IV. Drought

Drought is one of Wyoming's most costly natural weather-related disasters. It indirectly kills more people and animals than the combined effects of hurricanes, floods, tornadoes, blizzards, and wildfires. Unlike other disasters that quickly come and go, drought's long-term effects have been responsible for mass migrations and lost civilizations. The 1980 and 1988 droughts in the US resulted in approximately 17,500 heat-related deaths and an economic cost of over $100 billion. Drought occurs in four stages and is defined as a function of its magnitude (dryness), duration, and regional extent. Severity, the most commonly used term for measuring drought, is a combination of magnitude and duration.

The first stage of drought is known as a meteorological drought. The conditions at this stage include any precipitation shortfall of 75% of normal for three months or longer. This criterion can be misleading as these so-called seasonal droughts are normal in Wyoming's semiarid climate. The second stage is known as agricultural drought. Soil moisture is deficient to the point where plants are stressed and biomass (yield) is reduced. The third stage is the hydrological drought. Reduced stream flow (inflow) to reservoirs and lakes is the most obvious sign that a serious drought is in progress. The fourth stage is the socioeconomic drought. This stage occurs when physical water shortages begin to affect people and the economy.

As these stages evolve and worsen over time, the impacts to the economy, society, and environment can converge into an emergency situation. Without reservoir water to irrigate farms, food supplies are in jeopardy. Without spring rains for the prairie grasslands, open range grazing is compromised. Without groundwater for municipalities, the hardships to communities result in increases in mental and physical stress as well as conflicts over the use of whatever limited water is available. Without water, wetlands disappear. The quality of any remaining water decreases due to its higher salinity concentration. There is also an increased risk of fires, and air quality degrades as a result of increased soil erosion in strong winds (blowing dust).

Drought conditions can vary considerable from region to region and location to location within Wyoming. There are multiple factors impacting moisture levels throughout the state, two of which are Wyoming's widely-varied topography and the size of the state. Wyoming lays claim to terrain consisting of mountains, rolling hills, and plains. Moisture content varies significantly across the state due to the interaction of Wyoming's terrain with variable weather systems. Weather systems containing rain and snow tend to interact significantly with Wyoming's terrain, and this of course results in varied moisture from one side of the state to the other. Drought does seem to be cyclical in nature throughout Wyoming's history, though it can be expected to vary region to region within each drought cycle. Drought is addressed in an overall, state-level perspective throughout this chapter, rather than through the lens of a regional perspective. This is partially due to the lack of availability of county-level drought data.

History

Widespread droughts in Wyoming, as determined from stream flow records, were most notable during three periods: 1929-1942, 1948-1962, and 1976-1982. The 1999-2004 drought is considered by many to be the most severe in recent history. Some longtime residents indicated that they remember streams drying up in the 1930s and 1950s. According to instrument records, there have been only seven multi-year (three years or longer) statewide droughts since 1895 (see Table 4.1), although single wet years such as 1957 (and probably 2005) have broken longer periods of drought (1952-1964 and 1999-present) into two separate events by this definition, making quantification of impacts difficult. Table 4.1 ranks the droughts based on statewide average annual precipitation during drought periods.

The state has endured drought in varying degrees since a drought that started in 1999, intensified in the spring of 2000, and endured through 2004. According to Figure 4.2, annual precipitation levels increased in 2004, technically signifying the end of the drought period. Dry conditions returned in 2005, improved somewhat in 2006, and then became especially severe in 2007. Drought conditions in the state began to ease in 2008 and continued to improve in the following years. Annual precipitation was actually higher than the long-term annual average in 2010 and 2011. However, the U.S. Drought Monitor for December 25, 2012 indicates that Crook County, and indeed much of Wyoming, is currently in drought conditions. The drought monitor for the week of December 25, 2012 is depicted in Figure 4.1, which shows the County in severe and extreme drought conditions.

