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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 for each topic.

As with all chapters in this final plan report, explicit lists of references are not provided. Instead, all references to report, 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

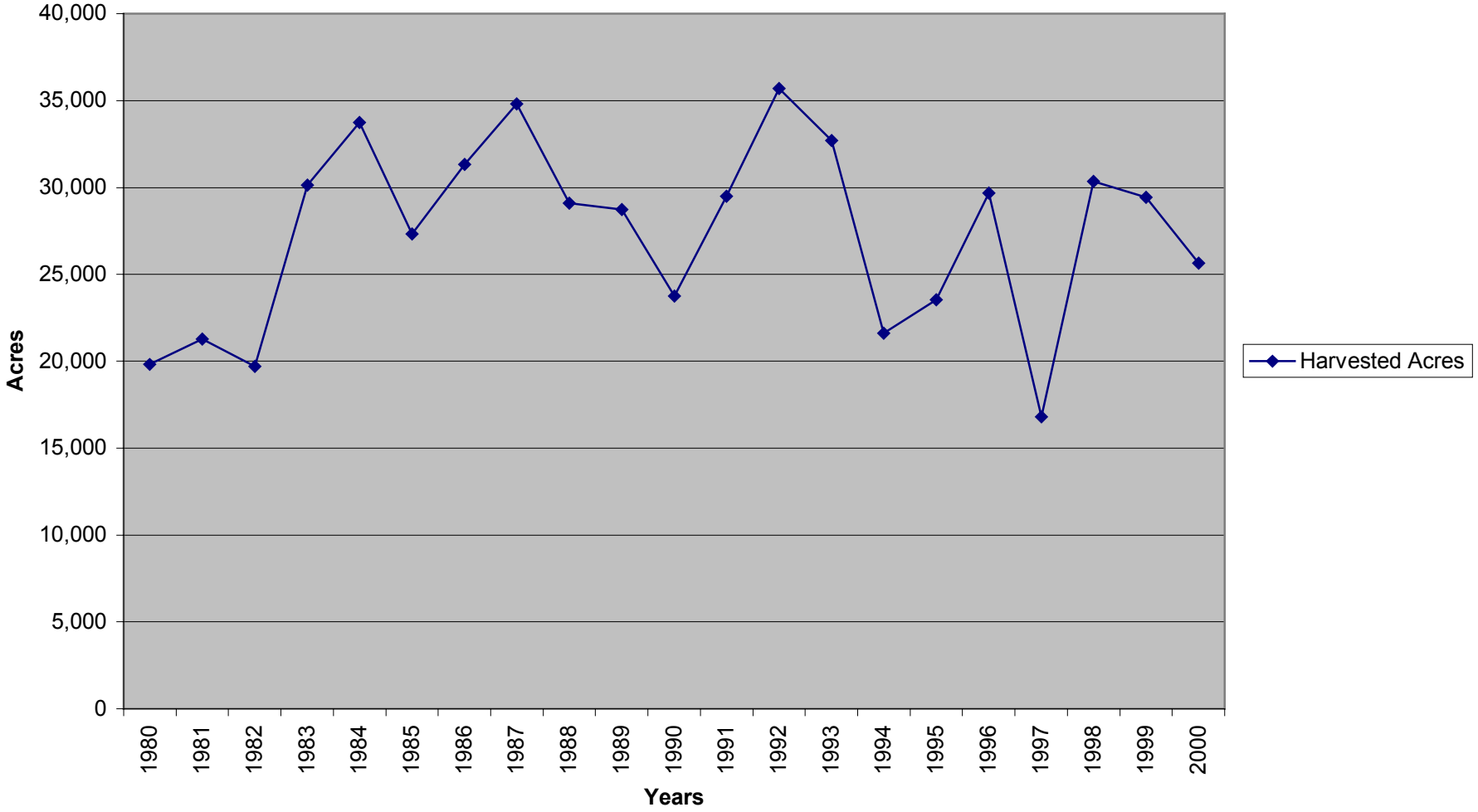
Background

Irrigated agriculture is the largest user of water in the Northeast Wyoming River Basins. The irrigated lands analysis conducted by for this study indicates that there are about 86,900 acres of irrigated land in the planning area. Of this total, 9,500 are idle, primarily due to water delivery system problems, and another 1,600 acres have been converted or are in the process of conversion to residential use. Of the remaining 75,800 acres that are actively irrigated, about 64,300 are served primarily by surface water and the remainder by ground water. Spreader dikes or intermittent diversions are used to irrigate about 30,300 of the 64,300 acres served by surface water. Total surface water depletions in the planning area are estimated to be about 69,500 acre-feet in a normal year, or about 1.08 acre-feet per acre for 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 17,000 acres to a high of about 36,000 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.

[1]WASS 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 by county is depicted in Figure IV-2. That figure shows that Niobrara County is the largest forage producer in the planning area, accounting for 37 percent of all forage harvested over the period from 1980 through 2000. Crook County is the second largest producer with 34 percent of the total, followed by Westin, Converse, and Campbell Counties in that order.

