TIGHT GAS RESERVOIRS • PART II

UNCONVENTIONAL GAS SOURCES

NATIONAL PETROLEUM COUNCIL • DEC. 1980

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John F. Bookout, Chairman—Committee on Unconventional Gas Sources

PART II

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Chapter Ten

NORTHERN GREAT PLAINS/WILLISTON BASIN

The area assessed in the Northern Great Plains and Williston Basin covers an area of approximately 120,000 sq mi in eastern Montana, western North and South Dakota, and northeastern Wyoming (Figures 10-1 and 10-2).

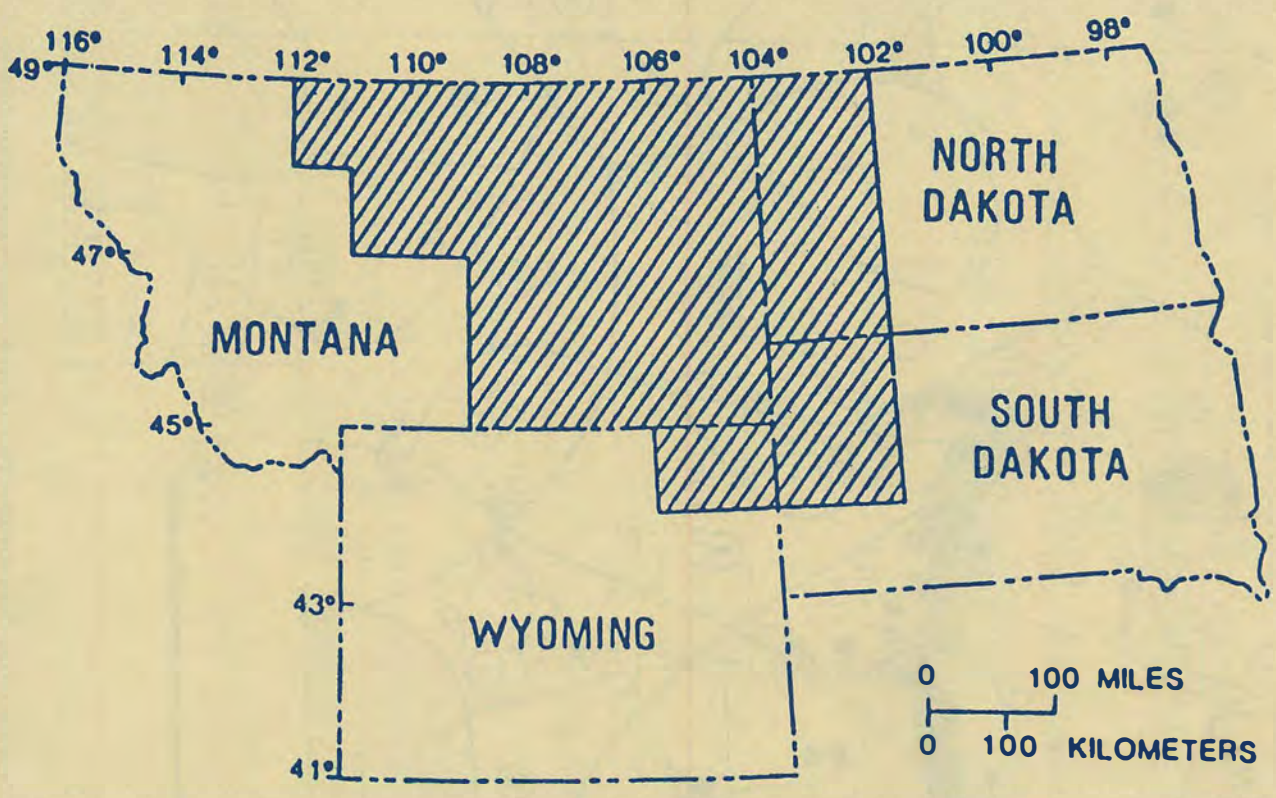


Figure 10-1. Index map of Northern Great Plains showing outline of study area (shaded area).

GEOLOGY

Cretaceous rocks have the best potential for recovery of gas from low-permeability reservoirs. The potential interval is confined to strata between the Lower Cretaceous Mowry Shale and the Upper Cretaceous Bearpaw Shale, and their equivalents as shown in Figure 10-3. The sequence is considered prospective where it (1) is marine in origin, and (2) consists predominantly of a thick shale column, with minor interbeds of siltstone and sandstone, or more persistent chalk beds. A detailed account of the natural gas potential of tight reservoirs in the area is given by Rice and Shurr.[1]

In general, Cretaceous rocks are an intertonguing sequence of marine and nonmarine rocks which attain a thickness greater than 20,000 ft in western Montana. The regional relationship of the

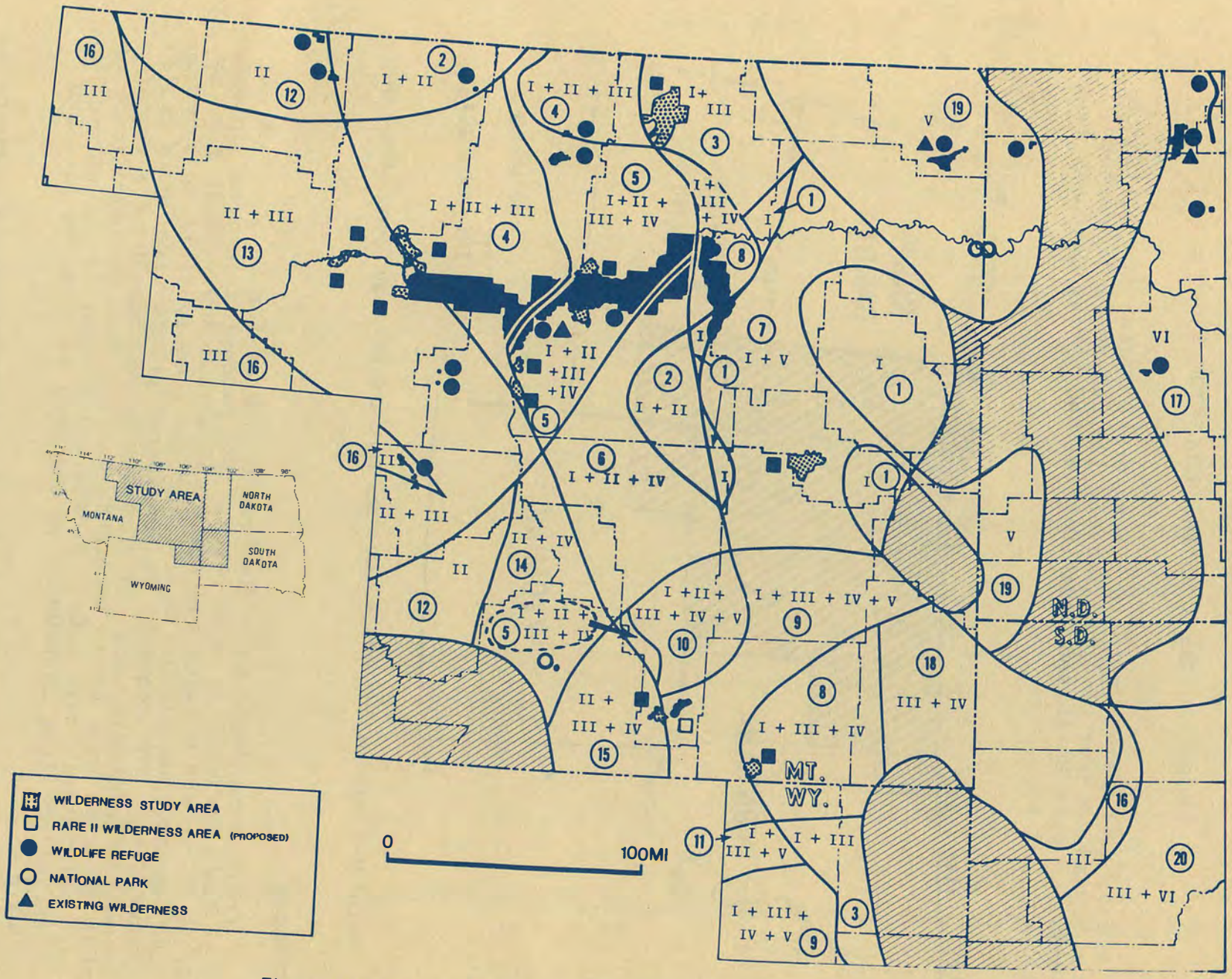


Figure 10-2. Index to Tight Gas Areas—Northern Great Plains-Williston Basin.

INDEX TO TIGHT GAS AREAS (See Figure 10-2)

NORTHERN GREAT PLAINS - WILLISTON BASIN

SUB BASIN NUMBERS	FORMATIONS
1	I MOWRY
2	I + II MOWRY + GREENHORN
12	II GREENHORN
4	I + II + III MOWRY + GREENHORN + CARLILE
5	I + II + III + IV MOWRY + GREENHORN + CARLILE + EAGLE
16	III CARLILE
8	I + III + IV MOWRY + CARLILE + EAGLE
19	V JUDITH RIVER
17	VI NIOBRARA
7	I + V MOWRY + JUDITH RIVER
9	I + III + IV + V MOWRY + CARLILE + EAGLE + JUDITH RIVER
10	I + II + III + IV + V MOWRY + GREENHORN + CARLILE + EAGLE + JUDITH RIVER
14	II + IV GREENHORN + EAGLE
15	II + III + IV GREENHORN + CARLILE + EAGLE
13	II + III GREENHORN + CARLILE
11	I + III + V MOWRY + CARLILE + JUDITH RIVER
20	III + VI CARLILE + NIOBRARA
18	III + IV CARLILE + EAGLE
3	I + III MOWRY + CARLILE
6	I + II + IV MOWRY + GREENHORN + EAGLE

EXPLANATION

Lined pattern indicates areas of little or no potential. There are also other small areas in which potential reservoirs have been eroded such as the Little Rockies, Cat Creek Anticline, and Porcupine Dome. These small areas are not shown on the map and have not been considered as potentially productive areas for this report.

The arabic sub basin numbers correspond to the last two digits in the case numbers in the economics tables. The Roman numberals identify the formations in each sub basin. Not all the area of a sub basin is necessarily contiguous. Small isolated portions of some sub basins may not be identified on the map with an arabic number, but all contain the appropriate formation numbers.

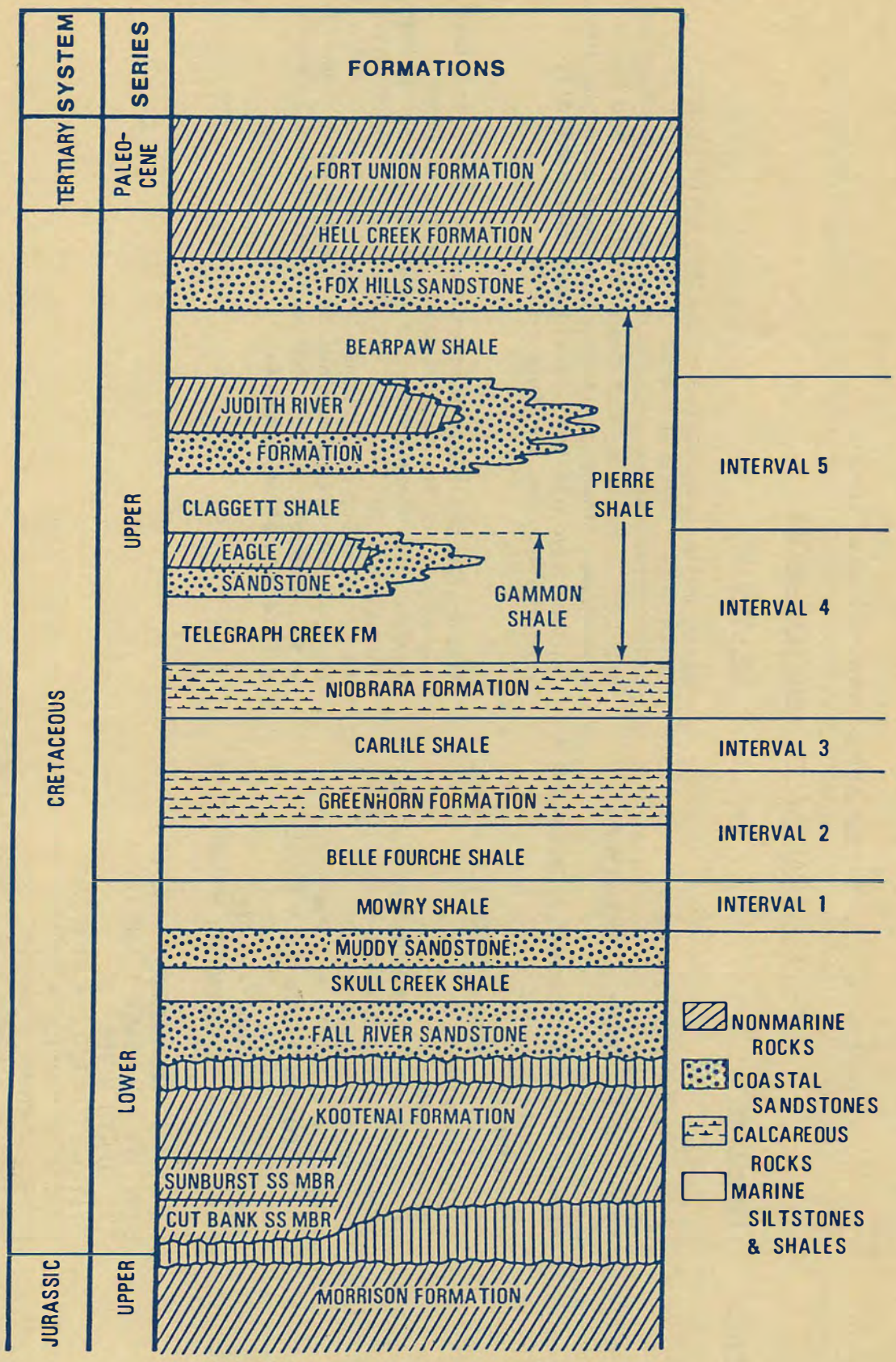


Figure 10-3. Generalized correlation chart of Cretaceous rocks in Northern Great Plains showing five potential intervals.

units and general distribution of facies are illustrated in Figure 10-4. The most active source areas were highlands to the west. The Canadian shield, to the east, provided little detrital material. All of the low-permeability reservoirs were deposited in a shallow shelf environment along a north-south-trending interior seaway which extended from the Gulf of Mexico to the Arctic Ocean during most of Cretaceous time.

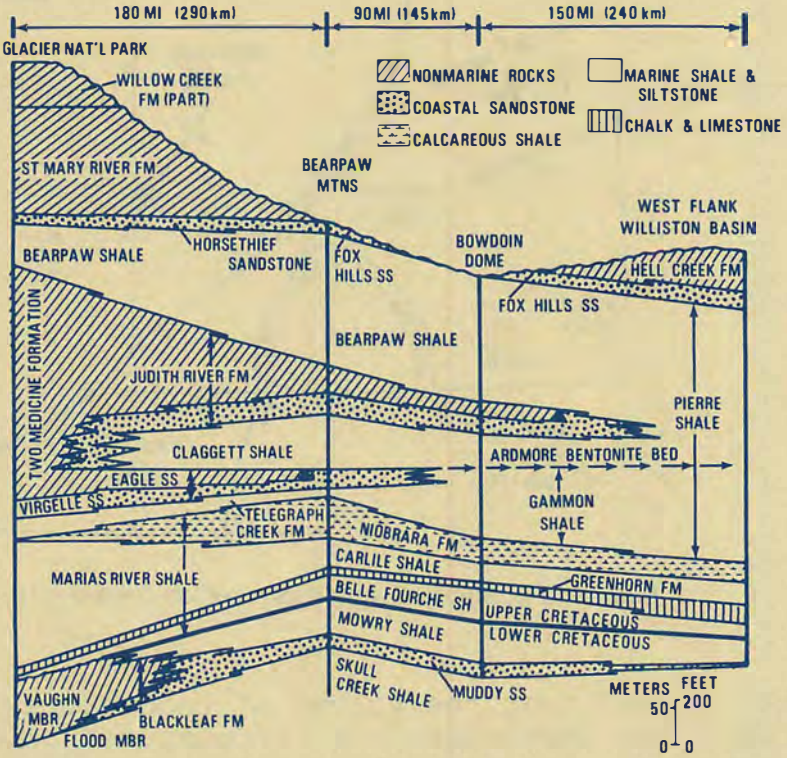


Figure 10-4. Diagrammatic cross section of selected Cretaceous rocks from Glacier National Park to west flank of Williston Basin, Montana.

The major structural features of the study area are shown in Figure 10-5. A large part of the study area is situated within the Williston Basin, one of the largest structural basins in North America. The basin influenced sedimentation and facies distribution during most of Paleozoic and early Mesozoic time. However, the Williston did not exist as a basin and did not exert any observable control on sedimentation during Cretaceous time.

Most of the structural features are products of Laramide orogeny which climaxed during latest Cretaceous and Paleocene time. Many of these structures had precursor elements which occupied their same relative position and influenced earlier Cretaceous sedimentation, particularly in the shelf area.

Natural Gas Potential

Using resource estimates of shallow, low-permeability reservoirs in western Canada as an analog, Rice and Shurr estimated that the study area may contain resources of natural gas in excess of

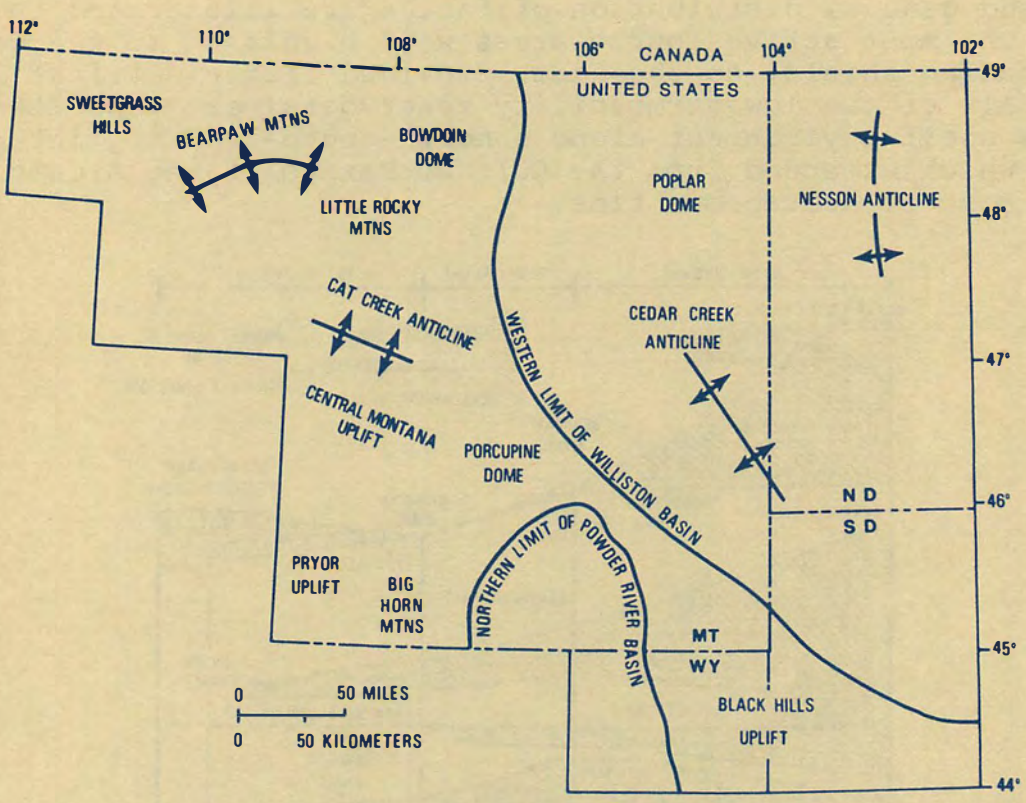


Figure 10-5. Map showing major tectonic elements.

100 TCF.[1] They stated that the volume of recoverable gas would be dependent upon the development of recovery technology and on increased gas prices. Lewin and Associates, Inc.[2] estimated that the Northern Great Plains Province and Williston Basin contained 74 TCF of undiscovered gas-in-place and 35 TCF of technically recoverable gas. However, they only considered 24,000 sq mi as prospective and their estimates, in many places, included conventional reservoirs. Tight reservoirs are difficult to distinguish on conventional logs in the area and are often overlooked.

Characteristics of Traps and Reservoirs

The natural gas potential of the northern Great Plains study area has a definite lateral and vertical distribution. The projected resources occur in low-permeability reservoirs developed in upper Lower and Upper Cretaceous rocks at shallow depths (less than 4,000 ft). The stratigraphic section considered potential for gas-bearing tight reservoirs was divided into five intervals. These intervals, which consist of one or more formations and their correlatives are shown on Figure 10-3 and listed below:

(1) Mowry Shale and equivalents.

(2) Belle Fourche Shale, Greenhorn Formation, and equivalents.

(3) Carlile Shale and equivalents.

(4) Niobrara and Telegraph Creek Formations, Eagle Sandstone, and equivalents.

(5) Claggett Shale, Judith River Formation, and equivalents.

Within each interval, several different facies occur. These facies were identified on electric logs and tied to nearby outcrops and cores. Each one of these facies has distinct reservoir types, some of which have low permeability.

Six major facies types -- nonmarine rocks, coastal sandstones, shelf sandstones, siltstones, shales, and chalks -- were identified. Each of these will be briefly characterized, along with their reservoir types and potential for gas production from tight reservoirs. Representative electric logs for each facies are shown in Figures 10-6 and 10-7.

I. Nonmarine rocks. Nonmarine rocks accumulated in a variety of coastal plain and delta plain environments. They were deposited during major regressive cycles and therefore are commonly underlain by coastal sandstones. Potential tight reservoirs, primarily channel sandstones, are limited in areal extent, and are unpredictable in distribution. Because of their shallow depth, low permeability, and limited areal extent, any production from these reservoirs would have to be commingled with other intervals to make economic wells.

II. Coastal sandstones. This facies consists of thick (greater than 40 ft), widespread sandstone bodies that were deposited along the shoreline. Because of the nature of their depositional processes, coastal sandstones are porous and permeable, and contain the principal hydrocarbon reservoirs in the Rocky Mountain region. For example, coastal sandstones developed in the Eagle Sandstone produce gas at Tiger Ridge field in north-central Montana, where they have an average porosity of 26 percent and permeabilities as high as 150 md.[3] At shallow depths of burial, these sandstones are often flushed with fresh water and gas accumulations are structurally controlled.

III. Shelf sandstones. Shelf sandstones were deposited in a shallow-marine environment that extended from the coastal zone to the edge of the slope. In this setting, sedimentation was controlled by current systems of varying direction and intensity. Sandstones, which make up a minor part of the total shelf sequence, are thin (often less than 1 in.), discontinuous, and tight. Natural gas is widespread in this facies because low permeability inhibits migration and because reservoirs are enclosed in organic-rich source rocks.

IV and V. Siltstones and shales. Siltstones and shales make up the major part of the shelf sequence. These two facies are grouped together at this time because conventional logs cannot distinguish between the two rock types, particularly when they are interbedded. Both siltstones and shales are potential low-permeability reservoirs. Production from shales, however, will probably not be economic unless they are naturally fractured.

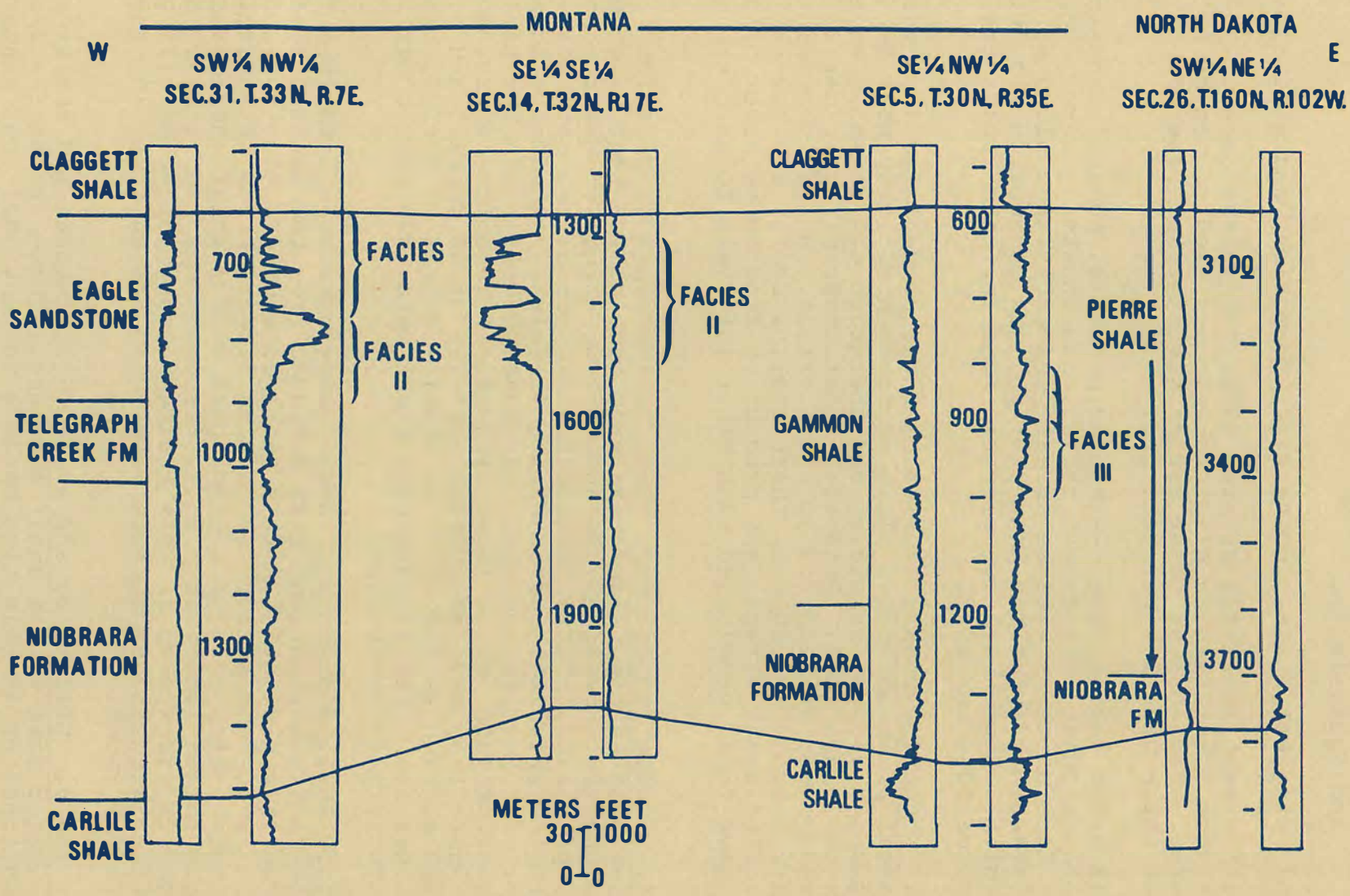


Figure 10-6. Electric log cross section showing typical expression of Facies I through V in interval 4. Facies types I through III are indicated on logs. Unmarked portion signifies the occurrence of Facies IV and V undifferentiated.

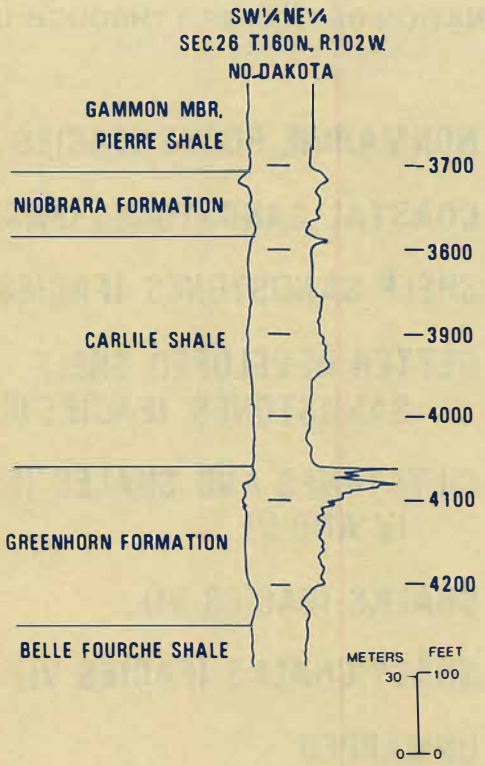


Figure 10-7. Electric log illustrating expression of Facies VI in Greenhorn and Niobrara Formations and Carlile Shale.

VI. Chalks. Chalks are fine-grained carbonate sediments composed of calcareous nannofossils and microfossils.[4] Chalks in the study area have varying amounts of shale and form persistent units. Generally, chalks have high porosities at shallow depths and contain ample storage capacity, but they are tight. Chalks are best developed in the eastern part of the study area away from the most active terrigenous source areas.

In summary, reservoirs developed in the shelf sandstone, siltstone, and chalk facies form the most promising low-permeability reservoirs and were considered as prospective for this report. These reservoirs are particularly attractive because they are enclosed by thick sequences of shale, which are the source rock for biogenic gas, and form an excellent seal for the entrapment of gas.

Distribution of Reservoirs

For each interval, the areal distribution of facies will be described and illustrated in Figures 10-8 through 10-12. At least part of each interval is composed of the siltstone and shale facies. However, facies other than siltstone and shale are mapped, if present.

Interval 1 (Figure 10-8). The facies map for interval 1, which contains the Mowry Shale and equivalents, is divided into three north-south-trending bands. The western and central bands indicate

EXPLANATION OF FIGURES 8 THROUGH 12.

NONMARINE ROCKS (FACIES I)

COASTAL SANDSTONES (FACIES II)

SHELF SANDSTONES (FACIES III)

BETTER DEVELOPED SHELF SANDSTONES (FACIES III)

SILTSTONES AND SHALES (FACIES IV AND V)

CHALKS (FACIES VI)

SHALY CHALKS (FACIES VI)

UNMAPPED

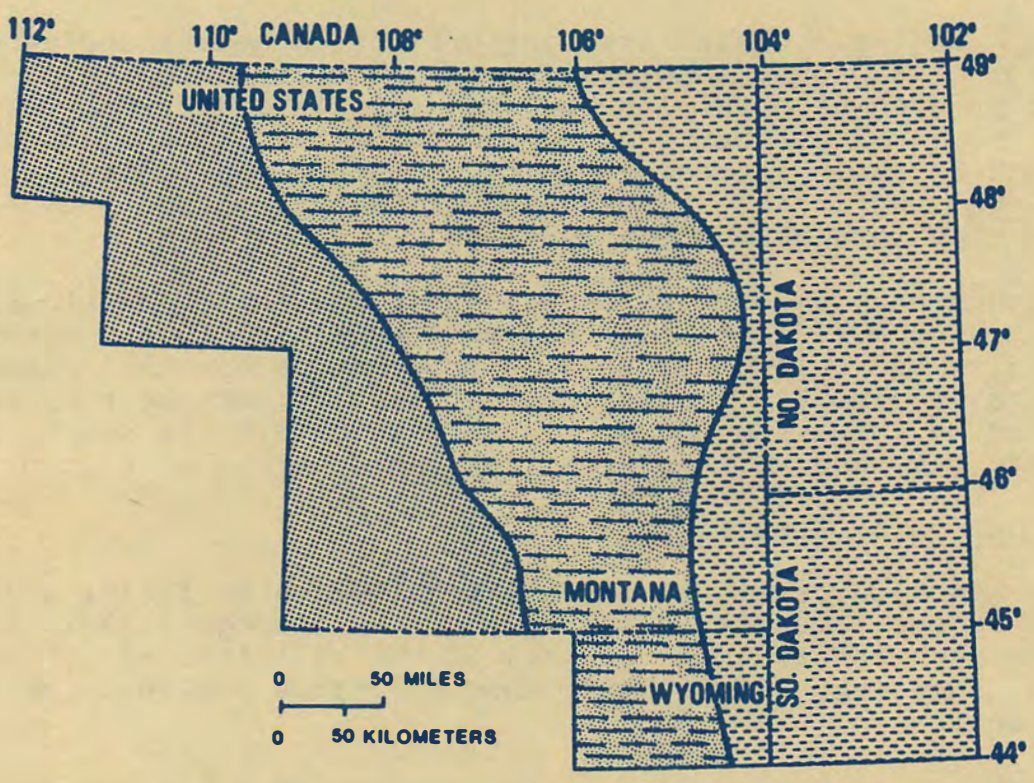


Figure 10-8. Facies map for interval 1.

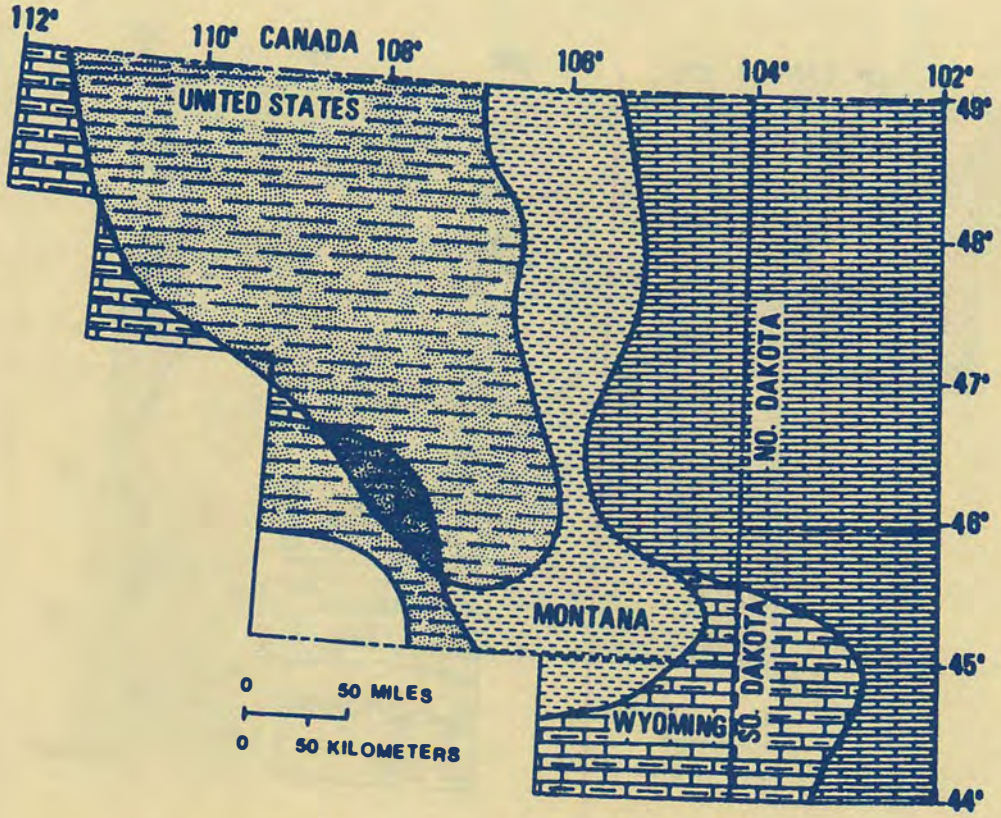


Figure 10-9. Facies map for interval 2.

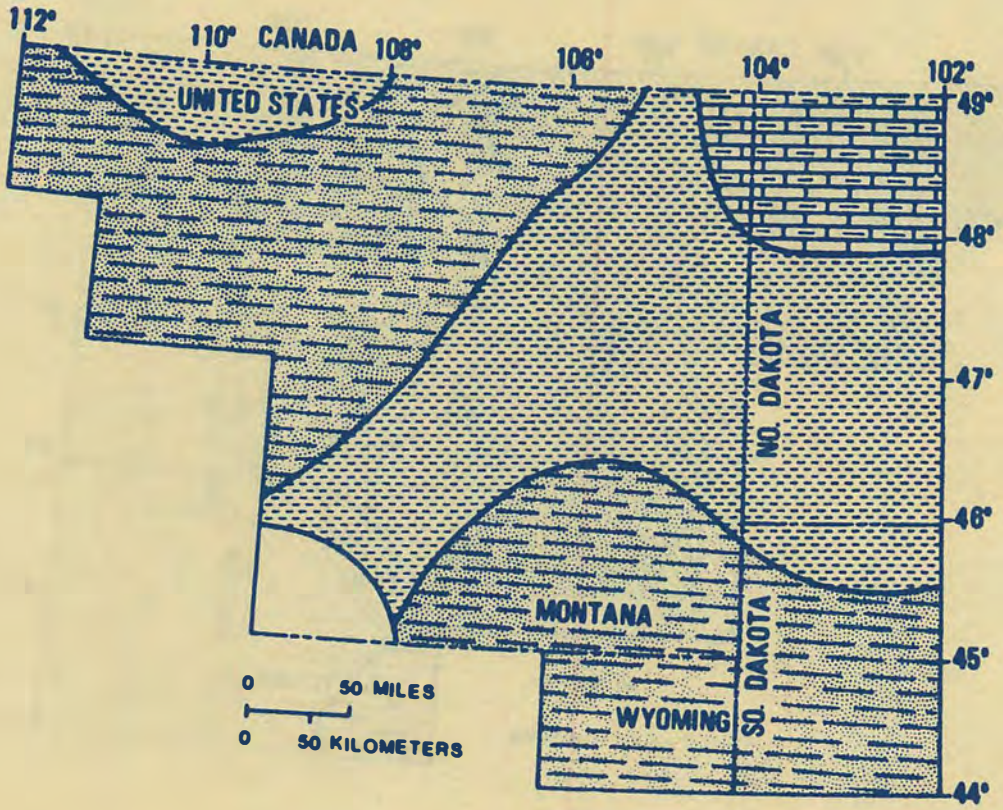


Figure 10-10. Facies map for interval 3.

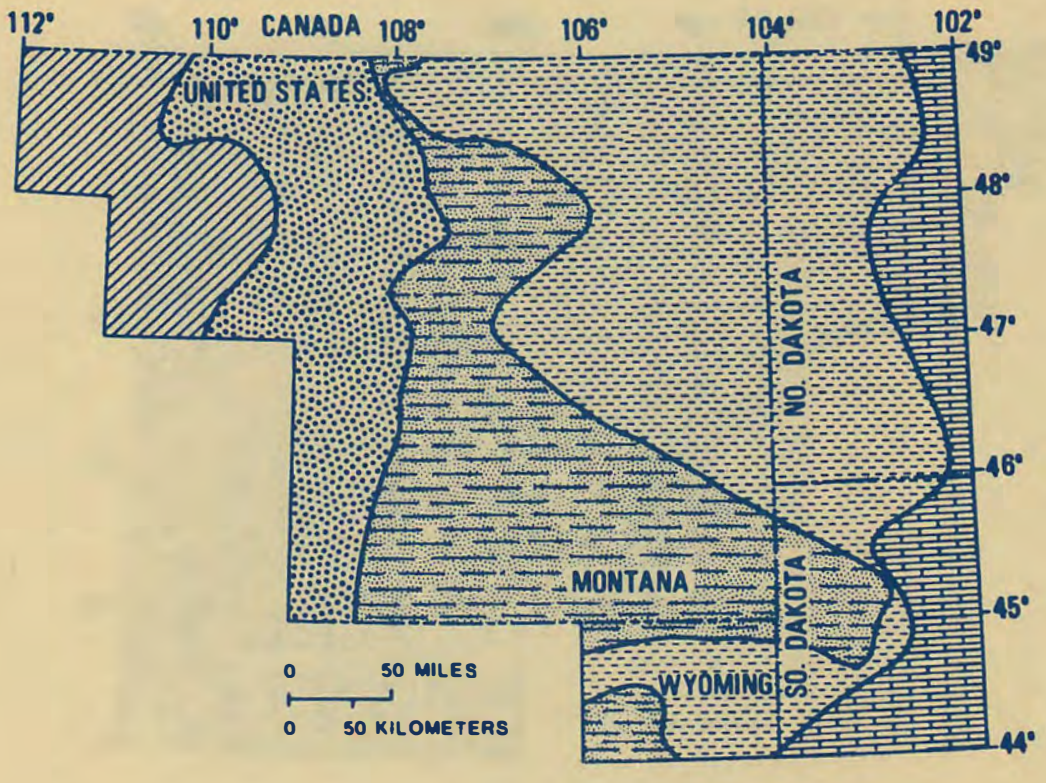


Figure 10-11. Facies map for interval 4.

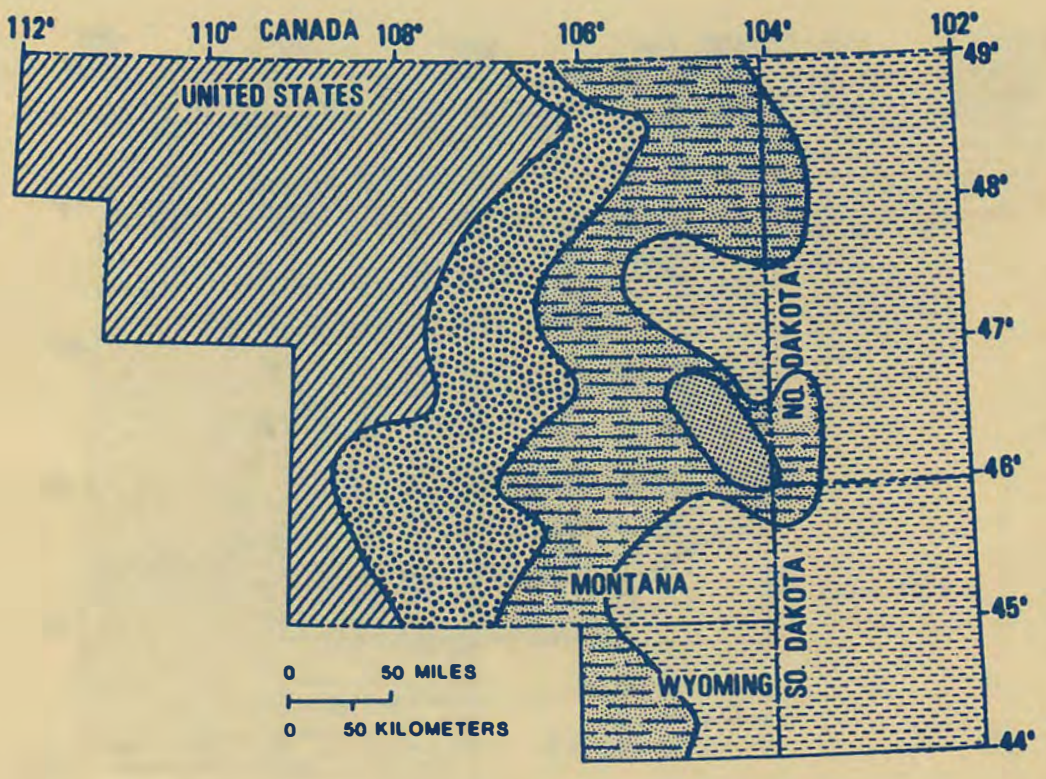


Figure 10-12. Facies map for interval 5.

the development of shelf sandstones in the upper part of the Mowry, while siltstones and shales occur throughout the interval in the eastern part. In the western band, a continuous sandstone interval, as much as 70 ft thick, is developed that contains numerous shale partings. In the central band, more typical thin and discontinous shelf sandstones are developed.

