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IV Demand Projections

For assessing the need for water into the future, this plan has developed estimates of water demand for each major use category out to year 2030. These estimates are discussed in detail in technical memoranda prepared for each topic.

As with all chapters in this final plan report, explicit lists of references are not provided. Instead, all references to reports, documents, maps, and personal communications are maintained in the Technical Memoranda that were prepared during the current planning process. Should the reader desire to review a complete list of references for the information presented in this chapter, the following memoranda should be consulted.

- Irrigation Water Needs and Demand Projections
- Population Projections
- Industrial Water Needs Projections
- Recreational and Environmental Water Requirements

A. Agricultural Demand Projections

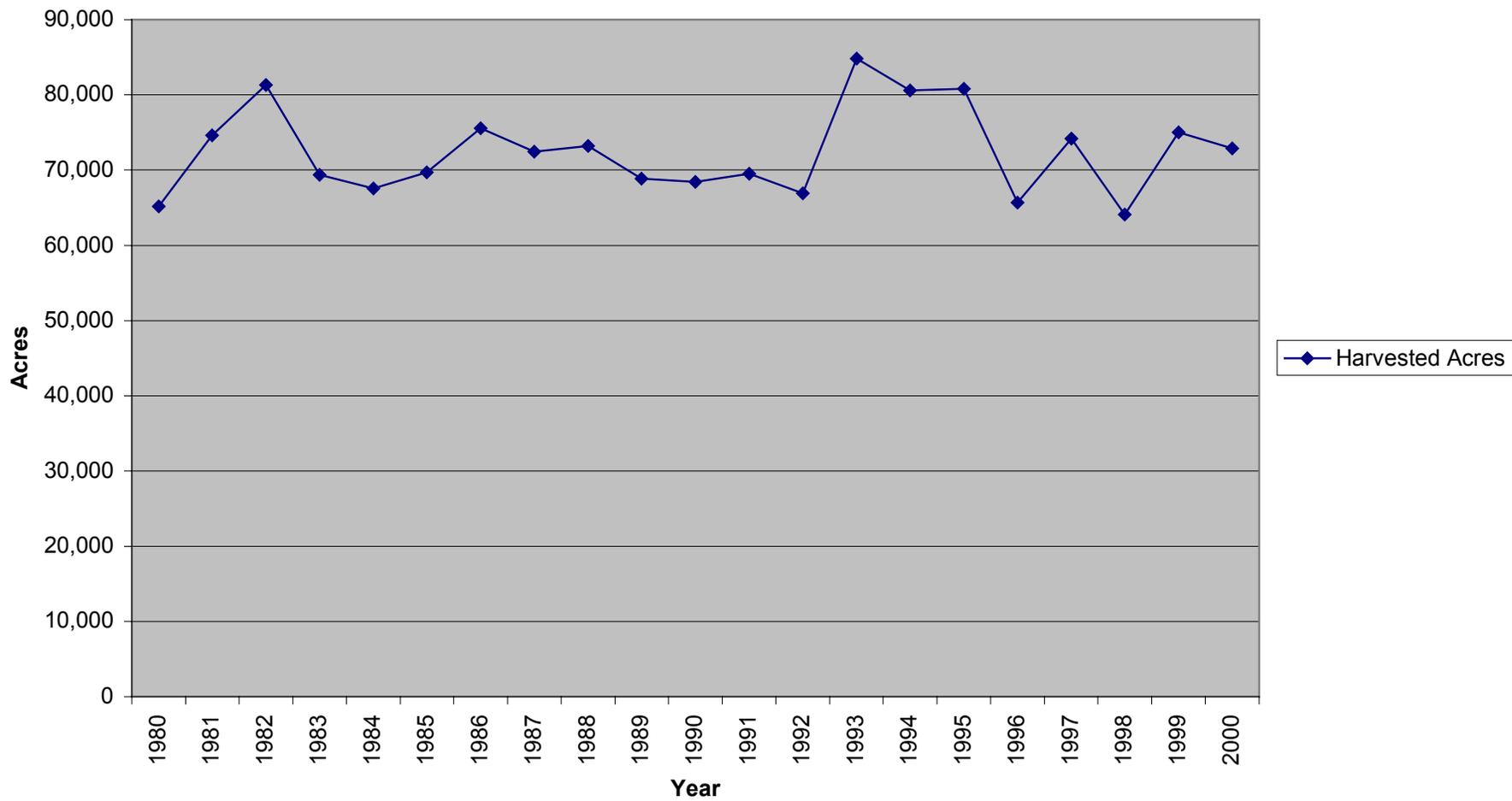
Background

Irrigated agriculture is the largest user of water in the Powder/Tongue River Basin. The irrigated lands analysis conducted for this study indicates that there are about 169,600 acres of irrigated land in the Basin. Of this total, 8,300 are idle, primarily due to water delivery system problems, and another 4,300 acres have been converted or are in the process of conversion to residential use. Of the remaining 157,000 acres that are actively irrigated, about 15,000 are irrigated using spreader dikes or intermittent diversions. Only about 200 acres rely primarily on groundwater as an irrigation water supply. The remaining 156,800 actively irrigated acres are served primarily by surface water diversions. Total surface water depletions in the Basin are estimated to be about 183,800 acre-feet in a normal year, or 1.17 acre-feet per acre for the actively irrigated lands with surface water diversions.

The majority of irrigated land is devoted to the production of forage crops such as alfalfa, grass hay, and irrigated pasture. Figure IV-1 shows estimates of harvested forage acreage in the planning area for the period from 1980 through 2000 as developed by the Wyoming Agricultural Statistics Service (WASS).¹ That figure shows that the number of acres of forage crops harvested each year varied from a low of about 65,000 acres to a high of about 85,000 acres. There appears to be no trend of increasing or decreasing production over time, meaning that the annual variations are likely attributable to variables such as weather, irrigation water availability, and cattle prices.

¹WASS county level acreage data were adjusted to Basin-wide estimates based upon the estimated proportion of irrigated acreage in each county that lies within the planning area.

Figure IV-1
Harvested Forage Acreage
1980-2000



The distribution of harvested forage acreage by county is depicted in Figure IV-2. That figure shows that Sheridan County is the largest forage producer in the Basin, producing an average of 53 percent of all forage harvested over the period from 1980 through 2000. Johnson County is the second largest producer with 39 percent of the total, followed by Campbell and Natrona Counties, each with four percent of the total.

A number of reservoirs store water for irrigation purposes in the planning area, but the availability of storage water varies among drainages. Eleven significant storage facilities deliver irrigation to irrigators in some parts of the planning area, including the Big Goose Creek and Little Goose Creek drainages in the Tongue River sub basin; Piney Creek and Clear Creek in the Clear Creek sub basin; the North Fork of Crazy Woman Creek and Muddy Creek in the Crazy Woman Creek sub basin; and the North Fork of the Powder River in the Powder River sub basin. A complete description of these storage facilities is presented in a separate technical memorandum.

