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MISSOURI REGION

NORTH DAKOTA STATE UNIVERSITY



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SPECIFIC PROBLEM ANALYSIS SUMMARY REPORT
1975 NATIONAL ASSESSMENT OF
WATER AND RELATED LAND RESOURCES
(TECHNICAL MEMORANDUM NO. 4)

Prepared by

MISSOURI RIVER BASIN COMMISSION

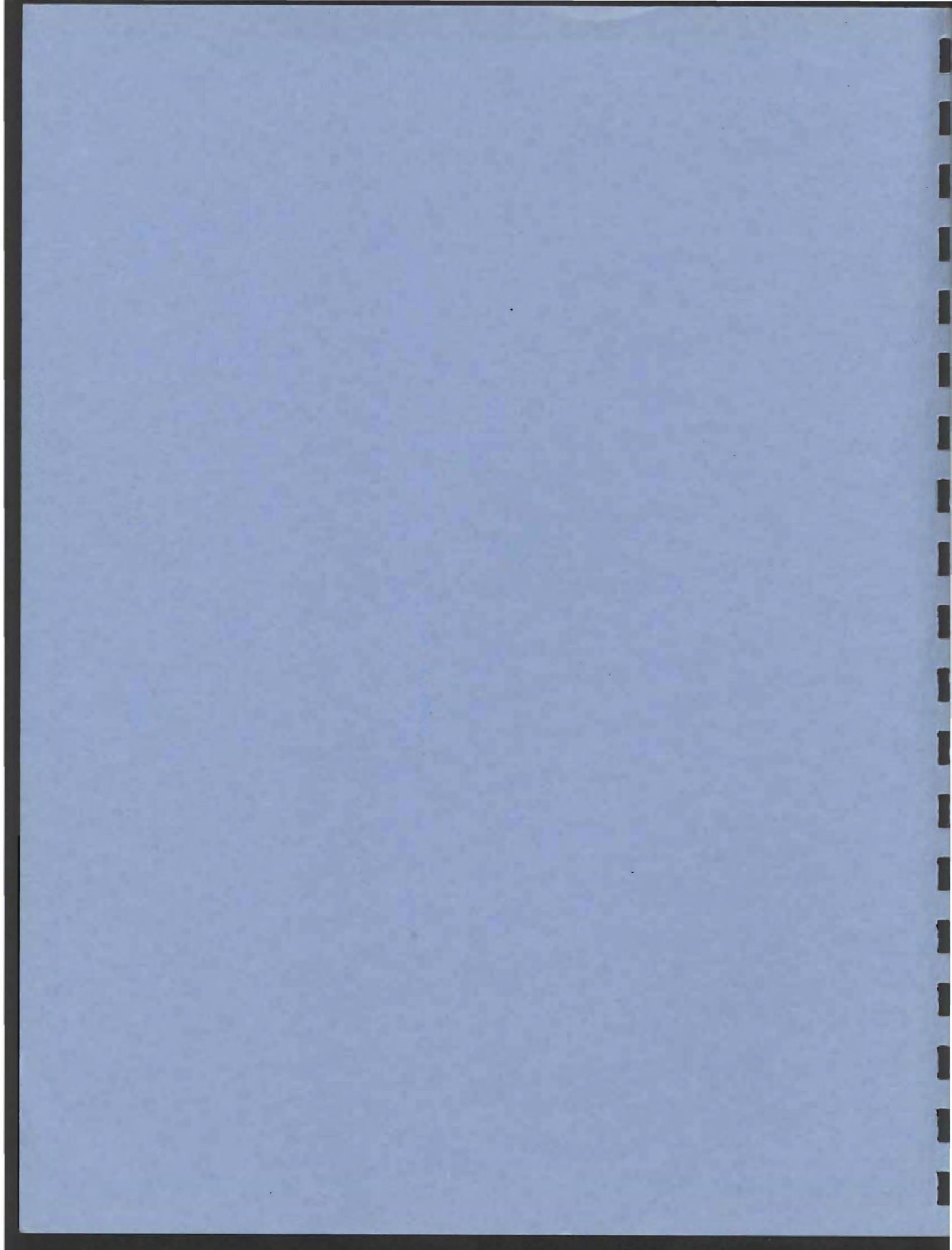
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As Regional Sponsor

for the

U.S. Water Resources Council

August 1977



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I. INTRODUCTION

A. National Assessment Objectives

The 1975 National Assessment of Water and Related Land Resources is being conducted by the U.S. Water Resources Council under authority of one of its major program objectives as required by the Water Resources Planning Act of 1965 (P.L. 89-80). Section 102 of that Act states in part that the Council shall:

...maintain a continuing study and prepare an assessment biennially, or at such less frequent intervals as the Council may determine, of the adequacy of supplies of water necessary to meet the requirements in each water resource region in the United States and the national interest therein.

The Council's first national assessment, completed in 1968, was the initial step in the development of a continuing process. On a national and broad regional basis, it described the nature of available water and related land resources, projected requirements to the year 2020, and identified and discussed emerging problems. The 1975 Assessment represents a second step toward a continuing assessment process, following the general guidelines in the 1968 Assessment. Broad objectives of the current assessment are to identify and describe existing and emerging needs and problems at national, regional, state, and subregional levels; relate these needs and problems to the adequacy of water and related land resources to meet the requirements and goals of the people for the proper conservation, development, use, and management of these resources, both now and for the foreseeable future; and identify specific geographic areas with complex problems which require more detailed investigations and planning.

The plan of study for the 1975 Assessment dated August 1974 (revised October 1974) stated that the Council will recommend:

The extent of the national interest and the Federal role in helping to provide the capability to meet needs and resolve individual or groups of problem issues within selected problem areas consistent with established cost-sharing policy assumptions.

The geographical areas where level B planning studies should be developed or updated, both between 1975 and 1985 and between 1985 and 2000.

Those data-collection and information-development program modifications that are necessary to provide for (a) implementing an improved continuing assessment process, and (b) the collection and compilation of data necessary to support planning studies.

What changes need to be considered in current legal and institutional arrangements, water policies, and water-related programs to provide the Nation with an improved basis for resolving those problems receiving high-priority ratings.

To accomplish the objectives of the assessment, three major activities were identified--nationwide analysis, specific problem analysis, and national priorities analysis. The nationwide analysis is being accomplished by Federal agencies under guidance of the U.S. Water Resources Council. This activity includes development of estimates, using nationally consistent criteria, of socio-economic characteristics, water withdrawals, water consumption, and water supply availability for 106 separate aggregated subareas (ASA's). Estimates were made for 1975 and then projected to the years 1985 and 2000 and serve as one basis for identifying and describing severe and urgent water-related problems. Specific problem analysis activities were undertaken by regional sponsors for the 21 major water resource regions of the Nation. The role of the Missouri River Basin Commission in the specific problem analysis is described in the ensuing paragraphs. The purposes of the national priorities analysis are to articulate, from the national viewpoint, priorities for resolving identified water-related problems, to prepare a national assessment report which contains both the national and state/regional viewpoints, to formulate conclusions, and to make recommendations concerning the Federal role in helping to resolve the high-priority problems.

B. Regional Sponsor Role

A Memorandum of Agreement between the Water Resources Council (WRC) and the Missouri River Basin Commission (MRBC) for services and participation in the 1975 Assessment was consummated February 6, 1975. Prior to that date a Framework

Updating Committee, comprised of four State and six Federal agency representatives, had been established for the purposes of updating and supplementing The Missouri River Basin Framework Report of June 1969. When MRBC accepted regional sponsorship for the 1975 Assessment, the Committee was assigned dual responsibility for the two interrelated and concurrent activities. Because of the considerable coordinated efforts required, each of the 10 member States and 10 Federal agencies designated a principal contact to work with the MRBC staff and the Committee.

The MRBC regional sponsor's role in the national assessment effort involved four distinct, but related, activities for the Missouri Region: 1) identification of water and related land resource problems and problem areas; 2) present and future uses and associated problems and issues relevant to water and related land resources; 3) identification of potential study areas; and 4) specific problem analysis summary report of water and related land resources. Each of the preceding activities has resulted in publication of a technical memorandum, reviewed and commented on by the MRBC members, and then transmitted to the Water Resources Council. Also, MRBC is participating with WRC in preparation of the Missouri Region Chapter of the final assessment report and will review and comment on the draft national report, including the conclusions and recommendations contained therein.

Activity one involved developing tentative analytical areas in which severe and interrelated water and related land resource problems exist or are expected to occur, delineating these areas on maps, and describing the problems associated with each area. This information was obtained through the 20 designated State and Federal agency principal contacts.

The second activity involved development of information concerning objectives, existing conditions and trends which collectively will enable planners to recognize and evaluate problems, needs and opportunities associated with management, conservation and development of the water and related land resources. The

State/Regional Future (SRF) evolved contains information on each of the eleven aggregated subareas (ASA's) in the Missouri Region relating to planning objectives; present and projected socio-economic characteristics, land use, water use and requirements, and water supplies; instream flow needs; environmental resources; erosion and sedimentation; water-oriented recreation; flood damages; navigation; and water quality. Modified Central Case (MCC) data prepared by Federal agencies from a national perspective, dated February 1976, is compared with the SRF data. MCC data were revised in 1977 but were furnished too late for MRBC to make comparisons in the regional technical memoranda. The problems and analytical areas described in the Activity One Technical Memorandum were further analyzed and then screened in Activity Two Technical Memorandum in order to present those problem areas with the more severe, urgent, and complex problems.

The third activity involved selection of problem areas in need of further study after a screening process involving a determination of which areas have recently or are being studied and which address the major problems and issues. The problem areas remaining were then reviewed and analyzed so that potential Level B, special study, and other areas could be designated where appropriate.

The fourth activity involves preparation of this summary report, including identification of the major problems and issues confronting the Missouri Region, and presentation of conclusions and recommendations concerning study and other relevant needs.

C. Public Participation

Since each State member of the MRBC represents his State and the public therein, the states assumed primary responsibility for their respective public involvement. Therefore, it was each State Member's responsibility to insure appropriate cooperative liaison with the Governor and his administration and to obtain public participation consistent with those cooperative efforts. Each state member was provided the number of technical memoranda copies requested for

each of four separate activities for appropriate review within his State. The list of participants is shown in Appendix I, and the Federal agency and State review comments on this memorandum are included in Appendix II.

II. THE MISSOURI REGION

The Missouri Region or River Basin, encompasses one-sixth of the contiguous United States. The Missouri River rises high in the Rocky Mountains, then flows generally southeastward, joining the Mississippi River near St. Louis. It includes all of Nebraska; most of Montana, North and South Dakota, and Wyoming; about one-half of Kansas and Missouri; and smaller parts of Colorado, Iowa, and Minnesota. The Missouri River drains a watershed of 513,300 square miles within the United States and about 9,700 square miles in Canada. Aside from international water accountability, the national assessment is concerned only with that part of the region within the United States. Much of the material presented is taken from The Missouri River Basin Comprehensive Framework Study Report published by the Missouri Basin Inter-Agency Committee in 1971.

A. Settlement Period

The Missouri River Basin was part of the Louisiana Territory purchased in 1803 by the United States from France. Very little was known about this vast territory at that time. The Lewis and Clark expedition of 1804-1806 was the most notable among many early explorations, many of which produced maps and descriptions of the area. Most early settlers in the 1840's and 1850's, aside from the fur trappers and traders, were people dropping off from wagon trains headed for the Oregon and California Territories. Following the end of the Civil War in 1865, uprooted Civil War survivors searching for a place to settle, the offering of public lands by the Homestead Act, and completion of the trans-continental railroad stimulated an interest in settlement of the area. In addition to migration from the eastern United States, many European immigrants came directly to the region, so that shortly after the turn of the century, the area was largely settled. All of the 10 states had been admitted to the Union by 1890.

Early settlers survived many hardships and self-survival was an early

requirement. With the invention of the steel plow and other farm machinery, crop production could be increased tremendously. Railroads were constructed throughout the region providing a means of transport for the farm products. However, weather was sometimes capricious and markets at attractive prices for farm commodities did not always exist. There were cycles of boom and bust. In the semi-arid and arid areas of the western part of the region where rainfall is usually less than about 25 inches annually; dryland farming, except for wheat, proved unsuccessful. Where water was available, irrigation was introduced, but only on a limited scale. With the passage of the Reclamation Act in 1902, Federal project-type irrigation was expanded notably, but it was not until the later years, since about 1950, that individual and group-type irrigation became more widespread.

B. Physical Characteristics

There are three major physiographic divisions within the Missouri Region-- the Interior Highlands, the Interior Plains, and the Rocky Mountain System. The Rocky Mountain System forms the western boundary of the region and has an exceptionally rugged topography, with many peaks surpassing 14,000 feet in elevation. Extending eastward from the Rocky Mountains is the Interior Plains division which characterizes the major portion of the region. Within this plains area are isolated mountainous areas, principal among which are the Black Hills in western South Dakota and northeastern Wyoming. Another distinctive area is the 24,000-square-mile Sand Hills area in north-central Nebraska. Although the Interior Plains are generally characterized as flat, the terrain is largely one of rolling hills and valleys. In the eastern part, an abundance of rainfall and stream development has created a more hilly topography. In the southeastern portion of the basin is the Ozark Plateaus province of the Interior Highlands physiographic division. This area is characterized by its rough topography underlain by sedimentary formations, largely limestone, which give rise to

cavernous underground channels with many flowing springs.

Because the region is so vast and was influenced by a variable geologic historical development, many sectional variations exist. The mountainous areas include primarily the Rocky Mountains of Colorado, Wyoming, and Montana, in the western part of the region and the Black Hills of western South Dakota. Slopes and stream gradients are generally steep. These areas are used primarily for timber, grazing, wildlife habitat, and recreation and are especially important as sources of water supply. In the north-central part of the Great Plains in the Dakotas and Montana, and in large intermountain valleys of Wyoming, are found the region's "rough lands and badlands." Natural vegetation is relatively sparse and soils generally are shallow. Grazing is the principal land use, although narrow areas of dry alluvial soils are devoted to irrigation and dry farming. The hilly lands appear intermittently from the bluffs of the Missouri River in western Missouri and Iowa to the foothills of the Rocky Mountains. Much of the hilly land is grazed, but substantial areas in the eastern part are clean tilled. The Ozarks Plateaus in Missouri and the grassy Flint Hills of Kansas are used largely for grazing, timber production, and wildlife habitat.

C. Climate

In the Missouri River Basin climate has a great influence on how the people live and on their socio-economic structure. Obviously it has a strong influence upon the basic agricultural industry, due primarily to the seasonal and variable regimen of precipitation, temperature, and winds.

The climate is determined largely by the interaction of three great air masses which have their origins over the Gulf of Mexico, the northern Pacific Ocean, and the northern polar regions. They regularly invade and pass over the region throughout the year, with the gulf air tending to dominate the weather in summer and the polar air dominating in winter. It is this seasonal domination of the air masses and the frontal activity caused by their colliding with each other which produces the general weather regimens found within the region.

Perhaps the most significant factor affecting the climate is the remoteness of the region from the distant source areas of the air masses. This means that the air masses have to cross wide land areas before they reach the region. In crossing these areas they leave much of their available precipitation, and their air temperatures are changed considerably by radiation from the land surface.

Primarily because of its midcontinental location, the basin experiences weather that is known for its fluctuations and extremes and there are variations between areas. Winters are relatively long and cold, while summers are fair and hot. Spring is cool, moist, and windy; autumn is cool, dry, and sunny. Averages are misleading, for seldom does "average" weather actually occur. Instead, weather tends to fluctuate widely around the annual averages, with the occurrence and the degree of the fluctuations being unpredictable. Thus, the climatic averages have to be thought of as generalizations of the more common occurrences over a period of time.

As shown in Figure 1, average annual precipitation varies from over 40 inches in parts of the Rocky Mountains and southeastern parts of the region to as low as 6 to 12 inches immediately east of the Rocky Mountains. Complicating the annual variations, there is a wide variation in the regionwide pattern of monthly precipitation.

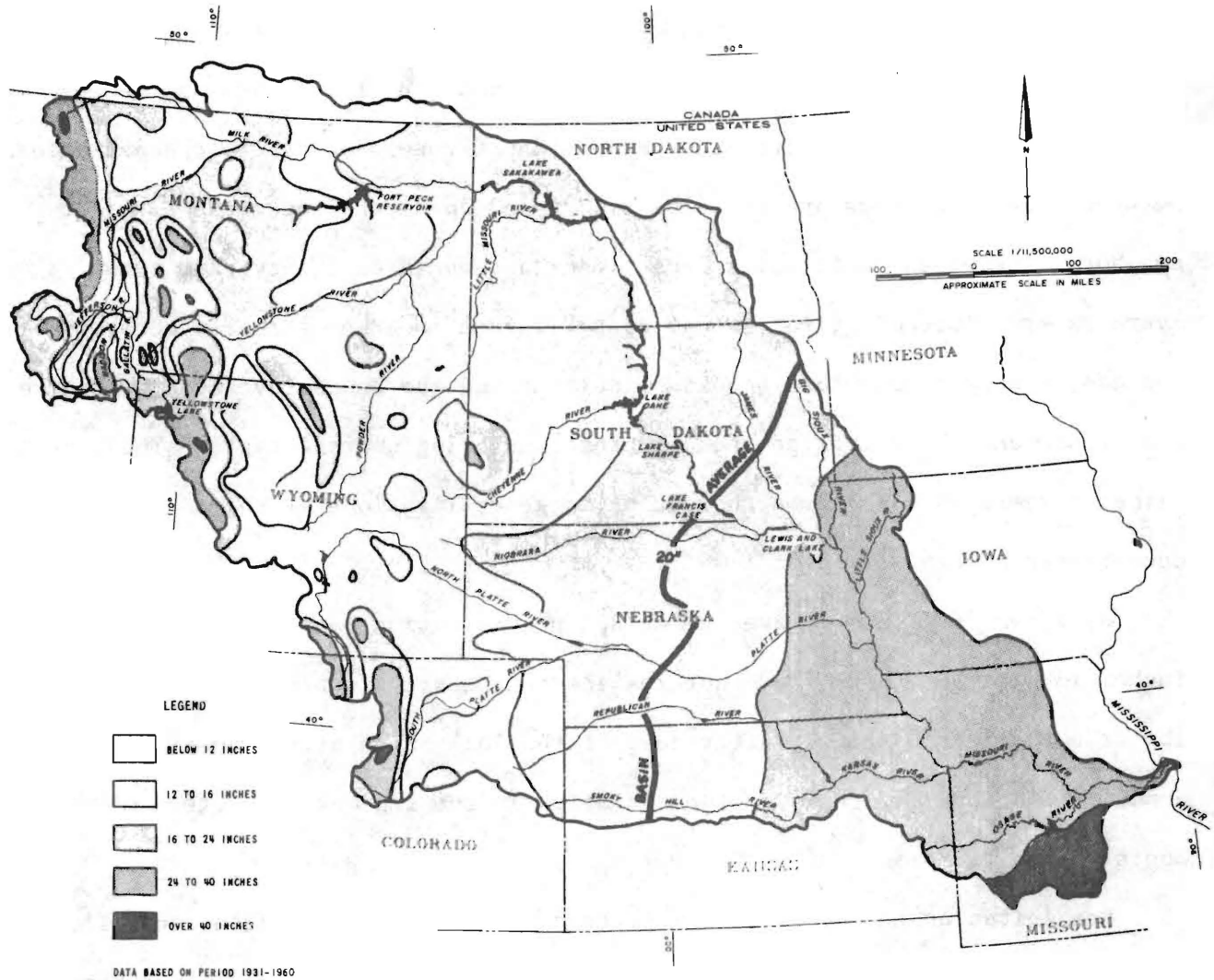
Precipitation received (Figure 1) from November through March generally is in the form of snowfall. Thunderstorms are prevalent in July and August and often are localized, with high-intensity rainfall. Prolonged droughts and lesser periods of deficient moisture may be interspersed with periods of abundant precipitation.

Most of the Great Plains, with the annual precipitation varying between 12 and 24 inches, is a high risk area agriculturally. Special farming practices are required to conserve the moisture available, even under normal conditions.

There are periods of extremely cold winter and hot summer temperatures.

Figure 1

AVERAGE ANNUAL TOTAL PRECIPITATION



Source: 1971 Missouri River Basin Framework Report

Extremes range from winter lows of -60° F in Montana to summer highs of up to 120° F in Nebraska, Kansas, and Missouri. The region regularly experiences over 100-degree temperatures in summer and below-zero temperatures in winter over most of its area.

One of the climatic factors that has an impact on much of the cultural and industrial activity, but particularly agriculture, is the continuous period with temperatures above freezing conditions. While the freeze-free period does not completely define the growing season for all crops and grasses, it is a general indicator of the most favorable period. Except for the mountainous areas in the west, the freeze-free period ranges from about 90 days in the northern part of the region to over 180 days in the southern portions.

Mean total hours of sunshine annually are favorable for agriculture and a healthful environment, ranging from under 2,400 hours in the northwest to as much as 3,200 hours in western Kansas and eastern Colorado.

Winds are the rule rather than the exception, particularly in the plains area. Average wind velocities of 10 miles per hour are prevalent over much of the region. In the plains area strong winds accompanied by snow sometimes create blizzard conditions dangerous to both man and livestock. High winds occasionally prevail during periods of high temperatures and deficient moisture that can destroy crops and desiccate rangeland within a few days. Parts of the region, particularly the south and east, are subject to cyclonic and tornadic winds that occasionally do considerable damage.

Most of the climatic forces are not amenable to change, but modern technology has done much to enable man to better cope with the extremes that affect his environment and culture. Special farm and range conservation practices, irrigation, and air conditioning in homes and factories are examples. Generalizations of the region's climate, however, are not always applicable to specific areas or to their seasonal advantages. Many people are attracted to parts of the region

because of the favorable climate. Particularly, the cool, dry, crisp days of summer are a tourist attraction in the western and other mountainous areas and in the Ozarks.

D. Socio-Economic Characteristics

Agriculture was historically and still is the dominant influence throughout the region. Largely it was settled on 80- and 160-acre tracts of farmland under various homestead acts during the last half of the 19th Century. Since then, largely because of mechanization, capital requirements, and farm efficiencies, average farm size has gradually increased with a corresponding decrease in farm population. This population shift has been from the farms or rural areas to the larger cities in and outside the region.

1. Population

Although the total basin population has been increasing, the rate of increase has been below the national average. Furthermore, the region's share of the total U.S. population of the 48 contiguous states has declined from 5.1 percent in 1940 to an estimated 4.3 percent in 1975. The upper States of Wyoming, Montana, and North and South Dakota are thinly populated and comprise about 60 percent of the region's land area but contain only about 20 percent of its people. Nearly one-half the area has a population density of fewer than 5 people per square mile. Of the 12 SMSA's, only 4 are in these upper States. The three largest metropolitan centers - Denver, Kansas City, and Omaha-Council Bluffs - are in the lower States. There are about 250 urban communities with a population over 2,500 and numerous smaller communities. These largely serve as trade centers and furnish the social services for the surrounding rural areas. Outmigration from the rural areas has created problems, particularly in the social services area. The declining populations of the rural areas make it more difficult to provide adequate schools, churches, local governmental units, medical facilities, transportation routes, and the numerous other people needs.

Total urban growth in the region has followed the national pattern. Small towns and cities under 5,000 population have tended to decrease, although there are exceptions. Cities with 5,000 to 10,000 populations have tended to remain relatively stable. Cities over 10,000 populations have had the largest percentage of growth. The 12 SMSA's in the region contain about one-half of its total population. They continue to function as the gateways of commerce. In addition, their economic bases have been diversified with manufacturing, professional and other services, and governmental functions becoming important segments of their economies. One of the very striking characteristics of the region is the absence of large urban populations on the plains. By far the largest concentration of the urban population is along the eastern edge and along the foot hills of the mountains in the west.

2. Earnings and Income

Although using OBERS disaggregations of total earnings for the Missouri Region show agriculture as representing less than 11 percent of the total earnings, agribusinesses, manufacturing, transportation, wholesale and retail trade, and other agriculturally related activities and services would probably aggregate to well over 50 percent of the total earnings. The remainder of the economy of the region, largely concentrated in the cities, is generally well diversified. Per capita income, historically and current, is below the national average. The economy of some parts of the upper States is affected by the large Indian reservations which have significant economic problems. Although the Indian segment comprises less than 1 percent of the total region population, Indian-owned land comprises 3.6 percent of the total land area. There are 23 Indian reservations located in 6 states. Indian unemployment has been high, ranging upwards to as much as about 70 percent of the employable work force, and Indian per capita income is generally less than \$2,000 per year.

