

Subject: **Powder/Tongue River Basin Plan
Population Projections
Task 4**

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INTRODUCTION

This memorandum presents population projections for the Powder/Tongue River Basin and communities and rural areas in those basins over a 30-year planning horizon. The purposes of these projections are to provide a basis for estimating future municipal and domestic water needs in the planning area, as well as provide insights into future water-based recreational resource needs.

The river basin water planning process developed by the Wyoming Water Development Commission (WWDC) specifies that population projections be developed for three planning scenarios:

1. Low Growth
2. Moderate Growth
3. High Growth

The following sections of this memorandum describe the approach and methodologies utilized in developing population projections for the Powder/Tongue River Basin as well as the results of the analysis.

APPROACH

Population projections can be developed using a variety of different approaches depending upon the purpose for which the projections are being developed, the amount of data available for making projections, and the time horizon over which the projections are to be made. The three most common methods for producing population projections are (1) time series analyses, (2) cohort survival analyses, and (3) employment-driven approaches.

Time series analyses typically involve assessing past growth trends and using those trends to project population into the future. Analytical methods used with this approach include computing average annual historical growth rates and fitting linear or non-linear equations to historical population data or indicators of population growth such as school enrollments, sales tax revenues, or other variables. Projections are usually based upon the assumption that future population changes will mimic past average annual growth rates or trends. The time series approach is relatively easy to implement, and its results are easily understandable. Its main disadvantage is that it does not explicitly consider the three primary determinants of regional population change: mortality rates, fertility rates, and migration patterns. Instead, the method implicitly assumes that past trends in relationships among these variables will continue into the future.

The cohort survival approach explicitly recognizes the three primary determinants of population change and requires forecasts of future mortality and fertility rates as well as net migration patterns. Projections of mortality and fertility rates by age and sex group (cohort) are available from the U.S. Census Bureau (USCB), as are projections of net migration patterns for different regions of the country. Projections of change for each cohort can be combined to produce forecasts of future population for a given geographic area. The advantage of the cohort survival approach is that it explicitly recognizes the determinants of

population change and takes them into account in developing projections. Its primary disadvantage is that in rural areas with relatively small population bases, the effects of changing migration patterns over time can overwhelm the effects of changes in mortality and fertility rates, thus making the projections extremely sensitive to assumptions about future net migration patterns.

Employment-driven approaches to population projections are based upon the assumption that net migration patterns are primarily determined by job availability, and that job availability can be projected into the future with reasonable accuracy. Thus, if we could accurately project how many jobs would be available in the planning area in the year 2030, we could estimate population in that year based upon estimates of how many people would be associated with each job. Estimates of the number of persons associated with each job may or may not explicitly take into account such factors as labor force participation rates, fertility rates, and mortality rates. If these factors are taken into account, the employment-driven approach becomes a special case of the cohort survival approach where net migration estimates are based upon employment forecasts.

The employment-driven approach incorporating labor force participation, fertility, and mortality rate changes is the most sophisticated approach commonly used for projecting regional population changes and can provide relatively accurate forecasts over relatively short time frames. Its primary disadvantage lies in the difficulty of forecasting economic activity and associated labor requirements by economic sector over long time periods. Even if future economic activity by sector could be forecast reliably 30 years into the future (a doubtful proposition), technological changes that affect the amount of labor needed by each sector often cannot be forecast reliably. For example, Wyoming's Powder River Basin has become the world's leading coal producer in recent decades with little growth in employment opportunities because of productivity gains associated with mechanized mining equipment. Accurately forecasting current levels of mining employment in the Powder River Basin 30 years ago would have been very difficult because the technology that determines current employment levels did not exist then.

Another disadvantage of the employment-driven approach is that migration patterns in the United States in recent decades have become less dependent upon local job availability and more dependent upon amenities and lifestyle variables such as climate, local infrastructure, crime rates, and scenic attributes. Many industries and jobs in the U.S. economy are now "portable" in the sense that they can be shifted from one locale to another based upon amenities or lifestyle variables with little change in competitive advantage.

Given the inherent shortcomings of all three population projection methodologies, there is no compelling reason to generate population projections for the planning area using one method to the exclusion of others. Instead, the approach taken for this study involves using three different methods to create a range of projections representative of low, moderate, and high growth scenarios. Those methods are discussed below, following a discussion of historic population growth trends.

