

MEMORANDUM

TO: WYOMING WATER DEVELOPMENT COMMISSION

FROM: HARVEY ECONOMICS

DATE: MARCH 16, 2010

RE: WIND-BIGHORN RIVER BASIN WATER PLAN UPDATE
MEMORANDUM 5B – PLANNING SCENARIOS AND METHODOLOGY

Section 1 - Introduction

This memorandum provides updates and revisions to the original Wind-Bighorn River Basin (Basin) planning scenarios and forecasting methodology. In order to be consistent with other basin plans and the Wyoming Framework Water Plan (WWC, 2007), Harvey Economics (HE) developed assumptions and planning scenarios to project low, medium and high water demand for key water use sectors. This memorandum describes:

- The assumptions formulated for each planning scenario;
- Methodology used to project future activity in Basin economic sectors;
- Economic projections for each sector; and
- Population projections for the Basin.

This memorandum provides the basis for water demand projections which are presented in memorandum 5C.

The original basin plan projected water use to 2030; this update provides water demand projections to 2060. A long range planning horizon is beneficial as water infrastructure supply projects require a lengthy planning period. HE began with the original basin plan and then conducted interviews with various persons knowledgeable about the Basin, and particular industries. Secondary source data was also collected, including information on conditions outside the Basin that could impact future conditions.

Section 2 - Approach

The original basin plan reviewed existing conditions within key water use sectors and made specific supply-driven assumptions about future potential development opportunities in each sector. For example, the original basin plan projections for agriculture were based solely on the future development of specific water infrastructure projects. For this update to that plan, HE has taken a demand-driven approach utilizing a modified economic base analysis for water use sectors.

Economic base analysis focuses on activities and sectors that drive economic and demographic change. This technique is less data intensive than econometric projections, an alternative and statistically iterative modeling approach to projections. Economic base analysis is well suited to the Basin as the study team was able to focus on the three key economic sectors, agriculture, industry and tourism. Agriculture and industry, particularly mining, are also the largest water using sectors in the Basin. The study team performed research on each key sector and conducted interviews to identify trends in the Basin since the original basin plan. The projections for these economic sectors then led to development of population projections and water demand projections for the Basin.

Section 3 - Planning Scenarios

The Wind-Bighorn Basin is a sparsely populated region with three major economic sectors, agriculture, mining and tourism. At the time of the original basin plan, about 82 percent of all water use in the Basin was for agriculture.

The original basin plan provided one set of projections for major water use sectors to 2030, the extent of the original projections. This memorandum provides three planning scenarios for each sector, as described below:

Low scenario – For this scenario, HE adopted the minimal likely development, or possible contraction, in the Basin. Although this scenario will not result in any new water demand pressures in the Basin due to socioeconomic activity, it provides a supportable lower boundary for water planning purposes.

Medium scenario – Under this scenario, HE adopted the most likely set of factors that will occur in the Basin over the planning horizon. This scenario represents the most probable future economic conditions in the Basin in the opinion of the study team.

High scenario – This set of assumptions assumed the highest growth that could potentially occur in the Basin over the planning horizon. These conditions will provide an upper boundary for water planning in the Basin.

For each water use sector within the Basin, a set of assumptions was developed that would inform the low, medium and high projections. These assumptions were based

upon Basin and state specific data as well as national and international prospects for economic sectors related to Basin activities.

Section 4 - Economic Assumptions and Planning Scenarios for Key Sectors

High, medium and low planning scenarios were developed for agriculture, municipal, industrial, recreational and environmental water use sectors.

Agriculture

Agriculture is the largest water user in the Basin and future agricultural demands will be the most important factor in total Basin water demands. Recent trends for the agriculture sector in the Basin are found in Memorandum 5A. The driving variables of water use for agriculture are the number of irrigated acres and livestock inventory.

Future Conditions

Big Horn County has a stable agriculture industry that is likely to remain at about the same level of activity in the future. About 80 percent of grazing in the county is on federal lands. The county is a net exporter of alfalfa. Irrigated acres have been stable, although cropping patterns change over time. There is little in the way of development pressure in the County, and that is likely to continue in the future. It will be important for farmers and ranchers to adopt new technologies to improve efficiencies in order to remain profitable (CES, 2009a).

Fremont County saw a decrease in cattle as a result of the drought, but cattle inventory in the County is expected to return to near pre-drought levels. A best case scenario for cattle would be an increase from a current inventory of about 97,000 head to 120,000 head. The County is a net exporter of alfalfa and hay crops. Ranchers are very dependent on federal lands for grazing. There has been a small amount of conversion of irrigated lands to ranchettes, but those lands maintain their water supplies and will still be irrigated. Pressure from development could increase somewhat in the long run. Cropping patterns in the County are stable and likely to remain relatively unchanged over time (CES, 2009b).

Hot Springs County is limited in the expansion of agriculture due to the large amount of public land. Ranchers are very dependent on grazing allotments on federal lands. Most farming in the County is traditional and there has not been a move to more high intensity land use, such as cash crops or organic farming. This change might happen within the planning horizon of this update. A stable or slightly declining agriculture sector is expected for the long term (Campbell, 2009).

Park County has experienced a decline in cattle due to rising production costs and falling commodity prices. Most grazing occurs on BLM and Forest Service lands. The cost and availability of public lands grazing is a constraint for some ranchers. There has been a

trend of wealthy individuals purchasing ranches, and although the level of production usually goes down, they are not usually subdivided. Consistent with these ranch purchases, land costs have also risen in the County, exceeding the value of crop production. Sugar beet production in the County is stable and processing capacities are near or at capacity. Overall, agricultural activity in the County is expected to be stable in the future (FSA, 2009).

