Wyoming Geo-notes

Number 48

Wyoming State Geological Survey
Gary B. Glass, State Geologist

Laramie, Wyoming
November, 1995

WYOMING GEO-NOTES
This quarterly digest on the State's geology and mineral resources and activities of the Geological Survey is available by subscription (four issues for $10.00) or as single copies at $3.00 each. Two-year subscriptions are accepted.

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Printed on 50% recycled fiber paper. 600 copies printed by Pioneer Printing and Stationery Company, Cheyenne, Wyoming.

Cover: Gold and some pyrope garnets recovered from Douglas Creek in Albany County. Pyrope garnets are one of several minerals that indicate the possibility of diamond-bearing rocks in the area. Photo by Paul Allred, 1995.

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MINERALS UPDATE

OVERVIEW

Gary B. Glass
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The State's Consensus Revenue Estimating Group (CREG) met in October and revised its estimates for mineral production and prices for the years 1995 through 2002. Those new estimates are reflected in this issue of *Wyoming Geo-notes*. This is also the first time CREG has projected so far into the future. The new projections show oil production declining at a rate of 4% per year, rather than the 10% CREG had forecast in January (**Table 1** and **Figure 1**). The smaller rate of decline is related to the higher oil prices received in 1995 (**Figure 2**) and projected into the future (**Figure 3** and **Table 2**). In January, CREG had predicted oil prices stabilizing at only $13.50. They are now predicting a flat $15.00 per barrel through 2002. Increased demand for Wyoming sour crude has helped maintain higher prices, and nets bonuses for some producers. In addition, Don Basko, Director of the Wyoming Oil and Gas Conservation Commission, feels a portion of this slowing rate of decline can be attributed to the positive effects that legislative incentives have had on the industry.

The new forecast for oil production is not without some downside risk as Canadian oil producers continue to propose new pipelines into the market areas for Wyoming crude. Looking at the history of Canadian oil coming into Montana, however, Canadian oil prices followed the prices paid for West Texas Intermediate, and their oil apparently was not sold at discounted prices. There are some major differences between now and when Canadian oil started into Montana. Canada currently has a significant surplus of oil and a more aggressive marketing strategy.

The effect of Canadian crude coming into Wyoming markets will depend in large part on the volume that is brought in and, of course, the delivered price. Obviously, refineries will need someone to supply their feedstock as Wyoming production declines. This is the quoted reason for importing Canadian crude.

In October, however, Amoco announced intentions to offer Canadian producers incentives to ship crude into this area of the west. Amoco, Conoco, and other pipeline companies are proposing volume discounts to reduce shipping costs for Canadian oil. Independent producers are concerned that this is a strategy to allow Canadian producers to increase their market share in the Rockies rather than just making up the difference between refinery demand and declining production. Creating an oversupply of oil will likely drive down Wyoming prices by at least eliminating any bonuses paid to local producers. Should the Canadians go for an increased market share, the effect on Wyoming producers would be far worse than the effect of simply replacing shortfalls in diminishing feedstocks. While the proposed Express Pipeline into Casper looks like it would only bring in sweet crude from Alberta, there are other proposed

Table 1. Wyoming mineral production (1981-1994) with forecasts to 2002[1].

Calendar Year	Oil[2]	Natural Gas[3]	Carbon Dioxide[4]	Helium[5]	Coal[6]	Trona[6]	Mined Uranium[7]	In-situ Uranium[8]	Sulfur[9]
1981	122.1	455.4	—	—	102.7	11.2	4.6	?	0.05
1982	118.7	465.1	—	—	108.0	10.9	2.1	?	0.07
1983	120.9	539.8	—	—	112.2	11.6	3.0	?	0.57
1984	127.8	600.1	—	—	130.7	11.7	1.6	?	0.71
1985	131.0	597.9	—	—	140.4	11.8	0.6	?	0.80
1986	122.4	563.2	23.8	0.15	135.4	13.0	0.2	0.04	0.76
1987	115.9	628.2	114.2	0.86	146.5	13.6	0.2	0.06	1.19
1988	114.3	700.8	110.0	0.83	163.6	14.9	0.3	1.16	1.06
1989	109.1	739.0	126.1	0.94	171.1	16.2	0.1	1.07	1.17
1990	104.0	777.2	119.9	0.90	184.0	16.2	0.2	1.1	1.04
1991	99.8	820.0	140.3	1.05	193.9	16.2	0.4	1.1	1.18
1992	96.8	871.5	139.2	1.04	189.5	16.4	0.1	1.2	1.20
1993	89.0	912.8	140.8	1.06	209.9	16.0	—	1.1	1.14
1994	80.2	959.2	142.6	1.07	236.9	16.1	—	1.2	1.10
*1995	77.0	976.3	142.6	1.07	254.1	17.3	—	1.2	1.20
*1996	73.8	993.1	142.6	1.07	265.4	17.3	—	1.2	1.40
*1997	71.0	1,010.2	142.6	1.07	277.3	18.0	—	1.2	1.40
*1998	68.2	1,027.5	142.6	1.07	289.6	18.3	—	1.7	1.50
*1999	65.4	1,045.0	142.6	1.07	302.6	18.5	—	1.7	1.50
*2000	62.8	1,062.9	142.6	1.07	310.1	18.5	—	1.7	1.60
*2001	60.3	1,080.9	142.6	1.07	317.8	18.5	—	1.7	1.60
*2002	57.9	1,099.3	142.6	1.07	318.5	18.5	—	1.7	1.70

*Estimated until official figures are available.
[1]Adapted from CREG, Wyoming State Government Revenue Forecast FY95-FY2002, October, 1995. [2]Millions of barrels (Source: Wyoming Oil & Gas Conservation Commission, 1981-1994); [3]Billions of cubic feet (primarily methane with some hydrogen sulfide and nitrogen) (Source: Wyoming Oil & Gas Conservation Commission, 1981-1994); [4] Billions of cubic feet. (Source: Wyoming Oil & Gas Conservation Commission, 1986-1994); [5]Billions of cubic feet, based on Exxon's estimate that the average helium content in the gas processed at Shute Creek is 0.5%; [6]Millions of short tons (Source: Wyoming State Inspector of Mines, 1981-1994); [7]Millions of short tons of uranium ore (not yellowcake) (Source: Wyoming Department of Revenue, 1981-1992); [8]Millions of pounds of yellowcake (U_3O_8) (Source: Wyoming Department of Revenue, 1986-1994; unknown between 1981-1985 because it was only reported as taxable valuation); [9]Millions of short tons (Source: Wyoming Oil & Gas Conservation Commission, 1981-1994).

Canadian pipelines that would service Wyoming's market areas for sour crude as well.

In regard to natural gas, the new CREG forecast for production is slightly higher than in January, but the annual growth rate was decreased from 2% to 1.5% (**Figure 4** and **Table 1**). While production is increasing, it is at the expense of price. Natural gas prices are now forecast at only $1.15 per thousand cubic feet (MCF) in 1995, which is a record low for recent times (**Figure 5** and **Table 2**). **Figure 6** shows the spot prices for methane at Opal, Wyoming. Because CREG felt that current prices were artificially low, they brought the price up gradually throughout the forecast period. Again, Canadian producers play a part in this price decline as more and more Canadian gas finds its way into the U.S. At the least, the proposed Altamont pipeline from Canada to southwestern Wyoming looks like it has been postponed indefinitely. Last quarter, the company had indicated that it would build and complete the pipeline by 1997 or 1998. There are indications, however, that Altamont may now be considering an alternative pipeline into Wyoming's market area in the mid-western states. This pipeline might go through central or eastern Wyoming, but not Opal.

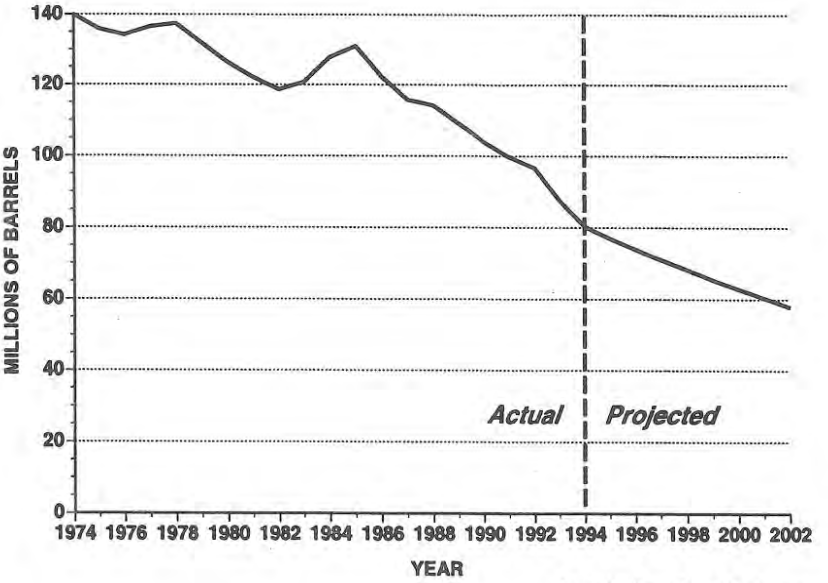


Figure 1. Annual oil production from Wyoming (1974 to 1994) with forecasts to 2002.

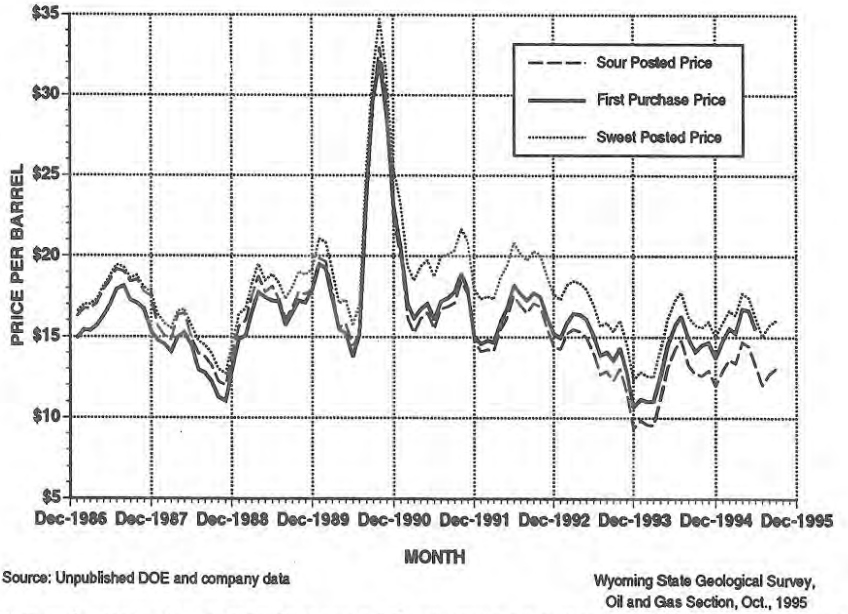


Figure 2. Wyoming posted Sweet and Sour crude oil prices and first purchase prices averaged by month (1987 to present).

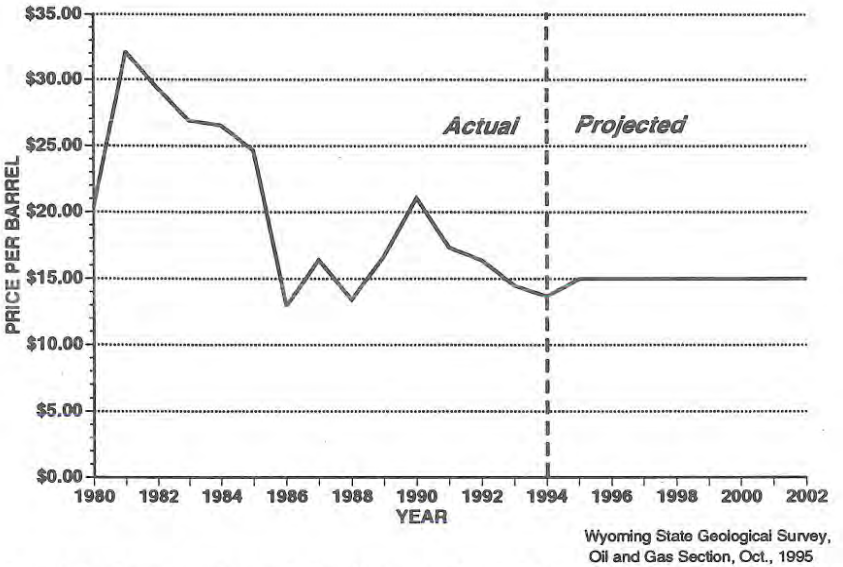


Figure 3. Average prices paid for Wyoming oil (1980 to 1994) with forecasts to 2002.

Table 2. Average prices paid for Wyoming oil, methane, coal, trona, and uranium (1985-1994) with forecasts to 2002[1].

Calendar Year	Oil[2]	Methane[3]	Coal[4]	Trona[5]	Uranium[6]
1985	24.67	3.03	11.36	35.18	36.82
1986	12.94	2.33	10.85	34.80	52.45
1987	16.42	1.78	9.80	36.56	43.55
1988	13.43	1.43	9.16	36.88	25.77
1989	16.71	1.58	8.63	40.76	22.09
1990	21.08	1.59	8.43	41.86	21.16
1991	17.33	1.46	8.09	44.18	-----
1992	16.38	1.49	8.14	44.50	-----
1993	14.50	1.81	7.32	40.08	-----
1994	13.67	1.63	*6.62	38.96	-----
*1995	15.00	1.15	6.33	40.70	-----
*1996	15.00	1.21	6.23	42.50	-----
*1997	15.00	1.27	6.15	42.50	-----
*1998	15.00	1.33	6.04	42.50	-----
*1999	15.00	1.40	5.94	42.50	-----
*2000	15.00	1.47	5.75	42.50	-----
*2001	15.00	1.54	5.65	42.50	-----
*2002	15.00	1.62	5.70	42.50	-----

* Estimated until official figures are available.

[1] Adapted from CREG, Wyoming State Government Revenue Forecast FY95-FY2002, October, 1995.

[2] First purchase price in dollars per barrel (weighted average price for sweet, sour, heavy, stripper, and tertiary oil). Source: Energy Information Administration, 1985-1994.

[3] Wellhead price in dollars per thousand cubic feet (MCF). Sources: Wyoming State Land and Farm Loan Office, 1989-1994 (derived from State royalty payments); Minerals Management Service, 1985-1988 (derived from Federal royalty payments).

[4] Dollars per short ton (weighted average price for coal mined by surface and underground methods). Source: Energy Information Administration, 1985-1993.

[5] Dollars per ton of trona, not soda ash. Source: Wyoming Department of Revenue, 1985-1994.

[6] Uranium prices in dollars per pound of yellowcake (weighted average price for in-situ and(or) surface-mined uranium). Source: Energy Information Administration, 1985-1990; no estimates available after 1990.

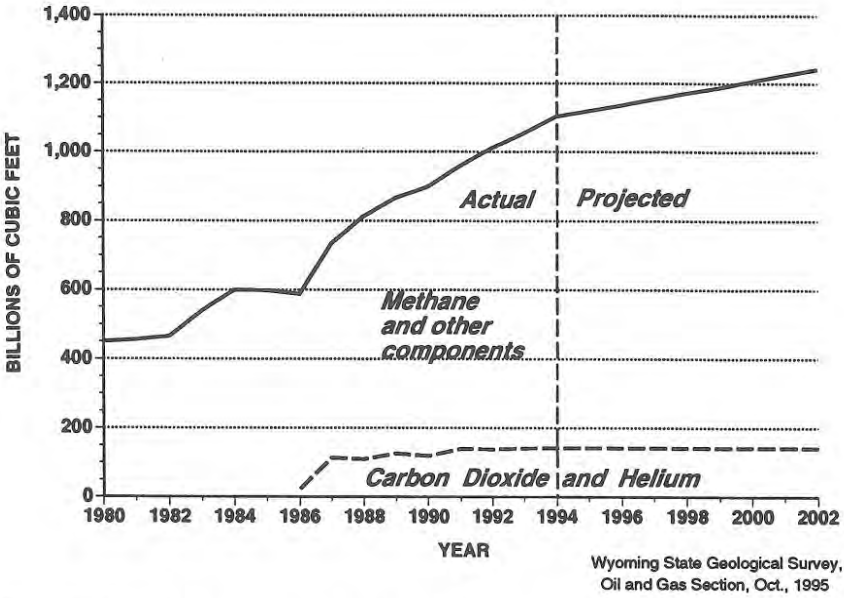


Figure 4. Annual natural gas production from Wyoming (1980 to 1994) with forecasts to 2002.