HISTORIC AND CURRENT POPULATION ESTIMATES

The first step in developing population projections was to examine historic population trends in the Powder/Tongue River Basin and the current population of its counties, communities and rural areas. The best source of information on historic and current population is the results of the U.S. Census conducted at 10-year intervals. Historical census information is readily available and the Census Bureau recently released the results of the 2000 Census. (Wyoming Department of Administration and Information [WDAI], 2001a).

Because the geographical boundaries of the planning area do not adhere to county lines, it was necessary to adjust the Census Bureau's county population estimates to reflect only the proportion of each county that lies within the planning areas' boundaries. The general adjustment process that was followed is described below:

- Cities and towns were classified as within or outside of the planning area and their populations allocated accordingly.¹
- Each county's rural population was estimated by subtracting the populations of all cities and towns from the county total.
- A proportion of the rural population of each county was allocated to the planning area based upon the percentage of the land area of each county that is in the planning area. The percentages used for this purpose are Campbell County (56.6 percent), Johnson County (100.0 percent), Natrona County (34.0 percent), and Sheridan County (100.0 percent).
- The proportion of each county's land area that is in the planning area was estimated from data contained in Table I-3 of Wyoming Water Planning Report No. 10 (State Engineer's Office, 1972), and county acreage figures reported in the Equality State Almanac (State of Wyoming, 1999).

Some adjustments to the land area method of allocating rural populations in the planning area were necessary for portions of Campbell, Johnson, Natrona, and Washakie Counties. For example, although 56.6 percent of the land area in Campbell County is located in the Powder River Basin, rural population growth in Campbell County in recent decades has not been proportional to land area. According to the Campbell County Engineer, approximately 90 percent of rural housing construction outside of Gillette has occurred in the Belle Fourche River Basin and only 10 percent in the Powder River Basin (Zahn, 2001). For that reason, post-1960 population estimates for rural areas of Campbell County are based upon the assumption that only 10 percent of the county's rural population growth occurred in the Powder River Basin.

Another exception involves treatment of rural areas of Johnson and Washakie Counties. A small portion of Johnson County lies in the Bighorn River Basin and a small portion of Washakie County lies in the Powder River Basin. These areas are very small and virtually unpopulated, however, so for purposes of rural population projections, 100 percent of Johnson County and zero percent of Washakie County were assumed to be in the planning area. A final exception involves rural areas of Natrona County that are located in the planning area. Post-1960 rural population estimates for the portion of Natrona County located in the planning area were adjusted to reflect the fact that growth in this area is more likely to reflect growth rates in rural Johnson County than in rural areas of Natrona County.

Population estimates for cities, towns, and rural areas of the planning area during the period from 1960 through 2000 are presented in Table 1. The results in that table show that the total population of the planning area grew from 27,665 in 1960 to almost 34,000 in 1990. By the year 2000, planning area population had grown to 38,436, an increase of 39 percent relative to 1960 population levels. The planning area accounts for about eight percent of Wyoming's total population of 493,782 according to the 2000 Census. Interestingly, the planning area's population grew at a more rapid rate from 1990 to 2000 than it did during the period from 1960 to 1990. From 1960 to 1990, the planning area's average annual rate of population increase was 0.69 percent, while the planning area's population grew at an annual rate of 1.25 percent from 1990 to 2000. The increased growth rate during the past decade appears to be attributable primarily to two factors; activity associated with Coal Bed Methane (CBM) development in some parts of the planning area, along with in-migration to scenic areas of the planning area by new residents intent upon escaping urban lifestyles in more populated areas of the country.

The results in Table 1 indicate that while most Powder/Tongue River Basin communities and rural areas experienced population increases over the past 40 years, some experienced population declines. The fastest growing communities in the planning area were Dayton and Ranchester in Sheridan County, with post-1960 population increases of 103.6 percent and 198.3 percent, respectively. The largest community

¹ A small portion of the City of Gillette is located in the Powder/Tongue River Basin. The vast majority of the city's land area and population are in the Northeast Wyoming River Basins, however, so Gillette was considered to be part of that basin for planning purposes and is not considered further in this memorandum.