Table 4.1 Wyoming's Recent Worst Multi-Year, Statewide Droughts

Period	Average Annual Precipitation (inches)	Percent of 1895-2006 Average Annual Precipitation (13.04")
1952-1956	10.65	81.69%
1900-1903	10.76	82.52%
1999-2004	11.07	84.89%
1987-1990	11.12	85.28%
1958-1964	11.67	89.49%
1974-1977	11.77	90.26%
1931-1936	11.79	90.41%

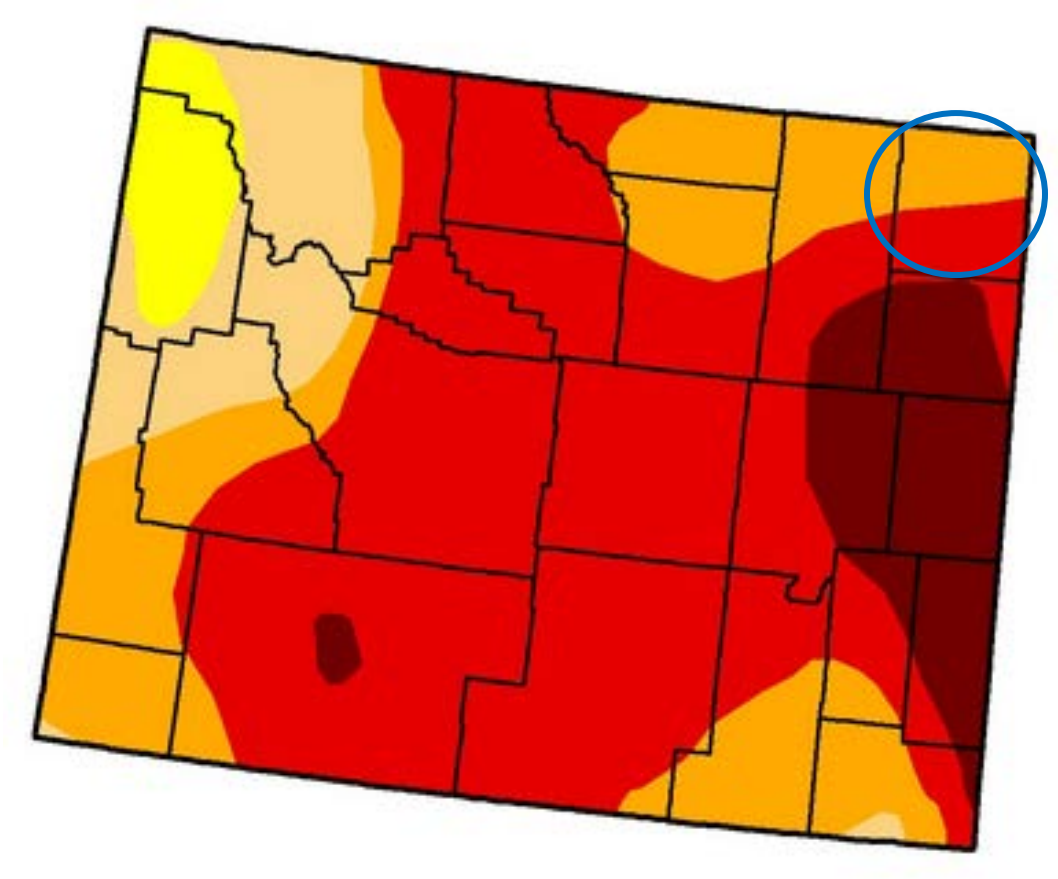

Figure 4.1 State Drought Conditions (percent area – Crook County circled in blue)

Week	Nothing	D0-D4	D1-D4	D2-D4	D3-D4	D4
December 25, 2012	0.00	100.00	96.15	86.03	64.23	10.51

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Instrumentation Record

As a whole, Wyoming's precipitation record from 1895-2006 reveals that, for the first half of the 20th century (except for the Dust Bowl years of the 1930s), there was generally a surplus of moisture. During the second half of the century there was a trend of increased periods of drought (Figure 4.2). Crook County specific data have not been analyzed.

