation of the appropriate conservation district's application.

[f]U.S. Bureau of Economic Analysis unpublished. On the average, one person will be hired for every 400 acres of additional irrigation. Primary employment benefits are the increases in farm jobs.

[g]These off-farm employment benefits are the nonfarm jobs created because firms supplying goods and services to more prosperous farmers hire more workers to handle the larger sales volume.

The income and employment estimates shown in Table III-16 are only rough estimates of future events based on today's technology. Agricultural progress is usually labor-saving, and labor productivity is increasing steadily. This trend suggests that if these systems are actually installed, the number of new jobs created may be lower than predicted here.

Municipal and Domestic Water Use. The granting of any of these applications should not affect existing or potential municipal water systems. On those tributaries which will be substantially dewatered, water quality may be sufficiently degraded to induce domestic users to seek other water sources.

Recreation and Aesthetics. The possible increased presence of waterfowl, which could result from expanded irrigation, could be considered a benefit to hunters and sightseers. Decreased flows and degraded water quality (in such cases as the Powder and Tongue rivers) might adversely affect such water-based recreational activities as swimming, fishing, and boating.

Variations in vegetative cover and color would change the appearance of newly irrigated areas. The migratory waterfowl which may be attracted for feeding would also affect aesthetics, as would the presence of ditches, pipelines, sprinklers, powerlines, and pumping units. Minor disturbances such as noise and dust would temporarily result from irrigation developments.

Impacts in Individual Conservation Districts

Park Conservation District

According to the Park Conservation District application, one irrigation project would store and utilize water from small mainstem Yellowstone tributaries south of Livingston. Among them, Tom Miner, Big, and Mill creeks, have confirmed spawning runs of cutthroat trout and potential runs of rainbow trout. Dewatering of these streams during the spring would destroy these spawning runs and adversely affect the important cutthroat trout population of the Yellowstone mainstem. These streams and Eightmile and Elbow creeks, the other two small tributaries mentioned for storage in the application, are all seriously dewatered in the late summer and early fall at the present level of irrigation development. Further (or more frequent) dewatering may eliminate the resident and fall spawning brown and brook trout and whitefish in these streams.

In the Shields River, irrigation development is limited by the water supply, not by the availability of feasibly irrigable lands. Further, the water could only be made available by the construction of storage. Depletion of 33,900 af/y for additional irrigation, as proposed in the application, would not provide minimum instream flows. Already, certain reaches of the Shields River in the vicinity of Wilsall are drastically dewatered in the late summer and early fall; the fishery is largely eliminated during those times. Implementation of this reservation request would aggravate that situation, perhaps limiting fall-spawning brown trout and whitefish to the lower part of the river.

Studies of the trout populations of the Shields River indicate that, in the mainstem, two-year-olds, three-year-olds, and older fish predominate; younger fish are largely absent. On the other hand, the populations of the small tributaries consist largely of zero-and one-year-old fish. It may be concluded that there is little or no recruitment in the mainstem and that the tributaries are vital to the maintenance of the mainstem populations. Impounding and/or spring dewatering of these tributaries, such as Brackett Creek, would therefore have a devastating effect on the mainstem fishery.

Sweet Grass Conservation District

The construction of new storage in the Sweet Grass drainage, as proposed in the application, would provide only up to 10 percent of the current average basin yield, prorated on a monthly basis, for instream flows. Such a flow reduction would almost eliminate the fishery in the productive middle portion of the drainage. In the lower reaches of the drainage, the fishery, already marginal because of dewatering and poor-quality irrigation return flows, would be virtually eliminated.

Carbon Conservation District

The flows of the Clarks Fork Yellowstone would be reduced during the irrigation season (May-September) as shown in the hydrograph, Figure III-1. Flow reductions would not be significant enough during most months to have a perceptible environmental impact. During August, however, the magnitude and frequency of low flows would change enough to cause at least a temporary adverse effect on the salmonid fishery of the upper river.

Carbon Conservation District's reservation would deplete an additional 6,000 af/y in Rock Creek. Late summer and early fall flows would be reduced below their already low level. Additional storage and altered operation of Cooney Reservoir on Red Lodge Creek could maintain minimum instream flows. Failure to maintain minimum instream flows would eliminate the resident fishery and the migrant spawning species below the confluence with the Red Lodge Creek in all but wet years.

Rosebud Conservation District

In the Tongue Subbasin, increased storage must be provided in order to supply Rosebud Conservation District's request for the diversion of 6,372 af/y and the depletion of 5,422 af/y, presumably by raising the existing Tongue River Dam. Impacts of that action would include the inundation of land and the attendant effects on soils and vegetation. With regard to aquatic life, stream habitat upstream from the existing reservoir would be reduced, but reservoir habitat would be expanded, and different species of fish would occur.

Historical monthly flows would be only slightly changed by storing and releasing 6,372 af/y. Historical median low flows would be slightly reduced; 90th-percentile low flows in summer months would continue to be very low, consisting principally of return irrigation flows. See Figure III-2, the

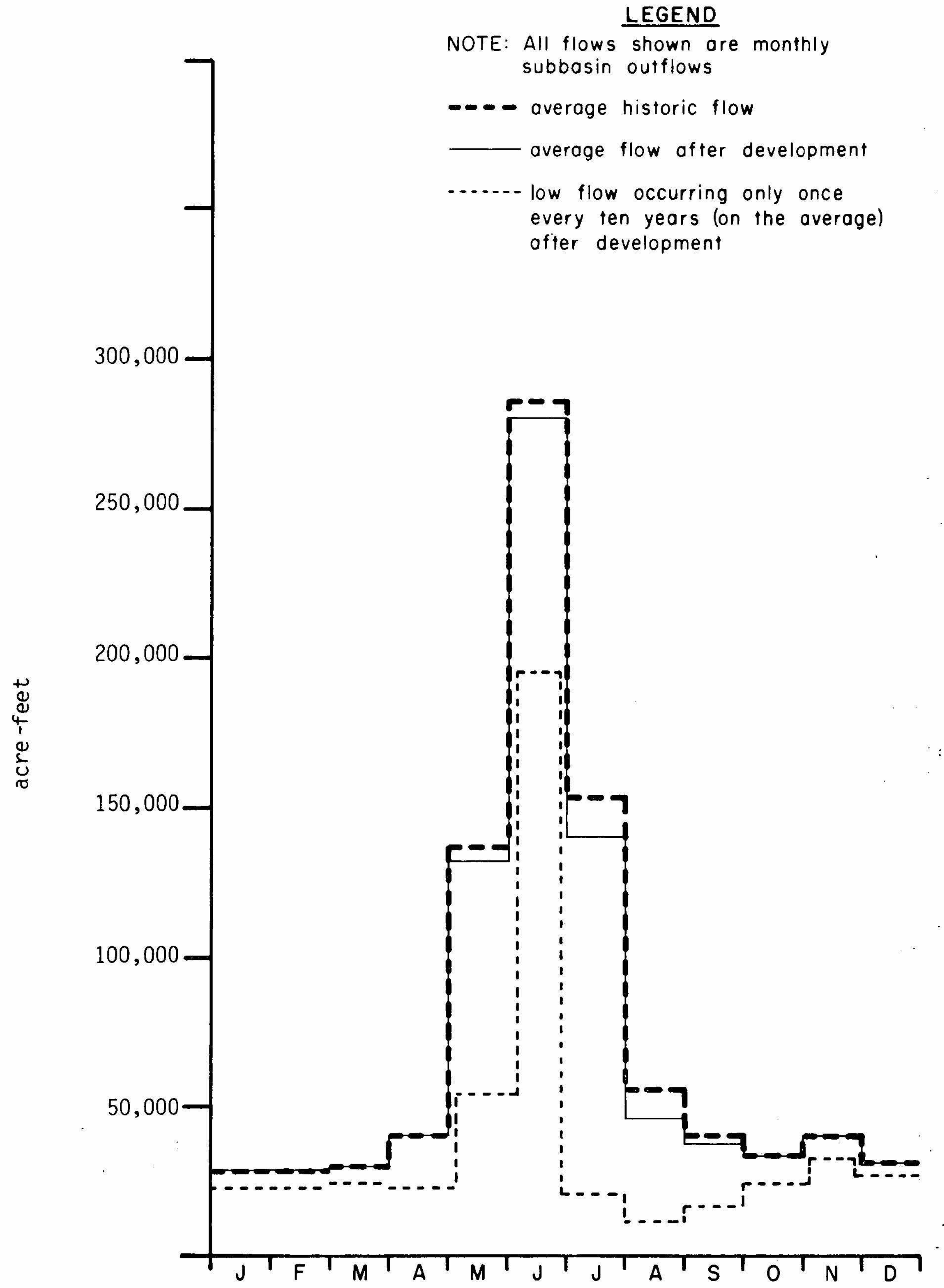


FIGURE III-1. Clarks Fork Yellowstone River Subbasin Monthly Outflows for the Carbon Conservation District Application

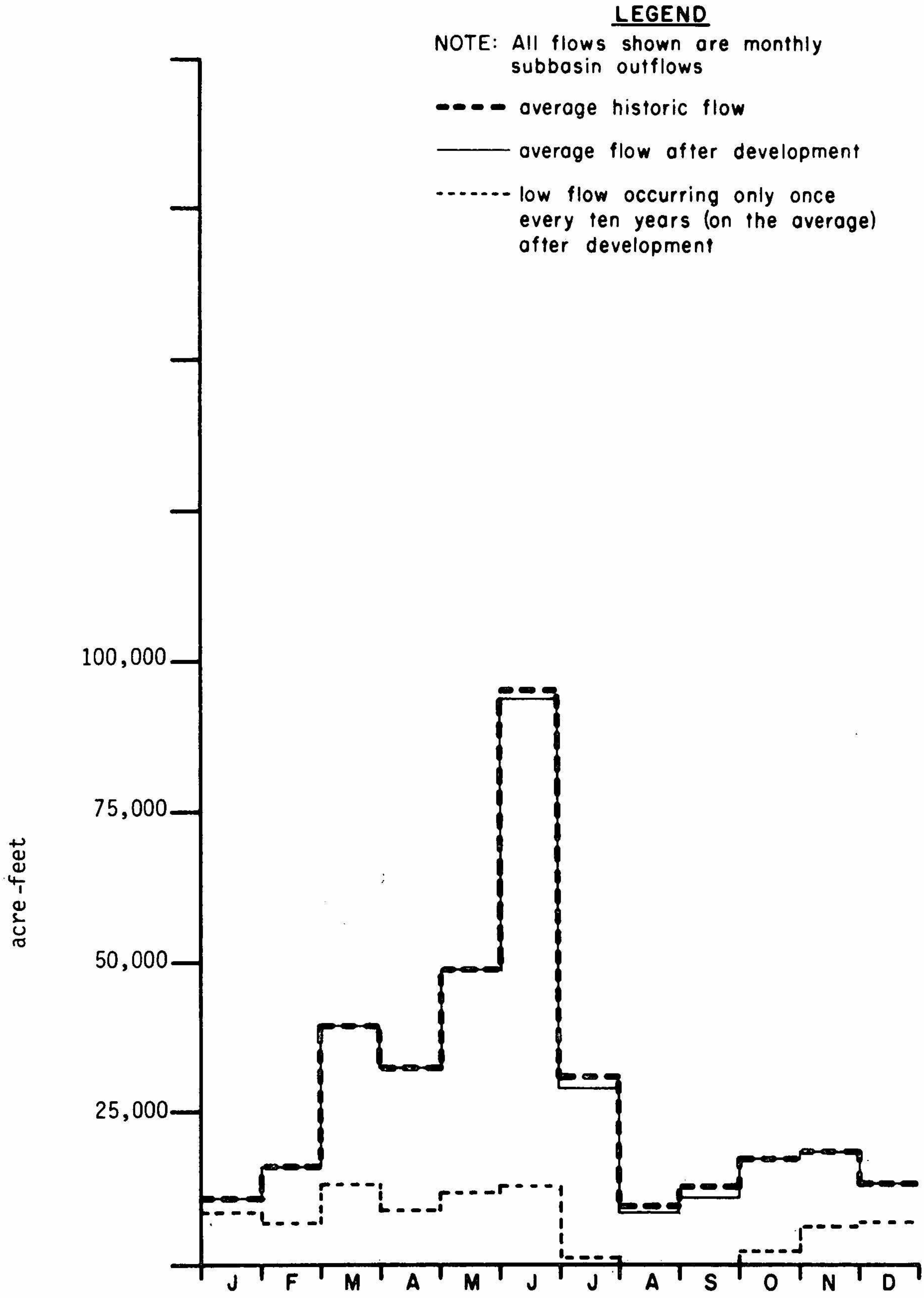


FIGURE III-2. Tongue River Subbasin Monthly Outflows for the Rosebud Conservation District Application hydrograph showing flow alterations in the Tongue River which would result from implementation of this reservation.

Water quality would also be affected. Because of flow depletions and return flows, an increase in river salinity would be especially significant in low-flow months if minimum instream flows were not maintained. For example, historical TDS levels for August are 509 mg/l and 765 mg/l for median and 90th-percentile low flows, respectively. After implementation of the Rosebud Conservation District application, these levels would increase to about 769 mg/l and 990 mg/l, respectively. Irrigation would require careful water management practices to reduce salt build-up in soils and to maximize the productivity of salt-sensitive crops.

TDS changes of this magnitude would have a significant impact on the aquatic species intolerant of high salt levels. The macroinvertebrate community could be degraded. Increased salinity from return flows would degrade the fisheries. During critical low-flow years, flows would continue to be seriously low in summer months; velocity, wetted perimeter, and depth would be reduced. All fish species would suffer during extreme low flows, especially channel catfish, which spawn during summer months.

Raising the existing Tongue River Dam would inundate some coal reserves and possibly interfere with current and proposed mining adjacent to the reservoir.

North Custer Conservation District

The North Custer Conservation District has requested reservations in both the Tongue and Powder subbasins.

At the current level of storage, water available in the Tongue Subbasin is not sufficient to provide the reservation request of 10,397 af/y; consequently, additional storage would be required. Historical median flows would be only slightly changed by storing and releasing 10,397 af/y (See Figure III-3). Ninetieth-percentile low flows would remain at a very low level. The impacts of constructing additional storage on the Tongue River would be the same as those discussed above for Rosebud Conservation District's application. TDS levels in the Tongue at the median and 90th-percentile low flows would be 945 mg/l and 1,142 mg/l, respectively, after implementation of North Custer Conservation District's application.

In the Powder Subbasin, implementation of North Custer Conservation District's request would deplete 74,568 af/y, an amount similar to the 82,720 af/y of the reduced high level of irrigation development considered in the Irrigation Emphasis Alternative of Part IV. For discussion of the significant impacts of that level of development, see page 253.