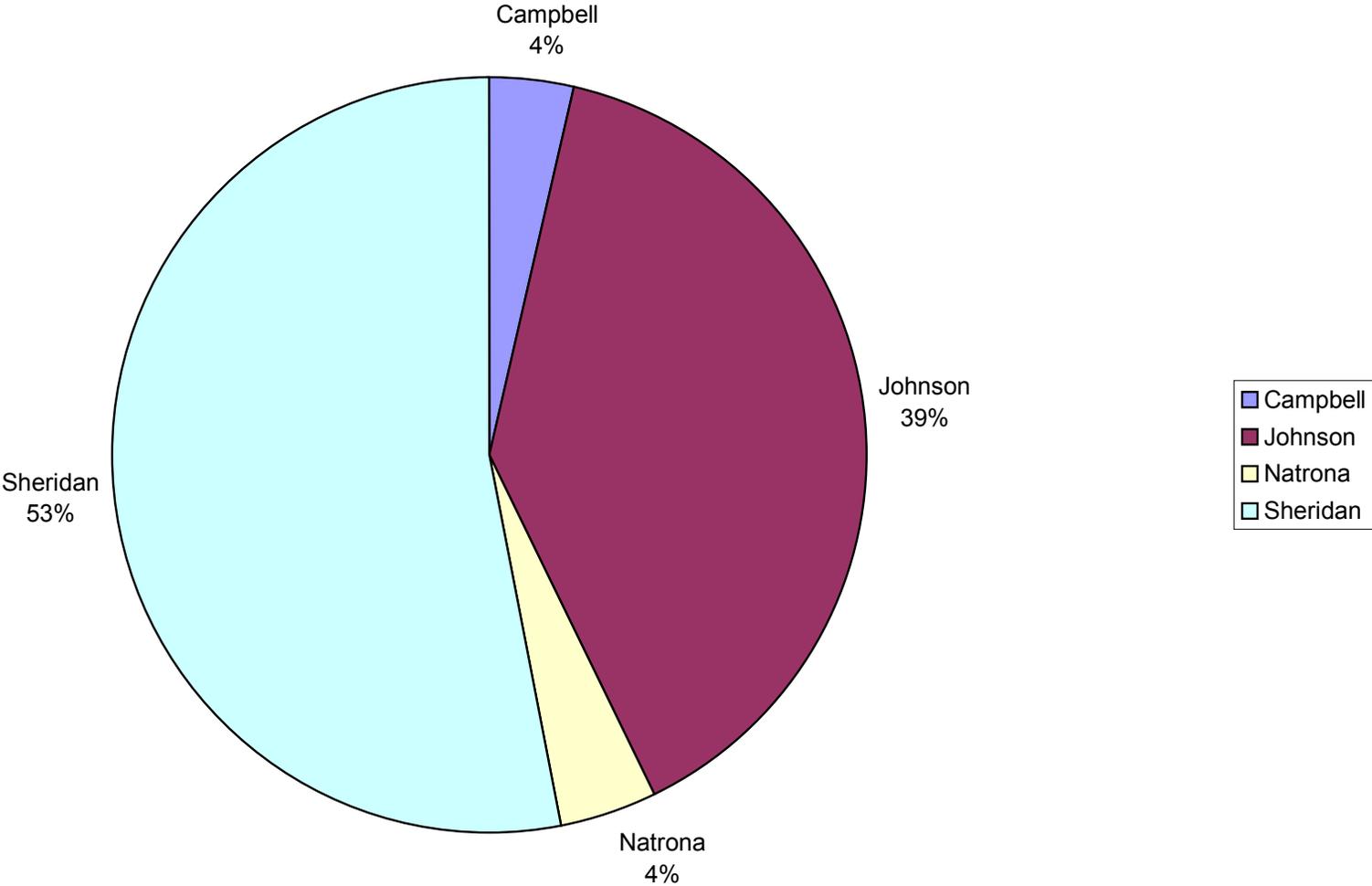
Trends in Livestock Production

Over the past two decades livestock production (cattle and sheep) in the Basin has remained relatively constant. There appear to be several interrelated reasons why this has occurred. One limiting factor with respect to herd size is the availability of summer range on federal lands, which constitute a large proportion of rangeland in the Basin. Both the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) have become more conservative in recent years with respect to the management of federal grazing allotments in an attempt to improve the quality of the range and provide adequate forage for wildlife. There has been little opportunity for producers with federal grazing allotments to increase their production on federal lands in recent years, and in some cases federal grazing rights have been restricted.

In discussing the future of irrigation in the planning area, it is necessary to distinguish between needs and demands for irrigation water. A need for additional irrigation water is an identifiable current or future use that would enhance the economic well being of the irrigator and/or the economy of the Basin as a whole. Demands are distinguished from needs by the fact that they are measured in relationship to price. To give a simple example, an irrigator may need additional irrigation water in a dry year to grow enough hay to provide winter feed for his cattle. If additional water costs \$500 per acre-foot, however, the irrigator's demand for additional water would probably be zero because it would be more cost-effective to either buy additional forage from other producers or reduce the size of his herd.

In analyzing municipal and industrial water uses, needs and demands are often viewed interchangeably. The cost of water is usually a relatively minor part of the costs involved in developing water intensive manufacturing facilities such as electric power plants. As a result, it can be assumed that manufacturers will demand the water that they need to expand production over a reasonable range of prices. Similarly, municipal needs are usually assumed to be essential and thus will be translated into demands over a reasonable price range. That convention was used for projecting municipal and industrial

Figure IV-2
Distribution of Harvested Forage Acreage by County
(1980-2000 Average)



demands in this planning study. Irrigated agriculture, however, is an industry in which producers are very sensitive to the price of water, and their demands for water can change dramatically as a function of price.

The hydrologic modeling effort undertaken for this planning study, as well as conversations with irrigators and water professionals, indicate that there are areas of the Powder/Tongue River Basin that could benefit from additional irrigation water, especially in dry years. Areas of particular need appear to be the Little Tongue drainage, some of the irrigated acreage along Clear Creek and its tributaries, the Middle and North Forks of Crazy Woman Creek, and the Powder River and some of its tributaries, especially Buffalo Creek. Additional irrigation water in these areas would stabilize forage production and allow ranchers to operate more profitably. Additional storage would also allow some operators to adjust more readily to potential future changes in the management of federal grazing allotments.

The biggest practical problem associated with fulfilling these needs for additional irrigation water is that the returns to forage production in recent decades have not been sufficient to offset the costs of new water storage projects. Studies of returns to irrigation water in other parts of Wyoming indicate that one acre-foot of irrigation water used for forage production in relatively high altitude areas of the state can be expected to generate a \$15 to \$25 increase in net farm income. The cost of developing new storage can be significantly higher than that figure even under very favorable circumstances.

Future demands for additional irrigation water in the planning area are thus largely dependent upon factors that might either increase the returns that Basin irrigators receive from irrigation or reduce the cost to them of developing new storage. Possibilities for increasing economic returns to irrigated agriculture in the Basin include diversifying cropping patterns into higher valued crops, the possibility that hay prices may rise to the point that it would be profitable to export hay from the Basin to other domestic markets, and the possibility that cattle prices may rise significantly over the next 30 years.

Although there are some opportunities for diversifying cropping patterns in the Powder/Tongue River Basin, it is doubtful that diversification out of forage production will occur on a wide enough scale over the next 30 years to warrant significant new water development projects. Specialty crops, such as alfalfa seed or seed potatoes, could possibly be grown in some of the lower elevation areas of the Basin. Seed alfalfa production is moving into Wyoming's Bighorn Basin, where acreage has grown from 2,000 to 15,000 acres in recent years. Nevertheless, such crops still require relatively small acreages and tend to be produced in areas that have a competitive advantage with respect to climate and/or soils, which does not appear to be the case in this planning area.

Some trends in the agricultural industry in the western U.S. suggest that certain types of forage production will become more valuable in the future as cash crops. As more agricultural land is taken from production in the future, there will be less hay production because it is among the lower valued crops that can be grown in lower elevation areas.

Wyoming is currently a net exporter of alfalfa and Timothy grass hay. No official statistics are available on the magnitude of hay exports from Wyoming, but some experts put the figure at about 25 percent, and expect that percentage to increase in the future. The largest market for Wyoming hay is now Colorado, but some producers in the Bighorn Basin are shipping hay by rail to dairies as far away as Florida and other east coast states. The types of hay expected to be in high demand in the future are alfalfa for dairies and Timothy hay for horses. Although alfalfa prices have been somewhat depressed in recent years, that trend is now reversing. Timothy hay is already bringing prices as high as \$180 per ton in some parts of Wyoming and alfalfa prices in many parts of the state now exceed \$100 per ton. If future market prices for these crops stabilize at high levels, it may become practical for some producers to develop additional storage and expand production of these crops for export markets.

Two other events could translate into more demand for irrigation water in the Powder/Tongue River Basin over the next 30 years, a significant and long-term increase in cattle prices and/or an increase in the amount of financial assistance available to producers for reservoir construction from state and federal agencies.

Cattle prices have increased somewhat in recent years as per capita beef consumption in the U.S. has stabilized at around 67 pounds after many years of decline. But according to the Cattleman's Beef Production and Research Board, per-capita consumption is not expected to increase in the future and will most likely decrease from today's levels. The USDA, however, is forecasting a significant increase in exports of U.S. beef over the next 10 years. The basis of this projection is the fact that demand for high quality beef in the Pacific Rim nations is expected to increase significantly in the future as the economies of these countries recover from the 1998 financial crisis that affected the region.

The prospects for increased federal assistance for reservoir construction seem more remote than the projected increase in cattle prices. Federal assistance for agriculture and new reservoir construction has been declining in recent years, and there are no indications that this situation will change over the planning horizon. The WWDC also has tightened its funding criteria for new water project construction in recent years. This tightening has been primarily motivated by budget constraints, however, and the possibility exists that more state funds may be allocated to water development over the next 30 years than are available under current economic conditions.

One potential low cost source of irrigation water for future use is CBM production water. Projections indicate that water production associated with CBM development in the planning area may exceed 150,000 acre-feet annually at some point during the next 10 years. There are several practical problems with utilizing that water for irrigation, however, one of which is the fact that high levels of production are not expected to last more than about 10 years. Given this relatively short duration, it is doubtful that many irrigators would be willing to make the significant changes in their operations that would be required to put this water to beneficial use.

Water Use Projections

For the reasons discussed above, the low, moderate, and high growth scenarios for future irrigation water demand in the planning area are based upon varying assumptions concerning the

financial returns to beef and forage production and the availability of WWDC assistance for new project construction.

Low Growth Scenario

The low growth scenario is based upon the assumptions that irrigation in the Powder/Tongue River Basin will continue to be dominated by forage production for winter livestock feed and that cattle and forage prices will not make sustained increases over the next 30 years relative to reservoir construction costs. This scenario also projects no increase in state funding available for new project construction and no change in WWDC criteria for financial assistance to project sponsors. As a result, irrigators will probably be unwilling to make long-term financial commitments to develop new storage following WWDC funding guidelines.

Numerically, total consumptive use of surface irrigation water is expected to remain relatively constant at 183,800 acre-feet in a normal year.

Moderate Growth Scenario

The moderate growth scenario is based upon the reasonably foreseeable possibility that cattle prices will increase significantly over the next 10 years as forecast by the USDA. Cattle prices are projected to stabilize at these higher prices over the planning horizon. This scenario also assumes that the WWDC will increase its financial commitment to new storage projects.

The combination of higher cattle prices and increased WWDC assistance will allow irrigators to maximize use of existing storage and fund some new storage projects in those parts of the Basin where developable sites are available. Storage in Lake DeSmet that is seldom fully utilized under current economic conditions, and additional water could be made available from Lake DeSmet through agreements with the Joint Powers Board that now owns and operates the reservoir. Furthermore, previous studies have identified several small storage sites that are off the Bighorn National Forest and which could potentially be developed if economic conditions improve for ranchers and the WWDC provides additional financial assistance.

The moderate growth scenario assumes that a combination of increased usage of Lake DeSmet storage plus one or two small storage projects would increase stored irrigation water use by an average of 15,000 acre-feet in a normal year. The equivalent increase in consumptive irrigation water use would be approximately 6,000 acre-feet annually. This scenario also assumes that Basin-wide irrigation efficiency would increase by one percent as a result of financial incentives, adding another 4,600 acre-feet to consumptive irrigation water use in a normal year. As a result, total surface irrigation water use would increase from 183,800 acre-feet under current conditions to 194,400 acre-feet in a normal year.