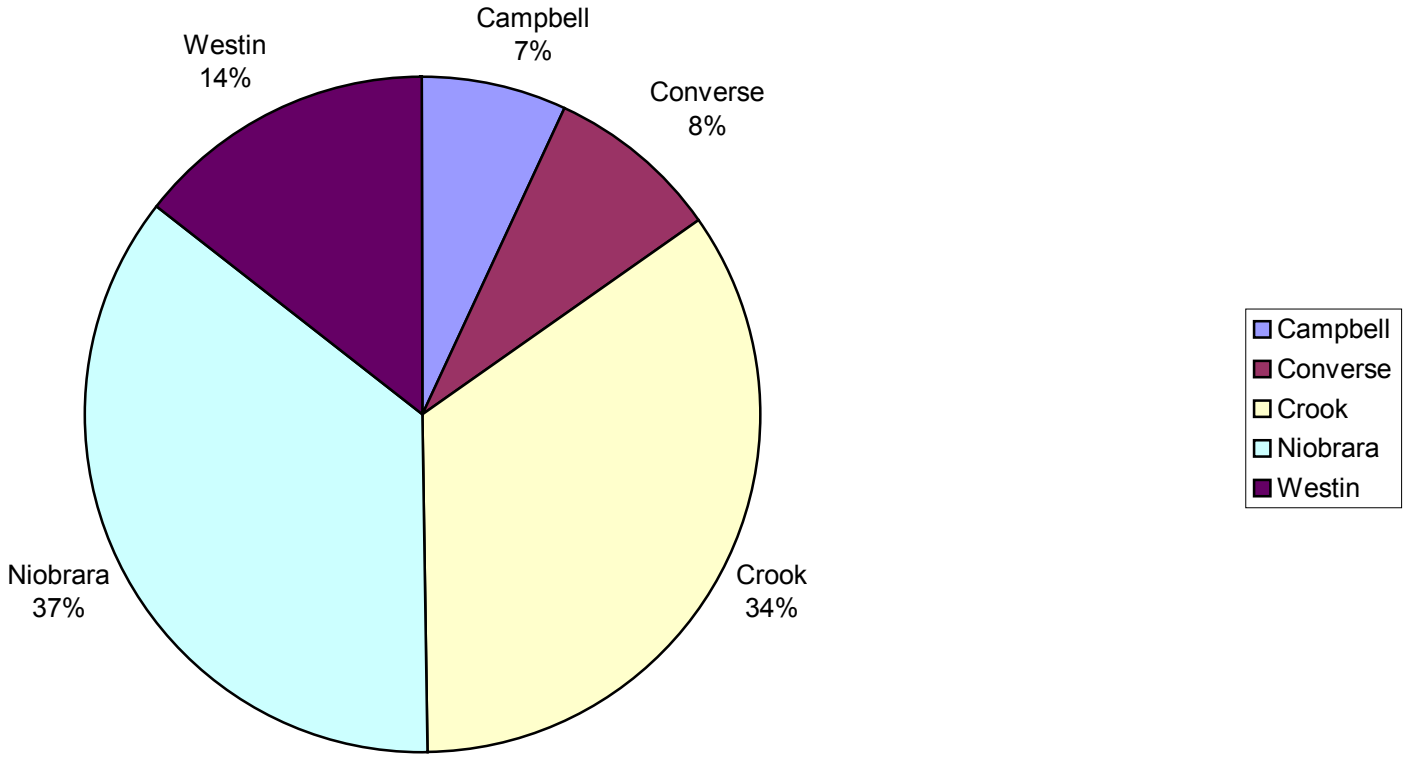
The only significant irrigation water storage facility in Northeast Wyoming is Keyhole Reservoir, a multipurpose facility operated by the Bureau of Reclamation. It can store up to 185,800 acre-feet of irrigation water, of which irrigators in South Dakota control 90 percent. About 18,000 acre-feet of Keyhole's storage is owned by the Crook County Irrigation District, which uses the water to supplement direct flow rights along the lower Belle Fourche River in Wyoming. The only other irrigation reservoirs in the planning area are small privately owned facilities. A complete description of storage facilities in Northeast Wyoming is presented in a separate technical memorandum. The lack of storage facilities in most parts of the planning area is partially offset by the availability of ground water in some locations. The fact that almost 18,000 acres of land are irrigated primarily by ground water is evidence of its importance in agricultural production, especially in the Niobrara River Basin.

Trends in Livestock Production

Over the past two decades livestock production (cattle and sheep) in Northeast Wyoming 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 available rangeland. 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.

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 region 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.

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



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 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 many areas of Northeast Wyoming that could benefit from additional irrigation water, especially in dry years. Areas of particular need include virtually all of the tributaries of Beaver Creek and the Cheyenne and Belle Fourche Rivers. 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. Additional irrigation water could also allow producers to expand their cattle herds on private holdings.

There are, however, several practical problems associated with developing new storage in the Northeast Wyoming River Basins. One problem is a lack of potential sites with available water and cost effective dam building potential. The short list of potential irrigation storage projects developed for this study includes only a few small reservoir sites on tributaries of the Belle Fourche River below Keyhole Reservoir. Another practical problem with developing new storage in the Belle Fourche River Basin is the Belle Fourche River Compact, which prohibits the development of reservoirs of over 1,000 acre-feet of storage for irrigation in Wyoming.

A third 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 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.

One potential low cost source of supplemental irrigation water is CBM production water. Projections made for this planning study indicate that water production associated with CBM development in the planning area may exceed 50,000 acre-feet annually during this decade. There are several practical problems with using CBM water for irrigation, however, one of which is the fact that high levels of production are not expected to last more than eight to 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. Using CBM water for irrigation is also

complicated by questions of water quality and the proximity of water production to areas of need. Unless these issues are resolved, there appears to be no significant long-term potential for enhancing agricultural production in Northeast Wyoming through the use of CBM production water for irrigation.

The lack of potential storage sites, compact restrictions, and other considerations discussed above make it unlikely that significant amounts of demand for additional irrigation water will develop in the Northeast Wyoming River Basins over the next 30 years. That fact is discussed further in the irrigation water demand scenarios discussed below.

Low Growth Scenario

The low growth scenario is based upon the assumptions that irrigation in the planning area 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. Numerically, total consumptive use of surface water for irrigation in the planning area is expected to remain relatively constant at 69,500 acre-feet in a normal year. Ground water utilization is also expected to remain unchanged at 16,900 acre-feet per year.

Moderate Growth Scenario

The moderate growth scenario is based upon a projection that cattle prices will increase significantly over the next 10 years as forecast by the USDA. An increase in cattle prices, however, is unlikely to provide enough financial incentive for ranchers in water-short areas of the Basin to develop storage facilities given compact restrictions in the Belle Fourche Basin and the lack of suitable sites for development in other parts of the Basin.

A long term increase in cattle prices is more likely to encourage producers to invest in more efficient water delivery and irrigation systems than to develop new storage. Financial incentives also may encourage some irrigators to utilize ground water more extensively, and may also encourage irrigators in the Crook County irrigation district to bring small amounts of idle lands into production by more fully utilizing their storage rights in Keyhole Reservoir. In addition, irrigators throughout the planning area would have incentives to maximize production when water was available, thus adding to consumptive use.

This scenario assumes that surface water irrigation efficiency will increase by one percent relative to the low growth scenario as a result of the financial incentives associated with a long-term increase in cattle prices. That efficiency increase would add 1,700 acre-feet to surface water consumptive use in a normal year. An additional 4,000 acre-feet of

Keyhole storage would be used for irrigation each year, adding another 1,600 acre-feet to Basin-wide consumptive use each year. Overall, surface water consumptive use is expected to increase from about 69,500 acre-feet to 72,800 acre-feet in a normal year without the construction of new storage facilities. Ground water utilization is expected to increase from 16,900 to 18,900 acre-feet annually.

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 higher. An increase in forage prices would be an additional incentive for producers to increase irrigated production. This scenario also assumes that the WWDC funding criteria for new projects would increase from 50 to 75 percent of construction costs. This combination of these factors would encourage irrigators to develop more efficient water delivery and irrigation systems, as well as expand ground water utilization. Assuming a two percent increase in average Basin-wide irrigation efficiency means that about 3,400 acre-feet of additional consumptive use would occur in a normal year relative to the low growth scenario.