Powder River Conservation District

Implementation of the Powder River Conservation District's reservation request would deplete 51,450 af/y from the Powder River, nearly the same as

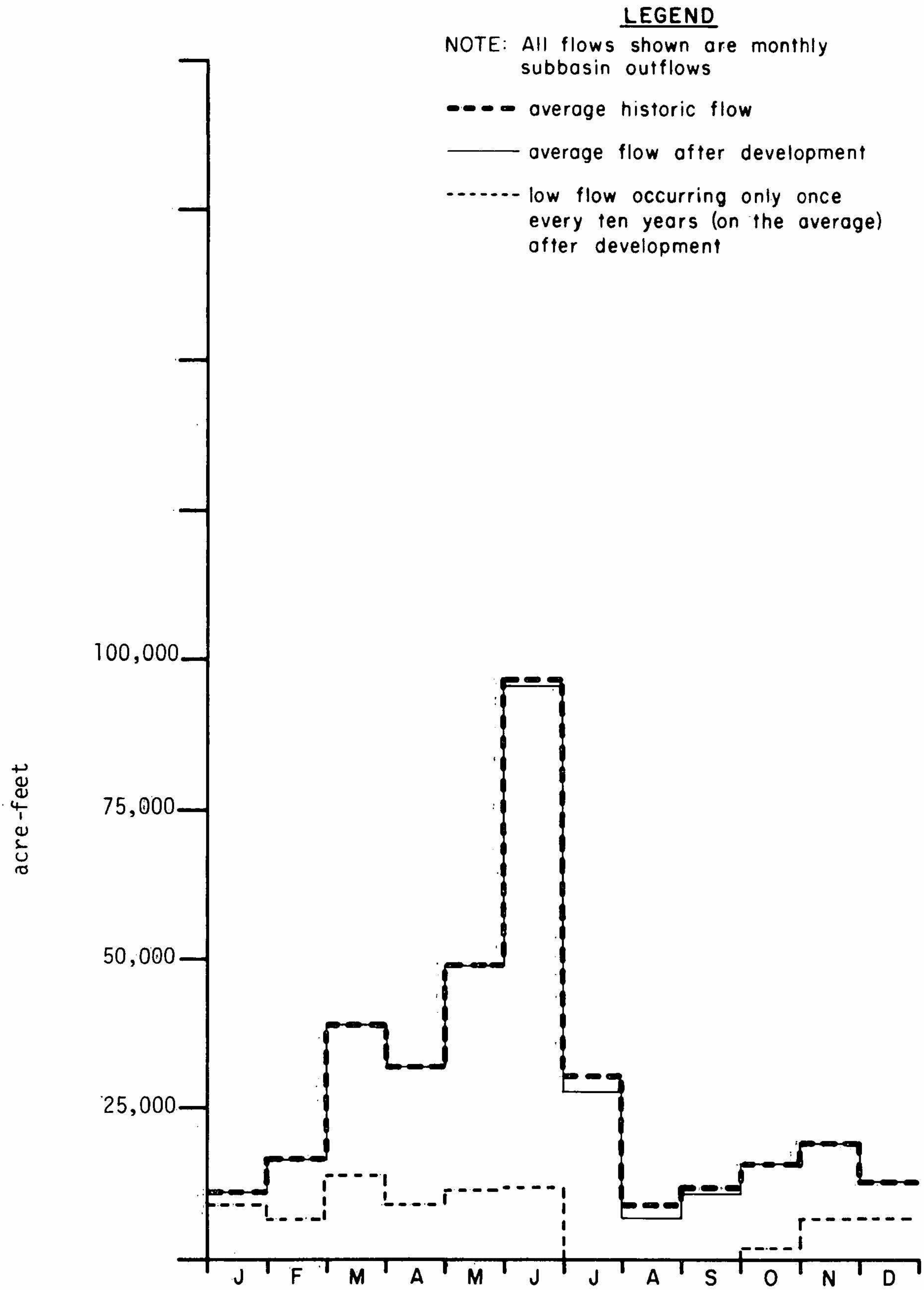
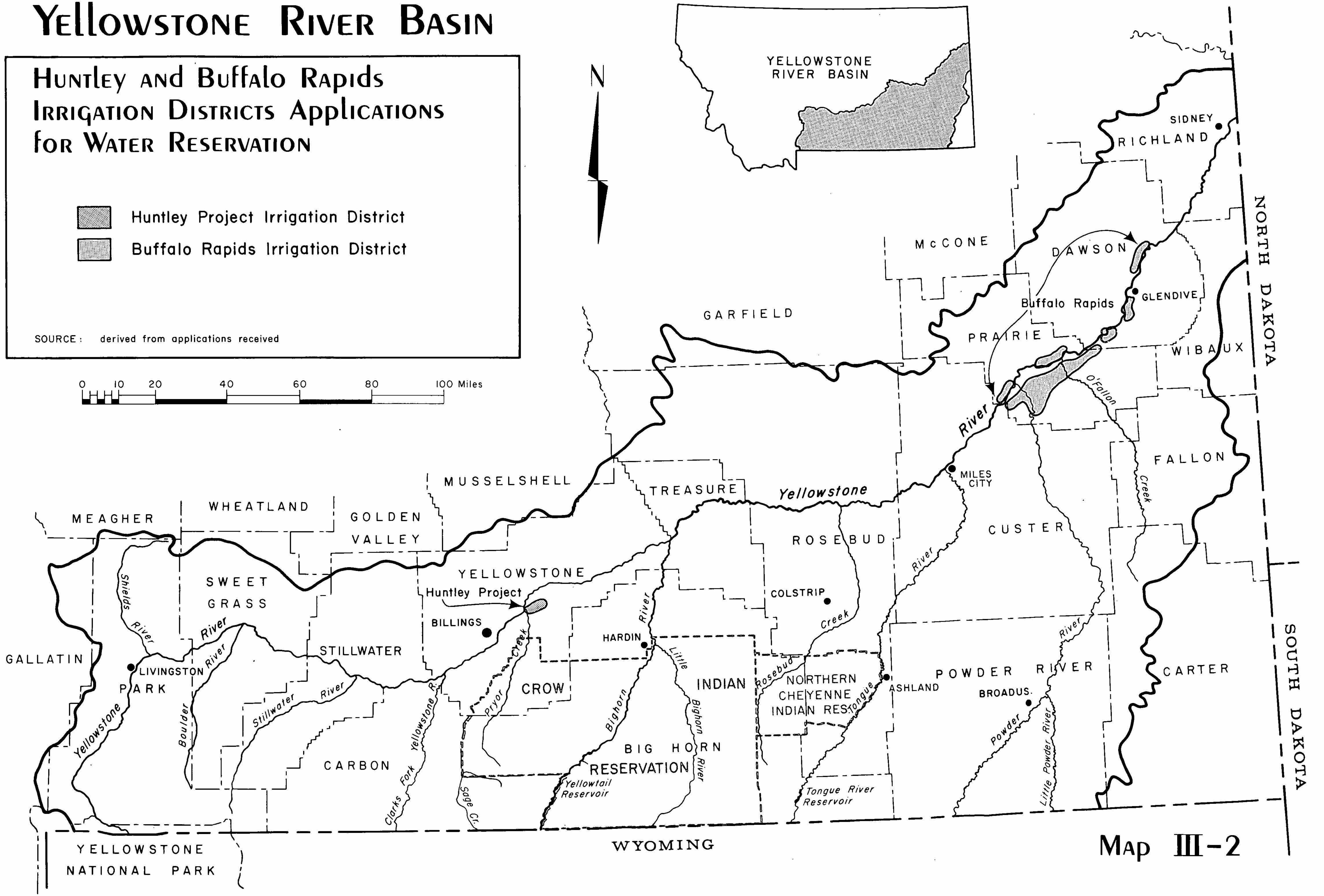


FIGURE III-3. Tongue River Subbasin Monthly Outflows for the North Custer Conservation District Application

Yellowstone River Basin



Map III-2

the 50,140 af/y which would be depleted by the low level of irrigation development of the Irrigation Emphasis Alternative of Part IV. For a discussion of the significant impacts of that level of irrigation development, see page 253.

IRRIGATION DISTRICTS

Irrigation districts are formed to cooperate with the United States under federal reclamation laws for the purpose of constructing irrigation projects. A district is a public corporation managed by a board of commissioners. Irrigation districts may acquire rights and interests in water and land and build dams and canals.

A district has the authority to tax lands within its boundaries in order to repay project costs; hence, this type of organization is considered a political subdivision of the state authorized to apply for the reservation of waters. Two irrigation districts have filed applications.

DESCRIPTION OF APPLICATIONS

The land proposed for future irrigation by each irrigation district is illustrated on Map III-2. The legal description of all lands may be obtained from DNRC.

Huntley Project Irrigation District

Huntley Project Irrigation District's application requests the reservation of up to 27,372.3 af/y from the Yellowstone River for irrigation of 4,000 acres. The lands proposed to be irrigated lie within the district's boundaries in Yellowstone County, within the Yellowstone and Anita units, and south of the Ballantine unit.

An apparent miscalculation in the application resulted in translating the peak water use rate of 92 cfs to seasonal water demand. The 27,372.3 af/y applied for amounts to almost seven acre-feet per acre, an exorbitant diversion rate for today's irrigation systems. For the impact analysis this request was scaled down to a more realistic diversion rate of three acre-feet per acre; the total diversion would thus be 12,000 af/y. Existing pumping facilities would be adequate; however, construction or enlargement of approximately 15 miles of canal would be required.

The 4,000 acres of feasibly irrigable lands identified in this application were also included in the application submitted by Yellowstone Conservation District. The latter application also included 1,725 acres (for a total of 5,725 acres, divided among flood (2,130 acres), sideroll (1,680), and center-pivot (1,915 acres) methods) within the boundaries of the Huntley Project Irrigation District.

According to the more detailed Yellowstone Conservation District application, the total diversion requirement for these 5,725 acres would be 14,576 af/y with a total depletion of 11,150 af/y.

Huntley Project Irrigation District's application was based on a U.S. Bureau of Reclamation study and indicates that development costs are $500 per acre. No comparison of benefits to costs was included; however, economic feasibility was indicated in the application on the Yellowstone Conservation District.

Buffalo Rapids Irrigation Project

Buffalo Rapids Irrigation Project's application requests the reservation of up to 124,434 af/y from the Yellowstone River for irrigation of 41,306 acres. The lands proposed to be irrigated lie in Prairie and Dawson counties both within and outside the project's boundaries, which begin 18 miles north and east of Miles City and extend to Glendive.

Not knowing whether the Dawson County or Prairie County conservation districts would apply for water reservations, Buffalo Rapids Irrigation Project included many lands a considerable distance beyond its boundaries to ensure that water would be reserved for future irrigation. Some of this land (24,771 acres) was subsequently included in conservation district water reservation applications, resulting in duplication in requests. However, the Buffalo Rapids Irrigation Project application is considered here as it was originally received.

The application largely involves areas studied by the U.S. Bureau of Reclamation, including the following units listed in the Yellowstone Division Report (U.S. Department of the Interior 1963).

Cracker Box	1,740 acres
Stipek	3,840 acres
Marsh	3,190 acres
Haley	2,372 acres
Colgate	760 acres
Saugus-Calypso	450 acres
	12,352 acres

In addition, the application requests water for bench lands, including:

Land behind Glendive Canal	8,500 acres
Terry Bench	17,354 acres
Terry Unit	1,300 acres
Fallon Unit	800 acres
	27,954 acres

The application also includes another 1,000 acres of land within the district's boundaries, bringing the total to 41,306 acres.

No additional storage is needed to supply these lands. However, extensive construction of the following would be required: river, relift, and lateral pumping plants; canals, laterals, and sublaterals; drains; and transmission lines and substations.

The cost data of the Bureau of Reclamation study upon which the Buffalo Rapids Irrigation Project's application is based indicate that the Colgate Unit and Terry Bench development are not economically feasible. In addition, the Saugus-Calypso Unit is not feasible as a Bureau project, but may be for private development. Although the economic feasibility of other units is not assessed in this application, it seems established for those parcels duplicated in the reservation requests of Prairie County and Dawson County Conservation Districts.

The limited cost information supplied is fourteen years old. The application asserts that additional lands will become economically feasible to irrigate with rising crop prices, changing federal standards for irrigation projects, and advancing irrigation technology.

ENVIRONMENTAL IMPACTS--IRRIGATION DISTRICT APPLICATIONS

Both applications request water only from the Yellowstone mainstem. Neither application by itself, if implemented, would result in enough depletion to significantly affect the river system. Impacts would be similar to those described above in "Generalized Impacts" under "Environmental Impacts--Conservation District Applications," with the exception that there would be no tributaries involved.

MONTANA DEPARTMENT OF STATE LANDS

The Department of State Lands, as one of 19 state agencies, is authorized by the Montana Water Use Act to apply for the reservation of waters.

The Congress of the United States, by the Enabling Act (25 Stat. 676) approved February 22, 1889, granted Sections 16 and 36 in every township within Montana for common school support. That and subsequent acts also granted acreage for other educational and state activities. Generally, the Department of State Lands, on approval of the State Land Board, manages the state-owned rangeland and cropland; the Department of Natural Resources and Conservation manages the state-owned forest land.

The Department of State Lands rules and regulations require that, before state funds are used in development or irrigation facilities, certain requirements must be met. In addition to adequacy of water supply and irrigable soils, economic feasibility must be demonstrated.

DESCRIPTION OF APPLICATIONS

The Department of State Lands has submitted three water reservation applications, described below, which request a total of 64,496 af/y for future irrigation of 27,789 acres. These lands are shown on Map III-3; their legal description may be obtained from DNRC.

Application No. 1

This application requested 21,429 af/y for flood or sprinkler irrigation of state-owned lands that are intermingled with private lands and that are integral parts of economic farm or ranch unit operations. Table III-17 shows the lands selected for state or lessee projects along each stream and the amount of water requested.

TABLE III-17

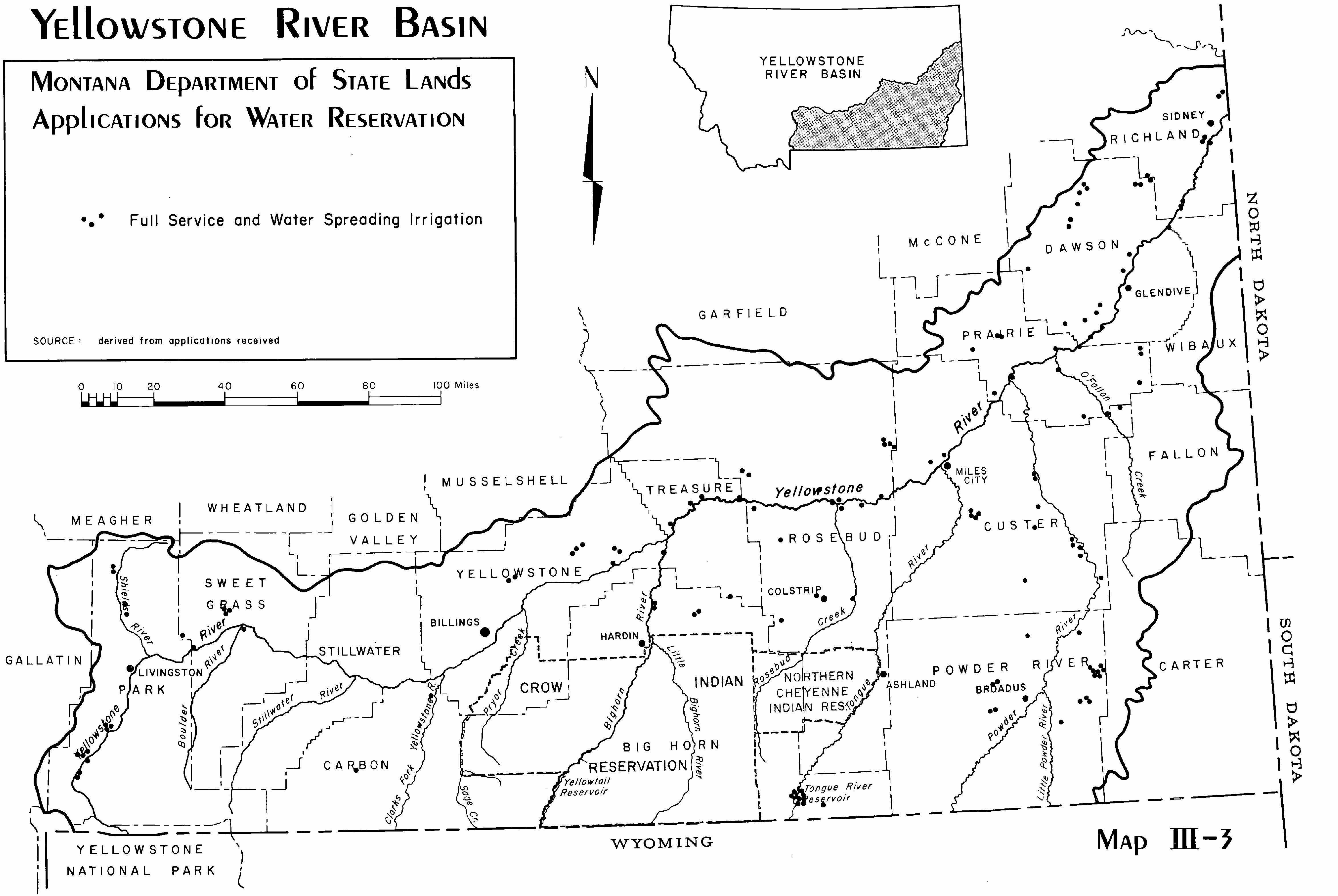
DEPARTMENT OF STATE LANDS APPLICATION NO. 1

Subbasin	Acres	Diversion, af/y
Upper Yellowstone	2,010	6,030
Clarks Fork Yellowstone	40	120
Billings Area	235	705
Bighorn	360	1,080
Mid-Yellowstone	1,870	5,610
Tongue	477	1,431
Kinsey Area	240	720
Powder	600	1,800
Lower Yellowstone	1,311	3,933
TOTAL	7,143	21,429

Farm budget analyses were used for estimating the Department of State Lands and the lessees' ability to pay costs for irrigating lands identified in this application. The annual per-acre payment capacity was compared to the annual per-acre cost for irrigation. With the exception of several potential projects, the application demonstrates the economic feasibility of irrigating lands in this category. In addition, at the reconnaissance level of evaluation, sufficient information has been provided to establish that the lands are potentially irrigable, although financial feasibility could change appreciably in future years due to changes in income and cost relationships.