3. Principal Industries

Although agriculture and its related activities are the dominant influences shaping the economy of the region, manufacturing and other commodity-producing industries play a very important role in many parts, particularly in the larger cities. Mining constitutes only a minor part of the total region economy; however, the vast coal resources in Montana, Wyoming, and North and South Dakota are becoming increasingly important to the region and the Nation in meeting burgeoning energy requirements. Tourism has been growing and will probably continue to increase in importance as a notable segment of the regional economy.

a. Manufacturing. Most manufacturing is situated in the lower and more populous areas of the region. This area also has the advantages of good access to transcontinental railroad lines and airways for transporting finished products and access to Missouri River navigation for transporting bulk commodities. There are no notable large water-using industries. Except for the large portion of manufacturing associated with agriculture, the remaining manufacturing activities are generally very heterogeneous. The Rocky Mountain foothills area in Colorado, which includes Denver, has been attracting many light water-using industries in this water-short area and, together with a favorable climate and scenic attractiveness, accounts to a large extent for the accelerating population growth in this area.

b. Mining and Energy. Metallic mineral resources are found in significant quantities in the mountainous areas of Montana, Wyoming, Colorado, and their peripheral outwash plains, and in the Black Hills of South Dakota. Gold, silver, copper, lead, and zinc ores have been extracted there in large quantities, and known reserves exist. Ferroalloys and other minor metals such as tungsten, vanadium, chromium, beryllium, and lithium have been produced periodically from localized ore deposits. Currently the sprawling open-pit low-grade iron ore operation near Atlantic City, Wyoming, and the larger but not yet completely

defined molybdenum ore body being developed near Empire, Colorado, overshadows other metal mining activities. The bulk of nonmetallic minerals found in the region is used for localized construction activities, although some of the more valuable chemical and fertilizer minerals are processed locally and marketed within and beyond the region.

The Missouri Region produces significant quantities of petroleum and natural gas, although total production is on the decline; however, in 1973, the region still accounted for about 7 percent of the Nation's total petroleum production. Uranium deposits are scattered throughout much of the Yellowstone River basin (ASA 1004), and this area has been contributing significant quantities to meet the national needs. The most significant known energy resource of the region is its large deposits of recoverable coal. The more than 450 billion tons of recoverable coal account for about 55 percent of the Nation's total. The States of Wyoming, Montana, and North Dakota possess the bulk of the reserve, with at least 350 billion tons of recoverable coal and lignite. Whereas in 1965 the region produced only about 3 percent of the total U.S. coal production, its share increased to about 4 percent in 1971 and to about 8 percent in 1973. While most of the production is shipped out of the area in unit trains, several electric power generating plants have been built within the area. Although it might appear on the surface that mine-mouth generation and transmission of power to the points of need would be more practical than hauling the coal, there are technological problems associated with long-distance power transmission.

c. Agriculture. Agriculture dominates the region with about 92 percent of the lands used for agricultural purposes. The region produces over one-third of the Nation's wheat and rye and nearly one-fourth of its corn, oats, barley, sorghum, and sugar beets. It also produces about one-fourth of the Nation's beef, pork, and lamb. The farm sector has been and is still undergoing many changes. Technological improvements and rapidly increasing farm efficiencies

have resulted in the size of farm units increasing year by year. Whereas the Nation's aggregate demand for agricultural output tends to be relatively inelastic, farm productivity has increased much faster, resulting in many commodity surpluses. More recently, the Nation was able to export some of the surpluses, especially food grains, but exports appear to be rather cyclical depending on world weather conditions, needs, and the ability or inability of foreign nations to pay. The amount of future exports will have a great effect on the region's future agricultural economy. Aside from the uncertainties which climatic conditions impose on agricultural prices and productivity, prices are also subject to supply and demand situations. Unlike manufacturing and industrial outputs of goods which can be more closely controlled by demand, agricultural output cannot. The many independent operators, climatic vagaries, world needs, export policies, and other variables make it almost impossible to control farm output and farm commodity demands.

d. Tourism. From the rugged mountains in the west to the densely wooded hills and meandering streams of the Ozarks Plateaus in the southeast, the region offers a myriad of varying outdoor recreation opportunities. It contains some of the best known developed recreation areas in the United States, including Yellowstone, Glacier, and Rocky Mountain National Parks, the Black Hills region, and the Ozarks region. One of the fastest growing national recreation pursuits is snow skiing, and many ski resorts have been built recently on the eastern slopes of the Rockies in Colorado, Wyoming, and Montana. There has been widespread interest within the region in attracting the tourist dollar. In some favored locations, tourism is the primary industry and in many other areas it is second only to agriculture. Consequently, there have been a number of concerted efforts to develop the scenic, historic, hunting, fishing, and other potentials and to provide the services needed by the tourists. In numerous areas of the region this industry has probably the greatest potential for future growth.

E. Land Resources, Development and Utilization

Of the 328.5 million acres of land in the Missouri Region, nearly 45 million acres, or about 15 percent, are in Federal ownership. Most of these Federal lands are in the westerly States of Montana, Wyoming, North and South Dakota, and Colorado. The largest tracts are managed by the Forest Service--19.4 million acres, Bureau of Land Management--18.5 million acres, National Park Service--2.3 million acres, Corps of Engineers--2.2 million acres, and Bureau of Reclamation--1.0 million acres. The Corps of Engineers and Bureau of Reclamation lands are acquired almost entirely for construction and operation of large Federal reservoirs and related facilities. Lesser acreages are managed by the military, the Fish and Wildlife Service, the Bureau of Indian Affairs, and the Agricultural Research Service.

Included in the nearly 284 million acres of privately owned lands are about 12 million acres of Indian lands, title to which is held in trust by the United States. The majority of the Indian holdings is in Montana, Wyoming, and North and South Dakota.

Management of the private lands is primarily for economic gains. These individual owners and managers historically have had the right to use their lands much as they saw fit, except for local zoning ordinances. More recently, unrestricted use has been affected somewhat by Federal and state environmental laws, the Federal Flood Plain Insurance Act, and other recently enacted laws. However, unless there is a major change in the general economic conditions of the Nation or land-use regulation laws are enacted, the current general land-use patterns will probably continue.

Approximately 298.4 million acres, or 92 percent of all lands in the Missouri Region are used for agricultural purposes. Table 1 shows the land and water acreage and the primary use, as estimated by the states and printed in Technical Memorandum No. 2, for 1975 and as projected for 1985 and 2000:

TABLE 1
Land and Water Acreage
Missouri Region
(thousands of acres)

	<u>1975</u>	<u>1985</u>	<u>2000</u>
Agricultural lands:			
Cropland:			
Non-irrigated	90,375	91,906	91,914
Irrigated	11,463	14,288	17,402
Pasture and range	169,434	164,118	159,830
Forest and woodland	28,631	28,490	28,406
Other	<u>2,803</u>	<u>2,788</u>	<u>2,789</u>
Subtotal	302,706	301,590	300,341
Nonagricultural lands:			
Transportation, urban and builtup	7,438	8,156	9,115
Other	<u>8,617</u>	<u>8,769</u>	<u>8,825</u>
Subtotal	16,055	16,925	17,940
Total land area	318,760	318,514	318,281
Total water area	4,365	4,611	4,844
Total region area	<u>323,125</u>	<u>323,125</u>	<u>323,125</u>

As might be expected, most of the pasture and range lands is in the western or more arid parts of the region, with croplands predominating in the eastern more humid areas. Although Nebraska and Kansas have the most acreage under irrigation, the other States also have considerable acreages which are being irrigated. Exceptions are Minnesota, Iowa, and Missouri, where irrigated acreages are small. For the 11.3 million acres shown to be currently under irrigation, no distinction is made between the lands considered to have full service water supplies and those which have only partial or intermittent water supplies available. Nearly all of the forest land is located in the Rocky Mountain area, the Black Hills of South Dakota, and the Ozarks area in the southeast part of the region. Much of the land managed by the Forest Service and the Bureau of Land Management is leased to ranchers and farmers for grazing purposes.

In addition to a number of national and state wildlife refuges scattered throughout much of the Missouri Region, large acreages of the public domain lands are dedicated to fish and wildlife preservation and enhancement. Agriculture, because of its land-area magnitude, supports the majority of wildlife and offers a great opportunity for general enhancement of wildlife values in the region. Most lands and waters in this category are in private ownership and wildlife enhancement measures thus are dependent upon private initiative. Most of the outdoor recreation opportunities in the basin are provided on public lands. The larger public recreation areas are located in the National Parks, National Forests, Corps of Engineers and Bureau of Reclamation reservoir areas, and state parks.

F. Water Resources, Development, and Utilization

The Missouri Region, in general, has adequate surface and ground water resources to meet current and projected needs. However, the water is not always available at the point of need or in the quantity or of the quality desired. As previously stated, the region average streamflows are made up of extreme fluctuations of too much water at times and far too little at others, which further complicates any analyses of water availability. It is also apparent that estimates of current (1975) amounts of water availability and water use or depletions vary over rather wide ranges. These differences surfaced during the regional participation in the national assessment effort and are discussed further in Sections III and IV of this technical memorandum.

During the westward migration and during the early settlement period, the Missouri River was used to transport people and goods, but this use dwindled as railroads were completed. Systematic development of the Missouri River for navigation was started during the latter part of the 19th Century, and was later continued by authorization of the Navigation and Bank Stabilization Project in 1912. The current 9-foot channel navigation and bank stabilization project,

extending 732 miles from Sioux City, Iowa, to the mouth of the river, was authorized in 1945 and construction is now nearing completion. The regulated flows needed for the normal 8-month navigation season are provided by an upstream system of six large multiple-purpose reservoirs on the main stem of the river.

In the 1860's the first significant irrigation was undertaken and the practice has continued to grow, stimulated in part by the Reclamation Acts of 1902 and later, with many project developments, but especially by the forces of general inadequacy of moisture and the instability of dryland agriculture. The use of water for irrigation historically has dwarfed the amounts of water used for all other purposes within the region and currently accounts for over 90 percent of the regionwide consumptive use. All available projections indicate that irrigation use will continue to dwarf all other water uses. Although all States except Missouri and Minnesota require either a water right or permit authority to divert water for any purpose, accurate measurements or accounting records of the actual amounts of water used for irrigation are not always available. As a result, the amounts of water used are based on estimates made with varying degrees of accuracy by State and Federal agencies.

It generally has been the responsibility of local people to provide their own water supplies, although Federal and state assistance and regulation has been significant. In the mid-1920's Federal and state assistance to farmers in providing land and water management practices was inaugurated. This assistance was strengthened and enhanced as a result of the drought of the 1930's and has since been accelerated by Federal, State, and local actions. Federal participation in flood control in the Missouri Region started shortly after enactment of the Flood Control Act of 1936 and has been modified almost continuously since then. Of particular importance to development of the water resources of the Missouri Region was the Flood Control Act of 1944, which adopted a comprehensive plan for basin-wide water resource development. That plan has been subsequently

modified and augmented by a number of Congressional authorizations. The 1944 Act stimulated creation of the Missouri Basin Inter-Agency Committee in 1945 to foster natural resources development. This committee was terminated with the establishment of the Missouri River Basin Commission in 1972 as the principal agency for the coordination of Federal, State, interstate, local, and non-governmental plans for the development of water and related land resources.

1. Surface Waters. Historical streamflow data reflect the constantly changing effects of water resource development and streamflow depletions. To be useful as a measure of surface water availability, historical streamflow data must be adjusted to reflect the constantly changing depletions. This is equally true when planning water resource developments and in making projections of future water uses. More recently, there have been significant increases in the use of ground water, particularly for irrigation. The effects of ground water usage on streamflows are quite complex and vary from one location to another. Ground water effects from the alluvia may show up immediately, or when at a distance they may take years before showing up in streamflow measurements. The 1971 MBIAC Framework Report estimated the 1970 level of depletions in the region to be 11.7 million acre-feet; whereas, the SRF estimate for the 1975 level of depletions is 15.6 million acre-feet as shown in MRBC's National Assessment Technical Memorandum No. 2. This difference is discussed at some length in Chapter III--comparison of the State/Regional Future (SRF), the Modified Central Case (MCC), and other estimates of water use and availability.

Contributions to streamflow vary considerably throughout the region as might be expected with a variable pattern of annual precipitation and runoff combined with a variable intensity of water utilization and development. Historically, annual outflow of the Missouri River has varied widely, with several years showing flows in excess of 100 million acre-feet to a low of 22 million acre-feet in 1934. Daily variations are more pronounced, ranging from 615,000

cfs recorded in July 1951 to a minimum of 4,200 cfs in 1940. Wide fluctuations are now moderated considerably by the operation of six main stem reservoirs and over 100 tributary reservoirs, each of which has over 25,000 acre-feet of storage capacity.

Almost every stream in the Missouri Region has experienced high flows and in many instances the accompanying devastating floods. The opposite effect of too little water has also been true, with all parts of the region having experienced numerous periods of subnormal precipitation and the accompanying droughts. The most notable drought periods regionally extended from 1930 to 1941 and from 1953 to 1959. More recently, widespread areas were seriously affected by subnormal precipitation in 1974, 1975, 1976, and extending through the early months of 1977.

2. Ground Water. The widespread occurrence of ground water within the region has enabled development, particularly for agriculture, both nearby and remote from perennial streams. In some locations the abundance of ground water has permitted municipal, industrial, and irrigation development where its quality was better or it was more readily available than surface water. Ground water accretions provide the basic flow for many surface streams which otherwise would flow only after runoff-producing precipitation. In some cases the streambeds lie above the water table and the streams lose water to the underlying aquifer. The relationships between ground water and streamflow are very complex in many areas of the region, are not very well understood, and are often clouded by emotion.

Generally, the principal source of ground water is precipitation that infiltrates the soil and percolates downward to the water table. Seepage from stream channels and reservoirs is another source. Along flood plains the quantity of recharge to ground waters resulting from temporary flooding may exceed that resulting from precipitation over the same area during several months or

even years. Some ground water recharge is artificial, as from surface-water irrigation, leakage from water distribution systems, outflow from septic tanks, and the like. Currently the deliberate artificial recharge of aquifers is practiced at only a few localities in the Missouri Region.

Under natural conditions, the average annual recharge and water uses balance out the average annual discharge or loss of ground water. Short-term rates of discharge and recharge, however, are rarely the same, since discharge is generally continuous and recharge intermittent. Thus, short-term fluctuations in the ground-water table can be expected. Further, pumping from wells affects the natural long-term balance of discharge and recharge to ground water. When the quantity of water withdrawn is small, its short-term effect is virtually imperceptible. However, when pumpage of ground water is relatively large, seasonal and long-term lowering of the water table is to be expected. The decrease in volume of ground water in storage is progressive unless a new balance between discharge and recharge can be established through decreasing the rate of natural discharge, increasing the rate of recharge, or both.

Within the region, ground water is used for irrigation, municipal, manufacturing, mining, rural domestic, and livestock purposes; and, to a limited extent, for cooling in electric power production. Of the nearly 9.8 million acre-feet of ground water withdrawals, as estimated in the SRF for 1975, about 8.5 million acre-feet, or 87 percent, were used for irrigation. Ground water is less likely to be contaminated than surface water and it is nearly free of sediment. Protected from the elements, it constitutes a water supply equally reliable throughout all seasons of the year. It is only recently that most of the States began to monitor more closely the ground water withdrawals; however, precise information on consumptive use of the water and net effects on streamflow are still not generally available. With the recent large increases in irrigation from ground water sources, brought on largely by installation of sprinkler systems and the higher

farm commodity prices of 1973 and 1974, the States are turning to legislation and administration to more closely control and monitor ground-water use.

The U.S. Geological Survey furnished the following estimates for use in the 1975 National Assessment showing the amounts of ground water in storage within the Missouri Region:

TABLE 2
Estimated Quantity of Ground Water of Less Than
3,000 mg/l Dissolved Solids Available From
Storage in Aggregated Subareas of the
Missouri Region ^{1/}

<u>ASA Number</u>	<u>Total Volume of Water in Storage (thousand acre-feet)</u>	<u>Volume of Water Available from Storage (thousand acre-feet)</u>
1001	390	239
1002	92	46
1003	183	92
1004	496,000	160,000
1005	450,000	137,000
1006	299,000	92,000
1007	45,000	22,900
1008	1,240,000	573,000
1009	75,000	34,400
1010	470,000	184,000
1011	<u>350,000</u>	<u>160,000</u>
TOTAL	3,425,665	1,363,677

^{1/} Some of the water in storage and shown as being available from storage far exceeds the allowable solids content for municipal and industrial use.

Estimates of the availability of ground water in the region have been based on the specific ground water data that exists as a result of previous investigations. In areas that have not been investigated they are based on the best evidence available. Some of these unstudied areas are so lacking in available data that the best current evaluations must be regarded as highly tentative. At various locations throughout the region, the quantity of water available to wells varies widely depending on the hydraulic character of the underlying rocks.

3. Water Quality. Public Law 92-500 dictates the Nation's water quality objectives. Section 101(a)(2) states: "...it is the national goal that wherever

attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water shall be achieved by July 1, 1983." This, then, is the overall governing rule for the Missouri Region.

In general, it can be assumed that municipal, industrial, and feedlot effluents, while currently causing some degradation immediately downstream from outfalls, will be appropriately treated as required by P.L. 92-500. At this time, there are no known feasible means of controlling water quality problems caused by farm and ranch operators, although increasing emphasis is being placed on management of irrigation water use and on education and training in the use of farm chemicals. It may be possible to reduce somewhat the salinity of irrigation return flows in some areas, although to what extent is not now determinable. One of the more significant stream pollutants throughout much of the Missouri Region is sediment resulting from sheet, gully, and streambank erosion. Prior to 1952 the Missouri River outflow had a natural sediment load of about 300 million tons annually, representing a load of about 575 tons per square mile per year. However, reservoir storage and conservation measures have reduced the recent Missouri River average sediment outflow to about 100 million tons annually. At Omaha, Nebraska, the average sediment load carried by the Missouri River dropped from 175 million tons annually to 25 million tons after closure of the Fort Randall Dam in 1952. Although improvements in land conservation practices, controlled grazing, taking some lands out of cultivation, and installing control structures will probably lessen the problem, stream sediment will always be a problem at numerous locations throughout the region. This is particularly true throughout most of ASA 1009 where average yields range from 250 to 9,500 tons per square mile per year for the affected drainage areas.

Despite numerous investigations and surveillance programs, available data concerning the quality of surface waters of the region are generally very inadequate.

More sampling stations and a reliable method to transmit and centralize the location of available data are needed. Records at most existing stations are not available for a period long enough to accurately define the changing quality of streamflow. Particularly deficient are data concerning the biological quality of surface waters.

Although, generally, ground water in the region is free from bacterial pollution, there have been numerous local problems associated with improper waste disposal, septic tank effluents, acid mine drainage, and other leakage problems. Also, the application of herbicides and fertilizers in many irrigated areas has caused local problems. Large areas, particularly in North and South Dakota, have ground water of inferior chemical quality which is of natural occurrence. Total dissolved solids content of the ground water ranging from 2,000 to 3,000 mg/l is common. Without desalinization treatment the water has very limited uses. While not meeting ideal standards, poor quality ground waters often are utilized for municipal, domestic, and other purposes in lieu of alternative supplies which are often difficult and much more costly to develop.

4. Status of Development. Water resource programs in the Missouri Region began over 100 years ago. The earlier water resource developments were constructed and financed primarily by individuals, private groups, and political subdivisions and were oriented largely toward single-purpose improvements to meet specific needs without substantial regard for other functions. Since 1949, most of the development has been constructed and financed largely by Federal funds with participation by local or non-Federal entities as required by the authorizing legislation for the various programs. The Pick-Sloan comprehensive development plan as authorized by the Flood Control Act of 1944 and subsequent authorizations shifted the emphasis from single-purpose to multiple-purpose programs.

The 1971 Framework Report showed that, in 1965, the Missouri Region contained 107 major reservoirs and 1,387 other reservoirs with individual storage

capacities of less than 25,000 acre-feet, which either were completed or under construction. In the aggregate these reservoirs provide a total of over 112 million acre-feet of storage capacity, 99 percent of which serves multiple purpose functions, including flood control, municipal and industrial water supply, irrigation, hydroelectric power, navigation, water quality improvement, fish and wildlife enhancement, and recreation. Nearly 75 million acre-feet of storage capacity is located in the six large main stem reservoirs of which all but 4,720,000 acre-feet, reserved exclusively for flood control storage, are used for multiple purposes. Since 1970, construction has been initiated or completed on about 12 additional major Federal reservoirs located on tributary streams which have a total storage capacity of over 2 million acre-feet. In addition, numerous P.L. 566 watershed projects, which include many smaller single-and multiple-purpose reservoirs, have been completed or are under construction.

Irrigation is by far the largest water user in the region. Currently, about 9 million acre-feet of storage located in tributary reservoirs is dedicated primarily for irrigation use. The large Garrison and Oahe multi-purpose units in the Dakotas will divert increasing amounts of water from these two large main stem reservoirs. These two large projects provide under first-stage development for the irrigation of about 440,000 acres of land (less than one-half of this in the Missouri Region with the remainder in the Souris-Red drainage) as well as providing municipal and industrial water for 64 cities and towns. Second-stage developments, not authorized, would expand the acreage to about 1.5 million acres. Most of the recent growth in irrigation over the region has resulted from increased use of ground water coupled with the installation of sprinklers by individual landowners. There have been no large Federal irrigation projects completed since completion of the Framework Report, and most of the recent large increases in irrigated acres have been from individual development rather than by groups

or political entities.

Various flood control programs and protective works are in operation throughout the region to reduce flood and erosion damages. Many improvements were made by individuals or by small groups in local areas. The major impetus for the Federal programs in the Missouri Region began with passage of the Flood Control Act of 1936, which recognized that reduction of flood losses was in the national interest. Since then a number of major reservoirs have been constructed which include large storage space allocations for flood control. Also, numerous channel, levee, and upstream watershed projects have been constructed which reduce flood damages in local areas. Although varying degrees of flood protection have been provided to well over 3 million acres in the basin, there remain about 13 million acres subject to flooding. The Corps of Engineers and the U.S. Soil Conservation Service estimated that at 1967 price levels and 1975 development the average annual flood damages in the region were nearly \$228.5 million. Assuming that recent trends of Federal appropriations for structural measures and flood plain regulation would be continued, the two agencies estimated that flood damages in 1985 would be about \$233 million and in 2000 about \$269 million at 1967 price levels. Floods are usually the major cause of streambank erosion and gully erosion. The Corps of Engineers estimated that, of the 538,100 miles of stream channel in the region, in 1975 there were 52,800 bank miles eroding, 11,200 miles of which were considered to have a serious erosion problem. The damages in 1967 dollars for 1975, 1985, and 2000 are estimated to be \$7 million, \$9.5 million, and \$11.4 million, respectively. For gully erosion, the Soil Conservation Service estimated that there are 2 million acres subject to damage with resultant damages in 1967 dollars as follows: 1975 - \$31.8 million, 1985 - \$65.4 million, and 2000 - \$69.7 million.

All of the larger cities and most of the smaller communities have central water supply systems. Although not determined, a number of the larger manufacturing

industries have self-supplied water systems. Most of the smaller industries and the commercial establishments obtain their water supplies from municipal systems. Generally, the rural residents obtain their supplies from individual wells, although recently a number of rural water supply systems serving smaller communities and the rural residents have been constructed and many more are in various stages of planning. In the more thinly populated areas, it is doubtful whether rural systems will ever be built. Many of the water supplies of the smaller communities and rural residents are highly mineralized and the quality is less than desirable. In 1974 the Congress passed the Safe Drinking Water Act which requires certain minimum standards for any water supply system serving 25 or more people. Since the Act provided neither funds nor implementing procedures for construction, its effect on the many smaller communities throughout the region with substandard drinking water supplies is not known at this time. Currently, less than one-half of the 9 million people residing in the Missouri Region obtain their water from surface supplies with the remainder being served by ground water.

Because the raising and feeding of livestock is so important to the region's economy, water supplies for livestock use have a high priority, ranking along with domestic use in most of the 10 States. The storage or withdrawal of stream-flow generally must not interfere with downstream livestock use; and in most of the States the construction of stockwater ponds is not legally restricted except in size and dam height. The Department of Agriculture estimated that in 1975 there were over 365,000 stockwater ponds in the region. These ponds, together with flowing streams and ground water, supply the large amounts of stockwater required. In many parts of the region, these ponds have a relatively short useful life and lose much of their capacity because of sediment inflows; consequently, they have to be rebuilt, enlarged, or replaced.

The electric power industry, one of the fastest growing industries of the

region, supplies power from a variety of generating plants. The facilities serving the region are comprised of about 560 systems, of which the investor-owned systems generate about 56 percent of the total electric energy produced. The remainder is produced by cooperatively owned, municipal and state owned, and one Federal hydroelectric system. Table 3 shows the 1974 composition of the basin's electric power supply, as shown in "Status of Electric Power in the Missouri River Basin," dated October 1976, and published by MRBC.