Interval 2 (Figure 10-9). This interval contains the Belle Fourche Shale, Greenhorn Formation, and equivalent rocks. A southward-protruding lobe of shelf sandstones, which are developed in the upper Belle Fourche and lower Greenhorn section, covers a large part of the western study area. These sandstones are locally called the Mosby Sandstone Member of the Greenhorn Formation and the informal Phillips and Second white specks sandstones of subsurface usage. In the southwest corner, shelf sandstones developed in the lower part of the Belle Fourche Shale are correlative with the Frontier Formation of the Big Horn Basin. Because of the numerous unconformities in the Frontier Formation and the lack of data in the Big Horn Mountains and Pryor uplift, the extreme southwestern part of the study area is unmapped. In the eastern region, chalks are well developed in the Greenhorn Formation. Chalks are also present in the Greenhorn in the southern and northwestern parts, but the electric log response suggests that they contain abundant shale.

Interval 3 (Figure 10-10). Only the Carlile Shale and its correlatives are included in interval 3. Two regions of shelf sandstones are developed. The northwest area had a source area in west-central Montana. Coastal sandstones equivalent to these shelf sandstones have been mapped in the disturbed belt where they have been correlated with the Cardium Sandstone of Alberta. These shelf sandstones are the informally named Bowdoin sandstone in north-central Montana. In the southern part of the study area, shelf sandstones were deposited that are equivalent to the Turner Sandy Member of the Carlile Shale which crops out along the flanks of the Black Hills. In addition, an impure chalk facies is developed in the medial part of the Carlile in the northeastern part of the map area.

Interval 4 (Figure 10-11). The Niobrara, Telegraph Creek, Eagle, and correlative units make up interval 4. In the western part of the study area, parallel, north-south-trending bands of nonmarine rocks and coastal sandstones demonstrate a western source for the Eagle Sandstone clastics. Underlying these facies, shelf sandstones are developed in the Telegraph Creek Formation. Shelf sandstones in the Eagle section form an irregular pattern seaward of the coastal sandstones. This facies projects a considerable distance to the east in the southern part of the study area where the shelf sandstones correlate with the Shannon Sandstone Member of the Steele Shale of the Power River Basin. Shallow gas was recently discovered in this facies in South Dakota near the Montana border. The chalk facies in the eastern study area marks the westernmost extension of the oldest chalk bench developed in the Niobrara Formation.

Interval 5 (Figure 10-12). Interval 5 represents the Claggett Shale, Judith River Formation, and correlative units. Once again the distribution of nonmarine rocks and coastal sandstones expresses a western source area for the Judith River Formation. The extent of the nonmarine rocks indicates that the Judith River Formation was widespread and surpassed only by the complete withdrawal of the sea during the Fox Hills regression. The eastward projections in boundaries between the nonmarine rocks, coastal sandstones, and shelf sandstones suggest that deltaic sedimentation controlled their distribution, even in shelf environment. The different pattern for shelf sandstones localized over the Cedar Creek anticline in eastern Montana emphasizes an area of better development. The region may have existed as a submarine shoal that resulted in the winnowing of sands during Judith River deposition.

Each of these facies maps illustrates that the shelf sandstone, siltstone, shale, and chalk facies are widespread in the study area. When the maps for all of the intervals are combined, potential low-permeability reservoirs are present over most of the study area.

Western Canada Analog

The advances in drilling and production techniques coupled with higher wellhead prices for natural gas stimulated a surge in drilling activity in Alberta in the 1970's. The drilling resulted in the development of an extensive area of shallow gas entrapped in tight reservoirs of Late Cretaceous age. Production from these shallow reservoirs now covers an area greater than 8,000 sq mi in southeastern Alberta with some older production in southwestern Saskatchewan (Figure 10-13). The size of this large gas accumulation is continually increasing and is controlled mostly by economics. Because similar facies are developed throughout the study area, western Canada serves as a model for developing and understanding low-permeability gas-bearing reservoirs in the United States portion of the northern Great Plains.

Figure 10-14 is a correlation chart for gas-productive rocks of southeastern Alberta and correlative strata of north-central Montana. In Alberta, the chief producing intervals are the Second white specks sandstone, the Medicine Hat Sandstone, and the equivalent of the Milk River Formation. Figure 10-15 is a gamma ray-electric log cross section through the productive area of southeastern Alberta that shows the stratigraphic position of the producing intervals and their perforated zones. All of the gas is produced from thin shelf sandstones scattered throughout a thick shale sequence. The shelf sandstones are identical to those developed within the study area.

The closest production from similar, low-permeability reservoirs in the study area comes from the Bowdoin field in north-central Montana (Figure 10-13). The productive intervals, as shown on Figures 10-14 and 10-16 are shelf sandstones developed in the upper Belle Fourche Shale and Mosby Sandstone Member of the Greenhorn Formation, which are locally called the informal Phillips

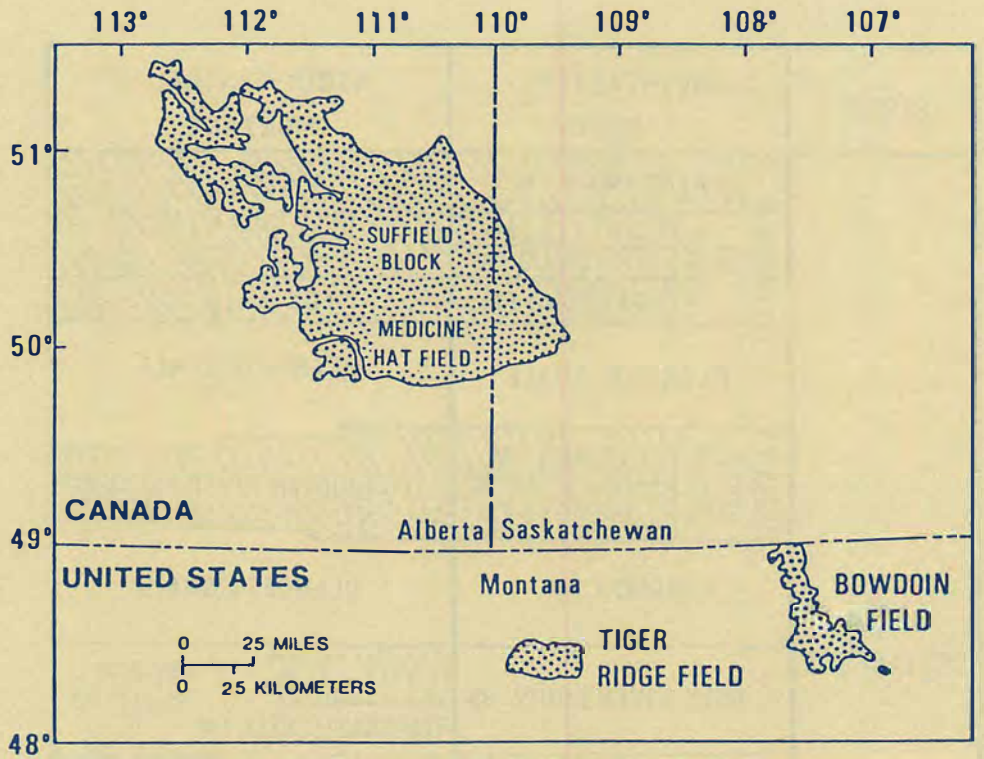


Figure 10-13. Map showing distribution of shallow gas fields (shaded area) in north-central Montana, southeastern Alberta, and southwestern Saskatchewan. Bowdoin field and large area in Canada produce from tight reservoirs. Tiger Ridge field produces from structural traps of conventional reservoirs.

sandstone, and in the Carlile Shale, which are locally termed the informal Bowdoin sandstone. A thin limestone in the upper Greenhorn Formation also produces natural gas.

The original part of the Bowdoin field was developed through the 1950's and covered an area of 200 sq mi. Most of the wells were natural, open-hole completions at depths between 800 and 1,000 ft. With the advent of improved well-completion technology and gas prices in the 1970's, the field was extended north to the Canadian border and now covers an area greater than 600 sq mi. The recently developed production occurs at depths ranging between 1,200 and 1,800 ft and the reservoirs require artificial stimulation before the production can be considered commercial. Details of this recent exploration are summarized by Nydegger, Rice, and Brown.[5]

In 1972, the government of Alberta became interested in the gas reserves of the Suffield block, which is centralized in the productive area of southeastern Alberta (Figure 10-13). The block, which covers an area of 1,000 sq mi, was evaluated by a 77-well program, the results of which were reported in 1974.[6,7] These reports represent the most complete documentation of Cretaceous gas production from tight reservoirs in the northern Great Plains. The extrapolation of these data emphasizes the natural gas potential of the United States portion of the northern Great Plains.

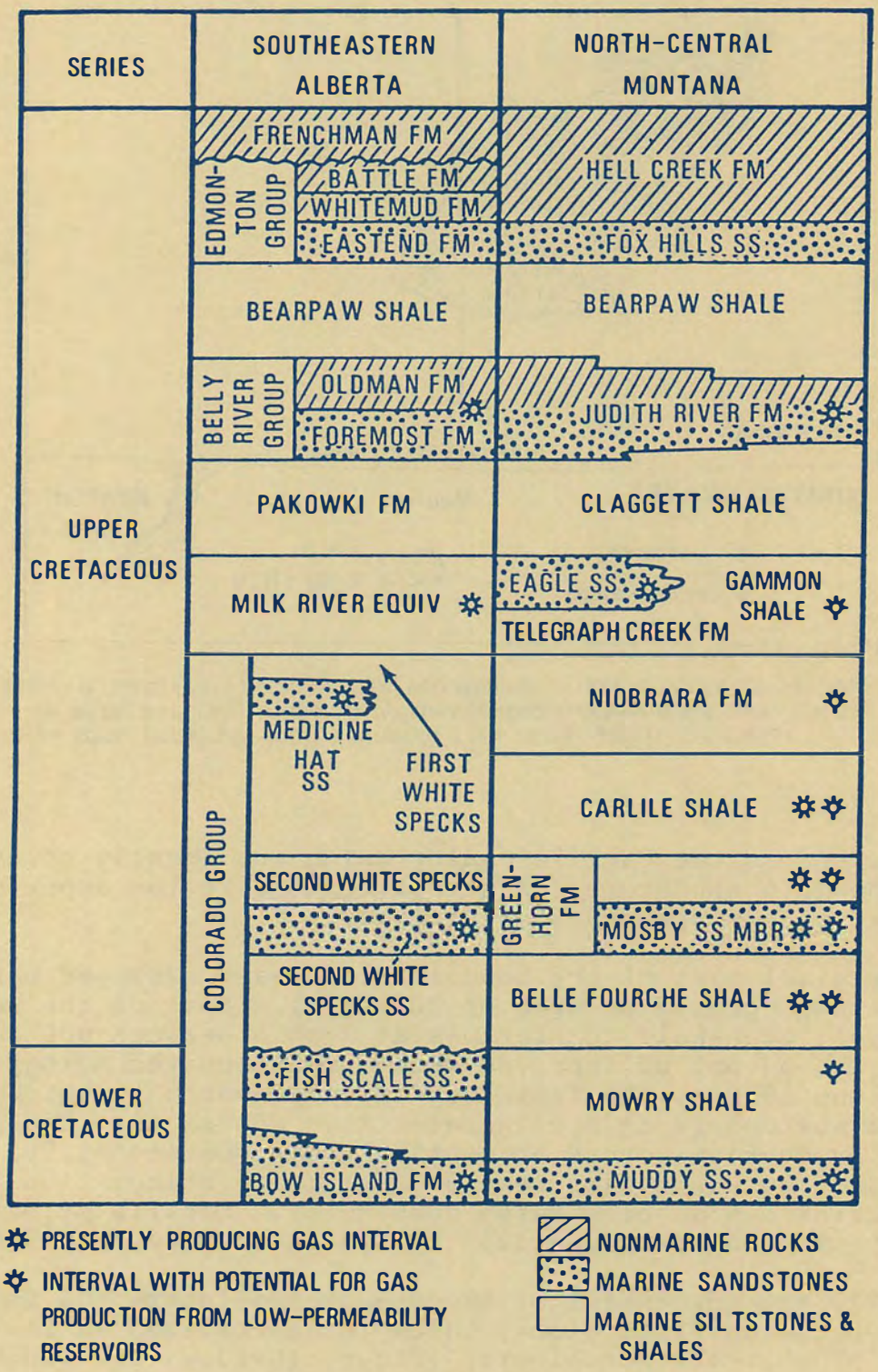


Figure 10-14. Correlation chart of selected Cretaceous rocks in southeastern Alberta and north-central Montana showing currently gas productive intervals and those with potential for production from tight reservoirs.

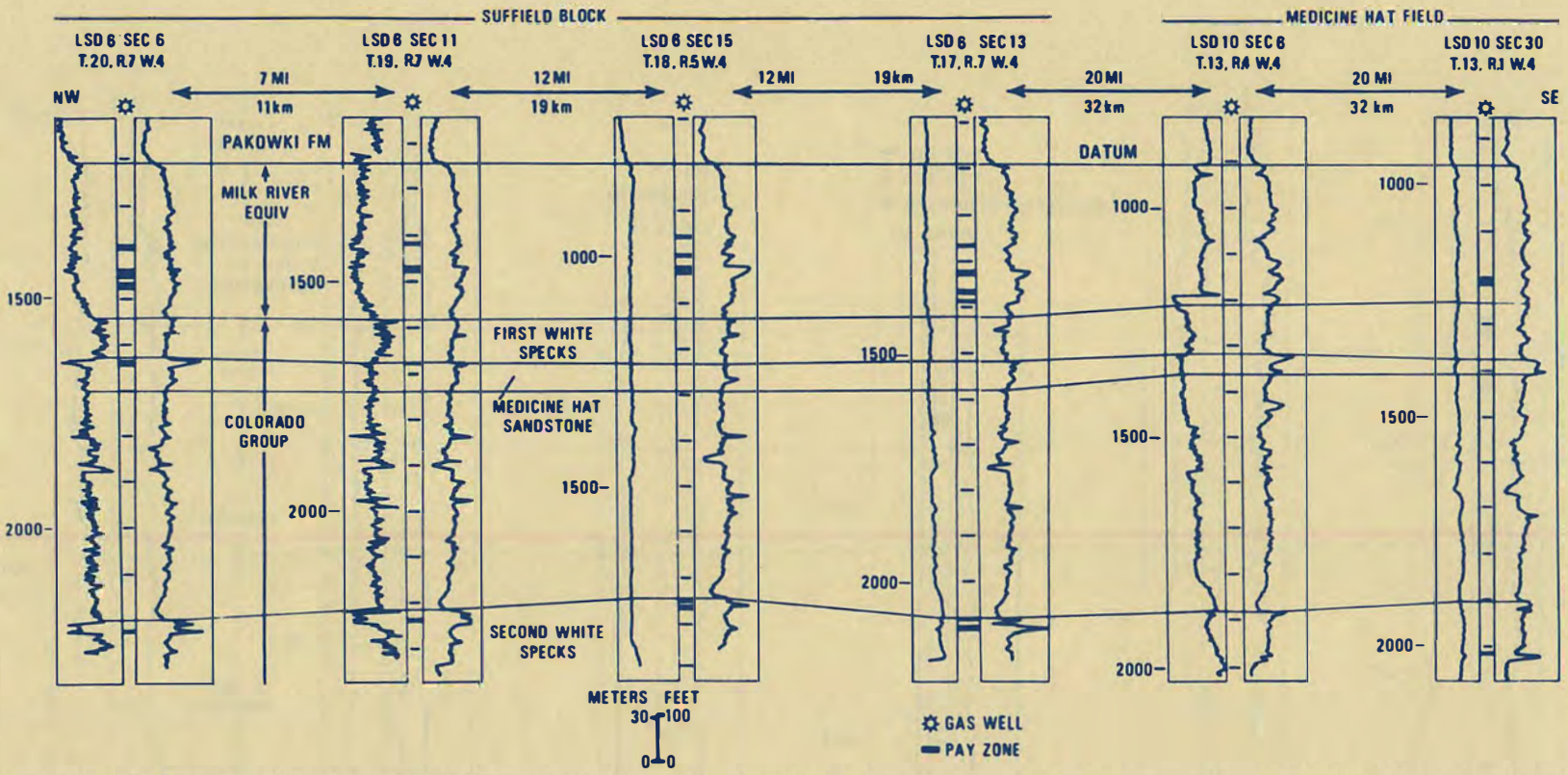


Figure 10-15. Gamma ray and electric log cross section through Suffield Block and Medicine Hat field in southeastern Alberta, showing correlation of lower Upper Cretaceous rocks and pay zones. Datum is top of Milk River equivalent.

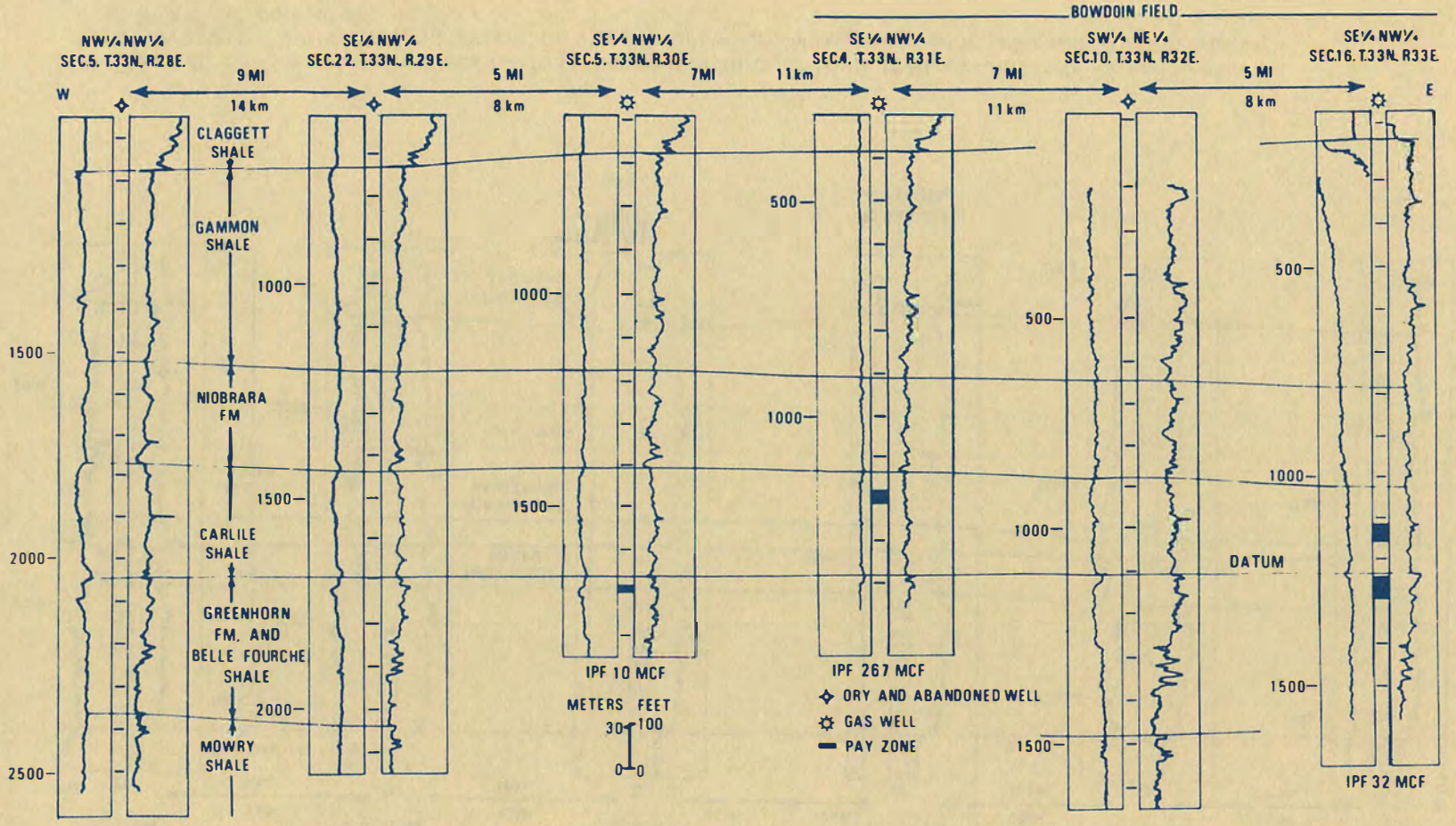


Figure 10-16. Electric log cross section through Bowdoin Dome area in north-central Montana, showing correlation of Upper Cretaceous units and pay zones. Datum is top of Greenhorn Formation.

On the basis of resistivity mapping and indicated production from 77 widely spaced wells, gas reserves in the Suffield block were assigned to each of the productive Upper Cretaceous intervals -- Second white specks, Medicine Hat, and Milk River. The Lower Cretaceous Bow Island Formation and Glauconitic Sandstone of the Manville Group were also examined, but they contain conventional reservoirs and occur at greater depths. The Suffield block was assigned a gas-in-place reserve figure of 3,533 BCf for the three Upper Cretaceous units and a recoverable sales gas figure of 2,533 BCF.[6]

Past Exploration History

A statistical summary of the recent exploration history and performance of the industry for Central Montana and Williston Basin is given in Tables 10-1 and 10-2. These statistics are based on AAPG data with some modifications to eliminate low risk field extension wells. Unfortunately, the study area for the estimates given in this report does not fall precisely within these AAPG provinces. This study area for this report includes the western part of the Williston Basin, northern part of Central Montana, and eastern part of the Sweetgrass Arch. However, the statistics as shown in the tables do show the general trends in exploration.

The data apply to all formations of all ages in the two areas for the periods 1960 to 1969 and 1970 to 1977. Estimates in this report are limited to the low-permeability reservoirs of Late Cretaceous age that occur at depths generally less than 3,000 ft. These reservoirs have generally been unrecognized and unexplored until the last few years.

The statistics for the Williston Basin show that there has been relatively little effort in exploring for natural gas throughout the total period. The Williston Basin contains large quantities of oil in conventional reservoirs of Paleozoic age. This oil has been the major target during the 1960's and 1970's and exploration has been conducted mainly by major oil companies.

Exploration statistics for Central Montana as shown in Table 10-2 give a better indication of the trends in our study area as a whole. The total number of wildcats, number of successful wildcats for gas, and amount of natural gas discovered increased dramatically from the 1960's to the 1970's. We believe this increase reflects the higher prices of gas and improved recovery technology. The decrease in well depths from the 1960's to 1970's indicated the trend toward exploration for shallow gas accumulations of biogenic origin.

Uncertainty of Reserves

Shallow gas in the Northern Great Plains is interpreted to be a product of the immature stage of hydrocarbon generation. The gas was generated in rapidly accumulating sediments by low-temperature decomposition of organic matter by anaerobic microorganisms and is referred to as biogenic gas. Natural gas in the other tight gas

TABLE 10-1

EXPLORATION PERFORMANCE - Williston Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	126	102	24	120	108	12	246	210	36
Gas	0	0	0	2	2	0	2	2	0
Oil	125	101	24	118	106	12	243	207	36
Oil and Gas	1	1	0	0	0	0		1	0
Amount of Petroleum Found									
Total, MMBOE ☆☆	161.3	101.8	59.5	292.8	272.5	20.3	454.1	374.3	79.8
Gas, BCF	0	0	0	2.1	2.1	0	2.1	2.1	0
Oil, MM Bbls.	157.6	98.5	59.5	275.9	255.6	20.3	433.5	354.1	79.8
Number of Wildcat Wells									
Total	1517	1454	63	994	959	35	2511	2413	98
Gas ☆	0	0	0	17	16	1	17	16	1
Oil ☆	1505	1442	63	977	943	34	2522	2385	97
Oil and Gas	12	12	0	0	0	0	12	12	0
Number of Wildcats/Year	152	145	7	124	120	4	140	134	6
Percent Wildcats Successful									
Total	8.3	7.0	38.1	12.1	11.3	34.3	9.8	8.7	36.7
Gas	-	-	-	11.8	12.5	0	11.8	12.5	0
Oil	8.3	7.0	38.1	12.1	11.3	35.3	9.6	8.7	37.1
Oil and Gas	8.3	8.3	-	-	-	-	8.3	8.3	-
Amount Found/Successful Wildcat									
Total, MMBOEE	1.3	1.0	2.5	2.4	2.5	1.7	1.8	1.8	2.2
Gas, BCF	-	-	-	0.1	0.1	-	1.1	1.1	-
Oil, MM Bbls	1.3	1.0	2.5	2.3	2.4	1.7	1.8	1.7	2.2
Average Depth of Wells, M ft.									
Oil	8.39	8.06	9.76	10.18	10.14	10.53	9.26	9.13	10.03
Gas	-	-	-	6.75	6.75	-	6.75	6.75	-

☆ Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

☆☆ Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

TABLE 10-2

EXPLORATION PERFORMANCE - Central Montana Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	70	54	16	179	153	26	249	207	42
Gas	26	22	4	153	131	22	179	153	26
Oil	44	32	12	26	22	4	70	54	16
Oil and Gas	0	0	0	0	0	0	0	0	0
Amount of Petroleum Found									
Total, MMBOE **	56.9	53.6	3.3	101.4	92.2	9.2	158.3	145.8	12.5
Gas, BCF	253.1	244.7	8.4	514.9	470.0	44.9	768.0	714.7	53.3
Oil, MM Bbls.	13.0	11.2	1.8	5.3	4.5	0.8	18.3	15.7	2.6
Number of Wildcat Wells									
Total	1135	1083	52	1720	1643	77	2855	2726	129
Gas *	421	402	19	1471	1405	66	1892	1807	85
Oil *	714	681	33	249	238	11	963	919	44
Oil and Gas	0	0	0	0	0	0	0	0	0
Number of Wildcats/Year	113	108	5	215	205	10	159	151	7
Percent Wildcats Successful									
Total	6.2	5.0	30.8	10.4	9.3	33.8	8.7	7.6	32.6
Gas	6.2	5.5	21.1	10.4	9.3	33.3	9.5	8.5	30.6
Oil	6.2	4.7	36.4	10.4	9.2	36.4	7.3	5.9	36.4
Oil and Gas	-	-	-	-	-	-	-	-	-
Amount Found/Successful Wildcat									
Total, MMBOEE	0.8	1.0	0.2	0.6	0.6	0.4	0.6	0.7	0.3
Gas, BCF	9.7	11.1	2.1	3.4	3.6	2.0	4.3	4.7	2.05
Oil, MM Bbls	0.3	0.4	0.2	0.2	0.2	0.2	0.3	0.3	0.2
Average Depth of Wells, M ft.									
Oil	3.70	3.89	3.19	3.57	3.58	3.55	3.65	3.76	3.28
Gas	2.59	2.55	2.83	1.94	1.88	2.34	2.04	1.97	2.42

* Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

sand basins has been generated dominantly by thermal degradation and cracking reactions. Biogenic gas is characterized by the enrichment of the light isotope C^{12} in the methane ($^{13}C_1$ values lighter than -55 °/.. relative to PDB standard) and by larger proportions of methane ($C_1/C_{1-5} > 0.98$).

In the Northern Great Plains, biogenic gas is associated with sediments deposited in a marine environment. The gas was probably generated locally because it is entrapped in tight reservoirs which are in close communication with organic-rich shales. In marine sediments, a succession of microbial ecosystems leads to the generation of the gas. After oxygen is consumed by aerobic respiration, sulfate reduction becomes the dominant form of respiration. Methane generation and accumulation become dominant only after the sulfate is depleted. The most important mechanism of methane production after sediment burial are anoxic environment, sulfate-deficient environment, low temperature, availability of organic matter, and sufficient space. These factors control the timing and depth of biogenic gas generation such that most of the gas is probably generated prior to burial depths of 3,000 ft early in the burial history as described above. Details on the generation, accumulation, and characteristics of biogenic gas are given by Rice and Claypool.[8]

An alternative interpretation is that the gas was generated in recent geologic time by microbiological activity. Recent in this context would mean during the Quaternary or perhaps during the Pliocene. The anaerobic, methanogenic microorganisms would enter the subsurface along faults, fractures, and outcrops. They would utilize CO_2 and degradation products from aerobic bacterial consumption of crude oil to generate the gas and thus they would be concentrated along oil-migration paths. If the biogenic gas was generated by this mechanism, the resulting accumulations would be areally restricted and the reserves would be about one-tenth of those estimated. (See the Appendix to Chapter 10 located at the rear of this volume for further discussion.)

The occurrence of natural gas is considered to be widespread in the Northern Great Plains for two reasons. First, gas generation is interpreted to be controlled by biological activity at shallow depths in accumulating organic-rich sediments as described above. Second, thick sequences of organic-rich shale with thin (often less than 1 in.), discontinuous beds and laminae of sandstone and siltstone are probably developed over large areas of the Northern Great Plains based on paleogeographic reconstruction and detailed studies of outcrops, cores, and geophysical logs. The beds and laminae of sandstone and siltstone are the tight reservoirs and the shale served first as a source and later as a seal for the gas. However, close well control is lacking in many areas and will be needed to fully evaluate the resource potential.

The Northern Great Plains is the largest of the areas evaluated in this report (120,000 sq mi) and is probably larger than all of the areas combined. Less than 40 percent of the total area is considered prospective and only in the parts where shelf sandstones

are developed because "sweet spots" may be present which would result in early economic development. Reserves in the prospective area are about 3 BCF per section which is comparable to the Suffield Block in southeastern Alberta.[6]

In the southeastern Alberta gas pool, about one half (7 TCF) of the reserves occur in the siltstone facies of the Milk River Formation equivalent. If the siltstone facies was considered as prospective for this report, the reserves for the Northern Great Plains would be considerably larger.

Improved gas prices and recovery technology, and pipelines are needed to develop the potentially large shallow gas reserves in the Northern Great Plains. Significant increases in gas prices have led to the widespread development of shallow gas in Alberta from identical reservoirs as developed in the U.S. portion of the Northern Great Plains. Part of these reserves are exported to Montana which imports 50 percent of its gas supply from Canada.

PRODUCTION

The Northern Great Plains/Williston basin area (Areas 1 and 2, Figure 7, Part I), which covers 120,000 squares miles, is the largest basin studied. Therefore, it is not surprising that this area also has the largest tight gas resource base, 100 TCF (see Table 8, Part I). Six pay formations included in the study (Mowry, Greenhorn, Carlile, Niobrara,* Eagle,* and Judith River) were considered individually in Figures 10-8 through 10-12, and in combination in Figure 10-2. This exhibit locates the 20 subbasins that have from one to five pay formations. Formation depths range from 1,400 to 4,000 feet. Multiple pay areas are developed via borehole commingling. This is economically attractive and is possible due to the common formation characteristics and relatively small vertical distances between formations.

Most fields are expected to be small (Figure 10-17) where the average size (50 percent cumulative probability of occurrence) for multiple pay field is 16 BCF. Only 1 percent of the fields will be as large as 100 BCF. Individual fields could cover from 3 to 2,600 sections. Bowdoin Dome and Suffield Block-Medicine Hat Fields cover 600 and 1,000 sections, respectively. Although field size may be geographically large, recovery per productive section (3.1 BCF per section average calculated from Table 10-5) and recovery per gross section (0.83 BCF per section for the 120,000 sections of total basin area) is small. Low formation pressure at shallow depths, low porosity, high water saturation, and modest net thickness result in relatively low amounts of in-place or recoverable gas per section of reservoir (e.g. Table 10-14). Exploration success ranges from 0 to 41 percent and averages about 18 percent, whereas development success was constant at 80 percent (see "Economics Summaries" for each subbasin starting with Table 10-12).

*Niobrara and Eagle are considered equivalent.

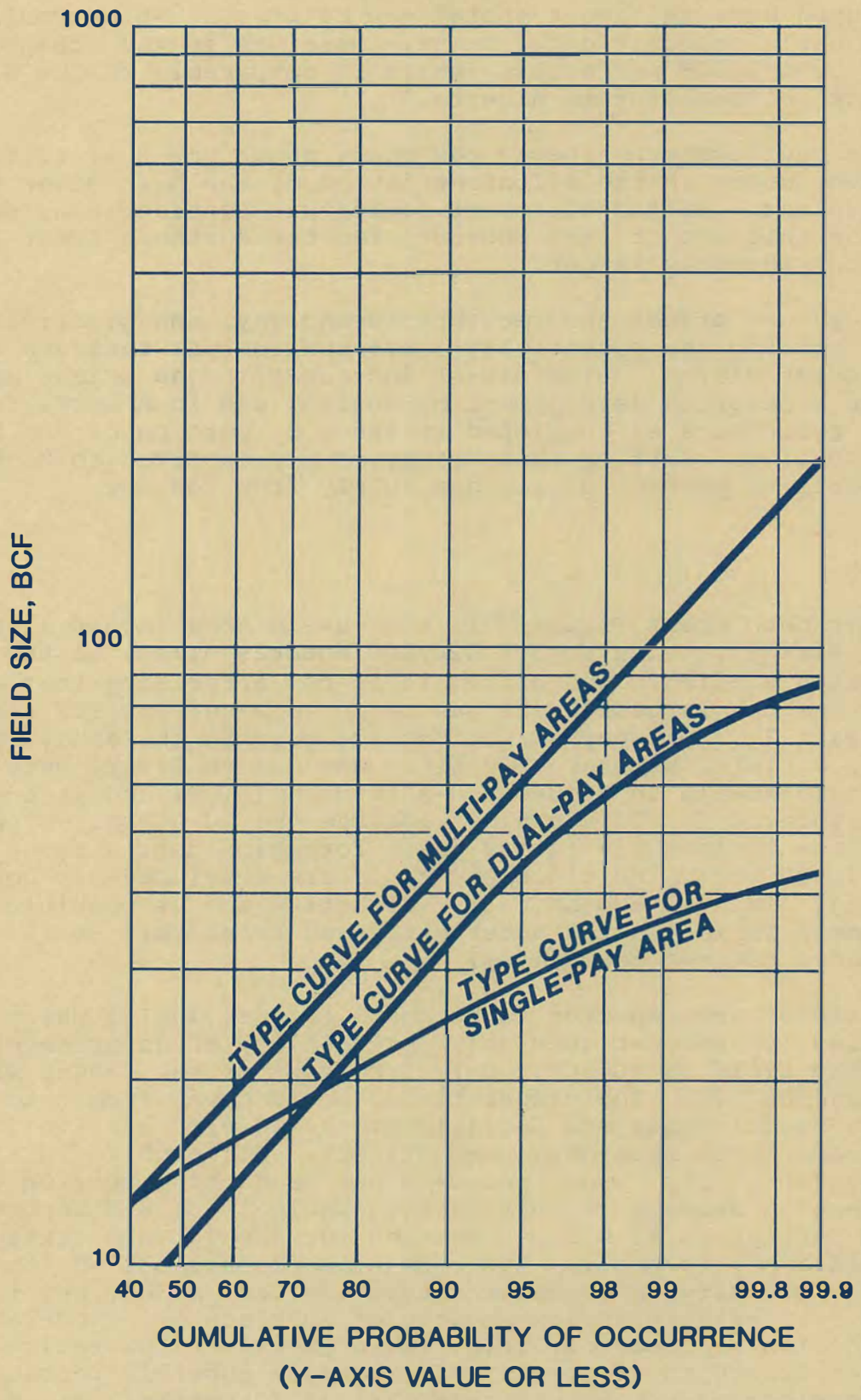
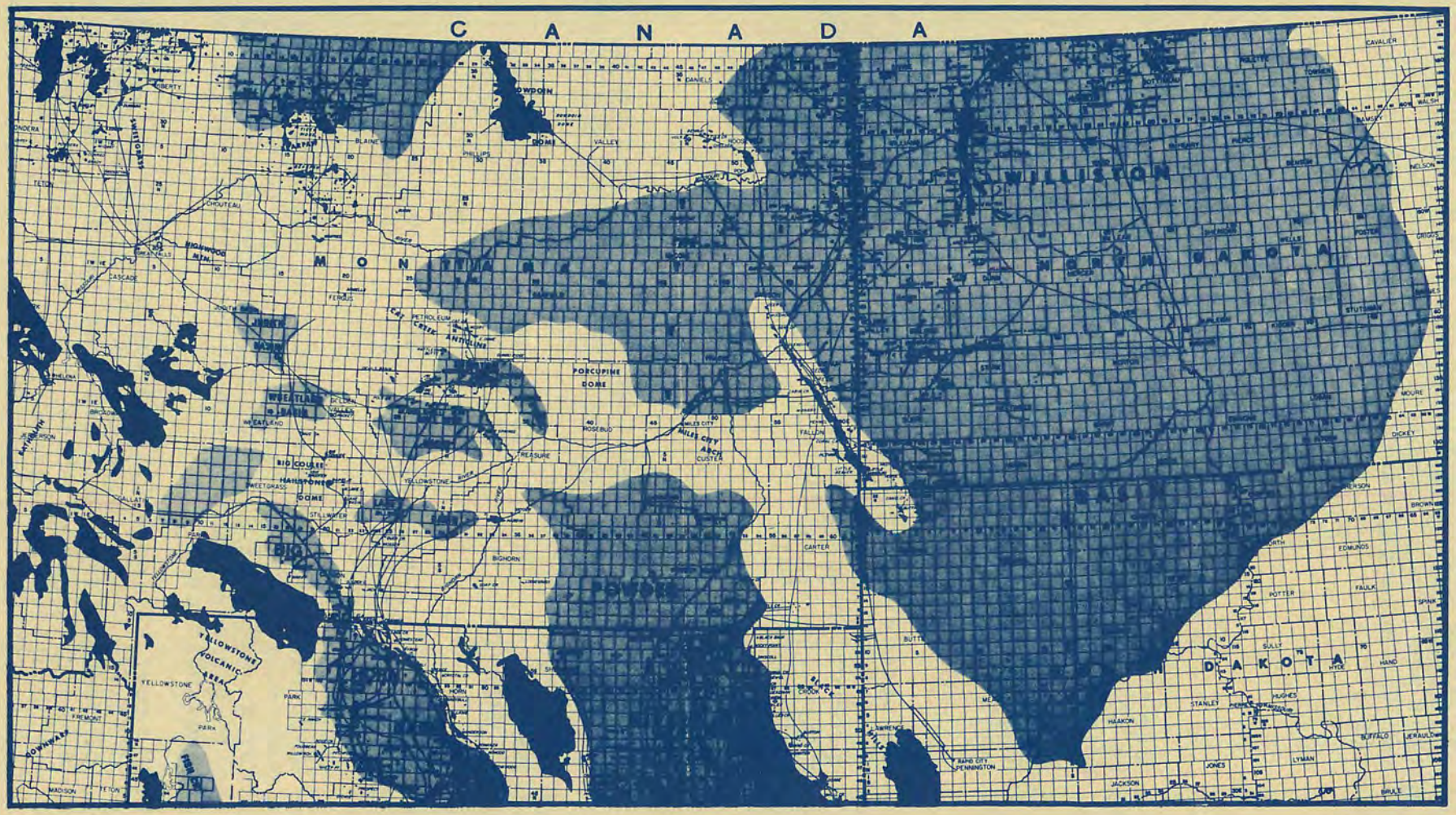


Figure 10-17. Field Size Distribution of Producible Gas, Northern Great Plains.



SOURCE: Petroleum Information Corporation. Updated to January 1980.

Figure 10-18. Oil and Gas Fields Map-Northern Great Plains/Williston Basin.

Production rates and 30-year cumulative production for the Mowry formation are shown in Table 10-8 for the base case and in Table 10-9 for the advanced case. The effect of the advanced technology is evident:

TABLE 10-3

	Base Case	Advanced Case	% Increase
1st. Year Rate			
Best Wells (0.3 md) MMCF/Yr	48	68	142
Poorest Wells (0.001md) MMCF/Yr	10	34	340
30-Year Cummulative			
Best Wells (0.3 md) MMCF	611	879	144
Poorest Wells (0.001 md) MMCF	76	273	359

Also, the effect of stacking (commingling) several pays can be determined by comparing a Mowry well's first year rates and 30-year cumulative production against those of a commingled well where the Mowry, Greenhorn, Carlile, Eagle and Judith River are completed (see Tables 10-71 and 72):

TABLE 10-4

	Base Case			Advanced Case		
	Mowry	Stacked	% Incr.	Mowry	Stacked	% Incr.
1st. Year Rate						
(0.3 md) MMCF/Yr	48	358	746	68	510	750
(0.001 md) MMCF/Yr	10	57	570	34	185	544
30-Year Cumulative						
(0.3 md) BCF	0.611	4.659	763	0.879	6.509	741
(0.001 md) BCF	0.076	0.416	547	0.273	1.479	542

Table 10-80 exhibits another benefit of advanced technology; i.e., the number of wells necessary to develop recoverable gas is reduced. For example, at 0.03 md, required well density is reduced from 3.3 wells per section in the base case to 1.3 wells per section in the advanced case.

Northern Great Plains/Williston basin tight gas formations are considered blanket. With the exception of the Niobrara, which is a Chalk, the production intervals are usually small sandstone or siltstone stringers in large shale intervals. These pays are hard to locate and quantify with existing evaluation techniques. In general, fields will be stratigraphic as opposed to structure related.

ECONOMICS

An evaluation of Table 10-6 would imply that, with the exception of single pay subbasins, there should be significant qualities of base case gas being developed at $2.50/MCF (constant 1979 dollars). Even though some pricing is now allowed to approach $2.50/MCF, very little of this gas is being developed at this time as a result of factors not obvious from the various tables. Three major reasons exist:

- Gas pricing is now just starting to approach the required incentive price.
- There are no pipelines available to transport the gas to market. Pipeline costs are not included in this study. Because of low formation pressure none of this low rate gas can be produced to pipeline without compression; many low rate wells are needed before major pipeline investments are made.
- Most of the existing exploration and development drilling in this area has been devoted to more profitable oil pays at deeper depths. In many cases the shallower tight gas pays were not evaluated or even detected during drilling. This is partially the result of the log identification problems noted previously.

One interesting aspect of developing this area is well cost. One example is given in Table 10-46. Drilling is a very minor investment item ($51,000) compared to base case ($84,000-$161,000) or advanced case ($106,000-$606,000) fracturing cost. Even surface facilities, which include compression and processing equipment as well as gathering lines, costs $103,000 -- over twice the drilling cost.

Table 10-6 shows that 54.7 TCF, or 55 percent, of the maximum recoverable gas (100.2 TCF, Table 10-5), is recoverable at $2.50/MCF with base case technology. Higher prices ($9.00/MCF) and advanced technology could improve recovery to 99.3 TCF or nearly all the recoverable gas, but pipelines and gas markets would be necessary.