Application No. 2

This application requested 15,078 af/y for waterspreading on 10,270 acres of state-owned lands that are intermingled with private lands and that could



Yellowstone River Basin
Montana Department of State Lands
Applications for Water Reservation
Full Service and Water Spreading Irrigation
SOURCE: derived from applications received
0 10 20 40 60 80 100 Miles
N
YELLOWSTONE RIVER BASIN
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
YELLOWSTONE NATIONAL PARK
SIDNEY
RICHLAND
McCONE
DAWSON
GLENDIVE
GARFIELD
PRAIRIE
WIBAUX
O'Fallon
FALLON
Creek
River
MILES CITY
MUSSELSHELL
TREASURE
Yellowstone
MEAGHER
WHEATLAND
GOLDEN VALLEY
ROSEBUD
CUSTER
YELLOWSTONE
SWEET GRASS
COLSTRIP
Creek
River
Shields
River
BILLINGS
HARDIN
River
GALLATIN
LIVINGSTON
PARK
Boulder
River
STILLWATER
Stillwater
River
Creek
Pryor
CROW
INDIAN
Little
Bighorn
River
Bighorn
Rosebud
NORTHERN CHEYENNE INDIAN RES.
Tongue
ASHLAND
POWDER RIVER
BROADUS
Powder
River
Little Powder River
CARTER
Yellowstone
CARBON
Clarks Fork
Yellowstone R.
Sage Cr.
BIG HORN RESERVATION
Yellowtail Reservoir
Tongue River Reservoir
Map III-3

be more fully developed by waterspreading and flood-irrigation practices. The maps accompanying the request showed that the majority of the lands are of soil class 2 and 3. Forty-five small tributaries sources were identified.

The application for these lands does not demonstrate financial or economic feasibility. Without cost and revenue estimates, no analysis is possible; however, the lands are considered marginal for irrigation in terms of soil classification and capability. Also, water-spreading and flood irrigation are totally dependent upon favorable climatic, precipitation, and runoff conditions that are highly variable from year to year.

Application No. 3

Application No. 3 requested 30,989 af/y to irrigate 10,376 acres of state lands which are intermingled with private lands and can only be developed as cooperative projects due to the large capital investment required. These lands are identified in Table III-18.

TABLE III-18

DEPARTMENT OF STATE LANDS, WATER RESERVATION REQUEST, APPLICATION NO. 3

Source	Acres	Diversion (af/y)
Yellowstone River	5,831	17,476
Sweet Grass Creek	1,908	6,100
Clarks Fork Yellowstone River	857	2,073
Bighorn River	140	386
Powder River	1,509	4,527
Tongue River	130	390
	10,374	30,898

These lands have been identified by, and are closely associated with, conservation district projects. However, the water reservation requests submitted by the districts excluded water to irrigate state lands within the boundaries of their projects (see Table III-19).

TABLE III-19

STATE LAND EXCLUDED FROM CONSERVATION DISTRICT
RESERVATION REQUESTS

Conservation District	State Land Excluded (Acres)
Park	1,290
Sweet Grass	2,250
Stillwater	113
Carbon	850
Yellowstone	1,950
Big Horn	670
Treasure	985
Rosebud	1,330
North Custer	1,240
Powder River	Unknown
Prairie County	532
Dawson County	1,932
Richland County	420
TOTAL	13,562

No figure is given in Table III-19 for Powder River Conservation District, since its application did not differentiate between the state and federal land (a total of 1,745 acres) excluded. However, even ignoring the state land in that county, it should be noted that more state land was excluded from conservation district applications (13,562 acres) than was included in this Department of State Lands application (10,374 acres).

ENVIRONMENTAL IMPACTS--DEPARTMENT OF STATE LANDS APPLICATIONS

The Department of State Lands reservation applications, if granted and implemented, would result in generalized impacts similar to those discussed for the conservation district applications. For the most part, the lands involved are in small, scattered parcels, so these impacts would be small.

Application No. 1 requests the following diversions from streams or sources for which no perceptible streamflow alteration or environmental impact would result:

Yellowstone mainstem (26 parcels): 14,388 af/y
Bighorn River (1 parcel): 1,080 af/y
Boulder River (1 parcel): 1,320 af/y

The remainder of the request involves proposed diversions from smaller tributaries: Powder River, Tongue River, Rock Creek (of the Shields River), Daisy Dean Creek, Shields River, Alkali Creek, Big Timber Creek, and Red Lodge Creek. The application makes no mention of storage; it was apparently assumed that, since each project is so small, an adequate water supply would be available. Some of these streams, however, experience low flows with sufficient frequency that a firm water supply may not always be available. Further (or more frequent) dewatering or construction of reservoirs would have serious adverse effects in these streams. As an alternative, the projects may accept less than a full-service water supply, as with waterspreading.

Application No. 2 requests 15,078 af/y for water spreading on small dispersed parcels of land intermingled with private lands. The impacts on the 45 tributaries specified for diversion could be major if the projects dewater these streams.

Application No. 3 involves lands associated with conservation district lands. The impacts resulting directly from the development of only these lands would be small; however, because these lands would be developed only in conjunction with associated conservation district lands, impacts resulting from implementation of this application could be considered as incremental increases to the more severe impacts resulting from implementation of the associated conservation district applications.

MUNICIPAL RESERVATION REQUESTS

DESCRIPTION OF APPLICATIONS

Applications for reservation of water for future municipal uses have been received from Livingston, Big Timber, Columbus, Laurel, Billings, Miles City, Glendive, and Broadus, as shown on Map III-4. Except for Billings, the amounts requested are small compared to the flow of the Yellowstone River, as shown in Table III-20. The Billings request totals 317,456 af/y with a peak demand of 1,190 cfs. No population projections were given in the application, but, assuming an average daily per-capita diversion of 200 gallons, Billings' approximate current rate, the requested quantity would serve a city of about 1,500,000, about twice the 1970 population of Montana.

ENVIRONMENTAL IMPACTS--MUNICIPAL APPLICATIONS

The increased populations predicted in these applications would have major impacts on the municipalities, but those impacts are beyond the scope of this impact statement. The environmental impacts of the depletions associated with all municipal applications, except that received from the City of Billings, would be minor, as shown in Table III-20.

The effects the withdrawals associated with implementation of the Billings application would have on flows of the Yellowstone River would depend on how much water is consumed and how much is returned, information not given in the application. During the high-flow months, May through July, flow reductions would probably be minor. Accordingly, the impact on the natural system would be small. During low-flow months, however, flows could be substantially reduced. For example, during January, the request is about 37% of the 90th-percentile low flow and 18% of the median flow. Presumably, less than half of the requested water would be consumed, making the flow reductions much less serious. However, much of the returned water is likely to be treated municipal and industrial wastewater. Unknown at this time is how well treated that water will be. Even if dependably treated by a secondary

TABLE III-20

MUNICIPAL WATER RESERVATION APPLICATIONS

Municipality	Proposed Development						Impacts		
	Amount Requested		Source of Water for Reservation	Present Population of Municipality	Projected Population[a]		Environmental	Economic	Percentage Requested of Average Annual Flow of Yellowstone[b]
	cfs	af/y			Population	Year			
Livingston	20.8	15,060	Yellowstone River	6,883[c]	35-40,000	2000	Negligible	Negligible	0.5
Big Timber	6.19	4,483	Yellowstone River	1,592[c]	3,000	2000	Negligible	Negligible	0.1
Columbus	3.6	2,606	Yellowstone River	1,173[c]	4,500	2007	Negligible	Negligible	0.05
Laurel	23.2	16,830	Yellowstone River	4,454[c]	35,000	2007	Negligible	Negligible	0.3
Billings	1190	317,456	Yellowstone River	63,729[d]	Not Given	-	See Text	See Text	See Text
Miles City	30	21,720	Yellowstone River	9,023[d]	20,000	1995	Negligible	Negligible	0.3
Glendive	17.62	12,756	Yellowstone River	6,305[c]	35-40,000	2007	Negligible	Negligible	0.2
Broadus	.84	605	Ground water	799[d]	4,000	1995	Negligible	Negligible	Not applicable

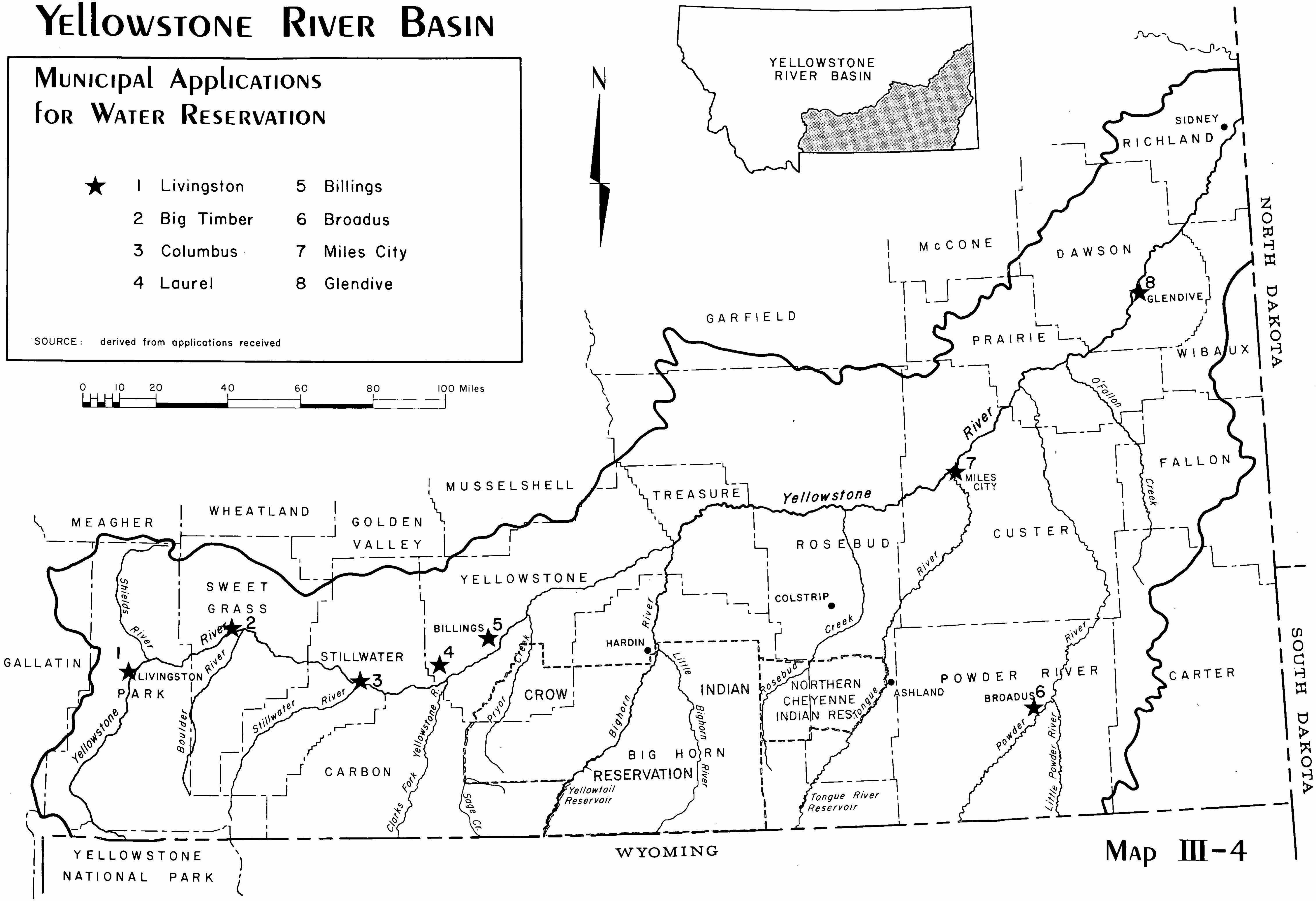
[a]Projections furnished by Applicant

[b]Percentages shown are of the average annual flow of the Yellowstone River mainstem as measured at the major gaging station nearest each municipality

[c]SOURCE: U.S. Department of Commerce 1971

[d]SOURCE: Montana DNRC 1976

Yellowstone River Basin



Map III-4

treatment plant, effluents of this magnitude would adversely affect the river, especially during low-flow periods. The improvements in the river's quality downstream from Billings in recent years could be lost.

The peak diversion of 1,190 cfs listed in the application is nearly three times the average requested diversion. The application did not specify the duration, frequency, or time of this diversion. If 1,190 cfs were diverted during low-flow times, the river would be drastically affected between the point of diversion and the areas of return flow.

Construction of the unspecified water-supply facilities are expected to have a negligible impact on income and employment in the Billings metropolitan area.

MULTIPURPOSE RESERVATION REQUESTS

DESCRIPTION OF APPLICATIONS

The Department of Natural Resources and Conservation (DNRC) has filed two applications for the reservation of water for future multipurpose storage projects: 450,000 af/y on the Tongue River and 1,150,000 af/y on the Powder River. Construction of the High Tongue Dam (with a firm annual yield of 112,000 af) on the Tongue River and Moorhead Dam (with a firm annual yield of 124,000 af, of which 75,000 would be available for use in Montana) would be required in order to provide those amounts of storage.

In effect, these applications request all unused and unappropriated water in these basins upstream from the dam sites. Without additional storage, significant new water development in these subbasins will not be possible.

The purpose of the request is to provide water for multipurpose projects. The reserved water would be for all beneficial uses. Specific uses are not stated because detailed engineering, economic, and environmental studies are necessary to determine the combination of uses that maximizes benefits from the water and minimizes adverse environmental impacts.

ENVIRONMENTAL IMPACTS--DNRC APPLICATIONS

The impacts of granting these applications would be similar to those of the No Action Alternative (pages 240 to 252) of Part IV for the Tongue and Powder subbasins, because industrial use would probably receive the largest allocation from these storage facilities in order to repay the cost of the facilities. It is unknown at this time what level of instream flows can be granted, if any, and still maintain the feasibility of the projects.

INSTREAM FLOW RESERVATION REQUESTS

Qualified applications may request instream flows "... to maintain a minimum flow, level, or quality of water." Fifteen such applicants have been received. In this section, the action proposed in each application is described and the resultant impacts assessed. The 13 instream flow requests from conservation districts are grouped to facilitate discussion.

CONSERVATION DISTRICTS

Each of the 13 conservation districts has applied for minimum flows to reasonably protect water levels at diversions of present irrigators. No specific flow was requested, however, except in the North Custer Conservation District application on the Yellowstone River, described below. The other conservation districts state the need to ensure a minimum flow for existing and future water uses and to protect existing water rights by avoiding the necessity of expensive reconstruction of pumping facilities, ditches, canals, or other facilities which could result from reduced flows. Each application states the need to examine existing diversions and their relationships with other users before quantifying the minimum flow.

Of course, the implications of maintaining minimum flows of an unsepcified amount are unknown. However, certain conclusions may be drawn from studies of a few existing gravity and pump diversions.

Major gravity diversions--for example, the T and Y diversion on the Tongue River and the Intake and Forsyth diversions on the Yellowstone River--have low dams which assure adequate water levels for the proper functioning of headgates for all flows considered, including those which would result from high levels of development. For headgates that have no diversion dams, the ability to divert water would presumably be restricted at extremely low flows. Unfortunately, no information is available on the number and location of these diversions or the minimum flows needed to protect them.

For pump diversions, it is assumed that water availability would not be a problem as long as water is flowing in the channel since pump suction intakes are usually located at or below the stream bottom. However, reduced flows and associated water levels would reduce pump efficiencies, increasing the cost of water pumped. In general, however, these pumping costs will remain low despite any future reductions in flow.