TABLE 3
Existing Electric Power Supply,
Missouri Region 1/
(calendar year 1974)

<u>Type of Plant</u>	<u>Number</u>	<u>Installed Capacity</u> (MW)	<u>Net Generation</u> (GWH)
Fossil-fired steam	91	14,447	62,482
Nuclear steam	2	1,282	4,290
Diesel	216	922	1,046
Combustion turbine	29	1,410	888
Combined cycle	1	52	29
Conventional hydro	59	3,348	17,372
Pumped storage	1	300	(181)2/
TOTAL	399	21,761	85,926

1/ Hydrologic boundary

2/ Net energy loss due to pumping water to upper reservoir

For the national assessment, data were compiled on county line boundaries which approximate the hydrologic boundaries. Although for most uses the differences are generally quite small, data for electric energy production and associated water requirements do show significant differences. Data compiled for the national assessment by the Federal Power Commission for estimated 1975 electric energy production, energy requirements for 1985 and 2000, and associated water use are shown in Table 4. Many of the new plants projected for construction by 1985 and 2000 are expected to utilize wet cooling towers or cooling ponds which require considerably less water withdrawals but consume slightly more water than once through cooling.

TABLE 4
Estimated Energy Production and Steam Electric
Cooling Water Requirements for 1975, 1985, and 2000,
Missouri Region

<u>Year</u>	<u>Energy Production</u> (GWH)	<u>Water Withdrawal</u> (thousand acre-feet)	<u>Water Consumption</u> (thousand acre-feet)
1975	75,236	4,958	75.0
1985	186,691	6,801	264.0
2000	448,618	5,687	712.0

Fossil-fired and nuclear steam-electric generating plants require large amounts of water for condenser cooling. The quantity of water required at each plant depends on the type of condenser cooling system, the operating efficiency of the plant, permissible temperature rise in the cooling water, and the amount of energy generated. In areas with insufficient water to support even the limited requirements of either wet cooling towers or cooling ponds, air-cooled, dry type cooling towers may be used. These are, however, the most costly to construct and also the most costly to operate of all the types of cooling systems. Because of these high costs, very few have been built and very few are currently planned for the Missouri Region.

A report published by MRBC in October 1976, "Status of Electric Power in the Missouri River Basin," shows that, currently, the electric power generating capacity is more than adequate to meet the region's demands and some power is being exported to areas of need. At present there is approximately 21,761 MW of installed capacity to meet an expected peak demand of 17,480 MW and a net annual energy requirement of 83,400 GWH of generation. The scheduled or planned additional capacity of 20,283 MW to be in service by 1984 would be more than adequate to meet the expected increase in 1985 peak demand of 17,680 MW and 85,600 GWH of generation. By the year 2000 the peak demand is expected to increase to about 87,600 MW, about two and one-half times the expected 1985 capacity in service, with a net energy requirement of 424,900 GWH. Nearly 75 percent of the currently

planned additions would be coal-fired steam plants and this predominance of the use of coal is expected to continue to the year 2000 unless there are significant technological changes brought about by the expanding research efforts underway.

G. Laws, Policies, and Administration of Water Use and Development

The development and use of water resources long have been recognized as a responsibility of both the States and the Federal Government. The laws have evolved gradually, stemming initially from the State and Federal constitutions, then progressive statutory action, and from many judicial decisions. From all of these have come the important elements of State and Federal policy, and particularly at the State level, the practical means for water administration. With the more recent increases in water use have come greater competition for the available water supplies and an ever-increasing number of controversies requiring adjudication. As the conflicts over water use increase, it is apparent that quantification of various water rights by competing interests within the Missouri Region will require an increasing amount of coordination and may subsequently require adjudication. Current and emerging water-use conflicts include such matters as Federal reserved rights, Indian rights, and interstate rights, and allocations as well as the intrastate conflicts.

Because of their complexity and the ever-evolving and changing Federal and State water laws and policies, it is difficult to provide a current and accurate summarization in a publication of this nature. It is pertinent to note, however, that the highlights of Federal and each State's legal and institutional structure for water resource development, administration, and management were published in Volume 3, "Laws, Policies, and Administration Related to Water Resources Development," of the Missouri River Basin Comprehensive Framework Study Report, dated June 1969. A supplement to Volume 3, updating it to changes which have occurred

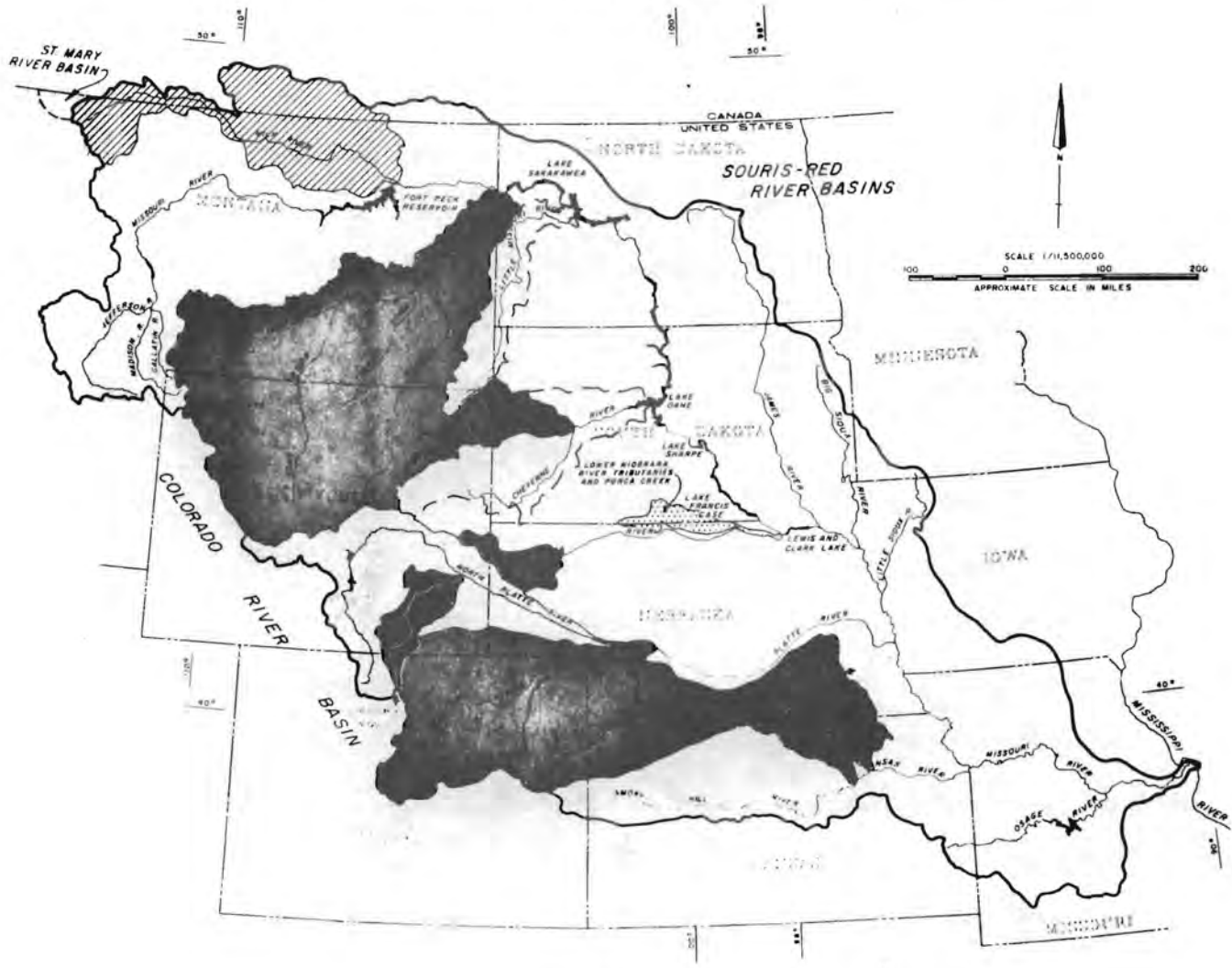
through 1975, is under preparation and will be published by MRBC in the near future.

1. State Water Laws, Policies, and Administration. In the general field of water laws, two fundamental doctrines were adopted by the States reflecting not only in part the origin of those who formulated them, but also the variable climatic and hydrologic conditions found from the subhumid east to arid west. Minnesota and Missouri recognize primarily the riparian doctrine, while Colorado, Montana, and Wyoming have specifically repudiated it and established the doctrine of appropriation rights. The Iowa water rights law makes substantially all uses of water in the State subject to permit and administrative regulation as to diversion, storage, or withdrawal, over some period of time not to exceed 10 years. Kansas, Nebraska, and North and South Dakota depend on the appropriation rights doctrine, but recognize the riparian doctrine in varying degrees in relation to the statutory rights. In these four States a riparian landowner could claim a water right to the extent of his reasonable use, but all waters in excess thereof remained subject to appropriation. However, Kansas passed legislation in 1945, and North and South Dakota in 1955, which provided that thereafter riparian landowners were to be governed by the same laws and would be obliged to follow the same appropriation procedures as nonriparian landowners. This legislation did not apply to landowners who were exercising or developing their riparian water rights at the time the legislation was enacted.







2. Interstate Compacts, Court Decrees, and International Treaty. Where rivers cross State boundaries, and with mounting usage, there can be problems in allocation of the interstate water and administration of water rights. Because of these problems and existing or impending litigation, several affected States have entered into interstate compacts or requested court apportionment of the affected waters for the river systems shown on Figure 2.

Figure 2

STATES AND RIVER SYSTEMS,
INTERNATIONAL WATERWAYS TREATY, AND INTERSTATE
WATER COMPACTS AND SUPREME COURT DECREES
MISSOURI RIVER BASIN



LEGEND

- INTERNATIONAL TREATY 
- EXISTING INTERSTATE WATER COMPACT 
- PENDING INTERSTATE WATER COMPACT 
- ACTIVE NEGOTIATION 
- INACTIVE NEGOTIATION 
- UNITED STATES SUPREME COURT DECREE 

The status and general provision of interstate compacts, court decrees, and one international treaty were described in the Missouri River Basin Framework Report and are not repeated herein, except for the Big Blue River Compact which was ratified by the States of Kansas and Nebraska and approved by Congress subsequent to completion of the Framework Report. The Kansas-Nebraska Big Blue River Compact became effective June 2, 1972, when the Act granting Congressional consent thereto was approved by the President of the United States. The Compact provides, among other matters, that certain minimum flows during specified months shall be maintained in the Little Blue and Big Blue rivers where they cross the Nebraska-Kansas State line and for the regulation of the use of ground water when it is determined that such use adversely affects the terms of the compact agreement.

3. Federal Water Laws and Policies. Federal laws and policies affecting water and related land resource development and management have evolved over many years. Early water resource legislation dealt with navigation and later with mining. In the arid west, and covering most of the Missouri Region, the turn of the century saw reclamation laws providing primarily for Federal assistance in irrigation development come into being. The drought years of the 1930's resulted in Federal legislation recognizing the principles of multi-purpose development and agricultural watershed conservation and protection. The Flood Control Act of 1936 recognized a Federal interest in flood control. The Flood Control Act of 1944 expanded and modified previous Federal legislation to recognize Federal involvement in all functional phases of water resource development and established coordination requirements between Federal agencies dealing in water resources development and with the States. For the Missouri Region, the 1944 Act authorized the "Pick-Sloan" comprehensive basin-wide development plan. This plan included five large main stem multiple-purpose reservoirs, numerous tributary reservoirs and attendant works, Missouri River levees extending from

Sioux City to the mouth, and several other local projects. While the major elements of the plan have been completed and are serving to meet many of the water needs of the region, remaining elements are in various stages of planning, awaiting planning funds, under development, or temporarily or permanently shelved. Other Federal legislation over this interval of time dealt with such important matters as water quality, hydroelectric power, municipal and industrial water, outdoor recreation, fish and wildlife conservation and enhancement, regulation of development on flood plains, and environmental concerns. Recently, Federal legislation has been more concerned with environmental matters and conservation than with resource developments. This is exemplified by the National Environmental Policy Act of 1969, Federal Water Quality Act Amendments of 1972, and other recent legislation.

H. Study Areas

The Missouri Region or River Basin is one of 21 major water resource regions of the Nation being analyzed for purposes of the 1975 National Assessment. Each region was further subdivided into aggregated subareas (ASA's) of which the Missouri Region has 11 as shown on Figure 3. Each ASA is comprised of one or more subareas. Each subarea, ASA, and the region are on county line boundaries to facilitate aggregation of much of the data being utilized in the national assessment. Water information, of course, is on hydrologic boundaries. Data for each ASA in the Missouri Region and a regional summary were published in MRBC's second technical memorandum dated August 1976. In this regional summary report, the data for each ASA are not repeated, but are shown at the end of this section only for the totals of the ASA's above Sioux City, Iowa (1001 through 1006), and where the regional totals comprise all of the 11 ASA's.

Figure 3
MISSOURI RIVER BASIN
1975 NATIONAL WATER ASSESSMENT
Aggregated Subareas



III. COMPARISON OF THE STATE/REGIONAL FUTURE (SRF), THE MODIFIED CENTRAL CASE (MCC), AND OTHER ESTIMATES OF WATER USE AND AVAILABILITY

Although the national assessment is concerned primarily with two sets of estimates, the State/Regional Future (SRF) and the Modified Central Case (MCC), in the Missouri Region the estimates shown in the Comprehensive Framework Study Report (FS) under the assumed 1970 and earlier levels of development are of particular significance and provide a basis for comparison. Also, it is worthy to note other ongoing and programmed studies which have or will have a bearing on determining water availability and use within the region. Each of the estimates and major studies is described and discussed briefly in the following paragraphs. Also, some significant comparisons are made and some of the effects of using or attempting to use one estimate over another estimate are discussed.

For reasons set forth hereinafter, there are wide ranges in the basic data and derivation of estimates for water use and availability in the Missouri Region. These occur primarily and in the largest degree because of a lack of firm data on irrigated areas and on unit requirements for withdrawals and net depletions to surface and ground water sources. This, together with differences of assumptions and procedures, makes impracticable any consensus at this time on water supplies used historically or currently, those presently available, and the probable uses and streamflow or ground water depletions under projected increased usage.

A. SRF Estimates

The State/Regional Future (SRF) estimates provide information concerning each of the 10 states. Planning goals and objectives and current (1975) and projected (1985 and 2000) estimates of socio-economic characteristics, primary land use, water use and requirements, and other data pertaining primarily to water and related land resources. The 11 ASA's for the Missouri Region were prescribed by WRC to provide uniform areas for reporting purposes. SRF estimates

were assembled by the Missouri River Basin Commission and are comprised of information and data furnished primarily by the 10 States, but to some extent by regional offices of the Federal agencies, complemented by data compiled by the MRBC staff from other available sources. More specifically, the States furnished data and information concerning the socio-economic characteristics, land use, and water use. Federal agency members of MRBC furnished data pertaining to electric energy production and associated water use, erosion and sedimentation, flood damages, navigation, and water quality. The MRBC staff compiled information pertaining to the environmental resources of the basin and estimates of water-oriented recreation utilizing the states' SCORP reports. SRF estimates of current and projected flows at the outflow point of each ASA were derived by using Framework Study estimates of full natural flows unmodified by any depletions, and subtracting from these estimates the accumulated upstream depletions through any target year. The Framework estimates of unmodified flows were adopted since they have gone virtually unchallenged. These flows were modified further by using the best available estimates of probable imports and exports and reservoir evaporation estimates as derived from the Framework Study. Since ground water use in several of the ASA's significantly affects streamflow, a ground water factor was applied so as to more accurately reflect possible streamflow effects. Approval by the MRBC members to print Technical Memorandum No. 2 for the national assessment did not constitute approval of the estimates contained in the report. In fact, considerable controversy has resulted and serious questions are being raised concerning the estimates of water withdrawals and depletions and their effect on streamflows--historical, current, and projected.

Since irrigation accounts for over 90 percent of the total water consumed in the region, excluding reservoir evaporation losses, some discussion of the States' estimates of irrigated acreage and water use appears appropriate. Quite obvious is a highly significant variance in the acreage of land actually irrigated

as contrasted to that only subject to such service. The unit values for irrigation withdrawals and streamflow depletions are also at considerable variance. Attempts were made to obtain estimates of the number of acres under irrigation which could be considered to have available and that use a full-service water supply and to obtain the number of acres which had available only a partial supply, but most of the States were unable to attempt such a classification. While basic techniques for such estimates are available and it is a fairly straightforward computation to determine water requirements for optimum crop production, very few areas in the Missouri Region have this optimum water supply available. To determine actual irrigation water use in the basin requires a great deal of knowledge about each area being irrigated, available water supplies, irrigation methods used, and many other factors that affect the net depletion to the streams and/or to ground water reservoirs.

The Bureau of Reclamation and the affected irrigation districts maintain comprehensive records on Federal irrigation projects. In its 1974 Summary Report on Water and Land Resources Accomplishments, the report showed for Reclamation projects 1.1 million acres in the Missouri Basin as being available for full-service irrigation, of which about 1 million acres were actually serviced that year. However, the serviced area is less than nine percent of the total reported by the States as being irrigated in 1975. There are numerous other organized group irrigation projects in the basin exclusive of areas irrigated by individuals. The total number of acres in these non-Federal group projects was not determined for the national assessment studies; however, the Framework Study shows about 5.8 million acres in existing group irrigation projects in 1970, which would indicate that in 1975 about 4.7 million acres were in non-Federal group projects. The Framework Study showed a total of 8.5 million acres (7.4 million full and 1.1 million intermittent service) being irrigated in 1970 which would indicate that 2.7 million acres were being irrigated by individuals.

Using the States' estimates of nearly 11.5 million acres irrigated in 1975, it would show an increase since 1970 of about 3 million acres; however, the MCC shows but 7.9 million acres in 1975, and the interpolation between the Framework Study, 1970 and 1980 irrigated area estimates, would be 8.8 million acres. It is significant to note that almost all of the recent new irrigation development has been accomplished by individual landowners, most of this served from ground water sources. While the Bureau of Reclamation maintains comprehensive records, other group project records vary from very poor to very good, and individual records vary according to the applicable State law reporting requirements. Whether the acreage actually receiving irrigation water in 1975 was about 8 million acres or well over 11 million acres obviously has a large impact on streamflow depletion from this use. The actual amount of irrigation water used varies seasonally and over the long-term average, depending on rainfall, available water supply, and other factors. While gross diversions are generally recorded, return flows are seldom monitored, which makes it difficult to determine the amount of water actually consumed in the irrigation process. Furthermore, with the increasing use of ground water for irrigation and other purposes and its complexities in relationship to streamflow, the determination of streamflow depletions is compounded. Unit withdrawals in the Framework Study estimates range up to 3.0 acre-feet per acre on the average and average streamflow depletions up to 1.6 acre-feet per acre--the corresponding MCC estimates are as high as 8 and 2.4 acre-feet, respectively, and the SRF estimates up to 5 and 2.5 acre-feet per acre. Obviously, these variances, too, have widely varying results when applied to irrigated areas. The foregoing observations are presented, not in defense of any one of the several estimates, but to point out the complexity and difficulties involved in attempting to arrive at reasonable estimates of irrigation water use within the Missouri Region unless and until accurate irrigated area and unit water use figures are available with a concensus thereon.

Although water used for purposes other than irrigation accounts for less than 10 percent of the total consumed within the region, the importance of these uses to the economy and social well-being of the residents cannot be overemphasized. Most of the States recognize domestic use as having the highest priority and some States place livestock water use in the same priority. Since most manufacturing, industrial, or mining concerns can afford to pay more for water than irrigators, they usually obtain needed water in one fashion or another when there is competition for available supplies. It is only recently that such competition has become evident although it may play a greater role in the future, particularly in such areas as the Front Range of the Rocky Mountains in Colorado and for areas of vast coal deposits in Wyoming, Montana, and North Dakota.

B. MCC Estimates

The only set of so-called MCC estimates furnished MRBC by WRC is dated February 1976. These estimates reflect information prepared by Federal agencies from a national perspective. They are currently under review and possible revision. Subsequently, considerable correspondence has been exchanged and several meetings have been held by MRBC and regional Federal agency representatives to discuss differences concerning both the MCC and SRF estimates and in comparison to others. Since the procedures used and the bases for developing the MCC and the SRF estimates were quite different, it does not appear worthwhile to pursue further at this time attempts at their complete reconciliation. Rather, the concerned interests need to recognize these differences, learn from the experience, and devise procedures or studies which will coordinate and improve future estimates and attain consensus on water uses and availability.

Comments pertaining to the MCC estimates were included in MRBC's Technical Memorandum No. 2 for the national assessment, and little if anything would be gained by repeating those comments at this time. However, since irrigation

water use in the region constitutes such a large portion of total water use, it is appropriate to summarize difficulties encountered in attempting to accept these MCC estimates. Using the 1967 Conservation and Needs Inventory (CNI) estimates of irrigated acres, updated by some arbitrary bases to 1973, may be appropriate for some areas in the 1975 base, but would not be appropriate for all areas in the Missouri Region. Recent local significant increases in the number of acres being irrigated have resulted primarily from increased prices being paid for farm commodities, increased use of ground water, and improved sprinkler irrigation systems. While the use of sprinkler irrigation systems is on the increase in many areas of the Missouri Region, the most notable increases have occurred in the Platte and Kansas river basins (ASA's 1007, 1008, and 1010). The MCC estimates are based on unit water withdrawals and consumptive use requirements for optimum crop production rather than actual water use. Since many irrigated areas of the region suffer from late season water shortages and, thus, few areas receive the amounts of water estimated for the MCC, it is obvious that the MCC irrigation estimates do not reflect actual water use--neither the withdrawals nor consumptive use.

In addition to the disparities in water use estimates by the MCC, its modified flow estimates raise an additional concern since they should show the amount of water actually available at the outflow point of each ASA. The MCC attempts to show the outflows for average annual conditions, labeled 80 percent condition (1 of 5 years), and the 95 percent condition (1 of 20 years). Also, while estimates of total ground water use and consumption from the ground water reservoir are shown, no attempts are made in the MCC to estimate the effects on streamflow. While it is difficult to determine the effects of ground water use on streamflow with the data generally available, use of large amounts of ground water has been increasing in several of the ASA's, and the effects need to be recognized in terms of net depletions to the ground water reservoirs and depletions

or contributions to the streams. Otherwise, available surface water supplies can be under or overstated.

C. Other Estimates

The 1971 Missouri River Basin Comprehensive Framework Study Report reflected in depth work by all affected agencies and the results have been used widely in many subsequent studies made for portions of the region. Among these are the Northern Great Plains Resources Program study, the Corps of Engineers' Missouri River Main Stem Reservoir Regulation studies, the Bureau of Reclamation Power Rate and Repayment studies, and industrial water marketing studies by a special ad hoc committee of MRBC. Other estimates of water availability and use have been or are being made by the States in their State water plans. The Corps of Engineers recently completed a draft of its "Review Report for Water Resources Development" (Umbrella Study) covering the Missouri River main stem from Three Forks, Montana, to Sioux City, Iowa, which discusses the effects on the future reservoir hydroelectric plant and river operations assuming different levels of depletion in Missouri River flows. The Bureau of Reclamation, collaborating with certain of the States and other agencies, has underway a Total Water Management study covering the Missouri River and tributary areas above the Gavins Point Dam, which is the lowermost of the six main stem dams on the Missouri River. This study is attempting to better appraise irrigated acreages, diversion quantities, actual water usage, etc. MRBC has underway a Level B study covering the Yellowstone River and adjacent coal areas which is currently scheduled for completion in November 1977. MRBC completed a Level B study of the Platte River Basin in Nebraska in 1976. An MRBC sponsored Level B study covering the Upper Missouri River Basin in Montana is budgeted for initiation in FY 1978. In addition, numerous other studies are underway or are programmed which cover smaller areas within the region, and each of which is concerned, among other subjects, with appraising water and land use, and their availability for instream

uses and added development.

D. Salient Comparisons of Estimates and Discussion

It appears appropriate to present several pertinent comparisons of consumptive water use estimates, their depletion effects on streamflow, and the residual water available to satisfy existing and future needs. Summary tables and comparisons for the drainage area upstream of Sioux City, Iowa, the outflow point of ASA 1006, are also presented since this is one of the key index stations in the region. It is the long-term gaging station used as a reference point to indicate water availability in the six large upstream reservoirs; it is the head of Missouri River navigation and generally indicates whether adequate water depths for commercial navigation are available; and, during drought conditions, it is the index point for showing anticipated reservoir inflows and reservoir releases necessary to maintain adequate flows to assure downstream water quality and fulfillment of essential water supply needs.