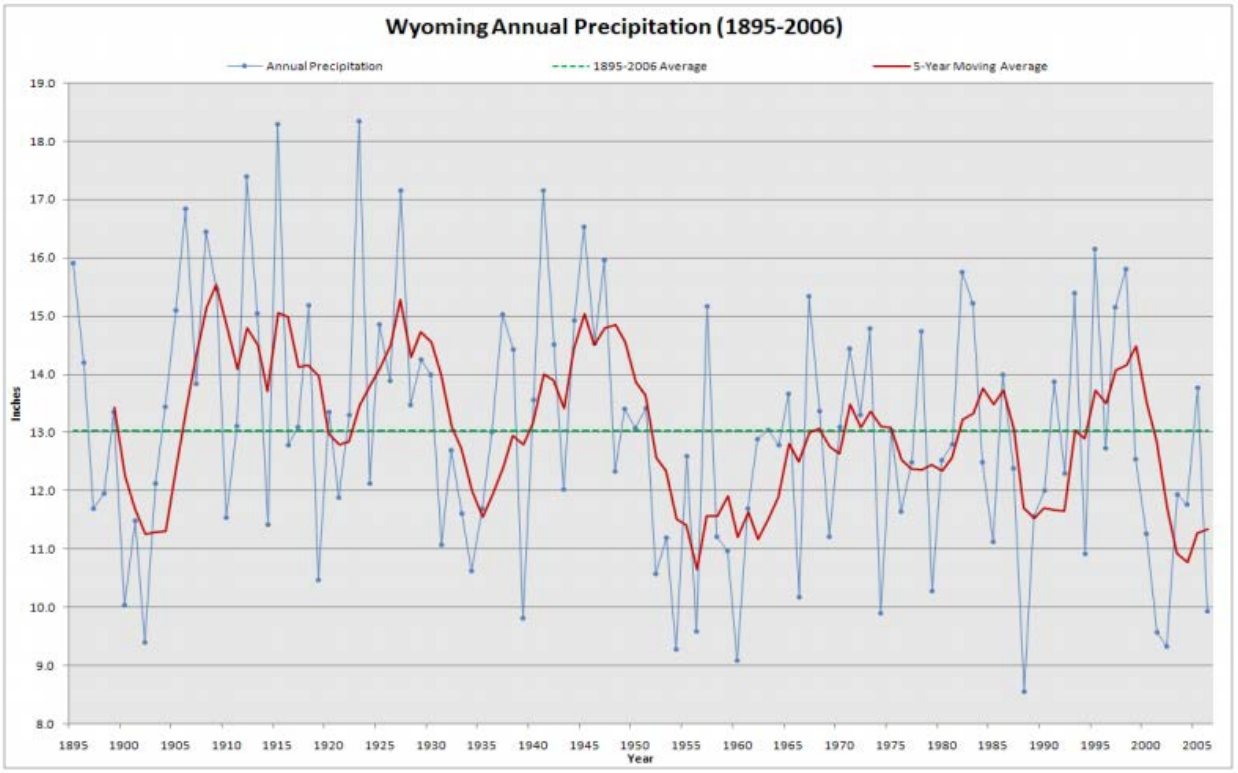

Figure 4.2 Wyoming Annual Precipitation (1895-2006)

Impacts

In order to assess the overall impact of drought on the planning area, information from the event of record is used. The event of record represents an anticipated worst-case scenario based on the most severe historic event. Based upon Table 4.1 and Figure 4.2, the drought of 1999-2004 is as significant, if not more significant than any other droughts in the last 100 years for the entire state. The data have not been analyzed for Crook County. Table 4.1, derived from the Wyoming Climate Atlas, indicates that the most significant droughts in the last century, in terms of precipitation deficit, were in 1952-1956, 1900-1903, and 1999-2004. In order to determine which drought period had the most significant impact on Wyoming, crop production and livestock inventory data for the two periods were compared. 1957 and 2005 were wetter years in Wyoming, with annual statewide precipitation totals above the 1895-2006 average. Those two years were used as endpoints for the droughts that started in 1952 and 1999 respectively. In both cases, the years following saw a return to drier conditions. Because of this, the most recent drought impacts were also calculated for 2005 and 2006, and are included in the summary tables. Tables 4.2 and 4.3 show peak decline (%) in production during drought compared to the 5-year pre-drought production average for various commodities.

A comparison of Tables 4.2 and 4.3 indicate that drought impacts to the Wyoming agricultural community were greater in the 1999-2004 drought than in the 1952-1956 drought. With the exception of dry beans, all commodities in the worst years of the 1999-2004 drought showed a

greater percentage decline in production than in the 1952-1956 drought. As a result, the 1999-2004 drought will be used as the drought of historic record to calculate dollar impacts.