High Growth Scenario

The high growth scenario is based not only upon the reasonably foreseeable possibility that cattle prices will increase over the planning horizon, but that reductions in forage production in high

growth areas of the west will drive forage prices high enough to encourage Basin irrigators to produce more alfalfa and Timothy hay.

If forage prices stabilize at higher levels and WWDC funding is increased in the future, additional storage could be developed in the Basin to support increased forage production. The amount of additional storage that would be developed and the amount of additional water that would be consumptively used under this scenario are difficult to estimate because the outcome depends not only upon future financial returns to forage and beef production, but also upon the cost of developing additional storage in those areas where unappropriated water is available.

The water use projection developed for this scenario is that the increase in surface irrigation water under high growth conditions will be double the amount of the increase projected for the moderate growth scenario. That means that the amount of irrigation water consumptively used in a normal year will increase by 21,200 acre-feet annually relative to the low growth scenario. That increase would bring average annual consumptive use by Basin irrigators to 205,000 acre-feet annually. Projected future irrigation water use for all scenarios is depicted in Figure IV-3.

B. Municipal and Domestic Demand Projections

Municipal and domestic use projections were created by combining current use rates with population projections for the Tongue/Powder River Basin. Current municipal and domestic consumption is described in Chapter II.

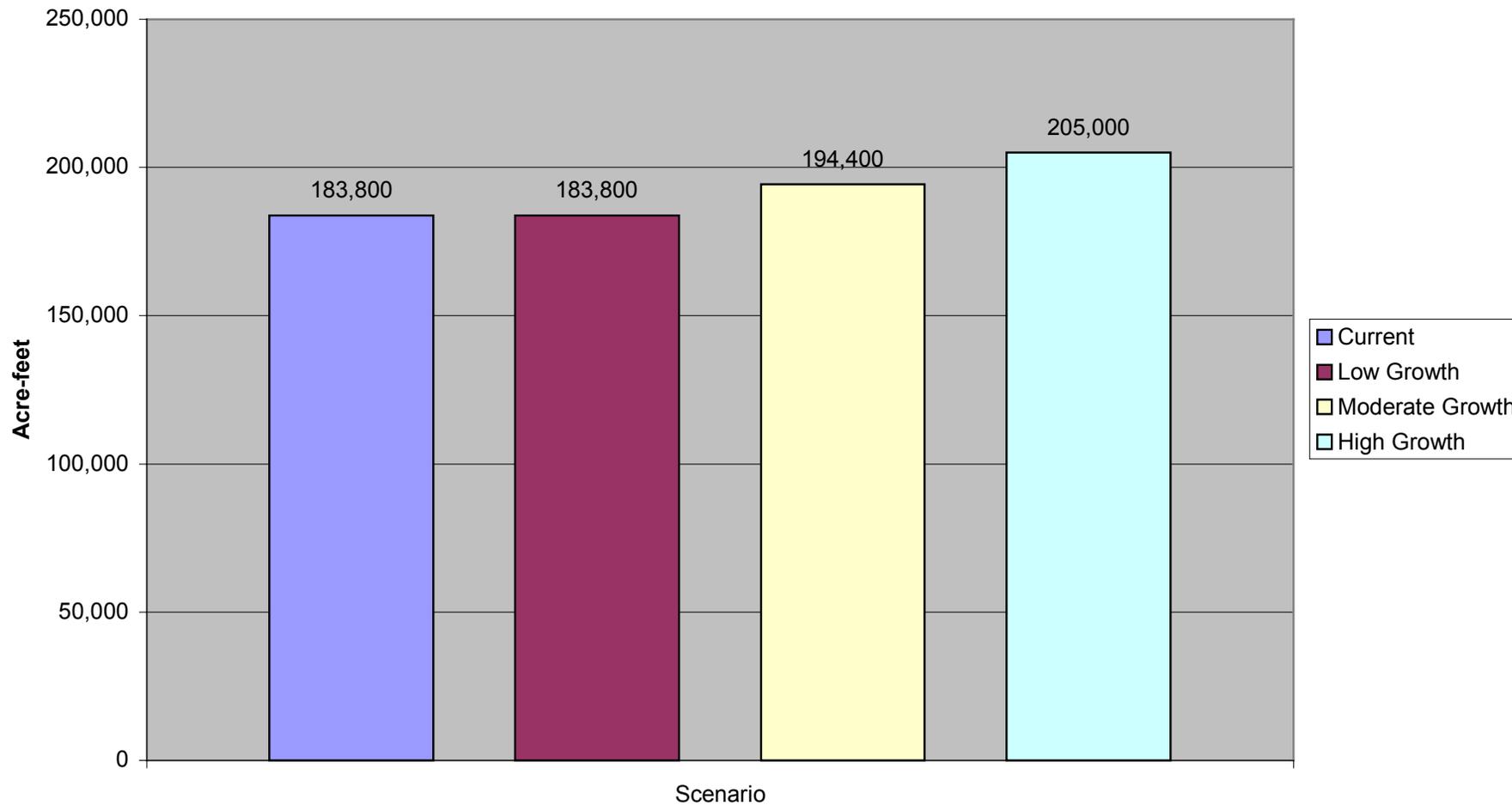
Population Projections

This section presents population projections for the communities and rural areas of the planning region for the time period from 2000 through 2030 for low, moderate, and high growth planning scenarios. The projections also provide a basis for assessing water-based recreational resource needs.

Current Population Estimates

The first step in developing population projections for the planning area was to estimate its current population. Population estimates for cities and towns were taken from the results of the 2000 Census. Because the geographical boundaries of the planning area do not adhere to county lines, it was necessary to adjust the county population estimates

Figure IV-3
Summary of Consumptive Irrigation Water Use Projections
2000-2030



from the 2000 Census to reflect only the proportion of each county that lies within the planning area boundaries. After this adjustment, the total current population of the Powder/Tongue River Basin is estimated to be approximately 38,400 persons.

The geographical distribution of the Basin's current population by county is depicted in Figure IV-4. That figure shows that almost 70 percent of the Basin's population resides in Sheridan County. Johnson County accounts for about 18 percent of the Basin's population, while Campbell and Natrona Counties each account for about six percent of the total.

WDAI Population Projections

The Division of Economic Analysis of the Wyoming Department of Administration and Information (WDAI) produces population forecasts for Wyoming counties, cities, and towns. The county population forecasts are based upon time series data from which growth rates are derived from variables such as population, sales tax collections, and school enrollments. These growth rates are used to forecast individual county population totals, and these county totals are adjusted to make them, consistent with state-level population forecasts that incorporate elements of the cohort survival and employment-drive approaches.

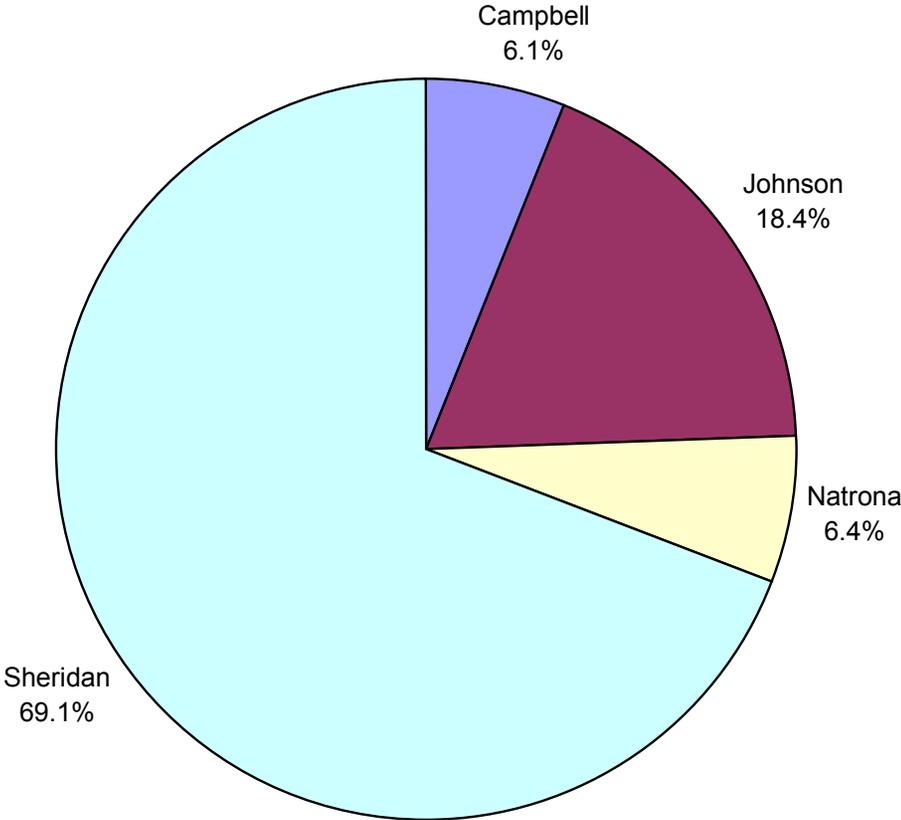
The Division of Economic Analysis forecasts population only 10 or fewer years into the future because of the uncertainties associated with such projections. Its most recent projections are through the year 2008 and are relatively conservative, a reflection of the relatively slow economic growth that many parts of the state have witnessed in recent years. A reasonable set of low growth rate population projections can be derived by computing the WDAI's average annual population growth rates for the planning area for the period from 1990 through 2008 and extending those growth rates through the year 2030.

U.S. Census Bureau (USCB) Projections

The USCB periodically produces population forecasts for each of the 50 states using a cohort survival approach. The most recent forecasts for the State of Wyoming are two sets of population projections through the year 2025, the Series A and Series B forecasts.