REFERENCES

1. Rice, D. D., and Shurr, G. W., 1978, "Potential for Major Natural Gas Resources in Shallow, Low-permeability Reservoirs of the Northern Great Plains," Montana Geol. Soc. Guidebook 24th Ann. Conf., Williston Basin Symposium, pp. 265-281.

2. Lewin and Associates, Inc., 1978, "Enhanced Recovery of Unconventional Gas - The Program, Volume II," Prepared for the U.S. Department of Energy; National Tech. Information Service HCP/T2705-02, 348 pp.

3. Bayliff, W. H., 1975, "Performance Review of Tiger Ridge and Bullhook Gas Units," Montana Geol. Soc. 22nd Ann. Pub., Energy Resources of Montana, pp. 31-37.

4. Scholle, P. A., 1977, "Current oil and gas production from North American Upper Cretaceous chalks," U.S. Geol. Survey Circ. 767, 51 pp.

5. Nydegger, G. L., Rice, D. D., and Brown, C. A., 1979, "Development of shallow gas reserves in low-permeability reservoirs of Late Cretaceous age, Bowdoin Dome area, north-central Montana," Soc. Petrol. Eng. AIME Paper No. 7945, 10 pp.

6. Suffield Evaluation Committee, 1974, "Final Report, Suffield Evaluation Committee, Relating to Evaluation of the gas resources of the Suffield Block," Prepared for the Province of Alberta, 31 pp.

7. Last, Kloepfer Ltd., 1974, "Suffield Evaluation Drilling Program -- A Report Submitted to the Suffield Evaluation Committee," Prepared for Province of Alberta, 75 pp.

8. Rice, D. D., and Claypool, G. E., in press, "Generation, Accumulation, and Resource Potential of Biogenic Gas," AAPG Bulletin.

TABLE 10-5

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
Northern Great Plains-Williston		Mowry	1,228	1,298
		Mowry + Greenhorn	1,031	2,221
		Mowry + Carlile	1,165	3,522
		Mowry + Greenhorn + Carlile	2,600	10,331
		Mowry + Greenhorn + Carlile + Eagle	2,272	12,165
		Mowry + Greenhorn + Eagle	1,832	5,386
		Mowry + Judith River	2,361	4,836
		Mowry, Carlile, Eagle	1,602	7,391
		Mowry, Carlile, Eagle, Judith River	2,115	11,966
		Mowry, Carlile, Judith River	1,256	4,514
		Greenhorn	2,250	2,245
		Greenhorn and Carlile	460	1,188
		Greenhorn + Eagle	1,431	4,036
		Greenhorn, Carlile, Eagle	804	3,353
		Carlile	2,700	3,945
		Niobrara	1,283	7,095
		Carlile, Eagle	815	2,186
		Judith River	3,910	3,093
		Mowry, Greenhorn, Carlile, Eagle, Judith Riv.	870	5,934
		Carlile and Niobrara	745	3,481
Basin Total			32,730	100,186

TABLE 10-6

SUMMARY OF NORTHERN GREAT PLAINS - WILLISTON BASIN GAS POTENTIAL

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Northern Great Plains - Williston		Mowry	0	614	1054	0	937	1298
		Mowry + Greenhorn	1667	2021	2022	1998	2221	2221
		Mowry + Carlile	2755	3037	3037	3487	3522	3522
		Mowry + Greenhorn + Carlile	8365	9041	9062	10255	10331	10331
		Mowry +Greenhorn +Carlile +Eagle	8926	10091	10127	9358	12165	12165
		Mowry + Greenhorn + Eagle	3728	4180	4192	4023	5327	5386
		Mowry + Judith River	0	4082	4097	3785	4836	4836
		Mowry, Carlile, Eagle	5215	5917	5933	5580	7391	7391
		Mowry,Carlile,Eagle,Judith Riv.	7843	9038	9067	8764	11842	11966
		Mowry, Carlile, Judith River	3313	3682	3694	4466	4514	4514
		Greenhorn	0	1670	1906	0	2041	2216
		Greenhorn and Carlile	921	998	1000	987	1188	1188
		Greenhorn + Eagle	2747	3143	3155	2934	3984	4036
		Greenhorn, Carlile, Eagle	2397	2695	2708	2596	3310	3353
		Carlile	0	2862	3116	0	3196	3945
		Niobrara	6756	6843	6843	7091	7091	7091
		Carlile, Eagle	1202	1623	1623	1589	2156	2186
		Judith River	0	0	1480	0	0	2281
		Mowry,Grnh.,Car.,Eagle,Jud.Riv.	3392	3672	3681	4546	5872	5934
		Carlile and Niobrara	2260	2518	2525	2530	3434	3481
Basin Total			54731	77727	80322	73989	95358	99341

TABLE 10-7

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

BASIN: Northern Great Plains-Williston
SUBBASIN: 1
FORMATION: Mowry

DEPTH (FT.): 3000
PRESSURE (PSIA): 1000
TEMPERATURE (°F): 108

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	258	10.6	5	311.92	257	0.30	0.10	0.90
0.1	356	9.0	6	468.00	361	0.40	0.10	0.90
0.03	307	7.4	8	442.45	321	0.50	0.15	0.90
0.01	184	6.0	10	268.77	195	0.40	0.15	0.90
0.003	117	5.7	14	227.29	115	0.30	0.10	0.90
0.001	6	5.0	20	14.61	9	0.30	0.10	0.90
	1228			1733.	1298			

TABLE 10-8

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	48	36	25	18	13	10				
2	35	24	16	10	7	5				
5	27	17	10	6	4	3				
10	21	14	8	5	3	2				
15	18	12	7	4	2	1				
20	15	11	6	3	2	1				
30	11	9	5	3	2	1				
30-YEAR CUMM. PROD. (MMCF)	611	420	259	158	107	76				

TABLE 10-9

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	68	55	53	43	41	34				
2	50	38	39	28	25	20				
5	38	27	27	19	15	12				
10	30	21	21	14	11	8				
15	26	18	18	12	9	7				
20	23	16	16	10	8	6				
30	18	13	13	9	6	5				
30-YEAR CUMM. PROD. (MMCF)	879	632	631	441	353	273				

TABLE 10-10

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 1
FORMATION: Mowry

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.6	1.6	257	1.1	1.1	257
.1	2.4	2.4	361	1.6	1.6	361
.03	4.0	4	321	1.7	1.7	321
.01	6.7	4	116	2.4	2.4	195
.003	12.3	4	37	3.7	3.7	115
.001	20.0	4	2	5.6	5.6	9
			1094			1298

TABLE 10-11

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 1
FORMATION: Mowry

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	95,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-12

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston — TECHNOLOGY Base Case

SUB BASIN 1 — FORMATION Mowry — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1201111	1.50	0	0	0	630	0	-382	0.0	0	0	0	0	0	0	0	0	0
21	2.50	6.7	1	A	1349	1.373	-325	2.90	-	-	-	3.4	-	-	-	-	-
31	3.10	17.1	2	AB	2925	3.429	-248	7.20	-	-	-	8.8	-	-	-	-	-
41	3.50	17.1	2	AB	2925	3.429	-790	9.10	-	-	-	8.8	-	-	-	-	-
51	5.00	29.8	3	ABC	6117	5.990	536	13.1	937	937	157	15.3	259	47	656	2624	3586
61	7.00	35.5	4	ABCD	7605	6.943	1941	19.5	1054	1132	151	18.2	240	53	801	3201	4296
71	9.00	35.5	4	ABCD	7605	6.943	3627	27.9	"	"	"	18.2	"	"	"	"	"
81	12.00	38.6	5	ABCDE	8245	7.217	6173	38.8	1105	1290	153	19.8	238	59	886	3543	4727
Discount Rate 15%																	
12	1.50	0	0	0	630	-	-391	-	0	0	0	0	0	0	0	0	0
22	2.50	6.7	1	A	1349	1.373	-412	-	0	0	0	3.4	0	0	0	0	0
32	3.10	6.7	1	A	1349	1.373	-343	-	"	"	"	3.4	"	"	"	"	"
42	3.50	17.1	2	AB	2925	3.429	-376	-	"	"	"	8.8	"	"	"	"	"
52	5.00	17.1	2	AB	2925	3.429	52	15.7	614	614	178	8.8	317	30	310	1243	1901
62	7.00	29.8	3	ABC	6117	5.990	804	21.8	937	937	157	15.3	259	47	656	2624	3586
72	9.00	35.5	4	ABCD	7605	6.943	1778	27.9	1054	1132	151	18.2	240	53	801	3201	4296
82	12.00	38.6	5	ABCDE	8245	7.217	3463	38.8	1105	1290	153	19.8	238	59	886	3543	4727
Discount Rate 20%																	
13	1.50	-	-	-	630	-	-399	0.0	0	0	0	0	0	0	0	0	0
23	2.50	-	-	-	630	-	-399	0.0	"	"	"	0	"	"	"	"	"
33	3.10	6.7	1	A	1349	1.373	-407	5.4	"	"	"	3.4	"	"	"	"	"
43	3.50	6.7	1	A	1349	1.373	-374	6.9	"	"	"	3.4	"	"	"	"	"
53	5.00	17.1	2	AB	2925	3.429	-212	15.7	"	"	"	8.8	"	"	"	"	"
63	7.00	29.8	3	ABC	6117	5.990	161	21.8	937	937	157	15.3	259	47	656	2624	3586
73	9.00	29.8	3	ABC	6117	5.990	901	30.5	"	"	"	15.3	"	"	"	"	"
83	12.00	35.5	4	ABCD	7605	6.943	2049	40.5	1054	1132	151	18.2	240	53	801	3201	4296

* CODE: A B C D E F
0.3 0.1 0.03 0.01 0.003 0.001

TABLE 10-13

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 1 — FORMATION Mowry — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1201211	1.50	6.7	1	A	1382	1.373	-523	0	-	-	-	3.4	-	-	-	-	-
21	2.50	17.1	2	AB	2511	3.428	-286	6.5	-	-	-	8.8	-	-	-	-	-
31	3.10	17.1	2	AB	2511	3.428	- 30	9.6	-	-	-	8.8	-	-	-	-	-
41	3.50	29.8	3	ABC	4745	5.990	216	11.5	937	937	157	15.3	259	47	338	1349	1993
51	5.00	35.5	4	ABCD	6288	7.213	1403	17.9	1132	1132	157	18.2	251	55	444	1776	2526
61	7.00	38.6	5	ABCDE	7324	7.871	3345	26.9	1287	1287	164	19.8	255	64	535	2146	3000
71	9.00	38.7	6	ABCDEF	7333	7.875	5327	36.9	1298	1298	166	19.9	259	64	544	2175	3042
81	12.00	38.7	6	ABCDEF	7333	7.875	8299	51.1	"	"	"	19.9	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	841	-	-507	0	-	-	-	0	-	-	-	-	-
22	2.50	17.1	2	AB	2511	3.428	-499	6.5	-	-	-	8.8	-	-	-	-	-
32	3.10	17.1	2	AB	2511	3.428	-326	9.6	-	-	-	8.8	-	-	-	-	-
42	3.50	17.1	2	AB	2511	3.428	-210	11.6	-	-	-	8.8	-	-	-	-	-
52	5.00	29.8	3	ABC	4745	5.990	425	19.2	937	937	157	15.3	259	47	338	1349	1993
62	7.00	35.5	4	ABCD	6288	7.213	1587	28.0	1132	1132	157	18.2	251	55	444	1776	2526
72	9.00	38.7	6	ABCDEF	7333	7.875	2963	36.9	1298	1298	166	19.9	259	64	544	2175	3042
82	12.00	38.7	6	ABCDEF	7333	7.875	4991	51.1	"	"	"	19.9	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	841	-	-513	0	-	-	-	0	-	-	-	-	-
23	2.50	6.7	1	A	1382	1.373	-506	3.1	-	-	-	3.4	-	-	-	-	-
33	3.10	17.1	2	AB	2511	3.428	-477	9.6	-	-	-	8.8	-	-	-	-	-
43	3.50	17.1	2	AB	2511	3.428	-393	11.6	-	-	-	8.8	-	-	-	-	-
53	5.00	17.1	2	AB	2511	3.428	-78	18.4	-	-	-	8.8	-	-	-	-	-
63	7.00	17.1	2	AB	2511	3.428	687	29.1	614	614	178	8.8	295	53	382	1532	2260
73	9.00	38.6	5	ABCDE	7324	7.871	1674	36.9	1287	1287	164	19.8	255	64	535	2146	3000
83	12.00	38.7	6	ABCDEF	7333	7.8	3157	51.1	1298	1298	166	19.9	259	64	544	2175	3042

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-14

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 2
FORMATION: Mowry, Greenhorn

DEPTH (FT.): 2750
PRESSURE (PSIA): 1185
TEMPERATURE (°F): 105

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	258	10.4	12	720	553	0.35	0.15	0.90
0.1	258	9.0	14	727	557	0.35	0.15	0.90
0.03	258	7.4	18	768	556	0.35	0.15	0.90
0.01	154	6.0	22	454	329	0.35	0.20	0.90
0.003	98	5.5	29	318	215	0.35	0.40	0.90
0.001	5	5.0	35	20	12	0.35	0.50	0.90
	1031			3007	2221			

TABLE 10-15

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + GREENHORN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	156	114	78	53	37	24				
2	117	78	49	30	20	13				
5	90	55	32	20	12	7				
10	71	45	25	14	8	5				
15	58	39	22	12	7	4				
20	49	35	20	11	7	4				
30	37	29	18	10	5	3				
30-YEAR CUMM. PROD. (MMCF)	1948	1325	789	467	292	179				

TABLE 10-16

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + GREENHORN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	222	176	164	129	112	81				
2	165	121	119	86	69	48				
5	123	85	84	56	43	28				
10	99	66	64	43	30	20				
15	84	57	55	36	26	16				
20	75	51	49	32	23	14				
30	60	43	41	27	18	12				
30-YEAR CUMM. PROD. (MMCF)	2825	1987	1912	1304	966	640				

TABLE 10-17

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 2
FORMATION: Mowry + Greenhorn

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.085	1.085	553	.748	.748	553
.1	1.634	1.634	557	1.089	1.089	557
.03	2.726	2.726	556	1.126	1.126	556
.01	4.561	4	288	1.636	1.636	329
.003	7.502	4	115	2.273	2.273	215
.001	13.755	4	3	3.869	3.869	12
			2072			2221

TABLE 10-18

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 2
FORMATION: Mowry + Greenhorn

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	86,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-19

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston

SUB BASIN 2

FORMATION Mowry and Greenhorn

TECHNOLOGY Base Case

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1202111	1.50	24.5	3	ABC	1972	5.181	-109	8.3	-	-	-	12.7	-	-	-	-	-
21	2.50	30.4	4	ABCD	2743	6.528	524	15.9	1957	1998	300	15.8	487	91	497	1990	3066
31	3.10	30.4	4	ABCD	2743	6.528	1006	21.1	"	"	"	15.8	"	"	"	"	"
41	3.50	33.2	5	ABCDE	2985	6.827	1311	23.5	2021	2214	296	17.2	473	99	547	2185	3301
51	5.00	33.2	5	ABCDE	2985	6.827	2564	35.1	"	"	"	17.2	"	"	"	"	"
61	7.00	33.5	6	ABCDEF	2992	6.833	4236	48.6	2022	2221	"	17.3	471	"	548	2191	3310
71	9.00	33.5	6	ABCDEF	2992	6.833	5908	60.2	"	"	"	17.3	"	"	"	"	"
81	12.00	33.5	6	ABCDEF	2992	6.833	8416	74.9	"	"	"	17.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	16.0	2	AB	1288	3.406	-245	8.2	-	-	-	8.3	-	-	-	-	-
22	2.50	24.5	3	ABC	1972	5.181	128	17.5	1667	1667	323	12.7	544	80	341	1360	2324
32	3.10	30.4	4	ABCD	2743	6.528	388	21.1	1957	1998	300	15.8	487	91	497	1990	3066
42	3.50	30.4	4	ABCD	2743	6.528	608	24.4	"	"	"	15.8	"	"	"	"	"
52	5.00	33.2	5	ABCDE	2985	6.827	1434	35.1	2021	2214	296	17.2	473	99	547	2185	3301
62	7.00	33.5	6	ABCDEF	2992	6.833	2574	48.6	2022	2221	"	17.3	471	"	548	2191	3310
72	9.00	33.5	6	ABCDEF	2992	6.833	3716	60.2	"	"	"	17.3	"	"	"	"	"
82	12.00	33.5	6	ABCDEF	2992	6.833	5428	74.9	"	"	"	17.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.0	1	A	1288	3.406	-332	8.2	-	-	-	8.3	-	-	-	-	-
23	2.50	24.5	3	ABC	1972	5.181	-96	17.5	-	-	-	12.7	-	-	-	-	-
33	3.10	24.5	3	ABC	1972	5.181	98	22.4	1667	1667	323	12.7	544	80	341	1360	2324
43	3.50	30.4	4	ABCD	2743	6.528	214	24.4	1957	1998	300	15.8	487	91	497	1990	3066
53	5.00	33.2	5	ABCDE	2985	6.827	807	35.1	2021	2214	296	17.2	473	99	547	2185	3301
63	7.00	33.2	5	ABCDE	2985	6.827	1643	48.6	"	"	"	17.2	"	"	"	"	"
73	9.00	33.5	6	ABCDEF	2992	6.833	2479	60.2	2022	2221	"	17.3	471	"	548	2191	3310
83	12.00	33.5	6	ABCDEF	2992	6.833	3734	74.9	"	"	"	17.3	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-20

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 2 — FORMATION Mowry, Greenhorn — DATE June, 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1202211	1.50	24.5	3	ABC	1792	5.181	12	10.1	1667	1667	323	12.7	544	80	178	712	1514
21	2.50	33.2	5	ABCDE	2567	6.962	888	19.9	2214	2214	317	17.2	507	106	284	1138	2035
31	3.10	33.5	6	ABCDEF	2579	6.977	1426	25.4	2221	2221	319	17.4	"	107	287	1151	2052
41	3.50	33.5	6	ABCDEF	2579	6.977	1784	28.9	"	"	"	17.4	"	"	"	"	"
51	5.00	33.5	6	ABCDEF	2579	6.977	3128	40.8	"	"	"	17.4	"	"	"	"	"
61	7.00	33.5	6	ABCDEF	2579	6.977	4920	54.4	"	"	"	17.4	"	"	"	"	"
71	9.00	33.5	6	ABCDEF	2579	6.977	6711	66.1	"	"	"	17.4	"	"	"	"	"
81	12.00	33.5	6	ABCDEF	2579	6.977	9399	80.9	"	"	"	17.4	"	"	"	"	"
Discount Rate 15%																	
12	1.50	24.5	3	ABC	1792	5.181	-233	10.1	-	-	-	12.7	-	-	-	-	-
22	2.50	30.4	4	ABCD	2334	6.528	303	20.0	1998	1998	306	15.7	497	93	242	970	1802
32	3.10	33.2	5	ABCDE	2567	6.962	681	25.4	2214	2214	317	17.2	507	106	284	1138	2035
42	3.50	33.2	5	ABCDE	2567	6.962	927	28.9	"	"	"	17.2	"	"	"	"	"
52	5.00	33.5	6	ABCDEF	2579	6.977	1852	40.8	2221	2221	319	17.4	"	107	287	1151	2052
62	7.00	33.5	6	ABCDEF	2579	6.977	3085	54.4	"	"	"	17.4	"	"	"	"	"
72	9.00	33.5	6	ABCDEF	2579	6.977	4317	66.1	"	"	"	17.4	"	"	"	"	"
82	12.00	33.5	6	ABCDEF	2579	6.977	6166	80.9	"	"	"	17.4	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.0	2	AB	1312	3.406	-367	8.1	-	-	-	8.3	-	-	-	-	-
23	2.50	30.4	4	ABCD	2334	6.528	1	20.0	1998	1998	306	15.7	497	93	242	970	1802
33	3.10	33.2	5	ABCDE	2567	6.962	269	25.4	2214	2214	317	17.2	507	106	284	1138	2035
43	3.50	33.2	5	ABCDE	2567	6.962	450	28.9	"	"	"	17.2	"	"	"	"	"
53	5.00	33.5	6	ABCDEF	2579	6.977	1131	40.8	2221	2221	319	17.4	"	107	287	1151	2052
63	7.00	33.5	6	ABCDEF	2579	6.977	2039	54.4	"	"	"	17.4	"	"	"	"	"
73	9.00	33.5	6	ABCDEF	2579	6.977	2947	66.1	"	"	"	17.4	"	"	"	"	"
83	12.00	33.5	6	ABCDEF	2579	6.977	4310	80.9	"	"	"	17.4	"	"	"	"	"

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 10-23

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	268	243	206	167	132	104				
2	199	168	149	110	82	61				
5	149	118	105	72	51	36				
10	119	92	80	55	36	26				
15	102	79	70	48	30	21				
20	91	72	62	41	27	18				
30	74	60	53	35	22	15				
30-YEAR CUMM. PROD. (MMCF)	3441	2763	2414	1688	1143	823				

TABLE 10-24

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 3
FORMATION: Mowry + Carlile

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.179	1.179	394	.818	.818	394
.1	1.762	1.762	870	1.175	1.175	870
.03	2.946	2.946	923	1.214	1.214	923
.01	4.918	4	570	1.760	1.760	701
.003	8.854	4	271	2.680	2.680	600
.001	14.671	4	9	4.136	4.136	34
			3037			3522

TABLE 10-25

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 3
FORMATION: Mowry + Carlile

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	74,278
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 91,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 316,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-26

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston

SUB BASIN 3

FORMATION Mowry and Carlile

TECHNOLOGY Base Case

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1203111	1.50	25.0	3	ABC	1730	5.549	66	11.0	2186	2186	394	13.1	650	99	357	1429	2535
21	2.50	32.8	4	ABCD	2503	7.525	873	20.0	2755	2886	366	17.3	575	119	565	2257	3516
31	3.10	39.1	5	ABCDE	3041	8.345	1396	24.3	3026	3487	361	20.6	546	142	717	2867	4271
41	3.50	39.1	5	ABCDE	3041	8.345	1790	28.0	"	"	"	20.6	"	"	"	"	"
51	5.00	39.5	6	ABCOEF	3053	8.358	3267	40.9	3037	3522	363	20.8	"	143	724	2894	4306
61	7.00	39.5	6	ABCDEF	3053	8.358	5238	55.6	"	"	"	20.8	"	"	"	"	"
71	9.00	39.5	6	ABCDEF	3053	8.358	7209	68.0	"	"	"	20.8	"	"	"	"	"
81	12.00	39.5	6	ABCOEF	3053	8.358	10166	83.6	"	"	"	20.8	"	"	"	"	"
Discount Rate 15%																	
12	1.50	25.0	3	ABC	1730	5.549	-176	11.0	0	0	0	13.1	0	0	0	0	0
22	2.50	32.8	4	ABCD	2503	7.525	315	20.2	2755	2886	366	17.3	575	119	565	2257	3516
32	3.10	32.8	4	ABCD	2503	7.525	682	26.1	"	"	"	17.3	"	"	"	"	"
42	3.50	39.1	5	ABCDE	3041	8.345	901	28.0	3026	3487	361	20.6	546	142	717	2867	4271
52	5.00	39.5	6	ABCDEF	3053	8.358	1907	40.9	3037	3522	363	20.8	"	143	724	2894	4306
62	7.00	39.5	6	ABCDEF	3053	8.358	3251	55.6	"	"	"	20.8	"	"	"	"	"
72	9.00	39.5	6	ABCDEF	3053	8.358	4594	68.0	"	"	"	20.8	"	"	"	"	"
82	12.00	39.5	6	ABCDEF	3053	8.358	6610	83.6	"	"	"	20.8	"	"	"	"	"
Discount Rate 20%																	
13	1.50	25.0	3	ABC	1730	5.549	-306	11.0	0	0	0	13.1	0	0	0	0	0
23	2.50	32.8	4	ABCD	2503	7.525	13	20.2	2755	2886	366	17.3	575	119	565	2257	3516
33	3.10	32.8	4	ABCD	2503	7.525	282	26.1	"	"	"	17.3	"	"	"	"	"
43	3.50	32.8	4	ABCD	2503	7.525	461	29.7	"	"	"	17.3	"	"	"	"	"
53	5.00	39.1	5	ABCDE	3041	8.345	1153	41.0	3026	3487	361	20.6	546	142	717	2867	4271
63	7.00	39.5	6	ABCDEF	3053	8.358	2138	55.6	3037	3522	363	20.8	"	143	724	2894	4306
73	9.00	39.5	6	ABCDEF	3053	8.358	3123	68.0	"	"	"	20.8	"	"	"	"	"
83	12.00	39.5	6	ABCDEF	3053	8.358	4601	83.6	"	"	"	20.8	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-27

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 3 — FORMATION Mowry, Carlile — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1203211	1.50	32.8	4	ABCD	2262	7.524	229	12.8	2886	2886	383	17.3	603	125	279	1114	2121
21	2.50	39.5	6	ABCDEF	2931	8.982	1362	23.7	3522	3522	392	20.8	591	155	406	1618	2770
31	3.10	39.5	6	ABCDEF	2931	8.982	2053	30.0	"	"	"	20.8	"	"	"	"	"
41	3.50	39.5	6	ABCDEF	2931	8.982	2513	34.0	"	"	"	20.8	"	"	"	"	"
51	5.00	39.5	6	ABCDEF	2931	8.982	4241	47.5	"	"	"	20.8	"	"	"	"	"
61	7.00	39.5	6	ABCDEF	2931	8.982	6544	62.7	"	"	"	20.8	"	"	"	"	"
71	9.00	39.5	6	ABCDEF	2931	8.982	8847	75.5	"	"	"	20.8	"	"	"	"	"
81	12.00	39.5	6	ABCDEF	2931	8.982	12302	91.8	"	"	"	20.8	"	"	"	"	"
Discount Rate 15%																	
12	1.50	32.8	4	ABCD	2262	7.524	-123	12.8	0	0	0	17.3	0	0	0	0	0
22	2.50	39.1	5	ABCDE	2905	8.943	612	23.7	3487	3487	389	20.6	588	152	398	1590	2727
32	3.10	39.5	6	ABCDEF	2931	8.982	1087	30.0	3522	3522	392	20.8	591	155	406	1618	2770
42	3.50	39.5	6	ABCDEF	2931	8.982	1404	34.0	"	"	"	20.8	"	"	"	"	"
52	5.00	39.5	6	ABCDEF	2931	8.982	2593	47.5	"	"	"	20.8	"	"	"	"	"
62	7.00	39.5	6	ABCDEF	2931	8.982	4179	62.7	"	"	"	20.8	"	"	"	"	"
72	9.00	39.5	6	ABCDEF	2931	8.982	5765	75.5	"	"	"	20.8	"	"	"	"	"
82	12.00	39.5	6	ABCDEF	2931	8.982	8144	91.8	"	"	"	20.8	"	"	"	"	"
Discount Rate 20%																	
13	1.50	25.0	3	ABC	1662	5.548	-300	11.9	0	0	0	13.1	0	0	0	0	0
23	2.50	39.1	5	ABCDE	2905	8.943	199	23.7	3487	3487	389	20.6	588	152	398	1590	2727
33	3.10	39.1	5	ABCDE	2905	8.943	548	30.1	"	"	"	20.6	"	"	"	"	"
43	3.50	39.1	5	ABCDE	2905	8.943	781	34.0	"	"	"	20.6	"	"	"	"	"
53	5.00	39.5	6	ABCDEF	2931	8.982	1659	47.5	3522	3522	392	20.8	591	155	406	1618	2770
63	7.00	39.5	6	ABCDEF	2931	8.982	2829	62.7	"	"	"	20.8	"	"	"	"	"
73	9.00	39.5	6	ABCDEF	2931	8.982	3999	75.5	"	"	"	20.8	"	"	"	"	"
83	12.00	39.5	6	ABCDEF	2931	8.982	5754	91.8	"	"	"	20.8	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-28

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 4
FORMATION: Mowry, Greenhorn, Carlile

DEPTH (FT.): 2280
PRESSURE (PSIA): 980
TEMPERATURE (°F): 98

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	416	10.4	25	1999.2	1538	0.40	0.10	0.90
0.1	572	9.0	31	2949.8	2270	0.40	0.10	0.90
0.03	728	7.4	42	4182.21	3029	0.40	0.15	0.90
0.01	494	6.0	48	2629.76	1905	0.40	0.20	0.90
0.003	372	5.5	59	2231.29	1515	0.40	0.25	0.90
0.001	18	5.0	70	116.45	74	0.40	0.30	0.90
	2600			14109.	10331			

TABLE 10-29

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + GREENHORN + CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	241	190	137	89	57	38				
2	180	131	86	51	32	20				
5	139	92	57	34	19	12				
10	111	74	44	24	13	8				
15	93	65	39	21	12	7				
20	79	59	35	18	10	6				
30	60	50	31	16	9	5				
30-YEAR CUMM. PROD. (MMCF)	3102	2215	1387	772	455	275				

TABLE 10-30

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + GREENHORN + CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	344	291	286	117	173	124				
2	256	202	208	78	108	73				
5	192	142	146	51	66	44				
10	154	111	112	39	48	31				
15	134	96	97	33	40	25				
20	118	86	88	30	35	22				
30	96	74	74	25	29	18				
30-YEAR CUMM. PROD. (MMCF)	4454	3322	3370	2159	1503	981				

TABLE 10-31

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 4
FORMATION: Mowry + Carlile + Greenhorn

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.192	1.192	1538	.830	.830	1538
.1	1.791	1.791	2270	1.194	1.194	2270
.03	2.998	2.998	3029	1.234	1.234	3029
.01	4.988	4	1528	1.786	1.786	1905
.003	8.952	4	677	2.710	2.710	1515
.001	14.856	4	20	4.175	4.175	74
			9062			10331

TABLE 10-32

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 4
FORMATION: Mowry + Carlile + Greenhorn

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	71,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 125,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 463,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0518

TABLE 10-33

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston

SUB BASIN 4

FORMATION Mowry, Greenhorn, Carlile

TECHNOLOGY Base Case

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
12041 11	1.50	31.6	4	ABCD	1879	7.101	229	13.4	8365	8742	1178	16.4	1896	372	1223	4890	8381
21	2.50	36.8	5	ABCDE	2224	7.759	1083	23.6	9041	10255	1165	19.1	1814	429	1518	6075	9836
31	3.10	36.8	5	ABCDE	2224	7.759	1641	29.8	"	"	"	19.1	"	"	"	"	"
41	3.50	36.8	5	ABCDE	2224	7.759	2012	33.7	"	"	"	19.1	"	"	"	"	"
51	5.00	37.1	6	ABCDEF	2256	7.792	3409	46.7	9062	10331	1163	19.3	1806	431	1541	6166	9947
61	7.00	37.1	6	ABCDEF	2256	7.792	5276	61.3	"	"	"	19.3	"	"	"	"	"
71	9.00	37.1	6	ABCDEF	2256	7.792	7143	73.4	"	"	"	19.3	"	"	"	"	"
81	12.00	37.1	6	ABCDEF	2256	7.792	9944	88.7	"	"	"	19.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	31.6	4	ABCD	1879	7.101	-76	13.4	0	0	0	16.4	0	0	0	0	0
22	2.50	31.6	4	ABCD	1879	7.101	514	24.8	8365	8742	1178	16.4	1896	372	1223	4890	8381
32	3.10	36.8	5	ABCDE	2224	7.759	866	29.8	9041	10255	1165	19.1	1814	429	1518	6075	9836
42	3.50	36.8	5	ABCDE	2224	7.759	1121	33.7	"	"	"	19.1	"	"	"	"	"
52	5.00	37.1	6	ABCDEF	2256	7.792	2076	46.7	"	"	"	19.3	"	"	"	"	"
62	7.00	37.1	6	ABCDEF	2256	7.792	3356	61.3	9062	10331	1163	19.3	1806	431	1514	6166	9947
72	9.00	37.1	6	ABCDEF	2256	7.792	4635	73.4	"	"	"	19.3	"	"	"	"	"
82	12.00	37.1	6	ABCDEF	2256	7.792	6555	88.7	"	"	"	19.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	23.8	3	ABC	1373	5.373	-187	14.0	0	0	0	12.3	0	0	0	0	0
23	2.50	31.6	4	ABCD	1879	7.101	193	24.8	8365	8741	1178	16.4	1896	372	1223	4890	8381
33	3.10	31.6	4	ABCD	1879	7.101	453	30.9	"	"	"	16.4	"	"	"	"	"
43	3.50	36.8	5	ABCDE	2224	7.759	623	33.7	9041	10255	1165	19.1	1814	429	1518	6975	9836
53	5.00	36.8	5	ABCDE	2224	7.759	1327	46.9	"	"	"	19.1	"	"	"	"	"
63	7.00	37.1	6	ABCDEF	2256	7.792	2267	61.3	9062	10331	1163	19.3	1806	431	1541	6166	9947
73	9.00	37.1	6	ABCDEF	2256	7.792	3210	73.4	"	"	"	19.3	"	"	"	"	"
83	12.00	37.1	6	ABCDEF	2256	7.792	4624	88.7	"	"	"	19.3	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-34

Economic Summary

BASIN Northern Great Plains-Williston
SUB BASIN 4
FORMATION Mowry, Greenhorn, Carlile
TECHNOLOGY Advanced Case
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
12042 11	1.50	23.8	3	ABC	1403	5.372	225	13.6	6838	6838	1273	12.3	2148	303	398	1592	4441
21	2.50	36.8	5	ABCDE	2261	7.798	1221	24.3	10255	10255	1315	19.1	2047	484	887	3555	6975
31	3.10	37.1	6	ABCDEF	2337	7.897	1813	30.2	10331	10331	1308	19.3	2034	486	917	3666	7102
41	3.50	37.1	6	ABCDEF	2337	7.897	2208	34.1	"	"	"	19.3	"	"	"	"	"
51	5.00	37.1	6	ABCDEF	2337	7.897	3687	47.2	"	"	"	19.3	"	"	"	"	"
61	7.00	37.1	6	ABCDEF	2337	7.897	5659	61.8	"	"	"	19.3	"	"	"	"	"
71	9.00	37.1	6	ABCDEF	2337	7.897	7631	74.4	"	"	"	19.3	"	"	"	"	"
81	12.00	37.1	6	ABCDEF	2337	7.897	10590	90.4	"	"	"	19.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	23.8	3	ABC	1403	5.372	-60	13.6	0	0	0	12.3	0	0	0	0	0
22	2.50	36.8	5	ABCDE	2261	7.798	566	24.3	10255	10255	1315	19.1	2047	484	887	3555	6975
32	3.10	36.8	5	ABCDE	2261	7.798	969	30.4	"	"	"	19.1	"	"	"	"	"
42	3.50	37.1	6	ABCDEF	2337	7.897	1243	34.1	10331	10331	1308	19.3	2034	486	917	3666	7102
52	5.00	37.1	6	ABCDEF	2337	7.897	2265	47.2	"	"	"	19.3	"	"	"	"	"
62	7.00	37.1	6	ABCDEF	2337	7.897	3629	61.8	"	"	"	19.3	"	"	"	"	"
72	9.00	37.1	6	ABCDEF	2337	7.897	4992	74.4	"	"	"	19.3	"	"	"	"	"
82	12.00	37.1	6	ABCDEF	2337	7.897	7037	90.4	"	"	"	19.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	23.8	3	ABC	1403	5.372	-221	13.6	0	0	0	12.3	0	0	0	0	0
23	2.50	29.0	4	ABCD	1864	6.535	180	24.2	8742	8742	1338	15.1	2188	388	661	2645	5882
33	3.10	36.8	5	ABCDE	2261	7.798	499	30.4	10255	10255	1315	19.1	2047	484	887	3555	6975
43	3.50	36.8	5	ABCDE	2261	7.798	699	34.2	"	"	"	19.1	"	"	"	"	"
53	5.00	37.1	6	ABCDEF	2337	7.897	1458	47.2	10331	10331	1308	19.3	2034	486	917	3666	7102
63	7.00	37.1	6	ABCDEF	2337	7.897	2469	61.8	"	"	"	19.3	"	"	"	"	"
73	9.00	37.1	6	ABCDEF	2337	7.897	3480	74.4	"	"	"	19.3	"	"	"	"	"
83	12.00	37.1	6	ABCDEF	2337	7.897	4997	90.4	"	"	"	19.3	"	"	"	"	"

* CODE: A B C D E F
0.3 0.1 0.03 0.01 0.003 0.001

TABLE 10-35

GEOLOGICAL DATA SUMMARY

BASIN: Northern Great Plains-Williston
SUBBASIN: 5
FORMATION: Mowry, Greenhorn, Carlile, Eagle

DEPTH (FT.): 2000
PRESSURE (PSIA): 860
TEMPERATURE (°F): 194

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	397	10.4	39	2465.09	1956	0.45	0.30	0.90
0.1	541	9.0	51	13801.50	2924	0.45	0.25	0.90
0.03	493	7.4	62	3462.73	2507	0.45	0.20	0.90
0.01	341	6.0	87	2725.03	1973	0.45	0.15	0.90
0.003	477	5.5	98	3936.01	2671	0.45	0.15	0.90
0.001	23	5.0	120	211.26	134	0.45	0.10	0.90
	2272			26602.	12165			

TABLE 10-36

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + GREENHORN + CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	302	251	164	131	77	52				
2	225	173	102	75	43	28				
5	174	121	69	49	25	16				
10	140	98	52	36	18	11				
15	119	87	46	30	16	9				
20	100	78	42	27	14	8				
30	80	66	37	23	12	7				
30-YEAR CUMM. PROD. (MMCF)	3906	2930	1648	1130	609	382				

TABLE 10-37

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + GREENHORN + CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	430	384	338	309	232	171				
2	320	267	247	206	145	101				
5	240	188	174	137	89	61				
10	194	147	133	104	64	42				
15	169	127	115	89	54	35				
20	149	114	104	79	48	30				
30	125	98	88	66	39	25				
30-YEAR CUMM. PROD. (MMCF)	5592	4396	4003	3153	2016	1360				

TABLE 10-38

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 5
FORMATION: Mowry + Greenhorn + Carlile + Eagle

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.223	1.223	1896	.854	.854	1896
.1	1.844	1.844	2924	1.229	1.229	2924
.03	3.086	3.086	2507	1.270	1.270	2507
.01	5.12	4	1541	1.835	1.835	1973
.003	9.181	4	1164	2.778	2.778	2671
.001	15.193	4	35	4.275	4.275	134
			10067			12105

TABLE 10-39

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 5
FORMATION: Mowry + Greenhorn + Carlile + Eagle

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	63,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 268,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 969,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-40

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston

SUB BASIN 5

FORMATION Mowry, Greenhorn, Carlile, Eagle

TECHNOLOGY Base Case

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1205111	1.50	34.5	4	ABCD	1689	7.354	413	16.3	8926	9358	1214	18.2	1881	419	911	3646	6859
21	2.50	42.7	5	ABCDE	2231	8.405	1335	26.7	10091	12032	1200	22.5	1762	513	1277	5105	8657
31	3.10	42.7	5	ABCDE	2231	8.405	1947	33.4	"	"	"	22.5	"	"	"	"	"
41	3.50	42.7	5	ABCDE	2231	8.405	2355	37.7	"	"	"	22.5	"	"	"	"	"
51	5.00	43.1	6	ABCDEF	2256	8.430	3888	51.7	10127	12165	1201	22.7	1758	518	1292	5167	8734
61	7.00	43.1	6	ABCDEF	2256	8.430	5934	67.4	"	"	"	22.7	"	"	"	"	"
71	9.00	43.1	6	ABCDEF	2256	8.430	7981	80.5	"	"	"	22.7	"	"	"	"	"
81	12.00	43.1	6	ABCDEF	2256	8.430	11050	97.1	"	"	"	22.7	"	"	"	"	"
Discount Rate 15%																	
12	1.50	34.5	4	ABCD	1689	7.354	64	16.3	8926	9358	1881	18.2	1881	419	911	3646	6859
22	2.50	34.5	4	ABCD	1689	7.354	692	28.6	"	"	"	18.2	"	"	"	"	"
32	3.10	42.7	5	ABCDE	2231	8.405	1083	33.4	10091	12032	1200	22.5	1762	513	1277	5105	8657
42	3.50	42.7	5	ABCDE	2231	8.405	1364	37.7	"	"	"	22.5	"	"	"	"	"
52	5.00	42.7	5	ABCDE	2231	8.405	2417	51.8	"	"	"	22.5	"	"	"	"	"
62	7.00	43.1	6	ABCDEF	2256	8.430	3826	67.4	10127	12165	1201	22.7	1758	518	1292	5167	8734
72	9.00	43.1	6	ABCDEF	2256	8.430	5235	80.5	"	"	"	22.7	"	"	"	"	"
82	12.00	43.1	6	ABCDEF	2256	8.430	7348	97.1	"	"	"	22.7	"	"	"	"	"
Discount Rate 20%																	
13	1.50	27.7	3	ABC	1337	5.968	-111	16.5	0	0	0	14.6	0	0	0	0	0
23	2.50	34.5	4	ABCD	1689	7.354	335	28.6	8926	9358	1214	18.2	1881	419	911	3646	6859
33	3.10	34.5	4	ABCD	1689	7.354	613	35.0	"	"	"	18.2	"	"	"	"	"
43	3.50	42.7	5	ABCDE	2231	8.405	807	37.7	10091	12032	1200	22.5	1762	513	1277	5105	8657
53	5.00	42.7	5	ABCDE	2231	8.405	1205	51.8	"	"	"	22.5	"	"	"	"	"
63	7.00	43.1	6	ABCDEF	2256	8.430	2627	67.4	10127	12165	1201	22.7	1758	518	1292	5167	8734
73	9.00	43.1	6	ABCDEF	2256	8.430	3669	80.5	"	"	"	22.7	"	"	"	"	"
83	12.00	43.1	6	ABCDEF	2256	8.430	1205	97.1	"	"	"	22.7	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-41