Table 4.2 Peak Commodity Production Changes from Pre-Drought (1947 – 1951) to Drought (1952 – 1956)

Commodity	5-Year Pre-Drought Production Average (1947-1951)	Units	Lowest Production During Drought (1952-1956)	Year of Lowest Production (1952-1956)	Percent Change
Winter Wheat	5,072	1,000 bu.	2,346	1954	-54%
Spring Wheat	1,579	1,000 bu.	600	1954	-62%
Barley	4,414	1,000 bu.	2,700	1956	-39%
Oats	4,577	1,000 bu.	2,470	1954	-46%
Dry Beans	1,009	1,000 cwt.	589	1955	-42%
Sugarbeets	413	1,000 tons	421	1955	+2%
Corn	227	1,000 bu.	161	1953	-29%
Alfalfa Hay	490	1,000 tons	675	1954	+38%
Other Hay	674	1,000 tons	442	1954	-34%
Cattle/ Calves Inventory	1,050	1,000 head	1,096	1954	+4%

Table 4.3 Peak Commodity Production Changes from Pre-Drought (1994-1998) to Drought (1999-2004)

Commodity	5-Year Pre-Drought Production Average (1994-1998)	Units	Lowest Production During Drought (1999-2003)	Year of Lowest Production	Percent Change
Winter Wheat	6,029	1,000 bu.	2375	2002	-61%
Spring Wheat	648	1,000 bu.	96	2002	-84%
Barley	8,383	1,000 bu.	4680	2002	-44%
Oats	1,648	1,000 bu.	600	2005	-64%
Dry Beans	691	1,000 cwt.	514	2001	-26%
Sugarbeets	1,151	1,000 tons	659	2002	-43%
Corn	6,328	1,000 bu.	4165	2002	-34%
Alfalfa Hay	1,581	1,000 tons	1150	2002	-27%
Other Hay	817	1,000 tons	450	2002	-45%
Cattle/ Calves Inventory	1,536	1,000 head	1300	2004	-16%

Dollar Impacts

While not the only sector impacted by drought, agricultural dollar impacts are often used to show the effects of drought due to the availability of data. During the development of this plan in 2012 agricultural statistics data was obtained from the Wyoming Field Office of the National Agricultural Statistics Service of the USDA. The dollar impact data is only available at a statewide, rather than county level. As mentioned previously the drought of record began in 1999 and continued through 2004.

The data below represent changes in production value for crops and changes in inventory value for cattle and calves. As such, the data should be considered impact value versus loss value. For example, with cattle and calves (Tables 4.4 through 4.12) inventory, the inventory decreased during the drought. Therefore the value of inventory on hand has decreased. The inventory decreased, however, because of the sale of the cattle and calves. The sales resulted in a short term increase in cash receipts to the farming and ranching community. The net result, however, is a decrease in inventory value, which is a negative drought impact over the long term.

Table 4.4 1999 Production and Inventory Value Impact

Commodity	5-Year Pre-Drought Production Average (1994-1998)	Units	1999 Production	Value (USD)	Production and Inventory Value Impact (USD)
Winter Wheat	6,029	1,000 bu.	6,105	2.12/bu	+ 161,120
Spring Wheat	648	1,000 bu.	264	2.54/bu	- 976,376
Barley	8,383	1,000 bu.	7,310	3.03/bu	- 3,251,190
Oats	1,648	1,000 bu.	1,539	1.45/bu	- 158,050
Dry Bean	691	1,000 cwt.	788	16.00/cwt	+ 1,555,200
Sugar Beet	1,150	1,000 tons	1,205	39.00/ton	+ 2,145,000
Corn	6,328	1,000 bu.	6,136	1.94/bu	- 372,480
Alfalfa Hay	1,581	1,000 tons	1,782	67.00/ton	+ 13,467,000
Other Hay	817	1,000 tons	1,008	60.00/ton	+ 11,436,000
Cattle/Calves Inventory	1,536	1,000 head	1,580	770.00/head	+ 33,880,000
TOTAL					**+ $57,886,224**

Table 4.5 2000 Production and Inventory Value Impact

Commodity	5-Year Pre-Drought Production Average (1994-1998)	Units	2000 Production	Value (USD)	Production and Inventory Value Impact (USD)
Winter Wheat	6,029	1,000 bu.	4080	2.70/bu	-5,262,300
Spring Wheat	648	1,000 bu.	232	2.70/bu	-1,123,200
Barley	8,383	1,000 bu.	7,885	3.08/bu	-1,533,840
Oats	1,648	1,000 bu.	1,485	1.55/bu	-252,650
Dry Bean	691	1,000 cwt.	762	16.8/cwt	+1,192,800
Sugar Beet	1,150	1,000 tons	1,156	32.5/ton	+195,000
Corn	6,328	1,000 bu.	7,656	2.02/bu	+2,682,560
Alfalfa Hay	1,581	1,000 tons	1,449	85.00/ton	-11,220,000
Other Hay	817	1,000 tons	650	80.00/ton	-13,360,000
Cattle/Calves Inventory	1,536	1,000 head	1,550	780.00/head	+10,920,000
TOTAL					**- $17,761,630**