Washakie County cattle inventory is expected to increase over current numbers, but may not return to pre-drought levels. Ranchers heavily depend on federal lands for grazing. The County is a net exporter of hay and alfalfa. A resurgence of small feed lots in the County may reduce the amount of hay exported. Cropping patterns in the County, especially hay and alfalfa crops, are related to livestock patterns. Sugar beet production in the County has decreased somewhat in recent years, but the local processing plant should continue operation into the future. There is also an expanding seed industry in the County, producing primarily alfalfa seed, red clover and dry bean seed varieties, which may increase crop production in the County over the long run (CES, 2009c).

Overall demand, prices, and the cost of inputs are critical to determining agricultural output. Whereas forecasting each of these factors over a period of 50 years entails a great deal of uncertainty, HE determined, through research and knowledge of the Basin economy, that certain underlying forces will drive future demand, output price and input costs for agricultural activities in the Basin:

- **U.S. and International Markets.** The state of world economic markets and demand for food, in particular beef and sugar, will impact the demand for Basin agricultural products.
- **Production costs.** Fuel, fertilizer and other inputs to agricultural production are related to the volatile energy sector. The price of these inputs will influence production in the Basin.
- **Pressure from development.** This pressure could come from the conversion of agricultural land to ranchettes or other residential uses. Although ranchettes often have some level of agricultural activity, it is generally less intensive than traditional agriculture.
- **Government payments.** Government price supports provide a level of assurance to farmers and ranchers and protect them from catastrophic losses in cases of extreme weather, floods or other disasters. The Farm Bill undergoes major revisions every five to seven years. Major changes to future price supports will have an impact on production.
- **Grazing on public lands.** Many Basin ranchers depend on public lands for cattle grazing. Pressure from environmental uses and overgrazing by wildlife on public lands might impact allotments and lead Federal agencies to reduce the size or

number of grazing permits. Elk, antelope and deer compete with cattle for grasses on public lands. There is anecdotal evidence that the population of these animals is on the rise which could contribute to overgrazing on public lands (USDA NASS, 2009). Conversely, improved conditions and expanded grazing permits would allow for expansion of cattle production in the Basin.

- **Water development projects.** This water planning effort may lead to the development of one or more projects currently under consideration. If development projects go forward, it will allow for increased agriculture in the Basin.

Planning scenarios for Agriculture

These driving influences and local insights led to development of assumptions for low, medium and high planning scenarios.

These assumptions are provided in Table 1.

Table 1. Planning Scenario Assumptions for Agriculture in the Wind-Bighorn Basin

	<u>Low</u>	<u>High</u>	<u>Medium</u>
General Influences	Weak economic conditions in U.S. and international markets	Strong economic growth in U.S. and international markets	Annual variations within narrow range long-term
	Costs of production rise faster than prices	Costs of production rise slower than prices	Costs of production balanced to prices
	Increasing ranchettes reduce agricultural intensity	Number of ranchettes stabilizes	Number of ranchettes stabilizes
Cattle	Authorized AUM's on public lands diminish further	Authorized AUM's recover moderately	Authorized AUM's stabilize
	Grass and stubble remain poor	Grass and stubble improve considerably	Grass and stubble improve somewhat
Crops	Crops and agricultural industry do not come back from recent drought/downturn	Crops and agricultural industry recover to pre-drought conditions	Crops and agricultural industry stay at present levels
	Alfalfa and grass hay affected by cattle prospects	Alfalfa and grass hay affected by cattle prospects	Alfalfa and grass hay affected by cattle prospects
	Sugar demand declines, one mill closes	Sugar demand rises, more beet production, one new sugar beet mill built	Sugar beets stable, plant capacities unchanged
	Westside Irrigation District project undeveloped	Westside Irrigation District project developed	Westside Irrigation District project undeveloped

Source: Harvey Economics, 2009.

Agriculture is a key economic sector in the Basin. Employment in agriculture represents about five percent of total employment and in 2007, sales of agricultural goods in the Basin were more than \$272 million. Agriculture has a high multiplier effect, which means that expenditures in this sector have a large impact as they ripple through the local economy. The Basin has a large percentage of public lands that present a constraint to expansion of agriculture but which also provide grazing opportunities for many of the cattle in the Basin. Cattle are the predominate livestock in the Basin, accounting for about 67 percent of all animal units in the Basin.

Under the original basin plan, the future completion of potential water development projects determined the three planning scenarios, with the low scenario including no development. Projections regarding livestock and cropping patterns were not made. This update utilizes the driving forces and assumptions above to develop projections of agricultural activity in the Basin to the year 2060.

High Scenario. The high scenario for agriculture includes the most favorable, realistic conditions that the study team envisions for the sector over the planning horizon. In order for this to be realized, input prices, such as fuel and fertilizer would be favorable to commodity prices. A strong U.S. economy and growth in international markets would increase demand for beef and other agricultural products.

Under this scenario, feed stocks are plentiful and contribute to growth in cattle. Improved conditions on public lands allows for the increase in AUMs. By the end of the planning horizon in 2060, HE projects roughly 330,000 head of cattle and 57,000 head of sheep, an increase of about 35 percent.

Under these favorable conditions, sugar beet production would expand in the Basin as demand for sugar increases. Croplands would increase about 8 percent, as conversion of agricultural lands for other purposes decline. Development of the Westside Irrigation Project would allow for an additional 9,300 irrigated acres. Increased production of alfalfa and hay grasses would be driven by a strong cattle market. Total irrigated acres under the high scenario would rise from about 635,000 acres under current conditions to 685,000 acres in 2060, not including any increases on the Wind River Indian Reservation, which are addressed separately later in this memorandum. These additional irrigated acres would mostly come from acres that were previously irrigated or currently used for dry land crops. The crop mix is expected to remain about the same with conversion of some acres from other crops to sugar beet production.

Low Scenario. The low scenario includes potential negative effects that would create the lowest likely scenario in the Basin over the planning horizon in the view of the study team. Under these conditions, weak economic conditions would depress overall demand from current levels described in Memorandum 5A, especially for beef and sugar. Input prices for fuel and fertilizers would rise faster than commodity prices, putting pressure on profitability.