Table 1
Powder/Tongue River Basin Population Estimates
1960-2000

Entity	Population			1960-2000 % Change
	1960	1990	2000	
Campbell Cty	1,291	2,113	2,333	80.7%
Johnson Cty				
Buffalo	2,907	3,277	3,900	34.2%
Kaycee	284	256	249	-12.3%
Rural	<u>2,284</u>	<u>2,612</u>	<u>2,926</u>	<u>28.1%</u>
	5,475	6,145	7,075	29.2%
Natrona Cty				
Edgerton	512	247	169	-67.0%
Midwest	NA	495	408	NA
Rural	<u>1,398</u>	<u>1,402</u>	<u>1,891</u>	<u>35.3%</u>
	1,910	2,144	2,468	29.2%
Sheridan Cty				
Clearmont	154	119	115	-25.3%
Dayton	333	592	678	103.6%
Ranchester	235	676	701	198.3%
Sheridan	11,651	13,904	15,804	35.6%
Rural	<u>6,616</u>	<u>8,271</u>	<u>9,262</u>	<u>40.0%</u>
	18,989	23,562	26,560	39.9%
BASIN TOTALS	27,665	33,964	38,436	38.9%
WYOMING	330,066	453,588	493,782	49.6%

in the planning area, Sheridan, grew by 35.6 percent over the same period, while Buffalo's population grew by 34.2 percent. The communities experiencing population declines from 1960 to 2000 include Kaycee, Edgerton, and Clearmont. Midwest was not incorporated in 1960 so no 40-year population trend comparisons are available.

The geographical distribution of the planning area's current population (based upon the 2000 Census) is depicted in Figure 1. That figure shows that almost 70 percent of the planning area's population resides in Sheridan County. Johnson County accounts for about 18 percent of the population, while Campbell and Natrona Counties each account for slightly over six percent.

POPULATION PROJECTIONS

Population projections through the year 2030 for Powder/Tongue River Basin communities and rural areas were developed using three different approaches to produce high, moderate, and low growth scenario projections. Those three approaches are described in the following three subsections. The fourth subsection describes the results of the analysis.

Extended WDAI Projections

The Division of Economic Analysis of the WDAI produces population forecasts for Wyoming counties, cities, and towns (WDAI, 2001b). 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-driven approaches. Population projections for cities and towns within each county are based upon population "shares" as derived from census counts or estimates.

The state-level forecasts are employment-driven with respect to magnitude, although they explicitly take into account fertility, mortality, and migration patterns by cohort. The state population forecast totals are controlled to match employment projections produced by Wharton Econometric Forecast Associates under contract with the Division of Economic Analysis. Thus, the total county-level projections are essentially employment-driven also.

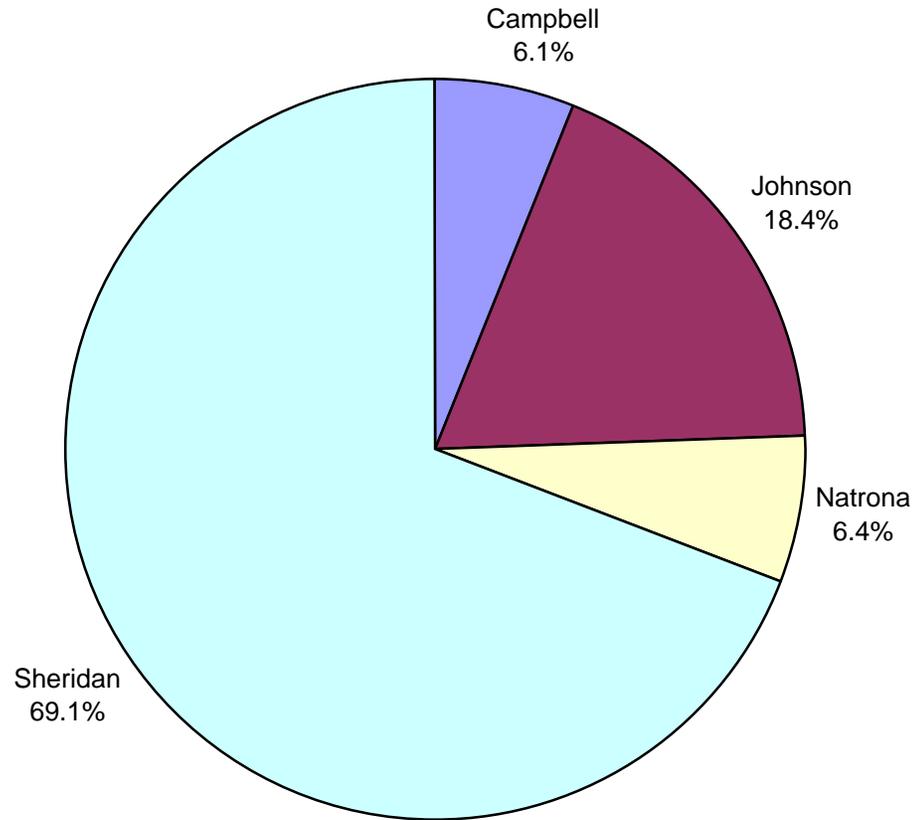
The Division of Economic Analysis forecasts population only 10 or fewer years into the future because of the uncertainties associated with such projections. Its most recent projections are through the year 2008 and are relatively conservative, a reflection of the relatively slow economic growth that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