Table 4.6 2001 Production and Inventory Value Impact					
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**2001 Production**	**Value (USD)**	**Production and Inventory Value Impact (USD)**
Winter Wheat	6,029	1,000 bu.	,2880	2.7/bu	-8,502,300
Spring Wheat	648	1,000 bu.	168	2.9/bu	-1,392,000
Barley	8,383	1,000 bu.	6,970	3.32/bu	-4,691,160
Oats	1,648	1,000 bu.	1,344	1.65/bu	-501,600
Dry Bean	691	1,000 cwt.	514	23/cwt	-4,071,000
Sugar Beet	1,150	1,000 tons	794	39.7/ton	-14,133,200
Corn	6,328	1,000 bu.	6375	2.3/bu	+108,100
Alfalfa Hay	1,581	1,000 tons	1,276	110/ton	-33,550,000
Other Hay	817	1,000 tons	605	105/ton	-22,260,000
Cattle/Calves Inventory	1,,536	1,000 head	1,470	780/head	-51,480,000
TOTAL					**- $140,473,160**

Table 4.7 2002 Production and Inventory Value Impact					
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**2002 Production**	**Value**	**Production and Inventory Value Impact**
Winter Wheat	6,029	1,000 bu.	2375	3.7/bu	-13,519,800
Spring Wheat	648	1,000 bu.	96	3.9/bu	-21,52,800
Barley	8,383	1,000 bu.	4,680	3.23/bu	-11,960,690
Oats	1,648	1,000 bu.	750	2.2/bu	-1,975,600
Dry Bean	691	1,000 cwt.	624	18.3/cwt	-1,226,100
Sugar Beet	1,150	1,000 tons	659	42.3/ton	-20,769,300
Corn	6,328	1,000 bu.	4,165	2.6/bu	-5,623,800
Alfalfa Hay	1,581	1,000 tons	1,150	111/ton	-47,841,000
Other Hay	817	1,000 tons	450	106/ton	-38,902,000
Cattle/Calves Inventory	1,536	1,000 head	1,320	760/head	-164,160,000
TOTAL					**- $308,131,090**

Table 4.8 2003 Production and Inventory Value Impact					
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**2003 Production**	**Value (USD)**	**Production and Inventory Value Impact**
Winter Wheat	6,029	1,000 bu.	3,915	3.4/bu	-7,187,600
Spring Wheat	648	1,000 bu.	180	3.15/bu	-1,474,200
Barley	8,383	1,000 bu.	6,975	3.46/bu	-4,871,680
Oats	1,648	1,000 bu.	1,104	1.8/bu	-979,200
Dry Bean	691	1,000 cwt.	645	17.4/cwt	-800,400
Sugar Beet	1,150	1,000 tons	752	41.2/ton	-16,397,600
Corn	6,328	1,000 bu.	6,450	2.5/bu	+305,000
Alfalfa Hay	1,581	1,000 tons	1625	80/ton	+3,520,000
Other Hay	817	1,000 tons	770	73/ton	-3,431,000
Cattle/Calves Inventory	1,536	1,000 head	1,350	890/head	-165,540,000
TOTAL					**- $196,856,680**

Table 4.9 2004 Production and Inventory Value Impact					
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**2004 Production**	**Value (USD)**	**Production and Inventory Value Impact**
Winter Wheat	6,029	1,000 bu.	3,510	3.2/bu	-8,060,800
Spring Wheat	648	1,000 bu.	240	3.25/bu	-1,326,000
Barley	8,383	1,000 bu.	7,050	3.41/bu	-4,545,530
Oats	1,648	1,000 bu.	795	1.55/bu	-1,322,150
Dry Bean	691	1,000 cwt.	541	25.9/cwt	-3,885,000
Sugar Beet	1,150	1,000 tons	812	41.7/ton	-14,094,600
Corn	6,328	1,000 bu.	6,550	2.48/bu	+550,560
Alfalfa Hay	1,581	1,000 tons	1,305	74.5/ton	-20,562,000
Other Hay	817	1,000 tons	756	69.5/ton	-4,239,500
Cattle/Calves Inventory	1,536	1,000 head	1,300	1,020/head	-240,720,000
TOTAL					**- $298,205,020**