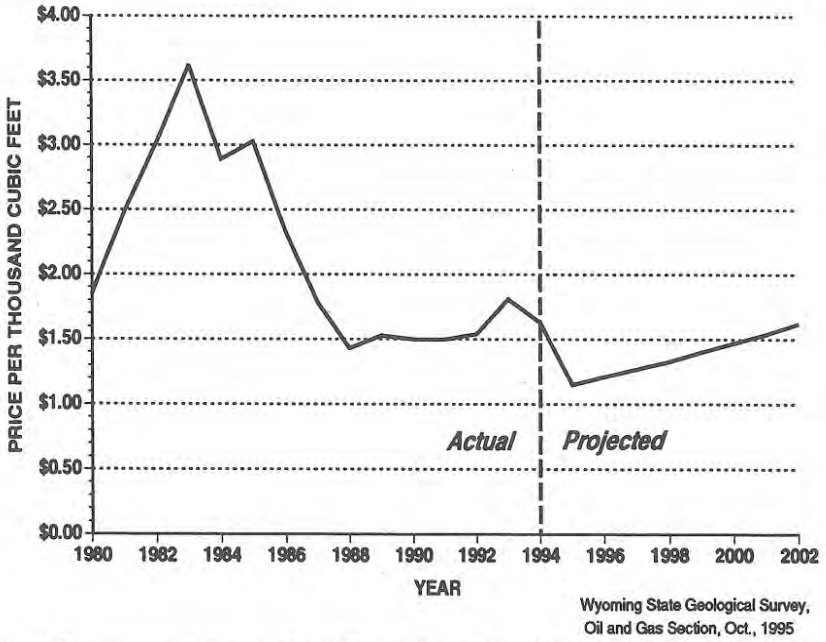
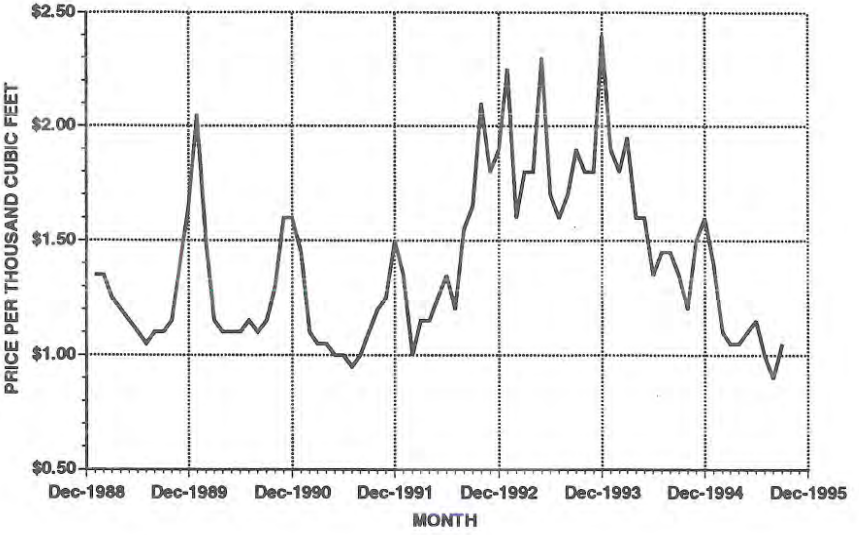


Figure 5. Average prices paid for Wyoming methane (1980 to 1994) with forecasts to 2002.



Source: American Gas Association

Wyoming State Geological Survey,
Oil and Gas Section, Oct., 1995

Figure 6. Spot prices for methane at Opal, Wyoming, averaged by month (1980 to present).

Of general interest, there are some new tables in the **Oil and Gas Update** in this issue of *Wyoming Geo-notes* (**Tables 3, 4, 5,** and **6**). These tables provide some historical comparisons related to monthly oil and gas production and prices.

In regard to coal, CREG increased its estimates of production from their January forecast (**Figure 7** and **Table 1**). Coal production for 1995 is now estimated at 254.1 million tons, which is 7% higher than the 236.9 million tons mined in 1994. This compares with the 15% increase noted for the first quarter of 1995. CREG expects production to increase about 4.5% a year through 1999 and then taper off through the remainder of the forecast years. There is still an upside chance that new production related to compliance with the Clean Air Act could accelerate this growth rate. But there is currently not enough information available to make a very reliable estimate of which power plants will or will not switch to Wyoming coal.

For some coal users, the low natural gas prices have made gas an attractive alternative to coal. In fact, one trona company in Wyoming is planning to switch from coal to gas next year. This kind of switching is more likely to affect the industrial markets for Wyoming coal than the utility markets. The industrial market only used about six million tons (2.5%) of the coal produced in Wyoming in 1994.

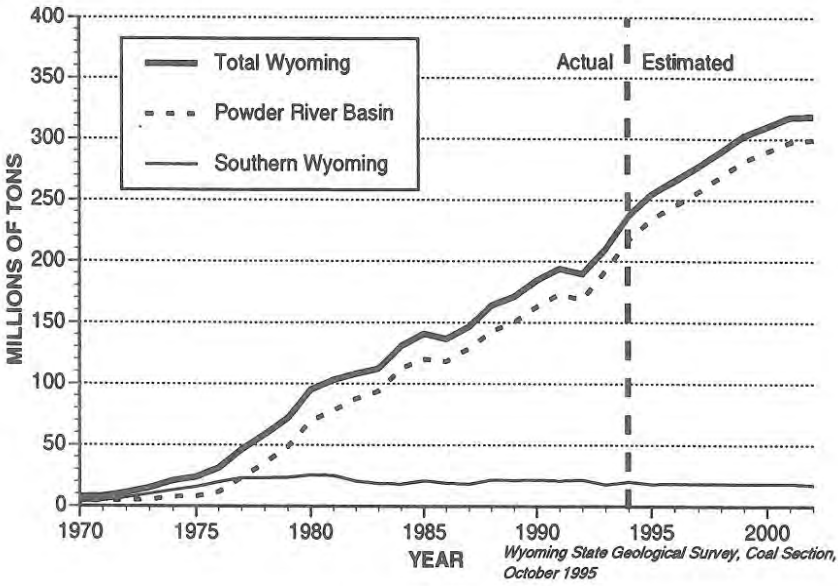


Figure 7. Annual coal production from Wyoming (1970-1994) with forecasts to 2002. Data from Wyoming Inspector of Mines (1970-1994) and Wyoming Consensus Revenue Estimating Group (1994-2002).

CREG's coal price forecast is now lower than it was in January (**Figure 8** and **Table 2**). This lowered forecast is based on our estimate that there is less higher-priced, older, long-term contracts still in existence than previously thought. **Table 9** on page 24 of the **Coal Update** reflects our new estimate of the percentages of low-price versus high-price coal sold in Wyoming. Delivered coal prices in the Federal Energy Regulatory Commission's (FERC's) public data base helped confirm this new estimate. Our Coal Section has prepared a summary of FERC data on prices and deliveries of Wyoming coal in 1994 and has published it in a new in-house publication designated *Coal Report 95-1*. There is information on this new report on page 53.

Last quarter, we noted that revenues from coal were tracking forecasts while production was somewhat higher than projected. At that time, we suggested that prices were probably lower than the January forecast for 1995. It now looks like the January forecast of $6.70 should have been about $6.62. The explanation for the lowered estimate of price in 1995 and in the forecast years is related to the mix of higher-priced coal on old contracts with lower-priced short-term or spot sale coal. In January, we were estimating that 42% of the coal sold in Wyoming in 1995 would be higher-priced contract coal. Our new

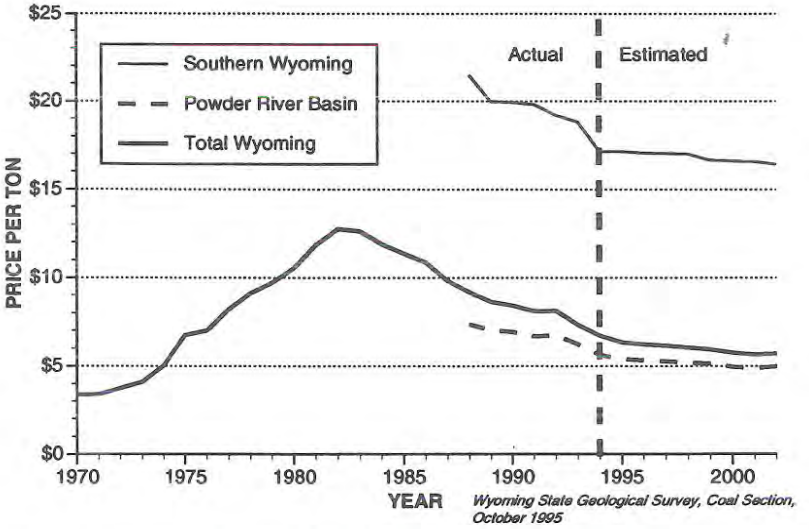


Figure 8. Average prices paid for Wyoming coal (1980 to 1993) with forecasts to 2002. Data from U.S. Energy Information Administration (1980-1993) and the Wyoming Consensus Revenue Estimating Group (1994-2002).

estimate shows that only 28% of the marketed coal will be higher-priced coal (**Table 9** on page 24). By 2000, that percentage will drop to only 10%.

Forecasts for trona and uranium indicate modest growth in trona production at least through 1999 and some growth in uranium production by 1998 (**Table 1**). Trona prices are forecast to increase to $42.50 by 1996 (**Table 2**).

OIL AND GAS UPDATE

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Prices paid to Wyoming oil producers for the first nine months of 1995 averaged $15.44, which is $1.95 per barrel higher than the $13.49 average for the first nine months of 1994 (**Table 3** and **Figure 3**). The average price in the first nine months of 1993 was $15.19 per barrel. The higher average price so far this year seems to be having a positive effect on oil production in the State. Production through the first half of 1995 was 39.8 million barrels compared to first half production of 40.6 million barrels in 1994 (**Table 4**). This is a 2% decline in production for the first half of this year, compared with a 9.1% decline between 1993 and 1994 (**Figure 1**).

Table 3. Average price (per barrel) received for oil in Wyoming.

	1992 Monthly	1992 Cumulative	1993 Monthly	1993 Cumulative	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative
JAN	$ 14.57	$ 14.57	$ 15.08	$ 15.08	$ 11.15	$ 11.15	$ 14.77	$ 14.77
FEB	$ 14.78	$ 14.68	$ 16.00	$ 15.54	$ 11.01	$ 11.08	$ 15.55	$ 15.16
MAR	$ 14.66	$ 14.67	$ 16.47	$ 15.85	$ 11.04	$ 11.07	$ 15.26	$ 15.19
APR	$ 15.99	$ 15.00	$ 16.41	$ 15.99	$ 12.59	$ 11.45	$ 16.73	$ 15.58
MAY	$ 16.77	$ 15.35	$ 16.11	$ 16.01	$ 14.53	$ 12.07	$ 16.65	$ 15.79
JUN	$ 18.23	$ 15.83	$ 15.11	$ 15.86	$ 15.73	$ 12.68	$ 15.52	$ 15.75
JUL	$ 17.66	$ 16.09	$ 13.91	$ 15.58	$ 16.31	$ 13.20	**$ 14.20**	**$ 15.53**
AUG	$ 17.27	$ 16.24	$ 14.08	$ 15.39	$ 14.89	$ 13.41	**$ 15.00**	**$ 15.46**
SEP	$ 17.73	$ 16.41	$ 13.57	$ 15.19	$ 14.10	$ 13.49	**$ 15.30**	**$ 15.44**
OCT	$ 17.51	$ 16.52	$ 14.23	$ 15.09	$ 14.53	$ 13.59		
NOV	$ 16.21	$ 16.49	$ 12.92	$ 14.89	$ 14.68	$ 13.67		
DEC	$ 15.23	$ 16.38	$ 10.66	$ 14.59	$ 13.71	$ 13.67		
Average yearly price		**$ 16.38**		**$ 14.59**		**$ 13.67**		

All averages derived from unpublished monthly reports by the Energy Information Administration except bold averages in 1995 are estimated from various unpublished posted price bulletins.

Wyoming State Geological Survey, Oil and Gas Section, October, 1995

Table 4. Oil production from Wyoming (1992 to present).

	1992 Monthly	1992 Cumulative	1993 Monthly	1993 Cumulative	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative
JAN	8,527,905	8,527,905	7,616,208	7,616,208	7,115,472	7,115,472	6,695,332	6,695,332
FEB	7,933,484	16,461,389	6,583,954	14,200,162	6,387,147	13,502,619	7,693,543	14,388,875
MAR	8,392,491	24,853,880	7,690,771	21,890,933	6,984,248	20,486,867	6,370,611	20,759,486
APR	8,079,724	32,933,604	7,355,334	29,246,267	6,672,207	27,159,074	6,219,119	26,978,605
MAY	8,235,583	41,169,187	7,533,207	36,779,474	6,847,709	34,006,783	6,419,035	33,397,640
JUN	7,960,645	49,129,832	7,307,445	44,086,919	6,594,914	40,601,697	6,392,817	39,790,457
JUL	8,186,319	57,316,151	7,572,346	51,659,265	6,773,956	47,375,653		
AUG	8,108,187	65,424,338	7,370,091	59,029,356	6,685,423	54,061,076		
SEP	7,847,059	73,271,397	7,162,224	66,191,580	6,446,719	60,507,795		
OCT	7,978,799	81,250,196	7,374,889	73,566,469	6,525,817	67,033,612		
NOV	7,728,632	88,978,828	6,897,568	80,464,037	6,257,924	73,291,536		
DEC	7,831,601	96,810,429	7,203,163	87,667,200	6,236,204	79,527,740		
Total Barrels Reported[1]		**96,810,429**		**87,667,200**		**79,527,740**		**39,790,457**
Total Barrels Not Reported By PI		**169,781**		**1,233,006**		**651,400**		
Total Barrels Produced[2]		**96,980,210**		**88,960,236**		**80,179,140**		

[1]Monthly production reports from Petroleum Information (PI).
[2] Wyoming Oil and Gas Conservation Commission.

Wyoming State Geological Survey, Oil and Gas Section, October, 1995

The situation in natural gas is reversed, as production through the first half of 1995 is higher than production in the first half of 1994 despite much lower prices this year. The average spot price at Opal through the first nine months of 1995 was $1.09 per thousand cubic feet (MCF), compared to $1.61 per MCF through the first nine months of 1994 (**Table 5** and **Figure 6**). The 561.0 billion cubic feet (BCF) of natural gas produced in the first half of this year is 19.8 billion cubic feet (BCF) higher than the 541.2 BCF produced in the first half of last year (**Table 6**). This is a production increase of 3.7%.