This scenario could also provide enough of a financial incentive for the construction of some small storage projects at identified sites on the tributaries of the lower Belle Fourche River. This scenario assumes that of the six such sites that have been identified, three would be developed over the next 30 years, with a total storage capacity of 3,000 acre-feet. Three thousand acre-feet of new storage would increase consumptive use by about 1,200 acre-feet annually. Total surface water consumptive use for this scenario is would increase to about 74,100 acre-feet annually. Ground water utilization would increase to 20,800 acre-feet annually. Projections of future consumptive use of surface irrigation water for all scenarios are depicted in Figure IV-3.

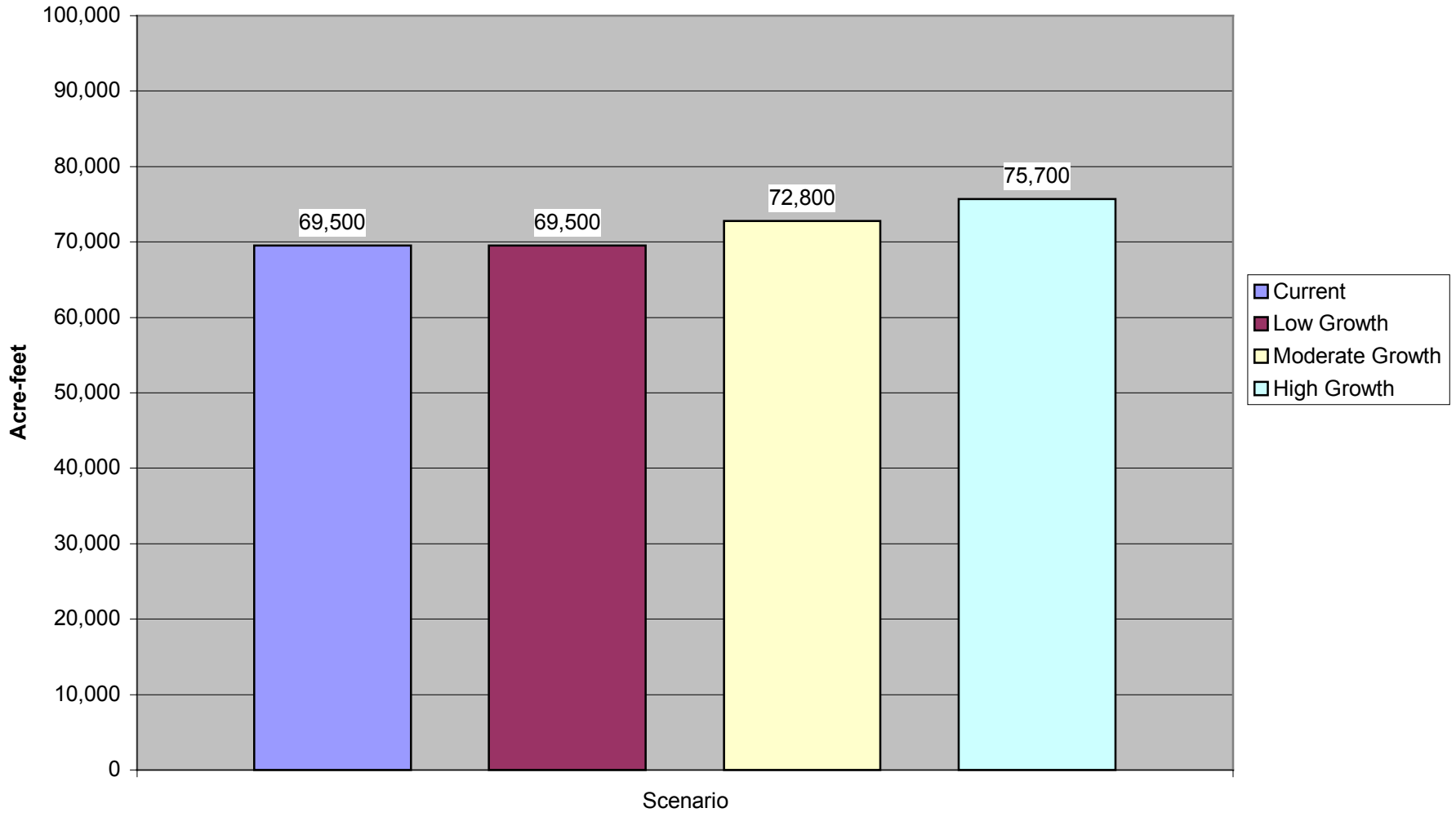
B. Municipal and Domestic Demand Projections

Municipal and domestic use projections were created by combining current use rates with population projections for the planning area. 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.

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



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 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 planning area is estimated to be approximately 48,500 persons.

The geographical distribution of the current population by county is depicted in Figure IV-4. That figure shows that almost 65 percent of the Basin's population resides in Campbell County. Westin County accounts for about 14 percent of the Basin's population, and Cook County about 12 percent. Niobrara and Converse Counties each account for about five percent of the total.

WDAI Population Projections

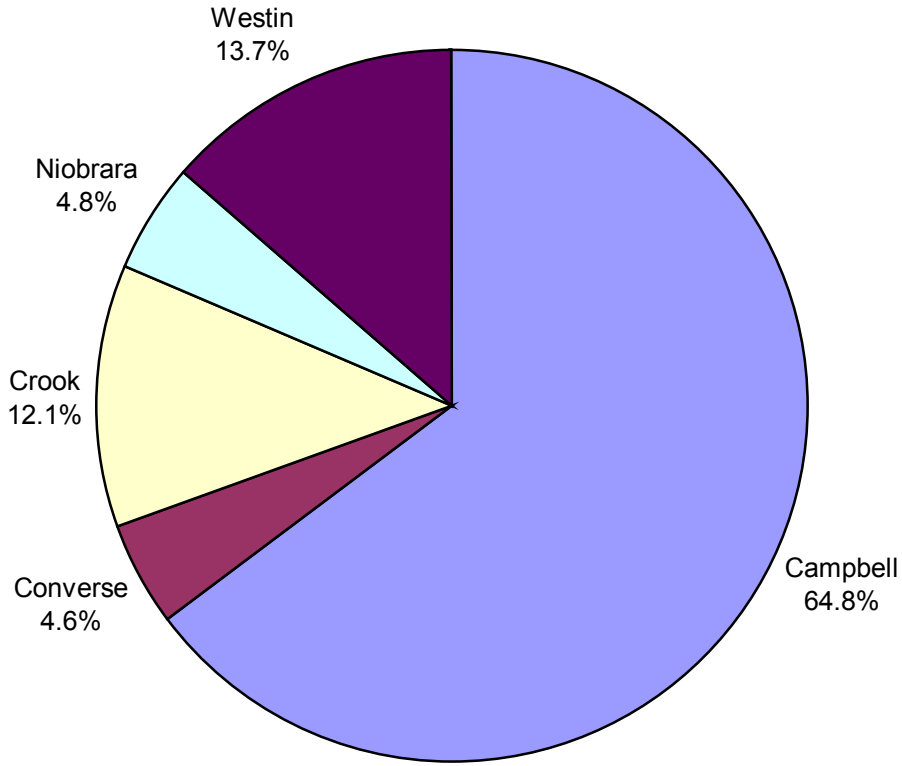
The Division of Economic Analysis of the Wyoming Department of Administration and Information (WDAI) produces population forecasts for Wyoming counties, cities, and towns. The county population forecasts are based upon time series data from which growth rates are derived from variables such as population, 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.