Tables 5 and 6 show estimated average annual depletions and residual flows for the Missouri River at Sioux City, Iowa, and Hermann, Missouri, for 1975, 1985, and 2000 for the State/Regional Future (SRF), Framework Study (FS) projections, and the estimated average annual depletions for the Modified Central Case (MCC). For comparative purposes, the full natural unmodified flows derived from the Framework Study were used for all three estimates as footnoted:

TABLE 5
Missouri River at Sioux City, Iowa, Estimated Average Annual Streamflow Depletions and Residual Flows (in million acre-feet)

	<u>Estimated Depletions</u>			<u>Residual Flows</u> ^{1/}		
	<u>1975</u>	<u>1985</u>	<u>2000</u>	<u>1975</u>	<u>1985</u>	<u>2000</u>
SRF	9.8	11.9	14.7	18.5	16.4	13.6
MCC	6.1	11.3	12.0	22.4	17.2	16.5
FS <u>2/</u>	7.8	9.8	11.7	20.5	18.5	16.6

TABLE 6
Missouri River at Hermann, Missouri, Estimated Average
Annual Streamflow Depletions and Residual Flows (in million acre-feet)

	<u>Estimated Depletions</u>			<u>Residual Flows</u> ^{1/}		
	<u>1975</u>	<u>1985</u>	<u>2000</u>	<u>1975</u>	<u>1985</u>	<u>2000</u>
SRF	15.5	18.6	22.5	49.2	46.0	42.4
MCC ^{2/}	14.7	19.6	20.6	51.0	46.0	45.0
FS ^{2/}	13.8	17.3	31.1	51.5	48.0	44.2

^{1/}Based on full natural, unmodified flows of SRF 64,900,000 and MCC 64,900,000 (both corrected for imports) and FS 65,297,000 acre-feet (not corrected for imports).

^{2/}As derived from Missouri River Basin Framework Study basic tables.

Projections can be made from any base condition and assuming any of various future events taking place. Obviously, from the table there are significant variances in both the base conditions and future projections. Generally, where water use is concerned, most projections have been overstated since they are usually based on an optimistic future of events that would encourage greater water use. However, of greatest concern to MRBC are the significant differences in estimates of current (1975) irrigated areas, water withdrawals, consumptive use, and depletions affecting streamflows. Dependable results in this respect are essential to all regional planning studies, to the operating agencies in forecasting water and power production and revenues, and to the States as they propose developments and the effects thereof locally and regionally.

To provide insight for the variations in basic data and magnitude of differences, reference is made to Table 7. Here, compared for the three major sources of projections, are the target year irrigated acreages, irrigation withdrawals, and irrigation consumptive use estimates. Considering that irrigation uses of water comprise about 90 percent of the total usage, it is apparent that irrigation impacts heavily on all withdrawals and consumptive uses of water in the region. It follows that to satisfy these irrigation consumptive uses there are major depletions to the combination of ground and surface (stream) sources. Neither

the SRF nor MCC show the amount of irrigation consumptive use supplied from ground water so it is impracticable to carry the comparison to "irrigation stream-flow" depletions as was done in Table 5 for "total" depletions. It is apparent from Table 7 that the wide divergence in the irrigated areas and unit water requirements therefor result in the wide divergence in withdrawals and consumptive uses, and obviously in streamflow and ground water depletions if they could be separated.

TABLE 7
Estimated Irrigated Area and Average Annual
Irrigation Withdrawals and Average Annual Consumptive Use
(thousand acres or acre-feet)

	<u>Irrigated Area^{1/}</u> <u>(thousand acres)</u>			<u>Average Annual</u> <u>Irrigation^{1/}</u> <u>Withdrawals^{1/}</u> <u>(thousand acres)</u>			<u>Average Annual</u> <u>Irrigation^{1/}</u> <u>Consumptive Use^{1/}</u> <u>(thousand acres)</u>		
	<u>1975</u>	<u>1985</u>	<u>2000</u>	<u>1975</u>	<u>1985</u>	<u>2000</u>	<u>1975</u>	<u>1985</u>	<u>2000</u>
<u>Upstream of Sioux City, Iowa</u>									
SRF	3,686	4,331	5,623	15,317	17,579	20,555	7,233	8,687	10,560
MCC	2,315	3,395	3,512	16,551	26,365	23,858	4,671	7,981	8,217
FS ^{2/}	3,120	3,712	4,547	7,867	9,743	11,989	4,913	5,766	6,927
<u>Upstream of Hermann, Missouri</u>									
SRF	11,463	14,288	17,402	31,389	37,688	43,226	16,053	20,351	25,331
MCC	7,890	8,976	9,614	35,912	45,913	42,360	14,833	19,096	19,299
FS	8,864	10,090	13,407	18,692	23,015	27,614	12,400	15,300	18,900

1/ As supplied from both surface and ground water sources.

2/ Figures for 1975 as interpolated between year 1970 and year 1980 original projections; those for 1985 as interpolated between year 1980 and year 2000 original projections.

Representatives of the Bureau of Reclamation have expressed grave concern about the various estimates of depletions and the Bureau's requirements to set power rates and to estimate power production and revenues so as to meet reimbursable costs within 50 years of project completions required by the directives implementing the Flood Control Act of 1944. Several representatives of states below Sioux City have expressed their concern that upstream depletions may

jeopardize the future viability of Missouri River navigation and their other water needs. The recently completed Corps of Engineers "Umbrella Report" also expressed concern about the various depletion estimates and how these affect planning for the future installation and need for additional hydroelectric generating units at the six main stem dams to meet increasing peak power load requirements.

It is obvious that one of the foremost requirements at this time is for the Federal agencies and the States to firm up the basic data and to realistically determine the amounts of water actually being used, where it is being used, and how much water is available currently and as projected. Until the basic data are obtained and verified, reservoir and related operations cannot be optimized, water resource planning conclusions cannot be formulated, and many attempted decisions for the future of the Missouri Region will be indecisive.

E. Summary Tables

The following tables are summaries of SRF and MCC data for the Missouri Region showing socio-economic characteristics, water volumetric requirements-withdrawals, water volumetric requirements-consumptive use, and surface water supplies. The first set of tables summarizes data for ASA's 1001 through 1006 upstream of Sioux City, Iowa, and the second set summarizes data for the entire region. MCC information displayed is taken from data dated February 20, 1976, except for electric energy production data which is as recently revised by the Federal Power Commission. In the Socio-Economic Characteristics tabulation, total land area includes water area and the acreage shown opposite feed crops is for all non-irrigated cropland; hence, the blanks shown opposite food crops and other crops. The SRF ground water withdrawals are the estimated amounts of ground water which do not deplete streamflows, i.e., mined ground water. They are not gross ground water withdrawals as shown for the MCC.

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 SOCIO-ECONOMIC CHARACTERISTICS

REGION: MISSOURI (10) TOTALS	STATES: COLORADO, IOWA, KANSAS, MINNESOTA, MISSOURI, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING									
CHARACTERISTIC	UNIT	MCC 1975	SRF 1975	MCC 1985	SRF 1985	SRF RATIO 1985/75	MCC 2000	SRF 2000	SRF RATIO 2000/75	
<u>Population: Total SMSA Non-SMSA</u>	Number (000)	8833.3	9065.7	9296.3	10045.4	1.11	10044.9	11760.9	1.30	
<u>Total Employment:</u>	Number (000)	3695.7	3937.2	4083.1	5059.9	1.29	4572.4	5758.5	1.46	
<u>Earnings: Total</u>	1967 \$ (000)	26721.0		37132.5			60302.0			
Agriculture, Forestry, Fishing		2861.7		2857.0			3363.3			
Manufacturing		4431.0		6289.7			10124.4			
Food and kindred products		874.6		1047.1			1371.6			
Paper and allied products		100.7		149.5			239.4			
Chemical and allied products		159.9		259.2			434.7			
Petroleum and coal products		87.0		101.9			143.1			
Primary metals		121.0		140.3			176.7			
Other		3087.8		4591.7			7758.9			
Mining		27.6		317.5			389.4			
Other		19401.4		27668.3			46424.9			
<u>Per Capita Income:</u>	1967 \$	3884.0	3279.0	5176.0	5313.0	1.62	7860.0	8077.0	2.46	
<u>Electric Energy Production</u>	GWH	75236.0	75236.0	186691.0	186691.0	2.48	448618.0	448618.0	5.96	
<u>Land Use: Total Land Area</u>	Acres (000)	323317.0	323125.4	323317.0	323125.4	1.00	323317.0	323125.4	1.00	
Agricultural, Total		309126.0	302706.3	297843.0	301589.5	1.00	296785.0	300340.8	0.99	
Feed Crops		47913.0	90374.9	42549.0	91906.2	1.02	48042.0	91913.7	1.02	
Food Crops		19422.0		16231.0			12403.0			
Other Crops		6462.0		9104.0			12885.0			
Forests and Woodland Grazed		6011.0	28631.3	9952.0	28489.7	1.00	9920.0	28405.8	0.99	
Pasture, Range and Other		229318.0	172236.7	220007.0	166905.7	0.97	213535.0	162619.5	0.94	
Other, Total		14191.0	20419.1	25474.0	21535.9	1.05	26532.0	22784.6	1.12	
Urban		1396.5	7437.6		8155.9	1.10		9114.5	1.23	
Irrigated Farmland		7890.0	11463.4	8976.0	14287.9	1.25	9614.0	17401.8	1.52	

1975 NATIONAL ASSESSMENT
Specific Problem Analysis Summary Report
VOLUMETRIC REQUIREMENTS (withdrawals)
(Million gallons per day-MGD)

REGION	MISSOURI (10) TOTALS	STATES: COLORADO, IOWA, KANSAS, MINNESOTA, MISSOURI, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING										SOURCE: Fresh Saline								
		MCC 1975	SRF 1975	MCC 1985	SRF 1985	SRF RATIO 1985/75	MCC 2000	SRF 2000	SRF RATIO 2000/75	X										
	<u>FUNCTIONAL USE</u>																			
	<u>Domestic:</u> Commercial and Institutional, Total	869.7	1263.5	946.5	1665.7	1.32	1049.9	2055.3												
	Central Systems	781.0	1091.6	858.8	1487.1	1.36	971.7	1874.8												
	Non-Central Systems	88.7	171.9	87.7	178.6	1.04	78.2	180.5												
	<u>Manufacturing:</u> Total	690.8	649.5	721.1	910.1	1.40	291.1	1166.1												
	Food and kindred products	187.7		113.0			93.1													
	Paper and allied products	1.8		3.6			7.2													
	Chemical and allied products	188.1		83.2			87.7													
	Petroleum and coal products	86.3		35.5			30.7													
	Primary metals	114.0		29.0			17.0													
	Other	112.9		456.8			55.4													
	<u>Minerals:</u> Total	340.5	313.3	406.5	340.4	1.09	518.0	417.7												
	Metals	35.1		42.3			54.0													
	Non-metals	160.8		206.1			279.9													
	Fuels	144.6		158.1			177.0													
	<u>Irrigation:</u> Total	32064.3	28026.2	40993.4	33650.3	1.20	37821.0	38595.0												
	Crops																			
	Other																			
	<u>Livestock:</u>																			
	Steam Electric:	408.2	436.0	502.2	580.8	1.33	579.8	729.6												
	Public Lands	4148.0	4964.6	6624.0	7312.2	1.47	5088.0	5444.9												
	Other Functional Uses:	266.8		327.6			403.6													
	<u>TOTALS</u>	38788.3	35653.1	50121.3	44459.5	1.25	45750.5	48408.6												

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 VOLUMETRIC REQUIREMENTS (consumptive use)
 (Million gallons per day-MGD)

REGION: MISSOURI (10) TOTALS	STATES: COLORADO, IOWA, KANSAS, MINNESOTA, MISSOURI, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING						SOURCE: Fresh Saline	
FUNCTIONAL USE	MCC 1975	SRF 1975	MCC 1985	SRF 1985	SRF RATIO 1985/75	MCC 2000	SRF 2000	SRF RATIO 2000/75
<u>Domestic:</u> Commercial and Institutional, Total	247.8	537.0	264.4	694.5	1.29	283.4	831.2	1.55
Central Systems	192.9	427.8	211.2	581.6	1.36	237.6	721.9	1.69
Non-Central Systems	54.9	109.2	53.2	112.9	1.03	45.8	109.3	1.00
<u>Manufacturing:</u> Total	136.1	194.0	119.5	335.8	1.73	207.8	506.8	2.61
Food and kindred products	22.6		36.3			65.1		
Paper and allied products	0.8		1.8			5.4		
Chemical and allied products	67.8		34.4			69.6		
Petroleum and coal products	23.0		17.3			24.9		
Primary metals	9.0		12.0			14.0		
Other	12.9		17.7			28.8		
<u>Minerals:</u> Total	106.5	113.0	120.9	117.3	1.04	142.5	137.4	1.22
Metals	5.1		6.0			7.5		
Non-metals	21.3		27.3			37.5		
Fuels	80.1		87.6			97.5		
<u>Irrigation:</u> Total	13243.4	14333.0	17050.4	18170.6	1.27	17231.6	22617.1	1.58
Crops								
Other								
<u>Livestock:</u>	408.2	428.8	502.2	574.1	1.34	579.8	727.4	1.70
<u>Steam Electric:</u>	49.0	66.6	229.0	216.4	3.25	565.0	575.9	8.65
<u>Public Lands:</u>	220.0		280.6			356.4		
<u>Other Functional Uses:</u>								
TOTALS	14411.0	15672.4	18567.1	20108.8	1.28	19366.6	25395.8	1.62

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 WATER SUPPLIES
 (Million gallons per day-MGD)

REGION: MISSOURI (10) TOTALS	STATES: COLORADO, IOWA, KANSAS, MINNESOTA, MISSOURI, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING				DURATION:		PROBABILITY: MEAN	
	MCC 1975	SRF 1975	MCC 1985	SRF 1985	MONTH	ANNUAL	X	80% 95%
<u>Present Modified Flow:</u>	45762.3	44195.4						
<u>Imports From Other Regions:</u>	412.4	413.0	482.5	483.1				597.1
<u>Exports To Other Regions:</u>	0	0	422.1	367.0				970.0
<u>Groundwater Withdrawals:</u>	5944.7	4040.3	5944.7	5941.0				8370.9
<u>Evaporation:</u>	2618.5	2618.5	2618.5	2618.5				2618.5
<u>Depletions:</u>	14411.0	15672.4	18567.1	20108.8				25395.8
<u>Natural Modified Flow:</u>	56434.7	58033.0						
<u>Future Modified Flow</u>			41254.2	41362.8			40303.0	38016.7

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 SOCIO-ECONOMIC CHARACTERISTICS
 (upstream of Sioux City, Iowa)

REGION: MISSOURI (10) - Aggregate of ASA's 01-06 (upstream of Sioux City, Iowa)	STATES: IOWA, MINNESOTA, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING								
CHARACTERISTIC	UNIT	MCC 1975	SRF 1975	MCC 1985	SRF 1985	SRF RATIO 1985/75	MCC 2000	SRF 2000	SRF RATIO 2000/75
<u>Population:</u> Total	Number (000)	1574.6	1673.7	1542.5	1850.9	1.11	1504.8	2086.2	1.25
SMSA				283.3			299.2		
Non-SMSA				1259.2			1205.6		
<u>Total Employment:</u>	Number (000)	633.6	683.4	628.7	827.9	1.21	640.2	1030.6	1.51
<u>Earnings:</u> Total	1967 \$ (000)	4181.7		5351.2			7973.2		
Agriculture, Forestry, Fishing		953.2		960.7			1134.5		
Manufacturing		319.3		431.6			654.3		
Food and kindred products		118.1		141.3			183.8		
Paper and allied products		0.3		0.4			0.7		
Chemical and allied products		2.4		4.0			7.3		
Petroleum and coal products		31.8		37.9			54.7		
Primary metals		15.6		17.7			21.7		
Other		151.1		230.3			386.1		
Mining		92.8		106.1			129.3		
Other		2816.4		3852.8			6055.1		
<u>Per Capita Income:</u>	1967 \$	3502.0	3227.0	4620.0	4423.0	1.37	7108.0	6989.0	2.17
<u>Electric Energy Production</u>	GWH	24364.0	24364.0	50705.0	50705.0	2.08	134320.0	134320.0	5.51
<u>Land Use:</u> Total Land Area	Acres (000)	180286.0	176747.0	180286.0	176747.0	1.00	180286.0	176747.0	1.00
Agricultural, Total		174125.0	170731.0	166336.0	170309.1	1.00	165932.0	169697.9	0.99
Feed Crops		21170.0	39495.8	18882.0	42456.7	1.07	22661.0	43977.5	1.11
Food Crops		10113.0		7551.0			3873.0		
Other Crops		20747.0		14635.0			14882.0		
Forests and Woodland Grazed		1599.0	18001.7	4032.0	17974.2	1.00	4023.0	17931.4	1.00
Pasture, Range and Other		120496.0	109479.1	121236.0	104367.8	0.95	120254.0	100974.5	0.92
Other, Total		5979.0	6016.0	13950.0	6437.9	1.07	14354.0	7049.1	1.17
Urban		182.0	2734.7		3047.6	1.11		3480.8	1.27
Irrigated Farmland		2315.0	3685.5	3395.0	4330.8	1.18	3512.0	5622.5	1.53

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 VOLUMETRIC REQUIREMENTS (withdrawals)
 (Million gallons per day-MGD)
 (upstream of Sioux City, Iowa)

REGION	MISSOURI (10) - Aggregate of ASA's 01-06 (upstream of Sioux City, Iowa)	STATES: IOWA, MINNESOTA, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING						SOURCE: Fresh Saline	
FUNCTIONAL USE	MCC 1975	SRF 1975	MCC 1985	SRF 1985	SRF RATIO 1985/75	MCC 2000	SRF 2000	SRF RATIO 2000/75	X
<u>Domestic:</u> Commercial and Institutional, Total	146.2	282.6	151.4	361.3	1.28	143.9	407.3	1.44	
Central Systems	121.7	233.8	128.3	310.9	1.33	134.8	351.9	1.51	
Non-Central Systems	24.5	48.8	23.1	50.4	1.03	19.1	55.4	1.14	
<u>Manufacturing:</u> Total	126.7	198.9	47.5	322.3	1.62	36.2	484.8	2.44	
Food and kindred products	40.4		25.3			19.2			
Paper and allied products									
Chemical and allied products									
Petroleum and coal products	47.0		11.5			9.6			
Primary metals	33.0		8.0			4.0			
Other	6.3		2.7			3.4			
<u>Minerals:</u> Total	159.8	97.8	186.3	234.7	2.40	228.9	290.2	2.97	
Metals	21.0		25.2			32.4			
Non-metals	49.2		62.7			84.0			
Fuels	90.6		98.4			113.4			
<u>Irrigation:</u> Total	14777.5	13675.6	23540.1	15695.8	1.15	21301.4	18353.0	1.34	
Crops									
Other									
<u>Livestock:</u>	146.4	151.6	186.6	189.7	1.25	213.9	232.0	1.53	
<u>Steam Electric:</u>	732.0	1132.4	1729.0	2176.4	1.92	1812.0	2155.8	1.90	
<u>Public Lands</u>	211.8		269.6			324.0			
<u>Other Functional Uses:</u>									
TOTALS	16300.4	15538.9	26110.5	18980.2	1.22	24060.3	21923.1	1.41	

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 VOLUMETRIC REQUIREMENTS (consumptive use)
 (Million gallons per day-MGD)
 (upstream of Sioux City, Iowa)

REGION: MISSOURI (10) - Aggregate of ASA's 01-06 (upstream of Sioux City, Iowa)	STATES: IOWA, MINNESOTA, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING						SOURCE: Fresh X	
	MCC 1975	SRF 1975	MCC 1985	SRF 1985	SRF RATIO 1985/75	MCC 2000	SRF 2000	SRF RATIO 2000/75
FUNCTIONAL USE								
<u>Domestic:</u> Commercial and Institutional, Total	60.5	139.6	61.4	171.8	1.23	61.3	193.5	1.39
Central Systems	45.3	98.8	47.4	130.6	1.32	49.9	148.2	1.50
Non-Central Systems	15.2	40.8	14.0	41.2	1.01	11.4	45.3	1.11
<u>Manufacturing:</u> Total	17.8	64.9	20.7	148.8	2.29	26.5	254.1	3.92
Food and kindred products	8.3		10.2			14.4		
Paper and allied products								
Chemical and allied products	4.8		5.7			7.7		
Petroleum and coal products	4.0		4.0			3.0		
Primary metals	0.7		0.8			1.4		
Other								
<u>Minerals:</u> Total	59.7	61.6	66.0	72.5	1.18	78.3	74.9	1.22
Metals	3.0		3.6			4.5		
Non-metals	6.6		8.1			11.4		
Fuels	50.1		54.3			62.4		
<u>Irrigation:</u> Total	4170.4	6457.8	7125.7	7756.1	1.20	7336.4	9428.9	1.46
Crops								
Other								
<u>Livestock:</u>	146.4	151.4	186.6	189.7	1.25	213.9	232.2	1.53
<u>Stream Electric:</u>	8.0	11.1	72.0	41.6	3.75	130.0	115.2	10.38
<u>Public Lands:</u>	169.8		227.6			300.0		
<u>Other Functional Uses:</u>								
TOTALS	4632.6	6886.4	7760.0	8380.5	1.22	8146.4	10298.8	1.50

1975 NATIONAL ASSESSMENT
 Specific Problem Analysis Summary Report
 WATER SUPPLIES
 (Million gallons per day-MGD)
 (upstream of Sioux City, Iowa)

REGION: MISSOURI (10) - Aggregate of ASA's 01-06 (upstream Sioux City, Iowa)	STATES: IOWA, MINNESOTA, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, WYOMING			DURATION: MONTH		PROBABILITY: MEAN X	
	MCC 1975	SRF 1975	MCC 1985	SRF 1985	ANNUAL X	MCC 2000	SRF 2000
<u>Present Modified Flow:</u>	17451.7	16602.1					
<u>Imports From Other Regions:</u>	120.5	121.1	120.5	121.1	120.5	121.1	121.1
<u>Exports To Other Regions:</u>	0	0	422.1	367.0	573.8	970.0	970.0
<u>Groundwater Withdrawals:</u>	446.8	81.0	446.8	121.1	446.8	148.3	148.3
<u>Evaporation:</u>	2010.0	2010.0	2010.0	2010.0	2010.0	2010.0	2010.0
<u>Depletions:</u>	4632.6	6886.4	7760.0	8380.5	8146.4	10298.8	10298.8
<u>Natural Modified Flow:</u>	23527.0	25296.4					
<u>Future Modified Flow</u>			13902.2	14781.1	13364.1	12287.0	12287.0

IV. IDENTIFICATION OF SEVERE WATER AND RELATED LAND PROBLEMS

Under the WRC guidelines for preparation of three previous regional technical memorandums, MRBC identified 58 problem areas in the Missouri Region. Through a screening process this number was reduced to 32 areas as having the more severe, urgent and complex problems and issues. During Activity 3 of the national assessment, 22 of the 32 problem areas were deemed to be adequately covered by recently completed or ongoing studies, and 10 were retained for further analysis as contained in MRBC's Technical Memorandum No. 3 and as listed in Paragraph A, below.

There are many major problems and issues being addressed in the 22 problem areas being studied; however, these may or may not be resolved. Since the major focus of the 1975 National Assessment is on specific problem analysis, it appears appropriate to at least summarize these major problems in this fourth and final regional technical memorandum, as contained in Paragraph B.

Finally, there are many broad major problems and issues in the region which transcend the specific problem areas previously covered. Following the WRC guidelines led to delineation of problem areas with specific problems and issues as covered in the three previous regional technical memorandums; however, MRBC would be remiss if these major broad regional problems and issues were not addressed. Many of these extend beyond the Missouri Region and some are national in scope. These are covered in Paragraph C.

A. Summary of Activity 3 Problem Areas

Technical Memorandum No. 3 described 10 problem areas in the Missouri Region and discussed the severe and urgent problems and issues in each area in need of resolution at this time. The 10 areas, their general locations, and a summary of the major problems in each area are presented below:

Bad River Basin. The Bad River Basin is located in west-central South Dakota. The major problems identified relate to inadequate water supplies as to

both quantity and quality to meet the municipal and rural needs; poor quality of the ground and surface waters; intermittent and, at times, no streamflows; flooding at two communities and in agricultural areas; land surface and gully erosion; sedimentation of small stock ponds and reservoirs; because of a general lack of adequate rainfall, the need to develop storage and more surface water irrigation; and a general lack of local water-oriented recreation areas.

White River-Medicine Creek Basins. The White River and Medicine Creek basins are located in southwestern South Dakota, with the headwaters of the White River basin extending into northwestern Nebraska. Major problems identified in these two basins include water supplies of inadequate quantity and poor quality for many municipalities and much of the rural area; unquantified water rights for the large Pine Ridge and Rosebud Indian reservations in South Dakota, including the uncertainty of their needs and potential impact on water supplies generally; frequent flooding of agricultural lands; streambank and gully erosion as well as surface land erosion; poor quality of much of the surface and ground water supplies; intermittent and low streamflows; lack of adequate fishing water and water-oriented recreation areas; pollution of the White River by erosion from the Badlands area; sedimentation of stockwater ponds; deterioration and inefficiency of many of the diversion, storage, and distribution structures of the Whitney Irrigation District in Nebraska; and, because of a general lack of adequate rainfall and streamflow and generally poor quality of the ground water and much of the surface water, there is a shortage of adequate irrigation water.