The Energy Information Administration (EIA, 1995) estimates proved reserves of natural gas in Wyoming at the end of 1994 were 10.88 trillion cubic feet (TCF). This is only slightly lower than the 10.93 TCF it estimated at the end of 1993. This small decline in estimated proved reserves occurred after a record 1.10 TCF of natural gas were produced in 1994. According to EIA, the increased number of natural gas wells drilled in Wyoming last year was responsible for 371 billion cubic feet (BCF) of gas found in wells that extended the limits of existing fields. The drilling also resulted in 17 BCF of gas discovered in new fields and 249 BCF of gas discovered in new reservoirs in old fields. In 1994, only producers in Texas and Louisiana discovered more natural gas in new fields and in new reservoirs in old fields than discovered in Wyoming. Wyoming ranks fourth behind only Texas, New Mexico, and Oklahoma in proved reserves of natural gas. EIA's estimates of Wyoming's proved reserves of crude oil paint a less optimistic picture. Proved reserves at the end of 1994 were only 565 million barrels compared to 624 million barrels at the end of 1993. Wyoming ranks seventh in proved reserves of crude oil behind Texas, Alaska, California, New Mexico, Oklahoma, and Louisiana.

In a related item, the Potential Gas Committee (1995) lowered its estimate of Wyoming's most likely resources of natural gas to 76.9 TCF. This compares with the 94.6 TCF the committee estimated two years ago. Most of the difference is in the estimate for the Thrust Belt, which has been lowered nearly 13 TCF. Even with this lower estimate, Wyoming has nearly 55% of the Rocky Mountain region's natural gas resources and nearly 10% of the resources in the lower 48 states. The committee's report not only breaks the resources into traditional resources that will be found above and below 15,000 feet depths, but it also includes resources in coal beds. Resources above 15,000 feet are estimated at 36.6 TCF, resources below 15,000 feet are estimated at 29.4 TCF, and resources in coal beds are estimated at 10.9 TCF. The Greater Green River Basin has the majority of the State's resources with 45.8 TCF, the Wind River Basin is second with 11.6 TCF, and the Powder River Basin is third with 8.3 TCF.

In comparison, earlier this year the U.S. Geological Survey (1995) estimated Wyoming's natural gas resource at 176.3 trillion cubic feet (see *Wyoming Geo-notes No. 46).* The U.S. Geological Survey's (USGS's) estimate is significantly higher than the Potential Gas Committee's estimate because the USGS includes proved reserves and unconventional resources that may not be recoverable by normal drilling, stimulation, and completion techniques. These resource categories are not included in the Potential Gas Committee's estimate.

Table 5. Average monthly spot price for natural gas at Opal, Wyoming.

	1992 Monthly	1992 Cumulative	1993 Monthly	1993 Cumulative	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative
JAN	$ 1.35	$ 1.35	$ 2.25	$ 2.25	$ 1.90	$ 1.90	$ 1.40	$ 1.40
FEB	$ 1.00	$ 1.18	$ 1.60	$ 1.93	$ 1.80	$ 1.85	$ 1.10	$ 1.25
MAR	$ 1.15	$ 1.17	$ 1.80	$ 1.89	$ 1.95	$ 1.88	$ 1.05	$ 1.18
APR	$ 1.15	$ 1.17	$ 1.80	$ 1.87	$ 1.60	$ 1.81	$ 1.05	$ 1.15
MAY	$ 1.25	$ 1.19	$ 2.30	$ 1.96	$ 1.60	$ 1.77	$ 1.10	$ 1.14
JUN	$ 1.35	$ 1.22	$ 1.70	$ 1.91	$ 1.35	$ 1.70	$ 1.15	$ 1.14
JUL	$ 1.20	$ 1.22	$ 1.60	$ 1.87	$ 1.45	$ 1.66	$ 1.00	$ 1.12
AUG	$ 1.55	$ 1.26	$ 1.70	$ 1.85	$ 1.45	$ 1.64	$ .90	$ 1.09
SEP	$ 1.65	$ 1.30	$ 1.90	$ 1.85	$ 1.35	$ 1.61	$ 1.05	$ 1.09
OCT	$ 2.10	$ 1.38	$ 1.80	$ 1.84	$ 1.20	$ 1.57		
NOV	$ 1.80	$ 1.42	$ 1.80	$ 1.84	$ 1.50	$ 1.56		
DEC	$ 1.90	$ 1.46	$ 2.40	$ 1.89	$ 1.60	$ 1.57		
Average yearly price[1]		**$ 1.46**		**$ 1.89**		**$ 1.57**		

[1]American Gas Association's monthly reports

Wyoming State Geological Survey, Oil and Gas Section, October, 1995

Table 6. Natural gas production by month from Wyoming.

	1992 Monthly	1992 Cumulative	1993 Monthly	1993 Cumulative	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative
JAN	89,618,649	89,618,649	88,172,339	88,172,339	93,146,775	93,146,775	100,111,524	100,111,524
FEB	81,194,839	170,813,488	80,726,687	168,899,026	85,623,666	178,770,441	86,787,107	186,898,631
MAR	83,058,343	253,871,831	88,920,212	257,819,238	94,388,052	273,158,493	94,159,061	281,057,692
APR	79,387,752	333,259,583	86,208,224	344,027,462	92,362,726	365,521,219	93,782,456	374,840,148
MAY	75,450,024	408,709,607	87,857,947	431,885,409	93,886,923	459,408,142	95,300,585	470,140,733
JUN	80,156,560	488,866,167	74,555,764	506,441,173	81,764,661	541,172,803	90,889,182	561,029,915
JUL	87,913,920	576,780,087	91,832,536	598,273,709	94,998,414	636,171,217		
AUG	88,052,852	664,832,939	91,562,051	689,835,760	93,743,790	729,915,007		
SEP	83,373,910	748,206,849	90,580,094	780,415,854	88,476,703	818,391,710		
OCT	87,308,510	835,515,359	93,388,208	873,804,062	95,232,646	913,624,356		
NOV	88,671,889	924,187,248	88,046,821	961,850,883	95,312,491	1,008,936,847		
DEC	87,579,985	1,011,767,233	90,133,281	1,051,984,164	87,115,084	1,096,051,931		
Total MCF Reported[1]		**1,011,767,233**		**1,051,984,164**		**1,096,051,931**		
Total MCF Not Reported By PI		**201,080**		**2,715,623**		**6,879,705**		
Total MCF Produced[2]		**1,011,968,313**		**1,054,699,787**		**1,102,931,636**		

[1] Monthly production reports from Petroleum Information (PI).
[2] Wyoming Oil and Gas Conservation Commission.

Wyoming State Geological Survey, Oil and Gas Section, October, 1995

The daily rig count for Wyoming averaged by month is behind that of 1994 (**Figure 9**). The lower count is attributed to the low natural gas prices realized so far in 1995.

Total revenue from lease sales so far this year is lagging far behind the total revenue from sales last year (**Table 7**). Leasing at the U.S. Bureau of Land Management's (BLM's) August sale was spread fairly evenly among the Greater Green River Basin, the Powder River Basin, the Wind River Basin, and the Bighorn Basin (**Figure 10**). Leasing at the September State Land and Farm Loan Office's sale was concentrated mainly in the Greater Green River Basin and the Powder River Basin (**Figure 11**).

The BLM's sale in August had a high per-acre bid of $160 made by Yates Petroleum Corp. for a 1,592.32-acre tract that covers all of section 20, W/2 section 24, and lots 5-8, E/2, E/2 W/2 section 30, T22N, R97W (location A, **Figure 10**). Parts of the lease are two miles southwest of Almond gas and condensate production in North Sheep Camp Field. The sale's second high per-acre bid of $85 was made by Exxon Corp. for an 880-acre lease that covers N/2 and SE section 13 and E/2 and S/2 SW section 24, T37N, R89W (location B, **Figure 10**). The lease is on the east side of Frenchie Draw Field. There were only six tracts at this sale that received bids of $50 or more per acre.

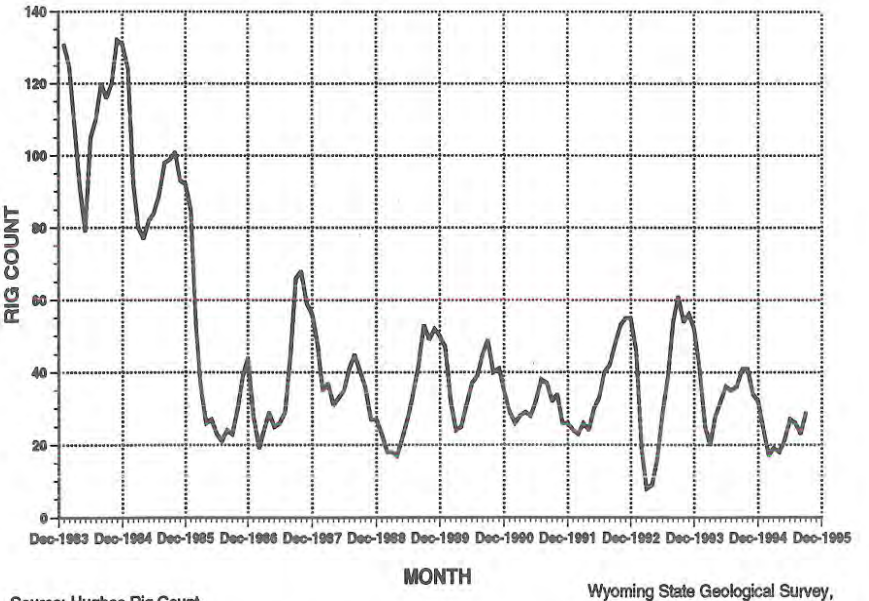

Figure 9. Wyoming daily rig count averaged by month (1984 to present).

Table 7. Federal and State competitive oil and gas lease sales in Wyoming.

FEDERAL SALES (BUREAU OF LAND MANAGEMENT)

Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
			1991				
TOTAL	$12,934,277	2,815	1,147	2,191,462	675,777	$19.14	$16,000.00
			1992				
TOTAL	$4,778,940	2,122	664	1,434,268	364,478	$13.11	$2,500.00
			1993				
February	$1,637,233	464	246	346,357	155,272	$10.54	$220.00
April	$2,116,184	478	259	351,465	177,989	$11.89	$220.00
June	$1,415,793	463	179	351,130	86,435	$16.38	$390.00
August	$1,877,405	462	262	374,274	208,495	$9.00	$400.00
October	$2,636,127	458	247	367,281	186,274	$14.15	$285.00
December	$3,259,266	444	276	275,435	180,879	$18.02	$320.00
TOTAL	$12,942,008	2,769	1,469	2,065,942	995,344	$13.00	$400.00
			1994				
February	$3,909,085	442	290	374,969	237,761	$16.44	$160.00
April	$4,248,182	498	278	369,657	201,690	$21.06	$275.00
June	$3,759,282	480	270	417,447	233,664	$16.09	$325.00
August	$5,100,550	439	294	323,410	217,157	$23.49	$255.00
October	$4,703,706	492	341	411,117	269,003	$17.49	$11,200.00
December	$5,386,789	617	367	479,930	290,384	$18.55	$390.00
TOTAL	$27,107,594	2,968	1,840	2,376,530	1,449,659	$18.70	$11,200.000
			1995				
February	$3,252,668	533	332	473,177	290,046	$11.21	$425.00
April	$1,591,709	531	206	483,826	189,003	$8.42	$160.00
June	$3,499,604	393	246	384,746	238,863	$14.65	$660.00
August	$1,105,381	488	165	420,189	149,025	$7.41	$160.00

STATE SALES (STATE LAND AND FARM LOAN OFFICE)

Month	Total Revenue	Number of parcels offered	Number of parcels leased	Total acres	Acres leased	Average price per acre leased	High price per acre
			1991				
TOTAL	$4,457,885	1,295	1,037	479,975	405,910	$10.98	$401.00
			1992				
TOTAL	$745,738	799	419	277,755	150,613	$4.95	$230.00
			1993				
March	$601,400	200	137	74,940	54,723	$10.99	$400.00
May	$362,840	200	141	82,388	56,770	$6.39	$90.00
September	$505,587	200	141	80,428	56,845	$8.89	$225.00
November	$510,290	200	143	73,517	53,801	$9.48	$155.00
TOTAL	$1,980,017	800	562	311,273	222,139	$8.91	$400.00
			1994				
March	$917,380	200	169	84,571	73,061	$12.56	$170.00
May	$802,688	200	141	75,523	54,199	$14.81	$205.00
September	$586,083	200	149	83,143	61,675	$ 9.50	$190.00
November	$998,001	200	148	88,542	66,217	$15.07	$142.00
TOTAL	$3,304,152	800	607	331,779	255,152	$12.95	$205.00
			1995				
March	$524,165	199	131	89,371	57,702	$9.08	$130.00
May	$452,747	200	125	75,633	49,735	$9.10	$78.00
September	$421,454	200	134	78,032	53,527	$7.87	$65.00

Sources: Wyoming State Land and Farm Loan Office, Petroleum Information Corporation - Rocky Mountain Region Report, and U.S. Bureau of Land Management.

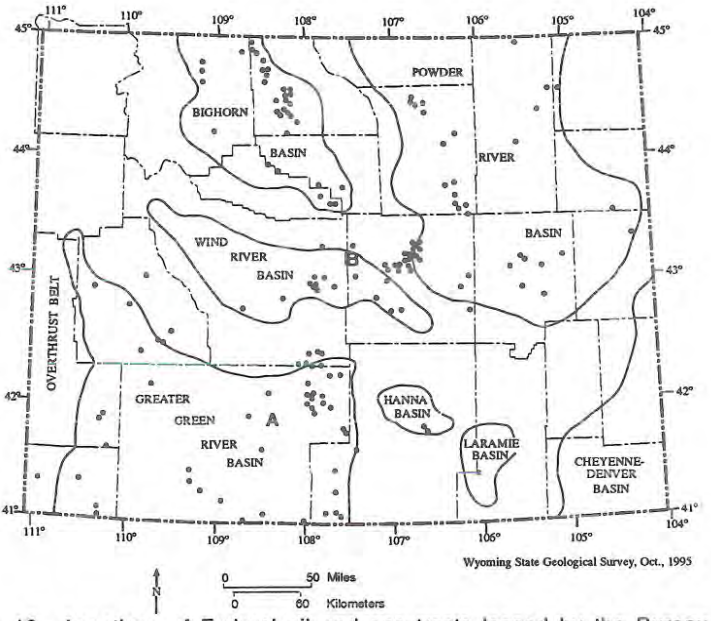

Figure 10. Locations of Federal oil and gas tracts leased by the Bureau of Land Management at the August, 1995, sale.

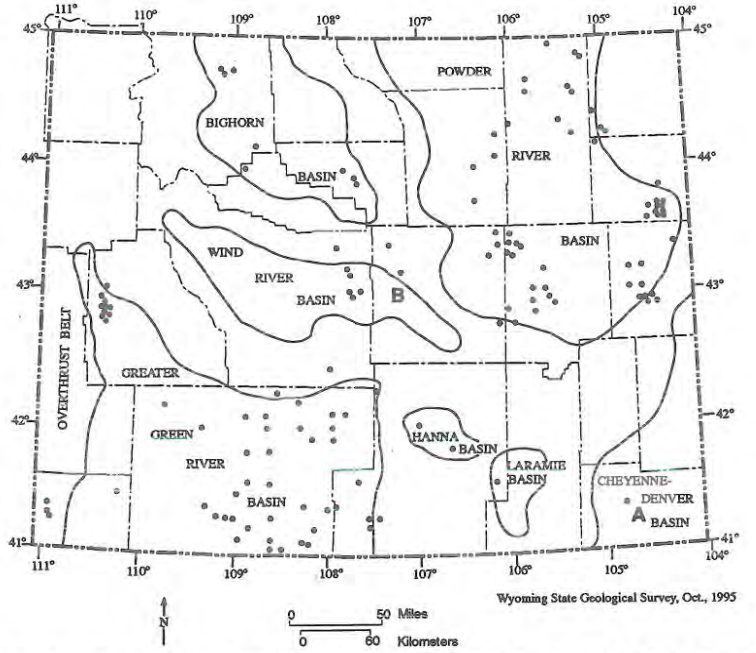

Figure 11. Location of State oil and gas tracts leased by the State Land and Farm Loan Office at the September, 1995, sale.