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 5 — FORMATION Mowry, Greenhorn, Carlile, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
120521	1.50	34.5	4	ABCD	2060	7.368	308	13.7	9358	9358	1270	18.2	1969	438	449	1795	4652
21	2.50	42.7	5	ABCDE	3115	9.279	1451	23.7	12032	12032	1297	22.5	1904	553	734	2934	6126
31	3.10	42.7	5	ABCDE	3115	9.279	2178	30.1	"	"	"	22.5	"	"	"	"	"
41	3.50	42.7	5	ABCDE	3115	9.279	2663	34.2	"	"	"	22.5	"	"	"	"	"
51	5.00	43.1	6	ABCDEF	3188	9.353	4504	48.1	12165	12165	1301	22.7	1904	561	753	3011	6230
61	7.00	43.1	6	ABCDEF	3188	9.353	6950	64.3	"	"	"	22.7	"	"	"	"	"
71	9.00	43.1	6	ABCDEF	3188	9.353	9396	78.5	"	"	"	22.7	"	"	"	"	"
81	12.00	43.1	6	ABCDEF	3188	9.353	13065	96.8	"	"	"	22.7	"	"	"	"	"
Discount Rate 15%																	
12	1.50	27.7	3	ABC	1694	5.968	-125	12.6	0	0	0	14.6	0	0	0	0	0
22	2.50	34.5	4	ABCD	2060	7.368	597	24.3	9358	9358	1270	18.2	1969	438	449	1795	4652
32	3.10	42.7	5	ABCDE	3115	9.279	1162	30.1	12032	12032	1297	22.5	1904	553	734	2934	6126
42	3.50	42.7	5	ABCDE	3115	9.279	1500	34.2	"	"	"	22.5	"	"	"	"	"
52	5.00	43.1	6	ABCDEF	3188	9.353	2777	48.1	12165	12165	1301	22.7	"	561	753	3011	6230
62	7.00	43.1	6	ABCDEF	3188	9.353	4482	64.3	"	"	"	22.7	"	"	"	"	"
72	9.00	43.1	6	ABCDEF	3188	9.353	6186	78.5	"	"	"	22.7	"	"	"	"	"
82	12.00	43.1	6	ABCDEF	3188	9.353	8742	96.8	"	"	"	22.7	"	"	"	"	"
Discount Rate 20%																	
13	1.50	27.7	3	ABC	1694	5.968	-307	12.6	0	0	0	14.6	0	0	0	0	0
23	2.50	34.5	4	ABCD	2060	7.368	215	24.3	9358	9358	1270	18.2	1969	438	449	1795	4652
33	3.10	34.5	4	ABCD	2060	7.368	515	30.1	"	"	"	18.2	"	"	"	"	"
43	3.50	34.5	4	ABCD	2060	7.368	715	33.7	"	"	"	18.2	"	"	"	"	"
53	5.00	42.7	5	ABCDE	3115	9.279	1789	48.2	12032	12032	1297	22.5	1904	553	734	2934	6126
63	7.00	43.1	6	ABCDEF	3188	9.353	3066	64.3	12165	12165	1301	22.7	1904	561	753	3011	6230
73	9.00	43.1	6	ABCDEF	3188	9.353	4338	78.5	"	"	"	22.7	"	"	"	"	"
83	12.00	43.1	6	ABCDEF	3188	9.353	6246	96.8	"	"	"	22.7	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-42

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 6
FORMATION: Mowry, Greenhorn, Eagle

DEPTH (FT.): 1475
PRESSURE (PSIA): 635
TEMPERATURE (°F): 86

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	403	10.7	26	1312.89	1009	0.40	0.30	0.90
0.1	458	9.0	34	1688.51	1298	0.40	0.25	0.90
0.03	311	7.4	47	1303.18	942	0.40	0.20	0.90
0.01	238	6.0	62	1066.67	771	0.40	0.20	0.90
0.003	403	5.5	72	1922.71	1304	0.40	0.15	0.90
0.001	19	5.0	85	97.29	62	0.40	0.10	0.90
	1832			7391.	5386			

TABLE 10-43

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + GREENHORN + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	122	102	77	58	36	23				
2	90	71	47	33	20	12				
5	70	49	32	20	11	7				
10	57	40	24	16	8	5				
15	49	35	21	13	7	4				
20	42	32	19	12	6	3				
30	34	28	17	10	5	3				
30-YEAR CUMM. PROD. (MMCF)	1624	1203	768	501	279	171				

TABLE 10-44

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + GREENHORN + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	173	156	155	135	105	75				
2	129	109	114	91	66	45				
5	97	77	81	61	41	27				
10	79	60	63	46	29	19				
15	69	52	54	39	24	15				
20	61	47	49	35	22	13				
30	52	40	41	29	18	11				
30-YEAR CUMM. PROD. (MMCF)	2299	1807	1874	1396	928	608				

TABLE 10-45

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 6
FORMATION: Mowry + Greenhorn + Eagle

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.541	1.541	1009	1.088	1.088	1009
.1	2.355	2.355	1298	1.567	1.567	1298
.03	3.941	3.941	942	1.617	1.617	942
.01	6.470	4	476	2.320	2.320	771
.003	11.552	4	451	3.482	3.482	1304
.001	18.948	4	13	5.329	5.329	62
			4189			5386

TABLE 10-46

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 6
FORMATION: Mowry + Greenhorn + Eagle

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	51,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 161,250
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 606,250
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-47

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 6 — FORMATION Mowry, Greenhorn, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1206111	1.50	25.9	3	ABC	1947	6.047	0.3	10.0	3251	3251	537	13.7	876	139	649	2597	4260
21	2.50	31.4	4	ABCD	2361	6.963	738	18.7	3728	4023	535	16.6	844	168	828	3311	5150
31	3.10	31.4	4	ABCD	2361	6.963	1226	23.9	"	"	"	16.6	"	"	"	"	"
41	3.50	31.4	4	ABCD	2361	6.963	1551	27.1	"	"	"	16.6	"	"	"	"	"
51	5.00	38.9	5	ABCDE	3054	7.746	2827	35.9	4180	5327	540	20.6	810	210	1116	4464	6600
61	7.00	39.3	6	ABCDEF	3091	7.769	4614	48.9	4192	5386	539	20.8	807	212	1128	4512	6659
71	9.00	39.3	6	ABCDEF	3091	7.769	6406	60.2	"	"	"	20.8	"	"	"	"	"
81	12.00	39.3	6	ABCDEF	3091	7.769	9096	74.4	"	"	"	20.8	"	"	"	"	"
Discount Rate 15%																	
12	1.50	25.9	3	ABC	1947	6.047	-244	10.0	0	0	0	13.7	0	0	0	0	0
22	2.50	31.4	4	ABCD	2361	6.963	220	18.7	3728	4023	535	16.6	844	168	828	3311	5150
32	3.10	31.4	4	ABCD	2361	6.963	547	23.9	"	"	"	16.6	"	"	"	"	"
42	3.50	31.4	4	ABCD	2361	6.963	766	27.1	"	"	"	16.6	"	"	"	"	"
52	5.00	38.9	5	ABCDE	3054	7.746	1576	35.9	4180	5327	540	20.6	810	210	1116	4464	6600
62	7.00	38.9	5	ABCDE	3054	7.746	2778	49.1	"	"	"	20.6	"	"	"	"	"
72	9.00	39.3	6	ABCDEF	3091	7.769	3981	60.2	4192	5386	539	20.8	807	212	1128	4512	6659
82	12.00	39.3	6	ABCDEF	3091	7.769	5790	74.4	"	"	"	20.8	"	"	"	"	"
Discount Rate 20%																	
13	1.50	19.6	2	AB	1506	4.775	-326	9.9	0	0	0	10.4	0	0	0	0	0
23	2.50	25.9	3	ABC	1947	6.047	-23	19.4	0	0	0	13.7	0	0	0	0	0
33	3.10	31.4	4	ABCD	2361	6.963	180	23.9	3728	4023	535	16.6	844	168	828	3311	5730
43	3.50	31.4	4	ABCD	2361	6.963	338	27.1	"	"	"	16.6	"	"	"	"	"
53	5.00	31.4	4	ABCD	2361	6.963	930	38.2	"	"	"	16.6	"	"	"	"	"
63	7.00	38.9	5	ABCDE	3054	7.746	1764	49.1	4180	5327	540	20.6	810	210	1116	4464	6600
73	9.00	38.9	5	ABCDE	3054	7.746	2636	60.3	"	"	"	20.6	"	"	"	"	"
83	12.00	39.3	6	ABCDEF	3091	7.769	3946	74.4	4192	5386	539	20.8	807	212	1128	4512	6659

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-48

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 6 — FORMATION Mowry, Greenhorn, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
120621	1.50	25.9	3	ABC	1888	6.047	28	10.3	3251	3251	537	13.7	876	139	365	1461	2842
21	2.50	31.4	4	ABCD	2400	7.215	883	19.3	4023	4023	558	16.6	878	175	490	1957	3500
31	3.10	38.9	5	ABCDE	3818	8.988	1500	22.2	5327	5327	593	20.6	889	231	791	3336	5075
41	3.50	38.9	5	ABCDE	3818	8.988	1937	25.6	"	"	"	20.6	"	"	"	"	"
51	5.00	38.9	5	ABCDE	3818	8.988	3574	37.3	"	"	"	20.6	"	"	"	"	"
61	7.00	39.3	6	ABCDEF	3942	9.072	5783	50.7	5386	5386	594	20.8	"	233	813	3250	5185
71	9.00	39.3	6	ABCDEF	3942	9.072	7989	62.5	"	"	"	20.8	"	"	"	"	"
81	12.00	39.3	6	ABCDEF	3942	9.072	11297	77.7	"	"	"	20.8	"	"	"	"	"
Discount Rate 15%																	
12	1.50	25.9	3	ABC	1888	6.047	-250	10.3	0	0	0	13.7	0	0	0	0	0
22	2.50	31.4	4	ABCD	2400	7.215	290	19.3	4023	4023	558	16.6	878	175	490	1957	3500
32	3.10	31.4	4	ABCD	2400	7.215	639	24.3	"	"	"	16.6	"	"	"	"	"
42	3.50	31.4	4	ABCD	2400	7.215	871	27.3	"	"	"	16.6	"	"	"	"	"
52	5.00	38.9	5	ABCDE	3818	8.988	2020	37.3	5327	5327	593	20.6	889	231	791	3336	5075
62	7.00	39.3	6	ABCDEF	3942	9.072	3509	50.7	5386	5386	594	20.8	889	233	813	3250	5185
72	9.00	39.3	6	ABCDEF	3942	9.072	5004	62.5	"	"	"	20.8	"	"	"	"	"
82	12.00	39.3	6	ABCDEF	3942	9.072	7246	77.7	"	"	"	20.8	"	"	"	"	"
Discount Rate 20%																	
13	1.50	19.6	2	AB	1573	4.775	-403	9.1	0	0	0	10.4	0	0	0	0	0
23	2.50	25.9	3	ABC	1888	6.047	-51	18.8	0	0	0	13.7	0	0	0	0	0
33	3.10	31.4	4	ABCD	2400	7.215	223	24.3	4023	4023	558	16.6	878	175	490	1957	3500
43	3.50	31.4	4	ABCD	2400	7.215	391	27.3	"	"	"	16.6	"	"	"	"	"
53	5.00	38.9	5	ABCDE	3818	8.988	1167	37.3	5327	5327	593	20.6	889	231	791	3336	5075
63	7.00	38.9	5	ABCDE	3818	8.988	2244	51.0	"	"	"	20.6	"	"	"	"	"
73	9.00	39.3	6	ABCDEF	3942	9.072	3336	62.5	5386	5386	594	20.8	"	233	813	3250	5185
83	12.00	39.3	6	ABCDEF	3942	9.072	4970	77.7	"	"	"	20.8	"	"	"	"	"

* CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001

TABLE 10-49

GEOLOGICAL DATA SUMMARY

BASIN: Northern Great Plains-Williston
SUBBASIN: 7
FORMATION: Mowry, Judith River

DEPTH (FT.): 2200
PRESSURE (PSIA): 950
TEMPERATURE (°F): 96

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	330	10.7	14	888.03	683	0.35	0.30	0.90
0.1	378	9.0	18	1100.05	846	0.35	0.30	0.90
0.03	614	7.4	21	1714.04	1241	0.35	0.25	0.90
0.01	519	6.0	25	1398.50	1013	0.35	0.25	0.90
0.003	496	5.5	30	1470.19	998	0.35	0.20	0.90
0.001	24	5.0	40	86.23	55	0.35	0.10	0.90
	2361			6657.	4836			

TABLE 10-50

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	137	112	69	47	29	22				
2	103	77	44	26	16	11				
5	79	54	29	17	9	7				
10	63	44	22	13	7	4				
15	52	38	19	11	6	4				
20	45	34	18	9	5	3				
30	33	28	16	8	4	3				
30-YEAR CUMM. PROD. (MMCF)	1755	1302	704	407	233	158				

TABLE 10-51

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	196	171	145	112	89	71				
2	146	119	105	74	55	42				
5	109	84	74	49	34	25				
10	87	65	57	37	24	17				
15	75	56	49	32	20	14				
20	67	50	44	28	18	12				
30	54	43	37	24	15	10				
30-YEAR CUMM. PROD. (MMCF)	2525	1954	1707	1137	771	565				

TABLE 10-52

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 7
FORMATION: Mowry + Judith River

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.18	1.18	683	.820	.820	683
.1	1.719	1.719	846	1.145	1.145	846
.03	2.872	2.872	1241	1.184	1.184	1241
.01	4.783	4	847	1.715	1.715	1013
.003	8.598	4	464	2.606	2.606	998
.001	14.319	4	15	4.023	4.023	55
			4096			4836

TABLE 10-53

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 7
FORMATION: Mowry + Judith River

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	68,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-54

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 7 — FORMATION Mowry, Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1207111	1.50	18.5	5	ABC	1823	4.223	-233	6.0	0	0	0	9.8	0	0	0	0	0
21	2.50	25.5	4	ABCD	2647	5.632	221	12.6	3618	3618	642	13.5	1051	164	1106	4424	6746
31	3.10	25.5	4	ABCD	2647	5.632	613	17.1	"	"	"	13.5	"	"	"	"	"
41	3.50	25.5	4	ABCD	2647	5.632	875	19.9	"	"	"	13.5	"	"	"	"	"
51	5.00	33.0	5	ABCDE	3531	6.557	1877	27.1	4082	4782	622	17.4	974	205	1538	6153	8870
61	7.00	33.3	6	ABCDEF	3551	6.570	3378	39.3	4097	4836	624	17.6	973	208	1550	6201	8932
71	9.00	33.3	6	ABCDEF	3551	6.570	4882	50.2	"	"	"	17.6	"	"	"	"	"
81	12.00	33.3	6	ABCDEF	3551	6.570	7137	64.2	"	"	"	17.6	"	"	"	"	"
Discount Rate 15%																	
12	1.50	10.6	2	AB	1071	2.385	-295	5.6	0	0	0	5.6	0	0	0	0	0
22	2.50	18.5	3	ABC	1823	4.223	-45	14.0	0	0	0	9.8	0	0	0	0	0
32	3.10	25.5	4	ABCD	2647	5.632	126	17.1	3618	3618	642	13.5	1051	164	1106	4424	6746
42	3.50	25.5	4	ABCD	2647	5.632	303	19.9	"	"	"	13.5	"	"	"	"	"
52	5.00	33.0	5	ABCDE	3531	6.557	916	27.1	4082	4782	622	17.4	974	205	1538	6153	8870
62	7.00	33.3	6	ABCDEF	3551	6.570	1928	39.3	4097	4836	624	17.6	973	208	1550	6201	8932
72	9.00	33.3	6	ABCDEF	3551	6.570	2944	50.2	"	"	"	17.6	"	"	"	"	"
82	12.00	33.3	6	ABCDEF	3551	6.570	4467	64.2	"	"	"	17.6	"	"	"	"	"
Discount Rate 20%																	
13	1.50	10.6	2	AB	1071	2.385	-354	5.6	0	0	0	5.6	0	0	0	0	0
23	2.50	18.5	3	ABC	1823	4.223	-212	14.0	"	"	"	9.8	"	"	"	"	"
33	3.10	18.5	3	ABC	1823	4.223	-66	18.2	"	"	"	9.8	"	"	"	"	"
43	3.50	25.5	4	ABCD	2647	5.632	-2	19.9	"	"	"	13.5	"	"	"	"	"
53	5.00	25.5	4	ABCD	2647	5.632	478	29.9	3618	3618	642	13.5	1051	164	1106	4424	6746
63	7.00	33.0	5	ABCDE	3531	6.557	1138	39.4	4082	4782	622	17.4	974	205	1538	6153	8870
73	9.00	33.3	6	ABCDEF	3551	6.570	1876	50.2	4097	4836	624	17.6	973	208	1550	6201	8932
83	12.00	33.3	6	ABCDEF	3551	6.570	2985	64.2	"	"	"	17.6	"	"	"	"	"

* CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001

TABLE 10-55

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 7 — FORMATION Mowry, Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1207211	1.50	18.5	3	ABC	1744	4.223	-183	7.1	0	0	0	9.8	0	0	0	0	0
21	2.50	33.0	5	ABCDE	3437	7.195	512	14.8	4782	4782	665	17.4	1040	153	857	3429	5545
31	3.10	33.0	5	ABCDE	3437	7.195	1047	19.6	"	"	"	17.4	"	"	"	"	"
41	3.50	33.3	6	ABCDEF	3474	7.237	1407	22.6	4836	4836	668	17.6	1042	222	869	3490	5603
51	5.00	33.3	6	ABCDEF	3474	7.237	2754	33.6	"	"	"	17.6	"	"	"	"	"
61	7.00	33.3	6	ABCDEF	3474	7.237	4550	46.4	"	"	"	17.6	"	"	"	"	"
71	9.00	33.3	6	ABCDEF	3474	7.237	6347	57.6	"	"	"	17.6	"	"	"	"	"
81	12.00	33.3	6	ABCDEF	3474	7.237	9041	71.9	"	"	"	17.6	"	"	"	"	"
Discount Rate 15%																	
12	1.50	10.6	2	AB	1210	2.385	-385	4.6	0	0	0	5.6	0	0	0	0	0
22	2.50	25.5	4	ABCD	2381	5.632	33	15.5	3785	3785	672	13.4	1100	171	536	2143	3950
32	3.10	33.0	5	ABCDE	3437	7.195	351	19.6	4782	4782	665	17.4	1040	153	857	3429	5545
42	3.50	33.0	5	ABCDE	3437	7.195	595	22.7	"	"	"	17.4	"	"	"	"	"
52	5.00	33.3	6	ABCDEF	3474	7.237	1512	33.6	4836	4836	668	17.6	1042	222	869	3490	5603
62	7.00	33.3	6	ABCDEF	3474	7.237	2736	46.4	"	"	"	17.6	"	"	"	"	"
72	9.00	33.3	6	ABCDEF	3474	7.237	3961	57.6	"	"	"	17.6	"	"	"	"	"
82	12.00	33.3	6	ABCDEF	3474	7.237	5797	71.9	"	"	"	17.6	"	"	"	"	"
Discount Rate 20%																	
13	1.50	10.6	2	AB	1210	2.385	-450	4.6	0	0	0	5.6	0	0	0	0	0
23	2.50	18.5	3	ABC	1744	4.223	-218	14.4	"	"	"	9.8	"	"	"	"	"
33	3.10	25.5	4	ABCD	2381	5.632	-2	19.9	"	"	"	13.4	"	"	"	"	"
43	3.50	25.5	4	ABCD	2381	5.632	133	22.7	3785	3785	672	13.4	1100	171	536	2143	3950
53	5.00	33.3	6	ABCDEF	3474	7.237	827	33.6	4836	4836	668	17.6	1042	222	869	3490	5603
63	7.00	33.3	6	ABCDEF	3474	7.237	1723	46.4	"	"	"	17.6	"	"	"	"	"
73	9.00	33.3	6	ABCDEF	3474	7.237	2619	57.6	"	"	"	17.6	"	"	"	"	"
83	12.00	33.3	6	ABCDEF	3474	7.237	3963	71.9	"	"	"	17.6	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-56

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 8
FORMATION: Mowry, Carlile, Eagle

DEPTH (FT.): 1935
PRESSURE (PSIA): 835
TEMPERATURE (°F): 93

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	417	10.4	32	2193.795	1688	0.45	0.30	0.90
0.1	224	9.0	42	1338.489	1020	0.45	0.25	0.90
0.03	320	7.4	57	2133.696	1545	0.45	0.20	0.90
0.01	256	6.0	75	1821.082	1318	0.45	0.20	0.90
0.003	369	5.5	80	2566.579	1742	0.45	0.15	0.90
0.001	16	5.0	85	107.494	68	0.45	0.10	0.90
	1602			10161.	7391			

TABLE 10-57

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	236	197	144	108	60	35				
2	176	136	90	61	33	19				
5	136	95	60	40	20	11				
10	110	77	46	29	14	8				
15	93	68	40	25	13	6				
20	80	61	37	22	11	5				
30	63	52	32	19	9	4				
30-YEAR CUMM. PROD. (MMCF)	3063	2302	1445	929	476	259				

TABLE 10-58

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	336	302	296	254	113	115				
2	250	210	217	169	70	69				
5	187	148	152	113	43	41				
10	152	115	117	85	31	29				
15	132	100	101	73	26	24				
20	117	90	91	65	23	20				
30	97	77	77	54	19	17				
30-YEAR CUMM. PROD. (MMCF)	4378	3456	3513	2596	1573	922				

TABLE 10-59

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 8
FORMATION: Mowry + Carlile + Eagle

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.321	1.321	1688	.924	.924	1688
.1	1.996	1.996	1030	1.330	1.330	1030
.03	3.338	3.338	1545	1.374	1.374	1545
.01	5.538	4	952	1.984	1.984	1318
.003	9.918	4	702	3.001	3.001	1742
.001	16.370	4	17	4.616	4.616	68
			5934			7391

TABLE 10-60

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 8
FORMATION: Mowry + Carlile + Eagle

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	62,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 161,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 606,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-61

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 8 — FORMATION Mowry,Carlile, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
12081 11	1.50	33.2	4	ABCD	1757	7.304	342	15.1	5215	5580	715	17.6	1112	238	630	2518	4498
21	2.50	33.2	4	ABCD	1757	7.304	1227	26.8	"	"	"	17.6	"	"	"	"	"
31	3.10	42.4	5	ABCDE	2263	8.203	1795	31.1	5917	7323	722	22.4	1057	306	882	3526	5773
41	3.50	42.4	5	ABCDE	2263	8.203	2188	35.2	"	"	"	22.4	"	"	"	"	"
51	5.00	42.8	6	ABCDEF	2285	8.224	3659	48.5	5933	7391	"	22.6	1055	310	893	3569	5825
61	7.00	42.8	6	ABCDEF	2285	8.224	5624	63.5	"	"	"	22.6	"	"	"	"	"
71	9.00	42.8	6	ABCDEF	2285	8.224	7590	76.0	"	"	"	22.6	"	"	"	"	"
81	12.00	42.8	6	ABCDEF	2285	8.224	10539	91.9	"	"	"	22.6	"	"	"	"	"
Discount Rate 15%																	
12	1.50	26.4	3	ABC	1398	5.997	25	15.6	4264	4264	711	13.9	1155	187	448	1791	3582
22	2.50	33.2	4	ABCD	1757	7.304	613	26.8	5215	5580	715	17.6	1112	238	630	2518	4498
32	3.10	42.4	5	ABCDE	2263	8.203	965	31.1	5917	7323	722	22.4	1057	306	882	3526	5773
42	3.50	42.4	5	ABCDE	2263	8.203	1233	35.2	"	"	"	22.4	"	"	"	"	"
52	5.00	42.4	5	ABCDE	2263	8.203	2239	48.6	"	"	"	22.4	"	"	"	"	"
62	7.00	42.8	6	ABCDEF	2285	8.224	3581	63.5	5933	7391	"	22.6	1055	310	893	3569	5825
72	9.00	42.8	6	ABCDEF	2285	8.224	4925	76.0	"	"	"	22.6	"	"	"	"	"
82	12.00	42.8	6	ABCDEF	2285	8.224	6941	91.9	"	"	"	22.6	"	"	"	"	"
Discount Rate 20%																	
13	1.50	26.4	3	ABC	1398	5.997	-143	15.6	0	0	0	13.9	0	0	0	0	0
23	2.50	33.2	4	ABCD	1757	7.304	270	26.8	5215	5580	715	17.6	1112	238	630	2518	4498
33	3.10	33.2	4	ABCD	1757	7.304	536	33.0	"	"	"	17.6	"	"	"	"	"
43	3.50	33.2	4	ABCD	1757	7.304	714	36.8	"	"	"	17.6	"	"	"	"	"
53	5.00	42.4	5	ABCDE	2263	8.203	1440	48.6	5917	7323	722	22.4	1057	306	882	3506	5773
63	7.00	42.8	6	ABCDEF	2285	8.224	2426	63.5	5933	7391	"	22.6	1055	310	893	3569	5825
73	9.00	42.8	6	ABCDEF	2285	8.224	3414	76.0	"	"	"	22.6	"	"	"	"	"
83	12.00	42.8	6	ABCDEF	2285	8.224	4897	91.9	"	"	"	22.6	"	"	"	"	"

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 10-62

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 8 — FORMATION Mowry, Carlile, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1208211	1.50	33.2	4	ABCD	1999	7.434	307	13.8	5580	5580	751	17.6	1168	248	329	1316	3064
21	2.50	33.2	4	ABCD	1999	7.434	1239	24.3	"	"	"	17.6	"	"	"	"	"
31	3.10	33.2	4	ABCD	1999	7.434	1799	29.9	"	"	"	17.6	"	"	"	"	"
41	3.50	42.4	5	ABCDE	2907	8.840	2294	31.5	7323	7323	828	22.4	1213	351	574	2293	4432
51	5.00	42.8	6	ABCDEF	2970	8.906	3937	44.4	7391	7391	830	22.6	"	355	589	2354	4511
61	7.00	42.8	6	ABCDEF	2970	8.906	6121	59.5	"	"	"	22.6	"	"	"	"	"
71	9.00	42.8	6	ABCDEF	2970	8.906	8305	72.6	"	"	"	22.6	"	"	"	"	"
81	12.00	42.8	6	ABCDEF	2970	8.906	11582	89.5	"	"	"	22.6	"	"	"	"	"
Discount Rate 15%																	
12	1.50	26.4	3	ABC	1603	5.997	-104	12.9	0	0	0	13.9	0	0	0	0	0
22	2.50	33.2	4	ABCD	1999	7.434	576	24.3	5580	5580	751	17.6	1168	248	329	1316	3064
32	3.10	33.2	4	ABCD	1999	7.434	961	29.9	"	"	"	17.6	"	"	"	"	"
42	3.50	33.2	4	ABCD	1999	7.434	1217	33.4	"	"	"	17.6	"	"	"	"	"
52	5.00	42.8	6	ABCDEF	2970	8.906	2365	44.4	7391	7391	830	22.6	1213	355	589	2354	4511
62	7.00	42.8	6	ABCDEF	2970	8.906	3869	59.5	"	"	"	22.6	"	"	"	"	"
72	9.00	42.8	6	ABCDEF	2970	8.906	5374	72.6	"	"	"	22.6	"	"	"	"	"
82	12.00	42.8	6	ABCDEF	2970	8.906	7630	89.5	"	"	"	22.6	"	"	"	"	"
Discount Rate 20%																	
13	1.50	26.4	3	ABC	1603	5.997	-279	12.9	0	0	0	13.9	0	0	0	0	0
23	2.50	33.2	4	ABCD	1999	7.434	204	24.3	5580	5580	751	17.6	1168	248	329	1315	3064
33	3.10	33.2	4	ABCD	1999	7.434	489	29.9	"	"	"	17.6	"	"	"	"	"
43	3.50	33.2	4	ABCD	1999	7.434	678	33.4	"	"	"	17.6	"	"	"	"	"
53	5.00	33.2	4	ABCD	1999	7.434	1390	45.4	"	"	"	17.6	"	"	"	"	"
63	7.00	42.8	6	ABCDEF	2970	8.906	2598	59.5	7391	7391	830	22.6	1213	355	589	2354	4511
73	9.00	42.8	6	ABCDEF	2970	8.906	3712	72.6	"	"	"	22.6	"	"	"	"	"
83	12.00	42.8	6	ABCDEF	2970	8.906	5382	89.5	"	"	"	22.6	"	"	"	"	"

* CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001

TABLE 10-63

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

BASIN: Northern Great Plains-Williston
SUBBASIN: 9
FORMATION: Mowry, Carlile, Eagle, Judith River

DEPTH (FT.): 1800
PRESSURE (PSIA): 775
TEMPERATURE (°F): 91

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	233	10.4	42	1490.687	1146	0.40	0.30	0.90
0.1	296	9.0	55	2146.089	1650	0.40	0.25	0.90
0.03	529	7.4	71	4070.919	2946	0.40	0.20	0.90
0.01	529	6.0	90	4184.073	3027	0.40	0.20	0.90
0.003	507	5.5	111	4533.594	3075	0.40	0.15	0.90
0.001	21	5.0	125	192.242	122	0.40	0.10	0.90
	2115			16618.	11966			

TABLE 10-64

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + CARLILE + EAGLE + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	274	229	159	115	75	47				
2	204	158	99	66	41	25				
5	158	111	67	42	25	15				
10	129	90	51	32	18	10				
15	108	79	45	27	16	8				
20	95	72	41	24	14	7				
30	74	60	36	21	11	6				
30-YEAR CUMM. PROD. (MMCF)	3584	2680	1600	995	588	342				

TABLE 10-65

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + CARLILE + EAGLE + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	390	350	327	271	223	151				
2	291	244	240	181	140	90				
5	218	172	168	121	86	55				
10	177	134	130	91	62	38				
15	153	116	112	78	52	31				
20	138	104	101	69	46	27				
30	114	90	86	58	38	22				
30-YEAR CUMM. PROD. (MMCF)	5111	4025	3894	2775	1950	1212				

TABLE 10-66

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 9
FORMATION: Mowry + Carlile + Eagle + Judith River

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.372	1.372	1146	.962	.962	1146
.1	2.079	2.079	1650	1.385	1.385	1650
.03	3.478	3.478	2946	1.430	1.430	2946
.01	5.752	4	2104	2.062	2.062	3027
.003	10.299	4	1193	3.111	3.111	3075
.001	16.948	4	29	4.782	4.782	122
			9068			11966

TABLE 10-67

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 9
FORMATION: Mowry + Carlile + Eagle + Judith River

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	58,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 284,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 1,034,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-68

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 9 — FORMATION Mowry, Carlile, Eagle, Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
120911	1.50	30.7	4	ABCD	1895	6.378	78	11.1	7843	8764	1230	16.2	1950	377	992	3971	7292
21	2.50	30.7	4	ABCD	1895	6.378	822	21.2	"	"	"	16.2	"	"	"	"	"
31	3.10	39.2	5	ABCDE	2417	7.272	1310	25.3	9038	11842	1243	20.7	1864	487	1341	5364	9056
41	3.50	39.2	5	ABCDE	2417	7.272	1645	28.9	"	"	"	20.7	"	"	"	"	"
51	5.00	39.2	5	ABCDE	2417	7.272	2901	41.1	"	"	"	20.7	"	"	"	"	"
61	7.00	39.6	6	ABCDEF	2444	7.296	4582	54.8	9067	11966	1243	20.9	1859	492	1357	5426	9135
71	9.00	39.6	6	ABCDEF	2444	7.296	6262	66.5	"	"	"	20.9	"	"	"	"	"
81	12.00	39.6	6	ABCDEF	2444	7.296	8782	81.5	"	"	"	20.9	"	"	"	"	"
Discount Rate 15%																	
12	1.50	20.3	3	ABC	1295	4.300	-154	11.1	0	0	0	10.7	0	0	0	0	0
22	2.50	30.7	4	ABCD	1895	6.378	323	21.2	7843	8764	1230	16.2	1950	377	992	3971	7292
32	3.10	30.7	4	ABCD	1895	6.378	628	28.6	"	"	"	16.2	"	"	"	"	"
42	3.50	39.2	5	ABCDE	2417	7.272	849	28.9	9038	11842	1243	20.7	1864	487	1341	5364	9056
52	5.00	39.2	5	ABCDE	2417	7.272	1708	41.1	"	"	"	20.7	"	"	"	"	"
62	7.00	39.6	6	ABCDEF	2444	7.296	2856	54.8	9067	11966	1243	20.9	1859	492	1357	5426	9135
72	9.00	39.6	6	ABCDEF	2444	7.296	4005	66.5	"	"	"	20.9	"	"	"	"	"
82	12.00	39.6	6	ABCDEF	2444	7.296	5728	81.5	"	"	"	20.9	"	"	"	"	"
Discount Rate 20%																	
13	1.50	20.3	3	ABC	1295	4.300	-273	11.1	0	0	0	10.7	0	0	0	0	0
23	2.50	30.7	4	ABCD	1895	6.378	48	21.2	7843	8764	1230	16.2	1950	377	992	3971	7292
33	3.10	30.7	4	ABCD	1895	6.378	272	26.6	"	"	"	16.2	"	"	"	"	"
43	3.50	30.7	4	ABCD	1895	6.378	422	30.0	"	"	"	16.2	"	"	"	"	"
53	5.00	39.2	5	ABCDE	2417	7.272	1045	41.1	9038	11842	1243	20.7	1864	487	1341	5364	9056
63	7.00	39.2	5	ABCDE	2417	7.272	1889	54.9	"	"	"	20.7	"	"	"	"	"
73	9.00	39.6	6	ABCDEF	2444	7.296	2736	66.5	9067	11966	"	20.9	1859	492	1357	5426	9135
83	12.00	39.6	6	ABCDEF	2444	7.296	4006	81.5	"	"	"	20.9	"	"	"	"	"

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 10-69

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 9 — FORMATION Mowry, Carlile, Eagle, Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
120921	1.50	30.7	4	ABCD	2630	6.644	-112	8.8	-	-	-	16.2	-	-	-	-	-
21	2.50	39.2	5	ABCDE	3728	8.514	896	17.3	11842	11842	1391	20.7	2086	545	850	3400	6881
31	3.10	39.2	5	ABCDE	3728	8.514	1554	22.5	"	"	"	20.7	"	"	"	"	"
41	3.50	39.2	5	ABCDE	3728	8.514	1993	25.8	"	"	"	20.7	"	"	"	"	"
51	5.00	39.6	6	ABCDEF	3824	8.597	3656	37.4	11966	11966	1392	20.9	2083	551	873	3492	6999
61	7.00	39.6	6	ABCDEF	3824	8.597	5874	51.5	"	"	"	20.9	"	"	"	"	"
71	9.00	39.6	6	ABCDEF	3824	8.597	8092	63.8	"	"	"	20.9	"	"	"	"	"
81	12.00	39.6	6	ABCDEF	3824	8.597	11419	63.8	"	"	"	20.9	"	"	"	"	"
Discount Rate 15%																	
12	1.50	20.3	3	ABC	1874	4.299	-462	6.8	0	0	0	10.7	0	0	0	0	0
22	2.50	30.7	4	ABCD	2630	6.644	164	17.2	8764	8764	1319	16.2	2091	405	520	2078	5094
32	3.10	39.2	5	ABCDE	3728	8.514	659	22.5	11842	11842	1391	20.7	2086	545	850	3400	6881
42	3.50	39.2	5	ABCDE	3728	8.514	964	25.8	"	"	"	20.7	"	"	"	"	"
52	5.00	39.2	5	ABCDE	3728	8.514	2104	37.6	"	"	"	20.7	"	"	"	"	"
62	7.00	39.6	6	ABCDEF	3824	8.597	3647	51.5	11966	11966	1392	20.9	2083	551	873	3492	6999
72	9.00	39.6	6	ABCDEF	3824	8.597	5184	63.8	"	"	"	20.9	"	"	"	"	"
82	12.00	39.6	6	ABCDEF	3824	8.597	7490	80.1	"	"	"	20.9	"	"	"	"	"
Discount Rate 20%																	
13	1.50	20.3	3	ABC	1874	4.299	-584	6.8	0	0	0	10.7	0	0	0	0	0
23	2.50	30.7	4	ABCD	2630	6.644	-155	17.2	"	"	"	16.2	"	"	"	"	"
33	3.10	30.7	4	ABCD	2630	6.644	108	21.8	8764	8764	1319	16.2	2091	405	520	2078	5094
43	3.50	30.7	4	ABCD	2630	6.644	283	24.8	"	"	"	16.2	"	"	"	"	"
53	5.00	39.2	5	ABCDE	3728	8.514	1241	37.6	11842	11842	1391	20.7	2086	545	850	3400	6881
63	7.00	39.6	6	ABCDEF	3824	8.597	2384	51.5	11966	11966	1392	20.9	2088	551	873	3492	6999
73	9.00	39.6	6	ABCDEF	3824	8.597	3526	63.8	"	"	"	20.9	"	"	"	"	"
83	12.00	39.6	6	ABCDEF	3824	8.597	5240	80.1	"	"	"	20.9	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-70

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

BASIN: Northern Great Plains-Williston
SUBBASIN: 10
FORMATION: Mowry, Greenhorn, Carlile, Eagle, Judith River

DEPTH (FT.): 1900
PRESSURE (PSIA): 820
TEMPERATURE (°F): 92

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	144	10.4	50	1160.78	893	0.45	0.30	0.90
0.1	178	9.0	67	1663.89	1280	0.45	0.25	0.90
0.03	191	7.4	83	1818.57	1316	0.45	0.20.	0.90
0.01	157	6.0	100	1460.29	1057	0.45	0.20	0.90
0.003	191	5.5	120	1954.18	1326	0.45	0.15	0.90
0.001	9	5.0	140	97.66	62	0.45	0.10	0.90
	870			8155.	5934			

TABLE 10-71

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + GREENHORN + CARLILE + EAGLE + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	358	305	204	140	88	57				
2	267	211	127	80	49	31				
5	207	148	86	52	29	18				
10	168	120	65	38	21	13				
15	142	106	57	32	19	10				
20	123	96	52	29	16	9				
30	96	81	46	25	14	7				
30-YEAR CUMM. PROD. (MMCF)	4659	3575	2049	1207	695	416				

TABLE 10-72

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + GREENHORN + CARLILE + EAGLE + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	510	468	419	330	264	185				
2	381	326	307	220	165	110				
5	285	229	216	146	102	67				
10	231	179	165	111	73	46				
15	200	155	144	95	61	38				
20	180	140	130	84	54	33				
30	148	120	110	71	45	27				
30-YEAR CUMM. PROD. (MMCF)	6509	5365	4979	3370	2299	1479				

TABLE 10-73

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 10
FORMATION: Mowry + Greenhorn + Carlile + Eagle + Judith River

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	2.292	2.292	893	.952	.952	893
.1	3.574	3.574	1280	1.340	1.340	1280
.03	6.483	4	812	1.384	1.384	1316
.01	10.372	4	407	1.997	1.997	1057
.003	18.916	4	280	3.020	3.020	1326
.001	28.753	4	9	4.643	4.643	62
			3681			5934

TABLE 10-74

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 10
FORMATION: Mowry + Greenhorn + Carlile + Eagle + Judith River

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	61,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 331,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 1,150,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-75

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 10 — FORMATION Mowry,Greenhorn,Carlile,Eagle,Judith River — DATE 10.'79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1210111	1.50	34.0	4	ABCD	1379	5.723	227	13.9	3392	4546	593	17.9	919	202	240	958	2317
21	2.50	34.0	4	ABCD	1379	5.723	909	24.2	3392	4546	593	17.9	919	202	240	958	2317
31	3.10	42.4	5	ABCDE	1655	6.269	1362	29.1	3672	5872	586	22.4	858	248	313	1252	2672
41	3.50	42.4	5	ABCDE	1655	6.269	1658	32.8	3672	5872	586	22.4	858	248	313	1252	2672
51	5.00	42.8	6	ABCDEF	1668	6.282	2769	44.9	3681	5934	586	22.6	856	251	316	1265	2688
61	7.00	42.8	6	ABCDEF	1668	6.282	4250	58.8	3681	5934	586	22.6	856	251	316	1265	2688
71	9.00	42.8	6	ABCDEF	1668	6.282	5733	70.7	3681	5934	586	22.6	856	251	316	1265	2688
81	12.00	42.8	6	ABCDEF	1668	6.282	7956	86.0	3681	5934	586	22.6	856	251	316	1265	2688
Discount Rate 15%																	
12	1.50	25.4	3	ABC	1171	4.856	-50	13.7	-	-	-	13.4	-	-	-	-	-
22	2.50	34.0	4	ABCD	1379	5.723	425	24.2	3392	4546	593	17.9	919	202	240	958	2317
32	3.10	34.0	4	ABCD	1379	5.723	708	29.7	3392	4546	593	17.9	919	202	240	958	2317
42	3.50	42.4	5	ABCDE	1655	6.269	923	32.8	3672	5872	586	22.4	858	248	313	1252	2672
52	5.00	42.4	5	ABCDE	1655	6.269	1690	45.0	3672	5872	586	22.4	858	248	313	1252	2672
62	7.00	42.8	6	ABCDEF	1668	6.282	2715	58.8	3681	5934	586	22.6	856	251	316	1265	2688
72	9.00	42.8	6	ABCDEF	1668	6.282	3739	70.7	3681	5934	586	22.6	856	251	316	1265	2688
82	12.00	42.8	6	ABCDEF	1668	6.282	5276	86.0	3681	5934	586	22.6	856	251	316	1265	2688
Discount Rate 20%																	
13	1.50	25.4	3	ABC	1171	4.856	-191	13.7	-	-	-	13.4	-	-	-	-	-
23	2.50	34.0	4	ABCD	1379	5.723	151	24.2	3392	4546	593	17.9	919	202	240	958	2317
33	3.10	34.0	4	ABCD	1379	5.723	361	29.7	3392	4546	593	17.9	919	202	240	958	2317
43	3.50	34.0	4	ABCD	1379	5.723	502	33.2	3392	4546	593	17.9	919	202	240	958	2317
53	5.00	42.4	5	ABCDE	1655	6.269	1080	45.0	3672	5872	586	22.4	858	248	313	1252	2672
63	7.00	42.4	5	ABCDE	1655	6.269	1841	58.8	3672	5872	586	22.4	858	248	313	1252	2672
73	9.00	42.8	6	ABCDEF	1668	6.282	2604	70.7	3681	5934	586	22.6	856	251	316	1265	2688
83	12.00	42.8	6	ABCDEF	1668	6.282	3748	86.0	3681	5934	586	22.6	856	251	316	1265	2688