Both series of projections indicate moderate future population growth for Wyoming based upon migration patterns in the mid-1990s. During that period, there was a moderate influx of new residents into some parts of Wyoming from elsewhere in the country. The effects of this migration pattern are apparent in parts of the Powder/Tongue River Basin. The USCB projections are based upon the assumption that this moderate rate of net in-migration will continue into the future.

Figure IV-4
Distribution of Current Population



Historical Growth Projections

A third set of population projections was developed from an analysis of historical population growth. The planning area experienced more rapid population growth during the 1990s than it experienced during the preceding 30-year period from 1960 through 1990. A reasonable set of high growth population projections can be developed by assuming that the absolute population growth that occurred during the 1990s will occur in each of the three following decades through the year 2030. Projecting this level of population growth into the future for each community and rural area in the Basin is the equivalent of assuming that the stimuli that lead to population growth in the 1990s, namely CBM development and lifestyle related in-migration, will continue to have the same population growth effects for the foreseeable future.

Results

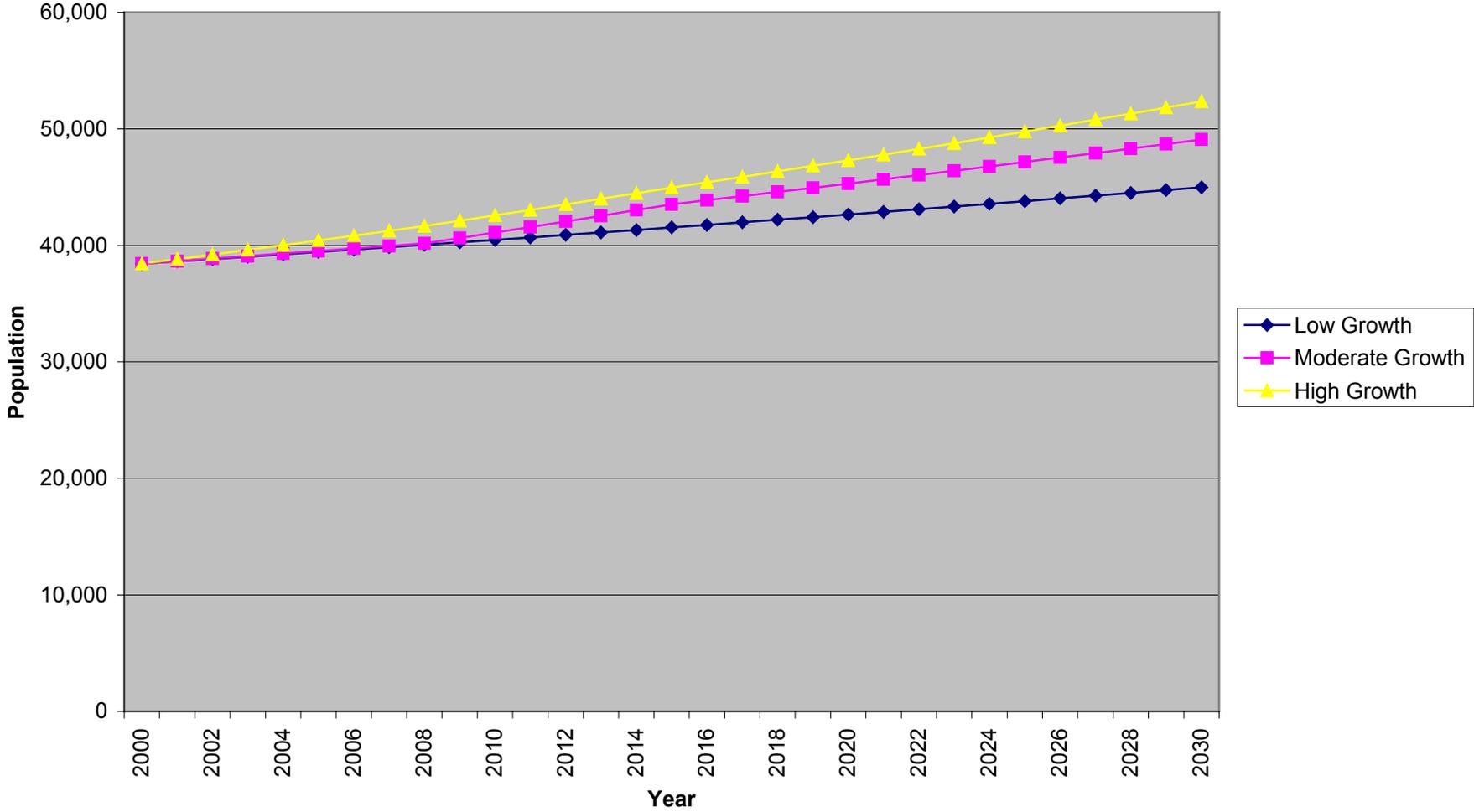
The three methods described above were used to generate population forecasts through the year 2030 for each community and rural areas. Generally speaking, the WDAI extended forecasts resulted in the smallest population projections, followed by the U.S. Census Bureau projections and the historical growth projections in that order. There were some exceptions to this generality, however, primarily because some communities have experienced population declines that were projected to continue over the next 30 years in the historical growth scenario. In some cases, these communities were projected to have higher growth rates (or less severe population declines) in one of the other two scenarios.

To adjust for such anomalies, the high growth scenario for each community and rural area was defined as the largest population forecast for 2030 generated by any of the three methods. Similarly, the low growth scenario was defined as the lowest population forecast, and the moderate growth scenario was defined as the middle 2030 population forecast. The results of the low, moderate, and high growth projections for the entire planning area are presented graphically in Figure IV-5.

Municipal Use Projections

Current per capita use rates for municipal water consumption are presented in Chapter II. These rates were applied to population projections for incorporated cities and towns in the planning area to estimate future municipal use. It should be noted that Chapter II describes municipal systems for some small-unincorporated areas for which population projections are not available. For purposes of projecting future use, these unincorporated areas are included in the domestic demand projections presented in the next section.

Figure IV-5
Low, Moderate, and High Growth Population Projections



Projections of future municipal use are presented in Table IV-1. That table shows that the four communities utilizing surface water supplies; Buffalo, Dayton, Ranchester, and Sheridan are projected to need between 8,600 and 10,000 acre-feet of water annually by the year 2030. The two communities relying on groundwater supplies, Clearmont and Kaycee, are projected to need between about 65 and 90 acre-feet annually by the year 2030. Two other communities, Edgerton and Midwest, are not included in the projections because they obtain their water supplies from a regional water system in Casper, and thus do not place demands upon water resources in the Powder/Tongue River Basin. The projections of municipal use for surface water users in Table IV-1 are diversion requirements, not consumptive use estimates. Consumptive use for the four communities using surface water is defined as the difference between diversions and returns to the stream from water treatment plants. As noted in Chapter II, total surface water depletions by municipalities in the Basin are estimated to be about 2,700 acre-feet annually. Projections of annual depletions for the low, moderate, and high growth scenarios are 3,200, 3,500, and 3,800.

In some cases there is a small difference between the populations shown for municipalities in the Population Projections technical memorandum and the population figures presented in Table IV-1. This difference is due to the fact that the population figures in Table IV-1 represent “service area” populations, whereas the population estimates in the technical memorandum adhere strictly to municipal boundaries.

An assessment was made of whether municipal systems for the communities listed in Table IV-1 have the capacity to supply their projected future water needs. This assessment involved comparing the peak demands associated with the projections with capacity of existing systems to meet those peak demands. The results indicate that all of the municipal systems listed in Tables IV-1 except Kaycee’s have the capacity to meet all future projected needs. Kaycee’s system capacity would be exceeded only under the high growth population projection scenario. It should be noted that this finding applies only to system capacity, not water availability. Some communities using surface water supplies, such as Sheridan, may need to acquire additional water rights to meet projected future needs.

Domestic Use Projections

Domestic use projections were developed by first calculating the number of persons in the planning area that are not served by the municipal systems listed in Table IV-1 and projecting that population figure into the future. (This calculation excluded the populations of Edgerton and Midwest, which are served by an out-of-basin water source.) Per capita domestic water consumption rates were then applied to the population projections to estimate future water use. The results are presented in Table IV-2 for two different daily per capita water consumption rates and three growth scenarios. The results show that current domestic use is estimated to be between 2,400 and 4,800 acre-feet per year. Future use projections range from a low of 2,800 acre-feet to a high of 6,400 acre-feet annually, depending upon the scenario. This water is expected to come from ground water sources.

**Table IV-1
Municipal Use Projections**

City/Town	Current Population	Current Use(gpcpd)	2030 Population Projections			2030 Use (gpd)			2030 Use (acre-feet/yr)		
			Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Surface Water Users											
Buffalo	3,900	325	4,808	5,086	5,763	1,562,600	1,652,855	1,872,912	1,750	1,851	2,098
Dayton	678	234	792	868	936	185,328	203,175	218,979	208	228	245
Ranchester	701	300	776	800	891	232,800	239,906	267,200	261	269	299
Sheridan	18,500	260	21,809	23,762	25,158	5,670,407	6,178,068	6,541,162	6,352	6,920	7,327
Total	23,779		28,185	30,515	32,748	7,651,135	8,274,003	8,900,253	8,570	9,268	9,970
Groundwater Users											
Clearmont	125	220	112	139	158	24,630	30,609	34,674	28	34	39
Kaycee	300	210	275	333	377	57,687	69,831	79,193	65	78	89
Total	425		387	472	535	82,317	100,440	113,867	92	113	128
Grand Total	24,204		28,572	30,987	33,282	7,733,452	8,374,443	9,014,120	8,663	9,381	10,097

**Table IV-2
Domestic Use Projections**

Description	Current	Low Growth	Moderate Growth	High Growth
Basin Population	38,436	44,994	49,096	52,379
Municipal Population	24,204	28,629	31,008	33,353
Rural Population	14,232	16,365	18,088	19,026
Domestic Use (150 GPCD-in af/yr)	2,391	2,750	3,039	3,197
Domestic Use (300 GPCD-in af/yr)	4,783	5,499	6,078	6,394

C. Industrial Demand Projections

Current industrial water uses in the Powder/Tongue River Basin are described in Chapter II. This section presents projections of industrial water needs in the Basin for the period from 2000 through 2030. These projections provide a basis for gauging the adequacy of current water supplies in the Basin to meet potential future needs. Projections were developed for low, moderate, and high growth scenarios.