Poor conditions on public lands would result in decreased grazing allotments putting additional pressure on cattle production. In addition, development pressure from conversion of agricultural lands to ranchettes and for other development would reduce agriculture's intensity or take land out of production. Exclusive of general economic conditions, the proliferation of ranchettes in the Basin will result from wealthy people choosing to establish a residence here as compared with other locations. Much of this conversion would likely occur in Park County. Sheep inventories would fall about 45 percent, continuing the current trend due to falling prices for wool and fears of animal loss from predators. Under the low scenario, cattle inventories would fall from 245,000 under current conditions to 210,600 in 2060. The Westside Irrigation Project would not be developed. Irrigated acres would decline about 10 percent from 635,000 under current conditions to 570,000 in 2060. This 11 percent decline in irrigated acres would occur as the full gamut of negative economic and agricultural conditions indicated in Table 1 befalls Basin farmers and ranchers, causing them to retire or sell land for other purposes.

Mid Scenario. This represents the most likely set of circumstance that will occur in the Basin over the planning horizon. Under these conditions, agriculture will see little change in current conditions. In interviews with knowledgeable, local officials, most stated that future conditions would remain relatively unchanged from current conditions described in Memorandum 5A.

Under this scenario, economic conditions would vary within a narrow range. Inputs, such as fuel costs and fertilizers, would be balanced to commodity prices. Grazing on federal lands would stabilize, with little change from current allotments. Alfalfa and hay cropping would remain steady along with cattle productions. Sugar beet production would also remain at, or near, current levels. The Westside Irrigation Project would not be developed under this scenario. The 2007 Draft EIS found the Project was not financially viable under current financing and cropping conditions (BLM, 2007).

Although there will certainly be some shifts in cropping and some variations in cattle and sheep inventory, overall the situation will be static. Projections for irrigated acres and livestock, by scenario are presented in Table 2.

Table 2. Current and Projected 2060 Cattle, Sheep and Irrigated Acres by Crop Type, Wind-Bighorn Basin, By Scenario

Crops (Acres)	Current	Projections/2060		
		Low	Mid	High
Alfalfa	220,000	197,000	220,000	237,000
Beans	53,487	48,000	53,000	49,000
Corn	46,132	41,000	46,000	42,000
Grass Hay	202,918	182,000	203,000	219,000
Spring Grains	72,342	65,000	72,000	78,000
Sugar Beets	40,220	36,000	40,000	59,000
Total Crop Acreage	635,000	570,000	635,000	685,000
Livestock Head				
Cattle	245,000	210,600	269,000	330,000
Sheep	42,000	23,000	46,000	57,000
Total Livestock	287,000	233,600	315,000	387,000

Source: MWH, "Task 3 – Agricultural Water Use Technical Memorandum, November 16, 2009 and Harvey Economics, 2009.

Farm employment is expected to change in relationship to irrigated acres. That is, under the high scenario, employment would increase about eight percent over current levels, remain about the same under the mid scenario, and decrease about 11 percent under the low scenario.

Industrial Sector

Various mining activities account for about 99 percent of all industrial water use in the Basin and the bulk of this is attributable to petroleum industry by-product. In 2009, oil and gas production occurred in all of the Basin counties. Much of the existing oil and gas production in the Basin is from wells that are old, and production from them is declining. Fremont County dominates natural gas production in the Basin. There is one operational coal mine in Hot Springs County. Other minerals produced in the Basin include bentonite and gypsum. Although resources exist, uranium is not currently mined in the Basin.

Driving forces that will impact future mining and other industrial activity in the Basin include:

- **U.S. and International Demand.** Continued population growth and demand from developing nations will impact worldwide energy demands and prices.

- **Advances in Technology.** Further, technological advances, if they occur, will impact mining in a variety of ways. Potential innovations include improved recovery techniques and advances in renewable energy and alternative fuels.
- **Environmental Concerns.** Pressure from environmental concerns regarding future development will compete with the need for energy security for the nation.
- **Nuclear Energy.** A revival of nuclear energy production in the U.S. would likely impact uranium prospects in the Basin.
- **Demand for Sugar.** Sugar beet processing in the Basin will be impacted by changes in the demand for sugar.
- **Construction.** The state of the construction industry will impact gypsum mining and wallboard production, as well as Basin gravel mining.
- **Demand for Bentonite.** Bentonite use is closely tied to the petroleum industry, although it has a wide variety of uses.
- **Power Generation.** Population growth and transmission capacity will in part determine the prospects for new generation in the Basin.

Future Conditions

In 2008, total oil production in the Wind-Bighorn Basin was about 17.1 million barrels. New wells are expected to be drilled during the planning horizon, however they will likely be smaller, more expensive and more difficult to access. Future production is expected to decline as existing wells play out, even with the new production. If carbon dioxide flood technology becomes feasible, oil production will decline, but at a slower rate (BLM, 2009d).

In 2008, natural gas production in the Wind-Bighorn Basin was 172 billion MCF (thousand cubic feet). Almost all of this production occurred in Fremont County, in the Wind River Sub-Basin. Future production in the Wind River Sub-Basin is projected to grow during the planning horizon. Shale gas production in the later years of the planning horizon is remotely possible, and would increase total production (BLM, 2009b).

The Big Horn Sub-Basin will likely see a decline in gas production over the planning horizon. Significant new discoveries in the Basin would cause the decline to occur more slowly. There is potential for coalbed natural gas in the Big Horn Basin that might be exploited in the last half of the planning period (BLM, 2009b).

As of 2009, only one coal mine was active in the Wind-Bighorn Basin. Although coal resources are located in the area, much larger and more economically advantageous reserves are available in other parts of the state. Increased future production would require economic viability of large underground mines.