Allocation of U.S. Census Bureau Projections

The U.S. Census Bureau (USCB) periodically produces population forecasts for each of the 50 states using the 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 forecasts and the Series B forecasts (USCB, 2001). Both series of projections use the cohort-survival approach and incorporate the USCB's "middle series" projections of fertility and mortality rates by cohort for each state. Both series also use migration patterns based upon recent data (early 1990s) concerning address changes reported on federal income tax returns. The only difference between the Series A and Series B projections is that the latter are adjusted slightly to make them more consistent with employment projections by state issued by the Bureau of Economic Analysis of the U.S. Department of Commerce. There is no significant difference between the Series A and Series B population forecasts for the state of Wyoming.

Both series of projections indicate moderate future population growth for Wyoming based upon migration patterns in the early 1990s. During that period, there was a moderate influx of new residents into some

Figure 1
Distribution of Current Population
Powder/Tongue Basin



parts of Wyoming from elsewhere in the country. The effects of this migration pattern are apparent in parts of Johnson and Sheridan Counties. The USCB projections are based upon the assumption that this moderate rate of net in-migration will continue into the future, and that fertility and mortality rates for the state will follow the USCB's middle series projections.

A reasonable set of moderate growth population projections for the planning area can be developed from the USCB's Series A projections for Wyoming using the following methodology:

- Use the WDAI population forecasts to estimate the percentage change in the planning area's population from 1990 to 2008, as well as the corresponding percentage changes for communities and rural areas of each county.
- Use the WDAI population forecasts to compute a percentage change in Wyoming's population from 1990 to 2008.
- Compute a relative growth rate (RGR) for each planning area community or area relative to the state as the ratio of the percentage changes described above.
- Use the annual growth rates for Wyoming's population derived from the USCB's Series A projections multiplied by the RGRs described above for each community and rural area to derive estimated annual population growth rates in the planning area for the post-2008 period.

Historical Growth Projections

A third set of planning area population projections was developed from an analysis of historical growth in communities and rural areas of the planning area. As discussed above, the planning area experienced more rapid population growth during the 1990s than it experienced during the preceding 30-year period from 1969 through 1990. A reasonable set of high growth population projections can be developed by assuming that the absolute population growth that occurred in the planning area 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 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.