Figure IV-4
Distribution of Current Population



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 USCB projections are based upon the assumption that this moderate rate of net in-migration will continue into the future.

Historical Growth Projections

A third set of population projections was developed from an analysis of historical population growth. The planning area experienced rapid population growth during the 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 that period will occur during the next 30 years.

Results

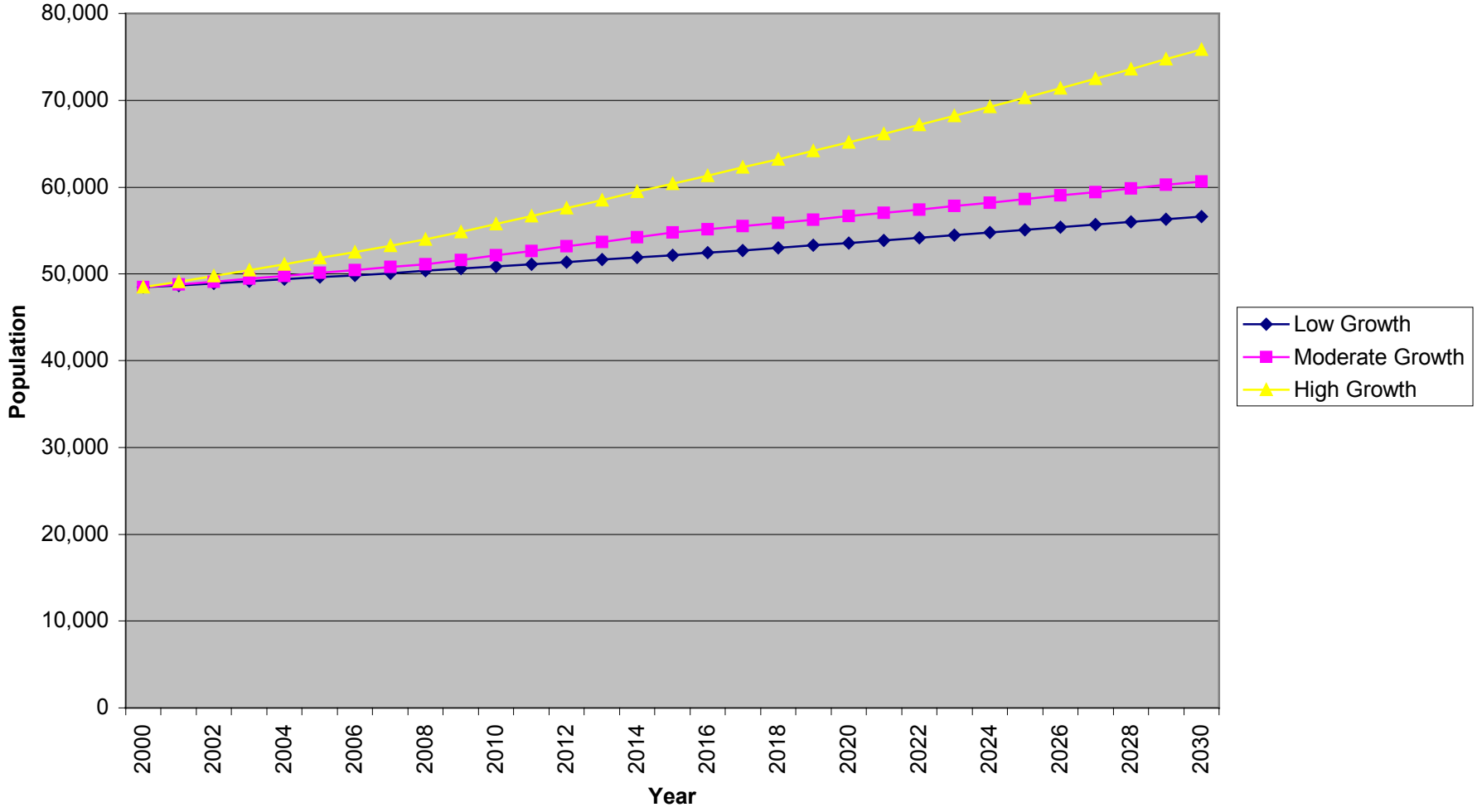
The three methods described above were used to generate population forecasts through the year 2030 for communities and rural areas. Generally speaking, the WDAI extended forecasts resulted in the smallest population projections, followed by the U.S. Census Bureau projections and the historical growth 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 water use are presented in Table IV-1. All of the incorporated communities in Northeast Wyoming rely upon ground water. Gillette, the largest municipality in the planning area, is projected to need between 6,300 and 8,500 acre-feet of water annually by the year 2030. All of the other communities will need 1,000 acre-feet or less. Total municipal needs will range between 8,500 and 11,800 acre-feet, depending upon the growth scenario.

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 Gillette's and Moorecroft's have the capacity to meet all future projected needs. Both communities are studying ways to expand their municipal water supply systems.

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. 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 2,700 and 5,500 acre-feet per year. Future use projections range from a low of 6,000 acre-feet to a high of 8,200 acre-feet annually, depending upon the scenario. This water is expected to come from ground water sources.

C. Industrial Demand Projections

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

Coal-fired Electric Power Production

Four coal-fired electric power plants are now operating in Northeast Wyoming. Three of the plants, Neal Simpson #1, Neal Simpson #2, and Wyodak #1, are located near the

Table IV-1
Municipal Use Projections

City/Town	Current	Current	2030 Population Projections			2030 Use (gpd)			2030 Use (acre-feet/yr)		
Surface Water Users	**Population**	**Use(gpcpd)**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
None											
Groundwater Users											
Gillette	22,000	200	28,182	28,952	37,686	5,636,400	5,790,400	7,537,200	6,314	6,486	8,443
Hulett	450	100	521	553	572	52,110	55,305	57,195	58	62	64
Lusk	1,600	160	1,173	1,891	2,048	187,710	302,592	327,680	210	339	367
Manville	100	700	73	121	129	51,287	84,770	90,370	57	95	101
Moorcroft	807	375	749	995	1,048	280,875	373,125	393,000	315	418	440
Newcastle	3,300	225	2,673	3,300	3,996	601,510	742,500	899,168	674	832	1,007
Pine Haven	222	220	239	275	363	52,580	60,500	79,860	59	68	89
Sundance	1,250	150	1,500	1,509	1,611	225,000	226,313	241,688	252	254	271
Upton	950	225	684	950	1,150	153,939	213,750	258,638	172	239	290
Wright	1,500	219	1,940	1,979	2,873	424,751	433,292	629,078	476	485	705
Total	32,179		37,735	40,525	51,476	7,666,161	8,282,546	10,513,875	8,587	9,278	11,777