Coal-fired Electric Power Production

Currently there are no coal-fired electric generating facilities in the Powder/Tongue River Basin. The Basin has coal and water resources to support such a facility, however, and the area has been studied in the past as a possible site for power generation. The Lake DeSmet Energy Company is actively pursuing a developer to use its coal reserves and water rights for power production, but no firm proposals have been submitted to date. The company has vast coal reserves in the vicinity of Lake DeSmet, and has storage rights for 62,000 acre-feet in Lake DeSmet and 5,140 acre-feet of storage in Healy Reservoir that could be used for power production.

There could be an air quality constraint involved in locating a generating facility in the planning area due to its proximity to wilderness areas in the Bighorn National Forest. Whether this constraint would be a fatal flaw depends upon a number of factors that are matters of speculation at this time, including the plant's design and location and the results of air quality modeling that would have to be undertaken for permitting purposes. The area does have the advantage of existing storage rights in Lake DeSmet that could be used to support wet cooling technology for power production, which is in use at other facilities in the state, including the Laramie River Station in Platte County and the Jim Bridger Power Plant in Sweetwater County. Wet-cooled plants are usually more efficient and less costly to run than dry-cooled plants such as the WYodak facilities near Gillette, but their water requirements are much larger.

Another potential source of water for power production is low-cost groundwater from coal-bed methane (CBM) production. The process of extracting methane gas from coal seams produces large quantities of water that must be disposed of in some fashion, and use of that water for wet cooling in electric power production would be a logical way to make use of water that would otherwise be re-injected into aquifers, stored in small reservoirs, or discharged into streams.

There are problems with implementing such a proposal, however. One problem is the fact that although the production life of coal-bed methane resources in the Basin is not known with certainty, resources may be depleted in a shorter time frame than the 50-plus year life expectancy of a coal-fired generating facility. Also, that water production from coal seams tends to peak when the seam is first tapped, and then drop off dramatically as methane production increases, meaning that there is a great variation in the amount of water produced at one location over time.

Projections of future water needs for electric power generation are described below for low, moderate, and high growth scenarios. These projections are based upon the assumptions of wet cooling technology and surface water utilization.

Low Growth Scenario

The low growth scenario assumes that no electric power generating facilities will be built in the planning area over the next 30 years. This scenario is equivalent to assuming that (1) the competitive advantage that other areas have held in power production in the past will continue in the future, or (2) air quality constraints will be too restrictive to site a facility in a desirable location.

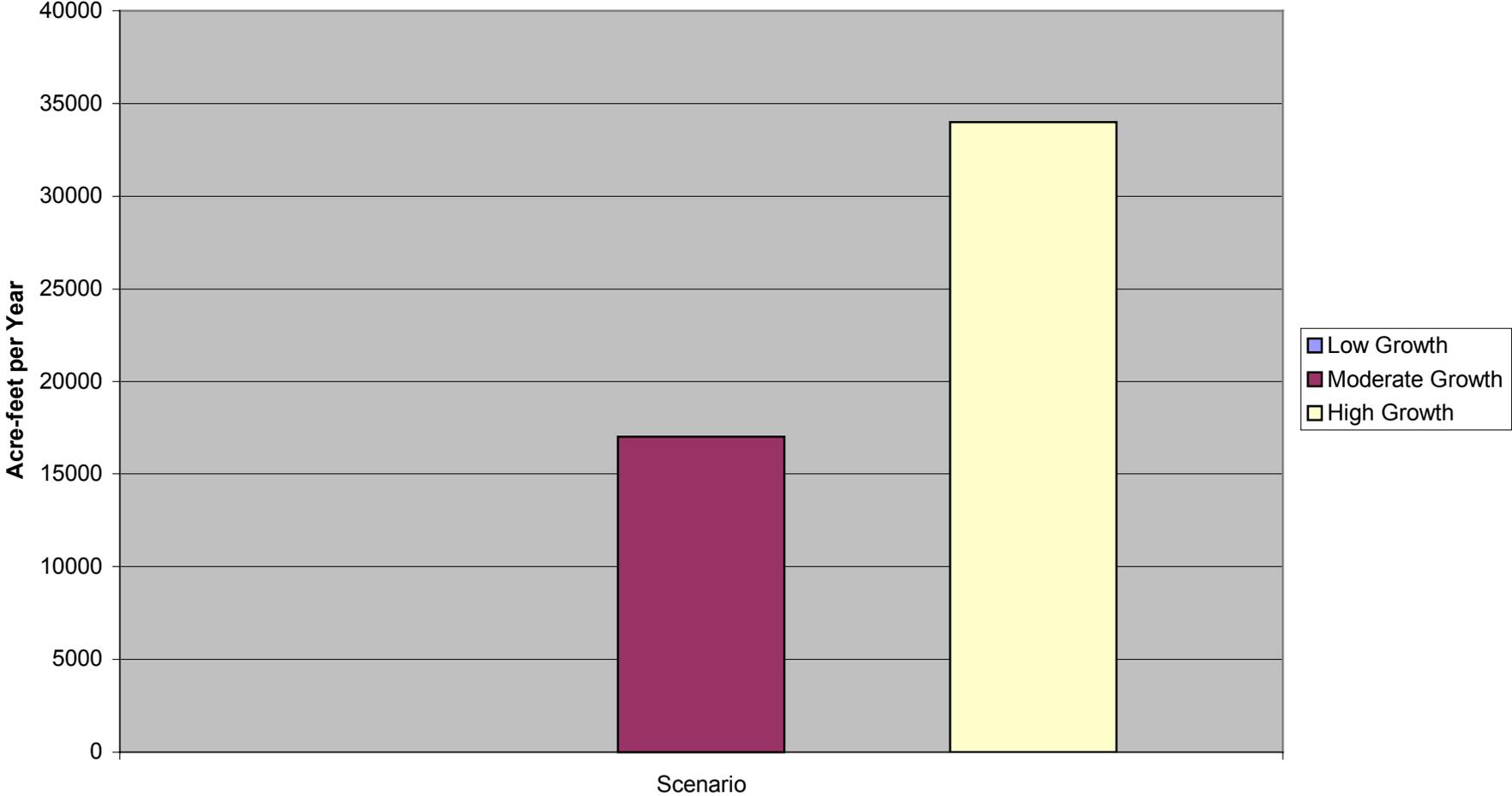
Moderate Growth Scenario

The moderate growth scenario for electric power production assumes that air quality constraints on power generation can be overcome and that the availability of coal and the water resources needed for wet cooling technology will be attractive enough for a power generator to build a 1000 megawatt (MW) facility in the PTRB sometime during the next three decades. The industrial water requirements for this scenario are 17,000 acre-feet annually.

High Growth Scenario

The storage rights available in Lake DeSmet should be large enough to support 2000MW of coal-fired electric power generation using wet cooling technology. The high growth scenario for electric power production thus assumes the relatively low cost water available for power production in Lake DeSmet will be used to generate 2000MW of power sometime during the next 30 years. The industrial water requirements for this scenario are 34,000 acre-feet annually. Future electric power generation water use projections for all three growth scenarios are presented graphically in Figure IV-6.

Figure IV-6
Electric Power Water Demand Projections
2030



Coal Mining

Most of the active coal mines in northeastern Wyoming are located in the Belle Fourche and Cheyenne River Basins to the west of the Powder River. The one large active surface coal mine in the planning area is the Spring Creek Mine Operated by Kennecott Energy in northern Sheridan County. This mine produces approximately 11.3 million tons of coal annually, or about three percent of the 338 million tons of coal that were mined in Wyoming in 2000.

Surface coal mines use water primarily for dust abatement and reclamation, with lesser amounts used for equipment wash-down and domestic purposes. The primary sources of water for most mines are dewatering wells drilled into the coal seam ahead of advancing pit operations and sump wells to remove water from the pit. A few mines are extracting dry coal, however, and have drilled groundwater wells away from the coal seam to meet their needs.

Future water use by the coal industry in the Powder/Tongue River Basin is expected to increase slightly for two reasons. First, the Spring Creek Mine may expand production in the future if coal prices remain firm at current levels or increase. Second, some additional mines may be opened in the future to supply coal for electric generating facilities either in or out of the Basin. Nevertheless, most mines will continue to meet their relatively small operational water needs from groundwater sources on site. These activities are not expected to affect either surface water resources or other groundwater users in the Basin. Thus, water requirements for the mining industry have not been projected into the future.

Oil and Natural Gas Production

Traditional oil and gas production in the Powder/Tongue River Basin has been declining in recent years. According to the Bureau of Land Management, the number of wells plugged is expected to exceed the number of wells drilled each year for the foreseeable future. This trend will be offset by an increase in CBM production as discussed in the following section.

Very little water is consumptively used by the oil and gas industry in the planning area; only small amounts are consumed for domestic purposes and to create drilling mud. Pumping operations generally produce water as a by-product of oil and gas production. This process water can be re-injected or discharged (with appropriate permits) depending upon circumstances. Water flooding operations are sometimes carried out on mature fields to increase production. In such cases, water wells can be drilled to provide flooding water. There are about 240 such wells in the Powder/Tongue and Northeast Wyoming River Basins combined.