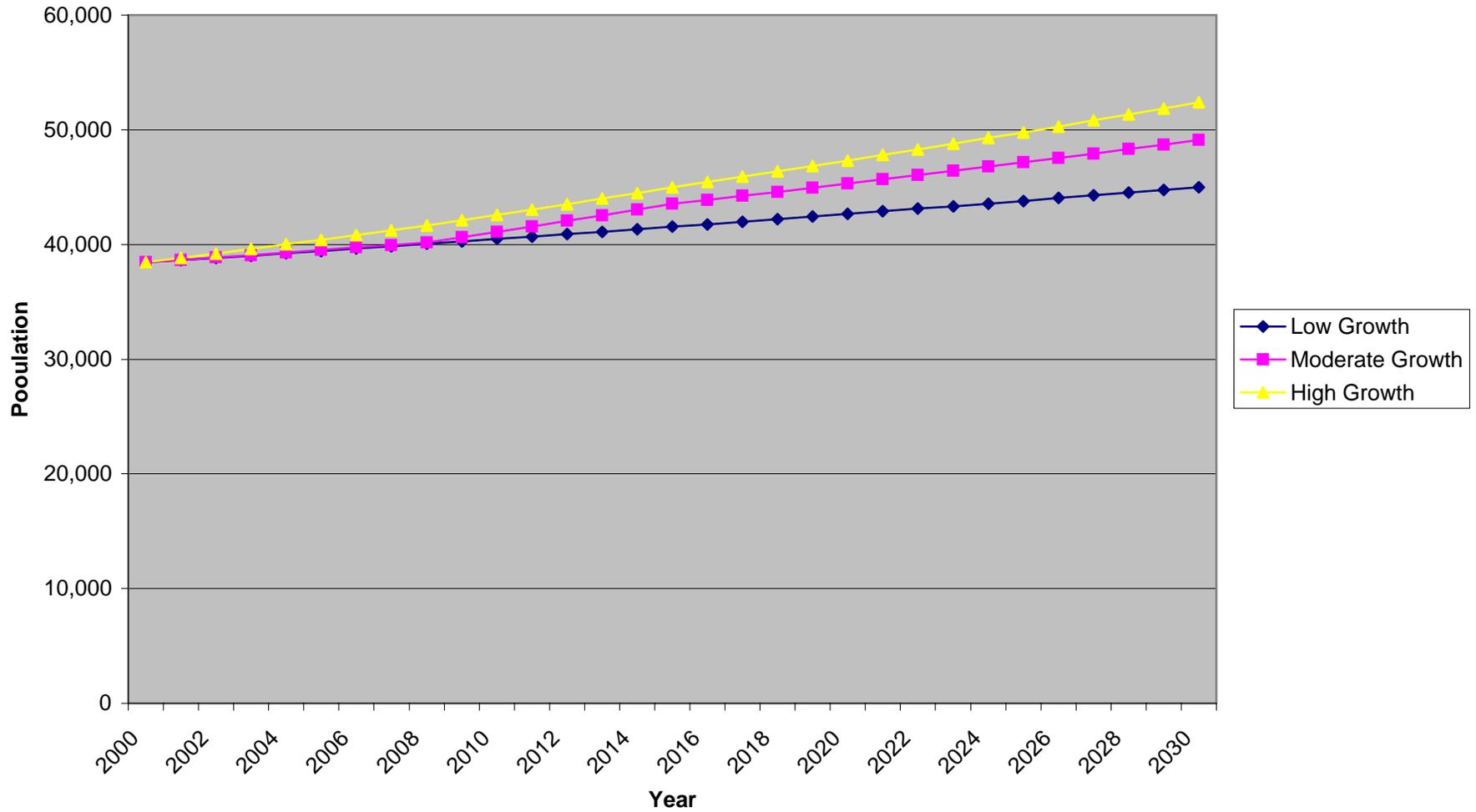
Results

The three methods described above were used to generate population forecasts through the year 2030 for each community and rural area in the planning area. 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 2.

Figure 2 shows that the low growth scenario projects only a modest population increase for the planning area over the next 30 years, from about 38,500 persons in the year 2000 to 45,000 persons by the year 2030. This increase is based upon WDAI projected growth rates for the area, and corresponds to an average annual growth rate of 0.53 percent. This growth rate is slightly lower than the 0.69 percent

Figure 2
Low, Moderate, and High Growth Population Projections
Powder/Tongue River Basin



average annual growth rate that occurred in the planning area from 1960 through 1990. On an absolute basis, however, the low growth scenario projects more population growth over the next 30 years than occurred during the 1960–1990 period because the population base now is larger. The low growth scenario projects a population increase of about 6,500 persons for the planning area over the next 30 years. The planning area’s actual population growth during the period from 1960 to 1990 was about 6,300 persons.

The moderate growth scenario projects that the planning area’s total population will grow to about 49,100 persons by the year 2030. That result is based upon Census Bureau projections, and represents an increase of 10,600 persons relative to the 2000 Census. The corresponding average annual growth rate is 0.82 percent, which is higher than the population growth rate of 0.69 percent annually that occurred from 1960 to 1990, but lower than the 1.25 percent annual growth rate that occurred from 1990 to 2000.