Table IV-2
Domestic Use Projections

Description	Current	Low Growth	Moderate Growth	High Growth
Basin Population	48,460	55,639	60,670	75,872
Municipal Population	32,179	37,646	40,465	51,360
Rural Population	16,281	17,993	20,205	24,512
Domestic Use (150 GPCD-in af/yr)	2,736	3,023	3,395	4,119
Domestic Use (300 GPCD-in af/yr)	5,471	6,046	6,790	8,237

Wyodak Mine seven miles east of Gillette. An interesting characteristic of all three of these plants is that they use air rather than water for cooling steam produced during electric power generation. As a result, their water consumption is significantly lower than is the case for more conventional water-cooled electric power plants. The only water-cooled electric generating facility in Northeast Wyoming is the Osage Station, located near Osage in Westin County. Total annual water use for power production in the planning area is approximately 1200 acre-feet annually.

Several companies have announced plans to build additional generating capacity in Northeast Wyoming, and those plans are in various stages of implementation. If all announced facilities were built, generating capacity in the planning area would rise from 463MW today to 2,820MW at some point in the future. It is possible that some announced facilities will not be built, however, due to financial considerations or permitting difficulties. On the other hand, plans for other facilities not yet announced may be forthcoming over the 30-year horizon of this planning study.

The plans for plants that have been announced involve dry cooling towers and limited usage of ground water for process purposes. Water requirements for dry-cooled plants are less than for plants with wet cooling towers which are in use at other locations in the state, including the Laramie River Station in Platte County and the Jim Bridger Power Plant in Sweetwater County. While wet-cooled plants are more efficient and less costly to run than dry-cooled plants, their water requirements are much larger. Given the fact that there is relatively little surface water available in proximity to the coal resources of Northeast Wyoming, it appears likely that dry cooling will remain the technology of choice for power production for the foreseeable future.

One factor that might change that conclusion is the availability of low-cost ground water from coalbed methane (CBM) production. At least one power company has expressed an interest in utilizing CBM water for cooling purposes. There are several potential problems with implementing such a proposal, however. One problem is the fact that coalbed methane resources may be depleted in a shorter time frame than the 50-plus year

life expectancy of a coal-fired generating facility. Also, the CBM industry is composed of a large number of players. Organizing those individuals and companies and providing the infrastructure needed to transport a consistent volume of water to a site for cooling purposes could prove to be a daunting challenge. Nevertheless, the potential use of CBM water for industrial purposes remains an interesting possibility.

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 assumption that dry cooling and limited ground water pumping for process water will continue to be the predominant technology employed. This total includes 2,390MW of planned new capacity minus 33MW of capacity retired at the Osage Station. For comparison purposes, estimates are also given for what water requirements would be for wet-cooling technology.

Low Growth Scenario

The low growth scenario for future electric power production assumes that only 50 percent of the 2,390MW of announced new capacity discussed above will eventually be built. That additional capacity would bring total generating capacity in the planning area to 1,625MW in the year 2030. Assuming dry cooling technology, total annual water use for power generation would rise to about 3,700 acre-feet annually by 2030. Almost all of this water would be supplied by ground water wells. If low cost surface water or CBM water were available in sufficient quantities to make wet cooling technology practical for the new plants, water consumption would rise to about 20,800 acre-annually by the year 2030.

Moderate Growth Scenario

The moderate growth scenario for electric power production assumes that the permitting and financial uncertainties surrounding future expansion will be resolved over the next 30 years and that all currently planned capacity additions will be on line by that date. In that case, 2,390MW of additional generating capacity would be in place by the year 2030, bringing to the total to 2,820MW. Assuming dry cooling technology, total water requirements would be about 6,900 acre-feet annually. Assuming wet cooling technology for new generating units, total water requirements would rise to about 41,100 acre-feet annually.

High Growth Scenario

The high growth scenario for electric power production assumes that all capacity additions envisioned for the moderate growth scenario will take place, and that an additional 1,200MW of capacity not yet announced will be added to help meet the nation's growing energy needs. This additional capacity may require the adoption of new emissions control technology to meet air quality standards or the relaxation of those standards to allow increased production, neither of which is assured. Nevertheless, the

addition of 1,200MW of generating capacity above the 2,390MW envisioned for the moderate growth scenario constitutes a reasonable high growth scenario forecast.

Total generating capacity for the high growth scenario is 4,020MW and total water requirements would be about 10,100 acre-feet annually. Assuming wet cooling technology for the new capacity would bring total water requirements to slightly over 70,000 acre-feet annually. Future electric power generation water use projections for all three growth scenarios are presented graphically in Figure IV-6.

Coal Mining

Northeast Wyoming is a major coal-producing region with enormous resources of low sulfur, low BTU coal that can be mined from the surface due to relatively shallow overburden. During the year 2000, there were 14 active mines in the planning area with a total annual production of 322.7 million tons.