Big Sioux River Basin. The Big Sioux River Basin is located in eastern South Dakota, northwestern Iowa, and southwestern Minnesota. The major water problems of the basin have been identified as an inadequate water supply for Sioux Falls, South Dakota; highly mineralized ground waters that result in a number of communities and much of the rural area being without an appropriate source of water supply; protracted periods of low streamflows cause water quality

problems in the Big Sioux River; frequent flooding of many of the cities and communities as well as agricultural areas that results in frequent damage and loss of crops; poor ground water quality and a lack of reservoir storage severely limits irrigation; low streamflows frequently cause water quality problems and reduce stream fisheries; a lack of adequate fishing waters and, particularly, at or near most of the communities, a lack of water-oriented recreation areas; a lack of adequate recreational facilities at some of the natural lakes; and high water development costs, together with local attitudes and inadequate support concerning institutional arrangements and cost-sharing for needed project developments.

Middle North Platte River Basin. The Middle North Platte River Basin problem area consists of the drainage of the North Platte River and its tributaries from the Seminoe Reservoir in Wyoming downstream to the Nebraska state line. Major problems identified include unsatisfactory water quality at several communities; potential water uses for steam-electric power plant cooling, coal gasification, and uranium milling in areas that already utilize most of the available water supplies pose water supply problems; irrigation return flows and municipal discharges at Casper, Wyoming, cause water quality problems; several communities experience occasional flooding; about 156,000 acres of rural lands are subject to flooding; stream sediments adversely affect stream fisheries and storage capacities of reservoirs; about 23,000 acres are subject to erosion damage; about 7,000 acres have drainage problems; many of the irrigated areas suffer from late season water shortages; many of the irrigation facilities are in need of rehabilitation and improvement, reservoir fluctuations, dewatering of tributaries during the irrigation season, low tributary streamflows, and the practice of rapid drawdown at Guernsey Reservoir to flush sediment into irrigation canals and laterals are detrimental to the fishery locally; and increasing stream depletions are causing concern downstream in Nebraska.

Nebraska Panhandle. The Nebraska Panhandle problem area consists of the North Platte River drainage above Lake McConaughy and the drainage of Lodgepole Creek in Nebraska. Major problems include those of water quality caused by several municipal and industrial effluent discharges, non-point agricultural runoff, feedlot runoff, and chemical sediment content of irrigation return flows; several communities, about 236,000 acres of agricultural land and many irrigation structures suffer from periodic flooding; soil losses from cultivated lands exceed eight tons per acre per year; 70,000 acres of land have a drainage problem; problems related to irrigated areas include systems rehabilitation and betterment, water use conflicts and shortages, surface/ground water complexities, and institutional constraints; increasing surface and ground water depletions and man-made pollution that threaten the future of Nebraska's major trout fishery; and pending energy developments and associated water use in Wyoming pitted against agricultural and other water uses in the Panhandle that already show and pose additional potential water use conflicts.

Upper Republican River Basin. The Upper Republican River Basin problem area includes all the drainage of the Republican River and White Rock Creek above their confluence. Major problems identified include several communities susceptible to flooding; over 37,000 acres identified by the Department of Agriculture as being subject to floodwater and sediment damages; stream sediments are a major problem; water quality; ground water pumping for irrigation reduces surface water supplies and adversely affects several large Federal reclamation projects as well as private irrigation; some irrigation facilities that are in need of rehabilitation or replacement; the Harlan County Reservoir recreation use problems caused largely by reservoir fluctuations, sediment deposition, and upstream depletions; and replacement of wildlife habitat lost due to the rehabilitation of irrigation facilities and accompanying problems related to funding, maintenance, and selections of environmentally suitable

replacement lands.

Big and Little Blue River Basins. This problem area consists of the Big and Little Blue river basins above the Tuttle Creek Reservoir. The major problems cited include excessive amounts of iron, dissolved solids, and nitrates in numerous community ground water supplies; improperly treated wastewater discharges of communities that cause surface water pollution; concentrations of septic tanks at cabin agglomerations cause some pollution of both ground and surface water supplies; other water quality problems result from livestock wastes, runoff and leaching from irrigated lands, and pesticides from agricultural areas; many communities that suffer from frequent flooding and nearly 480,000 acres of agricultural land subject to periodic flooding; logs and other debris cause log jams at bridges resulting in frequent damage and raising of flood crests; land surface and gully erosion affects 914,000 acres of agricultural land; improved drainage is needed on about 160,000 acres of the flat uplands, shallow depressions, and bottomland areas; irrigation pumping of ground water is causing serious declines in ground water levels; and the entire area has a serious deficiency of water-oriented recreation areas.

Tri-Cities, Missouri. The Tri-Cities problem area is made up of the three central Missouri counties of Boone, Callaway, and Cole. Major problems identified include urban flooding; acid mine drainage from orphaned coal mines; poor ground water quality in deep aquifers due to high salinity; shallow aquifers experiencing increasing pollution from surface drainage; septic tank wastes that are primarily responsible for water pollution in the Devil's Icebox Cave in Rock Bridge Memorial State Park; and acid mine drainage and other water pollution that causes frequent fish kill.

Lake of the Ozarks, Missouri. The Lake of the Ozarks problem area is located in south-central Missouri. Among the major problems identified are both point-source and non-point source pollutants; recent increases in clearing

forest and woodland areas for agricultural uses; effects on recreational use of the lake because of enrichment from pollutants; need to upgrade resort and community waste treatment; need to control or prevent resort and residential septic tank leachates from reaching the lake and causing ground water quality problems; unplanned and uncontrolled intensive development surrounding the lake; and the lack of laws and policies to govern development and local operations to correct the cited problems.

Ogallala Ground Water Area. The Ogallala ground water problem area within the Missouri Region covers all or parts of 52 counties in western Nebraska, 5 counties in northeastern Colorado, and 9 counties in northwestern Kansas. Major problems identified include a projected increase in irrigated acreage from the present 4.1 million acres to 6.2 million acres by the year 2000; increasing municipal, industrial, and other water uses; inability of the available ground water resource to support the increasing irrigation and other demands; severe ground water declines that already affect several parts of the area; tremendous economic and social effects on the region with projected ultimate loss of irrigated areas; and widespread resistance to legal and institutional needs to manage the ground water resource.

B. Major Problems in Areas Under Study

Of the 32 severe and urgent problem areas listed in Technical Memorandum No. 2, the 10 areas listed above were retained for further analysis in Activity 3, and 22 problem areas were considered to be adequately covered by recently completed or ongoing studies as listed in Technical Memorandum No. 3. The problems described in Technical Memorandum No. 2 cover almost every facet associated with inland waters. The 22 problem areas are listed below:

AREAS WITH SEVERE AND URGENT PROBLEMS,
BUT ALREADY COVERED BY RECENTLY COMPLETED
OR ONGOING STUDIES

Jefferson-Madison-Gallatin River Basins
Great Falls, Montana SMSA
Upper Yellowstone River
Shoshone River Basin
Lower Bighorn River Basin
Tongue River Basin
Powder River Basin
Upper Lake Sakakawea
Upper Heart-Green River Basin
James River Basin
Omaha-Council Bluffs Metropolitan Area
South Platte River Basin in Colorado
Loup-Middle Platte Basin
Lower Platte River Basin
Southwestern Iowa and Northwestern Missouri Tributaries
Cedar Bluff-Kanopolis-Salina
Kansas City SMSA
Madison Ground Water Area
West Basin Coal Area
Upper Missouri River Main Stem
Lower Missouri Main Stem
Indian Land and Water Resources

The most recent drought (1974-1977), particularly severe in some areas of the region, has accentuated water shortage problems. It has resulted in water rationing for some communities and threats of probable rationing for many more. Some communities have had to haul water for their local needs. The worst effects of the drought have been on agricultural areas. Inadequate rainfall has resulted in poor crop production, dried up pastures, dry stock ponds, numerous dry wells, and dwindling reservoir storages. While there generally has been water available to date for most irrigated areas in the Missouri Region (some areas suffer from chronic late season shortages), dryland farming and the cattle industry have been the hardest hit. A number of areas have been declared disaster areas, making them eligible for Federal assistance. These Federal programs provide some financial assistance but do not provide solutions to the problems in lack of rainfall, water supply shortages, falling ground water levels, diminishing reservoir supplies, dried up streams, or greatly diminished streamflows, and the many

other problems associated with droughts.

While the recent drought has affected the entire Missouri Region, some areas are suffering more than others. From the standpoint of a large number of people being directly affected, among the more glaring problem areas are the rapidly growing Denver Metropolitan area and the entire Rocky Mountain Front Range area in Colorado, which are in need of additional municipal and industrial water supplies. In fact, the entire South Platte drainage area suffers from water supply shortages, and these are being accentuated by the recent drought.

Almost every area has water quality problems. Those caused by industrial or municipal pollutants are being corrected, and it is anticipated that by 1983 there will be few, if any, of these problems remaining. On the other hand, many water quality problems resulting from natural and non-point sources probably will remain. Some areas were also reported as having problems from saline seeps and water quality being affected also by irrigation return flows and acid mine drainage. Numerous small communities in the areas under study have water supply problems. While a few rural water districts have been developed, which are or will be serving some of these communities, the progress in development and planning generally is very slow. Almost every problem area also suffers from insufficient water-based recreational opportunities. These shortages are most pronounced in and near areas of concentrated populations. Instream flow needs to maintain fish populations, ecosystems, and associated terrestrial habitats compete with other water needs. Land erosion is cited for most of the problem areas since it reduces the productive capacity of the land. Also prevalent is gully and streambank erosion which is causing loss of valuable lands and results in stream sediment that causes further problems. Falling ground water levels in several areas are causing considerable concern over future availability of adequate supplies for irrigation and, in some cases, municipal needs. In some areas high ground water pumpage rates are affecting streamflow and their

impact will increase over time.

Numerous urban area flood problems were reported and repeated flooding of large areas of agricultural lands were cited as causing severe losses of crops and millions of dollars of damage. A number of river segments were identified as being appropriate for consideration as designated wild and scenic rivers, Low streamflows and water pollution from many point sources were reported to be adversely affecting stream fisheries at many locations throughout the region. The need for more reservoir storage to supply water for energy, agricultural, and municipal needs was an often repeated concern. A source of funding adequate to develop projects for municipal water supply, irrigation, recreation, and other needs was indicated to be a problem of many areas. Other problems cited in the national assessment survey included conversion of agricultural lands to urban and other uses, clearing of forest and wood lands for agricultural use, conversion of marginal lands to row cropping, draining of wet lands for agricultural use, which reduces available wildlife habitat, and overgrazing of pasture lands and public lands.

Although it can be stated that almost all of the more serious problem areas in the Missouri Region have been studied at one time or another, are being investigated, or studies are programmed to consider them, solutions or resolutions of the problems are often difficult. Studies can formulate and present plans for possible implementation; however, lack of a source of adequate financing can, and often does, forestall many plan implementations. Controversies over project construction have caused and will continue to cause numerous delays and, in some cases, have resulted in projects not being built at all. Since water needs, people's desires and choices, laws, policies, institutional arrangements, and many other factors are constantly changing, to accomodate it is imperative that water resource uses and plans be updated continually.

C. Major Problems and Issues in the Missouri Region

Most of the broad major water-use problems and issues which plague the Missouri Region have been presented in the problem area descriptions contained in the three preceding technical memorandums. Even so, a more thorough description and a discussion will be helpful to a better understanding of the nature and scope of the broader problems and issues, particularly as they affect the Missouri Region. These are presented and discussed in the following paragraphs:

1. Indian Water and Related Land Resources Problems

The problem of uncertainties in the application and quantification of Indian water rights has long been considered one of the most pressing for the region. There are 23 Indian reservations in the region containing about 12 million acres of land. Although the total Indian land area comprises but four percent of the total area of the region, these lands are a significant part of the land area in the four upper States, comprising 15 percent of Montana, 8 percent of Wyoming, 6 percent of North Dakota, and 20 percent of South Dakota. Nearly all of the water flowing into the upper Missouri River is also contributed by these four States. The six large main stem dams operated by the Corps of Engineers and several not quite so large tributary reservoirs operated by the Bureau of Reclamation regulate the upper basin flow for hydropower production and downstream needs for navigation, water quality, water supply, and other purposes, as well as utilization of the reservoirs for recreation, fish, and wildlife. It can readily be seen that the unknown and unquantified Indian water claims could seriously impact on other water uses, not only of the Missouri River main stem, but for the tributaries as well.

It is not the purpose of this technical memorandum to present a lengthy discourse on the legalities of Indian water rights and claims since this could fill volumes. Suffice it to say here that the Indians' rights to water are generally based on treaties with the United States, case law, and interpre-

tations of previous court rulings. It is significant to note that the American Indian Tribes of the Northern Great Plains recently declared that they have rights which are prior and paramount to the waters of all rivers, streams, or other bodies of water, including all tributaries thereto, which flow through, arise upon, underlie, or border upon their reservations. With such sweeping claims by the Indians, the concern of the States, the Federal agencies charged with operating water resource projects, and the other 99 percent of the region's people is understandable.

Recent attempts by some States and several Federal agencies to determine current and projected water uses and needs on Indian lands have been rebuffed because of impending adjudications in the Federal court system. With an uncertain future associated with Indian water rights, water resource planners are currently faced with the difficult situation of not knowing how much water is or will be available for purposes outside the Indian reservations. The MRBC has established an ad hoc committee to address these and similar or related problems and to recommend a course of action or study to be undertaken by the Commission. Because of the many problems of attempting to outline completely a study of this nature at this time, it was decided that the committee will continue to function so that the problems will continue to be addressed and evaluated. The committee will then be in position to make periodic reports to MRBC, develop timely proposals to study, and make future recommendations as appropriate.

2. Federal Reserved Water Rights

The problems associated with reserved water rights for Federal lands are similar to those of the Indian lands--they are unquantified and relatively unknown as to location. Although about 45 million acres, or about 14 percent of the total region are in Federal ownership, current total water use on these lands is quite small. The Bureau of Land Management and the Forest Service

manage about 38 million acres primarily for outdoor recreation, range, timber, watershed, and fish and wildlife habitat. One viewpoint holds that, when lands were reserved from the public domain, the United States impliedly reserved water sufficient for use in accordance with the purposes for which the lands were reserved and as of the date of land withdrawal. The Property Clause of the constitution, which gives to congress power "to make all needful rules and regulations respecting the territory or other property belonging to the United States..." is the basis for Federal control of waters arising on Federal lands. The Federal reserved water doctrine appears to have developed in part from a dispute over authority of the States to exercise control over the appropriation and use of water on Federal lands.

The large Federal land holdings pose particularly vexing problems for all western States, but particularly in the Missouri Region. Although there is little development and current water use on most Federal lands in the region is small, added uses may not conform with the State water-right structures and there could be a cloud on the validity of State-granted rights. Thus, there is a need for a determination concerning the Federal reserved water doctrine and means should be developed to quantify the water-use requirements of reserved lands so that other water rights can be safely and firmly established and water resource planning can proceed in a meaningful and rational manner. Several court suits concerning specific Federal land areas currently in the process of adjudication may result in clarifying a determination of reserved water rights on Federal lands.

3. Alternative Uses of Water

As water use in the Missouri Region increases, competition for the remaining available supplies will intensify. Some of the tributary basins already are short of water, the available water having been overappropriated. In the upper South Platte River Basin in Colorado, some cities and industries have purchased

irrigation water rights to satisfy their needs. Serious questions have been raised concerning the construction of thermal power plants in some localities, the extent of their water use, and their effects on downstream flows. The viability of some Federal irrigation projects has been questioned, particularly as to whether projected water supplies are available to satisfy proposed needs. Additional questions are being raised concerning the adequacy of some existing streamflows to maintain fisheries, riverine recreation, and wetlands used by migrating waterfowl. Thus, competition for available water supplies in some areas is already intense. The future appears to be one of growing competition with more disagreements and contentions.

Another area of some concern relates to existing Federal projects and programs. Questions have been raised, for instance, as to whether some existing Federal reservoir projects are best fulfilling the needs of the region. A number of these projects were conceived, authorized, and constructed a number of years ago to satisfy needs as perceived at that time. Do these projects best serve current needs or have needs changed? Would the project purposes, water allocations, and project operations be the same today as when the projects were built? Many of these projects were built or were underway prior to basic legislation requiring full recognition being given to recreation and fish and wildlife enhancement as project purposes and to which joint project costs could now be allocated. Although environmental quality has always been of concern to water resource planners, there has been increasing emphasis place on environmental concerns. Many Federal, State, and local laws and policies concerning water resource developments also have changed. It appears that it would be appropriate to undertake a systematic review of existing projects, which may be accomplished as a part of a larger study which assesses current and projected water uses and needs.

Concern for water availability and uses reaches every area of the region.

What happens upstream affects the downstream areas. Some river systems are covered by an International Treaty, interstate compacts, and court decrees; however, while these are significant, they represent only a relatively small portion of the total region. For the large remaining areas not thus covered, any State could conceivably use all of the water flowing into or through its State, although this appears to be unlikely. Nevertheless, there is concern about recent estimates of accumulated water use in many parts of the region and an even greater concern as to what the future may bring. The recent drought situation has accentuated this concern.

The Governors of the 10 basin states are enough concerned so that a conference meeting to discuss critical water issues in the Missouri River Basin was held in St. Paul, Minnesota, on August 3-4, 1976. They unanimously adopted the following resolution:

"That the Missouri River Basin Commission implement on an annual basis a meeting that would involve the Governors of the basin similar to our involvement in this August 3-4, 1976, Missouri River Basin Governors conference meeting".

The second such conference was held in Omaha, Nebraska, on May 3-4, 1977, and a third meeting is scheduled to be held in Montana in 1978. With this expressed concern and the desire of the Governors to meet annually, it is evident that the water resources of the Missouri River Basin are in need of critical examination and study. We need to know where we are, where do we intend to go, and what we are willing to do about it.

4. Current Water Supply Availability and Use

Various estimates of water supply availability and use have been discussed in the preceding Section III. The problems associated with differing estimates of current water supply availability and use are closely akin to those discussed in the previous section, "Alternative Uses of Water". While the "need to know where we are" aspects could be undertaken in the broader study of alternative

uses of water, it is imperative that studies be undertaken as soon as possible to determine water availability, current uses, effects on streamflow, etc., and to arrive at determinations acceptable to the States and the Federal agencies concerned. There is too much at stake to delay these determinations. Federal laws and policies require that agencies operating Federal reservoirs perform these operations in accordance with the authorizing legislation and, in the case of hydropower, to set power rates at a level adequate to cover operation and maintenance costs and to repay investment costs over a specified number of years. To perform these assigned tasks in an acceptable manner, the Federal agencies need to have reliable estimates of probable amounts of water currently available or those likely to be available for both the short-term and the long-term future. In order to properly manage its waters, each State needs to know how much water is currently available prior to embarking upon planning for its future.

5. Water for Energy

Probably the most widely discussed topic in the Nation today is energy. Water is an important component of energy production. Today's electric power industry could not function without adequate quantities of water for cooling purposes. If synthetic gas and oil are to be produced from coal, water will be a necessary component of the process. Hydropower, although only a small but important part of total energy production, is completely dependent on water. Many reports on energy have been written and many projections of energy needs have been made. Most projections are based on "what if" scenarios, but all projections show a growing need for energy. None of them show declines. Water will play an important role in our energy growth, although to what extent is difficult to estimate. The Chicago regional office of the Federal Power Commission has furnished current water use estimates for existing electric power plants and, based on plants under construction and those planned, has furnished

projections of future water use for 1985 and 2000. These estimates have been generally accepted throughout the region; however, future water needs for other types of energy production are dependent on an uncertain future. Initial estimates of water requirements for energy production were never great compared to available supplies, and more recent estimates have tended to forecast even lesser amounts of water requirements. At this writing, there is no unified national energy policy; however, it appears that the national policy now taking shape would place greater emphasis on the use of coal and less reliance on the use of natural gas and oil, with primary emphasis on conservation measures and improved energy use efficiencies.

The large deposits of low sulphur coal lying close to the earth's surface in the Northern Great Plains of the region have received considerable attention. Mining of this coal has been increasing at a steady rate. Future increases are greatly dependent on such matters as national energy policies, economics, changing technologies, and environmental and social concerns. An MRBC funded Level B study covering the Yellowstone River basin and Adjacent Coal Areas is currently scheduled for completion late in calendar year 1977. The study is examining the critical issues confronting this 127,000-square mile area in southeastern Montana, northeastern Wyoming, and southwestern North Dakota. Potential energy and agricultural developments would place large water consumption demands upon the study area's water supplies. Maintenance of stream flows to meet esthetic, environmental, and recreation potentials is the major nonconsuming water demand. Agriculture and energy will compete to a degree with each other for water, but primary competition will be between those uses that divert and consume the water against those uses that require water to be left in the streams. Crossing all of the potential water use demands are the questions of reserved water rights for the large areas of Federally owned lands and of Indian water rights in the area and the manner in which they may affect the future uses of water supplies.

The major question to be answered is: "Will the water supply be adequate in quantity and quality to meet the forecasted demands while maintaining the quality of life and social well-being of all the people?"

6. Ground Water and Surface Water Interrelationships

Ground water hydrology is one of the more difficult components of total water resource management and planning. While there is considerable knowledge concerning ground water resources in some areas of the region, there is a notable lack of information on other areas. The interrelationships of ground water with surface waters is even more complex than either resource taken alone. Although it is generally acknowledged that, for most areas, there is an interrelationship, the extent or effects thereof are not well understood. Available information shows that in some areas ground water levels are declining, which indicates that pumpage rates have outstripped aquifer recharge rates. In most areas, infiltrating precipitation is the only source of replenishment to the aquifer. In other areas, stream channels intercept aquifers and there may be an interchange of water depending on the local relationships of water levels, soils, rock formations, etc. It is becoming increasingly apparent that the total water supply, both ground and surface, should be viewed as a single resource. More and better knowledge is needed on the extent and quality of underground water supplies and aquifer recharge rates. Determinations need to be made as to the interrelationships of surface and ground waters, e.g., how does increased ground water use affect surface waters and how does increased surface water use affect the quantity and quality of ground water supplies. We need to know whether these effects are short-term or long-term, whether there is a time lag before the effects show up, and whether this can be measured in days, months, or years. Because of variances, study areas need to be established and special study criteria unique to each area need to be determined.

7. Interbasin and Interstate Water Transfers

Interbasin water transfers or diversions have always been viewed with considerable trepidation, and, when State lines are involved, fears become magnified. Consequently, while many diversions have been proposed, only a few have been adopted for implementation. Authorized and currently under construction are the Garrison Diversion and Oahe Units in North and South Dakota. Colorado and Wyoming import water from the Colorado River Basin to the South and North Platte River basins. The International Treaty of 1910 with Great Britain apportions between the United States and Canada waters of the St. Mary and Milk rivers. Other interstate compacts and court decrees provide for only limited diversions, except that the Yellowstone River Compact forbids diversions from the basin unless agreed to by all three signatory States.

Competition for available water is increasing. Desires to increase water use for irrigation and other legally defined beneficial consumptive uses are competing with those desires to maintain and, in some instances, to increase instream flows for fish, wildlife, and ecosystems for recreation. These latter flow needs are as yet largely undefined and undetermined, although some studies are underway and others are being initiated.

Droughts, with their accompanying low streamflows and diminishing ground water supplies, usually result in those suffering from a lack of rainfall and short water supplies casting covetous aspirations for diversions from those areas and streams with a seemingly more plentiful water supply. Consequently, there is much discussion about interbasin water transfers but, so far, little legislative action has resulted to permit their realization. Two of the more serious current proposals are (1) for diversion of Oahe Reservoir water by pipeline to western South Dakota for municipal and industrial needs and possible irrigation use and extending to the coal fields in northeastern Wyoming for energy needs, and (2) slurry pipelines to transport coal long distances beyond

the confines of the Missouri River Region, which also have the potential for intermediate deliveries.

Interbasin water transfers within the confines of State boundaries is in itself usually quite complex, involving legal questions and policy issues as well. Taking water from a basin in one State and transferring it for use in another basin of a different State is even more complex. Interbasin transfer of waters may, in the future, fulfill needs considered to be dire enough so that States may be willing to approach the subject with considerably less apprehension. Certainly, this option should be kept open, since it may prove to be the only viable solution to a particularly vexing problem in certain instances.

8. Legal, Policy, and Institutional Problems

If there were no competition for available water supplies or if everyone had an ample supply of water, there would be no legal, policy, or institutional problems. To overcome some of these deficiencies and water supply limitations, water storage reservoirs have been constructed, water is being imported and exported, interstate compacts have been negotiated, and other innovative measures have been undertaken. Some of the past actions have not been tested concerning their legality and it is quite evident that there are a host of upcoming actions which will be subject to adjudication through the court systems. Some of the legal, policy, and institutional problems have been highlighted in the foregoing problem discussions; however, it appears appropriate to present briefly some discussion of other major problem areas.