The North Custer Conservation District applied for a minimum flow of 4000 cfs during irrigation months (April-October) to ensure a sufficient water level at Kinsey Irrigation Company pumping plants. Figure III-4 illustrates the water available for development assuming this minimum flow is granted. One

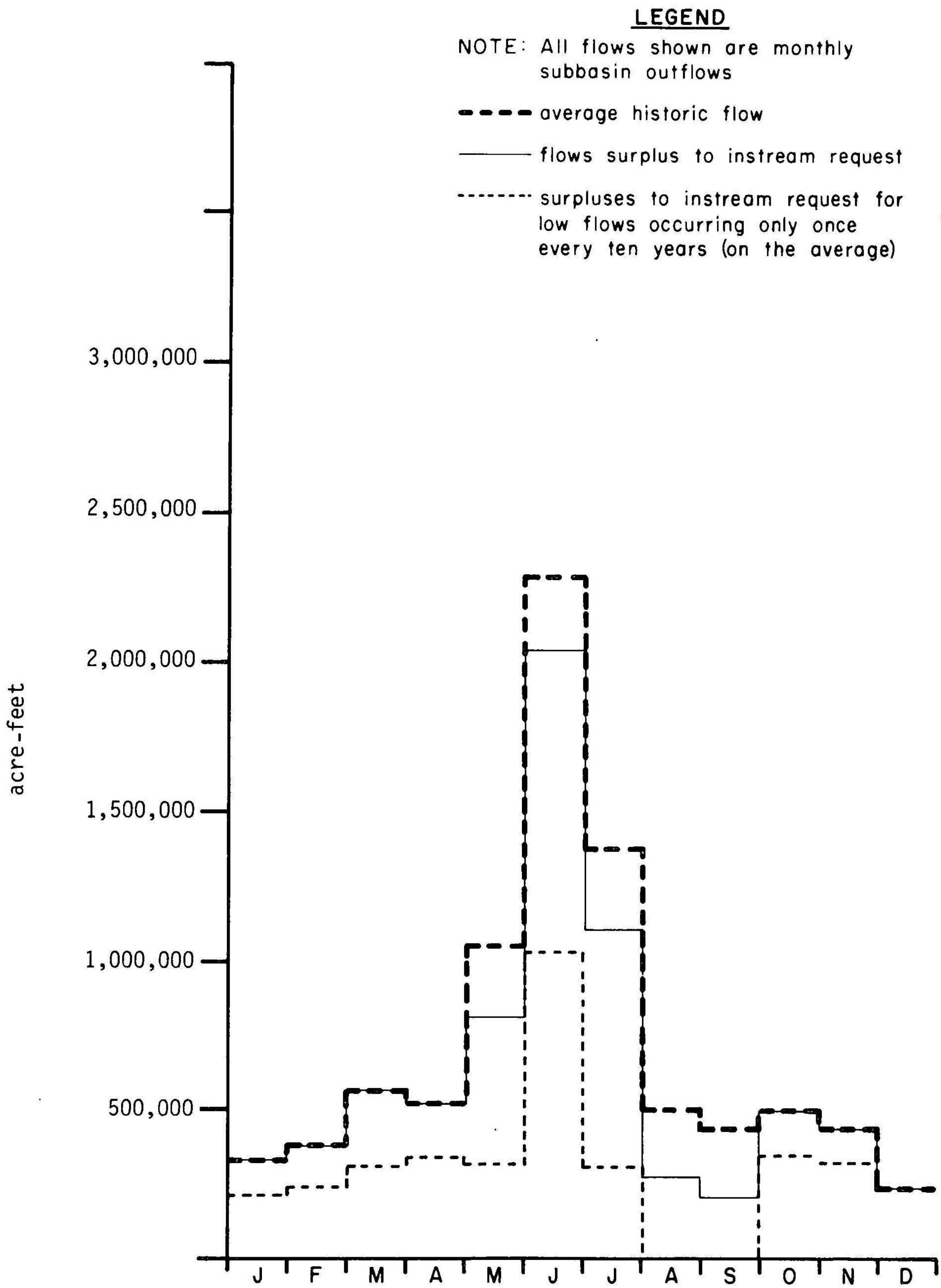


FIGURE III-4. Kinsey Area Subbasin Monthly Surpluses to the North Custer Conservation District Minimum Flow Application year in ten, on the average, there would be an inadequate water supply in August and September for any new full-service irrigation without storage.

MONTANA FISH AND GAME COMMISSION

DESCRIPTION OF APPLICATION

In 1969, Section 89-801 (R.C.M. 1947) was amended to allow the Department of Fish and Game to appropriate the unappropriated waters on twelve designated streams in quantities necessary to maintain streamflow for preservation of fish and wildlife habitat. The department subsequently filed for varying amounts of water in the Yellowstone River from Gardiner to the north-south Carbon-Stillwater county line (including the reach of river classified "Blue Ribbon"). The quantity filed for at that county line was 2600 cfs (154,700 af/month) from April 16 to October 31 and 1500 cfs (89,250 af/month) from November 1 to April 15 (for a total flow of 1,520,132 af/y).

The 1973 Montana Water Use Act named fish and wildlife as a beneficial water use. Water reservations are the only means for establishing an instream water right for that use, since there is no provision in the law for the perfection of a water right other than by diversion.

Early in 1974 the Montana Fish and Game Commission applied for a water reservation on the Yellowstone River that totaled 7.1 mmaf/y at Sidney. In that application the Commission indicated the request was tentative and would be modified after more information was gathered. Since that time the Department of Fish and Game has conducted extensive biological studies throughout the Yellowstone Basin and, as a result, has amended the original water reservation application. The amendment requests water in the Yellowstone River from Gardiner to the Montana-North Dakota state line as well as in many of its tributaries, as shown on Map III-5.

For descriptive purposes the request has been disaggregated into the nine planning subbasins shown in Figure I-1.

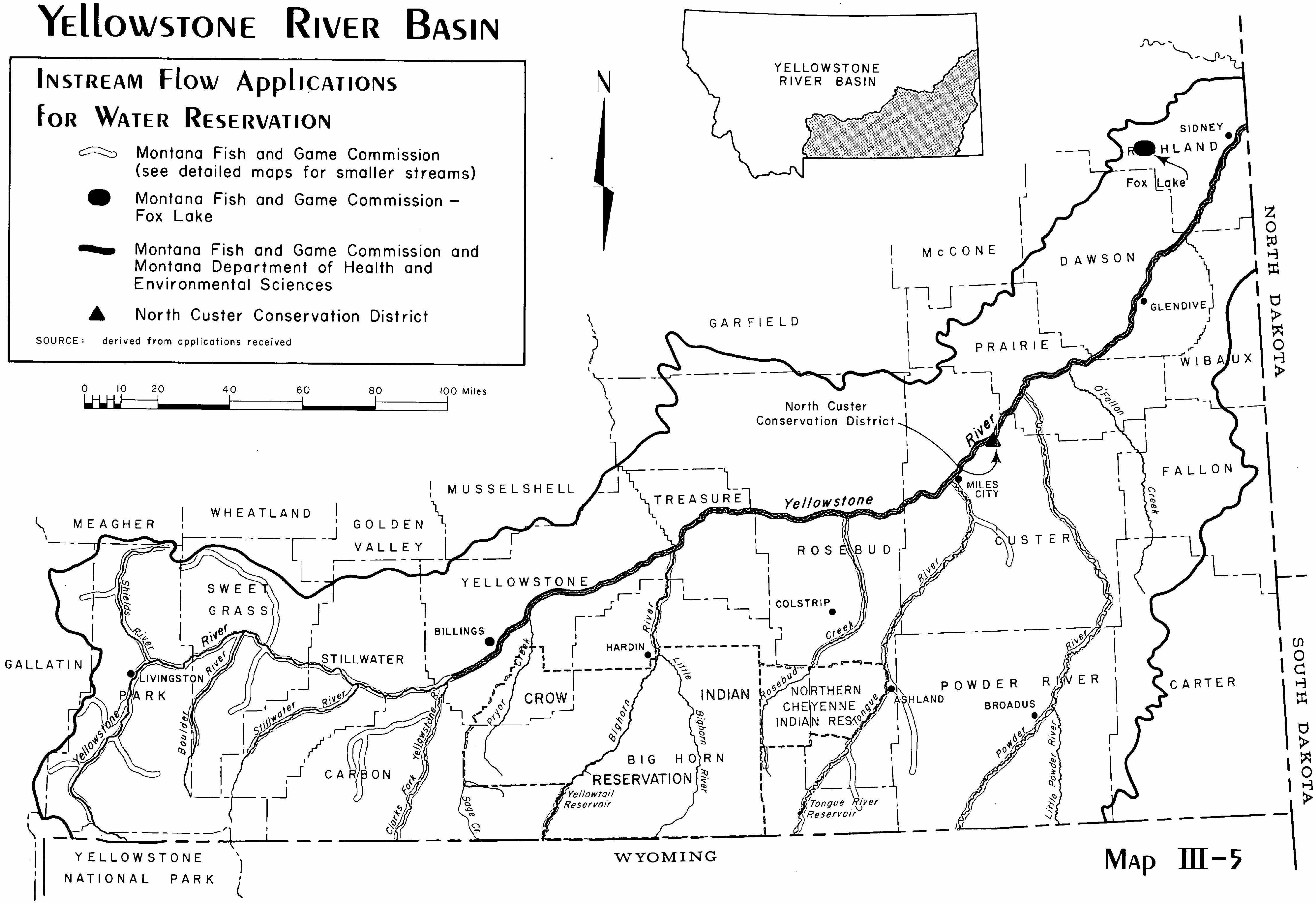
UPPER YELLOWSTONE SUBBASIN

The Fish and Game Commission reservation request for the Upper Yellowstone Subbasin includes many small streams in addition to the Yellowstone River. The locations of the many streams involved are shown on Maps III-5a to III-5c. These streams are separated into the three categories listed below:

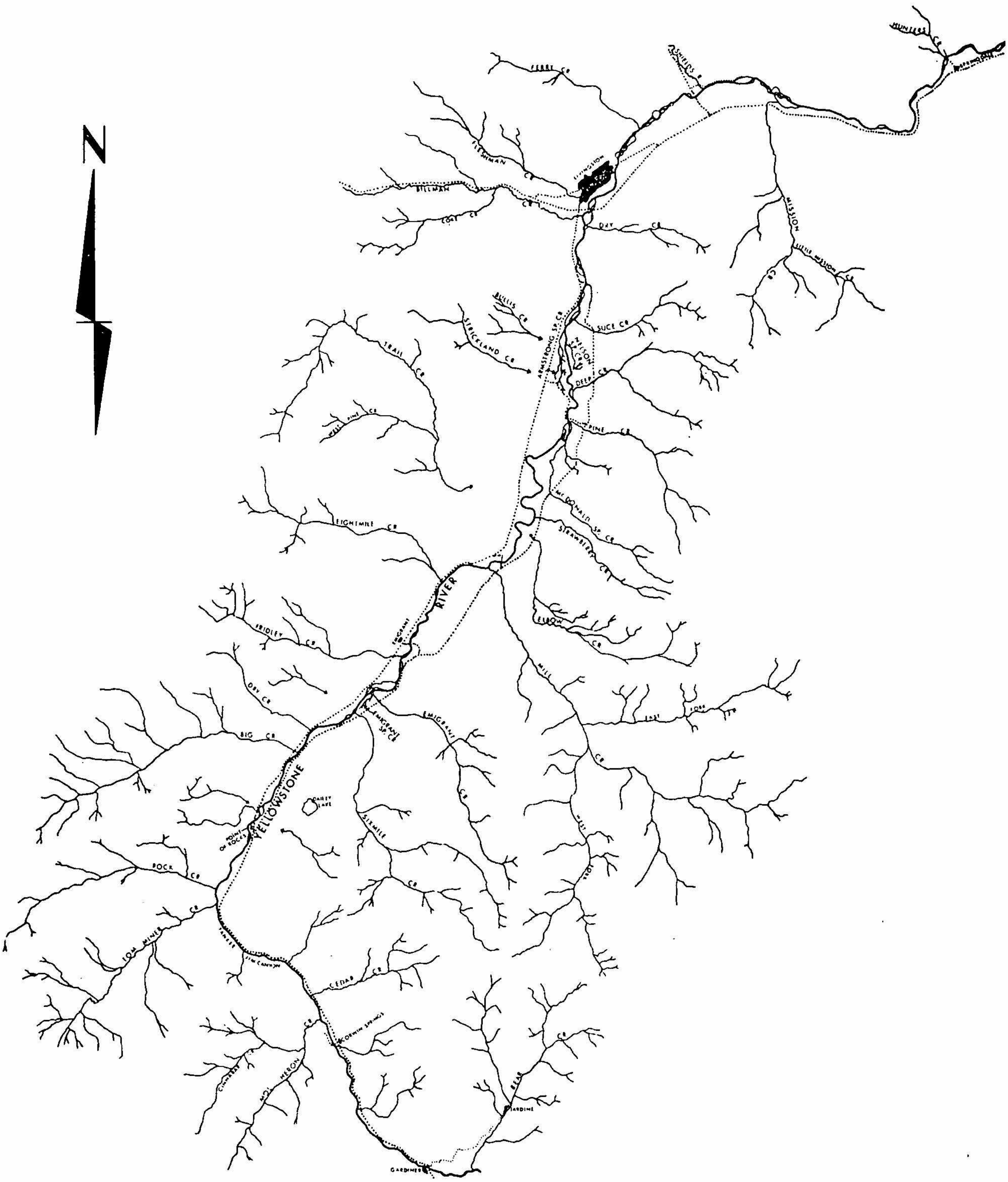
1) Streams for which specific amounts were requested for each month or for certain portions of the year;

2) Smaller streams for which flow quantities were not specified; rather, the instantaneous flows (all streamflows subject to existing water rights) were requested for certain portions of the year; and

3) Spring creeks for which the instantaneous flow was requested for the entire year.


YELLOWSTONE RIVER BASIN
INSTREAM FLOW APPLICATIONS FOR WATER RESERVATION
Montana Fish and Game Commission (see detailed maps for smaller streams)
Montana Fish and Game Commission – Fox Lake
Montana Fish and Game Commission and Montana Department of Health and Environmental Sciences
North Custer Conservation District
SOURCE: derived from applications received
0 10 20 40 60 80 100 Miles
N
YELLOWSTONE RIVER BASIN
SIDNEY
RICHLAND
Fox Lake
McCONE
DAWSON
GLENDIVE
GARFIELD
PRAIRIE
WIBAUX
NORTH DAKOTA
North Custer Conservation District
River
MILES CITY
FALLON
O'Fallon
Creek
MUSSELSHELL
TREASURE
Yellowstone
MEAGHER
WHEATLAND
GOLDEN VALLEY
ROSEBUD
CUSTER
SWEET GRASS
YELLOWSTONE
COLSTRIP
Shields River
River
BILLINGS
Creek
GALLATIN
STILLWATER
HARDIN
River
LIVINGSTON
Boulder River
PARK
Little
Rosebud
NORTHERN CHEYENNE INDIAN RES.
ASHLAND
POWDER RIVER
CARTER
SOUTH DAKOTA
CROW
INDIAN
Pryor Creek
Yellowstone
Stillwater River
Bighorn
Bighorn River
Tongue
River
BROADUS
CARBON
Yellowstone R.
Clarks Fork
BIG HORN RESERVATION
Yellowtail Reservoir
Sage Cr.
Tongue River Reservoir
Powder
Little Powder River
River
YELLOWSTONE NATIONAL PARK
WYOMING