In summary, water use by the oil and gas industry is generally non-consumptive, is spread over a large geographic area, and typically does not impact either surface water

resources or other groundwater users in the planning area. For these reasons, future requirements for this industry have not been quantified.

Coal-bed Methane Production

Coal-bed methane production has become widespread in Powder/Tongue River Basin over the past few years, and is expected to increase dramatically in the future. CBM development is not a consumptive user of water resources, but produces groundwater as a by-product of gas production. The process involves pumping water from coal seams to relieve pressure on methane gas so that it can be captured at the surface. The availability and disposal of CBM process water presents both problems and opportunities in the formulation of a water plan for the Basin.

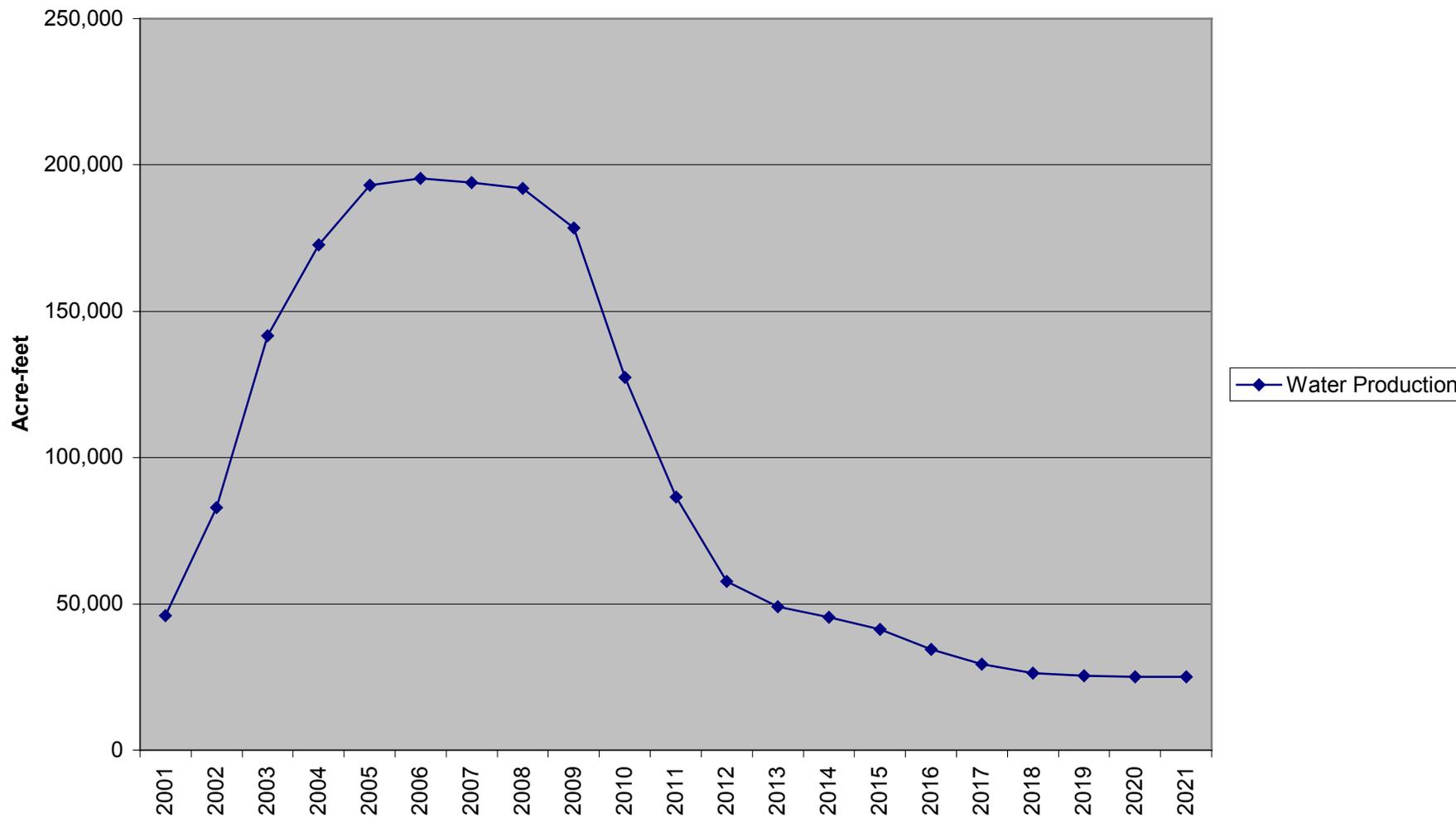
Projected water production for Powder/Tongue River Basin CBM wells is depicted in Figure IV-7 for the period from 2001 through 2020. That figure shows that produced water is expected to reach a peak of about 190,000 acre-feet annually by the year 2005. Production is expected to remain at that level for about five years, and then drop off to less than 25,000 acre-feet annually by the year 2019. The projected dramatic drop off in CBM production water after the year 2010 poses problems for the potential use of CBM production water for industrial purposes such as electric power generation. Most large industrial facilities have design lives of 35 to 50 years or longer, while the projections show that large amounts of CBM will be available for only a relatively short period.

Coal Conversion Facilities

Several companies have studied the possibility of building coal conversion facilities in the Campbell County over the past 20 years. There appear to be two rationales for such facilities. One rationale is the fact that coal contains a high percentage of water by weight, meaning that eliminating or reducing the water content of coal prior to shipment could mean substantial savings in transportation costs to out-of-state utilities and other users. The second rationale is that the vast coal reserves of the region could be used to produce synthetic versions of fuels such as gasoline if petroleum prices were to increase or government programs were in place to stimulate domestic energy production.

If coal conversion facilities were constructed in Wyoming during the next 30 years, they would more likely be sited in the Belle Fourche River Basin than in the Powder/Tongue River Basin because there are more active coalmines in the Belle Fourche Basin. Nevertheless, it is not improbable that some type of coal conversion facility might be sited in the Powder/Tongue River Basin over the planning horizon of this study. One reason is that as energy related industrial activity increases in the Belle Fourche River Basin, some activity may be forced to other locations for air quality considerations. For that reason, the high growth scenario for industrial water use assumes that one coal conversion facility designed to produce solid boiler fuel from coal will be constructed in the planning area by the year 2030. The water requirements for such a facility would be approximately 1,000 acre-feet annually.

Figure IV-7
Projected Annual CBM Water Production



Other Potential Future Uses

The industrial water use projections described above focus on existing industrial uses or those that have been proposed but not implemented in the past. The potential for other water-intensive industries, not discussed above, to relocate to the Powder/Tongue River Basin over the next 30 years also warrants discussion.

According to the U.S. Department of Commerce, four industry groups in the United States account for over 95 percent of all industrial water use. Those industries are (1) electric power producers, (2) chemical and allied products manufacturers, (3) primary metals producers, and (4) paper and allied products manufacturers. Electric power producers alone account for over 80 percent of all industrial water use in this country each year. The other three industrial groups account for roughly 14 percent of all industrial water use.

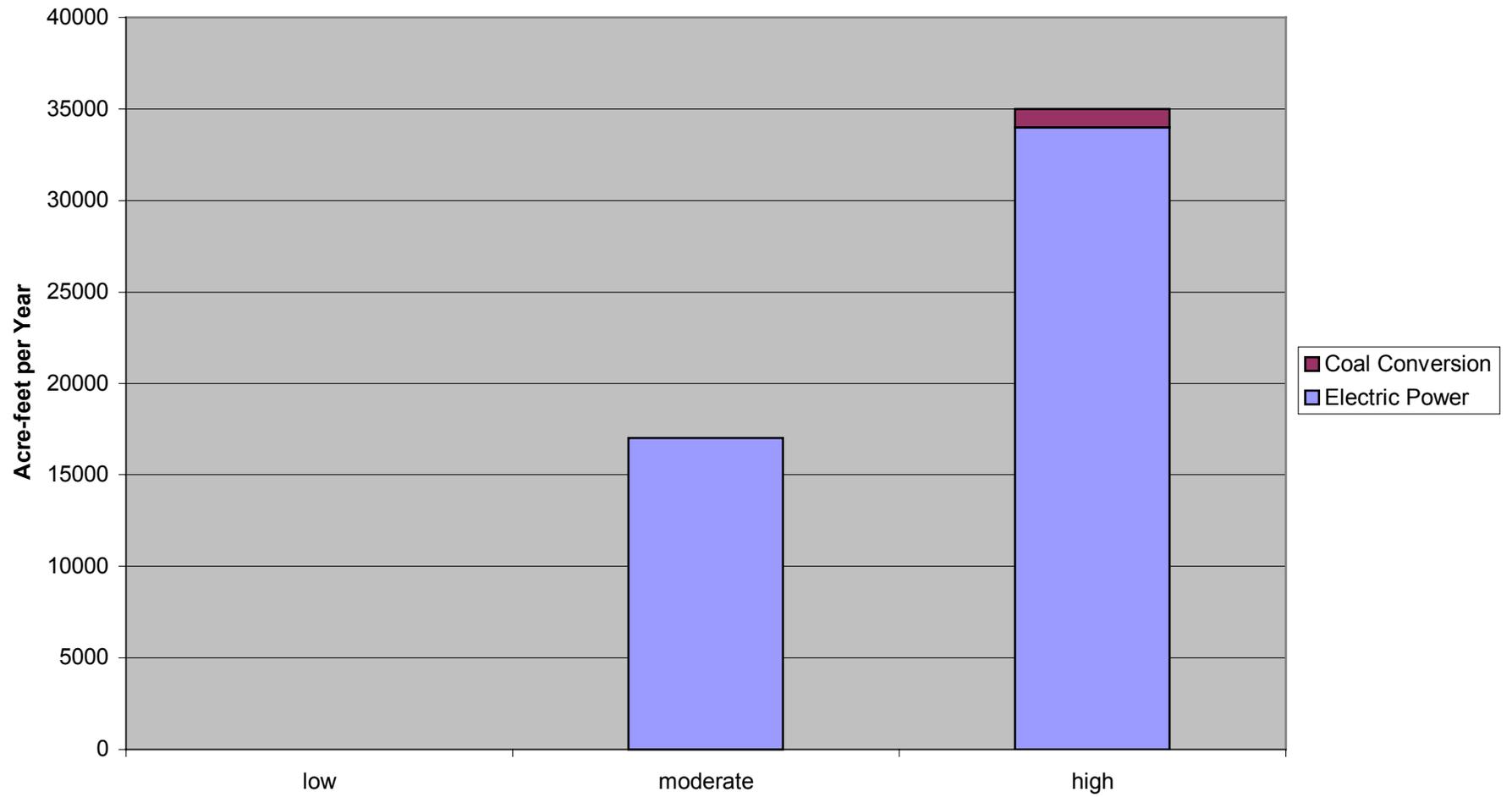
Projections of future water requirements for electric power generators are discussed above. The other three water intensive industries, chemicals, primary metals, and paper, tend to locate in areas close to their primary inputs. The fact that none have located in the Powder/Tongue River Basin in the past is an indication that commercially viable resources needed for their manufacturing operations are not present on a competitive basis compared to other regions of the country. Although this situation could change in the future as resources are exhausted elsewhere, such developments are not foreseeable at this time.