Table 4.10 2005 Production and Inventory Value Impact					
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**2005 Production**	**Value (USD)**	**Production and Inventory Value Impact**
Winter Wheat	6,029	1,000 bu.	4,350	3.5/bu	-5,876,500
Spring Wheat	648	1,000 bu.	315	3.19/bu	-1,062,270
Barley	8,383	1,000 bu.	5,580	3.28/bu	-9,193,840
Oats	1,648	1,000 bu.	600	1.6/bu	-1,676,800
Dry Bean	691	1,000 cwt.	776	18.7/cwt	1,589,500
Sugar Beet	1,150	1,000 tons	801	42.8/ton	-14,937,200
Corn	6,328	1,000 bu.	6,860	2.45/bu	+1,303,400
Alfalfa Hay	1,581	1,000 tons	1,560	75/ton	-1,575,000
Other Hay	817	1,000 tons	756	72/ton	-4,392,000
Cattle/Calves Inventory	1536	1,000 head	1,400	1,140/head	-155,040,000
TOTAL					**- $190,860,710**

Table 4.11 2006 Production and Inventory Value Impact					
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**2006 Production**	**Value (USD)**	**Production and Inventory Value Impact**
Winter Wheat	6,029	1,000 bu.	3,645	4.58/bu	-10,918,720
Spring Wheat	648	1,000 bu.	234	3.8/bu	-1,573,200
Barley	8,383	1,000 bu.	4,845	3.32/bu	-11,746,160
Oats	1,648	1,000 bu.	684	2.15/bu	-2,072,600
Dry Bean	691	1,000 cwt.	590	22/cwt	-2,222,000
Sugar Beet	1150	1,000 tons	798	46.8/ton	-16,473,600
Corn	6,328	1,000 bu.	5,805	2.64/bu	-1,380,720
Alfalfa Hay	1,581	1,000 tons	1,400	101/ton	-18,281,000
Other Hay	817	1,000 tons	715	103/ton	-10,506,000
Cattle/Calves Inventory	1,536	1,000 head	1,400	1,010/head	-137,360,000
TOTAL					**- $212,534,000**

Table 4.12 Production and Inventory Value Impact for Worst Year of Drought						
Commodity	**5-Year Pre-Drought Production Average (1994-1998)**	**Units**	**Worst Yearly Production Of Drought**	**Year**	**Value (USD)**	**Production and Inventory Value Impact (USD)**
Winter Wheat	6,029	1,000 bu.	2,375	2002	3.70/bu	- 13,519,800
Spring Wheat	648	1,000 bu.	96	2002	3.90/bu	- 2,152,800
Barley	8,383	1,000 bu.	4,680	2002	3.23/bu	- 11,960,690
Oats	1,648	1,000 bu.	750	2002	2.20/bu	- 1,975,600
Dry Bean	691	1,000 cwt.	514	2001	23.00/cwt	- 4,071,000
Sugar Beet	1,150	1,000 tons	659	2002	42.30/ton	- 20,769,300
Corn	6,328	1,000 bu.	4,165	2002	2.60/bu	- 5,623,800
Alfalfa Hay	1,581	1,000 tons	1,150	2002	111.00/ton	- 47,841,000
Other Hay	817	1,000 tons	450	2002	106.00/ton	- 38,902,000
Cattle/Calves Inventory	1,536	1,000 head	1,300	2004	1,020.00/head	- 240,720,000
TOTAL						**- $387,535,990**

Future Potential Impacts

The 1999-2004 drought can be shown to be the drought of historic record. There have been significant impacts on the agricultural industry from the 1999-2004 drought. The worst-case year was 2002, with a negative dollar impact of $308,131,090 statewide. Crook County is 2.9% of the State of Wyoming in land area. If it is assumed that the drought impact is equally distributed across the state, which in reality it is not, the potential drought impact in Crook County for 2002 would be approximately $8.9M. The total impact statewide for the 1999-2004 drought is $903,541,356. If it is assumed that the drought impact is equally distributed across the state, which in reality it is not, the potential drought impact in Crook County would be approximately $26.2M for a multi-year drought.

Summary

PROPERTY AFFECTED: High
POPULATION AFFECTED: High
PROBABILITY: High
JURISDICTION AFFECTED: County