The State Land and Farm Loan Office's sale in September had a high per-acre bid of $65 made by Wilshire Oil Co. for a 640-acre tract that covers section 8, T15N, R65W (location A, **Figure 11**). The lease is just over a mile southwest of a horizontal oil-producing well in the Niobrara at Silo Field. The sale's second highest per-acre bid was $54 made by James Clark for a lease that covers N/2 NE and NE NW section 8 and NW NW section 9, T35N, R86W. The lease is about three miles southeast of gas and condensate production in Waltman Field (location B, **Figure 11**). Only three leases at this sale received bids of $50 or more per acre.

Exploration and Development

Company data, news releases, and information compiled and published by Petroleum Information indicate the following significant exploration and development events occurred in Wyoming during the third quarter of 1995. The numbers preceding discussions below refer to locations on **Figure 12**.

1. Union Pacific Resources began drilling a horizontal test of the Twin Creek Limestone in Yellow Creek Field. The 30-1H Yellow Creek Shallow well is drilling from a surface location in SE SW section 30, T15N, R120W. True vertical depth of the well is projected at 5,720 feet.

2. Texaco Exploration & Production completed a discovery in the Dakota at its 1 Ham's Fork Unit well in NW SW section 14, T22N, R113W. The well flowed 359,000 cubic feet of gas per day between 11,996 and 12,008 feet. The discovery is two miles west of production from the Frontier and Dakota in the Shute Creek Field area.

3. Celsius completed an offset well to a 30-year-old Wasatch gas discovery at its 8-1 Big Drop well in SW NW section 8, T13N, R99W. The well is about a half mile south of an abandoned Wasatch gas discovery. The new well flowed 5.2 million cubic feet of gas per day from perforations between 2,128 and 2,388 feet.

4. OXY USA completed an infill well in Wild Rose Field. The 2 State E well in NE SW section 16, T17N, R93W flowed 3.1 million cubic feet of gas, 43 barrels of condensate, and five barrels of water per day from the Almond between 9,592 and 9,618 feet.

5. Yates Petroleum completed a new Lewis producer. The 4 Bravo Unit well in NW SE section 4, T23N, R99W averaged 1.1 million cubic feet of gas, 130 barrels of condensate, and 13 barrels of water per day during its first four days of production from an unreported interval.

6. Key Production completed a deeper pool discovery in Golden Goose Field. The 23-8 Golden Goose well in NE SW section 8, T28N, R92W averaged 167 barrels of oil and 1,124 barrels of water per day during its first month of

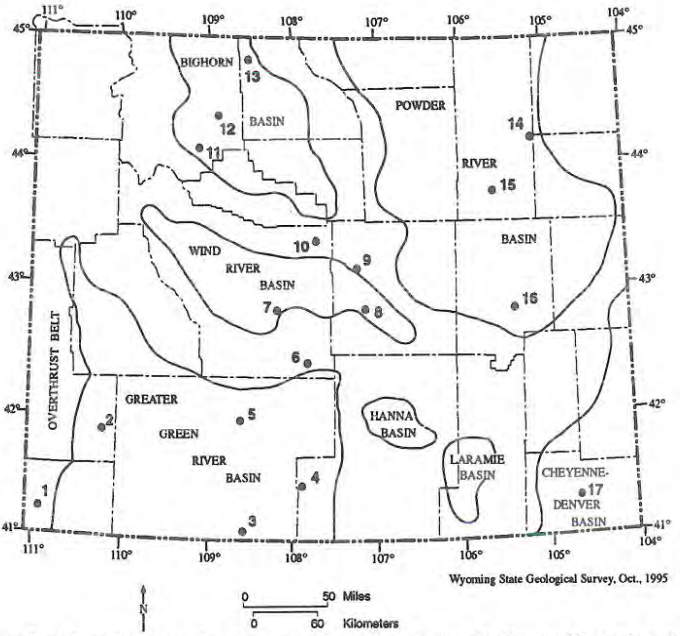

Figure 12. Oil and gas exploration and development activities in Wyoming during the third quarter of 1995 (exclusive of coalbed methane activities).

production from an unreported interval in the Nugget Sandstone. Golden Goose also produces from the Muddy and Dakota.

7. CENEX Inc. completed a horizontal discovery in an unreported interval in the Tensleep Sandstone. The 3-28H Federal well in NE NW section 28, T33N, R95W averaged 51 barrels of oil per day during its first three days of production.

8. Amerada Hess completed a new Muddy "Grieve sand" producer in the Saddlerock Field area. The 35-22 Saddlerock Unit well in SW SE section 26, T33N, R86W flowed 480 barrels of oil and 226,000 cubic feet of gas from between 8,612 and 8,636 feet.

9. Barrett Resources completed a new well in its Cave Gulch Unit. The 3 Cave Gulch Unit well in SW NW section 32, T37N, R86W flowed 5.0 million cubic feet of gas and 40 barrels of condensate per day from perforations between 8,537 and 8,830 feet in the lower Lance. The lower Lance had not been tested in this area.

10. Louisiana Land & Exploration will drill a third test of the Madison Limestone in Madden Field. The two previous wells are producing a combined 50 million cubic feet of gas per day, which is being processed at a new gas plant in the area. This third test, the 4-36 Bighorn well, will be drilled to 24,697 feet in SW NE section 36, T39N, R91W.

11. Marathon Oil will drill horizontal wells from two existing wells in Pitchfork Field. The 4H Pitchfork well is being drilled from a surface location in NW SE section 11, T48N, R102W to an unreported interval in the Phosphoria Formation. The 44H Pitchfork Unit well will be drilled from a surface location in NE SW section 11, T48N, R102W to an unreported interval in the Tensleep Sandstone.

12. Marathon ran production casing at its horizontally redrilled 8H Government Tract 3B well in Oregon Basin Field. The well was drilled from a surface location in NW SW section 5, T51N, R100W to an unreported interval in the Tensleep Sandstone.

13. Texaco Exploration & Production completed its 5 Yates well in SE NE section 33, T56N, R97W. The well flowed 3.6 million cubic feet of gas and 144 barrels of water per day from five Morrison intervals between 1,748 and 1,995 feet.

14. Samedan Oil completed a new well in Duvall Ranch Field. The 2-4 Duvall Ranch Unit well in NW SE section 2, T49N, R69W averaged 293 barrels of oil per day during its first 10 days of production. The well is producing from the Minnelusa at a depth of approximately 8,500 feet and the well extends the limit of the field to the northeast.

15. Meridian Oil completed a new wildcat in the Turner. The new discovery is seven miles northeast of the nearest Turner production at Night Creek Field. The 41-30 Marquiss well in NE NE section 30, T44N, R73W averaged 97 barrels of oil and 17 barrels of water per day during its first six days of production. The well was drilled to an approximate depth of 10,450 feet.

16. Vastar Resources completed two new horizontal discoveries on the southern flank of the Powder River Basin. The 1-27H Idarado well was drilled from a surface location in SW SE section 27, T33N, R71W and flowed 1.75 million cubic feet of gas, 70 barrels of condensate, and 620 barrels of water per day from the Frontier Formation. The well was drilled to a true vertical depth of 11,568 feet. The 1-36 Rooster Rock well, also completed by Vastar, was drilled from a surface location in NE NW section 36, T33N, R71W. The well flowed 1.75 million cubic feet of gas, 245 barrels of condensate, and 50 barrels of water per day from an interval in the Niobrara below a true vertical depth of 10,948 feet. Richardson Operating Co. also completed a horizontal well in this area. The 1H Box Creek well was drilled from a surface location in SW NE section 19, T33N, R71W to a true vertical depth of 11,055. The well was reported as an oil and gas discovery in the Niobrara. No other details have been released.

17. Union Pacific Resources will drill a Niobrara test on the southwestern flank of Silo Field. The 1H Elk Mountain 41-4 well will be drilled from a surface location in NE NE section 4, T15N, R65W.

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COAL UPDATE

P. Daniel Vogler
Staff Geologist-Coal, Wyoming State Geological Survey

After a strong first quarter (up 15% over 1994), coal deliveries for the second quarter didn't rise as high as previously anticipated. Second quarter deliveries were only 7.6% higher than 1994 (**Figure 13** and **Table 8**). The most notable change in Wyoming coal deliveries this year was the weakened spot market for the first six months of the year. Spot deliveries for March and April, especially, were down 15.7% and 11.0% compared to those months in 1994, respectively (**Figure 14**). Spot market tonnages fell below 4 million tons in both April and June. July contract deliveries, however, increased substantially. If coal deliveries follow past trends, Wyoming will be on track to produce an estimated 254.1 million tons of coal for 1995. While coal production may be up for 1995, the majority of the coal produced will be sold at prices below $5.00/ton FOB the mine (**Table 9**). **Table 10** provides an estimate of average coal prices from northeastern Wyoming, southern Wyoming, and the State as a whole.

In the third quarter, Entech, a subsidiary of Montana Power put two of its Wyoming coal properties up for sale. The Grass Creek mine, located roughly 20 miles northwest of Thermopolis, and the Rocky Butte mine, roughly 10 miles south of Gillette, have both been tendered. The Grass Creek mine is the only developed property of the two, being a truck-shovel operation with an estimated 10 million tons of reserves (Vogler and others, 1995). The Rocky Butte mine has never been developed and contains approximately 625 million tons of reserves (Western Water Consultants and others, 1992).

PacifiCorp announced in August that it will lay off 14 employees at its Naughton power plant in western Wyoming. The company said that there are plans to lay off 44 positions at the Jim Bridger power plant and another 25 at the Dave Johnston plant. In July, PacifiCorp reduced the staff at its Centralia plant in Washington by 54.

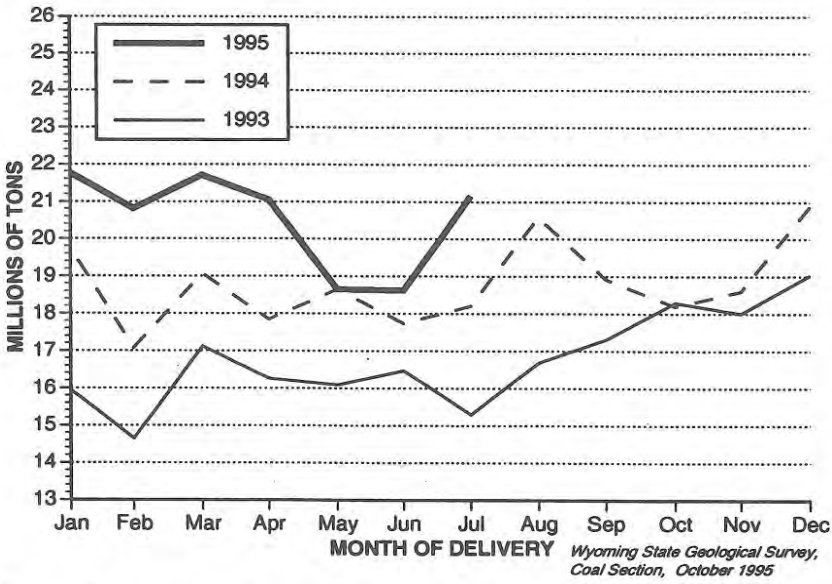


Figure 13. Reported deliveries from Wyoming coal mines (1993 through July, 1995). (From COALDAT Marketing Report by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities).

Black Hills Power & Light has been given approval to raise its electric rates 8.97%. The rate will allow the utility to pay for its newly built Neil Simpson No. 2 power plant near Gillette. According to news releases, this short-term rate increase will actually lower long-term rates below what were previously proposed.

Riverton Valley Electric Association (RVEA) is seeking a rate increase from the Wyoming Public Service Commission. The proposed 16% rate hike would net $1 million. RVEA has cited a decrease in sales resulting from the loss of electricity demand by the regional oil and gas industry.

Union Pacific Resources has plans to offer 37 million shares of common stock at an initial offering of $18-20 in hopes of raising $663.9 million. The net proceeds of the sale, plus a borrowed $248.1 million, will be used to pay a dividend of $912 million to its parent company, Union Pacific Corporation.

The well traveled rail corridor for Powder River Basin coal, from eastern Wyoming to western Nebraska, will become more congested. Union Pacific Railroad's coal delivery demand has risen 17% in the last year according to company officials. Consequently, Union Pacific is increasing the length of their

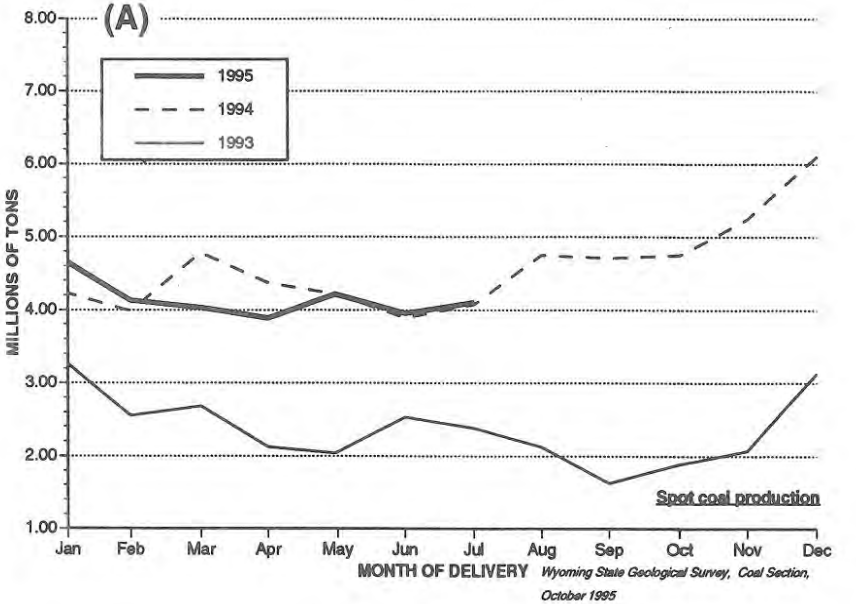
Table 8. Coal deliveries by month from Wyoming mines.

	1992 Monthly	1992 Cumulative	1993 Monthly	1993 Cumulative	1994 Monthly	1994 Cumulative	1995 Monthly	1995 Cumulative
JAN	16,407,150	16,407,150	15,931,150	15,931,150	19,326,770	19,326,770	21,531,910	21,531,910
FEB	14,604,480	31,011,630	14,646,090	30,577,240	17,171,910	36,498,680	20,800,760	42,332,670
MAR	14,429,650	45,441,280	17,112,970	47,690,210	19,178,990	55,677,670	21,707,320	64,039,990
APR	14,063,060	59,504,340	16,259,770	63,949,980	17,839,110	73,516,780	21,047,560	85,087,550
MAY	14,518,590	74,022,930	16,085,470	80,035,450	18,652,290	92,169,070	18,652,290	103,739,840
JUN	14,655,600	88,678,530	16,473,920	96,509,370	17,741,480	109,910,550	18,632,530	122,372,370
JUL	15,592,050	104,270,580	15,296,480	111,805,850	18,213,540	128,124,090	21,154,850	143,527,220
AUG	16,467,100	120,737,680	16,682,090	128,487,940	20,572,120	148,696,210		
SEP	14,878,150	135,615,830	17,310,330	145,798,270	19,129,450	167,825,660		
OCT	15,122,820	150,738,650	18,300,070	164,098,340	18,189,260	186,014,920		
NOV	14,757,230	165,495,880	18,007,970	182,106,310	18,595,500	204,610,420		
DEC	16,096,150	181,592,030	19,034,530	201,140,840	20,866,710	225,477,130		
Total Tonnage Reported[1]		**181,592,030**		**201,140,840**		**225,477,130**		
Total Tonnage Not Reported to FERC		**7,878,226**		**8,784,986**		**11,430,937**		
Total Tonnage Produced[2]		**189,470,256**		**209,925,826**		**236,908,067**		

[1] COALDAT Marketing Reports by Resource Data International, Inc., compiled from FERC Form 423 filed monthly by electric utilities

[2] State Mine Inspector's Annual Reports

Wyoming State Geological Survey, Coal Section, October, 1995



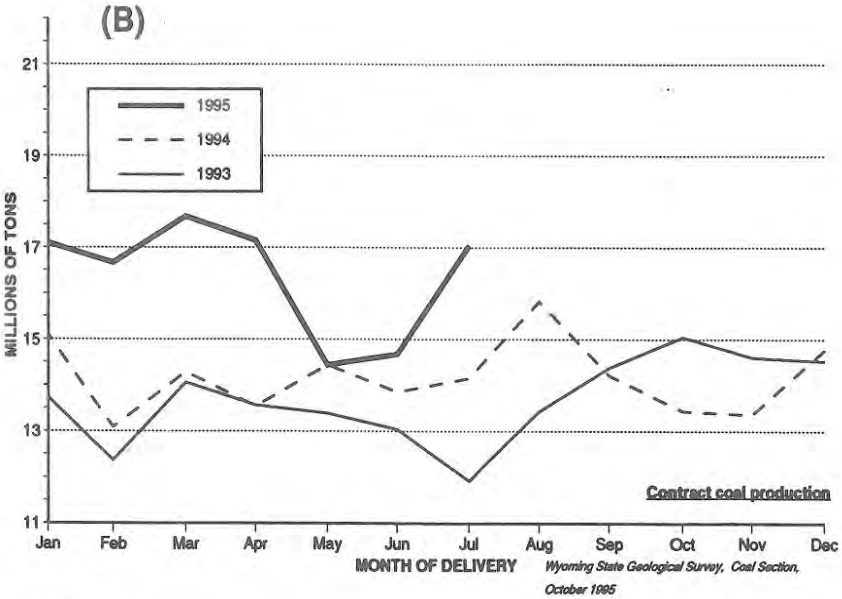


Figure 14. Monthly coal deliveries from Wyoming (1993 through July, 1995). (A) Coal sold on the spot market and (B) coal sold on contract. (From COALDAT Marketing Report by Resource Data International, Inc. compiled from the FERC Form 423 filed monthly by electric utilities).