Uranium is present in the Wind-Bighorn Basin, but as of 2009 there was no market for it. A re-emergence of the nuclear power industry in the U.S. would likely result in a resumption of Basin uranium development.

Miscellaneous minerals and industry are likely to play a minor future role. Bentonite and gypsum production are expected to stay at current levels or to increase modestly (BLM, 2009a). The most favorable potential biofuel production in the Basin is ethanol from cellulosic biomass from forest and primary mill residues (USDOE, 2009).

Beyond these influences, global issues might affect Basin mineral industry development prospects. If climate change concerns translate into tangible action, coal prospects will further diminish, natural gas and bentonite development might accelerate somewhat, and uranium development might be encouraged. Other environmental issues might also grow in importance to change these prospects. Mineral development prospects will continue to be subject to high levels of uncertainty.

Planning scenario assumptions related to mining and industrial sectors and arising from the driving influences and local insights are set forth in Table 3.

Table 3. Planning Scenario Assumptions for Industry in the Wind-Bighorn Basin

	<u>Low</u>	<u>High</u>	<u>Medium</u>
Petroleum	Slight net increase in natural gas production	New technologies generate increasing production after 2030	Declines in Big Horn Basin more than offset increases in Wind Basin
Bentonite	Stable to declining	20% increase in output	Slight increase
Coal	Small operation closes	Two relatively small mines operate <300,000 tons/year	One operation continues, expands slightly
Uranium	No resumption	Three new operations; industry reborn	One operation with moderate output
Power Plants	No new plants	One steam powerplant	No new plants
Beet Processing	Slight decline in acres/processing	Increased acreage/one new processing facility	Steady output/processing
Ethanol/Other	No ethanol/biofuel production	One production facility for ethanol from cellulosic biomass (forest and primary mill residues)	No ethanol/biofuel production

Source: Harvey Economics, 2009.

The original basin plan projected that industrial water use in the Basin would grow only as a result of additional power generating facilities. The low scenario assumed no growth in industrial water use, the mid scenario included one 200 MW coal-fired steam turbine facility and the high scenario envisioned an additional 500 MW gas-fired combination turbine facility. The high scenario projected total industrial water use of 115,000 acre-feet of industrial water use by 2030.

In this basin plan update, it is assumed that for each scenario a number of factors will come into play to determine total industrial water use in the Basin.

High Scenario. Under the high scenario, the most favorable conditions for mining and industry that are reasonable for the Basin over the planning horizon are assumed. This scenario assumes high demand for fossil fuels will continue. Increased production of natural gas will occur due to application of new technologies. In the Bighorn Basin, this increased production could be from shale gas. Mowry Shale, a shale formation located in the Basin, has been identified as a potential resource. In the Wind River Basin, new technology could make coal gasification economically feasible (BLMa, BLMb). The high scenario also assumes that two small coal mines in the Basin will produce less than 300,000 tons of coal annually.

Increased demand for bentonite for mining and other uses is likely under this scenario. The increase in sugar beet production under the high agriculture scenario would require an additional processing facility. The U.S. Department of Energy Alternative Fuels and Advanced Data Center have identified potential for ethanol production from cellulosic biomass in the Basin. Under the high scenario, one production facility using forest and primary mill residues would be in operation (USDOE, 2009).

The market for uranium in the U.S. fell sharply as concerns developed regarding the safety of nuclear power plants. Wyoming is second only to New Mexico in uranium reserves, some of which are in the Basin. If construction of new nuclear power facilities in the U.S. resumes, uranium mining would likely resume in the Basin. Under the high scenario, it is assumed that three uranium mines are in operation. In addition, it is assumed that one steam generated power plant will be constructed.

Low Scenario. This scenario assumes that there will be modest growth in gas production over the long term, accounting for a modest increase in water demand. Oil production in the Basin is projected to fall to about 4,000,000 barrels per year by 2060. Gas production is expected to rise to about 425,000,000 MCF, primarily in the Wind River Basin. The market for bentonite is projected to be stable or possibly decline modestly. It is also assumed that there will be no resumption of nuclear power plant construction in the U.S. and as a result there will be no uranium mining in the Basin.

The large amount of coal reserves in other parts of Wyoming make them better candidates for power generating facilities. No additional transmission capabilities would be available in the Basin under the low scenario. Thus, no power generating facilities in the Basin are envisioned. No ethanol or biofuel production facilities are constructed

under these circumstances. As in the low agriculture scenario, there is a decline in sugar beet production, reducing beet processing somewhat.

Mid Scenario. The middle scenario represents the most likely set of circumstances in the Basin in the view of the study team. In this setting, natural gas production will rise to about 650,000,000 MCF, with the bulk of the production taking place in the Wind River Basin. Oil production would fall to about 11 million barrels per year by 2060. Overall industry increases from increased natural gas production will contribute to an increase in bentonite production. Improved technologies in coal mining would allow for one operation with minimal output to continue.

As in the low scenario, no new power generating facilities would be constructed, since locations in other parts of the state offer proximity to coal and transmission infrastructure. As in the mid agriculture scenario, sugar beet production and processing would remain stable over the long term.

Current industrial production and projections by scenario for 2060 are provided in Table 4.

Table 4. Current and Projected 2060 Industrial Production, Wind-Bighorn Basin, By Scenario

Annual Production	Current	Low	Medium	High
Oil (barrels)	17,808,000	4,000,000	10,975,000	13,170,000
Natural Gas (MCF)	194,988,183	425,600,000	659,680,000	791,616,000
Bentonite (tons)	1,500,000	1,500,000	1,600,000	1,800,000
Coal (tons)	1,100	—	2,000	300,000
Beet Processing (tons)	620,000	600,000	800,000	1,200,000
Ethanol	—	—	—	one facility
Fossil Fuel Power Generation	—	—	—	one facility

* Sugarbeet yields are variable. 2006 production was more than 700,000 tons.
Source: NASS, WYOGCC, Yearbook, HE

Employment from industrial growth over the long term is uncertain. Although there will certainly be additions to employment under the medium and high scenarios, advances in technology tend to reduce employment. Therefore it is expected that employment under the medium and high scenarios will not be in direct proportion to production.