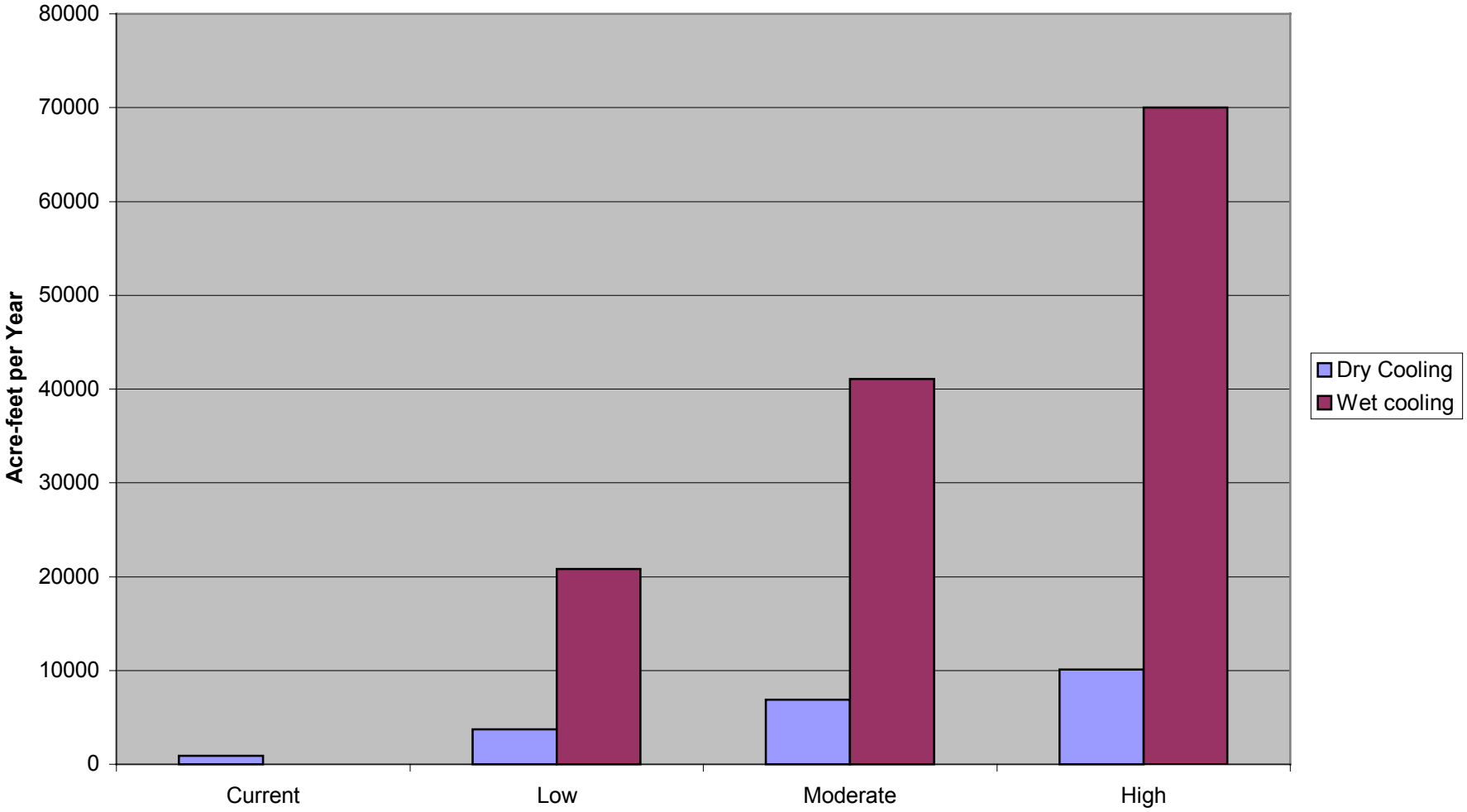
These coal mines use water primarily for dust abatement and reclamation, with lesser amounts used for equipment wash-down and domestic purposes. The primary sources of water for most mines are dewatering wells drilled into the coal seam ahead of advancing pit operations and sump wells to remove water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

Future water use by the coal industry is expected to increase slightly for two reasons. First, the pits at some mines are expanding away from the coal processing facilities on site, thus requiring longer hauls and more water use for dust suppression. Second, some mines anticipate expanding production in the future if coal prices remain firm at current levels or increase. Nevertheless, most mines will continue to meet their operational water needs from dewatering wells and sumps on site. These activities are not expected to affect either surface water resources or other ground water users. 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 planning area 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 coalbed methane (CBM) production as discussed in the following section.

Figure IV-6
Electric Power Water Demand Projections
2000-2030



Very little water is consumptively used by the oil and gas industry in the Northeast Wyoming; 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 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 ground water users. For these reasons, future requirements for this industry have not been quantified.

Coalbed Methane Production

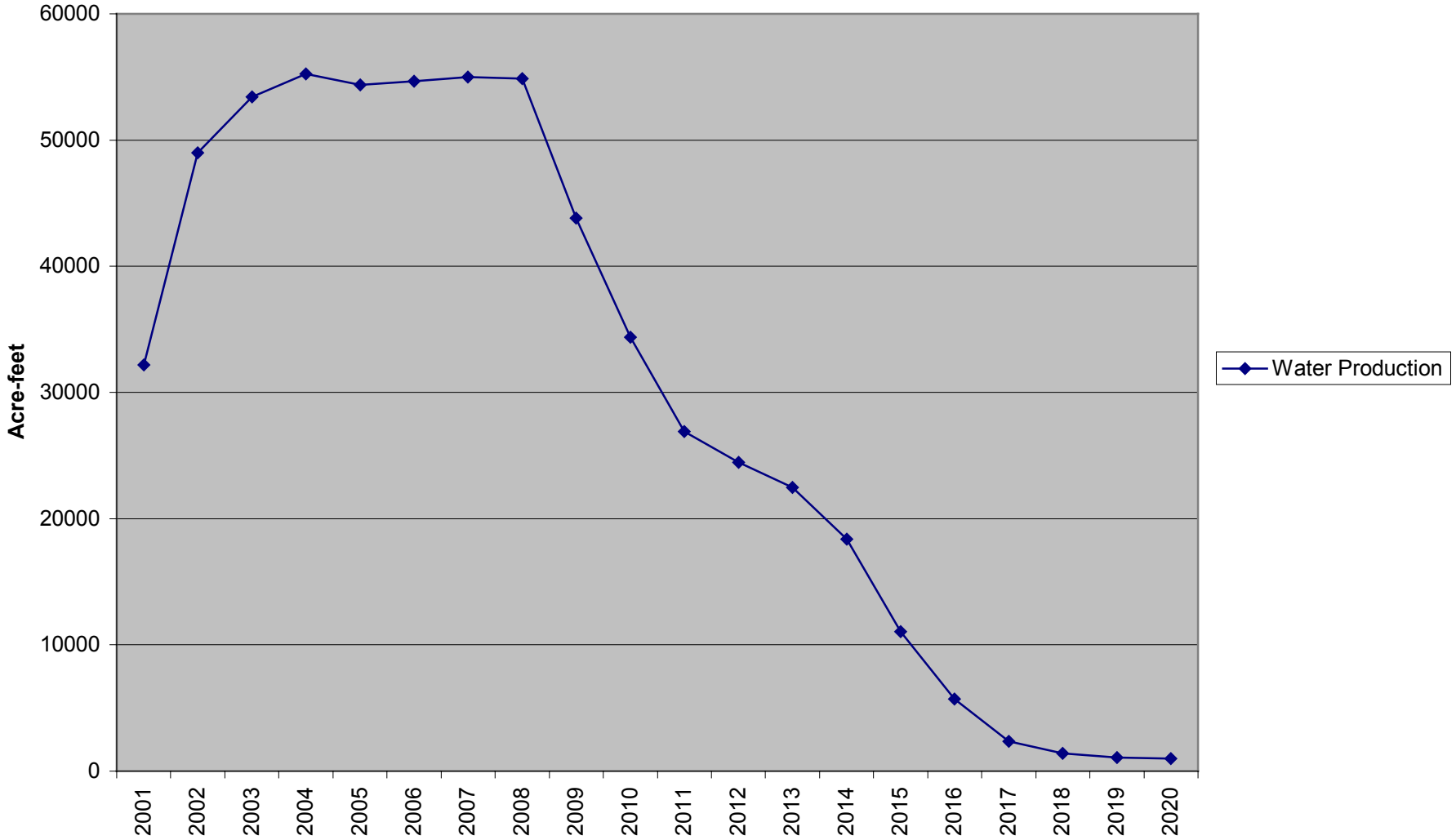
Coalbed methane production has become widespread in Northeast Wyoming over the past few years, and is expected to increase in the future. CBM development is not a consumptive user of water resources, but produces ground water as a by-product of gas production. The process involves pumping water from 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 planning area.