The high growth scenario results show that the planning area’s population is expected to grow to 52,400 persons by the year 2030, an increase of 13,900 persons relative to the 2000 Census. That result is based upon the assumption that the absolute population growth that occurred in the planning area between 1990 and 2000 will be repeated during each of the first three decades of this century. It corresponds to an average annual growth rate of 1.04 percent, and a total population increase of about 36 percent over the next 30 years.

Low, moderate, and high growth projections for communities and rural areas of the planning area are given in Tables 2 through 4. The results in Table 2 indicate that under low growth assumptions, some communities will continue to experience population decreases over the next 30 years, while other communities and rural areas will experience modest growth. Buffalo, Dayton, Ranchester, and Sheridan are all expected to experience growing populations under this scenario, while Kaycee, Edgerton, Midwest and Clearmont are projected to lose population. This pattern is a projected continuation of historical growth for those communities. All rural areas are projected to add population under this scenario.

Population projections for moderate growth scenario are given in Table 3. For this scenario, all communities and rural areas of the planning area are expected to experience at least some population growth over the next 30 years. On an absolute basis, the largest population gains will occur in Sheridan and rural areas of Sheridan County. On a percentage basis, Buffalo and rural areas of Johnson County are expected to grow the fastest, partly because they currently have relatively small populations compared to Sheridan and Sheridan County.

Population projections for the high growth scenario are presented in Table 4. For this scenario, like the moderate growth scenario, all communities and rural areas of the planning area are expected to experience population growth over the next three decades. The amount of growth is larger, however, than under the other two scenarios. The largest growth would occur in Sheridan, with a population increase of almost 6,000 persons over the 30-year planning horizon. Significant population increases would also occur in Buffalo and rural areas of Johnson and Sheridan Counties. Total population would increase from 38,400 in the year 2000 to 52,400 in 2030 under this scenario.

Table 2
Powder/Tongue River Basin Population Projections
Low Growth Scenario

Entity	Population		Percentage Increase
	2000	2030	
Campbell Cty	2,333	2,990	28.1%
Johnson Cty	7,075	8,899	25.8%
Buffalo	3,900	4,808	23.3%
Kaycee	249	228	-8.3%
Rural	2,926	3,863	32.0%
Natrona Cty	2,468	2,395	-3.0%
Edgerton	169	91	-46.1%
Midwest	408	278	-31.8%
Rural	1,891	2,026	7.1%
Sheridan Cty	26,560	30,711	15.6%
Clearmont	115	103	-10.5%
Dayton	678	792	16.8%
Ranchester	701	776	10.7%
Sheridan	15,804	18,631	17.9%
Rural	9,262	10,409	12.4%
TOTAL BASIN	38,436	44,994	17.1%

Table 3
Powder/Tongue River Basin Population Projections
Moderate Growth Scenario

Entity	Population		Percentage Increase
	2000	2030	
Campbell Cty	2,333	2,990	28.1%
Johnson Cty	7,075	9,282	31.2%
Buffalo	3,900	5,086	30.4%
Kaycee	249	276	10.7%
Rural	2,926	3,920	34.0%
Natrona Cty	2,468	3,020	22.4%
Edgerton	169	181	7.1%
Midwest	408	487	19.3%
Rural	1,891	2,353	24.4%
Sheridan Cty	26,560	33,804	27.3%
Clearmont	115	128	11.7%
Dayton	678	868	28.1%
Ranchester	701	800	14.1%
Sheridan	15,804	20,299	28.4%
Rural	9,262	11,708	26.4%
TOTAL BASIN	38,436	49,096	27.7%

**Table 4
Powder/Tongue River Basin Population Projections
High Growth Scenario**

Entity	Population		Percentage Increase
	2000	2030	
Campbell Cty	2,333	3,082	32.1%
Johnson Cty	7,075	10,000	41.3%
Buffalo	3,900	5,763	47.8%
Kaycee	249	313	25.8%
Rural	2,926	3,924	34.1%
Natrona Cty	2,468	3,606	46.1%
Edgerton	169	210	24.4%
Midwest	408	526	29.0%
Rural	1,891	2,870	51.8%
Sheridan Cty	26,560	35,690	34.4%
Clearmont	115	145	26.2%
Dayton	678	936	38.0%
Ranchester	701	891	27.1%
Sheridan	15,804	21,492	36.0%
Rural	9,262	12,227	32.0%
TOTAL BASIN	38,436	52,379	36.3%

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