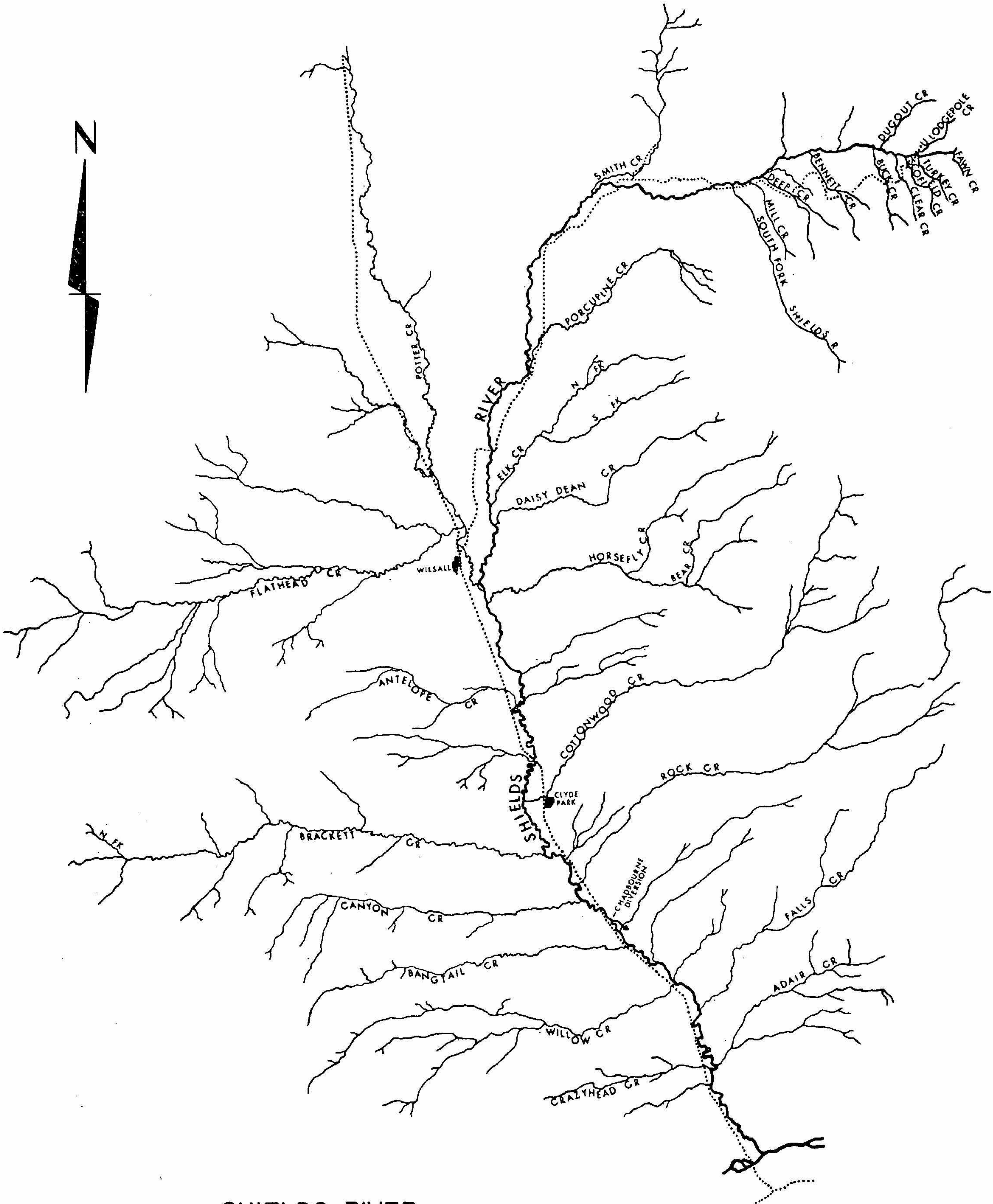
Map III-5



SOURCE: Montana Department of Fish and Game

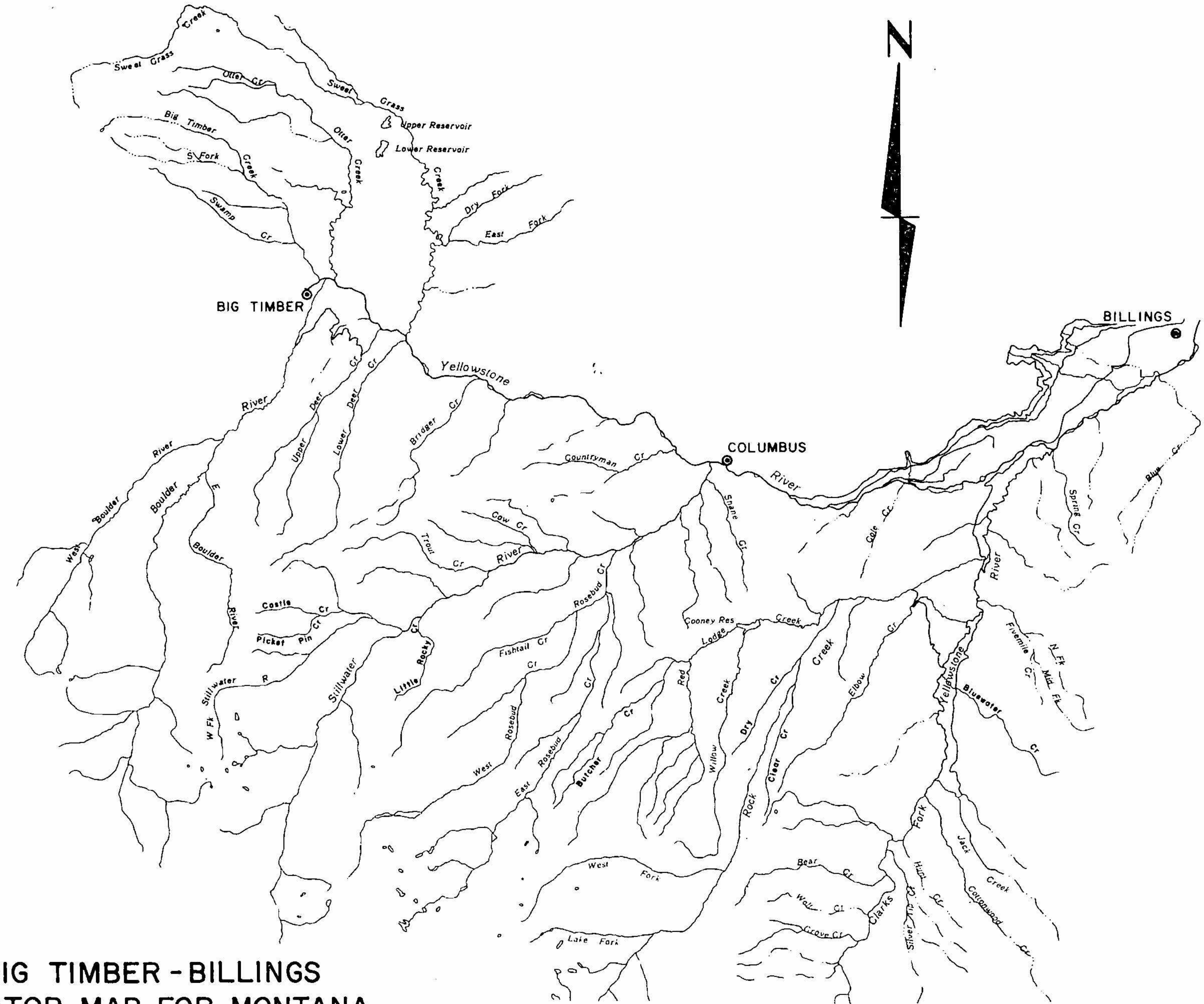
UPPER YELLOWSTONE RIVER
LOCATOR MAP FOR MONTANA FISH AND GAME COMMISSION
APPLICATIONS FOR WATER RESERVATION

MAP III-5a



SHIELDS RIVER
LOCATOR MAP FOR MONTANA
FISH AND GAME COMMISSION
APPLICATIONS FOR WATER RESERVATION
MAP III-5b

SOURCE: Montana Department of Fish and Game



BIG TIMBER - BILLINGS LOCATOR MAP FOR MONTANA FISH AND GAME COMMISSION APPLICATIONS FOR WATER RESERVATION

MAP III-5c

SOURCE: USGS 1965,1969

Streams With Specific Quantities Requested

Tables III-21 and III-22 show the streams for which specific amounts were requested for each month or for certain portions of the year. For those streams for which specific monthly flows were requested, only the total annual request is shown. In each case, even though the application may have specified several reaches on the same stream, only the quantities requested for the most downstream reach are shown here.

TABLE III-21

UPPER YELLOWSTONE SUBBASIN STREAMS WITH SPECIFIC FLOW REQUESTS: FISH AND GAME COMMISSION APPLICATION

River and Reach	Flow Requested			Peak Flow Requested
Yellowstone River Gardiner to Tom Miner Creek	Jan. 1-May 10 (Instantaneous flow)	May 11-Aug.10 (956,826 af)	Aug. 11-Dec.31 (Instantaneous flow)	15,000 cfs for 24-hour period during May 11-Aug.10
Tom Miner Creek to Big Creek	Jan. 1-May 10 (Instantaneous flow)	May 11-Aug. 10 (744,396 af)	Aug.11-Dec.31 (Instantaneous flow)	15,000 cfs for 24-hour period May 11-Aug. 10
Big Creek to Shields River	Jan. 1-May 10 (Instantaneous flow)	May 11-Aug. 10 (898,908 af)	Aug.11-Dec.31 (Instantaneous flow)	18,200 cfs for 24-hour period during May 11-Aug.10
Shields River to Boulder River	Jan.1-May 10 (Instantaneous flow)	May 11-Aug.10 (907,240 af)	Aug.11-Dec.31 (Instantaneous flow)	18,200 cfs for 24-hour period during May 11-Aug 10
Boulder River to Stillwater River	1,308,847 afy which includes a 23,587 cfs flow for one day			
Stillwater River to north-south Carbon-Stillwater County line	1,608,567 afy which includes a 29,486 cfs flow for one day			
North-South Carbon-Stillwater county line to Clarks Fork Yellow-stone River	3,176,498 afy which includes a 29,486 cfs flow for one day			
Shields River at mouth	Jan.1-Mar.31 (Instantaneous flow)	Apr.1-July 20 (39,811 af)	July 21-Dec.31 (Instantaneous flow)	744 cfs for 24-hour period during Apr.1-July 31
Brackett Creek at mouth	Jan. 1-Apr. 15 (Instantaneous flow)	Apr. 16-July 10 (9,446 af)	July 11-Dec.31 (Instantaneous flow)	151 cfs for 24-hour period during Apr.16-July 10

TABLE III-22

UPPER YELLOWSTONE SUBBASIN STREAMS WITH VARIABLE MONTHLY FLOW REQUESTS: FISH AND GAME COMMISSION APPLICATION

Stream	Total Annual Request, af
Big Timber Creek	28,701
West Boulder River	74,096
East Boulder River	23,157
Boulder River	217,990
Upper Deer Creek	5,614
Lower Deer Creek	5,615
Sweet Grass Creek	36,644
Bridger Creek	3,268
Picket Pin Creek	5,546
Castle Creek	16,526
West Fork Stillwater River	57,530
Little Rocky Creek	3,380
West Fishtail Creek	4,586
East Fishtail Creek	3,740
Fishtail Creek	8,563
West Rosebud Creek	61,537
East Rosebud Creek	55,809
Stillwater River	438,827

Streams With No Specific Quantities Requested

Listed in the Fish and Game Commission reservation request are a number of small streams for which no specific quantity is requested. The application requests the instantaneous flows at certain times of the year and a dominant discharge (the flood flow recurring about every other year, on the average) for a 24-hour period during a portion of the year.

For Yellowstone mainstem tributaries, the instantaneous flow is requested from January 1 to May 10 and from August 11 to December 31. During the remainder of the year (May 11 to August 10), the only water requested is the dominant discharge for a single, unspecified 24-hour period; the dominant discharge is not quantified in the application. These streams are:

Bear Creek	Eightmile Creek
Mol Heron Creek	Mill Creek
Cinnabar Creek	Trail Creek
Cedar Creek	Suce Creek
Tom Miner Creek	Coke Creek
Rock Creek	Billman Creek
Big Creek	Fleshman Creek
Sixmile Creek	Little Mission Creek
Fridley Creek	Mission Creek

In Shields River tributaries, shown on Map III-5b, the request is for the instantaneous streamflow from January 1 to March 31 and July 21 to December 31. During the remainder of the year (April 1 to July 20) the only water requested is the dominant discharge, not quantified in the application, for a single, unspecified 24-hour period. These streams are:

Smith Creek
Flathead Creek
Cottonwood Creek
Rock Creek

Spring Creeks

The third category of streams includes the spring creeks, Emigrant, McDonald, Nelson, and Armstrong, for which all flows (subject to existing rights) are requested year round.

CLARKS FORK YELLOWSTONE BASIN

Each stream included in the application for this subbasin (shown on Map III-5c) has a specific flow specified. Table III-23 shows the annual total, even though in the application monthly flows are requested. Each stream is listed only once even though, in the application, more than one reach of the stream may have been applied for.

TABLE III-23

CLARKS FORK YELLOWSTONE SUBBASIN STREAMS

Stream	Total Annual Flow Request,af
Clarks Fork Yellowstone River	504,020
Clear Creek	13,874
Dry Creek	1,448
Willow Creek	27,562
Red Lodge Creek	35,175
Butcher Creek	14,540
Rock Creek	67,677
Bluewater Creek	14,479

BILLINGS AREA SUBBASIN

The Yellowstone River is the only stream the Fish and Game Commission applied for in the Billings Area Subbasin. That request totaled 4,110,343 af/y, which includes a peak flow of 34,500 cfs for a 24-hour period between May 1 and July 31.

BIGHORN SUBBASIN

For the Bighorn River, variable flows totaling 2,484,187 af/y were requested.

For Sage Creek, which flows southward into the Shoshone River in Wyoming (tributary to the Bighorn River), 10,866 af/y were requested.

MID-YELLOWSTONE AND KINSEY AREA SUBBASINS

Requests for this subbasin include the following streams:

Yellowstone River	7,876,889 af/y, which includes a 24-hour flow of 47,000 cfs
Rosebud Creek	11,450 af/y

TONGUE SUBBASIN

The Fish and Game Commission request in this subbasin included the Tongue River and Hanging Woman, Otter, and Pumpkin creeks. Requested annual quantities are listed below:

Tongue River	243,090 af/y
Hanging Woman Creek	1,880 af/y
Otter Creek	1,940 af/y
Pumpkin Creek	7,270 af/y

POWDER SUBBASIN

The application asks for 198,350 af/y for the Powder River at its mouth.

LOWER YELLOWSTONE SUBBASIN

The request for the Yellowstone River is 8,206,723 af/y, which includes a 52,000 cfs flow for one 24-hour period.

ENVIRONMENTAL IMPACTS--FISH AND GAME COMMISSION APPLICATION

GENERALIZED IMPACTS

The specific purpose of the Fish and Game Commission application is to prevent future adverse environmental impacts by preserving instream flows for fish and wildlife habitat. In doing so, public recreation would be enhanced and water quality would tend to be maintained.

The application attempts, where adequate information is available, to be sensitive to the instream flow needs for:

1) maintenance of fish spawning and rearing areas;
2) shelter for fish;
3) food sources for fish;
4) maintenance of riparian wildlife habitats; and
5) preservation of existing channel form including islands, bars, and backwater areas.

Primary Impacts

Streamflow Alterations

The purpose of this application is to prevent excessive streamflow alterations. However, there would be, in some streams, surplus waters available for diversion and consumption. These situations are discussed below, by subbasin, under Secondary Impacts.

Channel Form

This application, if granted, would tend to preserve the existing channel form in the streams for which water was requested. In some streams, all the unused and unappropriated waters were requested. In others a 24-hour dominant discharge was requested. In others yet, the application included monthly flows during the peak runoff which would perform the work necessary to maintain the channel in its current dynamic form.

In most of the streams applied for, onstream reservoirs, which have the largest potential for causing channel changes, would be precluded by the granting of this request.

Water Quality

Granting of this application would tend to maintain water quality at its present level by preserving flows for the assimilation and dilution of wastes and by limiting agricultural and industrial development which could pollute the streams. However, in many cases, surplus waters are available for development. Water quality degradation could result.

Ecosystems

The intent of this reservation request is to maintain the status quo of the periphyton, macroinvertebrates, fish, migratory waterfowl, and riparian wildlife and vegetation of the Yellowstone Basin. Note, however, that the status quo includes occasional ecosystem degradation due to the dewatering of tributary streams which is intensified by the current level of irrigation development. Granting of this application would have no effect on existing uses of water.

Secondary Impacts

Granting the Fish and Game Commission application would tend to make water unavailable to potential consumptive users.

Agricultural Water Use

Granting the Fish and Game Commission reservation request would have beneficial effects for existing irrigators and adverse effects on potential future irrigators.

Existing irrigators would benefit from the maintenance of water quality and the maintenance of water levels at existing diversions. No attempt is made here to quantify these benefits.

The costs (adverse effects) to agriculture would be the farmers' profits foregone as a result of the inability to put the water to economic use. These costs are difficult to quantify because of the inability to accurately predict how much irrigation would be developed if the instream reservations were not granted. In an attempt to estimate the upper limit of these costs, a linear programming (LP) model, which simulates streamflows and consumptive uses, was developed. With constraints on the availability of water and irrigable lands, the model calculates the hypothetical combination of land and water resources which would yield the maximum profits, defined as the difference between crop revenues and operation costs.

For several crops in seven of the Yellowstone's subbasins, agricultural returns associated with several levels of instream flow requirements were estimated. Total subbasin irrigation profits decrease as less and less water is available for irrigation. This decrease in profits is the upper limit of the cost to future irrigators from the corresponding change in the amounts of instream flows. By varying the instream flow requirements from zero to 100% of the Fish and Game Commission request, the cost of each incremental addition to instream flows was estimated.

The potential costs to future irrigators vary with the amount of water in the streams. In years and months of high streamflows there may be enough water to satisfy both the instream requirements and the agricultural demands. During these times, the costs of instream flows to irrigators would be zero. However, in low-flow times, water may be present in quantities insufficient to satisfy both instream users and agriculture. The potential losses to irrigators could be large in this situation.

Irrigated agriculture appears to be expanding in the Yellowstone Basin. If that expansion would continue over time, the costs of instream flow reservations would increase over time. The costs would be zero at present since the instream reservation would not affect existing users. These costs would increase in time proportionate to the amount of irrigation which would have been developed in each year had the instream reservation not been granted.

Potential future costs to irrigators were estimated by the LP model for the year 2000. An annual increase in irrigated acreage of 6,500 was assumed. It was also assumed that future irrigators would divert and deplete 3.0 and 2.0 acre-feet/acre, respectively. The potential increase in irrigated acreage over 1975 levels would be 162,500 acres; the cost to potential irrigators if that amount of irrigation were precluded by granting this application would be $45 per acre, or $15 per acre-foot of water that would have been diverted to irrigate that acreage, for a total annual cost of $7,312,500.

The costs estimated by this analysis would be borne by the irrigators precluded from development. If these costs were incurred, secondary costs about twice that size would be suffered by the consumer and service sectors where the irrigation profits would have been spent.

It must be emphasized that this analysis is not a prediction of the future costs of granting the Fish and Game Commission request. It is an estimate of the future costs that would be borne by irrigators if the instream reservation was the single factor which would constrain irrigation expansion. Obviously there are other factors which may act as constraints for such expansion. Among them are:

1) Water quality degradation resulting from irrigation and other developments;

2) Inadequacy of processing facilities for sugar beets and other cash crops;

3) Market advantages of producers in other regions or countries;

4) National farm policies; and

5) Farmer preferences for dry-land cropping and livestock grazing.

Municipal and Domestic Water Use

This reservation request, if granted, would benefit municipalities and domestic users of surface waters by tending to maintain water quality near its present level.

Industrial Water Use

Future industrial water users would benefit from the maintenance of water quality which the granting of this application would tend to provide. However, they would also suffer water shortages, since the reservation would tend to make water less available for development. Where surplus waters would be available, storage of flood flows would be required in order to provide a firm year-round supply. Where surplus waters would not be available, development of alternative water sources would be required. If it became necessary for a new user to develop ground water or import water via aqueduct because the reservation restricted access to surface waters, the additional water development costs would be the costs to industry of the reservation. These costs are difficult to estimate because it is not known what industrial development would occur in the absence of the instream reservation. The costs of developing alternative water supplies could be estimated if the location of the development were known.