Tourism and Recreation Sectors

Tourism is an important economic sector in the Basin, with \$497 million visitor spending in 2008. However, employment in tourism and related occupations tend to be low-paying, seasonal and do not spur sustained, year-round economic development (EADIVb).

The Wyoming Office of Travel and Tourism has adopted an advertising campaign to increase awareness of the State as a destination. Recent efforts have focused on nearby markets such as Denver and Salt Lake City (SMRa, 2009).

Driving forces that will impact future tourism and recreation in the Basin include:

- **U.S. Economic Conditions.** Economic conditions impact vacation and recreational spending.
- **Fuel Cost.** Because the Basin is somewhat remote, high fuel costs would likely have a negative impact on Basin tourism. Almost 80 percent of Wyoming visitors travel by automobile (SMRb, 2008).
- **Population Growth.** Population growth, particularly in neighboring states, would have a positive impact on Basin tourism and recreation.
- **Perception of Wyoming.** Awareness of Wyoming as a vacation destination will improve Basin tourism.
- **Trends in Tourism.** The Basin is primarily attractive to those interested in outdoor activities, such as hiking, climbing, hunting, fishing, rafting and wildlife viewing. If outdoor, active vacations and activities become more popular, this would increase recreation in the Basin.

The Basin offers a wide variety of recreational opportunities, many of which include water based activities. Tourism has increased in recent years, though at a modest rate. Major constraints to increased recreation in the area are a lack of easy access and competition from other recreation and tourist areas in the region.

The National Outdoor Leadership School (NOLS) is located in Fremont County. About 1,000 visitors come to the school for training each year. Increased attendance at NOLS may contribute to awareness of the Basin to those who are particularly interested in the type of activities that occur there (NOLS, 2009).

Although an old ski resort is being reopened in 2009, world class skiing is available in nearby Teton County and in Utah and Colorado. This resort will likely capture those already living in the area. Additional golf courses are also unlikely without meaningful population growth.

Immigration trends might also impact Basin tourism. There is evidence that Hispanic and Asian immigrants prefer city vacation experiences over national parks (EADIVb, 2007). If immigrants make up the bulk of regional population growth, wilderness outdoor recreation will not increase much.

Many opportunities for boating and fishing are available in the Basin, but they are probably under-utilized as of 2009 (Gritten, 2009). If neighboring states or other regions of Wyoming experience overcrowding at reservoirs or fishing locations, the Basin might benefit if boaters and anglers seek less crowded facilities. However, this growth can occur in the Basin without the need for additional recreation related water resource development.

Planning scenario assumptions for tourism and recreation based on the above driving influences are identified in Table 5.

Table 5. Planning Scenario Assumptions for Tourism and Recreation in the Wind-Bighorn Basin

	<u>Low</u>	<u>High</u>	<u>Medium</u>
U.S. Economic Conditions	1.5% growth per year	3% growth per year	2% growth per year
Fuel Costs	Fuel costs high relative to income	Fuel costs low relative to income	Fuel costs stable relative to income
Population Growth	Slow growth	High growth	Moderate growth
Perception of Wyoming	Little improvement in awareness of Wyoming as a vacation destination	Wyoming enjoys increased awareness and perception as a tourist destination	Moderate improvement in awareness of Wyoming as a vacation destination
Trends in Tourism	Increased immigration dampens growth in outdoor experience tourism	Consumer preference for outdoor/active vacations and recreation increases substantially	Consumer preference for outdoor/active vacations and recreation increases moderately

Source: Harvey Economics, 2009.

Water for tourism comes from municipal water systems and will be included in the municipal and domestic water use projections. Therefore, projections for tourism are not quantified. Water for recreation already exists in the streams and lakes in the region, plus through municipal systems for golf courses or as separate divisions for snow-making, for example. Based on HE's evaluations, recreation and tourism prospects over the forecasting horizon will not change recreation-related requirements.

Environmental water uses include wetlands and instream flows, which, like recreation, and boating, rafting, fishing and other related activities are non-consumptive. Future environmental water use is discussed in Memorandum 5C.

Section 6 - Wind River Indian Reservation (WRIR) Development Scenarios

Located within the Wind-Bighorn River Basin, the WRIR is a reservation encompassing two Indian Tribes, the Northern Arapaho and the Eastern Shoshone. Although there are several small communities and commercial activities on the reservation, almost all the economic activity and water use is related to agriculture. Through a host of court cases spanning many years, the WRIR was awarded certain reserved water rights in a process referred to as the Big Horn Adjudication (BHA). At the conclusion of this process, the courts determined that the WRIR was entitled to divert 499,862 acre-feet per year with a July 3, 1868 priority date, and those waters would be utilized to irrigate 108,000 acres of land within the reservation or utilized for "subsumed" uses. Besides irrigated agriculture, these waters could be used to meet legally compliant, subsumed purposes, such as municipal, commercial and light industrial water uses, presumably to support the agricultural economy. In addition, the courts also granted the WRIR 79,796 acre-feet per year of additional water rights, known as the Walton Awards, for existing water diversions on Indian fee land (Indian or non-Indian privately held lands that were originally allotted to individual Indians) within the Reservation. See Technical Memorandum 3H – Water Law and Water Administration for more information on the BHA.