Table 9. Coal production (1992 to 1994) with forecast to 2002 (millions of tons).

	1992	1993	1994	1995[1]	1996[1]	1997[1]	1998[1]	1999[1]	2000[1]	2001[1]	2002[1]
Campbell County	159.6	181.9	205.2	220.1	229.9	240.2	250.8	262.1	268.6	275.3	275.9
Converse County	8.5	10.2	11.7	12.5	13.1	13.7	14.3	14.9	15.3	15.7	15.7
Sheridan County	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Carbon County	4.1	4.4	4.4	4.7	4.9	5.2	5.4	5.6	5.8	5.9	5.9
Sweetwater County	12.6	9.2	11.2	12.0	12.5	13.1	13.7	14.3	14.7	15.0	15.1
Lincoln County	4.6	4.1	4.3	4.6	4.8	5.0	5.3	5.5	5.6	5.8	5.8
Hot Springs County	M	M	M	M	M	M	M	M	M	M	M
Total Wyoming	189.5	209.9	236.9	254.1	265.4	277.3	289.6	302.6	310.1	317.8	318.5
Annual Change	-2.3%	10.8%	12.9%	7.3%	4.4%	4.5%	4.4%	4.5%	2.5%	2.5%	0.2%
Low-priced coal[2]	57%	64%	67%	73%	75%	77%	82%	86%	90%	93%	94%

[1]Estimates by the Wyoming State Geological Survey, October, 1995. [2]Estimated percentage of total production that is sold on the spot market, through short-term contracts [less than one-year duration], or through renegotiated, longer-term contracts all at prices under $5.00. M means minor tonnage (less than 0.1 million tons).

Table 10. Breakdown of average prices paid for coal from northeastern Wyoming, southern Wyoming, and statewide (1988-1994) with forecasts to 2002[1].

YEAR	NORTHEASTERN	SOUTHERN	STATEWIDE
1988	$7.35	$21.45	$9.16
1989	$6.94	$19.76	$8.63
1990	$6.86	$19.36	$8.43
1991	$6.61	$18.81	$8.09
1992	$6.62	$18.84	$8.14
1993	$6.25	$17.72	$7.32
1994	$5.61	$17.13	$6.62
1995	$5.39	$17.12	$6.33
1996	$5.32	$17.05	$6.23
1997	$5.27	$17.02	$6.15
1998	$5.20	$16.99	$6.04
1999	$5.13	$16.64	$5.94
2000	$4.95	$16.61	$5.75
2001	$4.87	$16.57	$5.65
2002	$4.98	$16.41	$5.70

[1]Source of statewide data for 1988-1993 is the Energy Information Administration of the U.S. Department of Energy; forecasts for 1994-2002 are from the Wyoming Consensus Revenue Estimating Group. Regional breakdowns are estimated by the Wyoming State Geological Survey.

unit trains by 40-60 cars, making a unit train of 150 or more cars and over 2 miles long. The Burlington Northern-Santa Fe railroad's demands have also increased and they may elect to build even more track to handle the increased number of trains.

In related news, the State of Colorado failed to buy the Wyoming & Colorado Railroad Co.'s rail line from Walden to the Union Pacific line in Wyoming. Loss of this trackage will reduce the likelihood of developing some low-sulfur coal near the town of Walden. Also in Colorado, Cyprus-AMAX announced it was closing its Empire mine on December 10. This mine closure will result in the loss of 81 jobs. In July, 140 workers at Kennecott Energy's Colo-Wyo mine took buyouts aimed at reducing the work force at that Colorado mine.

Developments in the Powder River Basin

The U.S. Bureau of Land Management (BLM) has received two new Lease By Application (LBA) tract nominations. Jacobs Ranch nominated the Thundercloud tract, which contains approximately 4,000 acres and an estimated 432 million recoverable tons of coal. The tract is between the existing Jacobs Ranch and Black Thunder mines. The BLM (1983) indicated that this tract contains 8800+ Btu/lb coal with an average sulfur content of 0.39% on an as-received basis. The thick Wyodak coal bed underlies the property and dips to the west. Black Thunder and Jacobs Ranch are both presently drilling this property to verify coal stratigraphy and quality.

A second LBA, which was nominated by Powder River Coal, is a tract adjacent to the northern boundary of the present North Antelope W-119554 lease. It contains an estimated 550 million recoverable tons of coal. The average coal quality on this tract is likely to be about 8800+ Btu/lb and 0.3% sulfur.

KFx, the company that holds the rights to the K-Fuels process, announced in August that it had secured funding to complete a $42 million coal processing plant near Gillette. KFx said it had reached a licensing agreement with Thermo Ecotek Corp. of Waltham, Massachusetts, to build the plant in exchange for a 95% share of the project. A contract with Ohio Valley Electric Co. has been signed to deliver 500,000 tons of coal per year from this plant. KFx plans to build the plant at the Fort Union mine site. The plant is designed to process 700,000 tons of coal per year. The annual plant output would be 500,000 tons/year of coal enhanced to 11,000 Btu/lb. The main component of the enhancement process is drying of the coal.

Also in August, Carbontec announced plans to build a two-million-ton/year coal processing plant near Gillette. Although it is not known where the plant will be constructed, Carbontec plans to have the plant operational by November of 1996.

In Montana, the Crow Indian Tribe has expressed interest in opening a mine on the reservation near Young's Creek. The 2560-acre tract includes three Anderson-Dietz seams with 9400-9500 Btu/lb, 0.5% sulfur, and 3-4% ash. Arch Minerals, Kennecott Energy, CONSOL, Pittsburg & Midway Mining Company, Peabody Holding Company, Cyprus-AMAX, Franklin Coal Sales (Ziegler), Horizon Coal Sales (Entech), and Washington Construction Company have expressed interest in this tract (Montana Coal Council, 1995a).

In other Montana news, Meridian Minerals has sold its property near Roundup to John P. Baugues of Mountain, Inc., Knoxville, Tennessee. The property, which consists mainly of Tertiary coals, is in the southwestern Bull Mountain Basin. The reserves would be mined underground. Baugues intended to start the mine in mid-October. Annual production should be one million tons per year by 1997. He has commitments from Japanese and South Korean buyers for 500,000 tons/year. The mine is permitted for three million tons of coal per year (Montana Coal Council, 1995b).

Developments in Western and Southwestern Wyoming

Cougar Coal Co. recently announced that their mine near Rock Springs, formerly known as the Swanson mine, will remain closed. Recently Union Pacific Resources invested $200,000 to determine if it would be economic to reopen the mine. The mine was closed last Spring after a substantial ($1.3 million) tax delinquency had been realized.

Solvay Minerals Inc. announced in July that it would be switching from coal to gas at its soda ash processing plant west of Green River. It is not clear when the switch will actually occur.

The Rock Springs firm of Johnson-Fermelia recently completed a preliminary report on its assessment of subsidence risk at Rock Springs, Diamondville, Kemmerer, and surrounding areas. The drilling indicates that little risk is associated with the Diamondville and Kemmerer areas. In the Rock Springs area, the main areas of concern are the Blairtown area (southwestern Rock Springs) and the area along Interstate 80 near the old No. 7 mine of the Rock Springs Coal Company.

It was announced in July that the old Gebo underground coal mine near the town of Gebo would be partially reclaimed. The project was to be completed in September.

Arch Minerals' Seminoe II mine reopened on July 1st. Coal deliveries from Seminoe II should have begun in the third quarter. The reopening of this mine comes at the same time that production from Arch Minerals' Medicine Bow mine is declining.

The Carbon County Underground Coal Gasification Project has been temporarily stalled due to mechanical problems. Sources indicated that the test burn would resume soon.

Contracts

New coal contracts, test burns, solicitations, and spot sales for the third quarter of 1995 are summarized in **Table 11** and **Figure 15**.

In the third quarter, utilities in Texas were the most active in contracting for Wyoming coal. But the largest contract awarded was Lower Colorado River Authority's agreement with Cordero for 1.8 million tons of coal to be delivered in 1996. Caballo also signed a significant agreement, which will provide Southwestern Public Service Co. with 1.3 million tons/year in 1996 - 1997.

And quite significantly, the Texas Municipal Power Agency (TMPA) announced that they were switching from Texas Gulf Coast lignite to subbituminous coal as their primary feedstock. Subsequently, TMPA announced a solicitation for 0.9-1.8 million tons of subbituminous coal per year for testing. TMPA's switch, coupled with the news that petcoke blend tests at Houston Power & Light's Parish Plant were not very successful, may bode well for increasing the Texas market for Powder River Basin coals.

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Bureau of Land Management, 1983, Powder River coal tract summaries: U.S. Department of the Interior, 128 p.

Table 11. Activities involving coal producers in Wyoming during the third quarter of 1995[1].

	Utility	Power Plant	Coal Mine/Region	Activity	Tonnage	Comments
1.	Central and Southwest Services	various plants	Powder River Basin coal	So	3,500,000 t	
2.	Detroit Edison	various plants	Black Thunder Antelope	Sp Sp	400,000 t 200,000 t	
3.	Energy Service Co.	various plants	Powder River Basin coal	So	1,000,000 t	
4.	Hastings (NE) Utility Dept.	Whelan Energy Center	Powder River Basin coal	So	50,000-200,000 t	
5.	Independence (MO) Power & Light Dept.	White Bluff or Independence	Powder River Basin coal	So	150,000-250,000 t	Potential need for truck deliveries.
6.	Lower Colorado River Authority	Fayette Power Project No. 1 & 2	Cordero Black Thunder/Coal Creek	C Sp	1,800,000 t 400,000 t	
7.	Minnesota Power & Light	Boswell	Wyoming coal	So	500,000 t	1996 delivery.
8.	Omaha Public Power District	North Omaha Nebraska City	Powder River Basin coals	C	800,000 t	
9.	St Joseph (MO) Power & Light	Lake Road	Shoshone Black Thunder	T T	10,000 t 10,000 t	
10.	San Antonio Public Service Board	Deeley and Spruce	Powder River Basin coals	So	2,500,000 t	
11.	Southwestern Public Service Co.	Harrington	Black Thunder Caballo	Sp Sp	500,000 t 500,000 t	Caballo will continue 1.3 MMTPY through 1997.
12.	Texas Municipal Power Agency	Gibbons Creek	Subbituminous coal	So	900,000-1,800,000 t	For testing.

[1] Data obtained from : Coal Week, trade journals, periodicals, FERC database, and personal contacts.
C =Contract coal; T =Test burn; Sp =Spot coal; So =Solicitation; t =short ton; MMTPY =Million tons per year.
Wyoming State Geological Survey, Coal Section, October, 1995

Wyoming State Geological Survey, Coal Section, October 1995

Figure 15. Coal marketing activities related to Wyoming in the third quarter of 1995. [Numbers correspond to those in Table 11].

Montana Coal Council , 1995a, Montana Coal Council: September newsletter, Helena, 2 p.

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Western Water Consultants, Mariah Associates, Inc., and Browne, Bortz & Coddington, Inc., 1992, Final West Rocky Butte Coal Lease Application Environmental Impact Statement: U.S. Department of the Interior, Bureau of Land Management FES 92-11, p. 2-4.

INDUSTRIAL MINERALS AND URANIUM UPDATE

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Bentonite

Bentonite is a clay mineral with high ion exchange capabilities and which expands many times its dry volume when wet. It is used as a drilling mud, an additive that lubricates and cools the bit and carries rock fragments out of the hole. Other uses for bentonite such as in foundry clays, taconite pellets, containment barriers, mineral fillers, and kitty litter have increased while the amount of bentonite consumed by the drilling mud industry has decreased. Currently, these other uses account for most of the bentonite sold from mills in Wyoming.

Wyoming produces more bentonite than any other state. Other states with bentonite production are Montana, South Dakota, and Mississippi. In Wyoming, bentonite is mined in Big Horn, Crook, Johnson, Washakie, and Weston Counties (**Figure 16**).

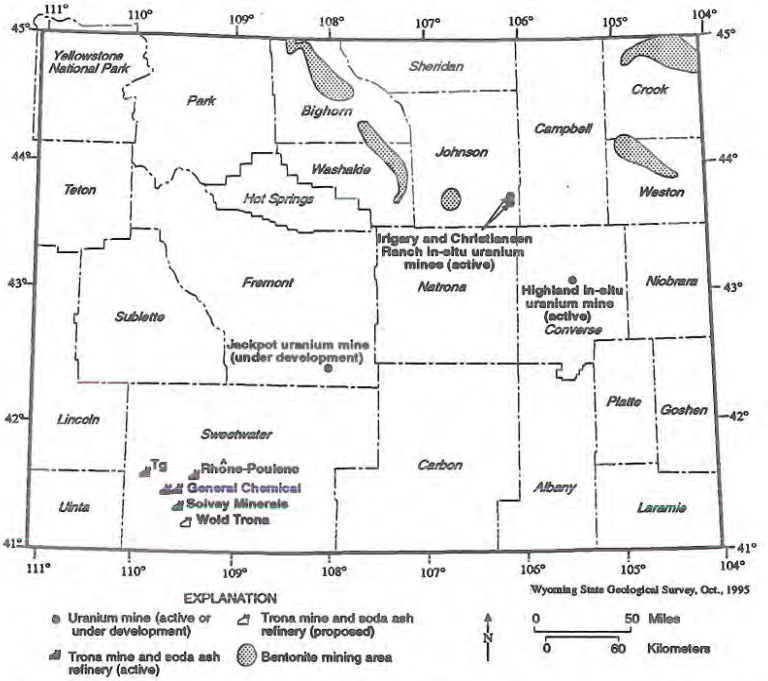

Figure 16. Industrial minerals and uranium activities in Wyoming during the third quarter of 1995.

During the third quarter of 1995, M-I Drilling Fluids purchased Fremont Chemical of Riverton. This purchase will expand the services of M-I and provide additional sales of their bentonite, which is used in drilling mud.