Summary of Findings

The largest demand for industrial water in the Powder/Tongue River Basin over the next 30 years is expected to be associated with the construction of new coal-fired electric generating facilities. A smaller amount of water will be needed for facilities that convert coal to alternative fuels. The most likely source of water for such facilities is storage in Lake DeSmet. That storage is owned by the Lake DeSmet Energy Company and by the joint powers board that is now operating the reservoir on behalf of Campbell, Johnson, and Sheridan Counties.

Projections of total future industrial water use in the planning area are given in Figure IV-8. That figure shows that for the low growth scenario, no additional industrial water use is projected beyond the small (unquantified) amounts employed in coal mining and oil and gas activity. For the moderate growth scenario, a projected 17,000 acre-feet would be utilized annually for wet cooling of a 1000MW coal-fired electric generating facility. For the high growth scenario, 34,000 acre-feet annually would be used for power generation and an additional 1,000 acre-feet would be utilized in a coal conversion facility, bringing total water requirements to 35,000 acre-feet annually.

Figure IV-8
Total Industrial Water Demand Projections
2030



D. Recreation Demand Projections

Current Recreation Activity

The most popular water-based recreational activity in the Powder/Tongue River Basin is fishing. Figure IV-9 shows that about 53 percent of Basin residents participate in fishing. The second most popular water-based recreational activity among residents is waterfowl hunting, followed by power boating, rafting and canoeing, and sailing.

The WGFD provided estimates of the number of annual activity days of angling and waterfowl hunting in the Powder/Tongue River Basin. Stillwater fishing on lakes and reservoirs in the Basin accounts for 132,000 activity days annually. About one-third of this activity occurs on Lake DeSmet. Much of the remaining stillwater fishing activity occurs on alpine lakes and reservoirs, which are concentrated on national forest lands.

Stream fishing in the Basin accounts for about 140,000 activity days annually. The upper reaches of many of the streams in the Basin provide very good trout fishing opportunities. The most popular areas for stream fishing in the Basin include the Tongue River, Clear Creek, the Powder River, and Crazy Women Creek.

Waterfowl hunters spend about 2,000 days annually in the pursuit of ducks and geese that inhabit or pass through the Basin. Activity day estimates are not available for other water-based recreational pursuits, including boating, water skiing, rafting, canoeing, sailing, and wind surfing.

Demand Projections

Future demands for recreational water resources in the planning area depend upon numerous factors, including population growth, tourism growth, and participation rates in various water-based recreational activities. Future participation rates depend upon changes in preferences over time as well as the availability of water resources and the amount of congestion encountered at recreational sites. Changes in future recreational preferences are hard to predict, so the projections described in this section are based upon the assumption that participation rates remain constant over the planning horizon. This assumption means that projected recreational demands are proportional to growth in population and tourism in the Basin. The potential effects of congestion on future recreational water uses are discussed in the following section.

Projections of population growth in the Powder/Tongue River Basin are described earlier in this chapter. Those projections are summarized in Table IV-3 in terms of average annual growth rates for the low, moderate, and high growth planning scenarios. Table IV-3 also gives projections of tourism growth over the planning horizon for low, moderate, and high growth scenarios.

Figure IV-9
Resident Participation in Water-based Recreational Activities

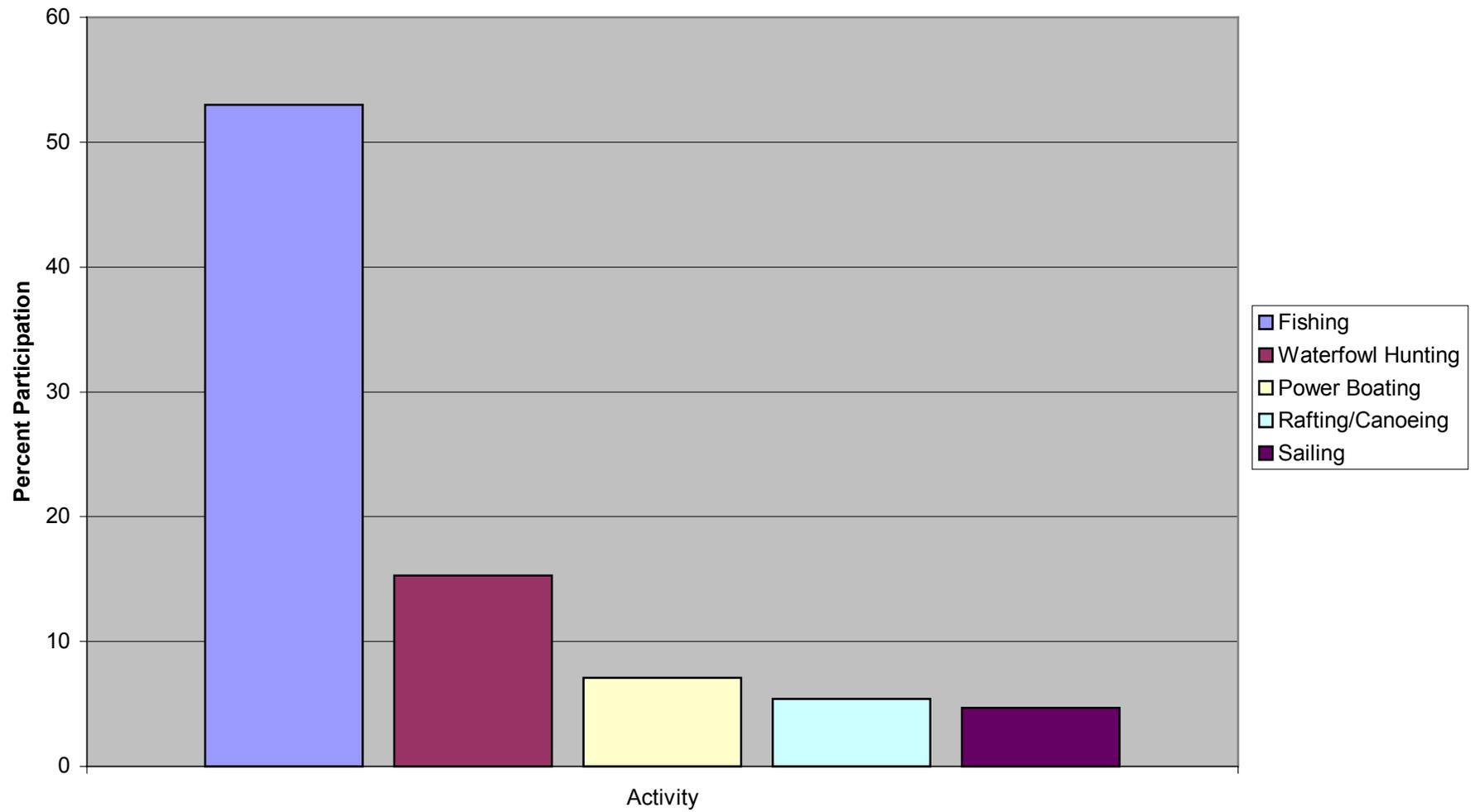


Table IV-3
Projected Annual Growth Rates: Population and Tourism (2000-2030)

Scenario	Average Annual Growth Rate	
	Population	Tourism
Low growth	0.53	1.00
Moderate growth	0.82	2.00
High growth	1.04	3.00

The other information needed to project future recreation demand is a breakdown of recreational activity between residents and nonresidents. No precise estimates exist, but based upon what information is available and the judgment of professionals in the WGFD, it was assumed that 80 percent of future hunting and fishing activity would be by Wyoming residents and 20 percent by non-residents.

This information was used to project future recreational activity days over the 30-year planning horizon from 2000 to 2030. Those projections are given in Table IV-4. The demand for stillwater fishing in the planning area is projected to expand significantly over the next three decades. Similar increases are projected for stream fishing demands. The demand for waterfowl hunting is also expected to increase over the planning horizon, but at a lesser growth rate than for fishing.