Recreation and Aesthetics

Granting the instream reservation request, thereby maintaining the existing fish and wildlife habitats, would tend to maintain the status quo with respect to recreation and aesthetics. This status quo may be considered to be a benefit in the future, assuming that further industrial and agricultural development would occur in the absence of the reservation and assuming such development would degrade the recreation potential and aesthetic quality of the basin.

The values of recreation and aesthetics are very real and very large, but at this time methods have not been developed for quantifying them in terms of dollars. Therefore, these values cannot be quantifiably compared with other economic values.

IMPACTS BY SUBBASIN--FISH AND GAME COMMISSION RESERVATION REQUEST

Some of the secondary impacts which would result if the Fish and Game Commission application were granted are unique to particular subbasins.

Upper Yellowstone Subbasin

This section considers the effect that granting the Fish and Game Commission request would have on the availability of water to irrigators in the Upper Yellowstone Subbasin. The three categories of streams specified in the application will be considered.

Streams with Specified Quantities Requested

This reservation, if granted, could virtually eliminate any new full-service irrigation from the Yellowstone mainstem. Irrigation could expand only if new irrigators would be willing to accept water shortages in the late fall in all years and most of the season in a few years.

Although the amount requested varies from Gardiner to the Clarks Fork Yellowstone River, the effect of the application would be the same. At Livingston the request is for all streamflow (subject to existing rights) after August 11, which precludes new irrigation after that time even though about 25 percent of the crop water needs occur after that time. Farther downstream, the request is for the 70th-percentile low flow; at this level, water would only be available for development seven years out of ten, on the average. Figure III-5 illustrates the months in which surplus water is left for development on the Upper Yellowstone mainstem.

For efficient, full-service irrigation systems, a good water supply is usually considered to be necessary about eight years out of ten, on the average. Many irrigators in Montana, however, continue to operate with a less reliable water supply, and other systems are not economical unless a more reliable water supply is provided.

Many of the tributary streams in the Upper Yellowstone subbasin for which the Fish and Game Commission has requested reservations also possess undeveloped irrigable lands. Table III-24 lists these streams and shows the lands which might be irrigated under favorable economic conditions if a water supply is available. Where detailed information is not available for the smaller tributaries, these streams are listed without acreage or depletion figures. Where figures are shown, the lands in the smaller tributaries of that watershed are included.

TABLE III-24

UNDEVELOPED IRRIGABLE LANDS IN UPPER YELLOWSTONE SUBBASIN TRIBUTARIES

Watershed	Irrigable Acres	Estimated Potential Depletion (af/y)
Shields River, including: Brackett Creek	50,387	100,774
Big Timber Creek	4,640	9,280
Boulder River, including: West Boulder River East Boulder River	8,054	16,108
Upper Deer Creek	50	100
Lower Deer Creek	690	1,380
Sweet Grass Creek	22,529	45,058
Bridger Creek	970	1,940
Stillwater River, including: Castle Creek Little Rocky Creek Fishtail Creek West Rosebud Creek East Rosebud Creek	11,863	23,726

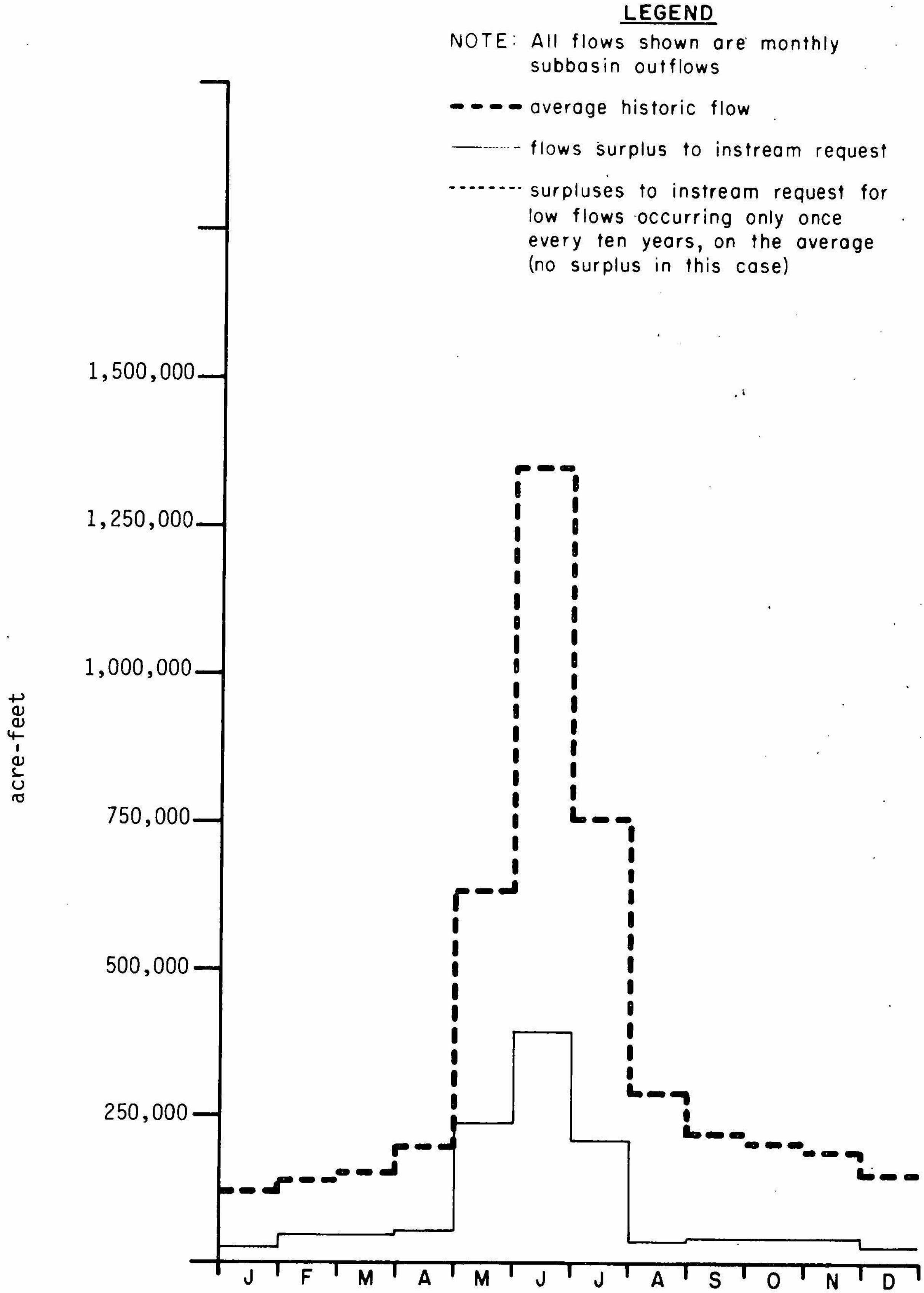


FIGURE III-5. Upper Yellowstone River Subbasin Monthly Surpluses to the Montana Fish and Game Commission Application

Table III-25 compares the Fish and Game Commission request with the 80th-percentile low flows for the streams shown in Table III-24. This comparison reveals that, in general, a sufficient water supply over and above the instream request is not available for full-service irrigation.

Streams With No Specific Quantities Requested

For several streams, no quantified flow of water was specified. Most of these are Yellowstone mainstem tributaries for which the application requested the instantaneous flow from August 11 to May 9 and a 24-hour dominant discharge sometime between May 11 and August 10:

Bear Creek	Eightmile Creek
Mol Heron Creek	Mill Creek
Cinnabar Creek	Trail Creek
Cedar Creek	Suce Creek
Tom Miner Creek	Coke Creek
Rock Creek	Billman Creek
Big Creek	Fleshman Creek
Sixmile Creek	Mission Creek
Fridley Creek	Little Mission Creek

Irrigation of alfalfa and hay has been and will probably continue to be the only significant water use along these streams. If implemented, this request would make water unavailable for additional irrigation from August 11 through the end of the growing season, during which time the crop water requirement is about 25% of the annual total. The spring dominant discharge request would be little problem to new irrigators since it would be for only a 24-hour period.

Most of the streams in this area appear to be fully developed for irrigation. That is, without additional water storage, few of these streams could support much new irrigation. New storage could probably carry spring floods over to satisfy both irrigation demands and the instream flow requests, but would probably be too expensive for irrigators. Passing the 24-hour dominant discharge through a dam would be a major problem for onstream reservoirs.

For four Shields River tributaries, Smith, Flathead, Cottonwood, and Rock creeks, the application requests the instantaneous flow from July 21 to March 31, and dominant discharge for 24 hours between April 1 and July 20. This request is similar to the one made for the Yellowstone tributaries, except that the application requests instantaneous flows beginning three weeks earlier. Granting this request would make even less water available to irrigators. Without storage, however, little new irrigation will be developed, with or without the instream reservation. It is doubtful that irrigators could afford to build dams, especially ones which could pass a 24-hour dominant discharge.

Spring Creeks. The Fish and Game Commission request for the four spring creeks (Emigrant, McDonald, Nelson, and Armstrong) is for all natural flow subject to existing rights. Obviously, implementation of this request would preclude any new consumptive uses in those streams. A cursory examination, however, shows that little irrigable land is undeveloped near those streams, and any undeveloped lands could be served from the Yellowstone River.

TABLE III-25

FISH AND GAME COMMISSION RESERVATION REQUESTS AND 80th PERCENTILE LOW FLOWS FOR UPPER YELLOWSTONE SUBBASIN TRIBUTARIES

Stream	May	June	Month July	Aug.	Sept.	Oct.
Shields River						
80%tile	16,360	11,543	2,520	800	420	1,710
F & G	15,685	14,955	1,590	July 11--Instantaneous flow		
Brackett Creek						
80%tile	3,200	2,560	800	370	300	370
F & G	4,420	3,335	655	July 11-- Instantaneous flow		
Big Timber Creek						
80%tile	7,995	16,660	10,455	3,690	2,200	2,090
F & G	5,226	10,710	4,622	655	1,190	920
West Boulder River						
80%tile	10,455	27,370	15,375	3,075	2,800	3,015
F & G	8,530	17,850	16,265	4,610	4,465	4,615
East Boulder River						
80%tile	2,890	6,545	4,490	615	595	985
F & G	1,230	9,820	3,075	1,355	1,190	1,110
Boulder River						
80%tile	48,955	132,270	51,122	7,257	7,500	8,730
F & G	18,630	100,560	34,740	11,375	11,603	12,360
Upper Deer Creek						
80%tile	5,535	13,685	8,160	1,355	1,250	1,720
F & G	745	1,490	490	490	300	310
Lower Deer Creek						
80%tile	4,740	11,010	7,260	1,050	1,010	1,480
F & G	745	1,490	490	490	300	310
Sweet Grass Creek						
80%tile	14,145	8,330	2,090	740	2,680	6,765
F & G	3,770	11,900	5,275	3,690	2,380	2,460
Bridger Creek						
80%tile	6,150	15,470	15,375	1,540	1,430	1,910
F & G	445	895	245	245	180	185
Stillwater River						
80%tile	67,650	238,000	95,940	33,210	27,965	14,760
F & G	34,435	123,470	91,000	45,500	37,490	27,055
Castle Creek						
80%tile	7,075	17,255	10,455	1,785	1,665	2,090
F & G	1,540	3,570	1,845	1,355	1,305	1,230
Little Rocky Creek						
80%tile	1,230	2,380	1,845	185	180	490
F & G	370	475	370	245	240	245
Fishtail Creek						
80%tile	3,690	8,330	5,840	800	775	1,230
F & G	860	1,430	860	615	595	615
West Rosebud Creek						
80%tile	12,300	32,130	17,835	3,570	3,275	3,385
F & G	4,820	1,160	15,990	11,990	1,140	4,000
East Rosebud Creek						
80%tile	10,455	27,965	15,685	3,075	2,856	2,950
F & G	3,074	1,190	12,300	9,225	4,760	3,700

Clarks Fork Yellowstone Subbasin

If implemented, this application would make water unavailable for use in new full-service irrigation. Some irrigation expansion would probably occur, but with only a partial water supply.

See the discussion preceding Tables III-24 and III-25 for the Upper Yellowstone Subbasin. Tables III-26 and III-27, below, are similar tables for Clarks Fork Yellowstone Subbasin streams. Table III-26 shows estimated irrigable acres; Table III-27 shows the Fish and Game Commission requests and the historic 80th-percentile low flows for the same streams. Figure III-6 shows, on a monthly hydrograph, the surplus flows which might be developed if the instream request were granted.

TABLE III-26

UNDEVELOPED IRRIGABLE LANDS IN CLARKS FORK YELLOWSTONE SUBBASIN TRIBUTARIES

Watershed	Estimated Irrigable Acres	Estimated Depletion (af/y)
Rock Creek, including:	19,378	38,756
Butcher Creek		
Red Lodge Creek		
Willow Creek		
Dry Creek		
Clear Creek		
Clarks Fork Yellowstone, including:	31,600	63,200
Bluewater Creek		

It may be seen in Table III-27 that, except for Rock Creek, little water is available in the Clarks Fork Yellowstone Subbasin for new full-service irrigation. The apparent surplus of water in Rock Creek is misleading. These data apply to the upper watershed; extensive irrigation development depletes much of this surplus in the lower watershed at the present time.

Billings Area Subbasin

Secondary Impacts

If the Fish and Game Commission application is granted, the Yellowstone mainstem near Billings would have no surplus flows for development, without storage, one year in ten. Even in an average year, no surplus would be available during the months of March, April, June, and December.

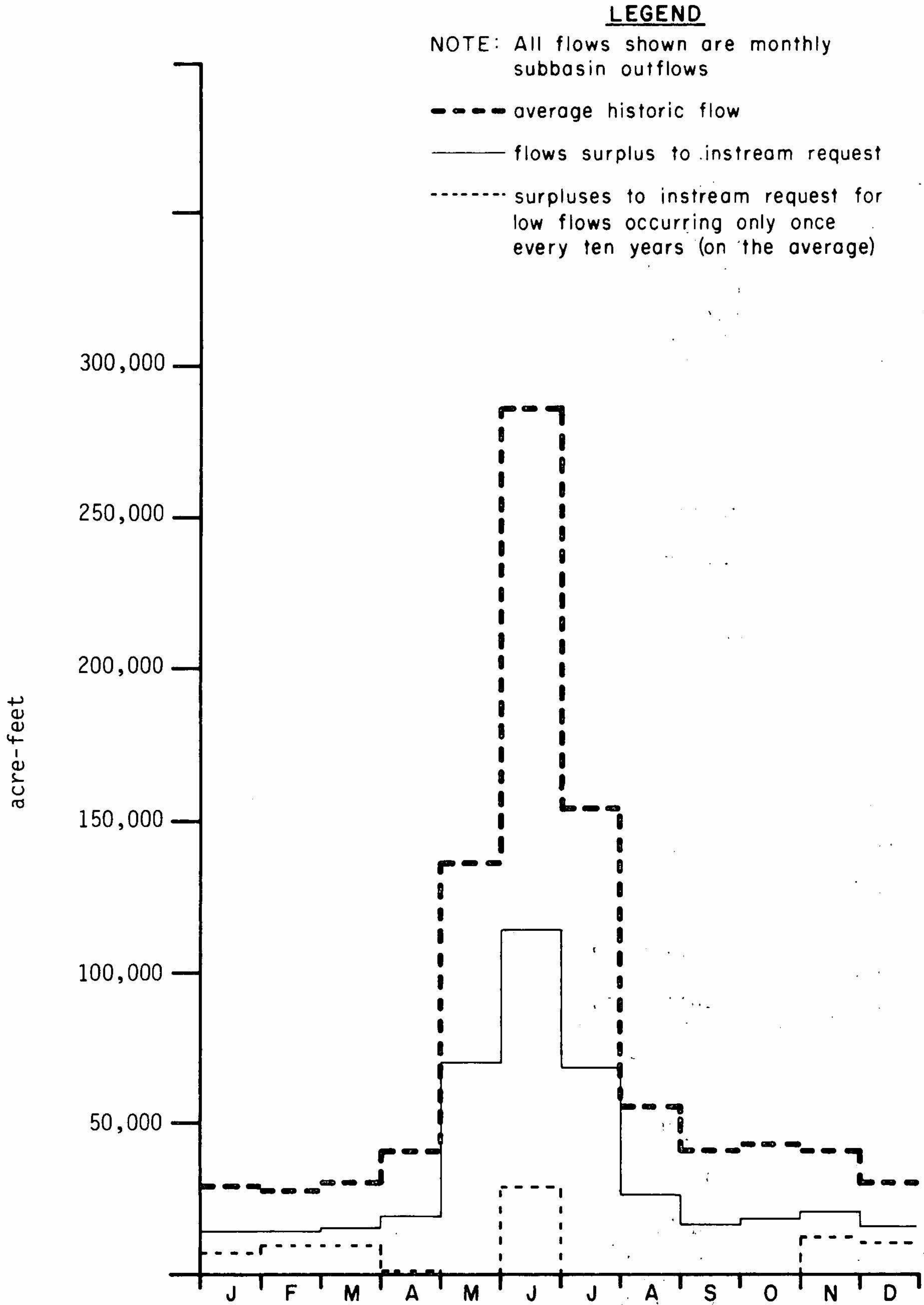


FIGURE III-6. Clarks Fork Yellowstone River Monthly Surpluses to the Montana Fish and Game Commission Application

TABLE III-27

FISH AND GAME COMMISSION RESERVATION REQUESTS AND 80th PERCENTILE LOW FLOWS FOR CLARKS FORK YELLOWSTONE SUBBASIN TRIBUTARIES

Stream	May	June	July	Aug.	Sept.	Oct.
Rock Creek						
80%tile	39,975	12,495	55,350	15,990	14,280	9,225
F & G	4,000	22,315	19,060	5,840	2,975	2,460
Butcher Creek						
80%tile	3,200	7,140	4,920	680	655	1,110
F & G	1,540	2,380	2,460	2,460	895	920
Red Lodge Creek						
80%tile	11,685	32,130	17,835	3,570	3,215	3,200
F & G	2,895	5,950	4,066	1,540	2,975	3,075
Willow Creek						
80%tile	5,045	11,900	7,690	1,670	1,070	1,600
F & G	2,085	2,975	3,075	1,845	1,785	1,845
Dry Creek						
80%tile	1,600	3,320	2,520	310	300	615
F & G	120	120	125	125	120	125
Clear Creek						
80%tile	1,230	2,380	1,845	185	180	490
F & G	1,250	1,785	1,625	1,230	1,190	1,230
Bluewater Creek						
80%tile	4,740	11,305	7,380	1,110	1,010	1,540
F & G	1,230	1,190	1,230	1,230	1,190	1,230

Bighorn River Subbasin

Secondary Impacts

The flow request for the Bighorn River was based on the outflow necessary to maintain the requested instream flows in the Yellowstone mainstem. The application was based on data from 1968 through 1975, the post-regulation water years with better than average flows.