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-76

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 10 — FORMATION Mowry, Greenhorn, Carlile, Eagle, Judith River — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *		AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1210211	1.50	34.0	4	ABCD	2410	7.039	79	10.8	4546	4546	646	18.0	1001	220	186	743	2150
21	2.50	42.4	5	ABCDE	3566	9.104	1212	20.3	5872	5872	645	22.4	945	273	319	1274	2811
31	3.10	42.4	5	ABCDE	3566	9.104	1931	26.1	5872	5872	645	22.4	945	273	319	1274	2811
41	3.50	42.4	5	ABCDE	3566	9.104	2411	29.9	5872	5872	645	22.4	945	273	319	1274	2811
51	5.00	42.8	6	ABCDEF	3649	9.187	4230	42.9	5934	5934	646	22.6	944	276	328	1309	2857
61	7.00	42.8	6	ABCDEF	3649	9.187	6650	58.6	5934	5934	646	22.6	944	276	328	1309	2857
71	9.00	42.8	6	ABCDEF	3649	9.187	9069	72.5	5934	5934	646	22.6	944	276	328	1309	2857
81	12.00	42.8	6	ABCDEF	3649	9.187	12699	90.8	5934	5934	646	22.6	944	276	328	1309	2857
Discount Rate 15%																	
12	1.50	25.4	3	ABC	1895	5.241	-331	9.3	-	-	-	13.4	-	-	-	-	-
22	2.50	34.0	4	ABCD	2410	7.039	370	20.2	4546	4546	646	18.0	1001	220	186	743	2150
32	3.10	42.4	5	ABCDE	3566	9.104	946	26.1	5872	5872	645	22.4	945	273	319	1274	2811
42	3.50	42.4	5	ABCDE	3566	9.104	1281	29.9	5872	5872	645	22.4	945	273	319	1274	2811
52	5.00	42.4	5	ABCDE	3566	9.104	2536	43.1	5872	5872	645	22.4	945	273	319	1274	2811
62	7.00	42.8	6	ABCDEF	3649	9.187	4237	58.6	5934	5934	646	22.6	944	276	328	1309	2857
72	9.00	42.8	6	ABCDEF	3649	9.187	5927	72.5	5934	5934	646	22.6	944	276	328	1309	2857
82	12.00	42.8	6	ABCDEF	3649	9.187	8463	90.8	5934	5934	646	22.6	944	276	328	1309	2857
Discount Rate 20%																	
13	1.50	25.4	3	ABC	1895	5.241	-488	9.3	-	-	-	13.4	-	-	-	-	-
23	2.50	34.0	4	ABCD	2410	7.039	13	20.2	4546	4546	646	18.0	1001	220	186	743	2150
33	3.10	34.0	4	ABCD	2410	7.039	303	25.4	4546	4546	646	18.0	1001	220	186	743	2150
43	3.50	34.0	4	ABCD	2410	7.039	496	28.7	4546	4546	646	18.0	1001	220	186	743	2150
53	5.00	42.4	5	ABCDE	3566	9.104	1586	43.1	5872	5872	645	22.4	945	273	319	1274	2811
63	7.00	42.8	6	ABCDEF	3649	9.187	2855	58.6	5934	5934	646	22.6	944	276	328	1309	2857
73	9.00	42.8	6	ABCDEF	3649	9.187	4120	72.5	5934	5934	646	22.6	944	276	328	1309	2857
83	12.00	42.8	6	ABCDEF	3649	9.187	6018	90.8	5934	5934	646	22.6	944	276	328	1309	2857

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-77

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 11
FORMATION: Mowry, Carlile, Judith River

DEPTH (FT.): 2,000
PRESSURE (PSIA): 860
TEMPERATURE (°F): 94

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	151	10.4	27	687.61	529	0.40	0.30	0.90
0.1	226	9.0	35	1154.50	888	0.40	0.25	0.90
0.03	339	7.4	40	1627.27	1178	0.40	0.20	0.90
0.01	276	6.0	50	1342.77	972	0.40	0.20	0.90
0.003	251	5.5	59	1320.88	897	0.40	0.15	0.90
0.001	13	5.0	75	79.06	50	0.40	0.10	0.90
	1256			6212.	4514			

TABLE 10-78

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, MOWRY + CARLILE + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	209	172	105	75	46	33				
2	156	119	66	43	25	17				
5	120	83	44	28	15	10				
10	97	67	34	20	11	7				
15	82	59	30	17	10	6				
20	69	54	27	15	8	5				
30	55	45	24	13	7	4				
30-YEAR CUMM. PROD. (MMCF)	2704	2010	1063	649	367	238				

TABLE 10-79

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, MOWRY + CARLILE + JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	297	263	218	178	139	107				
2	222	183	159	118	87	63				
5	166	129	112	78	53	38				
10	134	101	86	59	38	26				
15	117	87	74	51	32	22				
20	103	78	67	45	28	19				
30	86	67	57	38	23	15				
30-YEAR CUMM. PROD. (MMCF)	3870	3016	2582	1811	1213	850				

10-103

TABLE 10-80

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 11
FORMATION: Mowry + Carlile + Judith River

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.295	1.295	529	.905	.905	529
.1	1.954	1.954	888	1.302	1.302	888
.03	3.269	3.269	1178	1.345	1.345	1178
.01	5.426	4	716	1.943	1.943	972
.003	9.73	4	369	2.944	2.944	897
.001	16.116	4	12	4.531	4.531	50
			3692			4514

TABLE 10-81

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 11
FORMATION: Mowry + Carlile + Judith River

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	63,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 136,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 513,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-82

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston
SUB BASIN 11
FORMATION Mowry, Carlile, Judith River
TECHNOLOGY Base Case
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1211111	1.50	30.9	4	ABCD	2269	7.317	5	10.0	3313	3568	453	16.3	719	140	639	2556	4054
21	2.50	30.9	4	ABCD	2269	7.317	844	20.5	"	"	"	16.3	"	"	"	"	"
31	3.10	38.3	5	ABCDE	2840	8.209	1343	24.4	3682	4466	448	20.2	679	172	837	3345	5032
41	3.50	38.3	5	ABCDE	2840	8.209	1714	28.1	"	"	"	20.2	"	"	"	"	"
51	5.00	38.5	6	ABCDEF	2862	8.229	3108	40.5	3694	4514	450	20.3	679	174	846	3384	5083
61	7.00	38.5	6	ABCDEF	2862	8.229	4970	54.6	"	"	"	20.3	"	"	"	"	"
71	9.00	38.5	6	ABCDEF	2862	8.229	6833	66.4	"	"	"	20.3	"	"	"	"	"
81	12.00	38.5	6	ABCDEF	2862	8.229	9626	81.2	"	"	"	20.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	21.7	3	ABC	1417	4.744	-153	11.1	0	0	0	11.4	0	0	0	0	0
22	2.50	30.9	4	ABCD	2269	7.317	312	20.5	3313	3568	453	16.3	719	140	639	2556	4054
32	3.10	30.9	4	ABCD	2269	7.317	653	26.1	"	"	"	16.3	"	"	"	"	"
42	3.50	38.3	5	ABCDE	2840	8.209	864	28.1	3682	4466	448	20.2	679	172	837	3345	5032
52	5.00	38.3	5	ABCDE	2840	8.209	1810	40.6	"	"	"	20.2	"	"	"	"	"
62	7.00	38.5	6	ABCDEF	2862	8.229	3072	54.6	3694	4514	450	20.3	679	174	846	3384	5083
72	9.00	38.5	6	ABCDEF	2862	8.229	4337	66.4	"	"	"	20.3	"	"	"	"	"
82	12.00	38.5	6	ABCDEF	2862	8.229	6233	81.2	"	"	"	20.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	21.7	3	ABC	1417	4.744	-274	11.1	0	0	0	11.4	0	0	0	0	0
23	2.50	30.9	4	ABCD	2269	7.317	23	20.5	3313	3568	453	16.3	719	140	639	2556	4054
33	3.10	30.9	4	ABCD	2269	7.317	273	26.1	"	"	"	16.3	"	"	"	"	"
43	3.50	30.9	4	ABCD	2269	7.317	439	29.7	"	"	"	16.3	"	"	"	"	"
53	5.00	38.3	5	ABCDE	2840	8.209	1093	40.6	3682	4466	448	20.2	679	172	837	3345	5032
63	7.00	38.5	6	ABCDEF	2862	8.229	2015	54.6	3694	4514	450	20.3	679	174	846	3384	5083
73	9.00	38.5	6	ABCDEF	2862	8.229	2940	66.4	"	"	"	20.3	"	"	"	"	"
83	12.00	38.5	6	ABCDEF	2862	8.229	4328	81.2	"	"	"	20.3	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-83

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 11 — FORMATION Mowry, Carlile, Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1211211	1.50	30.9	4	ABCD	2254	7.459	227	12.8	3568	3568	479	16.3	761	147	338	1350	2596
21	2.50	38.3	5	ABCDE	3103	9.183	1360	23.2	4466	4466	487	20.2	736	186	508	2034	3466
31	3.10	38.3	5	ABCDE	3103	9.183	2062	29.4	"	"	"	20.2	"	"	"	"	"
41	3.50	38.5	6	ABCDEF	3160	9.244	2534	33.1	4514	4514	488	20.3	738	188	518	2074	3519
51	5.00	38.5	6	ABCDEF	3160	9.244	4303	46.4	"	"	"	20.3	"	"	"	"	"
61	7.00	38.5	6	ABCDEF	3160	9.244	6660	61.2	"	"	"	20.3	"	"	"	"	"
71	9.00	38.5	6	ABCDEF	3160	9.244	9018	73.8	"	"	"	20.3	"	"	"	"	"
81	12.00	38.5	6	ABCDEF	3160	9.244	12554	89.8	"	"	"	20.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	30.9	4	ABCD	2254	7.459	-127	12.8	0	0	0	16.3	0	0	0	0	0
22	2.50	38.3	5	ABCDE	3103	9.183	596	23.2	4466	4466	487	20.2	736	186	508	2034	3466
32	3.10	38.3	5	ABCDE	3103	9.183	1078	29.4	"	"	"	20.2	"	"	"	"	"
42	3.50	38.3	5	ABCDE	3103	9.183	1399	33.3	"	"	"	20.2	"	"	"	"	"
52	5.00	38.5	6	ABCDEF	3160	9.244	2611	46.4	4514	4514	488	20.3	738	188	518	2074	3519
62	7.00	38.5	6	ABCDEF	3160	9.244	4228	61.2	"	"	"	20.3	"	"	"	"	"
72	9.00	38.5	6	ABCDEF	3160	9.244	5846	73.8	"	"	"	20.3	"	"	"	"	"
82	12.00	38.5	6	ABCDEF	3160	9.244	8272	89.8	"	"	"	20.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	21.7	3	ABC	1499	4.744	-324	10.9	0	0	0	11.4	0	0	0	0	0
23	2.50	30.9	4	ABCD	2254	7.459	160	23.3	3568	3568	479	16.3	761	147	338	1350	2596
33	3.10	38.3	5	ABCDE	3103	9.183	531	29.4	4466	4466	487	20.2	736	186	508	2034	3466
43	3.50	38.3	5	ABCDE	3103	9.183	767	33.3	"	"	"	20.2	"	"	"	"	"
53	5.00	38.3	5	ABCDE	3103	9.183	1653	46.5	"	"	"	20.2	"	"	"	"	"
63	7.00	38.5	6	ABCDEF	3160	9.244	2845	61.2	4514	4514	488	20.3	738	188	518	2074	3519
73	9.00	38.5	6	ABCDEF	3160	9.244	4034	73.8	"	"	"	20.3	"	"	"	"	"
83	12.00	38.5	6	ABCDEF	3160	9.244	5817	89.8	"	"	"	20.3	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-84

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 12
FORMATION: Greenhorn

DEPTH (FT.): 2250
PRESSURE (PSIA): 965
TEMPERATURE (°F): 97

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	608	10.4	7	806.21	620	0.40	0.30	0.90
0.1	517	9.0	8	678.04	522	0.40	0.25	0.90
0.03	540	7.4	10	727.87	527	0.40	0.20	0.90
0.01	360	6.0	13	511.49	370	0.40	0.20	0.90
0.003	202	5.5	14	257.57	175	0.40	0.15	0.90
0.001	23	5.0	15	31.40	31	0.40	0.10	0.90
	2250			3013.	2245			

TABLE 10-85

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, GREENHORN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	66	47	32	23	13	8				
2	49	33	20	13	7	4				
5	38	23	13	9	4	2				
10	30	18	10	6	3	1				
15	25	16	9	5	2	1				
20	21	14	8	4	2	1				
30	16	12	7	4	2	1				
30-YEAR CUMM. PROD. (MMCF)	850	559	323	205	104	58				

TABLE 10-86

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, GREENHORN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	94	73	66	56	40	26				
2	70	51	48	37	25	15				
5	52	36	34	24	15	9				
10	42	28	26	18	11	6				
15	36	24	22	16	9	5				
20	32	21	20	14	8	4				
30	26	18	17	12	6	3				
30-YEAR CUMM. PROD. (MMCF)	1219	838	783	571	349	205				

10-110

TABLE 10-87

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 12
FORMATION: Greenhorn

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.4	1.4	620	.9848	.9848	620
.1	2.1	2.1	522	1.4	1.4	522
.03	3.8	3.8	527	1.6	1.6	527
.01	6.3	4	236	2.3	2.3	370
.003	11.0	4	64	4.4	4.4	175
.001	21.3	4	6	6.0	6.0	31
			1975			2245

TABLE 10-88

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 12
FORMATION: Greenhorn

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	70,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-89

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 12 — FORMATION Greenhorn — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1212111	1.50	12.4	1	A	1518	2.726	-350	2.9	0	0	0	6.5	0	0	0	0	0
21	2.50	19.6	2	AB	2333	4.294	27	10.3	1143	1143	266	10.4	450	52	385	1541	2428
31	3.10	29.1	3	ABC	4145	6.296	173	11.4	1670	1670	266	15.4	425	77	790	3162	4453
41	3.50	29.1	3.	ABC	4145	6.296	478	13.9	"	"	"	15.4	"	"	"	"	"
51	5.00	35.1	4	ABCD	5494	7.533	1542	19.9	1906	2041	252	18.6	387	88	1037	414	5662
61	7.00	35.1	4	ABCD	5494	7.533	3314	31.0	"	"	"	18.6	"	"	"	"	"
71	9.00	38.0	5	ABCDE	6251	7.886	5025	38.7	1969	2216	250	20.1	378	95	1188	474	6406
81	12.00	38.0	5	ABCDE	6251	7.886	7791	53.0	"	"	"	20.1	"	"	"	"	"
Discount Rate 15%																	
12	1.50	12.4	1	A	1518	2.726	-443	2.9	0	0	0	6.5	0	0	0	0	0
22	2.50	19.6	2	AB	2333	4.294	-254	10.3	"	"	"	10.4	"	"	"	"	"
32	3.10	19.6	2	AB	2333	4.294	-47	14.1	"	"	"	10.4	"	"	"	"	"
42	3.50	19.6	2	AB	2333	4.294	90	16.5	1143	1143	266	10.4	450	52	385	1541	2428
52	5.00	29.1	3	ABC	4145	6.296	678	22.7	1670	1670	266	15.4	425	77	790	3162	4453
62	7.00	35.1	4	ABCD	5494	7.533	1718	31.0	1906	2041	252	18.6	387	88	1037	4147	5662
72	9.00	35.1	4	ABCD	5494	7.533	2910	41.4	"	"	"	18.6	"	"	"	"	"
82	12.00	38.0	5	ABCDE	6251	7.886	4679	53.0	1969	2216	250	20.1	378	95	1188	4748	6406
Discount Rate 20%																	
13	1.50	-	-	-	-	-	-389	0	0	0	0	0.	0	0	0	0	0
23	2.50	12.4	1	A	1518	2.726	-330	9.6	"	"	"	-	"	"	"	"	"
33	3.10	19.6	2	AB	2333	4.294	-249	14.1	"	"	"	-	"	"	"	"	"
43	3.50	19.6	2	AB	2333	4.294	-150	16.5	"	"	"	-	"	"	"	"	"
53	5.00	29.1	3	ABC	4145	6.296	178	22.7	1670	1670	266	15.4	425	77	790	3162	4453
63	7.00	35.1	4	ABCO	5494	7.533	862	31.0	1906	2041	252	18.6	387	88	1037	4147	5662
73	9.00	35.1	4	ABCD	5494	7.533	1725	41.4	"	"	"	18.6	"	"	"	"	"
83	12.00	35.1	4	ABCD	5494	7.533	3020	55.5	"	"	"	18.6	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-90

ECONOMICS SUMMARY

BASIN Northern Great Plains- Williston — TECHNOLOGY Advanced Case

SUB BASIN 12 — FORMATION Greenhorn — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1212211	1.50	19.6	2	AB	2087	4.294	-366	4.7	0	0	0	10.4	0	0	0	0	0
21	2.50	19.6	2	AB	2087	4.294	147	11.8	1143	1143	266	10.4	450	52	259	1033	1791
31	3.10	29.1	3	ABC	3409	6.296	604	15.4	1670	1670	266	15.4	425	77	421	1683	2606
41	3.50	35.1	4	ABCD	4768	7.786	937	16.6	2041	2041	261	18.6	403	92	578	2316	3389
51	5.00	35.1	4	ABCD	4768	7.786	2353	26.1	"	"	"	18.6	"	"	"	"	"
61	7.00	38.0	5	ABCDE	5899	8.535	4411	35.9	2216	2216	259	20.1	392	99	711	2842	4041
71	9.00	38.2	6	ABCDEF	5971	8.562	6496	46.7	2248	2248	263	20.2	396	101	731	2928	4156
81	12.00	38.2	6	ABCDEF	5971	8.562	9634	61.4	"	"	"	20.2	"	"	"	"	"
Discount Rate 15%																	
12	1.50	12.4	1	A	1499	2.726	-464	3.5	0	0	0	6.6	0	0	0	0	0
22	2.50	19.6	2	AB	2087	4.294	-173	11.8	0	0	0	10.4	0	0	0	0	0
32	3.10	19.6	2	AB	2087	4.294	33	15.5	1143	1143	266	10.4	450	52	259	1033	1791
42	3.50	29.1	3	ABC	3409	6.296	237	18.0	1670	1670	266	15.4	425	77	421	1683	2606
52	5.00	35.1	4	ABCD	4768	7.786	1114	26.1	2041	2041	261	18.6	403	92	578	2316	3389
62	7.00	38.0	5	ABCDE	5899	8.535	2428	35.9	2216	2216	259	20.1	392	99	711	2842	4041
72	9.00	38.0	5	ABCDE	5899	8.535	3836	47.0	"	"	"	20.1	"	"	"	"	"
82	12.00	38.2	6	ABCDEF	5971	8.562	5952	61.4	2248	2248	263	20.2	396	101	731	2928	4156
Discount Rate 20%																	
13	1.50	12.4	1	A	1499	2.726	-521	3.5	0	0	0	6.6	0	0	0	0	0
23	2.50	19.6	2	AB	2087	4.294	-343	11.8	"	"	"	10.4	"	"	"	"	"
33	3.10	19.6	2	AB	2087	4.294	-193	15.5	"	"	"	10.4	"	"	"	"	"
43	3.50	19.6	2	AB	2087	4.294	-94	17.8	"	"	"	10.4	"	"	"	"	"
53	5.00	29.1	3	ABC	3409	6.296	438	27.1	1670	1670	266	15.4	425	77	421	1683	2606
63	7.00	35.1	4	ABCD	4768	7.786	1374	37.9	2041	2041	261	18.6	403	92	578	2316	3389
73	9.00	38.0	5	ABCDE	5899	8.535	2375	47.0	2216	2216	259	20.1	392	99	711	2842	4041
83	12.00	38.0	5	ABCDE	5899	8.535	3907	61.6	"	"	"	20.1	"	"	"	"	"

* CODE: A B C D E F
0.3 0.1 0.03 0.01 0.003 0.001

TABLE 10-91

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 13
FORMATION: Greenhorn, Carlile

DEPTH (FT.): 1925
PRESSURE (PSIA): 830
TEMPERATURE (°F): 93

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	71	10.4	21	242.88	180	0.45	0.30	0.90
0.1	94	9.0	24	318.02	245	0.45	0.25	0.90
0.03	124	7.4	31	445.54	322	0.45	0.20	0.90
0.01	92	6.0	38	328.55	238	0.45	0.20	0.90
0.003	75	5.5	44	284.28	193	0.45	0.15	0.90
0.001	4	5.0	50	15.66	10	0.45	0.10	0.90
	460			1635.	1188			

TABLE 10-92

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, GREENHORN + CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	153	111	77	54	33	20				
2	114	77	48	31	18	11				
5	88	54	32	20	11	6				
10	71	43	25	15	7	4				
15	60	38	22	12	7	3				
20	52	35	20	11	6	3				
30	41	29	17	9	5	2				
30-YEAR CUMM. PROD. (MMCF)	1990	1301	777	465	259	150				

TABLE 10-93

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, GREENHORN + CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	218	170	159	127	98	67				
2	162	118	116	85	61	40				
5	122	83	82	56	38	24				
10	98	65	63	42	27	16				
15	85	56	54	37	23	14				
20	76	51	49	32	20	12				
30	63	43	41	27	16	10				
30-YEAR CUMM. PROD. (MMCF)	2843	1954	1890	1301	856	536				

TABLE 10-94

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 13
FORMATION: Greenhorn + Carlile

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.275	1.275	180	.892	.892	180
.1	1.998	1.998	245	1.331	1.331	245
.03	3.342	3.342	322	1.375	1.375	322
.01	5.546	4	172	1.985	1.985	238
.003	9.930	4	78	3.001	3.001	193
.001	16.422	4	2	4.618	4.618	10
			999			1188

TABLE 10-95

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 13
FORMATION: Greenhorn + Carlile

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	61,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-96

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 13 — FORMATION Greenhorn and Carlile — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1213111	1.50	27.0	3	ABC	2289	7.022	-1	9.9	0	0	0	14.3	0	0	0	0	0
21	2.50	35.7	4	ABCD	3070	8.736	848	18.3	921	987	105	18.9	164	38	227	907	1336
31	3.10	35.7	4	ABCD	3070	8.736	1450	23.8	"	"	"	18.9	"	"	"	"	"
41	3.50	42.4	5	ABCDE	3729	9.527	1793	25.0	998	1179	105	22.4	153	44	283	1131	1616
51	5.00	42.4	5	ABCDE	3729	9.527	3421	37.2	"	"	"	22.4	"	"	"	"	"
61	7.00	42.8	6	ABCDEF	3772	9.557	5591	51.2	1000	1188	105	22.6	"	45	286	1145	1630
71	9.00	42.8	6	ABCDEF	3772	9.557	7768	63.4	"	"	"	22.6	"	"	"	"	"
81	12.00	42.8	6	ABCDEF	3772	9.557	11034	78.7	"	"	"	22.6	"	"	"	"	"
Discount Rate 15%																	
12	1.50	27.0	3	ABC	2289	7.022	-273	9.9	0	0	0	14.3	0	0	0	0	0
22	2.50	35.7	4	ABCD	3070	8.736	236	18.3	921	987	105	18.9	164	38	227	907	1336
32	3.10	35.7	4	ABCD	3070	8.736	640	23.8	"	"	"	18.9	"	"	"	"	"
42	3.50	35.7	4	ABCD	3070	8.736	909	27.3	"	"	"	18.9	"	"	"	"	"
52	5.00	42.4	5	ABCDE	3729	9.527	1917	37.2	998	1179	105	22.4	153	44	283	1131	1616
62	7.00	42.8	6	ABCDEF	3772	9.557	3374	51.2	1000	1188	"	22.6	"	45	286	1145	1630
72	9.00	42.8	6	ABCDEF	3772	9.557	4837	63.4	"	"	"	22.6	"	"	"	"	"
82	12.00	42.8	6	ABCDEF	3772	9.557	7033	78.7	"	"	"	22.6	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.6	2	AB	1429	4.616	-316	10.0	0	0	0	8.8	0	0	0	0	0
23	2.50	27.0	3	ABC	2289	7.022	-12	19.7	"	"	"	14.3	"	"	"	"	"
33	3.10	35.7	4	ABCD	3070	8.736	206	23.8	921	987	105	18.9	164	38	227	907	1336
43	3.50	35.7	4	ABCD	3070	8.736	401	27.3	"	"	"	18.9	"	"	"	"	"
53	5.00	42.4	5	ABCDE	3729	9.527	1099	37.2	998	1179	"	22.4	153	44	283	1131	1616
63	7.00	42.4	5	ABCDE	3729	9.527	2157	51.4	"	"	"	22.4	"	"	"	"	"
73	9.00	42.8	6	ABCDEF	3772	9.557	3214	63.4	1000	1188	"	22.6	"	45	286	1145	1630
83	12.00	42.8	6	ABCDEF	3772	9.557	4806	78.7	"	"	"	22.6	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-97

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston
SUB BASIN 13
FORMATION Greenhorn, Carlile
TECHNOLOGY Advanced Case
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
12132 11	1.50	35.7	4	ABCD	2776	8.864	156	11.6	987	987	111	18.9	171	40	120	482	813
21	2.50	42.4	5	ABCDE	3691	10.410	1311	20.9	1179	1179	113	22.4	166	48	172	687	1073
31	3.10	42.4	5	ABCDE	3691	10.410	2073	26.8	"	"	"	22.4	"	"	"	"	"
41	3.50	42.8	6	ABCDEF	3783	10.507	2584	30.4	1188	1188	113	22.6	165	48	176	705	1095
51	5.00	42.8	6	ABCDEF	3783	10.507	4509	43.4	"	"	"	22.6	"	"	"	"	"
61	7.00	42.8	6	ABCDEF	3783	10.507	7076	58.2	"	"	"	22.6	"	"	"	"	"
71	9.00	42.8	6	ABCDEF	3783	10.507	9643	70.8	"	"	"	22.6	"	"	"	"	"
81	12.00	42.8	6	ABCDEF	3783	10.507	13493	86.8	"	"	"	22.6	"	"	"	"	"
Discount Rate 15%																	
12	1.50	27.0	3	ABC	2068	7.022	-188	11.6	0	0	0	14.3	0	0	0	0	0
22	2.50	35.7	4	ABCD	2776	8.864	496	21.8	987	987	111	18.9	171	40	120	482	813
32	3.10	42.4	5	ABCDE	3691	10.410	1011	26.8	1179	1179	113	22.4	166	48	172	687	1073
42	3.50	42.4	5	ABCDE	3691	10.410	1356	30.6	"	"	"	22.4	"	"	"	"	"
52	5.00	42.8	6	ABCDEF	3783	10.507	2657	43.4	1188	1188	"	22.6	165	"	176	705	1095
62	7.00	42.8	6	ABCDEF	3783	10.507	4397	58.2	"	"	"	22.6	"	"	"	"	"
72	9.00	42.8	6	ABCDEF	3783	10.507	6137	70.8	"	"	"	22.6	"	"	"	"	"
82	12.00	42.8	6	ABCDEF	3783	10.507	8747	86.8	"	"	"	22.6	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.6	2	AB	1457	4.616	-366	9.7	0	0	0	8.8	0	0	0	0	0
23	2.50	35.7	4	ABCD	2776	8.864	102	21.8	987	987	111	18.9	171	40	120	482	813
33	3.10	35.7	4	ABCD	2776	8.864	416	27.4	"	"	"	18.9	"	"	"	"	"
43	3.50	42.4	5	ABCDE	3691	10.410	687	30.6	1179	1179	113	22.4	166	48	172	687	1073
53	5.00	42.8	6	ABCDEF	3783	10.507	1631	43.4	1188	1188	"	22.6	165	"	176	705	1095
63	7.00	42.8	6	ABCDEF	3783	10.507	2899	58.2	"	"	"	22.6	"	"	"	"	"
73	9.00	42.8	6	ABCDEF	3783	10.507	4167	70.8	"	"	"	22.6	"	"	"	"	"
83	12.00	42.8	6	ABCDEF	3783	10.507	6069	86.8	"	"	"	22.6	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-98

GEOLOGICAL DATA SUMMARY

BASIN: Northern Great Plains-Williston
SUBBASIN: 14
FORMATION: Greenhorn, Eagle

DEPTH (FT.): 1727
PRESSURE (PSIA): 740
TEMPERATURE (°F): 90

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	315	10.4	23	1054.56	811	0.50	0.30	0.90
0.1	343	9.0	28	1209.76	930	0.50	0.25	0.90
0.03	229	7.4	36	853.83	618	0.50	0.20	0.90
0.01	186	6.0	51	796.60	577	0.50	0.20	0.90
0.003	341	5.5	59	1548.72	1051	0.50	0.15	0.90
0.001	17	5.0	65	77.33	49	0.50	0.10	0.90
	1431			5541.	4036			

TABLE 10-99

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, GREENHORN + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	139	108	75	61	37	22				
2	103	75	46	35	20	12				
5	80	52	31	22	12	7				
10	65	42	24	16	8	5				
15	55	37	21	14	7	4				
20	48	33	19	12	7	3				
30	37	28	17	11	5	3				
30-YEAR CUMM. PROD. (MMCF)	1823	1265	751	522	291	161				

TABLE 10-100

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, GREENHORN + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	198	165	153	142	110	73				
2	147	115	112	95	69	43				
5	110	81	79	64	42	26				
10	89	63	61	48	30	18				
15	78	54	53	41	25	15				
20	70	49	47	36	22	13				
30	58	42	40	30	18	11				
30-YEAR CUMM. PROD. (MMCF)	2596	1899	1832	1460	963	586				

TABLE 10-101

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 14
FORMATION: Greenhorn + Eagle

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.412	1.412	811	.9916	.9916	811
.1	2.142	2.142	930	1.427	1.427	930
.03	3.588	3.588	618	1.473	1.473	618
.01	5.926	4	389	2.121	2.121	577
.003	10.587	4	397	3.196	3.196	1051
.001	17.779	4	11	4.907	4.907	49
			3156			4036

TABLE 10-102

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 14
FORMATION: Greenhorn + Eagle

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	56,185
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 114,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 409,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-103

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 14 — FORMATION Greenhorn and Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1214111	1.50	29.8	3	ABC	1977	6.317	68	11.0	2357	2357	373	15.9	589	111	462	1845	3006
21	2.50	36.3	4	ABCD	2397	7.373	891	20.7	2747	2934	"	19.4	565	136	600	2400	3700
31	3.10	36.3	4	ABCD	2397	7.373	1421	26.5	"	"	"	19.4	"	"	"	"	"
41	3.50	47.2	5	ABCDE	3369	8.601	1721	26.5	3143	3984	366	25.2	513	173	878	3511	5075
51	5.00	47.2	5	ABCDE	3369	8.601	3237	39.5	"	"	"	25.2	"	"	"	"	"
61	7.00	47.6	6	ABCDEF	3393	8.618	5257	54.4	3155	4036	"	25.4	512	174	885	3539	5110
71	9.00	47.6	6	ABCDEF	3393	8.618	7282	67.1	"	"	"	25.4	"	"	"	"	"
81	12.00	47.6	6	ABCDEF	3393	8.618	10318	83.1	"	"	"	25.4	"	"	"	"	"
Discount Rate 15%																	
12	1.50	29.8	3	ABC	1977	6.317	-192	11.0	0	0	0	15.9	0	0	0	0	0
22	2.50	36.3	4	ABCD	2397	7.373	335	20.7	2747	2934	373	19.4	565	136	600	2400	3700
32	3.10	36.3	4	ABCD	2397	7.373	694	26.5	"	"	"	19.4	"	"	"	"	"
42	3.50	36.3	4	ABCD	2397	7.373	934	30.2	"	"	"	19.4	"	"	"	"	"
52	5.00	47.2	5	ABCDE	3369	8.601	1858	39.5	3143	3984	366	25.2	513	173	878	3511	5075
62	7.00	47.2	5	ABCDE	3369	8.601	3228	54.5	"	"	"	25.2	"	"	"	"	"
72	9.00	47.6	6	ABCDEF	3393	8.618	4599	67.1	3155	4036	"	25.4	512	174	885	3539	5110
82	12.00	47.6	6	ABCDEF	3393	8.618	6659	83.1	"	"	"	25.4	"	"	"	"	"
Discount Rate 20%																	
13	1.50	22.4	2	AB	1453	4.866	-270	11.3	0	0	0	11.9	0	0	0	0	0
23	2.50	36.3	4	ABCD	2397	7.373	34	20.7	2747	2934	373	19.4	565	136	600	2400	3700
33	3.10	36.3	4	ABCD	2397	7.373	296	26.5	"	"	"	19.4	"	"	"	"	"
43	3.50	36.3	4	ABCD	2397	7.373	470	30.2	"	"	"	19.4	"	"	"	"	"
53	5.00	47.2	5	ABCDE	3369	8.601	1099	39.5	3143	3384	360	25.2	513	173	878	3511	5075
63	7.00	47.2	5	ABCDE	3369	8.601	2099	54.5	"	"	"	25.2	"	"	"	"	"
73	9.00	47.6	6	ABCDEF	3393	8.618	3098	67.1	3155	4036	"	25.4	512	174	885	3539	5110
83	12.00	47.6	6	ABCDEF	3393	8.618	4601	83.1	"	"	"	25.4	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-104

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 14 — FORMATION Greenhorn, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1214211	1.50	36.3	4	ABCD	2241	7.532	186	12.3	2934	2934	390	19.4	590	141	337	1349	2417
21	2.50	47.2	5	ABCDE	3788	10.089	1245	20.9	3984	3984	395	25.2	553	187	591	2363	3694
31	3.10	47.2	5	ABCDE	3788	10.089	1994	27.2	"	"	"	25.2	"	"	"	"	"
41	3.50	47.2	5	ABCDE	3788	10.089	2495	31.3	"	"	"	25.2	"	"	"	"	"
51	5.00	47.6	6	ABCDEF	3858	10.150	4383	45.1	4036	4036	398	25.4	556	189	605	2420	3769
61	7.00	47.6	6	ABCDEF	3858	10.150	6903	61.2	"	"	"	25.4	"	"	"	"	"
71	9.00	47.6	6	ABCDEF	3858	10.150	9422	74.8	"	"	"	25.4	"	"	"	"	"
81	12.00	47.6	6	ABCDEF	3858	10.150	13202	92.1	"	"	"	25.4	"	"	"	"	"
Discount Rate 15%																	
12	1.50	29.8	3	ABC	1821	6.316	-147	12.0	0	0	0	15.9	0	0	0	0	0
22	2.50	36.3	4	ABCD	2241	7.532	478	22.8	2934	2934	390	19.4	590	141	337	1349	2417
32	3.10	47.2	5	ABCDE	3788	10.089	983	27.2	3984	3984	395	25.2	553	187	591	2363	3694
42	3.50	47.2	5	ABCDE	3788	10.089	1324	31.3	"	"	"	25.2	"	"	"	"	"
52	5.00	47.2	5	ABCDE	3788	10.089	2606	45.3	"	"	"	25.2	"	"	"	"	"
62	7.00	47.6	6	ABCDEF	3858	10.150	4330	61.2	4036	4036	398	25.4	556	189	605	2420	3769
72	9.00	47.6	6	ABCDEF	3858	10.150	6051	74.8	"	"	"	25.4	"	"	"	"	"
82	12.00	47.6	6	ABCDEF	3858	10.150	8633	92.1	"	"	"	25.4	"	"	"	"	"
Discount Rate 20%																	
13	1.50	22.4	2	AB	1434	4.866	-308	10.9	0	0	0	11.9	0	0	0	0	0
23	2.50	36.3	4	ABCD	2241	7.532	132	22.8	2934	2934	390	19.4	590	141	337	1349	2417
33	3.10	36.3	4	ABCD	2241	7.532	408	28.5	"	"	"	19.4	"	"	"	"	"
43	3.50	47.2	5	ABCDE	3788	10.089	684	31.3	3984	3984	395	25.2	553	187	591	2363	3694
53	5.00	47.2	5	ABCDE	3788	10.089	1624	45.3	"	"	"	25.2	"	"	"	"	"
63	7.00	47.6	6	ABCDEF	3858	10.150	2885	61.2	4036	4036	398	25.4	556	189	605	2420	3769
73	9.00	47.6	6	ABCDEF	3858	10.150	4148	74.8	"	"	"	25.4	"	"	"	"	"
83	12.00	47.6	6	ABCDEF	3858	10.150	6041	92.1	"	"	"	25.4	"	"	"	"	"

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 10-105

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 15
FORMATION: Greenhorn, Carlile, Eagle

DEPTH (FT.): 1685
PRESSURE (PSIA): 725
TEMPERATURE (°F): 89

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	137	10.4	32	613.96	470	0.45	0.30	0.90
0.1	185	9.0	46	1031.35	789	0.45	0.25	0.90
0.03	161	7.4	60	962.59	693	0.45	0.20	0.90
0.01	128	6.0	78	806.67	581	0.45	0.20	0.90
0.003	183	5.5	85	1152.05	778	0.45	0.15	0.90
0.001	10	5.0	100	67.33	42	0.45	0.10	0.90
	804			4635.	3353			

TABLE 10-106

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, GREENHORN + CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	187	171	121	90	52	34				
2	139	119	75	51	28	18				
5	108	83	51	32	17	10				
10	88	67	38	25	12	7				
15	74	59	34	21	10	6				
20	65	54	31	18	9	5				
30	50	45	27	16	8	4				
30-YEAR CUMM. PROD. (MMCF)	2460	2015	1216	775	407	246				

TABLE 10-107

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, GREENHORN + CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	266	263	247	211	154	109				
2	199	183	182	141	96	65				
5	149	129	127	95	59	40				
10	120	101	99	71	42	28				
15	105	87	85	61	36	22				
20	94	78	77	54	32	20				
30	78	67	66	45	26	16				
30-YEAR CUMM. PROD. (MMCF)	3501	3025	2959	2167	1347	876				

TABLE 10-108

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 15
FORMATION: Greenhorn + Carlile + Eagle

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.426	1.426	470	1.003	1.003	470
.1	2.167	2.167	789	1.443	1.443	789
.03	3.625	3.625	693	1.490	1.490	693
.01	5.987	4	388	2.144	2.144	581
.003	10.691	4	291	3.230	3.230	778
.001	17.585	4	10	4.958	4.958	42
			2641			3353

TABLE 10-109

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 15
FORMATION: Greenhorn + Carlile + Eagle

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	55,215
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 203,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 750,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-110

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston
SUB BASIN 15
FORMATION Greenhorn, Carlile, Eagle
TECHNOLOGY Base Case
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1215111	1.50	26.4	3	ABC	1437	5.302	157	12.7	1997	1997	392	14.0	613	100	256	1022	1991
21	2.50	33.3	4	ABCD	1858	6.569	919	22.7	2397	2513	365	17.6	568	121	355	1419	2463
31	3.10	42.5	5	ABCD	2584	7.626	1371	25.7	2695	3310	353	22.5	517	150	512	2050	3231
41	3.50	42.5	5	ABCD	2584	7.626	1728	29.4	"	"	"	22.5	"	"	"	"	"
51	5.00	42.5	5	ABCD	2584	7.626	3068	42.3	"	"	"	22.5	"	"	"	"	"
61	7.00	42.9	6	ABCDEF	2603	7.641	4857	56.7	2708	3353	352	22.7	515	151	515	2061	3241
71	9.00	42.9	6	ABCDEF	2603	7.641	6648	69.0	"	"	"	22.7	"	"	"	"	"
81	12.00	42.9	6	ABCDEF	2603	7.641	9333	84.5	"	"	"	22.7	"	"	"	"	"
Discount Rate 15%																	
12	1.50	26.4	3	ABC	1437	5.302	-931	12.7	0	0	0	14.0	0	0	0	0	0
22	2.50	33.3	4	ABCD	1858	6.569	395	22.7	2397	2513	365	17.6	568	121	355	1419	2463
32	3.10	33.3	4	ABCD	1858	6.569	716	28.4	"	"	"	17.6	"	"	"	"	"
42	3.50	33.3	4	ABCD	1858	6.569	930	32.0	"	"	"	17.6	"	"	"	"	"
52	5.00	42.5	5	ABCDE	2584	7.626	1812	42.3	2695	3310	353	22.5	517	150	512	2050	3231
62	7.00	42.9	6	ABCDEF	2603	7.641	3032	56.7	2708	3353	352	22.7	515	151	515	2061	3241
72	9.00	42.9	6	ABCDEF	2603	7.641	4254	69.0	"	"	"	22.7	"	"	"	"	"
82	12.00	42.9	6	ABCDEF	2603	7.641	6088	84.5	"	"	"	22.7	"	"	"	"	"
Discount Rate 20%																	
13	1.50	26.4	3	ABC	1437	5.302	-231	12.7	0	0	0	14.0	0	0	0	0	0
23	2.50	33.3	4	ABCD	1858	6.569	106	22.7	2397	2513	365	17.6	568	121	355	1419	2463
33	3.10	33.3	4	ABCD	1858	6.569	342	28.4	"	"	"	17.6	"	"	"	"	"
43	3.50	33.3	4	ABCD	1858	6.569	499	32.0	"	"	"	17.6	"	"	"	"	"
53	5.00	42.5	5	ABCDE	2584	7.626	1113	42.3	2695	3310	353	22.5	517	150	512	2050	3231
63	7.00	42.5	5	ABCDE	2584	7.626	2009	56.8	"	"	"	22.5	"	"	"	"	"
73	9.00	42.9	6	ABCDEF	2603	7.641	2907	69.0	2708	3353	352	22.7	515	151	515	2061	3241
83	12.00	42.9	6	ABCDEF	2603	7.641	4255	84.5	"	"	"	22.7	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-111

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 15 — FORMATION Greenhorn, Carlile, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
121521	1.50	26.4	3	ABC	1670	5.302	41	10.5	1997	1997	377	14.0	613	100	133	531	1376
21	2.50	33.3	4	ABCD	2186	6.770	936	20.5	2596	2596	384	17.6	597	128	192	769	1686
31	3.10	42.5	5	ABCDE	3676	9.019	1726	24.8	3310	3310	367	22.5	538	156	330	1319	2343
41	3.50	42.5	5	ABCDE	3676	9.019	2185	28.5	"	"	"	22.5	"	"	"	"	"
51	5.00	42.9	6	ABCDEF	3737	9.071	3908	41.2	3353	3353	370	22.7	540	158	337	1348	2384
61	7.00	42.9	6	ABCDEF	3737	9.071	6208	56.3	"	"	"	22.7	"	"	"	"	"
71	9.00	42.9	6	ABCDEF	3737	9.071	8508	69.4	"	"	"	22.7	"	"	"	"	"
81	12.00	42.9	6	ABCDEF	3737	9.071	11958	86.2	"	"	"	22.7	"	"	"	"	"
Discount Rate 15%																	
12	1.50	26.4	3	ABC	1670	5.302	-226	10.5	0	0	0	14.0	0	0	0	0	0
22	2.50	33.3	4	ABCD	2186	6.770	352	20.5	2596	2596	384	17.6	597	128	192	769	1686
32	3.10	33.3	4	ABCD	2186	6.770	700	25.7	"	"	"	17.6	"	"	"	"	"
42	3.50	42.5	5	ABCDE	3676	9.019	1116	28.5	3310	3310	367	22.5	538	156	330	1319	2343
52	5.00	42.5	5	ABCDE	3676	9.019	2296	41.4	"	"	"	22.5	"	"	"	"	"
62	7.00	42.9	6	ABCDEF	3737	9.071	3884	56.3	3353	3353	370	22.7	540	158	337	1348	2384
72	9.00	42.9	6	ABCDEF	3737	9.071	5469	69.4	"	"	"	22.7	"	"	"	"	"
82	12.00	42.9	6	ABCDEF	3737	9.071	7846	86.2	"	"	"	22.7	"	"	"	"	"
Discount Rate 20%																	
13	1.50	26.4	3	ABC	1670	5.302	-374	10.5	0	0	0	14.0	0	0	0	0	0
23	2.50	33.3	4	ABCD	2186	6.770	28	20.5	2596	2596	384	17.6	597	128	192	769	1686
33	3.10	33.3	4	ABCD	2186	6.770	285	25.7	"	"	"	17.6	"	"	"	"	"
43	3.50	33.3	4	ABCD	2186	6.770	457	28.9	"	"	"	17.6	"	"	"	"	"
53	5.00	42.5	5	ABCDE	3676	9.019	1400	41.4	3310	3310	367	22.5	367	538	156	330	2343
63	7.00	42.9	6	ABCDEF	3737	9.071	2571	56.3	3353	3353	370	22.7	540	158	337	1348	2384
73	9.00	42.9	6	ABCDEF	3737	9.071	3742	69.4	"	"	"	22.7	"	"	"	"	"
83	12.00	42.9	6	ABCDEF	3737	9.071	5500	86.2	"	"	"	22.7	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-112