The Flood Control Act of 1944 authorized construction of five large Missouri River main stem reservoirs, numerous tributary reservoirs, and other water resource development projects. The plan for development of the reservoirs and associated developments originally referred to as the Pick-Sloan Plan is now designated the Pick-Sloan Missouri Basin Program. Most of the reservoirs have been constructed and are in operation. One important provision of the 1944 Act,

referred to as the O'Mahoney-Milliken Amendment, states:

The use for navigation, in connection with the operation and maintenance of such works herein authorized for construction, of waters arising in States lying wholly or partly west of the ninety-eighth meridian shall be only such use as does not conflict with any beneficial consumptive use, present or future, in States lying wholly or partly west of the ninety-eighth meridian of such waters for domestic, municipal, stock water, irrigation, mining or industrial purposes.

The 1944 Act is silent concerning relative preference to be given other nonconsumptive water uses, including hydropower generation. Whether as a result of the Act or for some other purpose or motive, considerable debate concerning foremost preference of use has been generated. As competition for use of available water supplies has increased so have questions and arguments pertaining to jurisdictional control. This is particularly evident concerning jurisdiction over water impounded in the Federally constructed reservoirs. Jurisdictional questions were raised by several of the States in commenting on extension of the Memorandum of Understanding between the Secretary of the Interior and the Secretary of the Army concerning water marketing for industrial purposes from the six Missouri River main stem reservoirs. The initial MOU was for a two-year period, ending February 24, 1977, and was twice extended to remain in effect now until September 1, 1977.

It is appropriate to present at least some of the more important issues raised concerning the MOU as they apply to the six main stem projects since they may apply also to other Federal reservoir projects. Since it is not explicitly covered in the Flood Control Act of 1944 or subsequent acts, the question has been raised whether the Federal agencies have congressional authority to market water from the six main stem projects for industrial uses. The authority of the Bureau of Reclamation to act as a water marketing agent of the Federal Government has been challenged, but a 1976 decision by the U.S. District Court in Montana supports the premise that this authority exists. If such authority does

exist, is the current allocation of costs of the projects involved appropriate or should a reanalysis of the cost allocation be required? Current procedures provide for the Bureau of Reclamation to deposit revenues from the sale of M & I water into the Missouri Basin Account which was established initially to be credited with revenues and thus show payout of reimbursable project costs. Is it appropriate to deposit revenues from the sale of this industrial water into this basin account? The amount of water made available for marketing for industrial use has been defined as being within the amounts of water available in the main stem reservoirs as authorized for Federal irrigation projects, but which will not be needed for this purpose for the next 40 to 50 years. This definition and the position that this water will revert to irrigation use is being questioned. Questions have also been raised as to whether the diversion of main stem reservoir water for industrial use, as provided for in the MOU, adequately recognizes the best interests of the downstream entities. Many other questions pertaining to explicit provisions of the MOU have been raised; however, these apply more directly to the MOU as executed and would not have the wide-spread effects of the foregoing questions.

Although there are no active formal water compact negotiations underway for division of interstate surface waters, there are indications that requests may be forthcoming to clarify or renegotiate some existing compacts. Some States feel that existing compacts have provisions which do not properly or adequately fulfill current water needs. An example is the Yellowstone River Compact, approved October 30, 1951, which has a provision that the signatory States (Wyoming, Montana, and North Dakota) must consent to any proposed diversion of waters outside the Yellowstone River Basin. Thus, if Wyoming's share of Yellowstone River water were to be proposed for use outside this basin, e.g., for development of coal fields situated elsewhere than in the Yellowstone basin, the diversion would require the unanimous consent of the compacting States.

Recent large increases in ground water use in many areas of the Missouri Region and elsewhere have raised questions concerning the need for new or revised State laws governing the use and management of ground waters. In many areas, the relationships of ground water to surface water are not very well understood and there is inadequate knowledge on the extent, recharge rates, interactions with surface waters, and other needed information concerning ground water. Recently, the State of Wyoming granted a water right for use of ground water from the Madison Formation for use in a coal slurry pipeline to transport coal to Arkansas. South Dakota objected to the use of this ground water for the stated purpose. A multi-million dollar study of the Madison Formation aquifer is now underway that will appraise the quantity of water available, its chemical and physical properties, probable effects of existing and proposed withdrawals, potential well fields, and desirable monitoring networks. The Ogallala formation supplies large amounts of ground water to large areas in Nebraska, Kansas, Colorado, Oklahoma, Texas, and New Mexico, however, it appears that this storage is being depleted. A multi-million dollar study of the Ogallala ground water area has been initiated. The Big Blue River and Upper Niobrara River compacts reflect considerations for ground water as well as surface flows and it may be that interstate ground water compacts similar to those dividing surface waters will become necessary in the future.

Generally, a State exercises control of the water originating within or flowing through the State although it is also generally recognized that, for interstate streams, the upstream State or States do not have the right to appropriate all the available waters to the detriment of downstream States. Hence, interstate compacts and, in some cases, negotiations or court decrees are resorted to in an effort to attain an equitable distribution of the available waters and avoid costly and time consuming litigation. The western States in the region have experienced a recent significant increase in requests for adjudication of

water rights and related problems, which is probably the result of increasing water use, competition for available water supplies, and recent drought conditions. It is also becoming increasingly apparent that either the Federal judicial or legislative process or both must be called on to settle some of the impending water problems facing the Missouri Region. Among these important issues are such matters as Indian water rights, Federal reserved rights, water use for interstate coal slurry pipelines, regional water allocations, and, of course, many others. What is important in these issues is to determine the quantities of water involved, the existing water rights both active and otherwise, how much water is or would be depleted from the streams and ground water reservoirs, and how much is or will be available for future uses. Planning for water resource development needs or for reservation for instream flow needs or other purposes is very difficult without quantification of water allocations to various purposes and locations. Since the States will be considerably affected, they will need to participate extensively in any studies or determination.

9. Funding Arrangement (Cost-Sharing)

Funding arrangements or cost-sharing for development and operation and maintenance of water resource projects generally means how much will be supplied by the Federal Government and how much or what part from non-Federal sources. Historically, the Federal Government has provided most of the waterway improvements for navigation. In the Missouri Region, most of the other improvements or developments prior to World War II were accomplished by local entities. Although tracing these developments and the evolvement of Federal laws and policies concerning water resource developments is interesting and is needed for a full understanding of how we got where we are, the 1971 Framework Study Report amply describes the process and it is not repeated here. Suffice it to say that all of the major projects and programs and most others since World War II have been financed by the Federal Government with appropriate repayment by non-Federal

entities for many of the services provided. The obvious reason for this is that the Federal Government was the only source with the capability and capital to undertake such projects and programs.

The evolution of the Federal laws, policies, administrative procedures, and cost-sharing requirements for Federal water resource developments has spanned many years and the projects and programs involve many departments, agencies, and bureaus. While there is some overlapping of responsibilities and there are inconsistencies in some cost-sharing responsibilities in some programs, the overlaps and inconsistencies are comparatively minor for a program which has been evolving over a long period of years and covers the entire Nation with its diverse water problems. There is relatively little so called "shopping" by the non-Federal entities among Federal agencies to get the best "deals".

It is not the purpose here to present all of the pro and con arguments concerning cost-sharing responsibilities. These arguments have been going on for years, they appear in many publications, and there is little likelihood of reaching total agreement among all MRBC members. Section 80(c) of the Water Resources Development Act of 1974 (P.L. 93-251) called on the President to make a study and investigation of various facets of water and related resources projects, including Federal and non-Federal cost-sharing, and to submit a report with his recommendations to the Congress. The study was completed by the Water Resources Council in 1976, but was returned by the Office of Management and Budget for reconsideration of a number of the recommendations. When the report with recommendations will be submitted to the Congress is uncertain.

The involvement of the Federal Government in water resources planning and development in the West resulted largely from a desire to settle and develop this part of the Nation, and the obvious inability of others to undertake comprehensive coordinated development projects and to provide the large capital required for their implementation. Generally, the States and others have only limited

capabilities and financial resources to undertake projects requiring a large capital investment. Comprehensive coordinated planning and development of projects and programs to satisfy water resource needs, particularly those involving large areas and large projects, often go beyond State lines. It is quite obvious that Congress recognized this need in evolving the Federal laws, policies, and administrative procedures which resulted in assigning various responsibilities to various Federal agencies and in appropriating funds to carry out the various programs. If the Nation wishes to continue to develop its water resources to meet its needs, the Federal Government is the only entity with the authority, capabilities, and financial resources to do so, although some States are taking steps to participate financially with local entities.

Federal water resource projects encompass the only Federal program which requires the rigorous testing of displaying both the beneficial and adverse effects, benefit-cost analyses, displays of environmental considerations, social well-being effects, and regional benefit displays. They have been labelled "pork barrel" and been attacked by many organizations, groups, and individuals for many reasons. Individual project benefit-cost analyses and general procedures performed by Federal agency water resource planners have been thoroughly scrutinized and tested both administratively and judicially. Analyses of projects for which the benefits accrue in future years are never perfect since there are no perfect crystal balls from which to glean this information. The exacting procedures followed provide a dependable basis for the Federal Government to make decisions concerning which projects it wants to construct or participate in. Continuation of Federal participation in water resource developments and to what extent should be based on how the governing bodies perceive the Nation's needs. Without large-scale Federal involvement and the provision of the capital to build and manage the projects, water and related land resources development would come to a virtual standstill since the capabilities and capital do not

exist elsewhere.

10. Instream Flow Needs

The desirability of maintaining certain instream flows for various purposes is becoming more widely recognized with increasing water uses. For many years, streamflows to supply needs for municipal and industrial purposes, mining, land irrigation, livestock, electric power generation, and inland navigation have been recognized. More recently, serious concerns are being expressed regarding the maintenance of minimum streamflows to maintain stream fisheries, wildlife, and ecosystems, to provide greater recreation enjoyment, and for esthetic reasons.

Within the limits of their natural occurrences, the flows available for instream use are dependent on State laws and water rights, interstate compacts, Supreme Court decrees, and international treaties and uses developed thereunder. There are only two states in the Missouri Region, Colorado and Montana, which currently give legal recognition to instream flow needs for fish and wildlife, although Kansas has procedures whereby establishment of minimum flows can be accomplished. A number of other states have considered such legislation. Water uses in the more arid parts of the region are largely controlled by existing water rights held by irrigators, cities and industry, and many of the tributary streams are already overappropriated. While most States recognize the desirability of maintaining instream flows for fish, wildlife, recreation, and other uses, currently these are recognized as being only incidental uses subordinate to those established previously under State water right laws. There are currently no Federal laws requiring or establishing minimum streamflows, although certain authorities reserved to the Federal Government in the Constitution might be interpreted in this light--the Commerce Clause, the General Welfare Power, and the Supremacy Clause. Also, recent Congressional acts concerning the preservation of rare and endangered species and where significant Federal actions are involved, may preclude Federal actions if changes in streamflows would have adverse effects on preservation of these species.

The U.S. Department of Interior Fish and Wildlife Service recently established an office in Fort Collins, Colorado, which is called the Cooperative Instream Flow Service Group. Its purpose is to make assessments of instream flow needs and to develop information pertaining thereto to assist biologists and recreation planners in establishing instream flow requirements and management strategies for riverine and stream environments. Previous instream flow requirement estimates have been based largely on judgment. The Cooperative Instream Flow Service Group will attempt to develop scientific bases for determining instream flow needs to maintain fisheries, recreation, wildlife, and ecosystems. It is quite apparent that there will be continuing problems concerning those desiring to divert streamflows for beneficial consumptive uses and those desiring to maintain or, in some cases, increase streamflows from their current levels.

11. Water Related Recreation Needs

The SRF estimates of water-related outdoor recreation demands were based on data and information contained in the State Comprehensive Outdoor Recreation Plan (SCORP) reports. Due to a lack of uniformity of data and information presented in the SCORP reports, it was difficult to prepare uniform data at the ASA level for recreation participation estimates, particularly by uniform activity classifications. While some of the SCORP reports included data on water and land areas available for recreation, others did not. One general conclusion that could be drawn from reviewing these reports is that there is a lack of adequate water and related land areas near most of the large urban centers and cities in the region to meet outdoor recreation needs.

The Bureau of Outdoor Recreation prepared recreation data for the MCC at the ASA level. A review of these data shows that, except for ASA 1009, there is no lack of impounded water areas to satisfy the overall recreation needs of the Missouri Region. The ASA's however, are rather large in areal extent. Available water areas in many instances are 200 or 300 miles distant from the centers of

population and often are embodied in one or several large reservoirs. Therefore, the MCC data are misleading. The MCC does not reveal that there are numerous areas in or near the population centers in the Missouri Region with inadequate water-oriented recreation opportunities and water areas. However, MCC information cites low streamflows and inadequate access as recreation problems in the region.

The non-uniformity of the State-prepared SCORP reports is a problem when attempting to determine the adequacy of water-oriented recreation opportunities available or in determining the inadequacy of available water and land areas and facilities. The Bureau of Outdoor Recreation prepared data for the MCC at the ASA Level does not adequately fulfill the need to determine the adequacy of water-oriented recreation areas and facilities. There is a need to establish uniform criteria and procedures in defining recreation opportunities and needs, evaluating recreation benefits, and assembling associated recreation data and information.

12. Environmental Concerns and Issues

The total environment includes of course everything surrounding us--all of the things occurring in nature and the man-made changes and additions. Man has modified the environment, starting from a primitive state and progressing to today's sophisticated life styles brought about by his technological innovations. Nature too has been evolving and changing the face of the earth. The ice ages drastically changed the geography. Changes are constantly taking place in animal and plant varieties. Today's environmental concerns and issues are generally related to nature--land, water, air, flora, and fauna--and man's effects on nature. The ensuing paragraphs then pertain to the more outstanding concerns and issues as they relate to the region's natural environment.

The problems of the need for quantification of instream flow needs for fisheries, wildlife, and ecosystem preservation have been previously discussed and water quality problems are discussed in a later section. As the uses of and

competition for available surface water supplies have increased, so have concerns about the amounts of water left or the lack thereof in the streams. Man's use of water to increase crop production, to satisfy municipal and industrial needs, and for other purposes has greatly reduced the streamflows in many areas of the region. In many instances, water stored in upstream reservoirs augments low streamflows, even to the extent of providing more flow than would have occurred under natural conditions. There are choices to be made such as whether to curb man's use of water, mandate certain minimum streamflows, or to provide upstream reservoir storage so that low streamflows can be augmented.

The Missouri Region, bounded on the west by the Rocky Mountains, with large expanses of prairie lands, low population densities, and a diverse climate, affords many opportunities for wild and scenic river and primitive recreation area designations. Many of these opportunities were described and discussed briefly in the regional Technical Memorandum No. 2. As each of these potentials is studied in detail, consideration will need to be given to its effects on residents of the area and whether it is in the best interests of the Nation to set these areas aside for control and limited use for environmental protection or preservation. The residents of the area under consideration should be given every opportunity to present their views.

Today's environmental concerns and issues include all of man's activities. Expanding cities continue to take land out of agricultural production or land which could be used for some other purpose. Inadequately treated municipal and industrial waters pollute our streams and, in some instances, our ground water. Man's use of the land to grow the food and fiber needed to feed and clothe the people of our Nation and the world affects the land and water and even the air. It affects naturally occurring animals, birds, and plants. Irrigation water used to increase crop production depletes the stream and ground water in storage. The arguments and contentions concerning man's effect on his environment rage on

and on. Scientists cannot agree on many of the short- and long-range effects on the environment or what the effects on projected lifestyles will be. One thing is certain, the interactions and complexities are too great for man to fully comprehend and evaluate using only limited available knowledge.

The national water assessment is concerned primarily with water and related lands and the needs and problems associated with them. In the Missouri Region, most of the publicized environmental concern controversies are related to Federal water resource developments and the permit process for developments by non-Federal entities. Current Federal planning processes provide that environmental quality be given equal consideration with economic evaluations; thus permitting a choice between environmental preservation and economic gains. Following the intricate guidelines, environmental quality objectives are displayed, together with economic evaluations and other considerations. The political process is relied upon to make the choices and to determine the tradeoffs. Several recent controversies in the region have revolved around Federal irrigation and multiple-purpose projects which include construction of reservoirs, canals, and associated facilities, as well as more intensive land cultivation. It is of interest to note that most of the recent increases in irrigated lands have been by individuals and that the total number of acres irrigated from Federal projects in the region constitute only about 10 percent of the total. The concerns and issues usually are over development or no development, although some are related to the manner of water use and what happens because of it. The available water resources are more or less finite although the amount of water available varies over wide limits from year to year and month to month. Primary concerns are for the extremes, or what balance to seek in storing excess waters for use during periods of shortages to attain higher degrees of utilization in fulfilling our growing needs or to be satisfied with water supplies remaining as provided by nature. Since every action involves environmental changes, and it is obvious

that human needs are going to continue to expand, the planning of water and related land resource developments should proceed with the best evaluations possible of alternative uses and for both beneficial and adverse effects. Just as adequate housing for protection against nature's elements is fundamental to mankind's well-being, so are efforts to improve on nature's way of providing inadequate precipitation and water availability or, at times, too much.

13. Navigation Flow Requirements

The Missouri River navigation project extends 732 miles from Sioux City, Iowa, to the mouth of the river near St. Louis, Missouri. It is an open river channel of 9-foot depth with the banks secured by stabilization structures. A system of six large main stem reservoirs regulates the river flow to provide water for several purposes, including an 8-month navigation season during the ice-free season from April through November. The flow rates needed to maintain 9-foot depths are 30,000 cfs at Sioux City, 32,500 cfs at Kansas City, and 35,000 cfs at the mouth of the river.

The upstream reservoir storage system provides a capacity equal to about three times the average annual flow at Sioux City. Because the amount of water available and the depletions above Sioux City are under contention, so is the present average annual flow at Sioux City. Nevertheless, it is probably somewhere around 19 to 22 million acre-feet annually. To maintain adequate streamflows to meet downstream water quality requirements and M & I needs and for an 8-month navigation season requires about 15 to 16 million acre-feet annually. Projections of possible depletions and residual water supplies indicate these average annual flows will probably be available through the year 2000 except during extended drought periods such as occurred from 1930-1941. However, because of increasing upstream depletions, inflows into the reservoir system would fall considerably below the average during extended drought periods. The first requirement in releases would be to maintain adequate streamflows for water

quality and M & I needs. With increased depletions beyond the year 2000 there may not always be enough water for a full 8-month navigation season. What the effect of a shortened navigation season, occurring several years in a row, on shippers and on the barge lines operating on the Missouri River would be is difficult to assess. However, it probably would reduce the total river tonnage shipped and it would dampen the interest of shippers and barge line owners in the maintenance of Missouri River navigation. Because of the slope of the Missouri River and its high sediment loads, and based on current technology, a system of locks and dams which would reduce the water requirement would be very costly and currently is not considered to be a viable solution.

Because of the lack of significant growth in commercial tonnage being carried on the Missouri River navigation system, the Mid-America Regional Council, with a grant from the Ozarks Regional Commission and contributed services from local governments in the Kansas City Metropolitan Region, has undertaken a three-phase study to "determine and evaluate opportunities to improve the economy of the Kansas City Metropolitan Region through river development."

14. Land Conservation and Erosion Control

The Missouri River Basin Comprehensive Framework Study Report stated that about 45 percent of the 324.7 million acres of basin lands have been adequately managed or treated by needed vegetative and/or mechanical practices. It should be safe to assume that some, although probably quite limited, progress in land conservation on the remaining 55 percent has been made although to what extent was not ascertained during this national assessment. While most Federal lands are adequately treated or managed, well over 50 percent of the lands in private ownership are in need of land conservation treatment or improved management practices. Without assistance from the U.S. Department of Agriculture programs, it is highly doubtful that much progress would be made in bringing about conservation practices on private lands.

A basic requirement for widespread attainment of land conservation is the proper use and management of all cropland, pasture and range, forest and woodland, and other agricultural lands for safe and continuous production without deterioration. In the eastern part of the region, water erosion is the dominant problem on croplands, with sheet and gully erosion being the major hazards to tilled soils with slopes exceeding 2 percent. Vegetated waterways, terraces, contour farming, strip cropping, proper use of crop residues, adequate use of fertilizers, and conversion of marginal croplands to permanent vegetation are the major treatments needed to control water erosion and provide protection to croplands. Some agricultural lands with excess water are in need of drainage. In the western and northern parts of the region, both wind and water erosion are dominant problems on croplands.

Agriculture is the principal industry of the region, hence, the primary interest of basin residents is in the land and its productivity. While historically most of those farming the land were concerned primarily with the current year's crops and gave little thought to the long-term future conditions of their land, education and concerns for the future have brought about changed attitudes and outlooks. Today, although not yet universal, there is widespread interest in land treatment and management practices to allow for safe and continuous production without causing land deterioration. Improved management practices are easily understood and can be instituted by individuals with only limited guidance needed; however, watershed improvements, such as those provided for under Public Law 566, require planning and technical study by trained individuals. Also, the laying out of contours, terraces, and gully erosion controls exceed individual capabilities. Thus, there is a need for increased funding to accelerate these Department of Agriculture programs.

15. Streambank Erosion and Channel Aggradation and Degradation

Streambank erosion is a relatively serious problem throughout most of the

Missouri Region, resulting in many acres of lost land annually and affecting numerous individual land owners. Solutions are costly, and, in most instances, solutions are not economically feasible and usually involve natural environmental controversy. Critical problems occur at many of the bridge crossings, particularly during high flood flows. These high flows often cause erosion around bridge abutments and cut through streambanks thus undercutting highway approaches. Bank deterioration has occurred immediately below many of the large dams and is particularly serious below the Garrison and Gavins Point Dams on the Missouri River. The most extensive erosion problems occur in ASA's 1004, 1005, 1009, 1010, and 1011 with the average annual dollar damage being greatest in ASA's 1009 and 1010. The lengths of serious streambank erosion and dollar damage estimates by ASA's and by states are presented in Technical Memorandum No. 2.

The Corps of Engineers examined bank erosion problems on the Missouri River below the six large main stem dams to the headwaters of the navigation and bank stabilization project at Sioux City, Iowa, in its recent report on the upper Missouri River (Umbrella Study). That report recommends remedial measures for all locations not previously authorized by Congress. Previously, Congress authorized remedial measures at specific locations and for demonstration projects as described in P.L. 88-253, Section 32 of P.L. 93-251, and Section 161 of P.L. 94-587. Except for authorization of emergency bank protection measures for the protection of public and quasi-public facilities under the Corps of Engineers continuing authorities program, the Missouri River navigation and bank stabilization project, and areas below the Garrison Dam, no other major bank protection projects have been authorized in the region.

Channel aggradation and degradation are problems at many locations throughout the region, affecting the water intakes of many municipalities, power plants, industry, and irrigators. At locations immediately downstream of channels which

have been straightened to improve their carrying capacity, many channels have filled in to the extent that they have lost much of their original capacity. This is caused by the faster moving water dropping its sediment load as it enters a meandering channel which slows the velocity of the water. At other locations, straightened channels are causing problems at bridge crossings and threatening improvements because of a degrading and widening channel. Most of the problems have resulted from piecemeal and uncoordinated efforts by individuals or groups of individuals.

16. Flooding Problems and Flood Plain Management

Much has been written concerning ever increasing flood damages despite large public expenditures for flood protection projects. It might be worthwhile to briefly review the historic settlement and development for a better understanding of how this came about. Early settlers built their homes and businesses in the flood plains largely because the rivers provided the means of transportation and water supplies. The railroads located in the flood plains because early industry and the people were there and construction of the rail lines was much simpler and less costly. Subsequently, industry and the people continued to build near available transportation routes. Congress, in the Flood Control Act of 1936, declared that flood control was in the national interest and subsequently authorized and funded many projects to reduce the damages and to alleviate human suffering resulting from floods. In many instances, the flood control projects resulted in more intensive use of the flood plains and many of the projects did not provide complete protection. These are only general observations and many exceptions could be made. Following the trend of increasing annual flood damages, Congress has instituted a National Flood Insurance Program in an effort to reduce annual disaster assistance outlays through the increased availability of flood insurance. This program includes extensive mapping programs of flood plains and classification of flood-prone areas to assist local interests in the

control of developments permitted in the flood-prone areas. Studies by the Corps of Engineers and the Soil Conservation Service currently consider all manners of possible means to reduce or control floods and flood damages. These include structural measures (upstream reservoirs, levees, floodwalls, and channel improvements); flood plain management, including zoning and regulation; flood proofing of existing and any proposed buildings; evacuation; and others.