Since only about 290,500 acre-feet of these water rights have been historically diverted on the reservation, the permitted water rights from the BHA represent a large potential diversion and future water use.¹ HE evaluated the potential for development of these water rights over the forecasting horizon in the context of low, high and medium scenarios, consistent with the Wind-Bighorn Basin Plan. In establishing future scenarios for WRIR development, HE reviewed aspects of the decree and Draft Wind River Water Plan, dated 2007. We also interviewed Sheridan Nicholas, the Wind River Irrigation Project Manager, Baptiste Weed, the Tribal Water Engineer, and attended a presentation by Ms. Catherine Vandemoer, entitled, "Our Water, Our Future", given in Lander on June 18, 2009.

¹ Nancy McCann, Wyoming State Engineers Office, November 9, 2009.

The potential for additional agricultural development on WRIR lands was evaluated as part of the BHA. Future practicably irrigable agricultural lands, referred to as “Futures” lands, consist of five properties: north Crowheart, south Crowheart, Arapahoe, Riverton East, and Big Horn Flats. The courts decreed a total of 53,760 acres in the Futures awards, as indicated in MWH, “Task 3 – Agricultural Water Use Technical Memorandum, November 16, 2009.” Separately, the tribes compiled their own set of non-agricultural water development prospects, as described in the draft Wind River Water Plan of 2007, although water for such development would come out of the total Futures awards.. This plan identified such activities as a bottled water plant, a rangeland water system, small-scale hydrogeneration, off-stream storage for recreation and other purposes, light industrial uses, cultural water uses, and community parks and gardens. The non-agricultural water development challenges facing the WRIR were clearly stated in the Draft Wind River Water Plan, described as an aspirational document.²

The agricultural and non-agricultural water development opportunities will require capital investment, operating monies, plus management and ongoing operational skills. Hence, on Indian lands as well as non-Indian lands, the demand for the products of the water’s beneficial use, the prices which can be gained for that output, and the financial and operational feasibility are paramount considerations in determining whether or not any development at all will take place. Notwithstanding private monies, public funds have not been forthcoming in sufficient amounts to move agricultural or non-agricultural developments forward on the WRIR, even in 2009 when major investments in infrastructure were underway throughout the U.S. After careful consideration of the foregoing information, HE devised three water development scenarios for the WRIR:

- Low scenario – “*Improving the Status Quo*”. The Wind River Irrigation Project is a priority for the WRIR. It is an existing irrigation project, which is not fully funded from an operational and maintenance standpoint. This project began in the 1920’s and includes 60,000 potentially irrigated acreages, with 37,000 acres actually developed.³ Under the low scenario, it is assumed that the two tribes will bring this BIA project up to economic sustainability. This will include the completion of rehabilitation work on Ray Lake and improving existing irrigation systems.
- High scenario – “*Futures Lands Fully Developed for Irrigation*”. Under this scenario, agricultural prospects are bright (see high scenario assumptions for agriculture). Demand, prices and costs justify investment and development of the full complement of Futures lands, amounting to 53,760 acres. A portion of the water rights granted under the Big Horn Adjudication would also be dedicated to subsumed and legally compliant uses indicated in the Tribal Water Plan.

² Catherine Vandemoer, July 2009.

³ Sheridan Nicholas, Project Manager, Wind River Irrigation Project, November 4, 2009.

- Middle scenario – “*Low Scenario Plus One Major New Development*”. Of the five separate agricultural Futures properties, Riverton East is perhaps the most likely to be developed. It is located near existing canals and close to the town of Riverton. It will require less money for development, and it has been studied more closely than development compared with the other Futures properties. It is assumed that, under the middle scenario, this property will be developed, amounting to an additional 3,814 irrigated acres. In addition, Washakie Lake will be expanded.

The large range in development prospects on the WRIR reflect the considerable uncertainty associated with the development of their water rights. Although water development opportunities are large, constraints to development are equally considerable, even over a 50 year time horizon.

Section 7 - Population Projections

Existing projections. HE reviewed the projections in the original basin plan and sought to identify any demographic projections that have been made since that time. Although the study team was unable to locate projections specific to the Basin for the planning horizon, two sources of moderate-term projections were found:

- ❖ U. S. Census Bureau – The *Interim Population Projections for States* project population for the State of Wyoming to 2030, by total population and by age cohort. The projections were developed using the cohort-component method, which projects births, deaths, internal migration, and international migration, based on recent trends.
- ❖ State of Wyoming – the Wyoming Department of Administration and Information, Economic Analysis Division (EADIV) prepared population projections by county, starting with Census Bureau estimates to 2007, and then developed projections to 2030 based on trends of demographic and economic variables.

Local planners within the Basin rely on the EADIV for projections, and do not produce their own local projections. The EADIV prepared a 10-year economic and demographic forecast, 2007 to 2016, and employment projections by occupation for the region. However, these projections are short term and were not suited to a long-term planning horizon. The Census Bureau projections and the EADIV projections were utilized in the population projections described below.

In the original basin plan, three population growth scenarios were presented to 2030. The projected 2030 population under the low, medium and high scenarios were 90,403, 94,600 and 114,407, respectively. This memorandum will update those projections based on recent trends and will provide low, medium and high population scenarios and projections to 2060.

Historical Wind-Bighorn Basin Population Trends. The population of the Basin grew at an average annual rate of about 0.5 percent per year between 1960 and 2008. Historical population figures for the five Basin counties since 1960 are shown in Table 6.

Table 6. Wind-Bighorn Basin Population, by County, 1960 through 2008

	1960	1970	1980	1990	2000	2008
Big Horn	11,898	10,202	11,896	10,525	11,461	11,322
Fremont	26,168	28,352	38,992	33,662	35,804	38,113
Hot Springs	6,365	4,952	5,710	4,809	4,882	4,622
Park	16,874	17,752	21,639	23,178	25,786	27,574
Washakie	8,883	7,569	9,496	8,388	8,289	7,821
Basin Total	70,188	68,827	87,733	80,562	86,222	89,452

Note: 2008 population is estimated

Source: U.S. Census Bureau and Wyoming Department of Administration and Information, Economic Analysis Division.