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 16
FORMATION: Carlile

DEPTH (FT.): 1600
PRESSURE (PSIA): 690
TEMPERATURE (°F): 88

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	216	10.4	13	386.53	297	0.50	0.35	0.90
0.1	594	9.0	17	1202.91	924	0.50	0.30	0.90
0.03	702	7.4	21	1443.94	1044	0.50	0.25	0.90
0.01	648	6.0	25	1286.54	931	0.50	0.20	0.90
0.003	513	5.5	28	1045.49	709	0.50	0.15	0.90
0.001	27	5.0	35	62.54	40	0.50	0.10	0.90
	2700			5428.	3945			

TABLE 10-113

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	70	58	39	27	16	11				
2	52	40	24	15	8	6				
5	40	28	16	9	5	3				
10	33	23	12	7	3	2				
15	27	20	11	6	3	2				
20	24	18	10	5	2	1				
30	19	15	8	4	2	1				
30-YEAR CUMM. PROD. (MMCF)	925	687	393	230	124	80				

TABLE 10-114

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, CARLILE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	99	89	80	62	47	35				
2	74	62	58	41	29	21				
5	55	44	41	28	18	13				
10	45	34	32	21	13	9				
15	39	30	27	18	11	7				
20	35	26	25	16	9	6				
30	29	23	21	13	8	5				
30-YEAR CUMM. PROD. (MMCF)	1316	1033	957	643	410	284				

TABLE 10-115

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 16
FORMATION: Carlile

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.485	1.485	297	1.045	1.045	297
.1	2.262	2.262	924	1.505	1.505	924
.03	3.785	3.785	1044	1.553	1.553	1044
.01	6.243	4	597	2.233	2.233	951
.003	11.147	4	255	3.363	3.363	709
.001	18.324	4	9	5.162	5.162	40
			3126			3945

TABLE 10-116

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 16
FORMATION: Carlile

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	53,302
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-117

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 16 — FORMATION Carlile — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1216111	1.50	15.8	2	AB	1836	3.410	-408	2.8	0	0	0	8.4	0	0	0	0	0
21	2.50	26.9	3	ABC	3707	6.118	-139	8.6	"	"	"	14.3	"	"	"	"	"
31	3.10	26.9	3	ABC	3707	6.118	299	12.7	2266	2266	370	14.3	594	100	1045	4178	5917
41	3.50	26.9	3	ABC	3707	6.118	591	15.3	"	"	"	14.3	"	"	"	"	"
51	5.00	38.4	4	ABCD	5776	8.395	1748	21.2	2862	3196	341	20.5	508	131	1600	6400	8639
61	7.00	47.0	5	ABCDE	7548	9.437	3498	28.4	3116	3905	330	25.1	463	155	2079	8317	11015
71	9.00	47.0	5	ABCDE	7548	9.437	5622	39.4	"	"	"	25.1	"	"	"	"	"
81	12.00	47.4	6	ABCDEF	7593	9.454	8807	54.8	3125	3945	330	25.3	462	157	2095	8377	11091
Discount Rate 15%																	
12	1.50	4.3	1	A	797	.744	-375	0	0	0	0	2.3	0	0	0	0	0
22	2.50	15.8	2	AB	1836	3.410	-234	9.9	"	"	"	8.4	"	"	"	"	"
32	3.10	26.9	3	ABC	3707	6.118	-167	12.7	"	"	"	14.4	"	"	"	"	"
42	3.50	26.9	3	ABC	3707	6.118	29	15.3	2266	2266	370	14.4	594	100	1045	4178	5917
52	5.00	38.4	4	ABCD	5776	8.395	659	21.2	2862	3196	341	20.5	508	131	1600	6400	8639
62	7.00	38.4	4	ABCD	5776	8.395	1946	33.0	"	"	"	20.5	"	"	"	"	"
72	9.00	47.0	5	ABCDE	7548	9.437	3147	39.4	3116	3905	330	25.1	463	155	2079	8317	11015
82	12.00	47.4	6	ABCDEF	7593	9.454	5287	54.8	3125	3945	"	25.3	462	159	2095	8377	11091
Discount Rate 20%																	
13	1.50	0	0		583	-	-382	0	0	0	0	0	0	0	0	0	0
23	2.50	15.8	2	AB	1836	3.410	-355	9.9	"	"	"	8.4	"	"	"	"	"
33	3.10	15.8	2	AB	1836	3.410	-237	13.5	"	"	"	8.4	"	"	"	"	"
43	3.50	26.9	3	ABC	3707	6.118	-259	15.3	"	"	"	14.4	"	"	"	"	"
53	5.00	26.9	3	ABC	3707	6.118	273	24.6	2266	2266	370	14.4	594	100	1045	4178	5917
63	7.00	38.4	4	ABCD	5776	8.395	1028	33.0	2862	3196	341	20.5	508	131	1600	6400	8639
73	9.00	38.4	4	ABCD	5776	8.395	1960	44.2	"	"	"	20.5	"	"	"	"	"
83	12.00	47.0	5	ABCDE	7548	9.437	3374	55.0	3116	3905	330	25.1	463	155	2079	8317	11015

* CODE: A B C D E F
0.3 0.1 0.03 0.01 0.003 0.001

TABLE 10-118

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 16 — FORMATION Carlile — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1216211	1.50	15.8	2	AB	1774	3.410	-366	4.0	0	0	0	8.4	0	0	0	0	0
21	2.50	26.9	3	ABC	3188	6.118	214	12.0	2266	2266	370	14.4	594	100	531	2125	3350
31	3.10	38.4	4	ABCD	5340	8.862	731	14.8	3196	3196	361	20.5	537	139	893	3571	5139
41	3.50	38.4	4	ABCD	5340	8.862	1161	17.6	"	"	"	20.5	"	"	"	"	"
51	5.00	47.0	5	ABCDE	8134	11.123	2967	24.5	3805	3905	351	25.1	492	165	1344	5375	7376
61	7.00	47.4	6	ABCDEF	8245	11.185	5698	37.4	3945	3945	353	25.3	493	167	1370	5475	7504
71	9.00	47.4	6	ABCDEF	8245	11.185	8437	49.8	"	"	"	25.3	"	"	"	"	"
81	12.00	47.4	6	ABCDEF	8245	11.185	12546	66.4	"	"	"	25.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	15.8	2	AB	1774	3.410	-496	4.0	0	0	0	8.4	0	0	0	0	0
22	2.50	15.8	2	AB	1774	3.410	-217	10.6	"	"	"	8.4	"	"	"	"	"
32	3.10	26.9	3	ABC	3188	6.118	87	16.1	2266	2266	370	14.4	594	100	531	2125	3350
42	3.50	26.9	3	ABC	3188	6.118	285	18.7	"	"	"	14.4	"	"	"	"	"
52	5.00	38.4	4	ABCD	5340	8.862	1363	27.8	3196	3196	361	20.5	537	139	893	3571	5139
62	7.00	47.0	5	ABCDE	8134	11.123	3157	37.6	3905	3905	351	25.1	492	165	1344	5375	7375
72	9.00	47.4	6	ABCDEF	8245	11.185	5008	49.8	3945	3945	353	25.3	493	167	1370	5475	7504
82	12.00	47.4	6	ABCDEF	8245	11.185	7787	66.4	"	"	"	25.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	15.8	2	AB	1774	3.410	-562	4.0	0	0	0	8.4	0	0	0	0	0
23	2.50	15.8	2	AB	1774	3.410	-359	10.6	"	"	"	8.4	"	"	"	"	"
33	3.10	15.8	2	AB	1774	3.410	-238	14.0	"	"	"	8.4	"	"	"	"	"
43	3.50	26.9	3	ABC	3188	6.118	-68	18.7	"	"	"	14.4	"	"	"	"	"
53	5.00	38.4	4	ABCD	5340	8.862	610	27.8	3196	3196	361	20.5	537	139	893	3571	5139
63	7.00	47.0	5	ABCDE	8134	11.123	1790	37.6	3905	3905	351	25.1	492	165	1344	5373	7375
73	9.00	47.4	6	ABCDEF	8245	11.185	3129	49.8	3945	3945	353	25.3	493	167	1370	5475	7504
83	12.00	47.4	6	ABCDEF	8245	11.185	5147	66.4	"	"	"	25.3	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-119

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

BASIN: Northern Great Plains-Williston
SUBBASIN: 17
FORMATION: Niobrara

DEPTH (FT.): 2700
PRESSURE (PSIA): 1150
TEMPERATURE (°F): 104

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	385	14.6	27	3210.9	2467	.20	.30	.90
0.1	385	12.0	30	2933.3	2253	.20	.25	.90
0.03	257	10.0	35	1903.9	1376	.20	.20	.90
0.01	192	7.0	40	1137.8	822	.20	.15	.90
0.003	61	4.5	40	232.4	174	.20	.15	.90
0.001	3	2.0	40	5.1	3	.20	.10	.90
	1283			9423.	7095			

TABLE 10-120

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, NIOBRARA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	364	254	162	99	44	17				
2	271	177	100	57	24	9				
5	210	123	68	37	14	5				
10	171	100	51	27	11	4				
15	145	88	45	23	9	3				
20	127	80	41	20	8	3				
30	99	67	36	18	7	2				
30-YEAR CUMM. PROD. (MMCF)	4816	2989	1619	859	355	134				

TABLE 10-121

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, NIOBRARA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	518	390	329	236	138	61				
2	387	272	242	157	84	34				
5	290	191	170	104	51	20				
10	235	150	132	79	37	14				
15	205	129	114	68	31	12				
20	184	117	103	60	27	10				
30	152	100	88	50	22	8				
30-YEAR CUMM. PROD. (MMCF)	6836	4487	3942	2402	1170	465				

TABLE 10-122

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains/Williston
SUBBASIN: 17
FORMATION: Niobrara

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.3	1.3	1.3	2467	1.0	1.0	2467
0.1	2.0	2.0	2253	1.3	1.3	2253
0.03	3.3	3.3	1376	1.4	1.4	1376
0.01	5.0	4.0	660	1.8	1.8	822
0.003	8.0	4.0	87	2.4	2.4	173
0.001	7.9	4.0	2	2.3	2.3	3
			6845			7094

TABLE 10-123

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains/Williston
SUBBASIN: 17
FORMATION: Niobrara

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	84,121
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	83,750
- Advanced Case [2000/4000 Ft. Fracture]	106,250 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0518

TABLE 10-124

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 17 — FORMATION Niobrara — DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1217111	1.50	17.9	4	ABCD	1172	4.023	60	11.2	6756	6918	1679	9.2	1973	300	687	2746	6707
21	2.50	17.9	4	ABCD	1172	4.023	544	19.9	"	"	"	9.2	"	"	"	"	"
31	3.10	19.3	5	ABCDE	1290	4.203	831	23.9	6843	7091	1628	9.9	2861	314	817	3271	7262
41	3.50	19.3	5	ABCDE	1290	4.203	1032	26.8	"	"	"	9.9	"	"	"	"	"
51	5.00	19.3	5	ABCDE	1290	4.203	1786	36.5	"	"	"	9.9	"	"	"	"	"
61	7.00	19.3	5	ABCDE	1290	4.203	2793	47.4	"	"	"	9.9	"	"	"	"	"
71	9.00	19.3	5	ABCDE	1290	4.203	3800	56.8	"	"	"	9.9	"	"	"	"	"
81	12.00	19.3	5	ABCDE	1290	4.203	5310	68.8	"	"	"	9.9	"	"	"	"	"
Discount Rate 15%																	
12	1.50	17.9	4	ABCD	1172	4.023	-135	11.2	0	0	0	9.2	0	0	0	0	0
22	2.50	17.9	4	ABCD	1172	4.023	195	19.9	"	"	"	9.2	"	"	"	"	"
32	3.10	17.9	4	ABCD	1172	4.023	394	24.5	6756	6918	1679	9.2	2973	300	687	2746	6707
42	3.50	19.3	5	ABCDE	1290	4.203	519	26.8	"	"	"	9.9	"	"	"	"	"
52	5.00	19.3	5	ABCDE	1290	4.203	1035	36.5	6843	7091	1628	9.9	2861	3148	817	3271	7262
62	7.00	19.3	5	ABCDE	1290	4.203	1722	47.4	"	"	"	9.9	"	"	"	"	"
72	9.00	19.3	5	ABCDE	1290	4.203	2409	56.8	"	"	"	9.9	"	"	"	"	"
82	12.00	19.3	5	ABCDE	1290	4.203	3439	68.8	"	"	"	9.9	"	"	"	"	"
Discount Rate 20%																	
13	1.50	15.0	3	ABC	955	3.254	-227	11.1	0	0	0	7.7	0	0	0	0	0
23	2.50	17.9	4	ABCD	1172	4.023	-114	19.9	0	0	0	9.2	0	0	0	0	0
33	3.10	17.9	4	ABCD	1172	4.023	144	24.5	6756	6918	1679	9.2	2973	300	687	2746	6707
43	3.50	17.9	4	ABCD	1172	4.023	241	27.3	"	"	"	9.2	"	"	"	"	"
53	5.00	19.3	5	ABCDE	1290	4.203	609	36.5	6843	7091	1628	9.9	2861	314	817	3271	7262
63	7.00	19.3	5	ABCDE	1290	4.203	1114	47.4	"	"	"	9.9	"	"	"	"	"
73	9.00	19.3	5	ABCDE	1290	4.203	1619	56.8	"	"	"	9.9	"	"	"	"	"
83	12.00	19.3	5	ABCDE	1290	4.203	2376	68.8	"	"	"	9.9	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-125

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 17 — FORMATION Niobrara — DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1217211	1.50	17.9	4	ABCD	1197	4.025	83	11.5	6918	6918	1719	9.2	3044	308	337	1349	5037
21	2.50	19.3	5	ABCDE	1323	4.304	629	20.3	7091	7091	1647	9.9	2895	318	417	1665	5295
31	3.10	19.3	5	ABCDE	1323	4.304	958	25.0	"	"	"	9.9	"	"	"	"	"
41	3.50	19.3	5	ABCDE	1323	4.304	1177	28.0	"	"	"	9.9	"	"	"	"	"
51	5.00	19.3	5	ABCDE	1323	4.304	1999	38.1	"	"	"	9.9	"	"	"	"	"
61	7.00	19.3	5	ABCDE	1323	4.304	3096	49.6	"	"	"	9.9	"	"	"	"	"
71	9.00	19.3	5	ABCDE	1323	4.304	4192	59.6	"	"	"	9.9	"	"	"	"	"
81	12.00	19.3	5	ABCDE	1323	4.304	5836	72.6	"	"	"	9.9	"	"	"	"	"
Discount Rate 15%																	
12	1.50	17.9	4	ABCD	1197	4.025	-133	11.5	0	0	0	9.2	0	0	0	0	0
22	2.50	19.3	5	ABCDE	1323	4.304	236	20.3	7091	7091	1647	9.9	2895	318	417	1665	5295
32	3.10	19.3	5	ABCDE	1323	4.304	463	25.0	"	"	"	9.9	"	"	"	"	"
42	3.50	19.3	5	ABCDE	1323	4.304	614	28.0	"	"	"	9.9	"	"	"	"	"
52	5.00	19.3	5	ABCDE	1323	4.304	1183	38.1	"	"	"	9.9	"	"	"	"	"
62	7.00	19.3	5	ABCDE	1323	4.304	1940	49.6	"	"	"	9.9	"	"	"	"	"
72	9.00	19.3	5	ABCDE	1323	4.304	2698	59.6	"	"	"	9.9	"	"	"	"	"
82	12.00	19.3	5	ABCDE	1323	4.304	3835	72.6	"	"	"	9.9	"	"	"	"	"
Discount Rate 20%																	
13	1.50	17.9	4	ABCD	1197	4.025	-256	11.5	0	0	0	9.2	0	0	0	0	0
23	2.50	19.3	5	ABCDE	1323	4.304	12	20.3	7091	7091	1647	9.9	2895	318	417	1665	5295
33	3.10	19.3	5	ABCDE	1323	4.304	181	25.0	"	"	"	9.9	"	"	"	"	"
43	3.50	19.3	5	ABCDE	1323	4.304	293	28.0	"	"	"	9.9	"	"	"	"	"
53	5.00	19.3	5	ABCDE	1323	4.304	715	38.1	"	"	"	9.9	"	"	"	"	"
63	7.00	19.3	5	ABCDE	1323	4.304	1278	49.6	"	"	"	9.9	"	"	"	"	"
73	9.00	19.3	5	ABCDE	1323	4.304	1840	59.6	"	"	"	9.9	"	"	"	"	"
83	12.00	19.3	5	ABCDE	1326	4.304	2684	72.6	"	"	"	9.9	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-126

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

BASIN: Northern Great Plains-Williston
SUBBASIN: 18
FORMATION: Carlile, Eagle

DEPTH (FT.): 1400
PRESSURE (PSIA): 600
TEMPERATURE (°F): 86

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	118	10.4	28	389.93	278	0.40	0.30	0.90
0.1	192	9.0	36	705.94	503	0.40	0.25	0.90
0.03	163	7.4	46	629.65	422	0.40	0.20	0.90
0.01	130	6.0	65	575.34	385	0.40	0.15	0.90
0.003	201	5.5	72	903.09	567	0.45	0.15	0.90
0.001	11	5.0	85	53.05	31	0.45	0.10	0.90
	815			3257.	2186			

TABLE 10-127

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	119	98	68	56	32	21				
2	88	68	42	32	18	11				
5	68	47	29	19	10	6				
10	56	38	21	15	7	4				
15	48	34	19	12	6	4				
20	42	31	17	11	6	3				
30	34	26	15	9	5	2				
30-YEAR CUMM. PROD. (MMCF)	1588	1155	682	477	255	155				

TABLE 10-128

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, CARLILE + EAGLE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	169	150	137	128	96	68				
2	126	105	101	86	60	41				
5	94	73	72	58	37	25				
10	77	58	55	43	26	17				
15	67	50	48	37	22	14				
20	61	45	43	33	20	12				
30	51	39	37	28	16	10				
30-YEAR CUMM. PROD. (MMCF)	2246	1737	1664	1332	846	553				

TABLE 10-129

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 18
FORMATION: Carlile + Eagle

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.598	1.598	278	1.13	1.13	278
.1	2.446	2.446	503	1.626	1.626	503
.03	4.09	4.0	422	1.678	1.678	422
.01	6.696	4.0	230	2.403	2.403	385
.003	11.948	4.0	190	3.601	3.601	567
.001	19.563	4.0	6	5.509	5.509	31
			1629			2186

TABLE 10-130

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 18
FORMATION: Carlile + Eagle

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	49,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 161,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 606,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-131

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 18 — FORMATION Carlile, Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1218111	1.50	23.1	3	ABC	1789	4.843	-130	7.8	0	0	0	12.2	0	0	0	0	0
21	2.50	30.3	4	ABCD	2244	5.798	453	15.8	1411	1589	247	16.0	394	75	361	1442	2271
31	3.10	30.3	4	ABCD	2244	5.798	859	20.6	"	"	"	16.0	"	"	"	"	"
41	3.50	30.3	4	ABCD	2244	5.798	1129	23.7	"	"	"	16.0	"	"	"	"	"
51	5.00	40.1	5	ABCDE	3173	6.755	2172	31.0	1623	2156	241	21.1	360	96	520	2078	3054
61	7.00	40.1	5	ABCDE	3173	6.755	3722	43.9	"	"	"	21.1	"	"	"	"	"
71	9.00	40.5	6	ABCDEF	3219	6.782	5275	54.9	1629	2186	240	21.3	358	97	526	2104	3085
81	12.00	40.5	6	ABCDEF	3219	6.782	7608	69.2	"	"	"	21.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	16.6	2	AB	1318	3.619	-263	7.8	0	0	0	8.8	0	0	0	0	0
22	2.50	23.1	3	ABC	1789	4.843	76	16.5	1202	1202	248	12.2	414	58	271	1086	1829
32	3.10	30.3	4	ABCD	2244	5.798	320	20.6	1411	1589	247	16.0	394	75	361	1442	2271
42	3.50	30.3	4	ABCD	2244	5.798	502	23.7	"	"	"	16.0	"	"	"	"	"
52	5.00	40.1	5	ABCDE	3173	6.755	1144	31.0	1623	2156	241	21.1	360	96	520	2078	3054
62	7.00	40.1	5	ABCDE	3173	6.755	2191	43.9	"	"	"	21.1	"	"	"	"	"
72	9.00	40.1	5	ABCDE	3173	6.755	3239	55.1	"	"	"	21.1	"	"	"	"	"
82	12.00	40.5	6	ABCDEF	3219	6.782	4815	69.2	1629	2186	240	21.3	358	97	526	2104	3085
Discount Rate 20%																	
13	1.50	16.6	2	AB	1318	3.619	-345	7.8	0	0	0	8.8	0	0	0	0	0
23	2.50	23.1	3	ABC	1789	4.843	-124	16.5	"	"	"	12.2	"	"	"	"	"
33	3.10	30.3	4	ABCD	2244	5.798	29	20.6	1411	1589	247	16.0	394	75	361	1442	2271
43	3.50	30.3	4	ABCD	2244	5.798	162	23.7	"	"	"	16.0	"	"	"	"	"
53	5.00	30.3	4	ABCD	2244	5.798	660	34.2	"	"	"	16.0	"	"	"	"	"
63	7.00	40.1	5	ABCDE	3173	6.755	1349	43.9	1623	2156	241	21.1	360	96	520	2078	3054
73	9.00	40.1	5	ABCDE	3173	6.755	2112	55.1	"	"	"	21.1	"	"	"	"	"
83	12.00	40.5	6	ABCDEF	3219	6.782	3259	69.2	1629	2186	240	21.3	358	97	526	2104	3085

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-132

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston — TECHNOLOGY Advanced Case

SUB BASIN 1-8 — FORMATION Carlile and Eagle — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *		AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
12182 11	1.50	23.1	3	ABC	1847	4.843	-130	8.1	0	0	0	12.2	0	0	0	0	0
21	2.50	30.3	4	ABCD	2450	6.096	595	16.5	1589	1589	261	15.9	416	79	218	870	1583
31	3.10	30.3	4	ABCD	2450	6.096	1049	21.1	"	"	"	15.9	"	"	"	"	"
41	3.50	40.1	5	ABCDE	4412	8.337	1517	21.7	2156	2156	258	21.1	387	104	379	1518	2387
51	5.00	40.1	5	ABCDE	4412	8.337	3082	33.0	"	"	"	21.1	"	"	"	"	"
61	7.00	40.5	6	ABCDEF	4572	8.434	5193	46.2	2186	2186	259	21.3	387	105	392	1568	2452
71	9.00	40.5	6	ABCDEF	4572	8.434	7306	58.2	"	"	"	21.3	"	"	"	"	"
81	12.00	40.5	6	ABCDEF	4572	8.434	10476	73.8	"	"	"	21.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	23.1	3	ABC	1847	4.843	-348	8.1	0	0	0	12.2	0	0	0	0	0
22	2.50	30.3	4	ABCD	2450	6.096	101	16.5	1589	1589	261	15.9	416	79	218	870	1583
32	3.10	30.3	4	ABCD	2450	6.096	409	21.1	"	"	"	15.9	"	"	"	"	"
42	3.50	30.3	4	ABCD	2450	6.096	615	24.0	"	"	"	15.9	"	"	"	"	"
52	5.00	40.1	5	ABCDE	4412	8.337	1671	33.0	2156	2156	258	21.1	387	104	379	1518	2387
62	7.00	40.1	5	ABCDE	4412	8.337	3095	46.6	"	"	"	21.1	"	"	"	"	"
72	9.00	40.5	6	ABCDEF	4572	8.434	4544	58.2	2186	2186	259	21.3	387	105	392	1568	2452
82	12.00	40.5	6	ABCDEF	4572	8.434	6709	73.8	"	"	"	21.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.6	2	AB	1493	3.619	-456	6.8	0	0	0	8.8	0	0	0	0	0
23	2.50	23.1	3	ABC	1847	4.843	-172	15.9	"	"	"	12.2	"	"	"	"	"
33	3.10	30.3	4	ABCD	2450	6.096	59	21.1	1589	1589	261	15.9	416	79	218	870	1583
43	3.50	30.3	4	ABCD	2450	6.096	209	24.0	"	"	"	15.9	"	"	"	"	"
53	5.00	30.3	4	ABCD	2450	6.096	773	34.0	"	"	"	15.9	"	"	"	"	"
63	7.00	40.1	5	ABCDE	4412	8.337	1941	46.6	2156	2156	258	21.1	387	104	379	1518	2387
73	9.00	40.1	5	ABCDE	4412	8.337	2983	58.5	"	"	"	21.1	"	"	"	"	"
83	12.00	40.5	6	ABCDEF	4572	8.434	4581	73.8	2186	2186	259	21.3	387	105	392	1568	2452

* CODE: A B C D E F
0.3 0.1 0.03 0.01 0.003 0.001

TABLE 10-133

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

BASIN: Northern Great Plains-Williston
SUBBASIN: 19
FORMATION: Judith River

DEPTH (FT.): 1400
PRESSURE (PSIA): 600
TEMPERATURE (°F): 86

NGL(BBL/MMCF): 0.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	411	10.4	9	437.80	334	0.40	0.30	0.90
0.1	371	9.0	12	434.70	349	0.40	0.25	0.90
0.03	938	7.4	14	1102.81	797	0.40	0.20	0.90
0.01	1017	6.0	15	1107.92	800	0.40	0.15	0.90
0.003	1114	5.5	18	1137.73	771	0.40	0.10	0.90
0.001	59	5.0	20	66.95	42	0.40	0.10	0.90
	3910			4288.	3093			

TABLE 10-134

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	38	32	20	12	8	5				
2	28	22	12	7	4	2				
5	22	15	8	4	2	1				
10	18	12	6	3	1	1				
15	15	11	5	2	1	0				
20	13	10	5	2	1	0				
30	11	8	4	2	1	0				
30-YEAR CUMM. PROD. (MMCF)	510	384	208	109	63	36				

TABLE 10-135

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, JUDITH RIVER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	54	50	42	29	24	16				
2	40	35	30	20	15	9				
5	30	24	21	13	9	5				
10	24	19	17	10	6	4				
15	21	16	14	8	5	3				
20	19	15	13	7	5	2				
30	16	13	11	6	4	2				
30-YEAR CUMM. PROD. (MMCF)	722	579	506	307	211	129				

TABLE 10-136

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 19
FORMATION: Judith River

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.6	1.6	334	1.130	1.130	334
.1	2.446	2.446	349	1.626	1.626	349
.03	4.087	4	797	1.680	1.680	797
.01	7.163	4	446	2.566	2.566	800
.003	10.992	4	281	3.282	3.282	771
.001	19.947	4	8	5.524	5.524	42
			2215			3093

TABLE 10-137

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN: 19
FORMATION: Judith River

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	49,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-138

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Base Case

SUB BASIN 19 — FORMATION Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1219111	1.50	-	-	-	583	-	-357	0	-	-	-	0	-	-	-	-	-
21	2.50	4.8	1	A	1097	.920	-348	0.70	-	-	-	2.5	-	-	-	-	-
31	3.10	8.8	2	AB	1789	1.861	-294	4.9	-	-	-	4.6	-	-	-	-	-
41	3.50	8.8	2	AB	1789	1.861	-206	6.5	-	-	-	4.6	-	-	-	-	-
51	5.00	17.4	3	ABC	4489	3.822	-43	9.6	-	-	-	9.1	-	-	-	-	-
61	7.00	17.4	3	ABC	4489	3.822	875	16.8	1480	1480	387	9.1	676	67	1309	5232	7284
71	9.00	27.3	4	ABCD	7403	5.281	1609	18.4	1927	2280	365	14.2	601	100	2154	8616	11471
81	12.00	27.3	4	ABCD	7403	5.281	3431	27.9	"	"	"	14.2	"	"	"	"	"
Discount Rate 15%																	
12	1.50	-	-	-	583	-	-367	0	-	-	-	0	-	-	-	-	-
22	2.50	4.8	1	A	1097	.920	-405	0.70	-	-	-	2.5	-	-	-	-	-
32	3.10	4.8	1	A	1097	.920	-360	2.9	-	-	-	2.5	-	-	-	-	-
42	3.50	8.8	2	AB	1789	1.861	-364	6.5	-	-	-	4.6	-	-	-	-	-
52	5.00	8.8	2	AB	1789	1.861	-143	11.9	-	-	-	4.6	-	-	-	-	-
62	7.00	17.4	3	ABC	4489	3.822	-164	16.8	1480	1480	387	9.1	676	67	1309	5232	7284
72	9.00	17.4	3	ABC	4489	3.822	781	23.7	"	"	"	9.1	"	"	"	"	"
82	12.00	27.3	4	ABCD	7403	5.281	1670	27.9	1927	2280	365	14.2	601	100	2154	8616	11471
Discount Rate 20%																	
13	1.50	-	-	-	583	-	-377	0	-	-	-	0	-	-	-	-	-
23	2.50	-	-	-	583	-	-377	0	-	-	-	0	-	-	-	-	-
33	3.10	4.8	1	A	1097	.920	-402	2.9	-	-	-	2.5	-	-	-	-	-
43	3.50	4.8	1	A	1097	.920	-381	4.2	-	-	-	2.5	-	-	-	-	-
53	5.00	8.8	2	AB	1789	1.861	-285	11.9	-	-	-	4.6	-	-	-	-	-
63	7.00	17.4	3	ABC	4489	3.822	-200	16.8	-	-	-	9.1	-	-	-	-	-
73	9.00	17.4	3	ABC	4489	3.822	246	23.7	1480	1480	387	9.1	676	67	1309	5232	7284
83	12.00	27.3	4	ABCD	7403	5.281	743	27.9	1927	2280	365	14.2	601	100	2154	8616	11471

* CODE: A B C D E F
0.3 0.1 0.03 0.01 0.003 0.001

TABLE 10-139

ECONOMICS SUMMARY

BASIN Northern Great Plains-Williston — TECHNOLOGY Advanced Case

SUB BASIN 19 — FORMATION Judith River — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
12192 11	1.50	4.8	1	A	1239	.920	-546	0	-	-	-	2.5	-	-	-	-	-
21	2.50	8.8	2	AB	1712	1.861	-597	3.3	-	-	-	4.6	-	-	-	-	-
31	3.10	8.8	2	AB	1712	1.861	-264	5.8	-	-	-	4.6	-	-	-	-	-
41	3.50	8.8	2	AB	1712	1.861	-175	7.3	-	-	-	4.6	-	-	-	-	-
51	5.00	17.4	3	ABC	3655	3.822	449	13.8	1480	1480	387	9.1	676	67	640	2561	3945
61	7.00	27.3	4	ABCD	6963	5.843	1610	18.4	2281	2281	391	14.2	644	107	1279	5114	7144
71	9.00	37.9	5	ABCDE	11987	7.944	3203	21.1	3051	3051	384	19.7	592	145	2200	8800	11737
81	12.00	37.9	5	ABCDE	11987	7.944	6159	31.8	"	"	"	19.7	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	866	-	-524	0	0	0	0	0	0	0	-	-	0
22	2.50	8.8	2	AB	1712	1.861	-512	3.3	"	"	"	4.6	"	"	-	-	"
32	3.10	8.8	2	AB	1712	1.861	-423	5.8	"	"	"	4.6	"	"	-	-	"
42	3.50	8.8	2	AB	1712	1.861	-363	7.3	"	"	"	4.6	"	"	-	-	"
52	5.00	17.4	3	ABC	3655	3.822	-91	13.8	"	"	"	9.1	"	"	-	-	"
62	7.00	17.4	3	ABC	3655	3.822	520	21.2	1480	1480	387	9.1	676	67	640	2561	3945
72	9.00	27.3	4	ABCD	6963	5.843	1406	25.8	2281	2281	391	14.2	644	107	1279	5114	7144
82	12.00	37.9	5	ABCDE	11987	7.944	3194	31.8	3051	3051	384	19.7	592	145	2200	8800	11737
Discount Rate 20%																	
13	1.50	0	0	-	866	-	-530	0	0	0	0	0	0	0	-	-	0
23	2.50	4.8	1	A	1239	.920	-536	0.4	"	"	"	2.5	"	"	-	-	"
33	3.10	8.8	2	AB	1712	1.861	-505	5.8	"	"	"	4.6	"	"	-	-	"
43	3.50	8.8	2	AB	1712	1.861	-462	7.3	"	"	"	4.6	"	"	-	-	"
53	5.00	8.8	2	AB	1712	1.861	-301	12.2	"	"	"	4.6	"	"	-	-	"
63	7.00	17.4	3	ABC	3655	3.822	75	21.2	1480	1480	387	9.1	676	67	640	2561	3945
73	9.00	17.4	3	ABC	3655	3.822	515	27.9	"	"	"	9.1	"	"	"	"	"
83	12.00	27.3	4	ABCD	6963	5.843	1589	36.5	2281	2281	391	14.2	644	107	1279	5114	7144

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 10-140

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 120,000
TYPE: Blanket

NGL(BBL/MMCF): 0.

BASIN: Northern Great Plains-Williston
SUBBASIN: 20
FORMATION: Carlile, Niobrara

DEPTH (FT.): 2050
PRESSURE (PSIA): 770
TEMPERATURE (°F): 95

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	108	13.6	31	719.42	442	0.40	0.30	0.90
0.1	175	11.2	47	1455.50	799	0.40	0.25	0.90
0.03	149	8.8	56	1160.15	692	0.40	0.20	0.90
0.01	119	6.6	65	806.61	617	0.40	0.15	0.90
0.003	184	4.9	70	997.17	904	0.45	0.15	0.90
0.001	10	3.4	75	40.29	26	0.45	0.10	0.90
	745			5179.	3481			

TABLE 10-141

WELL PRODUCTION SUMMARY--BASE CASE

NGP-WILLISTON, CARLILE + NIOBRARA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	213	204	132	85	44	23				
2	158	144	81	49	24	12				
5	122	99	56	30	14	7				
10	101	80	42	23	10	5				
15	87	71	36	19	9	4				
20	78	65	33	17	8	3				
30	62	56	29	15	7	3				
30-YEAR CUMM. PROD. (MMCF)	2876	2415	1314	733	348	169				

TABLE 10-142

WELL PRODUCTION SUMMARY--ADVANCED CASE

NGP-WILLISTON, CARLILE + NIOBRARA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	303	313	265	198	133	77				
2	226	220	195	133	82	45				
5	170	155	138	90	51	27				
10	138	122	107	67	36	19				
15	122	105	92	57	30	15				
20	110	95	83	52	27	13				
30	93	82	71	43	22	11				
30-YEAR CUMM. PROD. (MMCF)	4050	3638	3203	2043	1151	602				

TABLE 10-143

PRODUCTION WELL REQUIREMENTS

BASIN: Northern Great Plains-Williston
SUB-BASIN: 20
FORMATION: Carlile + Niobrara

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.420	1.420	442	1.01	1.01	442
.1	1.888	1.888	799	1.255	1.255	799
.03	3.417	3.417	672	1.409	1.409	672
.01	7.096	4	347	2.539	2.539	617
.003	14.028	4	258	4.269	4.269	904
.001	15.1	4	7	4.264	4.264	26
			2525			3481

TABLE 10-144

INVESTMENT AND OPERATING EXPENSES

BASIN: Northern Great Plains-Williston
SUB-BASIN:
FORMATION: Carlile + Niobrara

Geology and Geophysics ($/Prospect)	75,000
Drilling Cost ($/Well)	64,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 136,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 513,000
Surface Equipment ($/Well)	103,000
Annual Operating Expense ($/Well)	7,200
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0518

TABLE 10-145

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston
SUB BASIN 20
FORMATION Carlile - Niobrara
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
122011	1.50	30.3	4	ABCD	1552	5.726	154	12.6	2260	2530	395	30.3	629	120	293	1173	2215
21	2.50	"	"	"	"	"	842	22.8	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	1254	28.3	"	"	"	"	"	"	"	"	"
41	3.50	40.1	5	ABCDE	2133	6.523	1525	29.2	2518	3434	386	40.1	577	155	449	1795	2977
51	5.00	"	"	"	"	"	2679	41.2	"	"	"	"	"	"	"	"	"
61	7.00	40.5	6	ABCDEF	2161	6.543	4218	54.6	2525	3481	386	40.5	576	156	456	1824	3014
71	9.00	"	"	"	"	"	5761	66.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	8075	80.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	23.1	3	ABC	1268	4.843	-71	13.1	0	0	0	23.1	0	0	0	0	0
22	2.50	30.3	4	ABCD	1552	5.726	367	22.8	2260	2530	395	30.3	629	120	293	1173	2215
32	3.10	"	"	"	"	"	647	28.3	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	835	31.7	"	"	"	"	"	"	"	"	"
52	5.00	40.1	5	ABCDE	2133	6.523	1579	41.2	2518	3434	386	40.1	577	155	449	1795	2977
62	7.00	"	"	"	"	"	2628	54.8	"	"	"	"	"	"	"	"	"
72	9.00	40.5	6	ABCDEF	2161	6.543	3677	66.2	2525	3481	386	40.5	576	156	456	1824	3014
82	12.00	"	"	"	"	"	5254	80.8	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	23.1	3	ABC	1268	4.843	-203	13.1	0	0	0	23.1	0	0	0	0	0
23	2.50	30.3	4	ABCD	1552	5.726	102	22.8	2260	2530	395	30.3	629	120	293	1173	2215
33	3.10	"	"	"	"	"	309	28.3	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	446	31.7	"	"	"	"	"	"	"	"	"
53	5.00	40.1	5	ABCDE	2133	6.523	965	41.2	2518	3434	386	40.1	577	155	449	1795	2977
63	7.00	"	"	"	"	"	1735	54.8	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	2505	66.3	"	"	"	"	"	"	"	"	"
83	12.00	40.5	6	ABCDEF	2161	6.543	3662	80.8	2525	3481	386	40.5	576	156	456	1824	3014

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 10-146

ECONOMICS SUMMARY

BASIN Northern Great Plains - Williston
SUB BASIN
FORMATION Carlile - Niobrara
TECHNOLOGY Advanced
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
12202 11	1.50	30.3	4	ABCD	1819	6.095	133	11.8	2530	2530	415	30.3	662	126	168	673	1628
21	2.50	40.1	5	ABCDE	3226	8.337	1002	19.7	3434	3434	412	40.1	616	165	354	1422	2559
31	3.10	"	"	"	"	"	1628	25.5	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	2046	29.2	"	"	"	"	"	"	"	"	"
51	5.00	40.5	6	ABCDEF	3357	8.434	3620	41.7	3481	3481	413	40.5	616	167	373	1490	2646
61	7.00	"	"	"	"	"	5734	56.8	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	7848	69.8	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	11018	86.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	23.1	3	ABC	1434	4.843	-184	11.0	0	0	0	23.1	0	0	0	0	0
22	2.50	30.3	4	ABCD	1819	6.095	353	21.2	2530	2530	415	30.3	662	126	168	673	1628
32	3.10	40.1	5	ABCDE	3226	8.337	773	25.5	3434	3434	412	40.1	616	165	354	1422	2559
42	3.50	"	"	"	"	"	1060	29.2	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	2136	42.1	"	"	"	"	"	"	"	"	"
62	7.00	40.5	6	ABCDEF	3357	8.434	3589	56.8	3481	3481	413	40.5	"	167	373	1490	2646
72	9.00	"	"	"	"	"	5044	69.8	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	7226	86.7	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	23.1	3	ABC	1434	4.843	-323	11.0	0	0	0	23.1	0	0	0	0	0
23	2.50	30.3	4	ABCD	1819	6.095	55	21.2	2530	2530	415	30.3	662	126	168	673	1628
33	3.10	"	"	"	"	"	285	26.3	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	438	29.6	"	"	"	"	"	"	"	"	"
53	5.00	40.1	5	ABCDE	3226	8.337	1313	42.1	3434	3434	412	40.1	616	165	354	1422	2559
63	7.00	"	"	"	"	"	2374	57.1	"	"	"	"	"	"	"	"	"
73	9.00	40.5	6	ABCDEF	3357	8.434	3456	69.8	3481	3481	413	40.5	"	167	373	1490	2646
83	12.00	"	"	"	"	"	5069	86.7	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

Chapter Eleven

GREATER GREEN RIVER BASIN

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Chapter Eleven

GREATER GREEN RIVER BASIN

GEOLOGY

General Description

The Greater Green River Basin is a geologically defined area in southwestern Wyoming and northwestern Colorado with a surface area of approximately 23,000 square miles. Cretaceous and Tertiary rocks, which contain tight gas reservoirs, occupy approximately 20,000 square miles, have an average thickness of 15,000 feet, and have a rock volume of 56,000 cubic miles.

The basin is bounded on the west by the Thrust Belt; on the north by the Wind River and Sweetwater uplifts; on th east by the Rawlins, Sierra Madre, and Park Range uplifts; and on the south by the Uinta uplift and its southeastern extension, the Axial fold belt in Colorado. The basin is divided into sub-basins and intervening uplifts, some of which are recognized only in the subsurface. In the west is the Moxa arch and Bridger basin (also known together as the Green River basin in a restricted sense); in the center is the Rock Springs uplift; in the east, from north to south, is the Red Desert (Great Divide) basin, Wamsutter arch, Washakie basin, Cherokee ridge, and Sand Wash basin.