Projected CBM water production for Northeast Wyoming River Basins 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 55,000 acre-feet annually by the year 2004. Production is expected to remain at that level for about five years, and then drop off to less than 2,000 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.

Figure IV-7
Projected Annual CBM Water Production



Since 1980, three coal conversion facilities have been planned for Northeast Wyoming and have been issued construction permits by the Wyoming Industrial Siting Administration, although none have been built to date. For the low growth scenario, it was assumed that the market forces that have prevented the construction of such facilities in the past would continue throughout the 30-year planning horizon. For the moderate growth scenario, it was assumed that two such facilities would become operational, one to convert coal to solid fuels and one to convert coal to liquid fuels. The water requirements of the two plants are 2,200 acre-feet annually. This demand would probably be met from ground water sources.

The high growth scenario assumes that in addition to the coal conversion facilities described above, one coal-to-gasoline plant will become operational over the next 30 years. This plant would have an annual consumptive water use requirement of approximately 5,000 acre-feet annually, bringing total water use for the high growth scenario to 7,200 acre-feet annually. This requirement would most likely be met from ground water sources.

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 Northeast Wyoming River Basins 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.

Electric power generators are already represented in the Basin, and projections of their future water requirements 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 Northeast Wyoming 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 Northeast Wyoming River Basins 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. Barring the development of an inexpensive source of surface water, it is expected that these industrial needs will be met through the adoption of water conserving technologies such as dry cooling for power generation and the development of ground water resources to meet projected needs. If an inexpensive source of surface water were available, industry could employ more efficient wet cooling technologies for power generation and would have correspondingly larger water requirements.

Figure IV-8 summarizes total industrial water use projections for the planning area over a thirty-year planning horizon. The projections include water needed for electric power generation and coal conversion facilities. The projections are presented for the two different assumptions concerning power generation cooling technology. For the dry cooling option, total industrial water requirements are expected to rise from a current level of 900 acre-feet annually to between 3,700 (low scenario) and 17,300 (high scenario) acre-feet annually by the year 2030. The moderate growth scenario estimate is 9,100 acre-feet annually.

For the wet cooling option, total water requirements would grow to between 20,800 (low scenario) and 77,200 (high scenario) acre-feet annually by the year 2030. The moderate growth scenario estimate is 43,300 acre-feet annually. Although coalbed methane production water could provide enough water to meet the requirements of the wet cooling option on a short-term basis, it is not projected to be available over a long enough time period to warrant investments in wet cooling technology for power generation.

D. Recreation Demand Projections

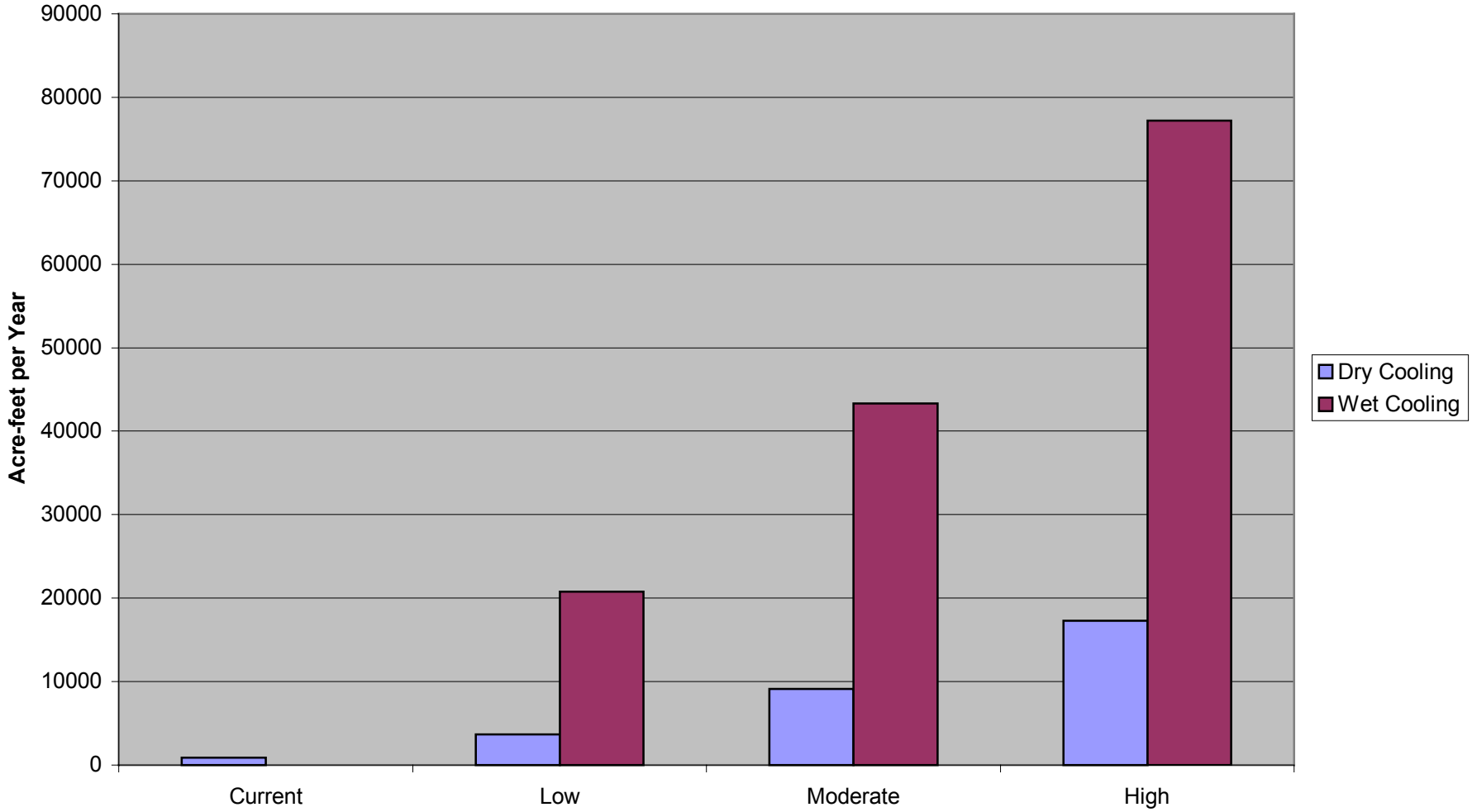
Current Recreation Activity

The most popular water-based recreational activity in the planning area is fishing. Figure IV-9 shows that slightly over 50 percent of planning area residents participate in fishing. The second most popular water-based recreational activity among residents is power boating, followed by waterfowl hunting, rafting and canoeing, and sailing.