Although the overall population of the Basin has grown since 1960, Big Horn, Hot Springs and Washakie counties have lost population. This was also true between 2000 and 2008. Declines were greatest in Hot Springs County, which lost an average 0.7 percent of its population each year from 1960 to 2008.

Growth, or decline, in municipal and domestic population and resulting water use in the Basin will be influenced by the economic sectors discussed above. Populations will tend to grow as major economic sectors grow. In addition to direct employment in these sectors, the multiplier effect of these jobs will induce additional employment and economic expansion with the Basin.

There is evidence that the area is also likely to attract some level of retirees from outside the Basin. Most retirees will not come for jobs, but their presence in the Basin will also have a modest multiplier effect as they spend money in the local economy. For some Basin counties, this impact will be muted as there are limited opportunities to purchase goods locally and consumers travel outside of the county to shop. For example, some Basin consumers travel to Sheridan or Billings, Montana, especially for large purchases (Frederick, 2009).

As discussed in Memorandum 5A, the Basin population is older than that of the state and the median age is rising. These projections are made by age cohort and show the impact of an aging population. In 2000, the Wyoming population had an old age dependency ratio of 19.8; the 2030 ratio is projected to be 50.7.⁴ Over the same period, the youth dependency ratio is projected to fall from 50.0 to 40.6.⁵ This trend will tend to

⁴ Old age dependency ratio = Age 65 and over/Age 20-64 x 100.

⁵ Youth dependency ratio = Age under 20/Age 20-64 x 100.

limit natural population growth within the Basin. In-migration will be key to Basin population growth.

High Scenario. The high scenario for population growth represents the most favorable conditions for economic and population growth over the planning horizon that can reasonably be expected. Under these conditions, growth will occur in all key Basin economic sectors. In addition, growth will occur from retirees relocating to the area. As the job picture in the Basin improves, it is expected that in-migration will occur and that the pattern of migration will likely attract a younger population. This will drive increases in natural population growth over the long run.

As discussed in the medium scenario, quality of life priorities and technological advances may increase telecommuting enabling more people to choose the rural lifestyle available in the Basin.

To forecast population under the high scenario, HE assumed that all Basin counties would experience an increased rate of growth, but that growth would be strongest in Fremont and Park counties. Population projections under the high scenario are provided in Table 7.

Table 7. High Scenario Population Projections for Wind-Bighorn Basin Counties, 2020 to 2060

	Big Horn	Fremont	Hot Springs	Park	Washakie	Total
2020	12,010	42,170	4,850	30,400	8,300	97,730
2030	12,620	46,120	5,100	33,250	8,720	105,810
2040	13,270	50,440	5,360	36,360	9,170	114,600
2050	13,950	55,170	5,630	39,770	9,640	124,160
2060	14,660	60,340	5,920	43,500	10,130	134,550

Source: Harvey Economics, 2009.

Under these conditions, the population would increase by about 46,000, or 0.8 percent per year for the Basin as a whole over the planning horizon.

Low Scenario. Under the low scenario, economic conditions for each of the key sectors are as described above, resulting in slow growth across the Basin. The U.S. Census Bureau (Census, 2009) projections for the State of Wyoming through 2030 project very slow growth in the state. These projections were developed using a cohort-component method, which applies the components of population change, births, deaths, internal international migration, to each birth cohort (persons born in a given year). These projections assume that past trends will continue into the future.

The Census projections for Wyoming project about a 6 percent increase, or about 0.2 percent annually, in the Wyoming population from 2000 to 2030. These projections exhibit a slower trend in growth than has been seen in recent years, across the Basin as a whole. However, under the low economic scenarios describe above in combination with an aging population and limited in-migration, HE believes that these projections represent a defensible low population scenario for the Basin.

The growth rate for the State of Wyoming was applied to the Basin as a whole, allocated to the counties and extrapolated out to 2060. Low scenario population projections for Basin counties are provided in Table 8.

Table 8. Low Scenario Population Projections for Wind-Bighorn Basin Counties, 2020 to 2060

	Big Horn	Fremont	Hot Springs	Park	Washakie	Total
2020	11,140	39,740	4,410	28,010	7,640	90,940
2030	11,250	40,910	4,270	28,830	7,430	92,690
2040	11,210	42,360	4,140	29,540	7,240	94,490
2050	11,160	43,850	4,010	30,240	7,050	96,310
2060	11,110	45,360	3,880	30,950	6,870	98,170

Source: U. S. Census Bureau – *The Interim Population Projections for States*, Harvey Economics, 2009.

These projections result in a total change in population from 2008 to 2060 of about 9,300 persons.

Medium Scenario. This scenario of population growth in the Basin is the most likely in the view of HE. Modest growth in economic sectors will spur in-migration. The more positive economic outlook of the region will attract retirees. As technology improves, more jobs will become “portable” as workers are able to work from home. The technology infrastructure in the Basin is good and those seeking a rural lifestyle may choose to relocate to the Basin

The EADIV produced population projections for Wyoming counties to the year 2030. These projections incorporate the cohort-component method, time-series trend analysis and employment projections. Under the EADIV projections, the population of the Basin would increase by almost 10,000 by the year 2030, or at an average annual rate of 0.4 percent. These projections are specific to the Basin and utilize standard projection methodology, making them well suited for this planning effort.

HE adopted the EADIV projections to 2030, and then extrapolated them out to 2060, using the same rate of growth as projected for the 2007 to 2030 time period.

Medium scenario projections are provided in Table 9.