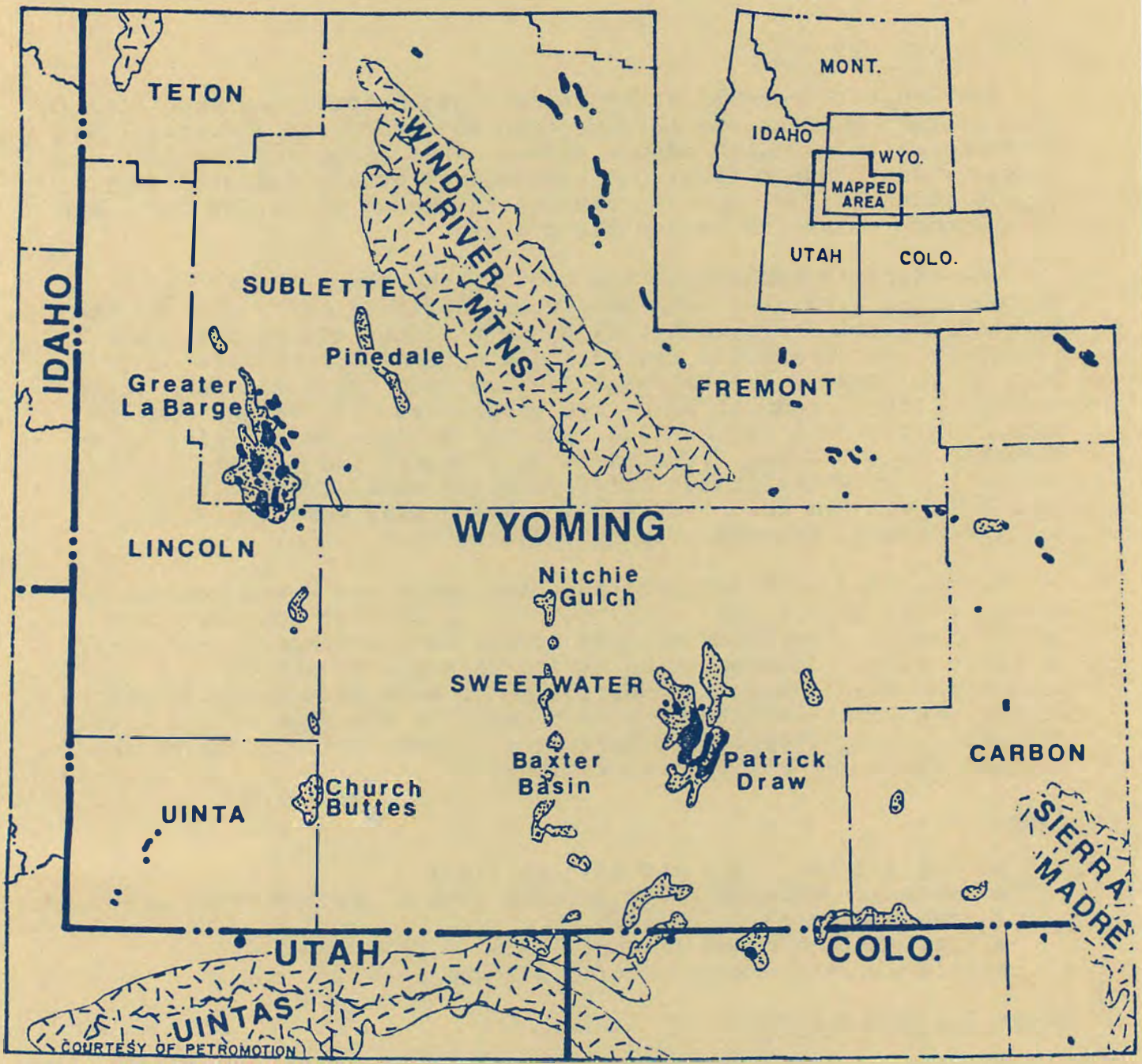
During most of Paleozoic time, the basin was characterized by marine shelf deposition. It acquired its present configuration mainly from the Laramide orogeny during late Cretaceous and early Tertiary time. Sedimentation during this period was chiefly non-marine and resulted in the deposition of much lenticular sandstone with significant amounts of clay present in the rock matrix. This is particularly true of the Mesaverde section which contains the bulk of the tight gas sand formations.

Maps

- Oil and gas field map (Figure 11-1)
- Base map showing basin outline with bordering structures and sub-basins (Figure 11-2)
- Correlation chart (Figure 11-3)
- Diagrammatic cross-section (Figure 11-4).

Tight Gas Formations

Formations containing tight gas sands are the late Cretaceous Mesaverde (sometimes sub-divided into Blair, Rock Springs, Ericson, and Almond), Lewis and Lance, and the Tertiary Fort Union. With the exception of the marine blanket sands in the very upper part of the Almond, these are fluvial lenticular sandstones with much clay filling. Also present in part of the western portion of the basin are the Cretaceous Frontier sands which are blanket and marine.



GREATER GREEN RIVER BASIN, WYOMING

Figure 11-1. Greater Green River Basin, Wyoming -- Oil and Gas Fields.

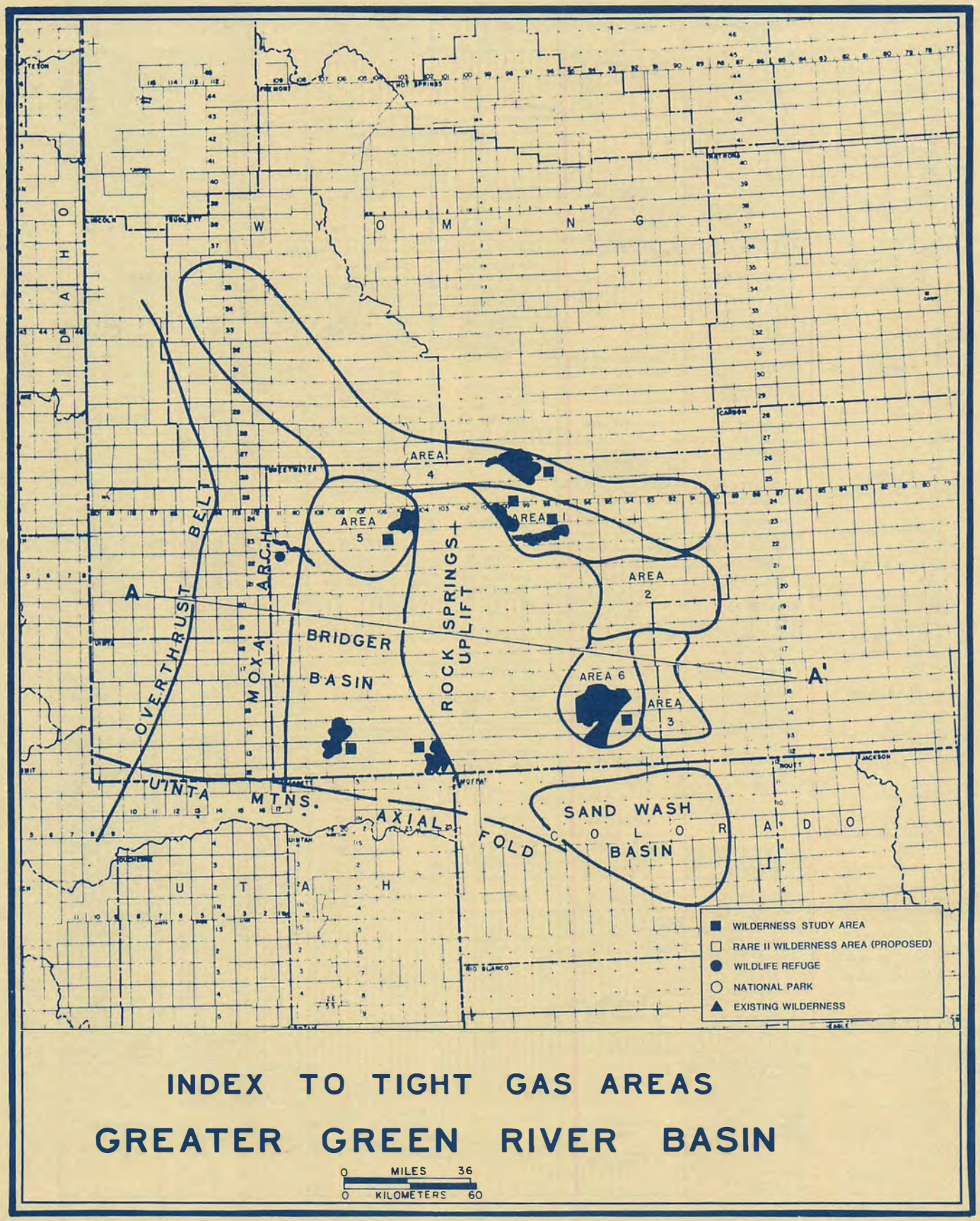
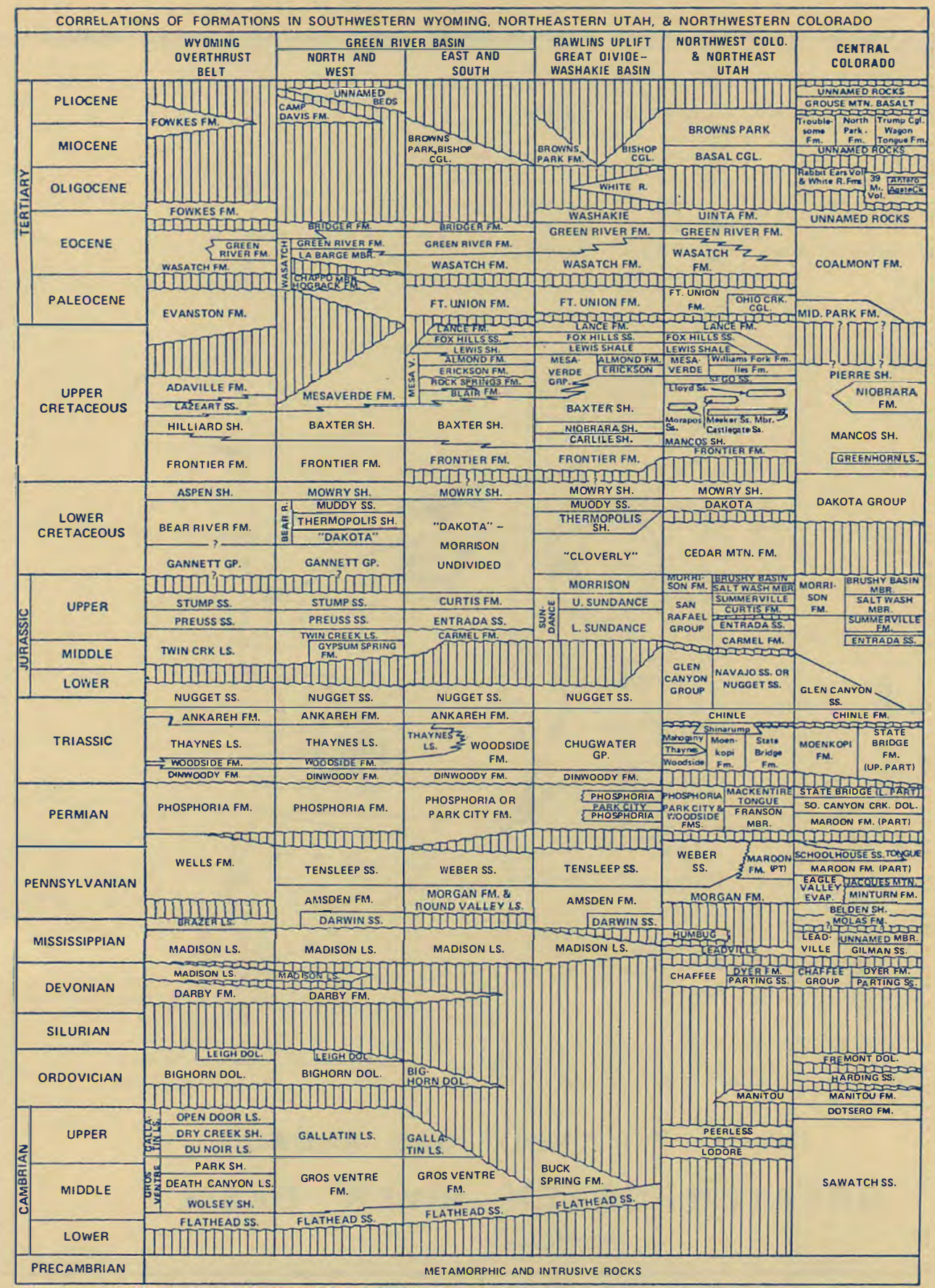


Figure 11-2. Index to Tight Gas Areas -- Greater Green River Basin.



Compiled by Richard N. Walker and G. J. Wiloth.

SOURCE OF DATA: RMAG GUIDEBOOK TO THE ENERGY RESOURCES OF THE PICEANCE CREEK BASIN, COLO., 1974; WGA SYMPOSIUM ON TERTIARY ROCKS OF WYOMING, 1969.

Figure 11-3. Stratigraphic Correlation Chart.

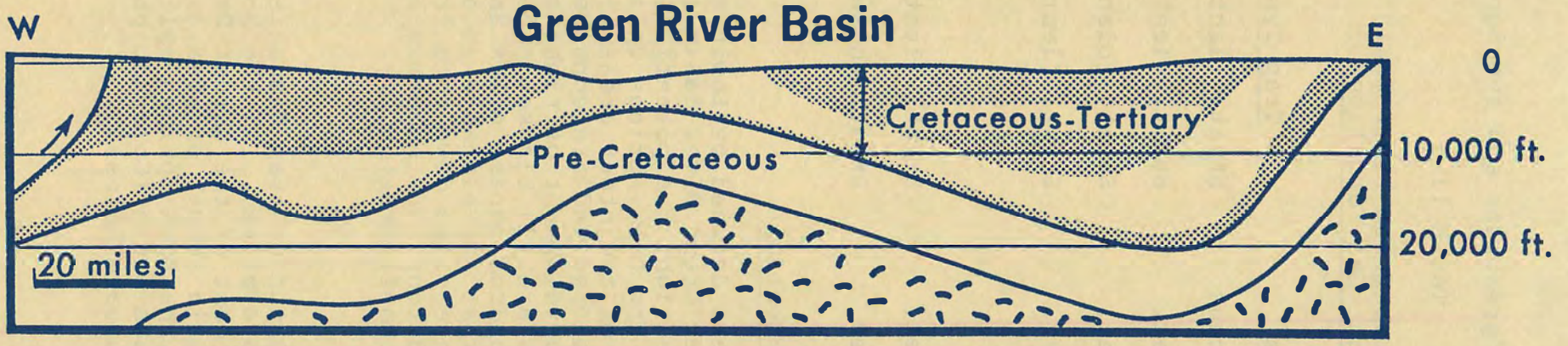


Figure 11-4. Diagrammatic Cross Section -- Green River Basin.

Table 11-1 lists the formations and average depths.

TABLE 11-1

Greater Green River Basin
Tight Gas Formations

Formation	Age	Trap Type	Depth
Fort Union	Paleocene	Strat. (lenticular)	7,500
Lance & Lewis	U. Cret.	Strat. (lenticular)	9,000
Almond A	U. Cret.	Strat. (blanket)	9,500
Almond B	U. Cret.	Strat. (lenticular)	10,000
Erickson, Rock Springs, Blair, & other Lower Mesaverde	U. Cret.	Strat. (lenticular)	12,000
Frontier	U. Cret	Strat. (blanket)	14,000

Analysis of Hydrocarbon Potential

Physical parameters were defined by Lewin and Associates (1978) for portions of the Greater Green River basin (3,400 square miles) that have the most obvious tight gas potential, have been incorporated into our analysis. The Rock Springs uplift, the western Wamsutter arch, and parts of the other areas have been excluded because they are well developed and are considered to have little additional potential for development of tight gas reservoirs. The tight gas-containing rocks are (1) blanket sandstones that can occupy areas of several hundred square miles and (2) lenticular (lens-shaped) sandstones that are elongate in outline and occupy areas of five or more square miles down to a fraction of a square mile. The lenticular sandstones are numerous and may overlap in a complex three-dimensional configuration.

Areas Analyzed

Areas studied, are (1) the central Washakie basin (area 6 of the Lewin report, 600 square miles), (2) the Moxa arch and the area west of the Moxa arch and east of the Thrust Belt (1,800 square miles), (3) the Bridger basin (south of area 4 of the Lewin report, between the Moxa arch and the Rock Springs uplift, 2,700 square miles) and (4) the Sand Wash basin (Colorado part of the Greater Green River basin, 1,500 square miles).

Washakie Basin. Tight blanket-sandstone reservoirs (Almond A and Frontier) in the central Washakie basin contain an estimated 13 trillion cubic feet (TCF) and lenticular sandstone reservoirs contain an estimated 20 TCF of gas in place, a total of 33 TCF.

The greatest undeveloped gas potential is believed to be in the Cretaceous Mesaverde Group sandstones. Additional gas is present in the Lewis, Lance, and Fort Union formations at shallower depths than the Mesaverde. The Mesaverde Group is untested in the deeper parts of the Washakie basin (as well as in the deeper parts of the Red Desert basin), but it is believed to have greater potential than the areas of recent drilling around the basin edges and on the Wamsutter arch for the following reasons: (1) more favorable reservoir rock trends, (2) higher reservoir pressures, (3) higher temperatures to generate gas from associated coals and carbonaceous shales and (4) more intense natural fracturing to enhance sandstone productivity.

Moxa Arch. The Moxa Arch is a north-south trending structural feature, approximately 80 miles long. On the arch, and in the area between the arch and the Thrust Belt, lenticular sandstones contain an estimated 25 TCF of gas in place, but it is expected that very little of this is commercially recoverable. In contrast to this low expectation, deeper Cretaceous (tight sandstones in the Frontier formation) and pre-Cretaceous rocks are undergoing extensive exploration and development along the arch and therefore are not considered further in our analysis.

Bridger Basin. The Bridger basin is an area of very little past exploration.

Lenticular sandstones in Cretaceous and Tertiary formations are estimated to contain 54 TCF of gas in place but only little economically-recoverable gas.

Sand Wash Basin. Gas in place in lenticular Cretaceous sandstones of the Sand Wash basin is estimated to be approximately 38 TCF. Again, probably very little of this is economically recoverable.

Reservoir data from the Lewin report were input into a single-well simulator that includes the effects of a hydraulic fracture to compute production rate versus time. As a general rule, permeability decreased with depth and net pay was usually decreased with increasing permeability; i.e., there exists more poor reservoir than good. Permeability-porosity relationships were taken from the Lewin data, or from general curves based on those data.

In the case of lenticular sands, estimates were made of the sand/shale ratio, or percent of gross objective section that is sandstone. This is important because lenticular sands in a very sandy section begin to behave similarly to blanket sands in terms of post-fracturing deliverability.

Results of well response (per well production yield) were incorporated in the exploration simulator algorithm with geologic judgments regarding wildcat success ratio and estimated percent of each sub-basin that would ultimately produce.

According to their geographic distribution, some reservoirs were "stacked;" that is, it was assumed that more than one formation may produce from one well if the pressures are not too dissimilar.

Exploration History

The Green River basin has produced gas for many years, earlier drilling being concentrated on structural anomalies, whereas more recent drilling was both for structural and stratigraphic traps. During the years 1970 through 1977, 450 exploratory wells resulted in 102 gas discoveries yielding 570 BCF or 5.6 BCF/wildcat successful well. Gas wildcat success increased from 11.9 percent for 1960-1969 to 22.7 percent for 1970-1977. For the same two time periods gas well depth increased from 6,570 to 10,850 feet. During the middle and late 1970's, much emphasis was shifted to low permeability tight gas sands, particularly in the eastern part of the basin where intense development is now occurring in limited areas. In the relatively unexplored areas, a somewhat better success ratio was assumed than has occurred in the past, reasoning that many wells with marginal reservoirs that were formerly plugged would be completed in the future due to advance technology and higher gas price.

Characteristics of Traps and Reservoirs

Trapping is conceived to be stratigraphic, occasionally controlled by up-dip changes from sand to shale, but chiefly determined by variations in peremability. Quality of production will depend on the amount of gas generated, net feet of pay, and porosity and permeability of the pay as well as other reservoir parameters. Much of the gas is at considerable depths, which greatly increases finding and development costs, but which carries its own reward in the form of greater pressure and temperature.

In these reservoirs, the permeability is adversely affected by the ubiquitous clay-filling and by the fact that the porosity is not always inter-granular but is often found in isolated pores that are connected by long thin pore-throats.

PRODUCTION

The general location map, Figure 11-1, shows the basin extending over a four-state area with the majority of the productive area in Wyoming. The various productive subbasins are shown in Figure 11-2 as are existing wilderness, national parks, wildlife refuges, proposed RARE II Wilderness Area, and proposed wilderness study area. All of these areas in Wyoming will limit the amount of tight

gas available for development. The potential gas-bearing rocks of the basin, the six subbasins and their various formations which comprise the Greater Green River basin, and the number of productive sections in each formation and the maximum recoverable gas are given in Table 11-3. Of the 86.5 TCF maximum recoverable gas in the Greater Green River basin, 36 percent (31.2 TCF) is available in Lewin Area 2 & 3. Within this subbasin, 42.5 percent (13.3 TCF) is contained in the Ericson, Rock Springs, Blair formation. The second largest maximum recoverable gas-containing formation is the Almond B stacked with the Ericson, Rock Springs, Blair. The stack will yield 7.2 TCF. This gas is contained in 416 sections, while the Ericson, Rock Springs, Blair formation gas is distributed over 1,142 sections. The average producing depths of the formations range from 7,500 feet for the Fort Union to 14,000 feet for the Frontier. The majority of the formations within the six subbasins have greater than 1.2 TCF maximum recoverable gas. The lowest yield of tight gas comes from the Almond formation in the Washakie subbasin (0.6 TCF). All other formations yield at least twice that amount.

The amount of gas potential as a function of price and level of technology is summarized in Table 11-4 for the various formations comprising the six subbasins. Three price levels ($2.50, $5.00, and $9.00) are given for base and advanced technology. Table 11-4 shows that the maximum gas potential for the Greater Green River basin using base technology is 46.2 TCF at a price of $9.00/MCF. The gas potential is reduced 33 percent to 30.8 TCF at $5.00/MCF and 93 percent at $2.50 to 3.1 TCF. Advanced technology together with a $9.00/MCF price will produce 74.4 (or 86 percent) of the 86.5 TCF maximum recoverable gas in the basin. Advanced technology substantially increases the amount of gas recovered at all price levels. At $2.50/MCF, approximately three times more gas is produced with advanced technology than with base technology. The incremental gas at $2.50 comes from the Frontier formation in subbasin W/2 Lewin 4, Bridger, Lewin 5 (3.4 TCF) and by stacking together the Almond A with Ericson, Rock Springs, Blair formations in the Lewin Area 1 subbasin (1.7 TCF). Likewise, stacking together the Lower Mesaverde with the Almond in Washakie subbasin adds 1.2 TCF at $2.50 using advanced technology. Doubling the price from $2.50/MCF to $5.00/MCF and using only base technology substantially increases (by a factor of 8.4) the gas potential of the basin, but still leaves 65 percent of the maximum recoverable gas in the ground.

Begining with Table 11-5 and continuing through Table 11-235, the tables are organized into 33 sets of seven tables each. Contained in each set are tables of geological data, gas production in MMCF per year per well over a 30-year period for both base and advanced technology, the number of wells required to produce the formation at the two technology levels, investment and operating expenses necessary for the specific formation in the particular subbasin, and the economic summaries for base and advanced technology.

TABLE 11-2

EXPLORATION PERFORMANCE - Green River Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	79	65	14	126	111	15	205	176	29
Gas	51	43	8	102	92	10	153	135	18
Oil	25	19	6	22	18	4	47	37	10
Oil and Gas	3	3	0	2	1	1	5	4	1
Amount of Petroleum Found									
Total, MMBOE **	148.1	111.1	37.0	505.9	226.5	279.4	654.0	337.6	316.4
Gas, BCF	629.7	321.0	308.7	570.0	483.2	86.8	1199.7	804.2	395.5
Oil, MM Bbls.	25.0	22.9	2.1	10.9	10.6	0.3	35.9	33.5	2.4
Number of Wildcat Wells									
Total	663	632	31	556	531	25	1219.0	1163.	56
Gas *	428	408	20	450	430	20	878	838	40
Oil *	210	200	10	97	93	4	307	293	14
Oil and Gas	25	24	1	9	8	1	34	32	2
Number of Wildcats/Year	66	63	3	69	66	3	68	65	3
Percent Wildcats Successful									
Total	11.9	10.3	45.2	22.7	20.9	60.0	16.8	15.1	51.8
Gas	11.9	10.5	40.0	22.7	21.4	50.0	17.4	16.1	45.0
Oil	11.9	9.5	60.0	22.7	19.4	100.0	15.3	12.6	71.4
Oil and Gas	12.0	12.5	0	22.2	12.5	100.0	14.7	12.5	50.0
Amount Found/Successful Wildcat									
Total, MMBOEE	1.9	1.7	2.6	4.0	2.0	18.6	3.2	1.9	10.9
Gas, BCF	12.3	7.5	38.6	5.6	5.3	8.7	7.8	6.0	22.0
Oil, MM Bbls	1.0	1.2	0.4	0.5	0.6	0.1	0.8	0.9	0.2
Average Depth of Wells, M ft.									
Oil	5.10	5.63	3.42	9.92	9.94	9.85	7.36	7.73	5.99
Gas	6.57	6.09	9.18	10.85	10.57	13.34	9.42	9.14	11.52

* Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

TABLE 11-3

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
Greater Green River	Lewin Area 1	Almond A	51	307
		Ericson, Rock Sprgs., Blair	276	3,180
		Fort Union	191	1,701
		Almond A + Almond B	90	1,156
		Almond A + Ericson, R/S, Blair	85	1,854
		Almond B + Ericson, R/S, Blair	215	3,855
		Lance and Lewis	267	1,787
	Sub-Basin Total		1,175	13,840
	Lewin Area 2 & 3	Almond A	436	1,465
		Almond B	228	1,247
		Ericson, R/S, Blair	1,142	13,301
		Fort Union	142	1,226
		Almond A + Almond B	187	1,687
		Almond B + Ericson, R/S, Blair	416	7,214
		Lance and Lewis	727	5,092
	Sub-Basin Total		3,278	31,232
	Washakie	Almond	27	159
		Lance - Lewis	192	1,823
		Lower Mesa Verde	285	4,401
		Lance-Lewis + Almond	48	735
		Lower Mesa Verde + Almond	75	1,608
	Sub-Basin Total		627	8,726
	E/2 Lewin Area 4	Mesa Verde	305	4,290
		Fort Union	178	2,298
		Fort Union + Mesa Verde	34	918
	Sub-Basin Total		517	7,506

(continued)

TABLE 11-3 (Continued)

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
	W/2 Lewin 4, Bridger Lewin 5	Fort Union	321	2,877
		Mesa Verde Lance	1,104	7,544
		Frontier	783	4,921
		Mesa Verde-Lance + Frontier	138	1,809
		Ft.Union + Mesa Verde-Lance	138	2,177
	Sub-Basin Total		2,484	19,328
Greater Green River	Sandwash	Lewis 7000	237	925
		Lewis 9000	263	1,304
		Mesa Verde 9000	143	1,307
		Mesa Verde 11000	169	1,648
		Lewis 7000 + Mesa Verde 9000	26	344
		Mesa Verde 9000 + Mesa Verde 11000	19	357
	Sub-Basin Total		857	5,885
Basin Total			8,938	86,517

TABLE 11-4

SUMMARY OF GREATER GREEN RIVER BASIN GAS POTENTIAL
(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Greater Green River	Lewin Area 1	Almond A	225	286	294	291	307	307
		Ericson, Rock Sprgs., Blair	0	0	1202	0	1609	2090
		Fort Union	0	729	783	0	1475	1670
		Almond A + Almond B	1059	1092	1092	1156	1156	1156
		Almond A + Ericson, R/S, Blair	0	1204	1204	1664	1854	1854
		Almond B + Ericson, R/S, Blair	0	1856	2090	0	3148	3839
		Lance and Lewis	0	992	1102	0	1389	1787
	Sub-Basin Total		1284	6159	7767	3111	10938	12703
	Lewin Area 2 & 3	Almond A	0	709	1231	1101	1326	1465
		Almond B	0	770	838	0	975	1156
		Ericson, R/S, Blair	0	4085	5046	0	6700	9164
		Fort Union	0	540	578	0	1078	1207
		Almond A + Almond B	1349	1660	1660	1687	1687	1687
		Almond B + Ericson, R/S, Blair	0	3358	3740	0	5952	7214
		Lance and Lewis	0	2699	2998	0	4404	4717
	Sub-Basin Total		1349	13821	16091	2788	22122	26610
	Washakie	Almond	0	139	154	159	159	159
		Lance - Lewis	0	623	762	0	463	1509
		Lower Mesa Verde	0	0	1737	0	0	3176
		Lance-Lewis + Almond	443	651	651	735	735	735
		Lower Mesa Verde + Almond	0	1307	1369	1194	1608	1608
	Sub-Basin Total		443	2720	4673	2088	2965	7187
	E/2 Lewin Area 4	Mesa Verde	0	0	1832	0	1235	3942
		Fort Union	0	688	886	0	1367	2070
		Fort Union + Mesa Verde	0	368	385	0	858	917
	Sub-Basin Total		0	1056	3103	0	3460	6929

(continued)

TABLE 11-4 (Continued)

BASIN	SUB-BASIN	FORMATION	BASE $2.50	BASE $5.00	BASE $9.00	ADVANCED $2.50	ADVANCED $5.00	ADVANCED $9.00
	W/2 Lewin 4, Bridger Lewin 5	Fort Union	0	0	978	0	1695	2489
		Mesa Verde Lance	0	0	3425	0	0	5004
		Frontier	0	3439	4349	3439	4737	4737
		Mesa Verde-Lance + Frontier	0	1237	1622	0	1809	1809
		Ft.Union + Mesa Verde-Lance	0	722	937	0	1454	2067
	Sub-Basin Total		0	5398	11311	3439	9695	16106
Greater Green River	Sandwash	Lewis 7000	0	674	752	925	925	925
		Lewis 9000	0	721	900	0	1304	1304
		Mesa Verde 9000	0	0	505	0	0	848
		Mesa Verde 11000	0	0	670	0	0	1092
		Lewis 7000 + Mesa Verde 9000	0	205	225	0	335	344
		Mesa Verde 9000 + Mesa Verde 11000	0	0	159	0	256	329
	Sub-Basin Total		0	1600	3211	925	2820	4842
Basin Total			3076	30754	46156	12351	52000	74377

A feel for the information contained in each of the 33 sets of tables can best be appreciated using the Almond A formation in subbasin Lewin 1 (Tables 11-5 through 11-11) as an example. Table 11-5 lists the geological data used in the production program to obtain the gas production for the six permeability levels ranging from 0.3 md to 0.001 md and shown in Table 11-6 in MMCF per year per well along with the 30-year cumulative production for each permeability level. Table 11-7 gives the same information as Table 11-6, but for advanced technology, which uses 4,000-foot fracture rather than the 1,000-foot radius used in base technology. Table 11-6 shows that the second highest permeability level (0.1 md) has the highest initial production level (548 MMCF per year) as well as the highest level during its second year, but it falls behind the production from the 0.03 md and 0.01 md permeability levels during the fifth year. After the 15th year it is less than the lowest permeability level (0.001 md). The highest cumulative production over the 30 years comes from the 0.03 md permeability level for base and advanced technology (2.6 BCF and 11.4 BCF, respectively). Although the highest permeabilities have the highest initial production rates, in general, they also have the highest decline rates. In the advanced case for the Almond A formation in subbasin Lewin Area 1 (Table 11-7), permeability level 0.03 md is a notable exception. It has the highest initial rate (1.1 BCF per year) and it also has the highest rate after 30 years' production (244 MMCF per year).

The total gas recovered from the Almond A using base and advanced technology is given in Table 11-8 along with the number of wells required per section at the six permeability levels. For permeabilities of 0.03 md or less, half as many wells per section will produce more gas using advanced technology than can be produced with base technology.

ECONOMICS

The basic geologic and production data are used with the economic simulator model to generate the necessary investment and the rates of return on investment from costs and risks associated with finding and producing tight gas from the two blanket sands and four lenticular sands of the basin. Each formation in each of the six subbasins is produced separately in the model; when geology and good completion practices permit, wells are also completed in two formations. This "stacking" practice was done in all six of the subbasins. They are listed in Table 11-3 along with the maximum recoverable gas.

The amount of tight gas production from the various formations and subbasins is dependent upon gas price and the level of technology employed to recover the gas. This is shown dramatically in Table 11-4 for single formation completions as well as several dual formation (stacking) completions. An example of what stacking can provide is illustrated in Table 11-4 by the Washakie subbasin, Almond and Lower Mesaverde formations. Using base case technology,

TABLE II-5

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: Lewin I
FORMATION: Almond A

DEPTH (FT.): 10,000
PRESSURE (PSIA): 6,200
TEMPERATURE (°F): 215

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	2	5.6	7	7.78	6	0.50	1.0	-
0.1	6	4.7	12	33.66	28	0.60	1.0	-
0.03	16	4.0	20	127.36	93	0.75	1.0	-
0.01	15	3.6	27	145.05	98	0.80	1.0	-
0.003	9	3.4	35	106.65	66	0.85	1.0	-
0.001	2	3.2	35	22.28	16	0.85	1.0	-
	51			443.	307			

TABLE 11-6

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND A

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	536	548	453	323	207	110				
2	260	309	278	194	120	62				
5	78	125	151	122	77	39				
10	22	49	81	80	57	29				
15	9	26	50	60	47	24				
20	6	12	36	46	40	21				
30	4	5	19	30	31	18				
30-YEAR CUMM. PROD. (MMCF)	1488	2046	2584	2388	1732	907				

TABLE 11-7

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND A

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	694	816	1102	881	686	393				
2	273	380	728	546	387	215				
5	60	110	496	350	236	126				
10	11	30	379	264	173	89				
15	3	10	323	226	143	77				
20	2	2	290	201	130	67				
30	1	0	244	172	108	55				
30-YEAR CUMM. PROD. (MMCF)	1442	2061	11439	8189	5469	2921				

TABLE 11-8

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Almond A

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	2.13	2.13	6	2.11	2.11	6
.1	2.11	2.11	28	2.09	2.09	28
.03	2.23	2.23	93	.519	.519	93
.01	2.75	2.75	98	.802	.802	98
.003	4.33	4	61	1.37	1.37	66
.001	7.78	4	8	2.4	2.4	16
			294			307

TABLE 11-9

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Almond A

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	923,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	108,540
- Advanced Case [2000/4000 Ft. Fracture]	138,000 - 356,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-10

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Lewin Area 1
FORMATION Almond A
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0801111	1.50	24.1	1	C	3530	-	-120	8.4	-	-	-	24.1	-	-	-	-	-
21	2.50	57.7	4	ABCO	6955	11.108	2659	31.8	225	225	20	57.7	8	12	21	84	125
31	3.10	72.4	5	ABCDE	8915	14.228	4630	41.6	286	291	"	72.4	6	14	28	112	160
41	3.50	"	"	"	"	"	5748	49.6	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	9940	78.5	"	"	"	"	"	"	"	"	"
61	7.00	76.2	6	ABCOEF	9362	14.649	15730	111.4	294	307	20	76.2	5	15	31	124	175
71	9.00	"	"	"	"	"	21435	141.0	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	29992	178.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1215	-	-690	0	-	-	-	-	-	-	-	-	-
22	2.50	57.7	4	ABCD	6955	11.108	1511	31.8	225	225	20	57.7	8	12	21	84	125
32	3.10	"	"	"	"	"	2558	43.6	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	3256	51.3	"	"	"	"	"	"	"	"	"
52	5.00	72.4	5	ABCDE	8915	14.228	6719	78.5	286	291	"	72.4	6	14	28	112	160
62	7.00	76.2	6	ABCDEF	9362	14.649	10933	111.4	294	307	"	76.2	5	15	31	124	175
72	9.00	"	"	"	"	"	15120	141.0	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	21401	178.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1215	-	-690	0	-	-	-	-	-	-	-	-	-
23	2.50	33.4	3	ABC	4760	6.711	426	28.0	127	127	19	33.4	13	6	13	51	83
33	3.10	57.7	4	ABCD	6955	11.108	1637	43.6	225	225	29	57.7	"	12	21	84	125
43	3.50	"	"	"	"	"	2181	51.3	"	"	"	"	"	"	"	"	"
53	5.00	72.4	5	ABCDE	8915	14.228	4762	78.5	286	291	"	72.4	6	14	28	112	160
63	7.00	"	"	"	"	"	7936	112.4	"	"	"	"	"	"	"	"	"
73	9.00	76.2	6	ABCDEF	9362	14.649	11231	141.0	294	307	"	76.2	5	15	31	124	175
83	12.00	"	"	"	"	"	16083	178.9	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 11-11

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Lewin Area 1
FORMATION Almond A
TECHNOLOGY Advance
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0801211	1.50	70.2	4	BCDE	3912	13.686	2012	32.2	285	285	21	70.2	7	14	9	33	63
21	2.50	76.2	6	ABCDEF	4703	14.869	4977	62.9	307	307	21	76.2	6	15	11	44	76
31	3.10	"	"	"	"	"	6717	80.8	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	7878	92.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	12228	130.8	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	18029	175.1	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	23830	213.6	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	32531	264.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	63.1	3	CDE	3137	12.457	973	30.3	257	257	21	63.1	8	13	5	21	47
22	2.50	72.4	5	ABCDE	4399	14.213	3219	63.0	291	291	20	72.4	5	15	9	39	68
32	3.10	76.2	6	ABCDEF	4703	14.869	4599	80.8	307	307	21	76.2	6	"	11	44	76
42	3.50	"	"	"	"	"	5459	92.1	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	8686	130.8	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	12989	175.1	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	17291	213.6	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	23745	264.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	48.4	2	CD	2407	9.347	297	26.7	191	191	20	48.4	11	9	3	12	34
23	2.50	72.4	5	ABCDE	4399	14.213	2253	63.0	291	291	"	72.4	5	15	9	39	68
33	3.10	76.2	6	ABCDEF	4703	14.869	3320	80.8	307	307	21	76.2	6	15	11	44	76
43	3.50	"	"	"	"	"	3995	92.1	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	6526	130.8	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	9901	175.1	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	13276	213.6	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	18339	264.2	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

27 sections of the Almond formation produces 139 BCF of gas at $5.00/MCF and a 15 percent discount rate, or about 5 BCF/per section. The lower Mesaverde is uneconomic at this price and discount rate. However, when these two formations are produced together they yield 1,307 BCF from 75 sections, or 17 BCF per section.

The investment and operating expenses for the Almond A formation in Lewin Area 1 subbasin are given in Table 11-9. Investment and operating expenses for other formations in Lewin Area 1 and the other five subbasins are distributed throughout the tables between Table 11-11 and Table 11-235. The major difference in various tables is in drilling and fracturing costs. Drilling costs vary directly with formation depth while fracturing costs vary with fracture length and height (base vs. advanced technology) as well as with formation depth. The fracture length and height determine the volume of frac fluid required and the amount of propping agent, all of which are directly related to cost.

The economic summaries for the various singularly completed formations as well as the stacked formations in the six subbasins appear between Tables 11-10 and 11-235. Table 11-10 is an economic summary of the Almond A formation in Lewin Area 1 subbasin using base case technology. This table and all other economic summary tables give three sets of data, corresponding to discount rates of 10, 15, and 20 percent. In each data set there are eight gas price levels, ranging from $1.50/MCF to $12.00/MCF. Case Number 0301131, Table 11-10, uses base case technology at $3.10/MCF and a 10 percent DCF ROR. If the entire productive area is drilled at $3.10/MCF, 72.4 percent of the prospects will be profitable. Of the six permeability levels in the formation, five (0.3 md to 0.003 md) will produce at a profit. The average exploration and production investment per prospect requires $8.915 million, which will given a net present value at a 10 percent discount rate of $4.63 million. The DCF ROR would be 41.6 percent. This level of investment would produce 14.23 BCF of gas per prospect. Interestingly, even though a well drilled in the 0.001 md permeability zone would produce nearly 1 BCF of gas over a 30-year period, it does not become profitable until a price of $7.00/MCF is attained at both 10 and 15 percent discount rates.

The 20 prospects (72.4 percent profitable) will produce 286 BCF of the 291 BCF maximum recoverable gas in place at $3.10/MCF price. A total of 160 wells will be required, of which 126 wells will be productive (14 wildcat wells and 112 development wells) and 34 dry (6 wildcat wells and 28 development wells).

The 15 and 20 percent discount rates are similar to the 10 percent rate. All of the permeability levels are brought on stream at a price of $7.00/MCF at discount rates of 10 and 15 percent, but a price of $9.00/MCF is required at a 20 percent discount rate. A minimum price of $2.50/MCF is required to turn a profit in the net present value column of Table 11-10.

The economic summary for advanced case technology is given in Table 11-11 and is interpreted in the same manner. Although significantly more gas is not recovered at the various price levels and discount rates for this particular formation, the investment required for exploration and production per prospect is considerably less ($4.7 million using advanced technology as opposed to $8.9 million for base technology in Case Numbers 0801231 and 0801131, respectively). Also, all of the maximum recoverable gas in place is produced much more efficiently using only 76 total wells rather than the 160 wells required with base technology.

If 4,000-foot radius fractures are attainable and 12 wells per section spacing is made possible, the Almond A formation in the Lewin Area 1 subbasin would be profitable at a price level of $1.50/MCF even at a discount rate of 20 percent.

Figures 11-5 through 11-10 show in graph form the various field size distributions for the five subbasins of the Greater Green River basin.

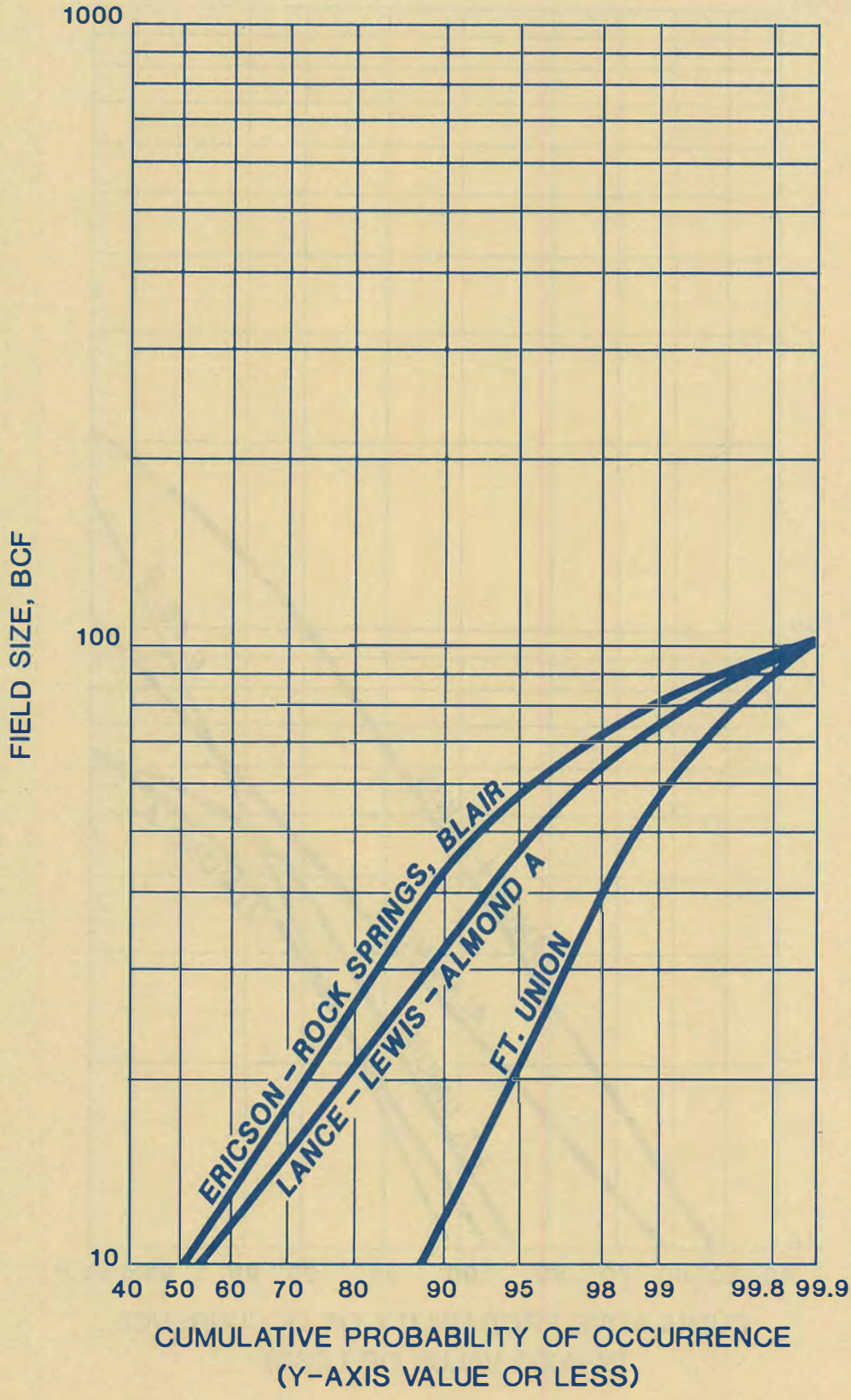


Figure 11-5. Field Size Distribution of Producible Gas, Lewin Area 1, Greater Green River.