The WGFD provided estimates of the number of annual activity days of angling and waterfowl hunting in the Northeast Wyoming River Basins. Stillwater fishing on lakes and reservoirs accounts for about 50,000 activity days annually. Most, but not all, of this fishing activity occurs at Keyhole Reservoir. Cook Lake in the Black Hills National Forest is also a popular fish site, as are several other small bodes of water scatter across the planning area.

Stream fishing in Northeast Wyoming accounts for only about 15,000 activity days annually. Stream fishing opportunities are limited in most parts of the planning area, although there are some good streams, such as Sand Creek, which arise in the Black Hills.

Figure IV-8
Total Industrial Water Demand Projections
2030



Waterfowl hunters spend about 3,000 days annually in the pursuit of ducks and geese that inhabit or pass through the Northeast Wyoming River Basins. 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 Northeast Wyoming 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.

Projections of population growth in 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.

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

Scenario	Average Annual Growth Rate	
	Population	Tourism
Low growth	0.52	1.00
Moderate growth	0,75	2.00
High growth	1.51	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 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 (2000-2030)

Activity	Activity Days by Scenario			
	Current	Low Growth	Moderate Growth	High Growth
Stillwater Fishing	50,000	62,000	72,000	93,000
Stream Fishing	15,000	19,000	22,000	28,000
Waterfowl Hunting	3,000	3,500	4,000	5,000
Totals	68,000	84,500	98,000	126,000

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 are 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 Northeast Wyoming River Basins, but for an area encompassing both the Powder/Tongue and Northeast Wyoming River Basins. Nevertheless, it is useful to review these supply estimates as background for assessing resource adequacy.

According to the WGFD, Northeast Wyoming and the Powder/Tongue River Basin 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. Fishery resources in the Northeast Wyoming River Basins are limited, with Keyhole providing the only large body of standing water available. Visitation data for Keyhole Reservoir show a strong correlation between visitation and storage contents, an indication that water availability is a limiting factor in recreation under current conditions. Without provisions for additional recreational storage in Keyhole, or the development of new storage sites, the planning area's ability to handle future increases in demand is limited. As a result, the demand for recreational fishery resources is expected to exceed the supply throughout the thirty-year planning horizon.

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 3,000 and 5,000 activity days by the year 2030. The WGFD has not estimated the supply of waterfowl hunting opportunities in Northeast Wyoming, partially because waterfowl 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 Northeast Wyoming River Basins are described in Chapter II. Those uses include:

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

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 planning area 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 Northeast Wyoming River Basins (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.

Instream Flows and Reservoir Bypasses

The WGFD has a goal of maintaining and enhancing existing fisheries through the statutory designation of instream flow segments and other management strategies. To date, only one application for an instream flow right in Northeast Wyoming has been

filed with the State Engineer. That application is for a 2.5- mile segment of Sand Creek in Crook County.

The extent to which future instream flow requests may conflict with potential storage developments for supplemental irrigation water is unknown, but is probably not a significant issue given the relative scarcity of stream fisheries and compact restrictions on reservoir development in many parts of the planning area. If conflicts did occur, they 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 is the provision of minimum flow bypasses at reservoir sites. Currently, there are no mandatory minimum bypasses for reservoirs in the planning area. Any development of additional reservoir storage in the future would likely bring about requests by the WGFD and others for such minimum flow bypass requirements.

Minimum Reservoir Pools

Another environmental water use is the provision of minimum reservoir pools for fish and wildlife purposes. None of the reservoirs in Northeast Wyoming have mandatory minimum pool requirements. Several years ago, the State of Wyoming attempted to procure a minimum pool in Keyhole Reservoir through a cooperative agreement with the Crook County Irrigation District. That attempt was unsuccessful, but the possibility exists that an agreement could be worked out in the future. Given the current federal regulatory environment, it is likely that any additional storage development would have to have a portion of its storage devoted to fish and wildlife purposes also.

Wildlife Habitat

Another important environmental use of water in the planning area is the provision of habitat for wildlife. Wildlife habitat exists in wetland and riparian areas on public and private lands throughout Northeast Wyoming, some of it occurring naturally and some of it as a result of human activity. A tabulation of wetlands wildlife habitat areas 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 in Northeast Wyoming. 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. The comparable figure for Northeast Wyoming is probably no larger and may be smaller. This level of consumptive use is relatively small and is not expected to change significantly over the planning horizon.

F. Summary of Projected 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	0	0	0	0
Industrial	negligible	negligible	negligible	negligible
Irrigation	69,500	69,500	72,800	75,700
Evaporation	23,500	23,500	23,500	23,500
Recreational	(non-consumptive)			
Environmental	(not estimated)			
Total	**93,000**	**93,000**	**96,300**	**99,200**

Projections of future ground water utilization are summarized in Table IV-6. The projections show that ground water utilization is expected to increase from a current level of 25,200 acre-feet annually to between 29,200 and 48,100 acre-feet, depending upon the growth scenario.

Table IV-6
Summary of Current and Projected Ground Water Consumptive Use

Use	Current	Projected Use by Growth Scenario (Acre-feet/Yr.)		
		Low	Moderate	High
Municipal/Domestic	12,700	14,600	16,100	18,200
Industrial[1]	900	3,700	9,100	17,300
Irrigation	16,900	16,900	18,900	20,800
Environmental	(not estimated)			
Total	30,500	35,200	44,100	56,300

Note 1: Excludes oil, gas, and mining uses.

G. Future Uses as Related to Compact Allocation

A comparison of projected surface water demands with water availability under the Belle Fourche River Compact is presented in Table IV-7. The estimated depletions reflect surface water irrigation depletions for the Belle Fourche River and Redwater Creek drainages, which are covered by the compact.

Table IV-7
Projected Use of Compact Allocation (Normal Year)

Surface Water	Projections by Growth Scenario (Acre-feet/Yr.)		
	Low	Moderate	High
Estimated Belle Fourche River Depletions	21,900	24,000	25,700
Wyoming's Remaining Compact Allocation of Belle Fourche Flows[1]	2,500	400	-1,300

Note 1: These values are based on the limiting dry year conditions and assume that projected increases in depletions will occur in the Belle Fourche and Redwater drainages in proportion to the respective compact allocations. During normal and wet year conditions the remaining compact allocation under the high growth scenario increases to 6,000 acre-feet and 15,100 acre-feet respectively.