In the Missouri Region, flood damage estimates were inventoried by the Soil Conservation Service for drainage areas of less than 400 square miles and by the Corps of Engineers for the remaining areas. The estimates made reflect a continuation of recent trends of Federal appropriations for structural measures and recent trends of flood plain regulation. The estimates show that, using 1967 dollars, the average annual damages in the region for 1975 were about \$228 million, which are estimated to increase to about \$233 million by 1985 and to about \$270 million by 2000. Over 45 percent of the annual damages occur in ASA 1011 which can be attributed to the greater amount of development and more frequent flooding because it is in the more humid part of the region. These estimates reveal that flooding is a major problem throughout much of the region. Numerous cities and communities have severe flood problems and large agricultural areas are subject to frequent flooding.

Since there are many remaining severe flooding problems in the region, water and related land resources development planning should consider all means whereby flood damages can be reduced, which may be structural solutions. Since flood control, flood protection, and national flood insurance are all Federal programs, it is obvious that any measures which would result in annual benefits or reduction of annual flood losses greater than the annual cost of the Federal programs should be undertaken. Efforts should also be made to improve warning systems of impending floods so as to reduce or eliminate the lives lost and reduce human suffering from flooding such as that which occurred at Rapid City,

South Dakota, in 1972 and in the Big Thompson Canyon in Colorado in 1976.

17. Municipal and Industrial Water Needs

The Safe Drinking Water Act of 1974 authorizes the Environmental Protection Agency to regulate the contaminant levels in public water systems and to promulgate national primary standards for drinking water, which includes all public systems with 15 or more connections and serving 25 or more persons, excluding systems used primarily for storage. The States are given primary enforcement responsibility. Many small communities in the region do not have readily available water supply sources which can pass standard public health requirements nor do they have the financial means whereby acceptable water supplies can be obtained. Without considerable Federal assistance, it is highly doubtful whether many of these communities will ever have acceptable public water supplies.

There are many communities and even several large cities in the region with inadequate sources of water supplies to meet these current and projected needs. The recent drought has affected many areas. Many communities and livestock raisers, particularly in the Dakotas, were forced to haul in water supplies. Many others instituted water rationing to conserve available supplies. The far below normal winter snowpack in the Rocky Mountains is causing great concern, particularly in Colorado where plans for water rationing and water use restrictions are being readied in case of need.

Studies are underway and some have been completed on tentative schemes to supply M & I water to a number of communities in eastern South Dakota. Similar studies are programmed for western South Dakota. Numerous studies have been made and others are underway to consider alternative schemes to supply M & I water for the cities and communities along the Front Range area of the Rocky Mountains in Colorado. Many communities in northwestern Missouri, southwestern Iowa, and southeastern Nebraska obtain their water from shallow aquifers which tend to dry up or nearly so during extremely dry periods. While rural water

districts are meeting some of the needs, many others are needed, and, in the more thinly populated areas, these types of solutions are far too costly. It is obvious that solutions are not easy, they are generally quite costly, and in many cases, are beyond the financial capability of those in need.

Even the large metropolitan areas of Kansas City and Omaha, situated along the Missouri River have problems. The problems are not a lack of water, since the Missouri River has an adequate supply; but relate to economics. The Kansas City Metro area obtains its water from the Missouri and the Kansas rivers; however, the population is spreading and moving in directions away from the rivers. Consequently, the distribution systems are being constantly extended and pumping becomes more costly. Sources of water supplies near the extremities of the expanding population areas are being sought in an effort to reduce distribution systems and pumping costs. Omaha, to meet its westward expansion needs, obtains a part of its water from wells in the Platte River alluvium. Some concerned citizens in the area are raising objections against Omaha's use of Platte River water. Other cities in the region also are facing problems concerning adequate sources of future water supplies and the costs of meeting expanded needs.

18. Water Quality and Low Streamflow Augmentation

Overall, the water quality objectives for the Missouri Region are dictated by Public Law 92-500. Section 101(a)(2) states: "...it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water shall be achieved by July 1, 1983." In general, it can be assumed that effluents from municipalities, industries, and feedlots, while currently causing some degradation immediately downstream from outfalls, will be appropriately treated as required by P.L. 92-500.

At this time, there are no known feasible means of controlling quality

problems caused by farm and ranch operators although increasing emphasis is being placed on management of irrigation water use and on education and training in the use of farm chemicals. It may be possible to reduce somewhat the salinity of irrigation return flows in some areas, although to what extent is not now determinable. One of the more significant stream pollutants throughout most of the Missouri Region is sediment resulting from sheet, gully, and streambank erosion. This problem is most prevalent throughout ASA 1009 and the northern part of ASA 1011 in northwestern Missouri and southwestern Iowa. Although improvements in land conservation practices, controlled grazing, taking some lands out of cultivation, and installing control structures will probably lessen the pollution, stream sediment will always be a major problem. Also, there are no apparent feasible solutions to the water quality problems caused by other naturally polluting areas, such as the Badlands of South Dakota in ASA 1005.

The amount of data available concerning the quality of surface waters in the region is somewhat less than desirable. More sampling stations and a reliable method to transmit the available data are needed to provide better coverage. Records at existing stations are not available for a period long enough to define accurately the changing quality of water. Data concerning the biological quality of surface waters are particularly deficient. The staff report to the National Commission on Water Quality recognized the lack of data as a nationwide problem. Also, the staff encountered problems in attempting an environmental assessment of the P.L. 92-500 program. The staff report, dated April 1976, states on Page IV-1: "measuring and predicting the environmental impacts of introducing certain pollutants into a controlled aquatic system is possible. However, relating that information to entire drainage systems, and accurately predicting effects resulting from introducing pollutants to or removing them from complex aquatic environments, usually stretches the application of ecosystems analysis beyond the present state-of-the-art and beyond the existing

data base." Therefore, the extent of the effectiveness of point-source treatment, as required by P.L. 92-500, on the complex aquatic ecosystem or in restoring waters to a pre-man status will never really be known.

While it appears that practically all point sources will be treated by 1983 to meet the prescribed requirements of P.L. 92-500, the region will still have water quality problems resulting from non-point sources. Also, in some areas, it is doubtful that the low, erratic streamflow can adequately assimilate even properly treated wastes. Particularly in those areas and possibly in other areas where advanced treatment would prove to be quite costly, consideration should be given to reservoir storage to augment low streamflows where this proves to be the only viable or most economical alternative.

19. Growth-No Growth

Like many parts of the Nation, many areas of the Missouri Region and some segments of the population have voiced a preference for a "no-growth" policy, although most states encourage industrial expansion and associated growth. Many ranchers, farmers, and others living in the coal-field areas of Wyoming, Montana, and North Dakota oppose development of the coal fields, not only because of the land disruption but because of the influx of people and expressed fears of attendant social problems. They would prefer a status quo to protect their current life styles. Some interests in the Rocky Mountain Front Range area in Colorado oppose further development because of strains being placed on the environment and particularly the available water supplies. While the most often expressed fears concerning environmental disruptions are those which would result from increased developments, many fears are related to increasing water uses. Increased water needs of many areas can be met only by additional reservoir storage, water diversion, or some other man-made provisions. Additional reservoir storage and water diversions always cause concern and protests from those concerned with environmental issues. Therefore, if there is to be growth,

the needs of the additional people will have to be met by some means. The solutions will not be easy.

V. IMPLICATIONS OF NOT SOLVING SEVERE WATER AND RELATED LAND RESOURCES PROBLEMS

The water and related land resource problems of the Missouri Region are widespread and diverse, and are typified by its varied climate and topography. The average temperatures, rainfall, and streamflows are determined from many extremes. Throughout most of the plains area temperatures above 100 degrees Fahrenheit during the summer months are quite common as are readings below zero degrees in the winter months. Droughts and floods occur intermittently and average annual rainfall is usually just a comparative number. Problems and issues and the means to resolve them are compounded by increasing needs for water and growing competition for the available resources. The implications of not resolving these problems are many and varied. Views of the various interest groups are different and their approaches toward resolution are not in agreement. Therefore, it is apparent that there will never be complete agreement on the implications of not resolving the severe water and related land resource problems of the Missouri Region. The perceptions of some would lean toward development and use of the water and land to meet growing food, fiber, energy, and industrial needs while others would tend toward preservation and conservation because of environmental and ecological concerns.

A. SRF, MCC, and Other Estimates

The State/Regional Future (SRF) estimates of current water and land use and projections for the years 1985 and 2000 were compiled from estimates prepared by each of the 10 states. The Modified Central Case (MCC) estimates are being prepared by the Federal agencies using a somewhat uniform set of criteria. Since the MCC estimates are currently being revised, regionally prepared implications concerning these estimates, and others, such as those appearing in the 1971 Framework Report and those used in connection with the Departments of Interior and Army Memorandum of Understanding on Water Marketing Policies from Missouri River main stem reservoirs, would have implications different than when

using SRF and MCC estimates. The need for a study to determine more precisely current water uses and water availability has been discussed previously. While implications using various estimates could be drawn, such a discussion here would be of questionable value since the need for a more definitive study is being discussed widely. Rather, it is considered to be more useful to discuss implications concerning the 19 major problems and issues affecting the Missouri Region. The SRF and MCC estimates of water withdrawals and consumptive water use and, resultant depletions of streamflow are significantly greater than other previous estimates. Because of this, some adverse comments were generated; particularly, as these greater estimates affect the current and projected operation of the Missouri River main stem reservoir projects and the indicated amounts of water available or likely to be available at and in the Missouri River below these projects. With the indicated reduced inflows to the reservoirs, less power would be generated, which would affect power rates calculated to repay the power investments.

B. Major Problems and Issues

With Indian and Federal reserved water rights being indeterminable, water resources planning is difficult and, in some cases, impossible. Until these rights are quantified, planners cannot determine how much water is available for use where and in what quantities. Although planning can proceed on the basis of "what if" type scenarios, there is great reluctance to make large investments for water resource developments without adequate assurance that the quantities of water needed will be available to make possible the repayment of the investment costs.

There is a need to determine more precisely how much water is currently being used, where it is being used, and for what purposes. These determinations will then lead to a better knowledge of how much water remains to meet future needs. Until this study is completed, planning for future water uses, quantifi-

cation of instream flow needs, water allocations, and related subjects cannot proceed with the definition needed. The implications of not resolving the quantification of current water uses are self-evident and place a stigma of uncertainty on planning for future water uses.

Water for energy is a problem. While completed studies and those underway indicate that adequate water supplies needed for energy development are available, the water is not always available in the quantities at the precise locations needed. The current Level B study of the Yellowstone River Basin and Adjacent Coal Area, scheduled for completion in 1977, will delineate the areas where and what types of water resources development projects are needed, as well as provide estimates of the quantities of water involved. If greater reliance is to be placed on the use of coal to meet the Nation's energy needs, development of adequate water supplies will also be required.

The effects on surface water supplies and on streamflows caused by the increased pumping of ground water for crop irrigation and other uses need to be defined in many areas of the Missouri Region. Also, there is a need to more fully understand the effects of ground water pumping on the available storage in various aquifers. Since each aquifer is unique and the effects on streamflows vary, specific areas for study need to be delineated. The consequences of not determining the basic relationships and subsequent management strategies to conserve or use the available supplies could be severe economic and social problems for large areas throughout the region.

Any proposal for transfer of water from one basin for use in another basin or across State lines is generally approached with considerable caution because there are legal questions concerning water rights and opposition from local residents. While some transfers of this nature are provided for under existing compacts and treaties, it appears that more serious consideration should be given to transfers from water surplus areas to water short areas. In some

cases, such transfers of water may provide the most feasible solution to meet energy, food, fiber, or other needs.

It is often argued that legal, policy, and institutional issues are the problems rather than the water resource itself. However, these are man-made contrivances established supposedly to solve the water problems or to protect the rights of individuals, groups, local governments, States, or the Nation concerning the quantity and quality of the water resources. Since man created the laws, policies, and institutions, he should also be able to change them if this proves to be the obvious solution. Closely related are cost-sharing problems cited in the recently completed WRC study made in response to Section 80(c) of the Water Resources Development Act of 1974. Congress has passed many laws, established policies, and created institutions to construct and manage water resources developments in cooperation with States and local governmental entities. Also established have been cost-sharing arrangements, usually determined on the basis of the nature of the benefits and non-Federal capabilities and responsibilities. Results of the Section 80(c) study were never transmitted to the Congress. The current uncertainty surrounding the Federal role in water resource developments and cost-sharing arrangements needs clarification. It is highly doubtful whether large water resource developments would be undertaken by any entity without considerable Federal involvement and funding.

Instream flows needed to provide and support recreation and maintain fisheries, wildlife, and ecosystems are not very well defined. At least partly because of this, there is a tendency on the part of conservationists and those concerned about maintaining ecosystems to generally oppose almost all diversions from streamflows and, particularly, any proposed new diversions and projects. In many cases the currently stated minimum streamflows are considerably greater for some periods of the year than occur under present conditions of development and water use. Without quantification of minimum streamflows needed and based

on more thorough studies and scientific analyses than are presently available, any new water diversions or proposed project developments may encounter delays until such determinations are made.

Water-related recreation needs too are not very well defined. The SCORP reports prepared by the States lack uniformity, making it difficult to prepare regionwide assessments of needs. There is a need to establish uniform procedures and sets of criteria for estimating various activity participations and in projecting water based recreation needs. Until this is accomplished, it will be difficult to determine the adequacy of existing water bodies and facilities to meet current recreation needs and even more difficult to project the future needs.

The environmental concerns and issues related to water uses, water resource developments, and water availability are generally directed to the notion that any change is detrimental to the environment. Since there are few yardsticks by which to measure environmental or ecological changes which would result from increased or changed water uses or from water resource developments, many decisions are based largely on judgments of what these effects would be. The Federal agencies have greatly improved their consideration and presentation of environmental and ecological effects in reports and environmental impact statements on proposed significant Federal actions. However, the constantly expanding list of endangered species and additional environmental factors to be considered make it difficult to keep environmental assessments current at all times and, at times, have even prevented completed projects from becoming operational. Addressing environmental concerns and issues is complex and difficult, and it becomes nearly impossible when these are constantly changing. While evaluation procedures for determining project benefits and costs are quite clearly established, similar evaluations of environmental and ecological effects are not established, making it difficult to prepare meaningful comparisons.

The flows to maintain an 8-month season for the Missouri River navigation project extending 732 miles from Sioux City, Iowa, to the mouth of the river are dependent on the amounts of water in storage in six large upstream main stem reservoirs operated by the Corps of Engineers. During prolonged drought periods, upstream depletions and tributary inflows may not be adequate to sustain a full 8-month navigation season. If upstream depletions become too great or drought conditions persist, Missouri River towboat operators may have to be satisfied with a shorter season or in time they may elect to forego attempts to maintain operations all together. If either of these events happens, shippers will probably have to rely partially or entirely on some other form of transportation for those commodities they normally ship by river barge.

There is a great need for soil conservation and land treatment measures, gully erosion control structures, and streambank erosion control throughout most of the region. Sheet erosion results in loss of valuable topsoil and gully and streambank erosion causes loss of valuable and irreplaceable lands. Most of this soil loss ends up as sediment in the streams and rivers where it causes further problems, particularly those of water quality. The implications of these soil and land losses on agricultural productivity are self-evident. While the collective losses in any one year may not be great, the long-term effects could result in serious reduction of the agricultural productivity of the lands.

Flooding is a problem throughout much of the Missouri Region. Although most of the major metropolitan areas have a fairly high degree of protection along the major waterways, there remain numerous problems along small tributaries and from a lack of adequate internal drainage. Many small communities suffer repeated damages to improvements currently located in the flood plain areas. Agricultural damages and rural improvements, such as roads, bridges, and utilities, remain high throughout most of the region. While flood insurance

may reduce some of the financial losses to residents of the flood plains, it does nothing to alleviate the hazards to human life and health, not to mention the massive efforts required to clean up the mud, slime, and debris left by floods. Crop losses and damages to farm and other rural area improvements cause financial hardships on the farming communities. Projections of increased world food and fiber requirements indicate the need for additional rural flood protection as one means of increasing agricultural productivity. Flooding, as with other natural disasters, causes damages which do not add to productivity.

Most of the large metropolitan areas of the region have adequate water supplies to meet current needs. One of the exceptions may be the Denver Metro and the Rocky Mountain Front Range area in Colorado where it has been indicated that, if current drought conditions persist water rationing may have to be invoked. Many small communities throughout much of the region have an inadequate source of supply and others are using water which does not comply with public health standards. Not improving the quantity and quality of water supplies where needed results in health hazards, human suffering, and disruption of many of the social amenities of area residents. Inadequate water supplies discourage the location of many new industries in small communities.

It is estimated that all point sources currently discharging into waterways will be treated adequately by 1983 as required by P.L. 92-500. Despite this, there will be some areas in the region where persistent low flows are not adequate to assimilate the remaining wastes. Where further treatment would be unreasonably expensive, consideration should be given to reservoir storage to provide low-flow augmentation. The National Water Quality Commission Report indicates that treatment of most urban storm runoff will be very costly. Reservoir detention or reservoir storage to augment low flows may prove to be the most feasible and economical solution. In other areas where flows are persistently low for extended periods, reservoir storage to augment low flows and improve water quality may

provide the only viable and economically justifiable solutions. If such storage does not receive adequate consideration during water quality and water resource planning studies, the most economical solution to water quality problems in some areas may not always be selected.

If a policy of no growth or very limited growth is espoused by an area or a state, economic hardships may result. If very restrictive policies concerning development of the coal areas are adopted, the Nation may suffer from a lack of adequate energy sources to meet the needs. The future prosperity of the Nation is dependent on interregional coordination and exchanges of goods and services, while taking appropriate precautions so as not to exploit the resources to the complete detriment of a particular area. Reasonable precautions should be undertaken and Federal assistance may be required to meet increased social costs impacting on specific localities.

VI. REGIONAL VIEWS OF PRESENT AND EMERGING NATIONAL ISSUES

The regional views of present and emerging national water-resource related problems and issues will be furnished in the regional comments on the draft National Assessment Report. Although most of these views are known at this time, it is considered more appropriate to reserve comments since the emphasis and manner of presentation in the national report could alter the nature of the regional comments.

VII. REVIEW PROCESS AND PUBLIC PARTICIPATION

Preparation of the regional technical memorandums was under the direction of the Framework Update/National Assessment Committee of the Missouri River Basin Commission, using guidelines provided by the Water Resources Council. The Committee provided leadership and direction to the MRBC staff in acquiring data and preparation of the memorandums. Each memorandum was approved for final publication by the MRBC members. Draft copies of this fourth and final regional technical memorandum were furnished to the 10 member States and 10 member Federal agencies of MRBC through principal contacts previously established for each State and agency. In addition, each State and Federal agency contact was requested to furnish a list of those agencies, offices, and others given an opportunity to review and comment on the draft. This list is included in Appendix I. State and Federal agency member comments are included in Appendix II. Public participation and review were the responsibility of each State.

VIII. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

The examination of water and related land resource problems in the Missouri Region conducted as a part of the 1975 National Water Assessment afforded an opportunity to review ongoing studies and programs, to examine problem areas where there are no ongoing studies, to review the major problems and issues confronting the region, and to assess the adequacy or inadequacy of the available water resources to meet the needs. From this examination certain conclusions can be drawn and recommendations made. Recognizing that planning and establishment of programs concerning water resources are dynamic processes, the procedures and processes proposed must be flexible and responsive to the ever changing goals and objectives as expressed by Federal and State laws and policies and, above all, the expressed desires and needs of the people.

To determine the serious problems and issues confronting the region, Federal and State agency representatives were requested to identify and locate major water and related land resource problems within their area of responsibility. From these, tentative analytical areas were delineated on maps and descriptions of the problems occurring in each area were prepared. This process resulted in identification of 58 problem areas. A preliminary screening process reduced the number to 32 containing the more serious, urgent, and complex problems and issues. Ongoing and recently completed studies were then reviewed to determine their adequacy in addressing the problems of the 32 problem areas. As a result 10 problem areas were retained for further analysis as presented in Technical Memorandum No. 3.

There are many serious water resource problems and needs in the 22 problem areas currently under study. Some of the ongoing and continuing Federal agency and State programs will no doubt resolve some of the problems but by no means all of them. The remaining problems and issues of the areas under study should

be addressed by presenting alternative plans or programs for problem resolution and making appropriate recommendations for implementation of projects or programs. Until these studies are completed and followed by project construction or program implementation, the problems will remain unless resolved by local entities. Most of the major problem resolutions are usually far beyond the financial capabilities of the local entities.

While the problems and issues in the 10 problem areas presented in Technical Memorandum No. 3 are serious, a reanalysis indicated that the following conclusions concerning each could be drawn:

Bad River Basin, South Dakota--The Corps of Engineers has Congressional authorizations to study all of the area west of the Missouri River in South Dakota, including the Bad River Basin. This study is proposed for funding in fiscal year 1979. Also, an MRBC sponsored subregional analysis is proposed to be undertaken by 1985 or sooner.

White River Basin, Nebraska and South Dakota--The Corps of Engineers has Congressional authorizations to study all of the area west of the Missouri River in South Dakota, including the White River Basin. The Corps is also proposing that a separately authorized study of the White River Basin be incorporated into the western South Dakota study, which would then include that part of the White River Basin in Nebraska. The western South Dakota study is recommended for funding in fiscal year 1979. Also, an MRBC sponsored subregional analysis is proposed to be undertaken by 1985 or sooner.

Big Sioux River Basin, Iowa, Minnesota, and South Dakota--The Corps of Engineers has a funded ongoing study covering the Upper Big Sioux River Basin and an Eastern South Dakota Water Supply study. This combined study is scheduled for completion in 1979. The bureau of Reclamation recently completed several studies for specific water problems, particularly those affecting Sioux Falls. An MRBC comprehensive study of the Big Sioux River Basin, including the Missouri

River near the mouth of the Big Sioux River is currently scheduled to be initiated in 1980 to assimilate and to fill out a basinwide plan.

North Platte River, Wyoming--This area would be included in a proposed Upper Platte River Basin Water Management Program study to be led by MRBC and the Department of Interior for initiation in fiscal year 1978.

Nebraska Panhandle--This area would also be included in the proposed Upper Platte River Basin Water Management Program study for initiation in fiscal year 1978.

Upper Republican River Basin, Colorado, Kansas, and Nebraska--The Bureau of Reclamation hopes to initiate work on an Upper Republican River Basin Water Management study at an early date, and the Soil Conservation Service has an ongoing cooperative study covering the Republican River basin in Nebraska. These agency studies will be coordinated and will cover the major water problems of this area.

Big Blue and Little Blue River Basins, Kansas and Nebraska--The State of Nebraska has studies underway leading toward preparation of a comprehensive plan for the second section of the State water plan for this basin in cooperation with and assistance from several Federal and state agencies. Assuming that the Federal agency assistance continues as programmed, further study proposals are considered unnecessary at this time.

Tri-Cities, Missouri--The most serious problems in this area are related to pollution of both surface and ground waters. Presumably, EPA's P.L. 92-500 programs will resolve the major point source pollution problems in the area. Other point source pollution problems may require the attention of State and local programs and enforcement. One remaining pollution problem stems from acid mine drainage from orphaned coal mines. Unfortunately, there currently are no Federal programs to resolve this problem. An MRBC sponsored study of the Missouri River drainage between Kansas City and the mouth is proposed to be

undertaken within the next 5 to 8 years and would address these and other problems.

Lake of the Ozarks, Missouri--The primary concern in this problem area relates to surface water quality problems, including both point source and non-point source pollutants. The major problems identified are caused by both point and non-point sources of pollution. Although it is expected that much of the present non-point pollution from upstream sources will be lessened by the Harry S. Truman Reservoir, some sources will still be viable. Much of the visible pollution is the result of unplanned and uncontrolled land use surrounding the lake. Surveys indicate serious pollution in certain high use coves and bays due to poorly treated wastewater discharges from resort areas. Also septic tank leachates are known to be problems in other areas and these affect not only surface waters but ground waters as well. There is a serious and pressing need for laws and policies to govern the residential and resort development. While, as mentioned above, water quality is seriously affected in high use areas, the main body of the lake still has good water quality.

Ogallala Ground Water Area, Colorado, Kansas, and Nebraska--A study of this problem area, which extends southward from the Missouri Region, has been initiated through funds provided by the Economic Development Administration.

To determine the adequacy of basic data collection programs in the region, the MRBC Fourth Annual Report, Basin and State Priorities, dated February 1977 was utilized. This report shows the need for improving programs in all ten States in the following categories of basic data collection and the relative priority adopted for each category. While accorded these overall priorities regionwide, it is recognized that for given portions any one of the basic data needs might there assume first importance. In the report it is recommended that a task force of State/Federal representatives be designated to determine data gaps for specific upcoming needs and thus assist in determining priorities to overcome these gaps.