Construction Aggregate

Construction aggregate is crushed and sized rock or sized gravel (river rock) that is mixed with cement to make concrete, mixed with asphalt to make road surfacing material, or used in a variety of other construction products. Construction aggregate has been produced in all of Wyoming's counties. According to current law, construction aggregate is not classified as a mineral, which means it belongs to the surface owner. The surface owner, therefore, has the right to sell construction aggregate from his or her property.

In July of 1995, the Wyoming Supreme Court ruled that because construction aggregate is not a mineral, counties can regulate its extraction. This ruling could seriously affect some aggregate owners and producers, since the ruling puts aggregate operations under the jurisdiction of county zoning and planning ordinances. Previously, construction aggregate has been treated more as a mineral right. As a result of this court ruling, the Natrona County Commissioners placed a moratorium on issuing new non-mineral mining permits. Caught in the moratorium is JTL Group's plan to open an aggregate quarry near the Edness Kimball Wilkins State Park.

Trona

Trona, a naturally occurring sodium sesquicarbonate mineral, is mined in Wyoming at five locations west of Green River, and processed into soda ash and a variety of sodium-based products at refining plants near the mines. A sixth mine and refining plant is under development (**Figure 16**).

Wyoming produces 90% of all of the soda ash from the U.S. The remaining 10% is produced in California from trona dredged from a saline lake in the Mojave Desert. Surficially exposed trona is also mined in Africa, and a deposit of bedded trona similar to Wyoming's is mined in Turkey. The rest of the world produces soda ash synthetically, using the Solvay Process. This process uses limestone, salt, and carbon dioxide. The Solvay Process is energy-intensive and costs much more than refining mined trona.

Wyoming's reserves of trona are enormous. The U.S. Geological Survey recently released a report on Wyoming's trona deposits (Wiig and others, 1995). Wyoming's reserves of trona are now calculated at 127 billion tons of mineable trona (occurring in beds four feet or greater in thickness). At the present rate of mining, that's enough to last almost 8,000 years, and it's enough to supply the entire world with soda ash for 2,500 years at the present rate of consumption.

Over one-third of Wyoming's soda ash is exported. That figure may increase because a Japanese soda ash producer announced it will close its

Solvay Process plant and import its soda ash requirements, most of which will come from Wyoming. The Japanese plant reportedly produced 200,000 short tons of soda ash per year. Wyoming's annual soda ash production, which is about 7.1 million tons will increase proportionally. Several of the soda ash refineries are expanding their plant capacity to accommodate anticipated increases in production.

The U.S. Bureau of Land Management (BLM) has not increased the royalty it charges for mined trona above the current 5% as reported in the last issue of *Wyoming Geo-notes*. The BLM, however, still wants to raise the royalty. Meanwhile, Wyoming's U.S. Representative Barbara Cubin has introduced legislation capping the Federal royalty rate at 5.5%.

In June, the soda ash producers announced increases in the spot price of soda ash from $90 per ton to $97 - $105 per ton. Contracted prices remain below these rates, which are the prices for over-the-counter sales by the producers.

Uranium

Uranium spot market prices have increased from around $7.00 per pound of yellowcake a year ago to $11.70 - $12.00 per pound. Much of this increase is due to the removal of artificially low prices established by NUEXCO.

Energy Fuels Nuclear, which had announced plans to start up uranium production from the Reno Ranch deposit in southern Campbell County, has gone out of business. It was a subsidiary of NUEXCO.

The only planned mine in Wyoming, other than the two operating in-situ properties, is the Jackpot mine, being developed by Kennecott in partnership with U.S. Energy-Crested Corporation. The mine site is located south of Jeffrey City on Green Mountain (**Figure 16**). The developers are confident that it will come into production sometime in the future. They have almost completed the planning and permitting process, but no startup date has been announced.

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METALS AND PRECIOUS STONES UPDATE

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The Metals and Precious Stones Section has compiled a partial list of Mineral Reports that have been prepared by the Wyoming State Geological Survey. These reports, which are available for the cost of photocopying, vary in detail and content and may consist of field notes, maps, assays, and other

geochemical data. The reports are also available for examination at the State Geological Survey's building in Laramie. In addition to the following reports, the Section also has numerous other reports from the late 1800s to early 1900s. A list of these other reports will be available from the section at a later time. For information on any of the following reports, contact W. Dan Hausel. The reports are listed in chronological order. The Mineral Report number and number of pages is also given.

Hausel, W.D., 1979, Evaluation of State Section 16, T12N, R73W for mineralization and kimberlite occurrences: Mineral Report MR79-1, 3 p.

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Hausel, W.D., 1980, South French Creek mineralized area, Albany and Carbon Counties: Mineral Report MR80-2, 3 p.

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Hausel, W.D., 1981, PEG copper claims, Rennecker Peak (Christina Lake Quadrangle): Mineral Report MR81-1, 2 p.

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Hausel, W.D., 1981, Geology of the Comstock mine and lode, Silver Crown district: Mineral Report MR81-3, 9 p.

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Hausel, W.D., and Jones, Suzanne, 1982, Field notes - Lost Muffler gold prospect, Rattlesnake Hills: Mineral Report MR82-9, 5 p.

Hausel, W.D., 1982, Field notes and assay report for the Sutherland and Red Boy prospects, Tin Cup district, Fremont County, Wyoming: Mineral Report MR82-10, 7 p.

Hausel, W.D., 1982, Report on assays of arsenopyrite-quartz veins on the Sweetwater River, South Pass greenstone belt, Wyoming: Mineral Report MR82-11, 3 p.

Hausel, W.D., 1983, Field notes (and mine map) on the Gold Dollar mine, South Pass district, Wyoming: Mineral Report MR83-1, 5 p. (map scale 1:240).

Hausel, W.D., 1983, Field report (and mine map) on the Dream gold mine, Lewiston district, South Pass greenstone belt, Wyoming: Mineral Report MR83-2, 5 p. (map scale 1:240).

Hausel, W.D., 1983, Field notes (and mine map) on the Carrie Shield gold mine, South Pass district, Wyoming: Mineral Report MR83-3, 5 p. (map scale 1:240).

Hausel, W.D., 1983, Field notes on the Michigan iron-copper mine, Hartville uplift, Goshen County, Wyoming: Mineral Report MR83-4, 5 p.

Hausel, W.D., 1983, Assay report on samples collected from the Lewiston, Burr, and Section 33 mines, Lewiston district, South Pass: Mineral Report MR83-5, 3 p.

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Hausel, W.D., 1983, Update on the Independence mine (section 8, T15N, R78W), Centennial Ridge district, Albany County, Wyoming: Mineral Report MR83-14, 5 p.

Hausel, W.D., 1983, Unnamed copper prospect at Granite, Laramie County, Wyoming: Mineral Report MR83-15, 3 p.

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Hausel, W.D., 1988, Assay report on vein samples from Mormon Canyon: Mineral Report MR88-2, 3 p.

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MINERAL RESOURCE AND RESERVE BASE ESTIMATES FOR WYOMING

PETROLEUM

Remaining Technically Recoverable Resources (January 1, 1995)	
Discovered (Includes oil, gas liquids, and condensate)	3.69 billion barrels[1]
Undiscovered	6.18 billion barrels[1]
Total	9.87 billion barrels
Remaining Reserve Base (January 1, 1995)	
Measured reserves (Proved reserves) (Includes oil, gas liquids, and condensate)	1.05 billion barrels[2]
Indicated and inferred reserves (Reserve growth in conventional fields)	2.64 billion barrels[1]
Total	3.69 billion barrels

NATURAL GAS

Remaining Technically Recoverable Resources (January 1, 1995)	
Discovered (Includes 36.2 trillion cubic feet (TCF) of methane[1] and 121.8 TCF of CO_2[3])	158.0 trillion cubic feet
Undiscovered (Includes 15.72 TCF of conventional methane[1]; 5.43 TCF of coalbed methane; 119.3 TCF of methane in tight gas sands in the Green River Basin; and 31.2 TCF of CO_2[3])	171.6 trillion cubic feet
Total	329.6 trillion cubic feet
Remaining Reserve Base (January 1, 1995)	
Measured reserves (Proved reserves) (Includes 10.2 TCF of methane[2] and 60.2 TCF of CO_2[3])	70.4 trillion cubic feet
Indicated and inferred reserves (Reserve growth in conventional fields)	26.0 trillion cubic feet
Total	96.4 trillion cubic feet

COAL

Remaining Resources (January 1, 1995)	
Identified and Hypothetical (Discovered)	1,427.8 billion tons[4]
Speculative (Undiscovered)	31.5 billion tons[4]
Total	1,459.3 billion tons
Remaining Reserve Base (January 1, 1995)	
Demonstrated strippable (Measured and indicated reserve base)	26.2 billion tons[5]
Demonstrated underground-minable (Measured and indicated reserve base)	42.5 billion tons[5]
Total	68.7 billion tons

TRONA

Original Resources (1995 estimate)	
Trona	76.0 billion tons[6]
Mixed trona and halite	51.0 billion tons[6]
Total	127.0 billion tons

URANIUM

Remaining Resource (December 31, 1989)	1.99 billion pounds U_3O_8[7]
Remaining Reserve Base (December 31, 1989)	
Uranium oxide recoverable at $30.00 per pound	66 million pounds[7]

OIL SHALE

Original Resources (January 1, 1981)	
Identified (Discovered)	320 billion barrels of shale oil[8]

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GEOLOGIC MAPPING AND STRATIGRAPHY UPDATE

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NEW GEOLOGIC MAPS COMPLETED FOR LARAMIE AREA

The Wyoming State Geological Survey recently released two new geologic maps covering the city of Laramie and an area to the south, including Red Buttes (**Figure 17**). These black and white maps are the first and second in a series of maps designed to aid city and county planners, industry, and the general public in more populated areas of Wyoming. These 1:24,000-scale maps (Laramie and Red Buttes Quadrangles) show the bedrock and surficial rock deposits in the Laramie area and the area south of Laramie, including the Buttes and Summit Estates housing developments. The maps provide information relating to mineral resources, geologic hazards, general geology, and structural geology as it relates to development and planning and to groundwater within the mapped area.

The maps depict where sand and gravel, limestone, and gypsum resources have been or are mined. Information is supplied on areas prone to debris flows or landslides, unstable windblown deposits, and areas of gypsum-rich soils, all of which should be considered in future development of the area. In addition, new structural information, commonly used in locating good sites for water wells, is included on the maps. Previously unrecognized folds and faults have been mapped, along with a new interpretation of the Red Hills fault complex, which runs north-south along the west flank of the Laramie Mountains, southeast of Laramie.

The *Preliminary geologic map of the Laramie Quadrangle* and the *Preliminary geologic map of the Red Buttes Quadrangle* are available from the Wyoming State Geological Survey as Preliminary Geologic Map 95-1 (PGM 95-1) and Preliminary Geologic Map 95-2 (PGM 95-2), respectively.

In a related note, the Geologic Mapping Section recently completed fieldwork on the Howell Quadrangle (**Figure 17**), located immediately to the north of the Laramie Quadrangle and the city of Laramie. The Spur Ridge, Sagebrush Park, and Sunset Acres housing developments occur within this quadrangle. The mapping identified previously unmapped faulting and folding and the Quaternary deposits were defined in much greater detail. Section personnel discovered dinosaur bone fragments in one of the Jurassic Morrison outcrops on

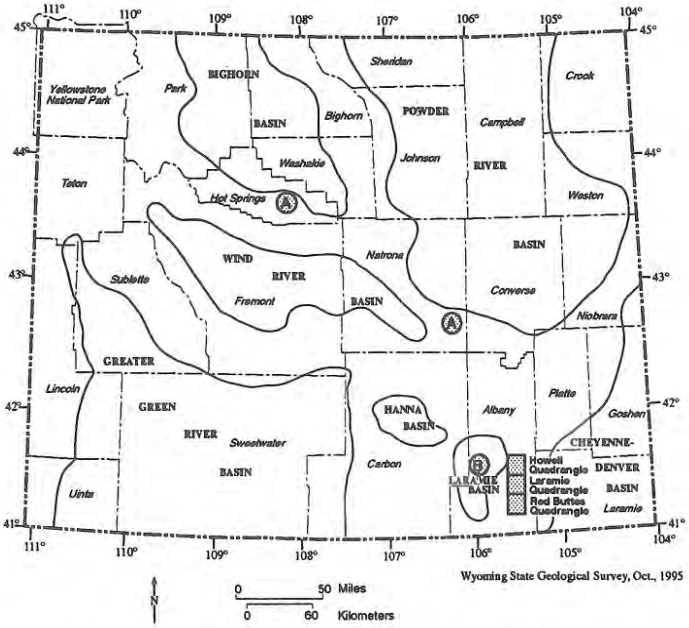


Figure 17. Index to selected reports and maps on Wyoming geology.

the quadrangle. However, further analysis of the outcrop is needed to determine the significance of the find. This map will be completed and available in 1996.

NEW INDEX OF GEOLOGIC MAPS COMPLETED

The Wyoming State Geological Survey recently released an index to selected out-of-state university theses and dissertation maps for areas in Wyoming. The index shows what area of the State has been mapped, lists the thesis or dissertation title, the university or college of origin, and the scale of the map. A total of 89 maps are indexed and paper copies of each map are kept in various Survey files. These 89 maps only represent a portion of the maps done by students in out-of-state universities and colleges. However, additional maps are being added to the Survey's files on a continuing basis. The index is available as Map Series MS-9S. Since the Geologic Mapping Section compiled this index using a digital format, it is easily and quickly updated as new maps are acquired. The Survey previously published seventeen other maps in this index series. All of these indices will be updated, and the number of them will be reduced by combining various of the existing indices together.

NEW BILL FOR FOSSIL COLLECTING ON FEDERAL LANDS PROPOSED

Congressman Johnson of South Dakota has written a bill entitled the "Fossil Protection Act of 1995". While current regulations allow hobbyists and scientists to collect invertebrate fossils on Federal lands for personal use only, vertebrate fossils can only be collected by scientists, upon issuance of a permit. The most significant aspect of the proposed bill centers around its provision allowing for commercial collection of vertebrate fossils on Federal lands, which is currently prohibited by regulations. Current laws and regulations governing the collection of fossils on Federal land are listed below:

Federal Land Policy and Management Act (43 U.S.C. 1732, Sec. 302 (b) of PL 94-579, 1976)

Theft of Government Property (62 Stat. 725; 18 U.S.C. 641)

Destruction of Government Property (62 Stat. 764; 18 U.S.C. 1361)

43 CFR 8365 (hobby collection of common invertebrate fossils; prohibits creating a hazard or nuisance)

43 CFR 3622 (hobby collection of petrified wood; prohibits undue degradation)

43 CFR 3610 (commercial collection of petrified wood)

Archeological Resources Protection Act (16 U.S.C. 470-aa-470mm; PL 96-96, 1979 and amendments)

Anyone interested in seeing a copy of the proposed bill can contact Gary Glass or Alan Ver Ploeg at the Wyoming State Geological Survey by calling (307) 766-2286.

NEW REPORTS DETAIL SOME STRUCTURAL GEOLOGY IN WYOMING

Two new articles on Wyoming structural geology were recently published. Stone (1995) discusses the Quealy wrench duplex, which contains a fault bordered pop-up structure that is associated with the Quealy Dome oil field in the Laramie Basin of southeastern Wyoming. This pop-up structure occurs between the North Quealy and South Quealy right lateral strike-slip faults, which are oriented west southwest to east northeast. Stone points out that the complexity of this structural feature, which escaped recognition by previous workers looking at the surface geology, was recently unraveled with the aid of several seismic

profiles. The results of this study could be useful in locating similar structures in this area that might have petroleum potential.

Molzer and Erslev (1995) propose tectonic models to explain the east-west basement-cored arches in central Wyoming, which are oblique to the northwesterly trending foreland faults and folds. The authors examine the structural features of the Owl Creek Mountains and Casper Mountain to test their tectonic model. The results of this study have important implications to petroleum exploration models and concepts used to explain these types of structural trends.