Table 9. Medium Scenario Population Projections for Wind-Bighorn Basin Counties, 2020 to 2060

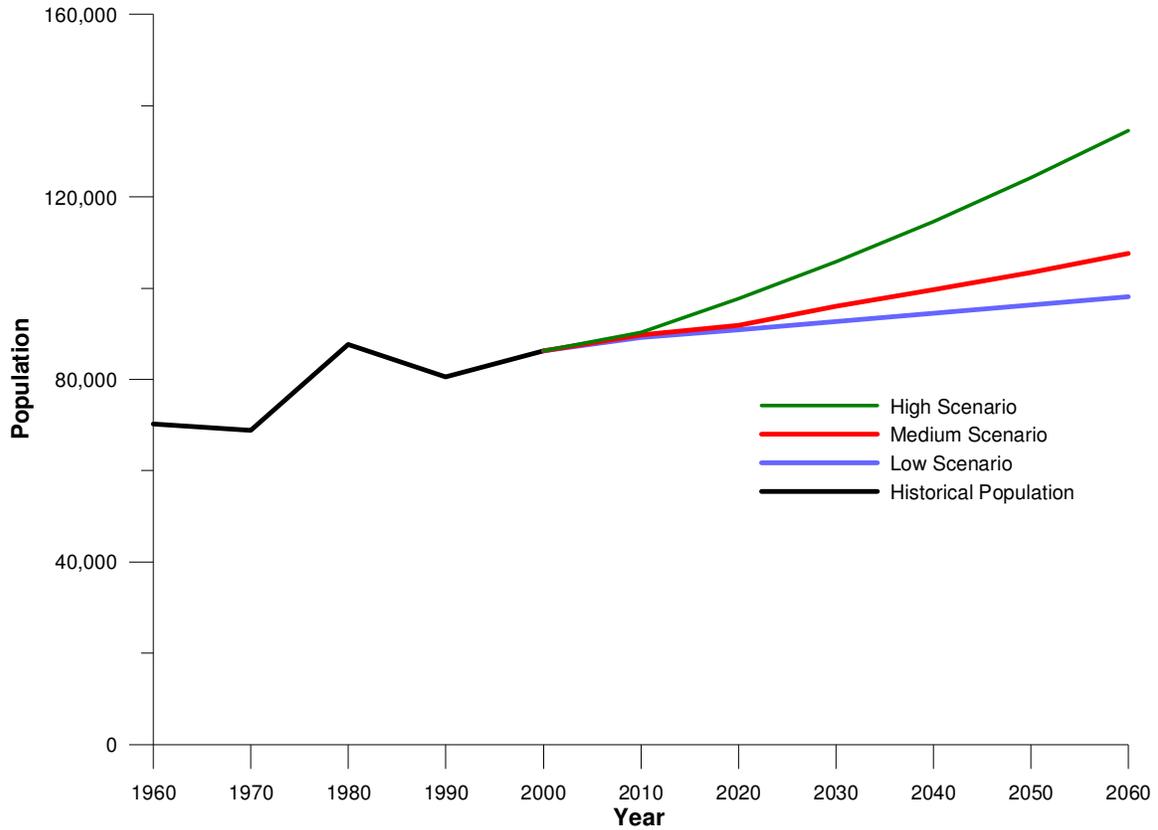
	Big Horn	Fremont	Hot Springs	Park	Washakie	Total
2020	11,240	40,110	4,450	28,270	7,710	91,800
2030	11,650	42,370	4,420	29,860	7,690	96,000
2040	11,820	44,690	4,360	31,160	7,640	99,700
2050	12,000	47,140	4,310	32,520	7,580	103,500
2060	12,170	49,720	4,250	33,930	7,530	107,600

Source: EADIVa and Harvey Economics, 2009.

Under these conditions, the population of the Basin would increase by about 19,000 by 2060, about double the increase projected under the low scenario, or about 0.4 percent per year on average.

Historical population and projected population under low, medium and high scenarios are provided in Figure 1.

Figure 1. Historical and Projected Population for the Wind-Bighorn Basin, by Scenario, 1960 to 2060



Source: Harvey Economics, 2009.

Section 8 - Summary

HE projected three future scenarios for agriculture, industry, tourism and the WRIR, the major economic sectors or areas for potential water use in the Basin. These planning scenarios were based on driving influences for each sector. The driving influences were developed by HE, based on interviews with local sources and on secondary data sources. HE also projected Basin population under three scenarios. This research led to high, medium and low planning scenarios, as summarized below.

Table 10. Summary Scenario Projections for Wind-Bighorn Water Use Sectors, 2060

	Current	Projections/2060		
		Low	Medium	High
Agriculture				
Total Crop Acreage	635,000	570,000	635,000	685,000
Total Livestock	287,000	233,600	315,000	387,000
Industry				
Oil (barrels)	17,808,000	4,000,000	10,975,000	13,170,000
Natural Gas (MCF)	194,988,183	425,600,000	659,680,000	791,616,000
Bentonite (tons)	1,500,000	1,500,000	1,600,000	1,800,000
Coal (tons)	1,100	—	2,000	300,000
Beet Processing (tons)	620,000	600,000	800,000	1,200,000
WRIR				
Change in Irrigated Acreage	N.A.	0	3,814	53,760
Population				
Basin Total	88,910	98,170	107,600	134,550

Source: Harvey Economics, 2009.

In the original basin plan, irrigated acres for agriculture were projected to remain unchanged from about 600,000 acres under the low scenario. The medium scenario was based on development of the Riverton East, Westside and North Crowheart Projects for an additional 69,000 irrigated acres. The high scenario projected that the mid scenario projects would be completed along with five additional projects for a total of 209,000 additional irrigated acres, or a total of more than 800,000 acres. Livestock projections were not made.

Industrial projections included a low scenario with no additional water use, a medium scenario with development of one coal fired steam turbine power generation facility. The high scenario added to the mid scenario with a second power generation facility.

Population in the Basin was projected to be unchanged at about 86,000 in 2030 under the low scenario. The medium projections called for a population of 94,600 in 2030. Under the high scenario, the 2030 population was projected to be 114,407.

The updated projections developed for this memorandum led to Basin water demand projections which are presented in Memorandum 5C.

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