Basic Data Collection Needs

<u>MRBC Priority</u>	<u>Study Subject or Area</u>
1	Soil surveys
2	Topographic mapping
3	Expanded stream gaging networks
4	Archeological, paleontological, and historic inventory appraisals
5	Expanded water quality monitoring
6	Land use inventory, including flood plains
7	Ground water data acquisition
8	Water use inventory
9	Color infrared aerial photographic coverage

The planning-related research needs of the region were also prioritized in the MRBC priorities report and are listed below:

Planning-Related Research

<u>MRBC Priority</u>	<u>Study Subject or Area</u>
1	Transfer water-use efficiency knowledge to operating practice
2	Strategies for water quality/quantity management, including non-point sources of pollution
3	Water supply availability and requirements
4	Biological-physical-chemical water quality interactions
5	Weather modification
6	Maintenance of minimum streamflows and instream flow needs
7	Application of remote sensing techniques
8	Multiple-objective planning

The most serious problems and issues confronting the Missouri Region which cover broad areas and are of widespread interest are described and discussed in Section IV(C). While it may be quite difficult to formulate, to the satisfaction of all concerned, plans to study many of the major problems and issues, the mere fact that the problems persist indicates the need to make extensive efforts to initiate appropriate studies. Hopefully, through the coordinated efforts of the Federal agencies, States, and others, all facets of the problems can be surfaced and appropriate resolutions of the problems and issues devised. At least, by the process of appropriate studies, alternative solutions could be devised from which selections could be made. Where agreement among concerned interests cannot now be reached for the undertaking of certain studies, these studies should not be delayed interminably lest interests outside the region step in and impose unwanted resolutions.

There is a pressing need to determine the Indian and Federal reserved water rights and the quantification of these rights. There is great reluctance among some of the Federal agencies and some of the States involved to undertake this study at this time because of the fear that it might prejudice the outcome of judicial proceedings. On the other hand, there is considerable support for a study of Indian and Federal reserved water rights, which would improve knowledge and the basis for negotiated answers in the event the courts are requested to adjudicate these rights. Since consensus of MRBC members could not be reached, an ad hoc committee has been retained to review and monitor activities of Federal and State agencies.

Frequent proposals have been made to undertake a study of alternative uses of water, changes in water use, water allocations, and related topics; however, consensus of MRBC members could not be reached to undertake a study of this nature at this time. It has been generally agreed that such a study should be undertaken, although it may not be appropriate at this particular time.

Improved efficiency in water use also should be a major consideration. Water thus conserved or saved would be available for other uses or left in the streams and underground reservoirs and, in some instances, may postpone the need for structural developments.

An integral part of the foregoing study would be a determination of current water uses and availability. Several recent estimates, including the SRF and MCC, have produced estimates of water quantity use and streamflow depletion effects of considerable disparity. To attain answers that can be given unified support in these respects, a foremost requirement is to conduct in-depth reviews of existing data and their adequacy, and field checks to establish dependable figures on irrigated lands and the amounts of water actually diverted and consumed. Equally important will be periodic updates. Water consumption must be evaluated in the final analysis on the basis of valleywide accountability rather than assumed unit values for smaller areas which tend to overstate the total net depletions. Contrasted to assumptions of full diversions and use, there must be determination of actual practice and weightings to reflect the mix of spreader (flood irrigation only), short, and generally full water application to arrive at meaningful averages.

An obvious requirement in satisfying the needs of the operating agencies, both state and Federal, the MRBC, and others is to complete the Bureau of Reclamation's Total Water Management Study now underway in collaboration with Montana-Wyoming and as projected for North and South Dakota above Sioux City but exclusive of the Niobrara River. In this study an attempt is being made to inventory the actual irrigated areas and water diversions, and finally to estimate net depletions, etc., by the end of FY 1979, and this should permit improved water accountability above Sioux City. Other similar studies are underway for certain areas below Sioux City that will give improved basic data of this type. However, for sizable portions of the areas now irrigated and expanding, existing data

will not show dependable bases upon critical review. Once inventoried, there is the requirement for each area to be updated periodically and thus to maintain a moving index and evaluation of water use together with availability as shown by flow records and reservoir/river operations. With ground truth data of given dates, modern techniques such as remote sensing and infrared photography are evolving that should permit better annual or periodic appraisals, as for irrigated areas.

Recognizing the importance of the subjects here addressed, there is need for added early work in appraising the basic data gaps and formulating means of overcoming them over time. Further, with firmer land/water use data, a small technical committee composed of a representative each from the Bureau of Reclamation, Corps of Engineers, and selected states, should review thoroughly and upgrade pertinent earlier studies thereof and determine the historical depletions and residual water supplies over the Missouri Region under present conditions. Having this, the committee could determine progressively for any set of agreed-upon projections of instream dedications, further resource development, and operating criteria, the added depletions and residual flows. With timely updates and responses to major needs therefore, this would provide authentic and dependable data to be used by all interests for index locations in the region, and within whose structure individual State and Federal agencies or others could develop more detailed information for particular usage. These index station data are too important, and find too much usage, to continue on any other basis than consensus criteria and results, and where these results will be deemed authentic and used by all interests.

Water for energy is a popular and important topic, not only within the Missouri Region, but also nationally. One of the most often asked questions today is, "will there be enough water to meet our energy needs and to supply other needs?" A review of the latest available electric power projections for

the Missouri Region by the Federal Power Commission shows thermal electric power generation increasing about sixfold from 1975 to 2000 or from 75,236 GWH to 448,618 GWH. The water consumed in the thermal electric power cooling process is expected to increase from 67 MGD in 1975 to 636 MGD in the year 2000. This is nearly 10 times more water than was consumed in 1975, but it represents only about 3 percent of the water projected for consumptive uses in the Missouri Region in the year 2000. While a problem in some areas locally, it does not appear that water availability will be a limiting factor on the development of projected thermal generation of power in the region. Depending on site location, water availability, and other factors, some plants may require a cooling system which is more costly than the current most common once-through cooling type.

There are a number of widespread concerns regarding the use of Missouri Region waters to support energy development initiatives. Some of the more probable impacts on the water resource base include the basic concerns associated with water depletion, alteration of streamflow patterns, transregion diversions related to coal slurry pipelines, water quality deterioration, destruction or alteration of established aquatic ecosystems, limitations on water-use options, and alteration of aquifer integrity including surface-ground water interchange. Completion of the Level B study on the Yellowstone River Basin and Adjacent Coal Area should provide much better definition of the impacts of energy development on the water resources of this coal-rich area. However, it does not appear that water availability would be a limiting factor, although adequate water quantities may not always be available at site-specific locations. Assuming that energy developments in this area would require as much as one-half million acre-feet annually, this would be only about 6 percent of the average annual amount of water currently flowing in the Missouri River below its confluence with the Yellowstone River and less than 3 percent of the average annual flow at Sioux City, Iowa.

Recent significant increases in the use of ground water for irrigation in some areas of the region are causing considerable concern. Some State legislatures are discussing making changes in water laws concerning the use of ground water; however, there is general recognition that better information on ground water recharge rates, short-term and long-term effects on aquifers and on streamflows, pumpage rates, falling water tables, and similar data are badly needed before attempting to significantly change or add to existing laws. Study areas need to be established and study criteria established for those areas where ground water use is increasing significantly and the basic studies initiated as soon as possible.

Interbasin transfers of water may provide the most viable and economical solutions to the problems of some water short areas. Existing legal and other restrictions pertaining to interbasin water transfers should be reviewed, particularly where it is determined that the need is great and other solutions are not available.

Legal, policy, and institutional arrangements concerning water resources should be reviewed periodically to determine if they are a part of the problem, if they are outdated, or if changes would improve problem resolution possibilities. Recent Congressional environmental legislation has not been in agreement with other Congressional actions which authorized and funded for construction numerous water resource development projects. These actions have resulted in considerable uncertainty and a waste of Federal funds. A cohesive Federal policy concerning water resources developments is needed. This is complicated, however, by a lack of assurance of Federal cost-sharing arrangements covered in a study and recommendations requested by Congress in Section 80(c) of the 1974 Water Resources Development Act. The States need to know the direction of Federal policies, assurances as to Federal institutional arrangements to carry out those policies, and what cost-sharing and other basic arrangements to expect.

Instream flow needs to meet withdrawal and consumptive water use needs for municipal and industrial purposes, mining, land irrigation, livestock, and thermal electric power generation, and for hydroelectric power operations and inland navigation have long been recognized. Minimum streamflows to maintain stream fisheries, wildlife, and ecosystems, to provide greater recreation enjoyment, and for esthetic purposes have only recently come under serious discussion but are gaining in recognition. There is a need to continue and, perhaps, increase the funding level of the recently initiated studies to make assessments of instream flow needs, to establish scientific bases for instream flow requirements, and to establish management strategies. These studies are needed to provide a better knowledge base on which decisions can be made on controversies concerning water uses and water resource developments versus conservation policies and needs and maintenance of ecosystems.

Numerous tributary streams in the Missouri Region are naturally intermittent and provide little or no opportunity for recreation enjoyment. On the other hand, there are many streams with adequate base flows which would provide excellent opportunities for development of recreation areas in a riverine environment to meet local recreation needs. In many cities and towns, development of flood plain areas for recreation provides opportunities for wise use of these areas. Existing reservoirs provide additional opportunities for expanding facilities and areas and to provide access to meet increasing recreation needs. In some instances, water supply reservoirs and some reservoirs on private lands are closed to the public, which could be opened to the public and access and recreational facilities provided for public enjoyment. It is also evident that the lack of adequate water and related land areas for recreational use is most pronounced at or near the cities and towns in the region. In addition to meeting recreation needs, there is a need to establish uniform criteria for use by States and Federal agencies in regional studies defining recreation opportunities

and needs, the evaluation of recreation benefits, and associated recreation data and information.

The primary concerns and issues pertaining to water resources and related lands in the Missouri Region revolve around developing or not developing proposed Federal water projects or the granting of Federal or State permits for the construction or development of facilities which may affect the quantity or quality of water. While water resource development proposals undergo rigorous evaluation tests, much scrutiny, and environmental analysis, most decisions where environmental issues are involved are based largely on judgment. There is a need to clarify procedures and evaluation techniques so that, once construction of a project has been started, there is assurance that it will be completed. In too many cases, regulations are changed without adequate consideration being given to the effects of those changes on projects, power plants, or other facilities being constructed. These changes often result in greatly increased project costs or, even worse, completed projects which cannot be operated for their intended purposes.

Because agriculture is the principal industry of the region, the widespread interest in land conservation measures and treatment practices is readily understandable. Through education and because of a desire by most farm operators to preserve the land while continuing farm productivity, there is widespread interest in following good land management practices and in installing land treatment and watershed protection measures. Although progress is being made in these areas, there is a need to increase Federal funding levels to accelerate these Department of Agriculture programs. Streambank and gully erosion are serious problems throughout most of the region. It is estimated that streambank erosion, measured in 1967 dollars, causes damages of nearly \$7 million annually. It is also estimated that there are over two million acres subject to gully erosion damage causing annual damages, in 1967 dollars, of almost \$32 million. Since a

large part of these losses represents the permanent loss of valuable land, it is obvious that measures should be taken or accelerated to prevent these losses.

Despite the large number of local flood protection projects completed, the many large reservoirs constructed by the Corps of Engineers and the Bureau of Reclamation with flood storage allocations, and the numerous watershed projects completed by the Soil Conservation Service, average annual flood losses in the Missouri Region continue to mount. There is a need to accelerate flood plain management studies followed by appropriate measures to reduce these ever-increasing flood losses, including realistic flood plain regulations.

Municipal and industrial water supply problems currently are most acute in the Rocky Mountain Front Range area of Colorado and for numerous small communities at many locations throughout the region. Although some progress is being made in providing public water supplies in adequate quantities and of suitable quality for many of the small communities, Federal funding levels should be accelerated.

While progress is being made in the treatment of point sources of stream pollutants, non-point runoff remains the major problem in the Missouri Region. There is a need for more sampling stations, a reliable method of transmitting the available data to provide better coverage, and the establishment of uniform reporting criteria to improve the water quality data information system. Low streamflows will limit the water quality of many streams in the region, and there is a need to consider reservoir storage to augment low flows where such storage would provide viable and economic solutions.

It was planned that the MRBC would update the Missouri River Basin Comprehensive Framework Report and that this effort would be meshed with the 1975 National Water Assessment efforts. In November 1976, MRBC agreed to prepare a Comprehensive Coordinated Joint Planning Report (CCJP). Since the CCJP would include a baseline record of resources, projects, programs, and a continuous planning process, it was also agreed that updating of the Framework Report would

be largely duplicative and, therefore, unnecessary. Consequently, there currently are no Level A studies contemplated and none is needed at this time. MRBC completed a Level B study on the Platte River Basin in Nebraska in 1976. The Level B study covering the Yellowstone River Basin and Adjacent Coal Area is scheduled for completion in CY 1977. A Level B study of the Missouri River Basin in Montana is budgeted for initiation in fiscal year 1978. No other Level B studies are contemplated at this time; however, several subregional analyses are scheduled, beginning with the James River Basin in FY 1978. There are numerous Level C and other studies covering entire river basins, significant parts of river basins, metropolitan areas, and other areas currently underway or programmed.

The CCJP process, report, and recommendations will provide background information; the basis for study, program, and project needs; and directions for the future. It is a dynamic process with the supporting data updated progressively and the report to be updated biennially. It will provide the information needed to point out the deficiencies and to show where greater emphasis is needed in basic data collection and planning-related research programs. It will point out those areas where regional, river basin, special, or other types of studies or programs are needed and the relative importance or need for each. The CCJP process provides a systematic approach to determining the areas where subregional analyses are needed and methods whereby the relative importance of each can be determined, including scheduling and budgeting recommendations. It also provides a process whereby the need and relative importance of implementation studies, programs, and projects can be determined. With the establishment of the CCJP process and biennial reporting, the MRBC members will be able to select those studies, programs, and projects which are directly needed and to seek their implementation on a systematic basis and in a timely manner commensurate with the capabilities of the States and Federal agencies.

B. Recommendations

The Missouri River Basin Commission recommends that:

1. The ongoing studies of water and related land resource problems and needs being accomplished by the Federal agencies be completed as expeditiously as possible.
2. For those States which have not completed State water plans, that these be completed as soon as practicable and that, where completed, the plans be continually updated; that the funds to the states being provided under Title III of P.L. 89-80 be increased to enhance their capabilities to complete and continually update State water plans and to participate as partners with the Federal Government in water resources planning activities.
3. A study to determine current water uses and availability, both surface and ground water, be undertaken immediately to include representation from the Bureau of Reclamation, the Corps of Engineers, and appropriate States; and that funding for the Total Water Management Studies, which relate to current water uses, be accelerated.
4. A study of problems and issues associated with water and related land resources for Indian and Federal lands and related matters be undertaken under the auspices of MRBC at the earliest date deemed appropriate.
5. A study of projected water needs, impacts, alternative water uses, and water pricing and marketing, including institutional arrangements, be undertaken under the auspices of MRBC at the earliest date deemed appropriate.
6. The follow-on studies to be recommended in the ongoing Level B study of the Yellowstone River Basin and Adjacent Coal Area be funded, undertaken, and completed as expeditiously as possible.
7. Where the use of ground water is significantly affecting the ground water resource and streamflows, and, particularly where such use is threatening water using developments and investments, that studies be undertaken in selected

areas to be determined through the CCJP process and report and the annual MRBC prioritizing process and report.

8. Studies by the Bureau of Reclamation, the Department of Agriculture and others of current water use for irrigation for Federal and non-Federal projects and private developments be accelerated to improve efficiencies of water use and thus conserve available supplies; and that existing irrigation developments be rehabilitated and upgraded where needed to become more efficient and conserve water use.

9. The studies initiated by the U.S. Fish and Wildlife Service concerning instream flow need determinations to maintain stream fisheries, wildlife, and ecosystems, to provide greater recreation enjoyment, and for esthetic reasons be accelerated through increased funding.

10. Steps be taken by the Bureau of Outdoor Recreation to establish uniform criteria for use by the States and Federal agencies in defining recreation opportunities and needs, the evaluation of recreation benefits, and associated recreation data and information.

11. Funding for the land conservation and management programs and watershed projects of the U.S. Soil Conservation Service and the States be accelerated.

12. To reduce the large annual losses of valuable lands, funding of programs of the U.S. Soil Conservation Service and the Corps of Engineers to control and prevent streambank and gully erosion be accelerated; and that current justification procedures for undertaking these programs be modified.

13. Programs of the U.S. Soil Conservation Service, the Corps of Engineers, and the Department of Housing and Urban Development to reduce flood losses in both urban and rural areas and to improve the National Weather Service and local flood warning systems be accelerated or instituted as appropriate.

14. Programs of the National Home Farmers Administration, Department of Agriculture, and other Federal agencies to provide water supplies of adequate

quantity and quality for numerous small communities throughout the Missouri Region be accelerated.

15. Particularly in those areas where advanced treatment would be costly and low-flow augmentation is needed to improve water quality, consideration be given to reservoir storage to augment low streamflows where this proves to be the only viable or the most economical alternative.

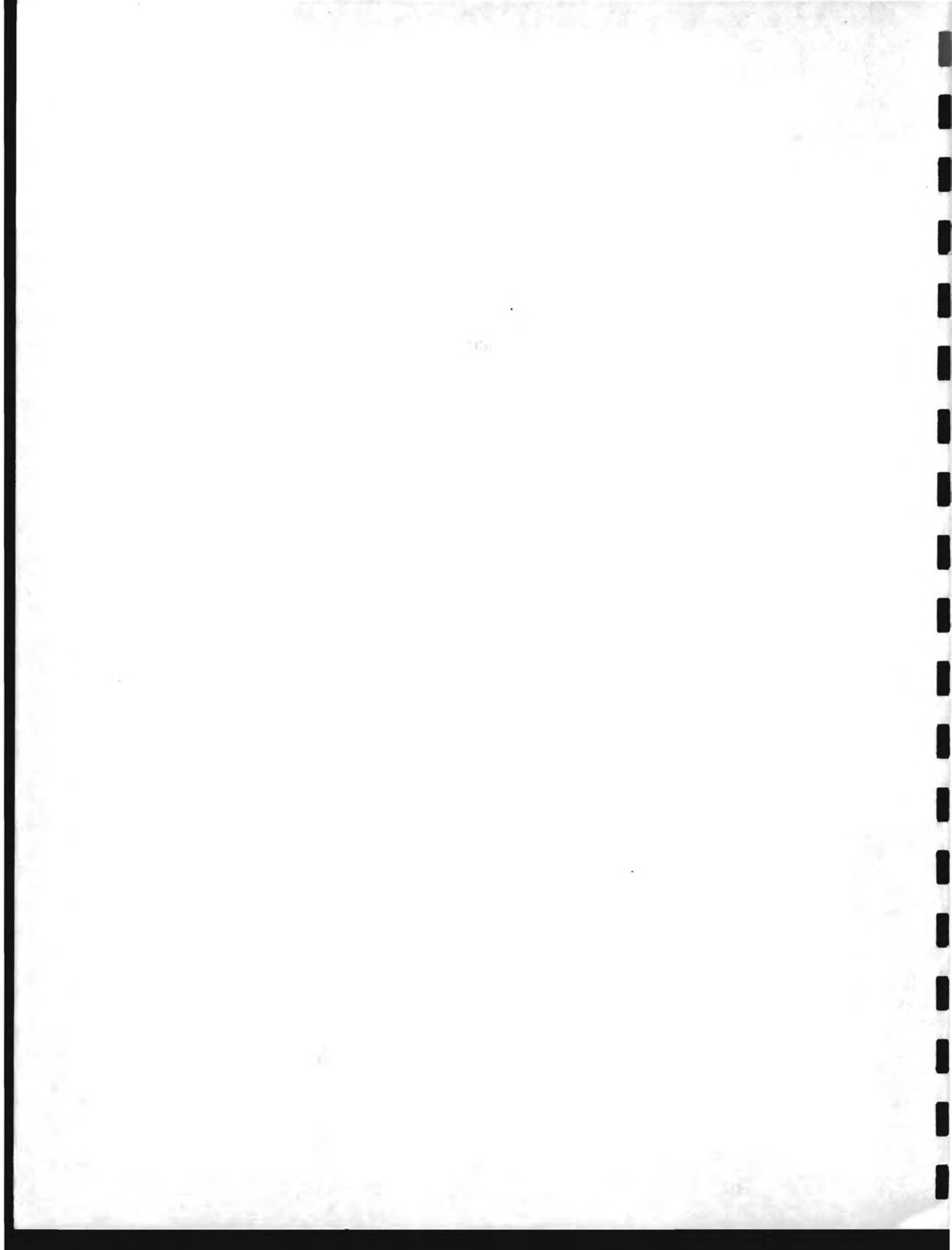
16. The establishment of an appropriate centralized water and related land resources data bank be investigated through MRBC's comprehensive planning program.

17. The CCJP process and biennial report, including the associated annual prioritization process, be used as a guide for determining needs for basic data planning-related research, studies of water and related land resource problems and potential resolutions, other water related programs, and water resource project or program implementation.

APPENDIX I

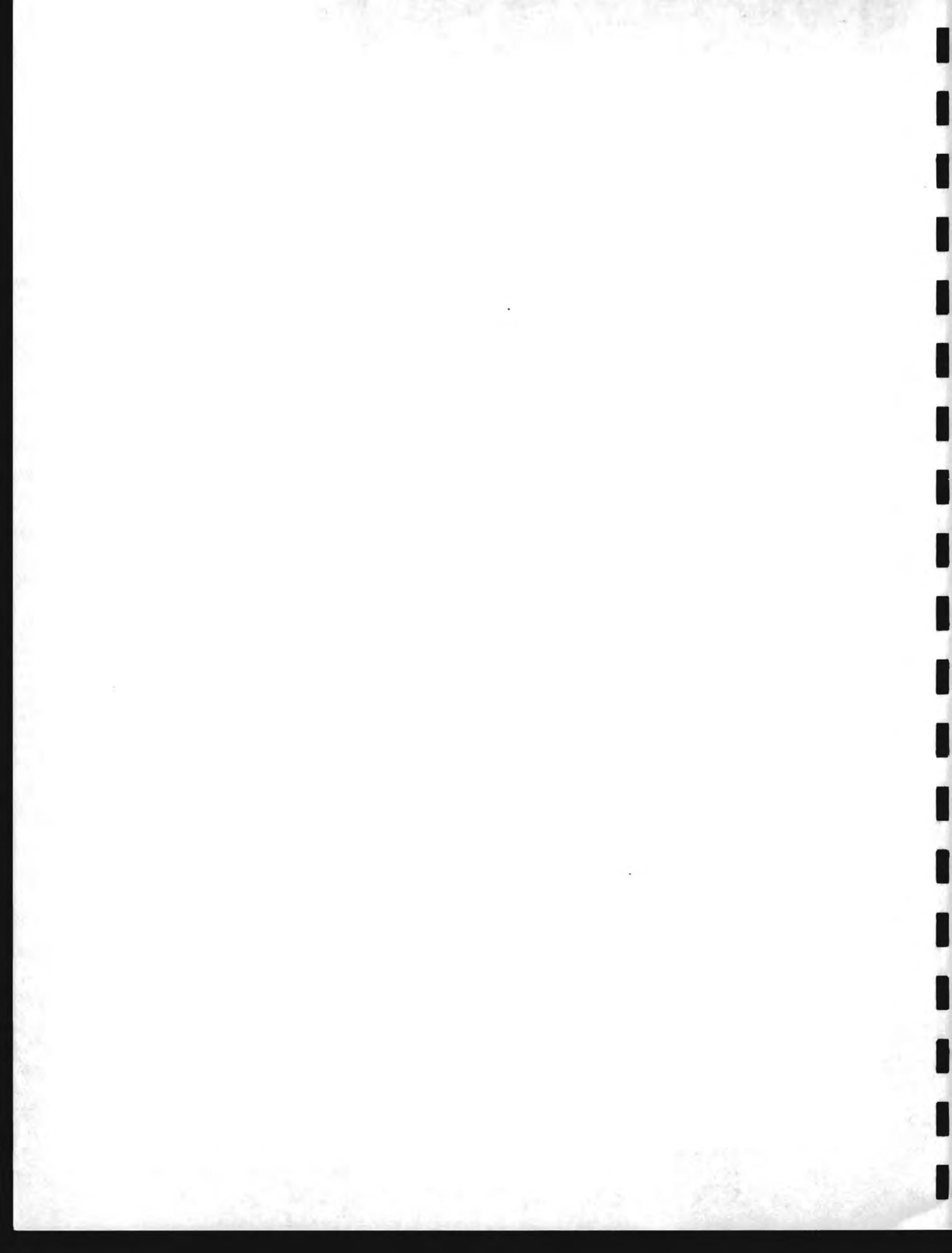
Technical Memorandum No. 4

Review Agencies



APPENDIX II

MRBC Member Comments



APPENDIX III

Updated SRF Electric Power Generation
and Related Water Uses for
1975, 1985, and 2000

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