Table IV-4
Current and Projected Water-based Recreational Activity Days

Activity	Activity Days by Scenario			
	Current	Low Growth	Moderate Growth	High Growth
Stillwater fishing	132,000	159,000	183,000	208,000
Stream fishing	140,000	169,000	194,000	221,000
Waterfowl Hunting	2,000	2,300	2,500	2,700
Totals	274,000	330,300	379,500	431,700

Adequacy of Existing Resources to Meet Projected Demands

The WGFD in the past has estimated the supply of water resources available to meet the demands of fishermen in various regions of the state. These supply estimates were expressed in terms of fishermen days, and reflect the amount of pressure that the Department believed at that time (1988) that publicly accessible fisheries could withstand

without significant deterioration. Although these estimates have not been updated in the past decade, they serve as one benchmark for judging the capacity of fisheries in the planning area to meet projected future demands. Unfortunately, the WGFD did not estimate fishery supplies separately for the Powder/Tongue River Basin, but for an area including the Powder/Tongue, Little Missouri, Belle Fourche, Cheyenne, and Niobrara River Basins. Nevertheless, it is useful to review these supply estimates as background for assessing resource adequacy.

According to the WGFD, the Powder/Tongue and Northeast Wyoming planning areas combined provide an annual supply of 405,000 activity days of fishing opportunities. With the exception of Keyhole Reservoir, almost all of this supply is located in the Powder/Tongue River Basin. When this figure is contrasted with a current utilization rate of 272,000 activity days in the Powder/Tongue Basin, it is apparent that there is no current overall shortage angling opportunities. Individual water may experience overcrowding at times, however, because they are easily accessible.

The projections of future demands for fishing opportunities described above range from 328,000 to 429,000 activity days annually by the year 2030, depending upon the growth scenario used. These demand scenarios indicate that fishing pressure demands may approach the supply of resources available in the Powder Tongue River Basin over the next 30 years. The implications of this conclusion are limited by the fact that there is a relatively fixed supply of streams in the Basin that are suitable for maintaining recreational fisheries. One inference that can be drawn is that future activities that would denigrate existing recreational stream fisheries could have significant negative recreational effects, while activities that enhance fisheries habitat could have significant positive effects.

Another inference that can be drawn from these projections is that private landowners who control access to good quality stream fisheries in the Basin own a valuable asset and may be able to derive income in the coming decades by allowing access to those fisheries, either through private leases, leases to public agencies such as the WGFD, or through daily access fees.

The other water-based recreational pursuit for which demand projections were developed is waterfowl hunting. Those projections indicate that demand is expected to ride from a current level of 2,000 activity days to between 2,300 and 2,700 activity days by the year 2030. The WGFD has not estimated the supply of waterfowl hunting opportunities in the Basin, partially because populations are migratory and hunting seasons and bag limits are established in accordance with guidelines established by the U.S. Fish and Wildlife Service.

E. Future Environmental Water Requirements

Current environmental uses of water in the Powder/Tongue River Basin are described in Chapter II. Those uses include:

- instream flows and reservoir bypasses;
- minimum reservoir pools; and
- maintenance of wetlands, riparian habitat, and other wildlife habitat.

Unlike recreational water requirements, environmental water requirements are not necessarily related to changes in population or tourism. Instead, environmental water requirements are at least partially a function of human desires concerning the type of environment in which people want to live. These desires are expressed in many ways, including environmental programs and regulations promulgated by elected representatives at the state and federal levels. Thus, future environmental water requirements in the Powder/Tongue River Basin will be determined, at least partially, by existing and new legislation dealing with environmental issues at the state and federal levels, and how that legislation is implemented by federal and state agencies.

Examples of such legislation include Wyoming Statutes S41-3-1001 to 1014, which stipulate that instream flows are a beneficial use of Wyoming's water and specify procedures for establishing such flows using unappropriated water. This legislation authorizes the WGFD to specify stream segments and flow requirements for an instream flow filing. The WWDC is authorized to file an instream flow application with the State Engineer and perform hydrologic analyses on filings recommended by the WGFD. The State Engineer can then issue a permit for an instream flow water right following a public hearing.

Future water requirements for instream flows in the Powder/Tongue River Basin (and other river basins throughout the state) depend largely upon how Wyoming's instream flow legislation is implemented over the 30-year planning horizon. Projecting the outcome of this process quantitatively would be difficult, and is perhaps unnecessary because instream flows and other environmental water uses are largely non-consumptive. Instream flow designations can conflict with potential new out-of-stream uses at specific locations, however, a topic that is discussed below.

Instream Flows and Reservoir Bypasses

Wyoming's instream flow statutes recognize the obvious economic fact that Powder/Tongue River Basin water resources have value in non-consumptive uses such as instream flows. Such flows not only contribute to aesthetic character and biological diversity of the Powder/Tongue River Basin, they also support recreational fisheries that are important to Basin residents and to the Basin's economy.

The WGFD has a goal of maintaining and enhancing existing fisheries in the Powder/Tongue River Basin through the statutory designation of instream flow segments and other management strategies. To date, a total of three applications involving six stream segments in the Little Bighorn, Tongue, and Powder River Drainages have been filed with the State Engineer. The extent to which current filings and future instream flow requests may conflict with potential storage developments for supplemental irrigation water in the Basin is unknown, but the potential for conflicts does exist. These

conflicts would have to be resolved on a case-by-case basis, weighing the potential benefits of water to the state in instream versus out-of stream uses.

Another tool for maintaining fisheries habitat in the planning area is the provision of minimum flow bypasses at reservoir sites. Currently, only three reservoirs in the Basin have minimum flow bypasses included as requirements in their permitting documents; Park, Tie Hack, and Twin Lake Reservoirs. The development of additional reservoir storage in the future would likely bring about requests by the WGFD and others for such minimum flow bypass requirements. As discussed elsewhere, the likelihood of additional storage being developed in the planning area will be greatly influenced by future trends in cattle and forage prices and state funding mechanisms available to irrigators in need of supplemental water.

Minimum Reservoir Pools

Another environmental water use is the provision of minimum reservoir pools for fish and wildlife purposes. Six reservoirs in the Basin have minimum pools listed in their permitting documents; Park, Dull Knife, Willow Park, Kearney, Cloud Peak, and Tie Hack. Given the current federal regulatory environment and public desires to maintain and enhance recreational fisheries in the Basin, it is likely that any additional storage developed in the future will have a portion of its storage devoted to fish and wildlife purposes.

Wildlife Habitat

Another important environmental use of water in the Powder/Tongue River Basin is the provision of habitat for wildlife. Wildlife habitat exists in wetland and riparian areas on public and private lands through out the Basin, some of it occurring naturally and some of it as a result of human activity. A tabulation of wetlands wildlife habitat areas in the planning area has been undertaken as a part of the geographical information system developed for this study. A description of the information in this database is contained in a separate technical memorandum.

Three federal programs, the Conservation Reserve Program (CRP), the Wetlands Reserve Program (WRP), and the Wildlife Habitat Incentives Program (WHIP) encourage the development of wildlife habitat on private lands. The CRP program is administered by the Farm Service Agency of the U.S. Department of Agriculture (USDA), and provides incentive payments for various conservation practices that will enhance wildlife habitat, as well as improve water quality and reduce erosion.

The WRP is administered by the Natural Resources Conservation Service (NRCS) of the USDA. It is a voluntary program that provides financial and technical assistance to private landowners to reestablish wetlands on their property. The WHIP is also administered by the NRCS, and provides technical and financial assistance to private landowners interested in improving wildlife habitat on their property. None of these programs result in significant amounts of consumptive water use. As a result, no

projections of future water needs for such programs were developed as a part of this water plan.

Direct Wildlife Consumption

There are no current estimates of consumptive water use by wildlife for the Powder/Tongue River Basin. An estimate developed for the Green River Basin puts consumptive use by big game and wild horses at about 500 acre-feet of water annually. A similar figure would be roughly correct for the Powder/Tongue River Basin. This level of consumptive use is relatively small and is not expected to change significantly over the planning horizon.

F. Summary of Projected Surface Water Demands

Table IV-5 summarizes current surface water uses in the planning area and projected demands for surface water resources through the year 2030 for the three growth scenarios.

**Table IV-5
Summary of Current and Projected Surface Water Uses**

Use	Current	Projected Use by Growth Scenario (Acre-feet/Yr.)		
		Low	Moderate	High
Municipal	2,700	3,200	3,500	3,800
Industrial	(included in municipal)	(included in municipal)	17,000	35,000
Irrigation	184,000	184,000	194,000	205,000
Evaporation	11,300	11,300	11,300	11,300
Recreational	(non-consumptive)			
Environmental	(not estimated)			
Total	198,000	198,500	225,800	255,100

G. Future Uses as Related to Compact Allocation

A comparison of projected surface water demands with water available under the Yellowstone River Compact is presented in Table IV-6. The comparison is broken down into the Tongue and Powder River sub-Basins because different compact limitations apply in each sub-basin. The Little Bighorn sub-Basin is not included in the projections because the compact does not cover it.

**Table IV-6
Projected Use of Compact Allocation (Normal Year)**

Surface Water	Projections by Growth Scenario (Acre-feet/Yr.)		
	Low	Moderate	High
Estimated Tongue River Depletions	78,200	81,800	87,400
Wyoming's Remaining Compact Allocation of Tongue River Flows ¹	40,000 to 67,000	40,000 to 67,000	40,000 to 67,000
Estimated Powder River Depletions	112,200	136,800	160,400
Wyoming's Remaining Compact Allocation of Powder River Flows ²	74,300	49,700	26,100

Notes:

- 1: These values are based on the limiting dry year conditions and include an assumed demand for 18,702 acre-feet of water for the State of Wyoming to supplement the supply of pre-1950 water rights. The total projected increase in depletions (87,400-78,200) is within the limits of this assumption. The remaining allocation is therefore not reduced under the moderate and high growth scenarios assuming the expanded depletions occur under pre-1950 water rights.
2. These values are based on the limiting dry year conditions.