Both of these articles are listed below, and the area of study is indicated on the accompanying index map (**Figure 17**).

A. Molzer, P.C., and Erslev, E. A., 1995, Oblique convergence during northeast-southwest Laramide compression along the east-west Owl Creek and Casper Mountain arches, central Wyoming: American Association of Petroleum Geologists Bulletin, v. 79, no. 9, p. 1377-1394.

B. Stone, D.S., 1995, Structure and kinematic genesis of the Quealy wrench duplex: Transpressional reactivation of the Precambrian Cheyenne Belt in the Laramie Basin, Wyoming: American Association of Petroleum Geologists Bulletin, v. 79, no. 9, p. 1349-1376.

GEOLOGIC HAZARDS

James C. Case
Staff Geologist-Geologic Hazards, Wyoming State Geological Survey

HOW TO MAKE YOUR WYOMING HOME MORE EARTHQUAKE RESISTANT

Damaging earthquakes can occur in any part of Wyoming, although the potential for damage is greatest in the western part of the State. The largest earthquake expected in western Wyoming would have a magnitude of 7.5; the largest expected in central Wyoming would have a magnitude of 6.75; and the largest expected in northern, eastern, and southern Wyoming would have a magnitude of 6.1.

A magnitude 7.5 earthquake could produce ground shaking so intense that most masonry and frame structures in the vicinity of the epicenter could be destroyed. A magnitude 6.75 earthquake could also produce significant damage in structures. Chimneys may fall, panel walls may be thrown out of frame structures, and partial collapse may occur in ordinary substantial buildings. A magnitude 6.1 earthquake could result in slight to moderate damage in well-built ordinary structures, with considerable damage in poorly built or badly designed structures.

Obviously, there is potential for people to be hurt in their homes if the structure partially or completely fails. During an earthquake, people can also be hurt from non-structural damage within their homes. Lights falling, bookcases tipping, and water heaters overturning all can lead to additional home damage or personal injury. In fact, in the United States, much of the damage or personal injury that occurs during an earthquake is non-structural in nature.

There are some things that a home owner or contractor can do to reduce the potential for home damage and personal injury from either structural or non-structural causes. Those actions, with simple explanations, are presented below. More detailed explanations can be obtained from the Wyoming State Geological Survey, the Wyoming Emergency Management Agency, or select offices of the Red Cross. It may be necessary to contact a contractor for unusual construction or situations.

Mitigation of Structural Damage

Bolting the wood frame (sill plate) of a house to its concrete foundation

If a house is not securely attached to its foundation, it could slip off the foundation during an earthquake. Although most newer homes are securely attached to the foundation, some newer homes and many older homes may not be properly attached. If the foundation is sound, the home can be attached to the foundation by bolting the sill plate to the foundation. The sill plate is the lowermost horizontal wooden member of the frame of the house. It bears the upright portion of the frame.

The sill plate can be bolted to the foundation using the following procedures:

Step 1) Drill 1/2" or 5/8" holes every 4' to 6' along the sill plate. The 1/2" holes may be adequate in areas of the State with a lower earthquake hazard. Drill the holes about 8 1/2" deep into the sill plate and concrete. Remove dust from the holes.

Step 2) Drive a 1/2" or 5/8" expansion bolt, 7"-8 1/2" long, with a top nut and washer in place into the hole with a sledgehammer. When the bolt cannot be

driven in any farther, tighten the nut down. Use a 1/2" bolt in the 1/2" hole, and a 5/8" bolt in the 5/8" hole.

Step 3) If there are any splices or steps in the sill plate, place bolts on either side of the step or splice (6"-12" from the end or splice).

Sheathing cripple walls

Houses often have short wood frame walls between the concrete foundation and the floor joists, especially houses with crawl spaces. These short walls are called cripple walls. If the cripple wall is not adequately braced, the home can shift sideways during an earthquake. The shifting can be minimized if the cripple walls are braced by attaching plywood sheathing to the vertical studs attached to the sill plate. Apply this sheathing in the following manner:

Step 1) If the sill plate is wider than the studs, install a horizontal block of wood as a bottom nailer between all of the studs. The bottom nailer must have the same width as the studs, and must be firmly attached to the sill plate.

Step 2) Cut sheets of 1/2" structural grade plywood so that the entire exposed portion of the cripple wall can be covered. If the cripple wall is longer than the sheets of plywood, cut the plywood so that adjacent sheets meet at the centerline of a stud.

Step 3) Nail the plywood to the studs by placing a nail every 3" to 4" around the perimeter of each sheet, making sure that the nails are driven into the studs. Then place a nail every 6"-12" along each stud within the perimeter of the sheet.

Step 4) Between each stud, drill a 1 1/2" ventilation hole at the top and bottom of the plywood sheath. Position the holes a few inches up from the sill plate and a few inches down from the top plate.

Mitigation of Non-structural Damage

Securing water heaters

During an earthquake, water heaters can overturn, possibly resulting in a gas leak or a fire or explosion associated with a gas leak. You can reduce the potential for these problems to occur by anchoring the water heater to the floor and(or) to nearby walls, and by installing a flexible gas line to the water heater. A water heater within 12" of a stud wall can be secured by taking the following actions:

Step 1) Mark the water heater at 6"-9" down from the top and 4"-6" up from the bottom controls. Locate the wood studs in the wall next to the water heater, and mark the stud that is closest to the right side of the heater and the stud that is closest to the left side of the heater. Transfer the two marks on the water

heater to the two selected studs. The marks should be transferred horizontally. There should be a total of four marks, with two on each stud.

Step 2) Drill a 3/16" diameter hole into each stud at the marked locations. Make the holes 3" deep.

Step 3) Measure around the water heater and add 2" to the measurement. Cut two pieces of 3/4" x 24 gauge perforated steel plumbers tape to the above measurement. Place a 1/4" x 1" round-head machine screw with a washer through one end hole of each of the tapes, and make a 90 degree bend as close to the edge of the washer as possible. Place these assemblies around the water heater, and put the machine screws through the nearest hole in the other end of the tapes. Temporarily fasten the tapes by putting a washer and nut on each of the screws and tighten the nuts.

Step 4) Using a yardstick, measure the distance from each of the holes in the studs to the point where the yardstick touches the metal tape around the water heater. Take the measurements from the upper right (left) stud hole to the point where the yardstick touches the right (left) side of the upper tape, and from the lower right (left) stud hole to the point where the yardstick touches the right (left) side of the lower tape. Add 1" to each measurement and cut four pieces of 1/2" diameter thinwall metal conduit to the measurements. Flatten 1" at all ends of the pieces of conduit, making sure that both ends of each piece of the conduit are flattened in the same plane.

Step 5) Drill a 5/16" hole in one end of each conduit, with the hole approximately 1/2" from the end of the conduit. Measure in approximately 1" from the end of the conduit with the hole drilled in it, and bend the end up approximately 45 degrees (this angle may vary). Hold the assigned piece of conduit on the wall and against the tape assembly (upper or lower, right side or left side), with the hole in the conduit over the hole in the wall, and mark the end of the conduit resting on the plumbers tape at one of the holes in the plumbers tape. Drill a 5/16" hole in the conduits at each of the marks.

Step 6) Loosen the plumbers tape around the tanks and place a 1/4" x 1" round head machine screw with washer from the inside through the holes in the tapes at all locations. Lightly tighten the tapes, and then place the conduits on the protruding machine screws, making sure that the conduits are placed in their proper location. Put a washer and nut on each protruding screw and tighten. Position the wall end of the conduits over the stud holes, and attach the conduits to the studs with 1/4" x 3" lag screws and flat washers.

Step 7) Firmly tighten the tapes by tightening the screws and nuts described in Step 3.

Step 8) Other suggestions for different water heater configurations are available at the Wyoming State Geological Survey. Contact Jim Case at (307) 766-2286 for more information.

Securing wood burning stoves

Free standing wood burning stoves are commonly used in Wyoming. Except for zero clearance units, units approved for mobile homes, and other special applications, fire codes usually require a 36" clearance around an older unlisted stove and an 18" clearance around a single-wall stovepipe. Many newer stoves, however, can be installed closer to combustibles, depending on the manufacturer's installation instructions. In any event, this means that the stove is usually unsupported on all four sides, and could easily tip over or slide during an earthquake. The stove could also separate from a stovepipe during an earthquake. The following recommendations for stabilizing a wood stove are based upon a report prepared by the Governor's Office of Emergency Services, State of California and the Federal Emergency Management Agency (1995):

Stoves resting on a brick hearth

For stoves on a brick hearth, there are two options. With the first option, use a masonry bit to drill a 1/2" hole in the center of four new bricks. Place a 3/8" diameter bolt through the bottom of each brick, insert the bolt through a 1/2" hole in the stove leg, and carefully tighten the bolt and brick to the stove leg with a washer and nut. Afterwards grout the bricks to the top of the hearth with one inch of new grout.

As a second option, place new bricks around the stove legs and grout them into place, leaving a pocket for each leg. Secure the stove legs to the hearth by filling the pockets with grout.

Stoves resting on a concrete slab

Anchor stoves on a concrete slab on grade directly to the concrete using 3/8" diameter expansion anchors embedded 3" into the concrete.

Stoves approved for mobile homes

These units usually come with pre-drilled holes in the legs. You can safely anchor the leg to the underlying floor framing using 3/8" diameter bolts and an oversized 2" diameter fender washer on the underside of the wood flooring.

Stove pipes

Secure stove pipes to the flue exit, and fasten pipe segments to each other. Pipe segments can be fastened together with sheet metal screws. If the pipe is of double wall construction, however, the screws must not penetrate the inner pipe wall.

If the stove pipe is unsupported for more than 8' between the stove and ceiling, provide one mid-height support. Do this by running the pipe through a

ready-made attic radiation shield which is braced to the wall to prevent lateral movement.

Other stove configurations

For configurations other than the ones discussed above, consult your stove vendor and(or) local fire department.

Securing propane tanks

Many rural homes use propane to provide fuel for heating, cooking, and the operation of gas appliances. Propane tanks can slide, rock, or overturn during an earthquake, which could break the supply line or rupture the tank. The following information on securing a propane tank is derived from the Governor's Office of Emergency Services, State of California and the Federal Emergency Management Agency (1995):

Step 1) Mount the tank on a continuous concrete pad that is 6" thick and 1' wider than the tank on either side. Attach the tank legs to the pad with 1/2" diameter expansion bolts, embedding them a minimum of 3" into the concrete pad.

Step 2) Provide a flexible hose connection between the tank and the rigid supply line.

Step 3) For large tanks, a special seismic shut-off valve can be installed. Although the valves are costly, they will shut off the gas supply during an earthquake.

Securing Heavy and Tall Objects in the Home

Personal injury during an earthquake is often caused by falling, tipping, or overturning objects. Overturned objects may also block hallways and doorways. There are many simple things you can do to reduce the possibility of such injury or blockage:

Tall furniture

Tall furniture, such as a bookcase, can easily tip over during an earthquake. Stabilize these tall objects by installing metal "L" brackets or "Z" clip brackets between the furniture and wall studs, preferably at the top of the unit. For free-standing units, attach brackets to the base of the unit and the floor. Keep the top shelves free of heavy items, especially if located near a sitting area or a bed. A wood molding attached to the front, lower edge of each shelf, will also help to prevent objects from sliding off the shelf.

Cabinets and drawers

Cabinets and drawers often contain glassware, household chemicals, sharp objects, or food. Securing the cabinets and drawers may prevent injury and reduce financial loss after an earthquake. The installation of positive catching latches, such as child-proof latches secures the cabinets and drawers. Many types of latches are available at hardware stores, lumber yards, and cabinet shops.

Hanging pictures

Hanging pictures that dislodge and fall can cause personal injury during an earthquake if they are near a sitting or sleeping area. The broken glass that results from the fall can also cause injury after an earthquake. In many cases, however, the pictures may be valuable or irreplaceable. Much of this risk can be minimized by hanging pictures on hooks that are screwed into wood framing members, such as studs.

Summary

A risk-free environment is not possible and cannot be guaranteed. However, if any of the above suggestions are implemented in your home, the chances of personal injury or property loss will be reduced.

References Cited

Governor's Office of Emergency Services-State of California and the Federal Emergency Management Agency, 1995, Guide to strengthening and repairing your home before the next earthquake: Governor's Office of Emergency Services-State of California, 46 p. (Copies available through ABAG, Publications Department, P.O. Box 2050, Oakland, CA, 94604; Catalogue number P-95002BAR, Cost: $4.00 plus $1.00 postage and handling).

Idaho Bureau of Disaster Services, 1992, Strengthening one- or two-story wood-frame homes - a homeowner's earthquake guide: Idaho Bureau of Disaster Services booklet, 24 p.

Wiss, Janney, Elstner Associates, Inc., 1994, Reducing the risks of non-structural earthquake damage: Federal Emergency Management Agency Report FEMA 74, Prepared under NETAC Contract EMW-92-C-3852, 131 p.

ROCK HOUND'S CORNER

W. Dan Hausel
Senior Economic Geologist, Wyoming State Geological Survey

During the past year, the Metals and Precious Stones Section of the Wyoming State Geological Survey has received numerous inquiries about gold from prospectors, rock hounds, and novices looking to start a new hobby. Gold prospecting can be a fun and sometimes rewarding hobby. For instance, we received a letter from one prospector who followed up on the Section's suggestion to look for gold along Strawberry Creek at South Pass. Over a period of a few weeks, he had recovered 27 ounces of gold. Another prospector recently stopped in with more than 5 ounces of gold he had found on Douglas Creek (**Cover photo**).

For those of you who are starting this hobby, there are several books on the market to help you understand gold. The only comprehensive book on gold in Wyoming was published as Bulletin 68 by the Wyoming State Geological Survey in 1989. It is entitled, *The geology of Wyoming's precious metal lode and placer deposits*. If you are looking for a place to search for gold, this book will assist you in finding gold in Wyoming.

Other books on gold that are highly recommended include: (1) Boyle, R.W., 1979, The geochemistry of gold and its deposits: Geological Survey of Canada Bulletin 280, 584 p., (2) Boyle, R.W., 1987, Gold: History and genesis of deposits: Van Nostrand Reinhold Company Inc., 676 p., and (3) Basque, G., 1976, Gold panners manual: Stagecoach Publishing Co., Ltd., Langley, B.C., 111 p.

Gold is a very heavy metal. Pure gold (which does not occur in nature) has a specific gravity of 19.3. In other words, gold is 19.3 times heavier than water. As a comparison, quartz has a specific gravity of only 2.65.

Natural gold is never pure. It occurs in solid solution with silver and contains small amounts of impurities such as copper, iron, bismuth, platinum, lead, zinc, and tin. The amounts of silver and other impurities in gold tend to lower the precious metal's specific gravity. For instance, silver has a specific gravity of 10.5, and most gold will contain at least 10 to 15% silver with some copper. As a result of these impurities, some gold has reportedly had a specific gravity as low as 15.

Knowing the specific gravity of gold can help one identify the metal. For instance, we recently had a large bronze-colored nugget brought in from the Middle Fork of the Little Laramie River that had a relatively high specific gravity. It was unlikely that nugget was gold because it was too hard and brittle. We measured its specific gravity, which was close to 7, and confirmed our suspicions that the nugget was indeed synthetic. It was a piece of brass that

had been thrown in the creek possibly by some miner as much as 100 years ago.

In addition to being very heavy, gold is relatively soft, sectile, and malleable. Gold has a hardness of only 2.5 to 3, whereas a knife blade has a hardness of 5. This means you can easily scratch and cut gold with a knife, unlike some other minerals that look like gold such as pyrite (fool's gold), which has a hardness of 6 to 6.5.

Gold is insoluble in acids, except for aqua regia. Aqua regia, a mixture of 3 parts concentrated hydrochloric acid and 1 part nitric acid, is very corrosive and is capable of dissolving gold and most anything else, including rock hounds and prospectors. Aqua regia should be used with utmost caution.