The Bighorn River is regulated by three reservoirs, of which Yellowtail Reservoir is the largest. Assuming that the operation program in effect for Yellowtail Reservoir were continued, no new development for irrigation uses would be possible if these instream flows were reserved. Different operation patterns could make a slight amount of water usable to potential irrigators, but probably none could be made available for industrial uses, since they require a relatively constant, year-round flow.

Crucial to an examination of water allocation in the Bighorn River is the Yellowstone Compact. Of the unused and unappropriated waters of that river, Wyoming is allotted 80% under compact provisions. While it is doubtful that Wyoming will ever consume its share of Bighorn water, it is clear that Montana should not reserve waters to which Wyoming is entitled.

The claim of the Crow Indian Tribe to waters of the Bighorn is legally certain, although at present unquantified.

The federal government has filed for direct flow and storage rights for the purpose of operating Yellowtail Reservoir. Federal filings, Indian claims, and existing rights far exceed the available water, so it is unlikely that adjudication of these claims will leave much water for this reservation request.

Mid-Yellowstone Subbasin

Secondary Impacts

The quantity requested for the Yellowstone River in this reach is 7.88 mmaf/y; the average annual flow at the end of that reach of 8.1 mmaf/y.

Even though water appears to be available over and above the requested amount, monthly and yearly flow variations would create water-supply problems for both new industrial and new irrigation users.

A mass-curve analysis was completed to investigate the ability of off-stream storage sites to firm up waters surplus to this request. Assuming an active offstream capacity of 878,000 acre-feet (approximately the combined capacities of the proposed Buffalo Creek, Cedar Ridge, and Sunday Creek off-stream sites), about 450,000 af/y might be made available on a firm basis utilizing flows surplus to the Fish and Game Commission request. The costs of this water would prohibit its use by irrigators, but probably not for the energy industry. The three sites mentioned here would probably be able to supply all water necessary for even a high level of energy development.

The request on Rosebud Creek is, for every month except March and June, significantly greater than the 80th-percentile flows, indicating that new irrigation development could be constrained along that creek. There are about 33,300 acres of irrigable land adjacent to Rosebud Creek, demonstrating the irrigation potential there. Natural flows of Rosebud Creek are extremely variable from month to month and from year to year, making irrigation, even without an instream reservation, a partial-supply operation. Even now, virtually all irrigation along the creek is partial irrigation because of the low flows in late summer and fall.

Tongue Subbasin

Secondary Impacts

The Fish and Game Commission request on the Tongue River is for 243,090 af/y; the average annual flow is 304,000 af/y. Because of large yearly and monthly flow variations, however, there is little water over and above the instream request in the months of July, August, and September. In low flow periods that occur only one year in ten (on the average), there is no surplus water in any month. Figure III-7 shows the monthly flows remaining for development, assuming the instream request were approved. Storage could provide year-round water supply even if this request were implemented, but while industrial users could probably afford the necessary reservoir, irrigators probably could not. Wyoming's share must be considered in reserving and allocating Tongue River water, as must federal and Indian water claims.

The application also included instream flows on Otter, Pumpkin, and Hanging Woman creeks. Because of the extreme variability of monthly and yearly flows in these plains streams, little surplus flows would be left for development if the instream request was granted.

Powder Subbasin

Secondary Impacts

For the Powder River, 198,350 af/y is requested by the Fish and Game Commission; the average annual flow is 416,000 af/y. Because of the extreme variability of monthly and yearly flows in the Powder River, no water would be available over and above the reservation in low flow periods that occur one year in ten, on the average. Wyoming could deplete a sizeable portion of the Powder River under provisions of the Yellowstone Compact; therefore, even a water storage facility might make only a small amount of water available for consumptive users; certainly not enough could be developed to make construction of the dam economically feasible. Figure III-8 shows the effect of this request on the surplus waters of the Powder River.

Kinsey Area and Lower Yellowstone Subbasins

Secondary Impacts

The Fish and Game Commission requested 8.2 mmaf/y in the Yellowstone River at Sidney. The average annual flow at that point is 8.8 mmaf/y. The difference, about 600,000 af/y, would not be readily available for irrigation or industrial use because of the unavailability of water during monthly and yearly low-flow periods. To operate economically, industrial users must be guaranteed a relatively constant supply of water; cash-crop irrigators normally require enough water eight years in ten, on the average.

Figure III-9 shows the average monthly flows as they now exist at Kinsey and the flows that would be available for development if the instream reservation were granted. No flow would be available for development during low flows that occur about one year in ten. This is also true two years in ten. Therefore the water supply is too unreliable for either cash-crop irrigation or industrial use. However, water storage facilities could carry water over for use during drier months and years. It is doubtful that irrigators could pay for those facilities.

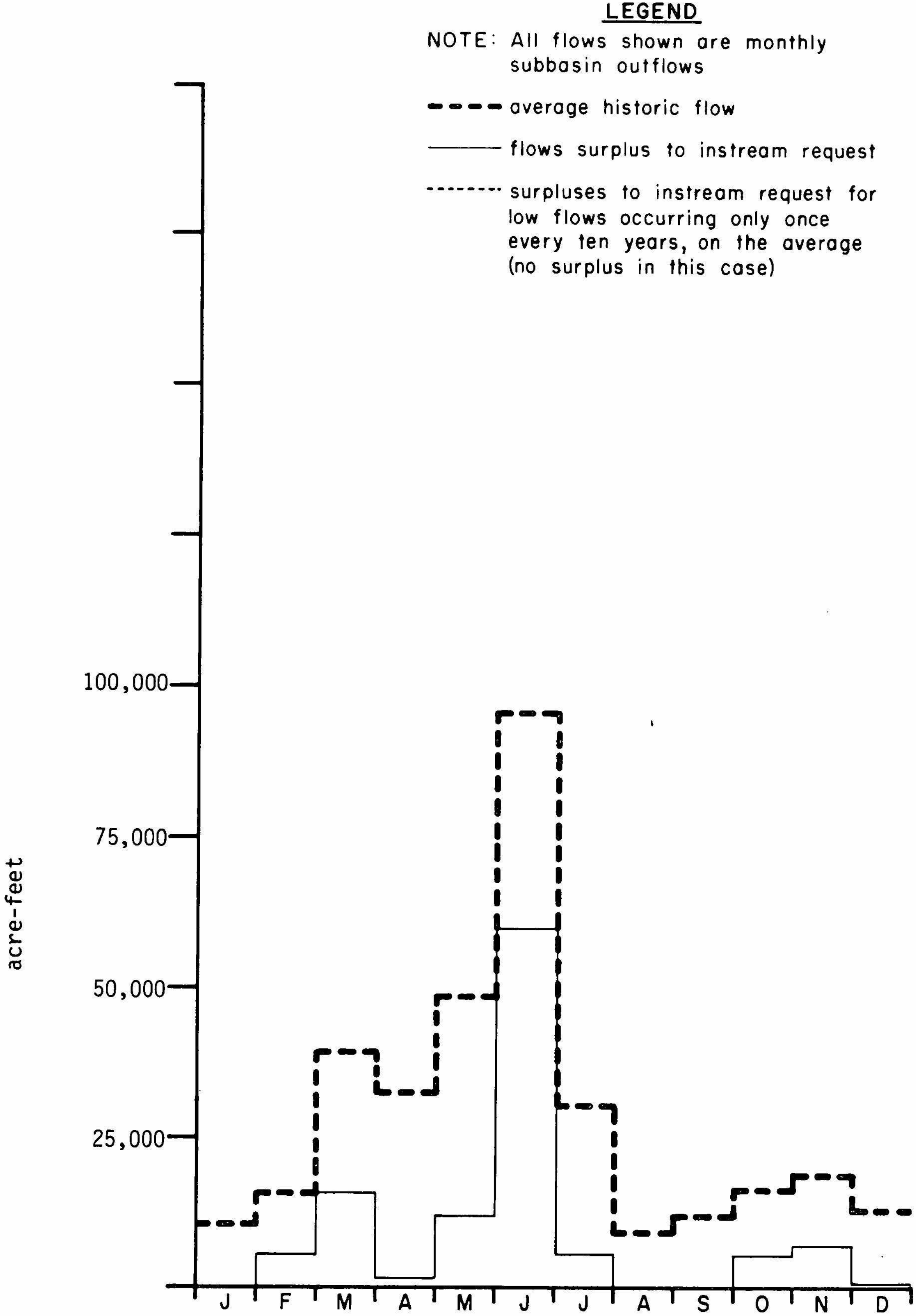


FIGURE III-7. Tongue River Subbasin Monthly Surpluses to the Montana Fish and Game Commission Application

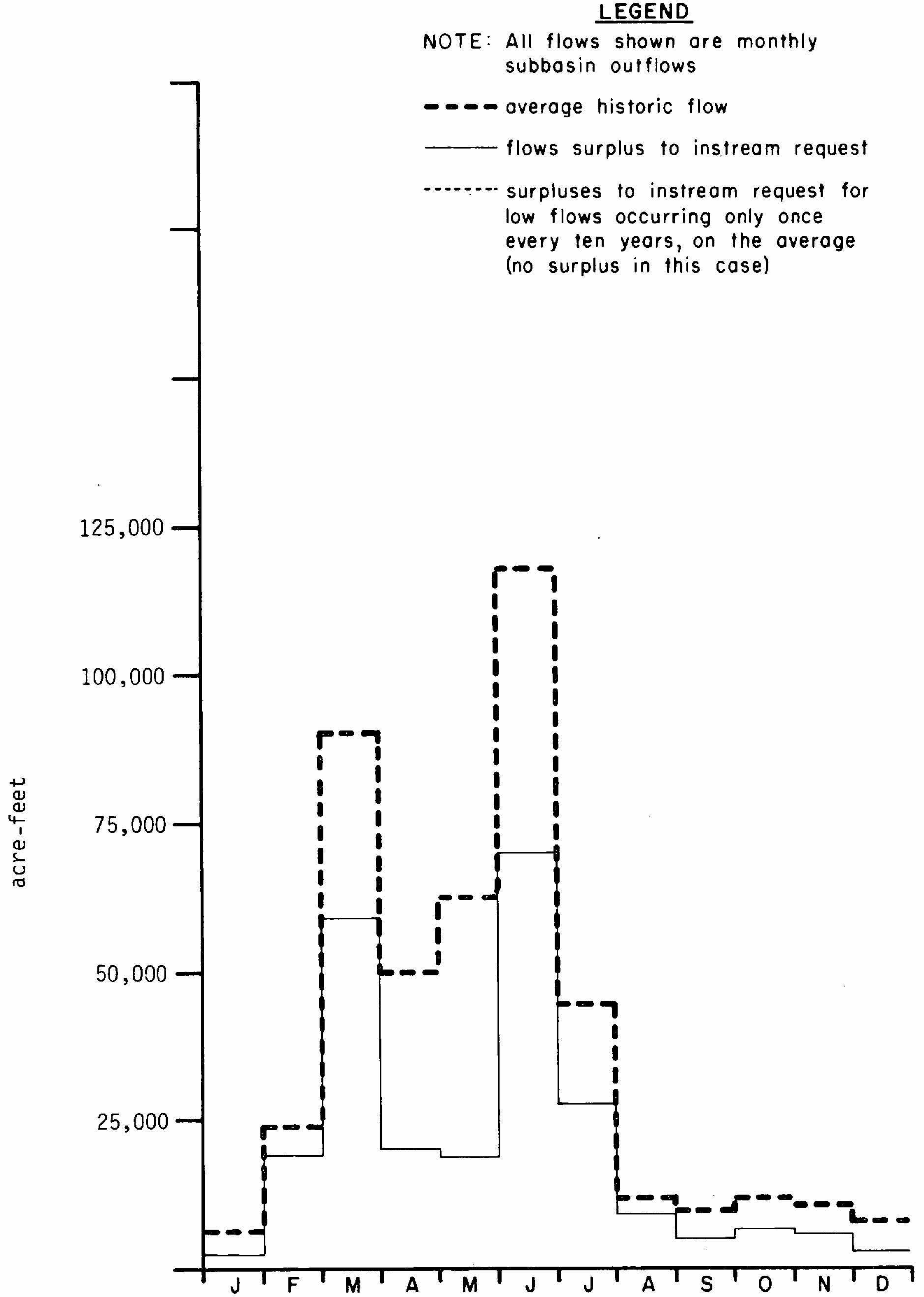


FIGURE III-8. Powder River Subbasin Monthly Surpluses to the Montana Fish and Game Commission Application

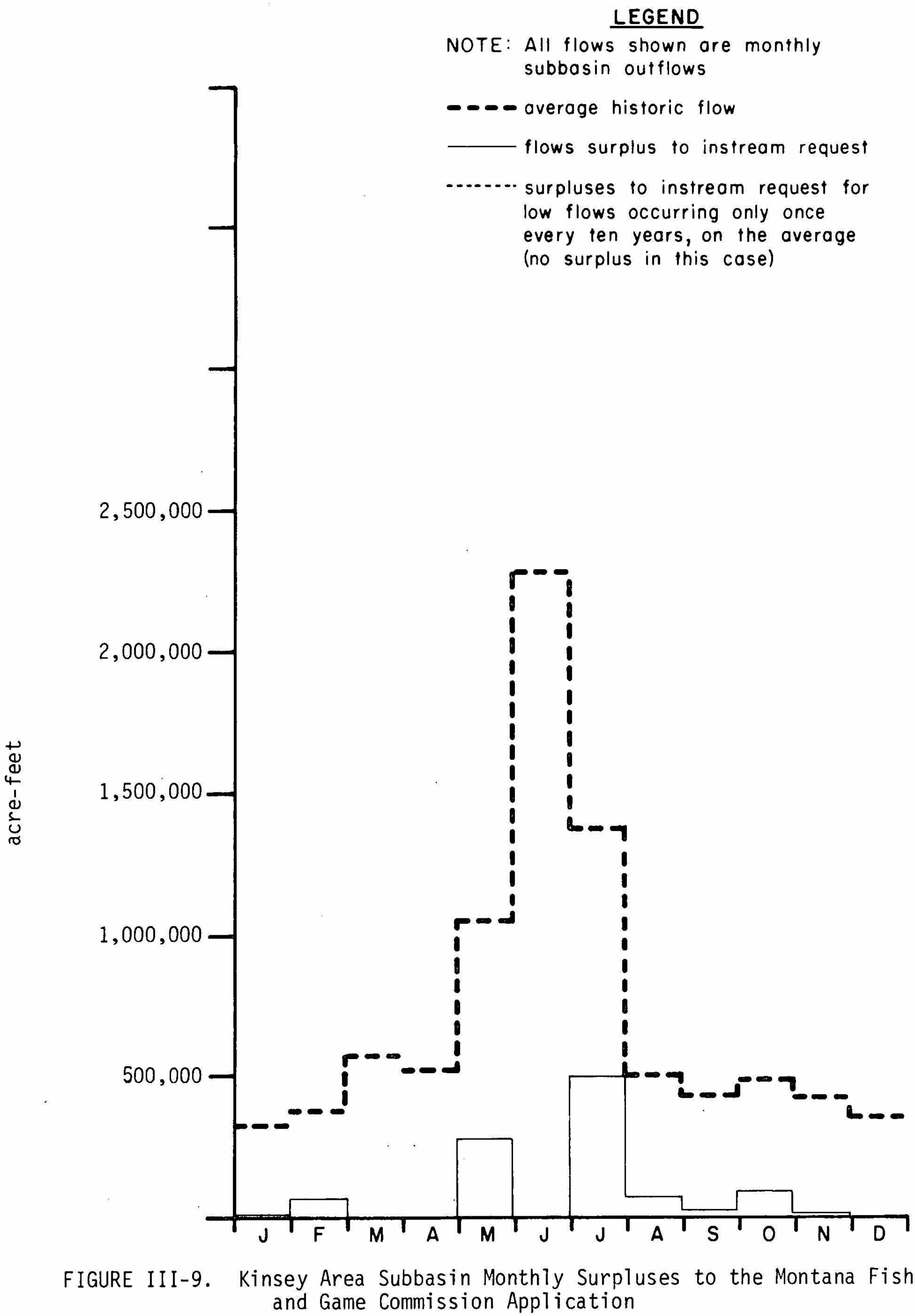


FIGURE III-9. Kinsey Area Subbasin Monthly Surpluses to the Montana Fish and Game Commission Application

Asserted Indian and federal reserved water rights, coupled with Wyoming's share of interstate tributaries (under provisions of the Yellowstone Compact), indicate that even less water is legally available than is physically present.

MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

DESCRIPTION OF APPLICATION

The Department of Health and Environmental Sciences (DHES) has filed a reservation request for an instream flow at the Montana-North Dakota state line of 6,643,000 af/y. The purpose of the application is to assure that Montana water quality standards will not be violated, to preserve the existing aquatic ecosystem, and to prevent significant degradation of state waters.

The portion of the Yellowstone River considered in this application is classed B-D_3 for water-quality purposes. This classification means that the quality is to be maintained suitable for drinking and domestic uses (after treatment) and bathing, swimming, and recreation including growth and propagation of nonsalmonid fishes.

In the justification for the request, DHES asserts that, by virtue of the B-D_3 water-quality classification of the Yellowstone, the water quality of the Yellowstone cannot legally be allowed to exceed the recommended limits of 500 mg/l for TDS and 250 mg/l for SO_4. Thus, any flow level below the amount necessary to maintain the established limits is prohibited by law. Accordingly, the stated limits establish the flow level request included in the application for reservation.

Based on these criteria, DHES requested flows for three reaches of the Yellowstone mainstem in order to provide the flows necessary to maintain TDS and sulfate concentrations below the standards. The flows were determined by various methodologies which are described in the application. The totals of the monthly Yellowstone mainstem flows requested are:

Clarks Fork Yellowstone to the Bighorn River (Billings Subbasin)	3,184,000 af/y
Bighorn River to the Powder River (Mid-Yellowstone and Kinsey subbasins)	5,015,000 af/y
Powder River to State Line (Lower Yellowstone Subbasin)	6,643,000 af/y

IMPACTS-DHES INSTREAM FLOW RESERVATION REQUEST

The impacts of the DHES application, if implemented, would be similar in the Billings, Mid-Yellowstone, Kinsey Area, and Lower Yellowstone subbasins. No request was made for tributary water.

GENERALIZED IMPACTS

Primary Impacts

Implementation of the DHES reservation request would not change the Yellowstone River and its ecosystems. Rather, it would tend to prevent changes in those systems. The primary purpose of the request is to maintain water quality at its present level. But, in so doing, it would also tend to maintain the status quo for the fish and wildlife which inhabit the river.

Since water quality, at least with respect to TDS and sulfate, the parameters which prompted the request, is better during high flows than low, the DHES application does not request a large portion of the peak flows, the flows necessary to maintain the channel in its dynamic, braided form. Because implementation of the DHES request would not prevent the construction of mainstem reservoirs nor protect the river from peak flow depletions, this reservation would not tend to preserve the channel form of the river.

Secondary Impacts

Agricultural Water Use

Implementation of the DHES request would benefit existing irrigators by maintaining water quality and by maintaining water levels at existing diversions.

The reservation would have the adverse effect of limiting the availability of water to future potential irrigators. Without storage, about one year in ten, there would be no water in excess of the reservation in all months but May, June, and July, the peak-flow months. Even in average years, no water would be available from September through April. See Figure III-10.

Assuming that irrigated agriculture would expand substantially in the absence of the DHES request, the cost to future irrigators can be estimated. See the discussion of agriculture water use in the evaluation of the Fish and Game Commission instream application (page 192), where it is illustrated that these costs could be very high. Because the DHES and Fish and Game Commission requests are similar, and because the method of analysis used here is not precise enough to differentiate between the impacts of the two, the same generalities apply here.

Municipal and Domestic Water Use

Municipal and domestic users would benefit from the maintenance of water quality. These benefits could be estimated if it could be predicted what development would occur if the request were not granted.

Industrial Water Use

Industrial water users would also benefit from the maintenance of water quality. But the reservation could limit the availability of water to those users, who could thus incur the additional cost of developing water from other sources.

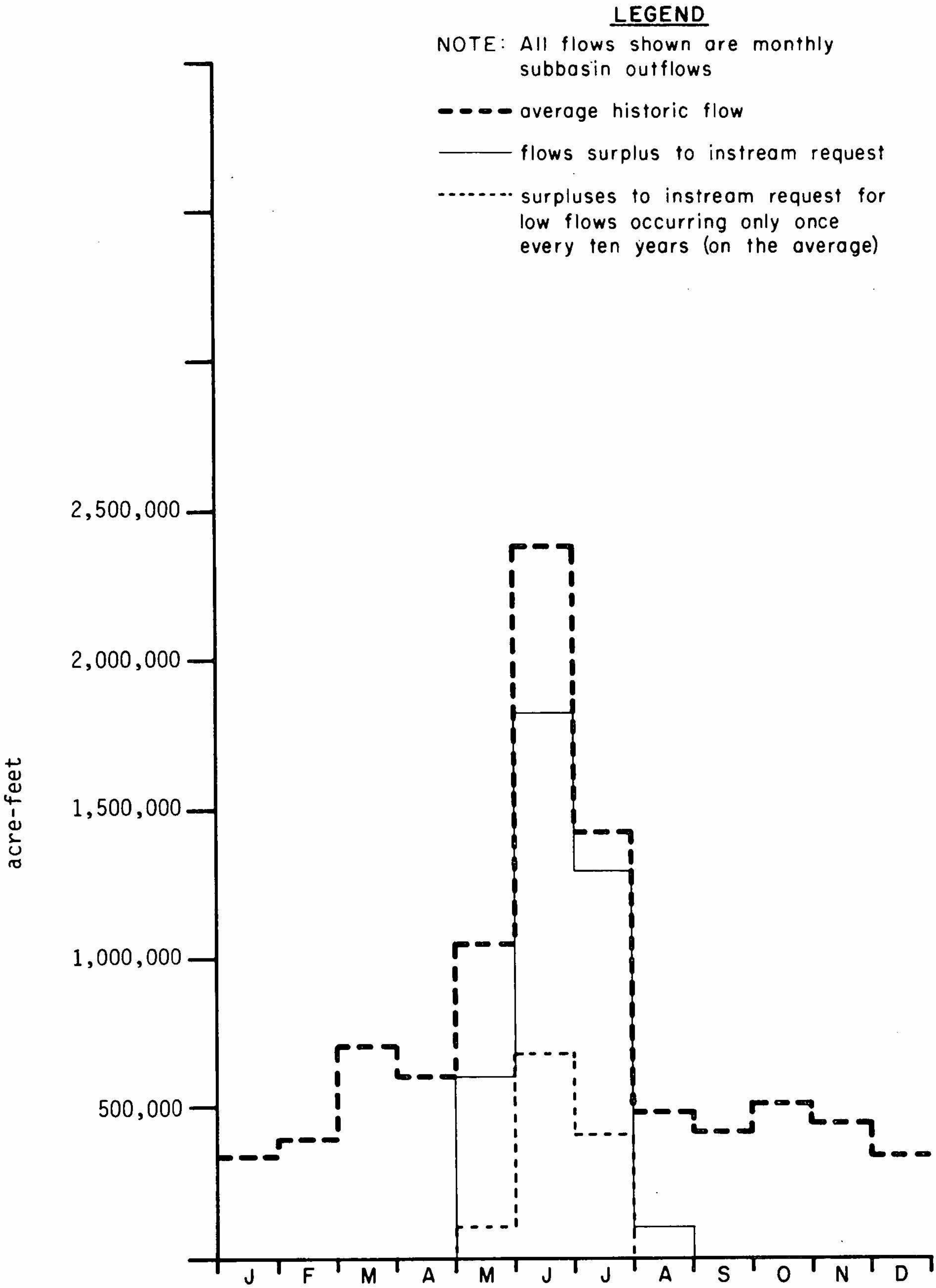


FIGURE III-10. Lower Yellowstone River Subbasin Monthly Surpluses to the Department of Health and Environmental Sciences Application

Recreation and Aesthetics

Granting the DHES request would tend to maintain the status quo with respect to recreation and aesthetics. This status quo may be considered to be a future benefit, assuming that the reservation would preclude irrigation and industrial development which would degrade the recreation potential and aesthetic quality of the basin.

Recreation and aesthetic values are very real and very large, but not quantifiable with today's methods.

CUMULATIVE APPLICATIONS

From the previous discussions of water availability it is apparent that not all water reservation applications can be approved. There is not enough water to fully satisfy all applicants in some subbasins. The conflict between some reservation applicants is further aggravated by the unquantified existing rights (including Indian and federal reserved water) and Wyoming's share of the four interstate tributaries. This conflict is primarily between instream and consumptive use applicants. Although there are a few exceptions, approval of each consumptive use request would not adversely affect any other diversionary application. All instream use could be approved, where water is available, since those applications are not in conflict with one another.

CUMULATIVE CONSUMPTIVE USE APPLICATIONS

It is possible to approve many of the consumptive use applications without adverse impacts on water supply for other consumptive requests. This course of action is available to the Board. The impacts resulting from such action are very similar to those described in the No Action Alternative of Part IV, beginning on page 242.

CUMULATIVE INSTREAM APPLICATIONS

Granting one instream flow application would not adversely affect another instream reservation. Therefore, all 15 of the instream applications could be granted. This situation would be the same as the Instream Flow Emphasis Alternative of Part IV, beginning on page 290.

MUTUAL EXCLUSIVENESS OF RESERVATION APPLICATIONS

Despite an apparently abundant water supply, the Yellowstone Basin does not produce enough water to satisfy the demands of all users. In general, potential consumptive users would all be accomodated; likewise, instream users could all be satisfied. But all demands for consumptive and instream users cannot be met at the same time. This section points out these conflicts, subbasin by subbasin.

UPPER YELLOWSTONE SUBBASIN

Applications for water reservations in the Upper Yellowstone Subbasin have been received from:

City of Livingston
City of Big Timber
City of Columbus
Park Conservation District
Sweet Grass Conservation District
Stillwater Conservation District
Fish and Game Commission
Department of State Lands

Each consumptive use application (municipal and irrigation) could be approved without adversely affecting other consumptive use applicants. For example, the Park Conservation District request, if implemented, would leave sufficient water to satisfy the other conservation districts and cities. However, if each conservation district and city application were approved, the Fish and Game Commission request could not entirely be fulfilled. In other words, the consumptive and instream use requests, as submitted, are mutually exclusive.

This conflict is apparent on the Yellowstone River but is more severe on the tributaries, notably the Shields River and Sweet Grass Creek. In these streams the instream requests are relatively large,and the conservation districts anticipate the use of all developable water.

Conflicts in the tributary streams where both irrigation and instream water uses are requested, along with the entities requesting water, are shown below:

1) Park Conservation District and Fish and Game Commission[a]

Big Creek
Tom Miner Creek
Mill Creek
Eight Mile Creek[b]
Fridley Creek
Fleshman Creek[b]
Shields River

2) Sweet Grass Conservation District and Fish and Game Commission[a]

Boulder River
Big Timber Creek
Upper Deer Creek[b]
Lower Deer Creek[b]
Bridger Creek[b]
Sweet Grass Creek

3) Stillwater Conservation District and Fish and Game Commission[a]

Stillwater River
West Rosebud Creek
East Rosebud Creek
Fishtail Creek

CLARKS FORK YELLOWSTONE SUBBASIN

Reservation applications have been received from the Fish and Game Commission for instream uses and from the Carbon Conservation District and the Department of State Lands for irrigation. Conflicts between instream and consumptive applications exist in the following streams:

Clarks Fork Yellowstone River
Butcher Creek
Willow Creek
Clear Creek
Red Lodge Creek
Rock Creek

[a] Department of State Lands may also have applied for water on small parcels of land along some of these streams.

[b] Although the map accompanying the application did not show irrigation projects on these streams, the narrative included a discussion of water supply possible from these small streams.

BILLINGS AREA SUBBASIN

The Yellowstone Conservation District, Huntley Project Irrigation District, Fish and Game Commission, Department of State Lands, Department of Health and Environmental Sciences, and the cities of Laurel and Billings all have applied for water from the Yellowstone mainstem in this subbasin, which extends from the mouth of the Clarks Fork Yellowstone River to the mouth of the Bighorn River.

The two instream use applications are duplicative in each month; however, in the fall and winter months, the DHES request is generally larger and in the spring months the Fish and Game request is usually greater. Streamflows could be reserved that would satisfy both instream applicants.

As explained earlier in Part III (pages 173 to 177) the City of Billings' application is difficult to analyze because of the lack of information submitted. Depending on the duration, frequency, or time of this request, it could mean that water would not be available to fully accommodate other applicants in this subbasin.

The major conflict in this subbasin, as in the others, is between the instream requests (Fish and Game Commission and Department of Health and Environmental Sciences) and the consumptive use applications (Cities of Billings and Laurel, Yellowstone Conservation District, and Huntley Project Irrigation District). These two types of applications are mutually exclusive in this subbasin. No applications were received for tributary streams.

BIGHORN SUBBASIN

Received for this subbasin were applications from the Fish and Game Commission and the Bighorn Conservation District, both for Bighorn River water. Because of unquantified federal and Indian reserved water rights and Wyoming's 80 percent share of the Bighorn River under the terms of the Yellowstone Compact, the large Fish and Game Commission request cannot be satisfied without modification. The Bighorn Conservation District application could be implemented, but not if the instream request were granted.

MID-YELLOWSTONE BASIN

In this subbasin water was requested by the following:

- Fish and Game Commission
- Department of Health and Environmental Sciences
- Treasure Conservation District
- Rosebud Conservation District
- North Custer Conservation District
- Department of State Lands

Once again the conflict is between instream and consumptive uses -- that is, irrigation and instream flow requests are not wholly compatible in this subbasin.

TONGUE SUBBASIN

Reservation requests for water in this subbasin have been received from the following:

Department of Natural Resources and Conservation
Department of State Lands
Fish and Game Commission
North Custer Conservation District
Rosebud Conservation District
Bighorn Conservation District

Because the Department of Natural Resources and Conservation has applied for what amounts to all unappropriated water in the Tongue River at the site of the High Tongue Dam, it would preclude the granting of the other reservation requests except the following:

1. Department of State Lands water spreading applications in Pumpkin Creek headwaters.

2. Fish and Game Commission's instream application on Hanging Woman, Pumpkin and Otter creeks.

The two applications listed above are the only two applications in this subbasin that would not be affected by another application nor would they directly affect another request.

KINSEY SUBBASIN

In this subbasin, water reservation requests have been received from the following:

Department of State Lands
Fish and Game Commission
North Custer Conservation District
Prairie County Conservation District
Department of Health and Environmental Sciences

Not all of these applications can be approved without modification because the consumptive use requests conflict with instream requests and vice versa.

POWDER SUBBASIN

Requests for reservation of Powder River water have been submitted by the following state agencies or state political subdivisions:

Department of State Lands
Department of Natural Resources and Conservation
Fish and Game Commission
North Custer Conservation District
Powder River Conservation District

The Fish and Game Commission has applied for a relatively large amount of water; the Department of Natural Resources and Conservation has requested the unappropriated water at the Moorhead Dam site, and the two conservation districts have applied for more water than is developable in the Powder River. Therefore, granting all requests, as submitted, is impossible.

LOWER YELLOWSTONE SUBBASIN

Reservation requests for water in the lower Yellowstone mainstem have been submitted by the following:

Department of State Lands
Fish and Game Commission
Prairie County Conservation District
Dawson County Conservation District
Richland County Conservation District
Department of Health and Environmental Sciences

Once again, granting all the reservations cannot be done because of the conflict between consumptive and non-consumptive use applicants.

Montana
Department of Natural Resources
and Conservation

Helena, Montana

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3

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