Gold is weighed by the troy ounce. One troy ounce is equivalent to 1.097 ounces avoirdupois or 31.1 grams. Jewelers measure the pureness of gold in terms of fineness. Fineness refers to the proportion of gold in an alloy, expressed in parts per thousand. In other words, pure gold is 1000 fine. Commercially traded gold is usually 995 fine or higher. Much of the natural gold found in Wyoming has been reported as about 850 to 950 fine.

The term karat, used in jewelry, has nothing to do with the weight of diamonds which are measured in carats. Karat refers to purity and is expressed in 24ths. So 24 karat gold (24k) is 1000 fine or pure gold: 14 karat gold is 58.33% gold alloyed with other metals.

In nature, gold occurs as native metal or as an essential constituent of 20 different mineral species. These gold-bearing minerals, most of which are very rare, are described in an article by W.E. Wilson (1982).

Most rocks found at the earth's surface contain only a background level of gold, which is about 5 ppb (parts per billion) gold. Locally, some rocks may average as much as 10 to 15 ppb gold, such as some volcanic rocks. But in order to make an ore out of these rocks, some rare conditions must occur to upgrade the gold values to as much as 3,000 times background.

Most of the world's gold has been recovered from the mining of paleoplacers (fossil stream beds). The principal paleoplacers occur as quartz-pebble conglomerates of Precambrian age. These deposits are found in the Witwatersrand of South Africa, Jacobina of Brazil, and Elliot Lake and Blind River of Canada. These paleoplacers are typically very old (greater than 2.5 billion years old), and they have yielded nearly 60% of the gold mined in the world throughout its history. In addition to gold, some of these rocks also contain diamonds and uranium.

Wyoming has several paleoplacers. In the northern parts of the Sierra Madre and Medicine Bow Mountains, there are conglomerates that are very

similar to the Witwatersrand conglomerates. These rocks have yielded some gold values. The highest known gold value in these rocks was from a drill core near Dexter Peak, which contained nearly 1/3 ounce of gold per ton. In addition to gold, these conglomerates also contain anomalous uranium. In addition, about 14 years ago, a diamond was recovered from a quartz-pebble conglomerate in the Medicine Bow Mountains.

In addition to these paleoplacers, areally large gold paleoplacers have been identified in the South Pass area of the Wind River Mountains. These paleoplacers are near Oregon Buttes, where an estimated 28.5 million ounces of gold occur in the Tertiary age conglomerates; near Red Canyon in the McGraw Flats area; and near Willow Creek south of Atlantic City. Recently, another gold paleoplacer was identified to the northeast of the Seminoe Mountains near the Miracle Mile along the North Platte River. Another paleoplacer, which had some historic production, is the Flathead conglomerate (Cambrian age) at Bald Mountain in the northern Bighorn Mountains.

The following publications of the Wyoming State Geological Survey contain information on these paleoplacers: Bulletin 68, Report of Investigations 44, and Report of Investigations 50.

Reference Cited

Wilson, W.E., 1982, The gold containing minerals: a review: The Mineralogical Record, Nov.-Dec., p. 389-400.

NEW PUBLICATIONS OF THE WYOMING STATE GEOLOGICAL SURVEY

*Geologic map of the Cheyenne 30' x 60' Quadrangle [scale 1:100,000], southeastern Wyoming, western Nebraska, and northern Colorado, by A.J. Ver Ploeg: Map Series MS-46, 1995.-$7.00 (folded), $8.50 (mailed rolled).

**Triceratops*, Wyoming State Dinosaur poster: Miscellaneous Publication, 1995.- $5.00 (over-the-counter), $6.50 (mailed rolled).

**Triceratops*, Wyoming State Dinosaur postcard: Miscellaneous Publication, 1995.- $0.25 each or 5 for $1.00.

Bibliography and index of graduate theses and dissertations of the Department of Geology and Geophysics, University of Wyoming (revision and update of 1989 version), by C.S. Boyd, A.J. Ver Ploeg, and others: Information Pamphlet 3, 1995.-$2.00.

Index to geologic mapping in Wyoming from out-of-state theses, by A.J. Ver Ploeg and C.M. Boyd: Map Series MS-9S, 1995.-$2.50 (xerox copies only).

Talc, including steatite, in Wyoming, by R.E. Harris: Open File Report 95-1, 1995.-$3.00 (xerox copies only).

A review of Wyoming's coal mines and markets: 1994, by P.D. Vogler and others: Coal Report 95-1, 1995. -$15.00 (xerox copies only).

The Open File Report series of the Wyoming State Geological Survey was discontinued as of August, 1995. Each geologic section of the Survey now releases its own numbered in-house reports and maps. Please contact the following Staff Geologists for coverage, availability, prices, or further information on reports dealing with specific commodities or topics:

W. Dan Hausel - Metals and precious stones

James C. Case - Geologic hazards and environmental geology

Rodney H. De Bruin - Oil and gas

Ray E. Harris - Industrial minerals and uranium

Alan J. Ver Ploeg - Geologic mapping and stratigraphy

P. Daniel Vogler - Coal

*New releases since the last issue of *Wyoming Geo-notes*.

The Wyoming State Geological Survey sells the *Atlas of Major Rocky Mountain Gas Reservoirs*, a publication jointly prepared by the New Mexico Bureau of Mines and Mineral Resources, the Colorado Geological Survey, the Utah Geological Survey, the Wyoming State Geological Survey, and the Gas Research Institute-$99.75. Available over-the-counter or PREPAID, by mail from the Wyoming State Geological Survey in Laramie. Checks, for this publication only, should be made payable to: New Mexico Bureau of Mines and Mineral Resources or NMBMMR. (Price includes postage and handling.)

Order these and other publications from: Wyoming State Geological Survey, Box 3008, University Station, Laramie, Wyoming 82071-3008. Phone: (307) 766-2286. Many of these publications are also available over-the-counter at the Wyoming Oil and Gas Conservation Commission (Basko Building) in Casper, Wyoming.

PUBLICATIONS OF THE WYOMING GEOLOGICAL ASSOCIATION

By special arrangement with the Wyoming Geological Association (WGA), the Wyoming State Geological Survey sells all of WGA's Annual Field Conference Guidebooks as well as its Symposium volumes. This includes the recently released Guidebook and Road Logs for the 1995 Field Conference on southwestern Wyoming ($75 + postage for WGA members; $85 + postage for non-members). These publications are available over-the-counter at the Survey's offices on the University campus in Laramie. Although they can be purchased by mail, prepayment is required. Call the Survey for individual prices and postage costs. WGA sale prices are also honored.

ATTENTION TOPOGRAPHIC MAP PURCHASERS!

The Wyoming State Geological Survey, an authorized dealer for U.S. Geological Survey maps, was informed in August, 1995, that sales prices for U.S. Geological Survey maps were increasing substantially and dealer discounts were decreasing. Because of these increased costs, we have been forced to raise our prices for U.S. Geological Survey topographic maps. Effective October 1, 1995, the new prices for topographic maps are as follows:

Wall map - Topographic map of Wyoming, scale 1:500,000 - $5.50 each

AMS sheets - scale 1:250,000 - $5.50 each

Wyoming metric series - scale 1:100,000 - $5.50 each

Topographic maps - scale 1:24,000 - $4.50 each

All these maps are available over-the-counter at the Survey offices in Laramie or by mail. We do not offer quantity discounts and can make no exchanges or refunds. Sales tax of 6% is added for Wyoming addresses and postage and map tubes for rolled maps are added on when appropriate.

NEW REPORT ON COAL MINES IN WYOMING

Dan Vogler, Head of the Wyoming State Geological Survey's Coal Section, has prepared a new publication entitled, *A review of Wyoming's coal mines and markets: 1994.* The report contains data on the 27 active coal mines in Wyoming. All data reported on each of the mines is public and was provided by the Department of Environmental Quality's Land Quality and Air Quality Divisions, the State Inspector of Mines, the Federal Energy Regulatory Commission, or the mining companies themselves.

For each of the described coal mines, there is information on delivered coal quality, overburden thickness, coal names and thicknesses, and basic mine statistics. **Figures 18** and **19** provide examples of the mine presentations. The publication also summarizes each of the mine's coal supply agreements with utilities throughout the nation. A brief summary of this data shows that the State's coal markets have seen the most gains in the Midwest. In 1994, over 77% of the coal produced in Wyoming was shipped to 13 different midwestern states. Copies of this report are available from the Wyoming State Geological Survey in Laramie. Ask for information on Coal Report No. 95-1.

BLACK THUNDER

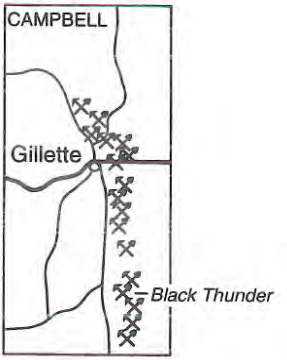
Operated by:
Thunder Basin Coal Company

Owned by:
ARCO Coal Company

Mine Start-up Date: 1977

Mine Manager
T. P. Walsh
Mailing Address
P. O. Box 406
Wright, WY 82732
Phone: (307) - 939-1300

EXPLANATION
- County Seat
- Interstate Highway
- US or State Highway
- Surface Mine



GEOGRAPHIC INFORMATION

Coal Field: Powder River
County: Campbell
Mine Type: Surface
Number of Acres Permitted: 13,217

AVERAGE DELIVERED QUALITY

Apparent Rank: Subbituminous

	1992	1993	1994
Btu/lb:	8,781	8,768	8,733
% Ash:	5.02	5.07	5.25
% Sulfur:	0.37	0.33	0.33
SO_2 (lbs)/mmBtu:+	0.84	0.75	0.75

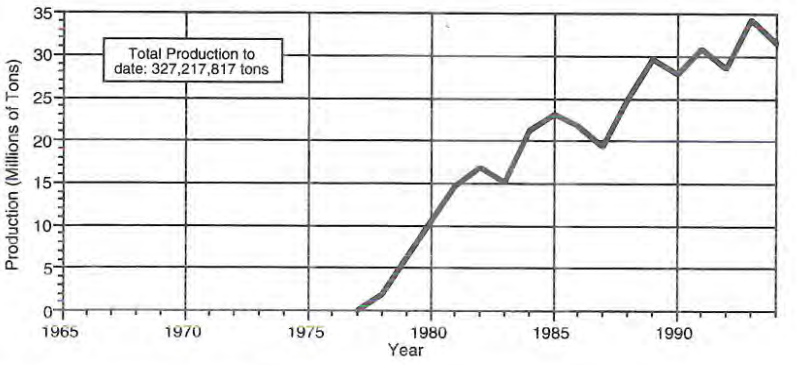
MINING METHODS, PRODUCTION, AND RESERVES

Method of Mining

Overburden: Dragline, Truck and Shovel
Coal: Truck and Shovel
Average Bed Thickness : 70
Average Overburden Thickness : 140
Range in Overburden Thickness : 15-240

Permitted Mineable Reserves: 828.7 million
Average Recovery Factor: 95.0%
1994 Production: 31,616,222
1994 Air Quality Limits: 44 million

PRODUCTION HISTORY



* Denotes data for more than one seam
\+ Pounds of SO_2 per million British Thermal Units (Btu)

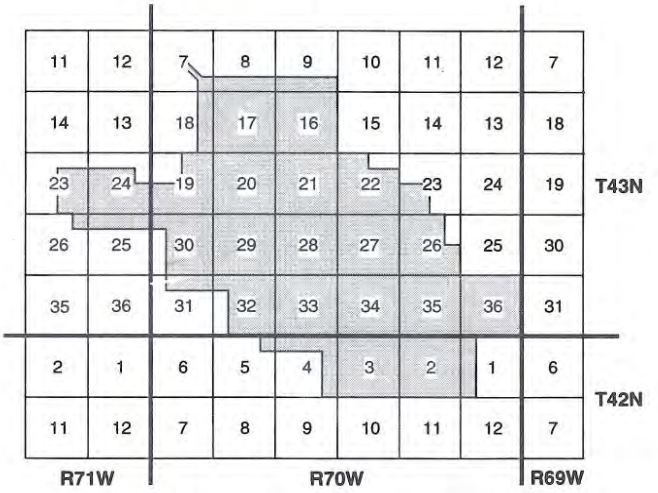
Figure 18. Example page from Coal Report 95-1.

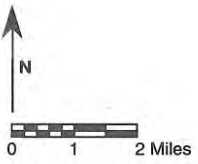
BLACK THUNDER

GEOLOGICAL INFORMATION

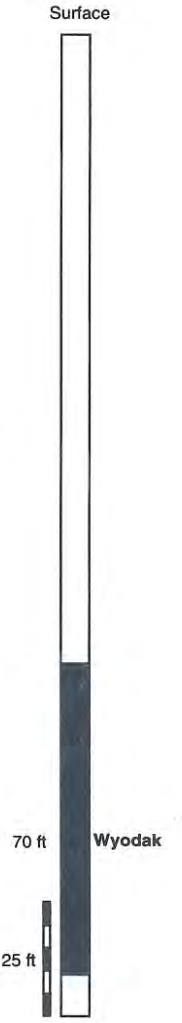
Age: Tertiary/Paleocene
Formation: Fort Union
Member: Tongue River
Zone/Bed Name(s): Wyodak (Roland, Wyodak-Anderson)

MINE LOCATION AND BOUNDARIES





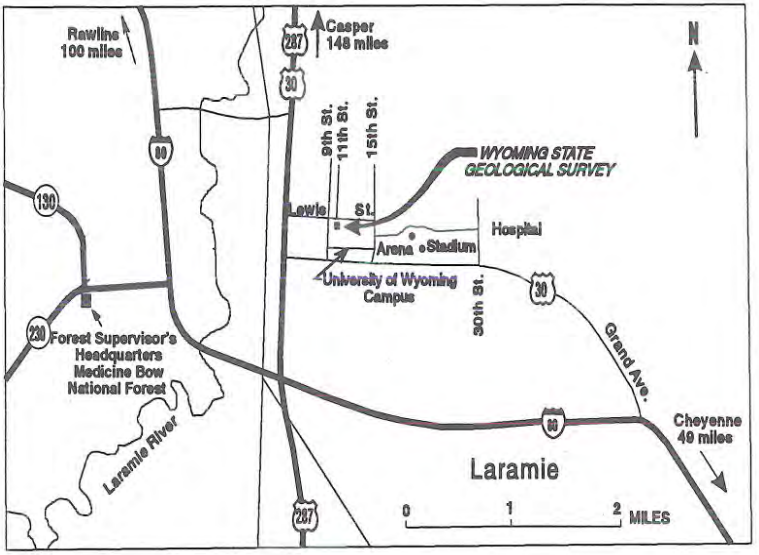
STRATIGRAPHIC SECTION

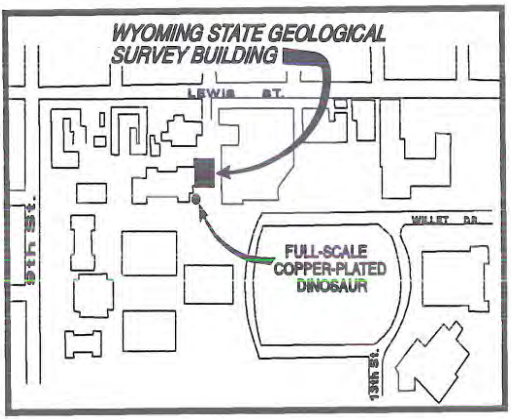


Number of Employees in 1994: 458

Figure 19. Second example page from Coal Report 95-1.

WYOMING STATE GEOLOGICAL SURVEY
LOCATION MAPS





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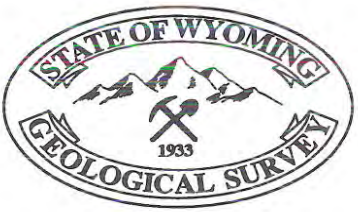
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