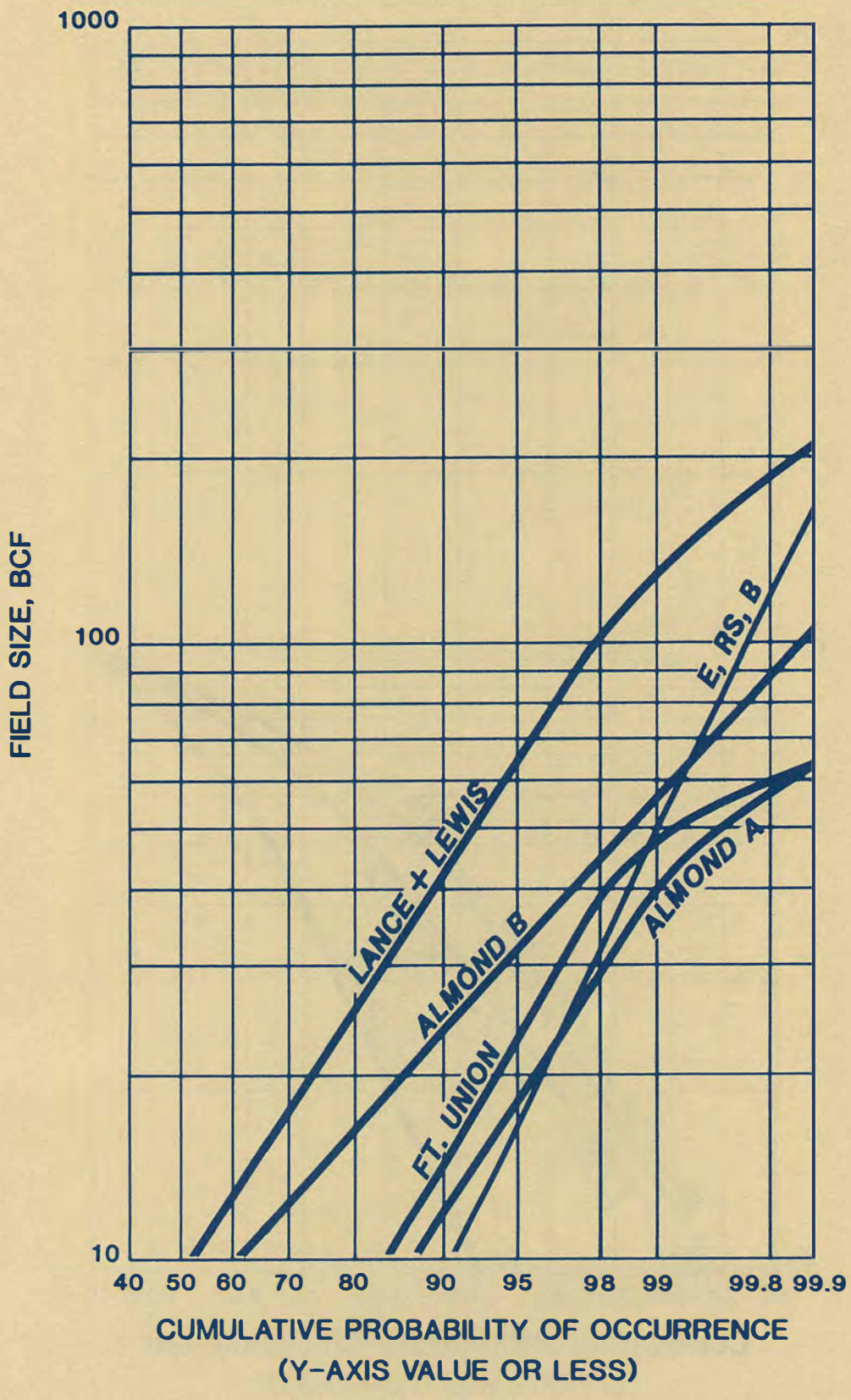


Figure 11-6. Field Size Distribution of Producible Gas, Lewin Areas 2 and 3, Greater Green River.

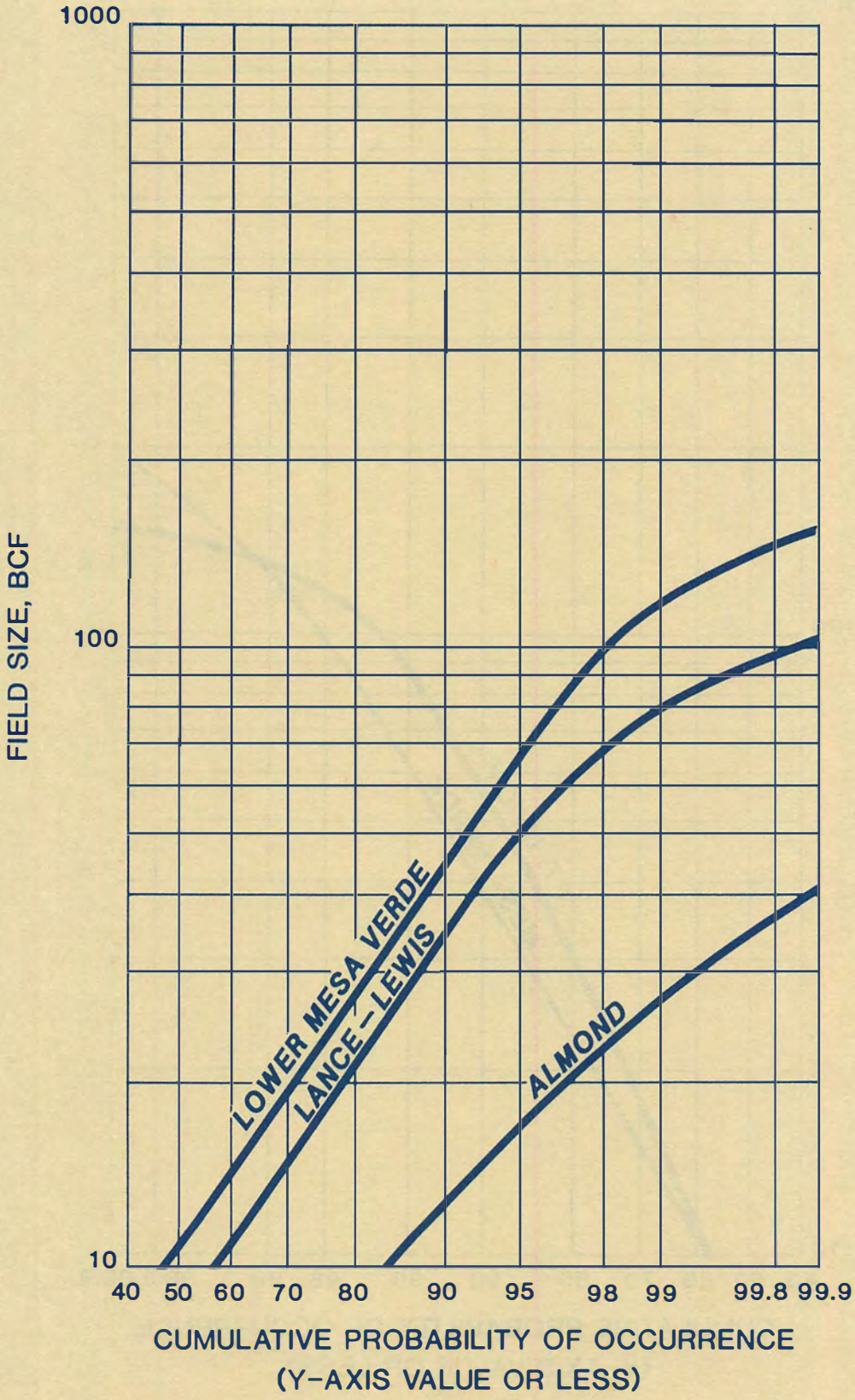


Figure 11-7. Field Size Distribution of Producible Gas, Washakie, Greater Green River.

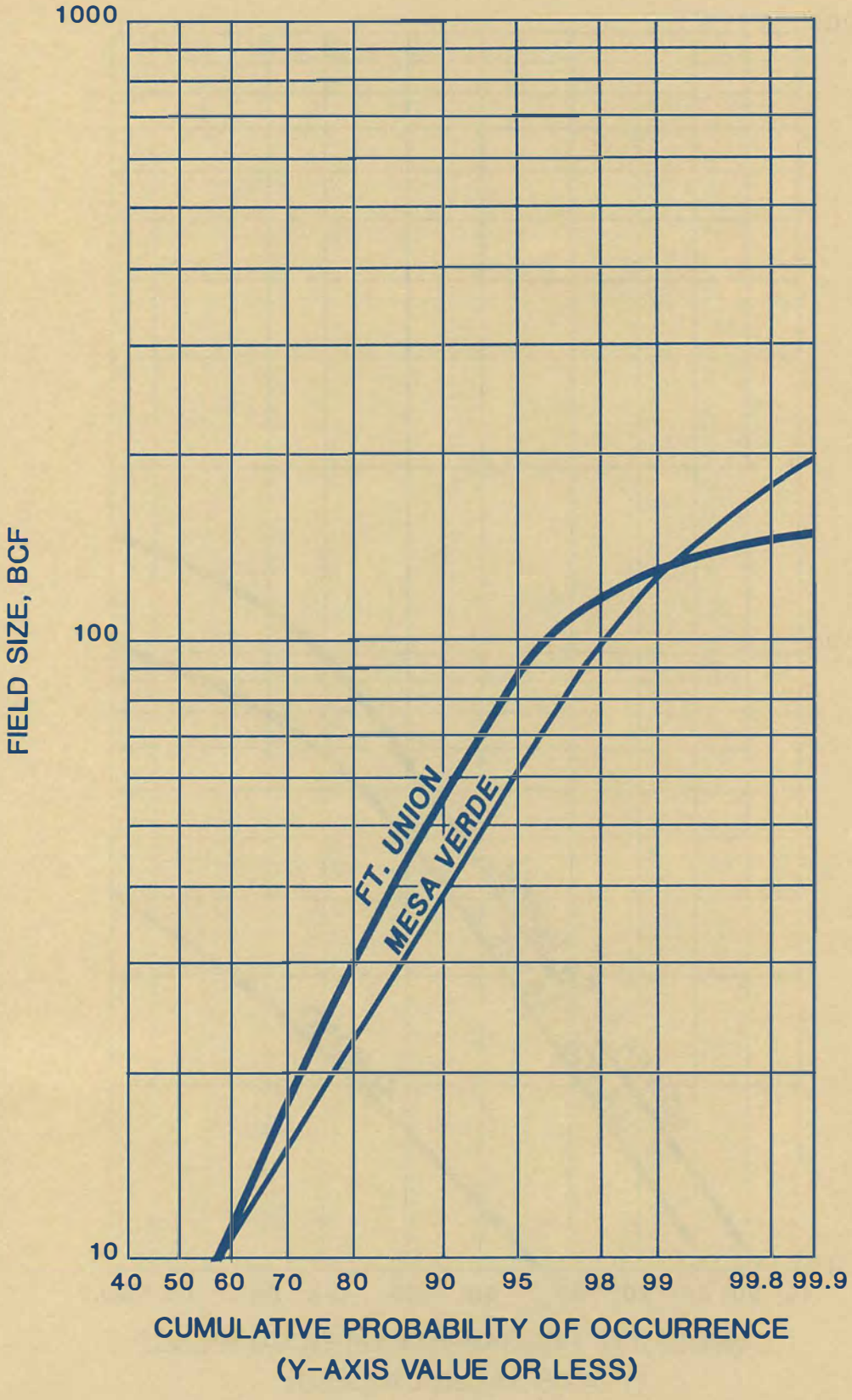


Figure 11-8. Field Size Distribution of Producible Gas, E/2, Lewin Area 4, Greater Green River.

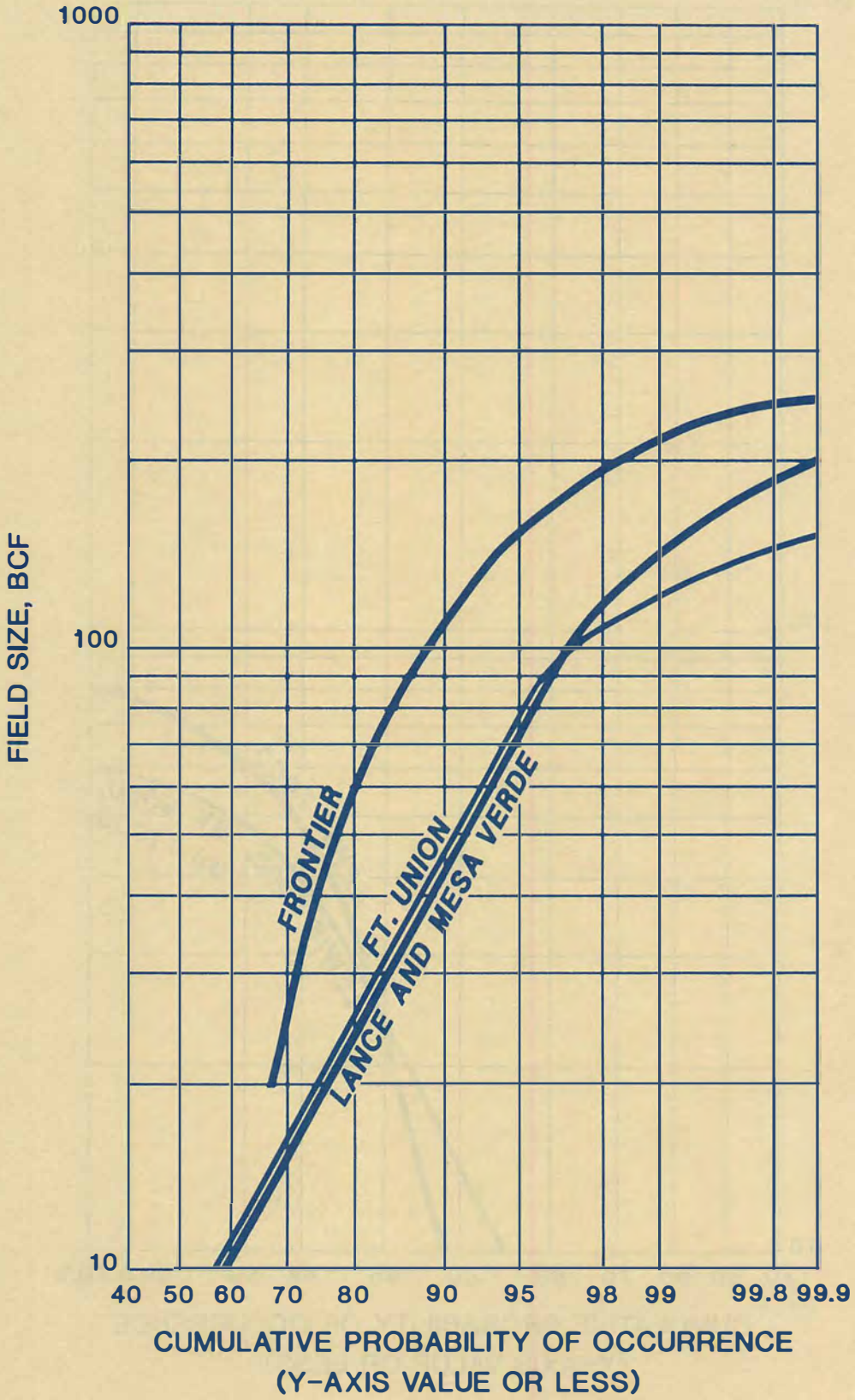


Figure 11-9. Field Size Distribution of Producible Gas, Bridger, Lewin 5, W/2, Lewin 4, Greater Green River.

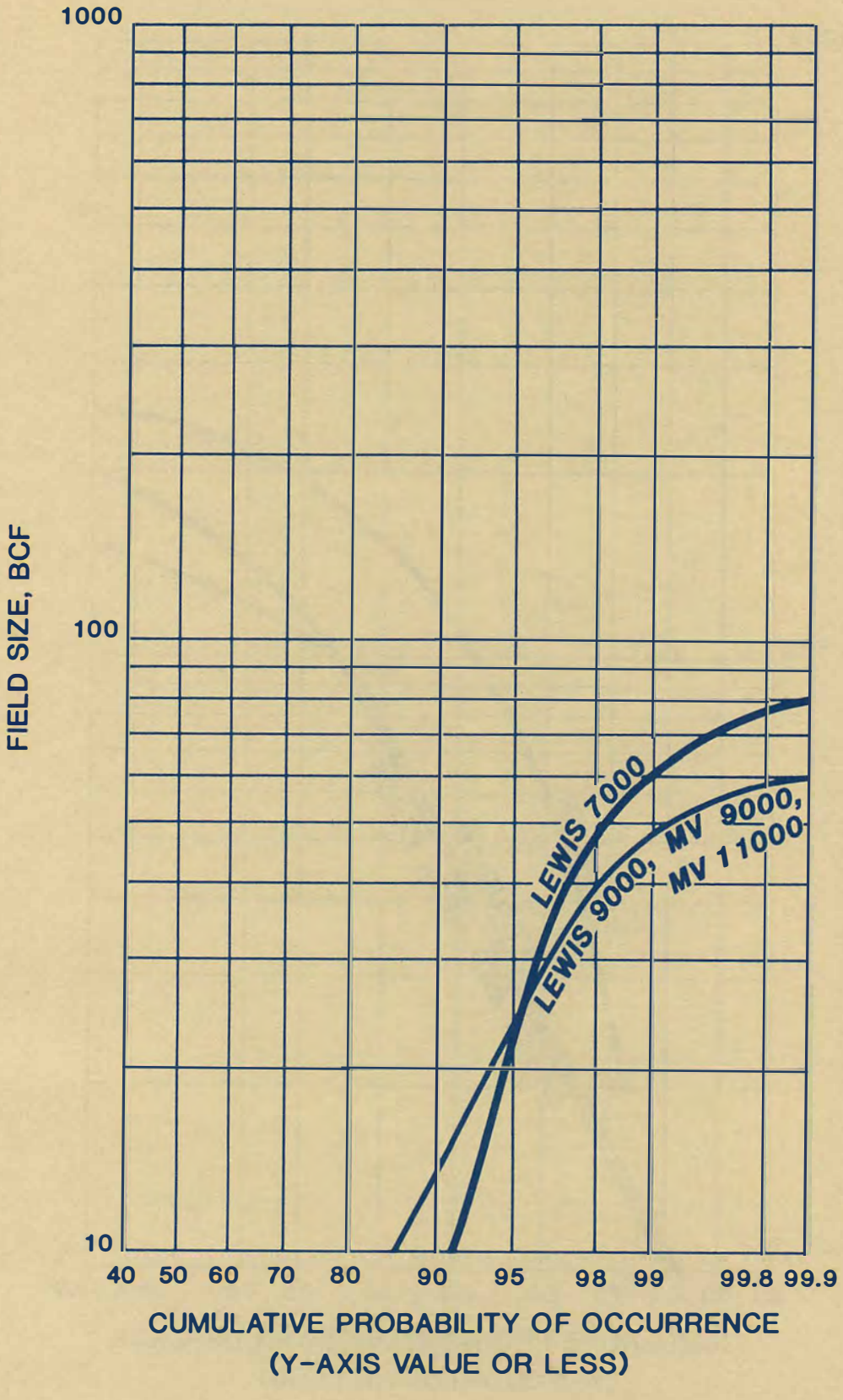


Figure 11-10. Field Size Distribution of Producible Gas, Sandwash Area, Greater Green River.

TABLE 11-12

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin I
FORMATION: Erickson, R/S, Blair

DEPTH (FT.): 11,000
PRESSURE (PSIA): 5,000
TEMPERATURE (°F): 225

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	14	5.9	25	155.68	110	0.25	1.0	-
0.01	58	5.2	35	795.76	563	0.40	1.0	-
0.003	83	4.5	50	1407.68	936	0.50	1.0	-
0.001	38	3.8	70	762.28	481	0.70	1.0	-
0.0003	36	3.1	100	841.32	481	0.80	1.0	-
0.0001	19	2.4	150	515.66	278	0.90	1.0	-
0.00003	11	1.8	200	298.54	147	0.95	1.0	-
0.00001	17	1.2	280	403.61	184	0.95	1.0	-
	276			5181.	3180			

TABLE 11-13

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, ERICKSON-ROCK SPRGS-BLAIR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			487	373	269	199	138	96	61	42
2			227	191	139	103	72	51	31	20
5			87	97	79	59	41	29	19	12
10			35	50	49	40	28	20	12	7
15			18	31	38	32	22	16	10	7
20			10	23	30	27	19	14	9	6
30			4	12	20	21	16	11	6	5
30-YEAR CUMM. PROD. (MMCF)			1570	1729	1600	1299	929	660	419	279

TABLE 11-14

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, ERICKSON-ROCK SPRGS-BLAIR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			560	467	324	299	218	160	103	67
2			219	216	163	135	94	69	45	29
5			64	90	88	73	52	40	25	16
10			20	37	49	43	31	26	18	11
15			10	21	34	28	23	21	14	9
20			5	14	26	22	16	15	12	8
30			2	7	15	14	11	12	9	5
30-YEAR CUMM. PROD. (MMCF)			1359	1619	1640	1429	1060	870	589	390

TABLE 11-15

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Ericson, Rock Sprgs., Blair

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.40	4	81	6.19	6	110
.01	5.63	4	400	6.04	6	563
.003	7.14	4	524	6.91	6	936
.001	9.76	4	297	8.75	8	481
.0003	14.81	4	130	12.77	12	452
.0001	22.22	4	50	16.68	12	200
.00003	30.76	4	19	22.54	12	78
.00001	40.0	4	18	28.95	12	75
			1419			2895

TABLE 11-16

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Ericson, Rock Sprgs.,Blair

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,194,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	176,000 - 995,000
- Advanced Case [2000/4000 Ft. Fracture]	351,000 - 1,827,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-17

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 1 — FORMATION Ericson, Rock Springs, Blair — DATE May 1980

					AVERAGE PER PROSPECT				BASIN TOTALS			WELLS					
CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE*	E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0802111	1.50	0	0	-	1780	-	-1010	0	-	-	-	0	-	-	-	-	-
21	2.50	0	0	-	"	-	-1010	0	-	-	-	0	-	-	-	-	-
31	3.10	9.5	2	CD	2097	.521	-785	0	-	-	-	9.5	-	-	-	-	-
41	3.50	23.1	3	CDE	3269	2.059	-313	6.4	-	-	-	23.1	-	-	-	-	-
51	5.00	33.1	4	CDEF	3635	2.536	525	15.7	1202	2090	474	33.1	317	157	122	489	1085
61	7.00	"	"	"	"	"	1506	27.3	"	"	"	"	"	"	"	"	"
71	9.00	43.2	5	CDEFG	4274	3.011	2871	40.6	1332	2571	442	43.2	251	191	147	588	1177
81	12.00	"	"	"	"	"	4571	60.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1780	-	-1006	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0	-	"	-	-1006	0	-	-	-	0	-	-	-	-	-
32	3.10	1.2	1	C	1810	.048	-984	0	-	-	-	1.2	-	-	-	-	-
42	3.50	9.5	2	CD	2097	.521	-803	0	-	-	-	9.5	-	-	-	-	-
52	5.00	23.1	3	CDE	3269	2.059	-89	13.5	-	-	-	23.1	-	-	-	-	-
62	7.00	33.1	4	CDEF	3635	2.536	810	27.3	1202	2090	474	33.1	317	157	122	489	1085
72	9.00	"	"	"	"	"	1568	39.3	"	"	"	"	"	"	"	"	"
82	12.00	43.2	5	CDEFG	4274	3.011	3111	60.0	1332	2571	442	43.2	251	191	147	588	1177
Discount Rate 20%																	
13	1.50	0	0	-	1780	-	-1001	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-1001	0	-	-	-	0	-	-	-	-	-
33	3.10	0	0	-	"	-	-1001	0	-	-	-	0	-	-	-	-	-
43	3.50	1.2	1	C	1810	.048	-979	0	-	-	-	1.2	-	-	-	-	-
53	5.00	23.1	3	CDE	3269	2.059	-325	13.5	-	-	-	23.1	-	-	-	-	-
63	7.00	"	"	"	"	"	191	23.8	1005	1609	488	"	375	113	102	410	1001
73	9.00	33.1	4	CDEF	3635	2.536	1002	39.3	1202	2090	474	33.1	317	157	122	489	1085
83	12.00	43.2	5	CDEFG	4274	3.011	2217	60.0	1332	2571	442	43.2	251	191	147	588	1177

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-18

ECONOMICS SUMMARY,

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area 1 — FORMATION Ericson, Rock Springs, Blair — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08022 11	1.50	0	0	-	2147	-	-1218	0	-	-	-	0	-	-	-	-	-
21	2.50	0	0	-	"	-	-1218	0	-	-	-	0	-	-	-	-	-
31	3.10	8.3	1	D	2600	.536	-989	0	-	-	-	8.3	-	-	-	-	-
41	3.50	9.5	2	CD	2663	.598	-892	0	-	-	-	9.5	-	-	-	-	-
51	5.00	33.1	4	CDEF	6021	3.960	1258	20.6	2090	2090	528	33.1	353	175	249	997	1774
61	7.00	"	"	"	"	"	2992	36.8	"	"	"	"	"	"	"	"	"
71	9.00	43.2	5	CDEFG	9400	5.506	6064	52.2	2542	2571	462	43.2	262	200	359	1437	2258
81	12.00	"	"	"	"	"	9620	80.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2147	-	-1209	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0	-	"	-	-1209	0	-	-	-	0	-	-	-	-	-
32	3.10	0	0	-	"	-	-1209	0	-	-	-	0	-	-	-	-	-
42	3.50	0	0	-	"		-1209	0	-	-	-	0	-	-	-	-	-
52	5.00	23.1	3	CDE	4901	2.983	189	17.4	1609	1609	539	23.1	414	125	187	748	1474
62	7.00	33.1	4	CDEF	6021	3.960	1874	36.8	2090	2090	528	33.1	353	175	249	997	1774
72	9.00	"	"	"	"	"	3237	53.7	"	"	"	"	"	"	"	"	"
82	12.00	43.2	5	CDEFG	9400	5.506	6833	80.8	2542	2571	462	43.2	262	200	359	1437	2258
Discount Rate 20%																	
13	1.50	0	0	-	2147	-	-1201	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-1201	0	-	-	-	0	-	-	-	-	-
33	3.10	0	0	-	"	-	-1201	0	-	-	-	0	-	-	-	-	-
43	3.50	0	0	-	"	-	-1201	0	-	-	-	0	-	-	-	-	-
53	5.00	23.1	3	CDE	4901	2.983	-165	17.4	-	-	-	23.1	-	-	-	-	-
63	7.00	33.1	4	CDEF	6021	3.960	1168	36.8	2090	2090	528	33.1	353	175	249	997	1774
73	9.00	"	"	"	"	"	2287	53.7	"	"	"	"	"	"	"	"	"
83	12.00	43.2	5	CDEFG	9400	5.506	5071	80.8	2542	2571	462	43.2	262	200	359	1437	2258

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-19

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin I
FORMATION: Ft. Union

DEPTH (FT.): 7000
PRESSURE (PSIA): 3500
TEMPERATURE (°F): 165

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	3	6.7	7	8.85	7	0.20	1.0	-
0.03	16	5.9	14	83.2	60	0.35	1.0	-
0.01	44	5.2	28	403.04	293	0.45	1.0	-
0.003	65	4.4	50	899.6	613	0.35	1.0	-
0.001	44	3.8	76	799.04	509	0.25	1.0	-
0.0003	19	3.1	100	370.5	219	0.20	1.0	-
	191			2564.	1701			

TABLE 11-20

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		224	202	218	182	147	94			
2		84	101	112	95	77	50			
5		22	46	61	54	44	28			
10		6	21	35	36	30	19			
15		2	12	25	27	24	16			
20		1	8	18	23	21	13			
30		0	4	11	17	16	10			
30-YEAR CUMM. PROD. (MMCF)		500	809	1170	1159	980	640			

TABLE 11-21

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		312	238	264	234	213	156			
2		146	122	136	119	100	68			
5		57	62	74	66	56	38			
10		22	32	42	39	37	26			
15		11	21	30	29	29	18			
20		7	15	22	23	22	15			
30		3	8	14	15	15	10			
30-YEAR CUMM. PROD. (MMCF)		1020	1119	1420	1320	1189	829			

TABLE 11-22

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Ft. Union

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	4.56	4	6	2.23	2.23	7
.03	4.67	4	51	3.37	3.37	60
.01	5.69	4	205	4.69	4.69	293
.003	8.13	4	300	7.14	7.14	613
.001	11.79	4	173	9.71	9.71	509
.0003	18.0	4	48	13.88	12.	188
			783			1670

TABLE 11-23

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Ft. Union

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	469,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	151,200
- Advanced Case [2000/4000 Ft. Fracture]	301,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-24

ECONOMICS SUMMARY,

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 1. — FORMATION Ft. Union — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0803111	1.50	0	0	-	761	-	-435	0	-	-	-	0	-	-	-	-	-
21	2.50	21.6	2	DE	1094	.843	-212	3.2	-	-	-	21.6	-	-	-	-	-
31	3.10	23.3	3	CDE	1159	.925	-88	7.2	-	-	-	23.3	-	-	-	-	-
41	3.50	30.4	4	CDEF	1283	1.157	58	11.7	729	1475	630	30.4	438	192	95	379	1103
51	5.00	"	"	"	"	"	385	21.6	"	"	"	"	"	"	"	"	"
61	7.00	33.2	6	BCDEFG	1312	1.200	855	35.6	783	1701	653	33.2	436	217	102	408	1163
71	9.00	"	"	"	"	"	1305	48.5	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	1981	66.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	761	-	-432	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0	-	"	-	-432	0	-	-	-	0	-	-	-	-	-
32	3.10	21.6	2	DE	1094	.843	-206	6.2	-	-	-	21.6	-	-	-	-	-
42	3.50	23.3	3	CDE	1159	.925	-131	9.4	-	-	-	23.3	-	-	-	-	-
52	5.00	30.4	4	CDEF	1283	1.157	167	21.6	729	1475	630	30.4	438	192	95	379	1103
62	7.00	"	"	"	"	"	498	34.8	"	"	"	"	"	"	"	"	"
72	9.00	33.2	6	BCDEFG	1312	1.200	864	48.5	783	1701	653	33.2	436	217	102	408	1163
82	12.00	"	"	"	"	"	1377	66.7	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	761	-	-428	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-428	0	-	-	-	0	-	-	-	-	-
33	3.10	12.1	1	D	1061	.578	-312	2.6	-	-	-	12.1	-	-	-	-	-
43	3.50	21.6	2	DE	1094	.843	-221	8.2	-	-	-	21.6	-	-	-	-	-
53	5.00	30.4	4	CDEF	1283	1.157	34	21.6	729	1475	630	30.4	438	192	95	379	1103
63	7.00	"	"	"	"	"	299	34.8	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	565	47.4	"	"	"	"	"	"	"	"	"
83	12.00	33.2	6	BCDEFG	1312	1.200	1003	66.7	783	1701	653	33.2	436	217	102	408	1163

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-25

ECONOMICS SUMMARY,

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area 1 — FORMATION Ft. Union — DATE May 1980

CASE NO.	GAS PRICE $/MCF	AVERAGE PER PROSPECT: PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0803211	1.50	0	0	-	975	-	-556	0	-	-	-	0	-	-	-	-	-
21	2.50	21.8	2	DE	1612	1.340	-228	4.7	-	-	-	21.8	-	-	-	-	-
31	3.10	23.5	3	CDE	1661	1.421	-43	8.9	-	-	-	23.5	-	-	-	-	-
41	3.50	"	"	"	"	"	66	11.5	966	966	680	"	520	160	114	456	1250
51	5.00	30.4	4	CDEF	2040	1.923	753	25.7	1475	1475	767	30.4	534	233	183	734	1684
61	7.00	33.2	6	BCDEFG	2356	2.137	1606	41.3	1670	1701	781	33.2	522	259	223	893	1898
71	9.00	"	"	"	"	"	2413	56.8	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	3622	78.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	975	-	-550	0	-	-	-	0	-	-	-	-	-
22	2.50	"	"	-	"	-	-550	0	-	-	-	0	-	-	-	-	-
32	3.10	23.5	3	CDE	1661	1.421	-194	8.9	-	-	-	23.5	-	-	-	-	-
42	3.50	"	"	"	"	"	-112	11.5	-	-	-	"	-	-	-	-	-
52	5.00	30.4	4	CDEF	2040	1.923	386	25.7	1475	1475	767	30.4	534	233	183	734	1684
62	7.00	"	"	"	"	"	938	41.0	"	"	"	"	"	"	"	"	"
72	9.00	33.2	6	BCDEFG	2356	2.137	1621	56.8	1670	1701	781	33.2	522	259	223	893	1898
82	12.00	"	"	"	"	"	2535	78.5	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	975	-	-544	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-544	0	-	-	-	0	-	-	-	-	-
33	3.10	12.3	1	D	1299	.714	-398	2.5	-	-	-	12.3	-	-	-	-	-
43	3.50	21.8	2	DE	1612	1.340	-238	10.6	-	-	-	21.8	-	-	-	-	-
53	5.00	23.5	3	CDE	1661	1.421	30	21.1	966	966	680	23.5	520	160	114	456	1250
63	7.00	30.4	4	CDEF	2040	1.923	604	41.0	1475	1475	767	30.4	534	233	183	734	1684
73	9.00	"	"	"	"	"	1043	55.6	"	"	"	"	"	"	"	"	"
83	12.00	33.2	6	BCDEFG	2356	2.137	1864	78.5	1670	1701	781	33.2	522	259	223	893	1898

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-26

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUB-BASIN: Lewin Area I
FORMATION: Almond A + Almond B

DEPTH (FT.): 10200
PRESSURE (PSIA): 6300
TEMPERATURE (°F): 220

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket + Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS-IN-PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE-OF-NATURE IS PRODUCTIVE	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE-OF-NATURE IS PROD 1st W/C	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE-OF-NATURE IS PROD 2nd W/C
0.3	3			37	31			
0.1	11	*	*	157	125	*	*	*
0.03	29			479	361			
0.01	27			506	359			
0.003	16			338	225			
0.001	4			89	55			
	90			1606	1156			

* Refer to individual formations for these data.

TABLE 11-27

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND A + ALMOND B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	904	917	822	691	575	479				
2	414	462	431	347	273	215				
5	135	182	209	180	134	96				
10	47	74	106	105	81	53				
15	23	41	65	75	62	39				
20	16	21	45	55	50	31				
30	9	10	24	35	36	23				
30-YEAR CUMM. PROD. (MMCF)	2629	3180	3719	3530	2870	2049				

TABLE 11-28

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND A + ALMOND B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1114	1236	1522	1301	1106	812				
2	413	520	868	686	527	355				
5	104	154	540	395	281	171				
10	28	46	396	281	190	106				
15	12	19	333	235	152	86				
20	8	8	296	207	136	73				
30	4	3	246	175	111	58				
30-YEAR CUMM. PROD. (MMCF)	2439	3060	12439	9189	6469	3920				

TABLE 11-29

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin Area 1
FORMATION: Almond A + Almond B

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.3	3.70	3.70	31	3.98	3.98	31
0.1	3.45	3.45	125	3.59	3.59	125
0.03	3.33	3.33	361	1.00	1.00	361
0.01	3.73	3.73	359	1.43	1.43	359
0.003	4.92	4.	183	2.18	2.18	225
0.001	6.57	4.	33	3.42	3.42	55
			1092			1156

TABLE 11-30

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin Area 1
FORMATION: Almond A + Almond B

Geology and Geophysics ($/Prospect)	
Drilling Cost ($/Well)	922,571
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	280,000
- Advanced Case [2000/4000 Ft. Fracture]	479,200 - 697,900
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-31

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 1 — FORMATION Almond A + Almond B — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0804111	1.50	57.7	4	ABCD	4207	8.013	976	23.7	876	876	110	57.7	47	63	50	201	362
21	2.50	76.2	6	ABCDEF	4982	10.218	3689	58.7	1092	1156	106	76.2	25	81	62	249	418
31	3.10	"	"	"	"	"	5161	78.0	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	6142	90.3	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	9821	132.1	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	14726	179.5	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	19632	220.5	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	26990	273.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	31.2	2	BC	2809	0	-12	14.7	486	486	0	31.2	-	-	-	-	-
22	2.50	72.4	5	ABCDE	4840	9.906	2493	58.0	1059	1101	106	72.4	29	77	60	239	406
32	3.10	76.2	6	ABCDEF	4982	10.218	3707	78.0	1092	1156	"	76.2	25	81	62	249	418
42	3.50	"	"	"	"	"	4472	90.3	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	7345	132.1	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	11174	179.5	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	15004	220.5	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	20748	273.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1338	0	-748	0	-	-	-	-	-	-	-	-	-
23	2.50	72.4	5	ABCDE	4840	9.906	1774	58.0	1059	1101	106	72.4	29	77	60	239	406
33	3.10	76.2	6	ABCDEF	4982	10.218	2755	78.0	1092	1156	106	76.2	25	81	62	249	418
43	3.50	"	"	"	"	"	3376	90.3	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	5705	132.1	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	8810	179.5	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	11916	220.5	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	16574	273.6	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 11-32

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area 1 — FORMATION Almond A + Almond B — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0804211	1.50	70.2	4	BCDE	3065	9.598	1683	36.0	1070	1070	112	70.2	34	78	18	75	205
21	2.50	76.2	6	ABCDEF	3727	10.729	4387	76.5	1156	1156	108	76.2	26	83	27	111	245
31	3.10	"	"	"	"	"	5897	98.8	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	6904	113.0	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	10681	162.0	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	15715	219.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	20750	269.5	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	28303	335.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	70.2	4	BCDE	3065	9.598	1041	36.0	1070	1070	112	70.2	34	78	18	75	205
22	2.50	76.2	6	ABCDEF	3727	10.729	3137	76.5	1156	1156	108	76.2	26	83	27	111	245
32	3.10	"	"	"	"	"	4318	98.8	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	5105	113.0	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	8056	162.0	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	11991	219.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	15926	269.5	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	21828	335.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	48.4	2	CD	1991	6.155	167	24.6	720	720	117	48.4	61	56	3	14	135
23	2.50	76.2	6	ABCDEF	3727	10.729	2336	76.5	1156	1156	108	76.2	26	83	27	111	245
33	3.10	"	"	"	"	"	3300	98.0	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	3942	113.0	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	6352	162.0	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	9564	219.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	12777	269.5	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	17595	335.6	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 11-33

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin Area I
FORMATION: Almond A + Ericson, Rock Sprgs., Blair

DEPTH (FT.): 11,000
PRESSURE (PSIA): 5500
TEMPERATURE (°F): 225

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket + Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	4	*	*	110.39	78	*	*	*
0.01	18			504.59	357			
0.003	26			827.16	550			
0.001	12			427.89	270			
0.0003	11			458.27	262			
0.0001	6			272.67	147			
0.00003	3			162.47	80			
0.00001	5			241.29	110			
	85			3005.	1854			

* Refer to individual formations for these data.

TABLE 11-34

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND A + ERICKSON-ROCK SPRGS-BLR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			858	743	640	570	509	467	432	412
2			446	410	359	322	291	270	250	239
5			206	216	198	178	160	148	138	131
10			104	118	117	109	97	88	80	76
15			66	79	86	79	70	63	58	54
20			46	58	65	63	55	49	44	42
30			27	34	43	43	38	34	29	27
30-YEAR CUMM. PROD. (MMCF)			3760	3930	3790	3489	3129	2859	2609	2469

TABLE 11-35

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND A + ERICKSON-ROCK SPRGS-BLR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			1441	1349	1205	1180	1100	1041	984	948
2			751	748	695	667	626	601	577	561
5			391	417	415	400	379	367	352	343
10			260	277	289	283	270	266	257	251
15			211	222	236	230	225	222	215	211
20			185	193	206	202	196	195	192	188
30			153	158	167	165	163	164	161	157
30-YEAR CUMM. PRED. (MMCF)			8870	9129	9149	8939	8579	8389	8110	7900

TABLE 11-36

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin Area 1
FORMATION: Almond A + Ericson, Rock Sprgs.,Blair

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.03	4.82	4.	65	2.04	2.04	78
0.01	5.03	4.	284	2.16	2.16	357
0.003	5.62	4.	392	2.33	2.33	550
0.001	6.42	4.	168	2.51	2.51	270
0.0003	7.50	4.	140	2.73	2.73	262
0.0000	8.55	4.	69	2.91	2.91	147
0.00003	8.89	4.	36	2.87	2.87	80
0.00001	8.62	4.	51	2.70	2.70	110
			1204			1854

TABLE 11-37

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin Area 1
FORMATION: Almond A + Ericson, Rock Sprgs.,Blair

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,193,919
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	284,570 - 1,103,300
- Advanced Case [2000/4000 Ft. Fracture]	672,100 - 2,148,410
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-38

ECONOMICS SUMMARY,

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 1 — FORMATION Almond A + Ericson, Rock Springs, Blair — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08051 11	1.50	9.5	1	D	2418	1.553	-842	0	-	-	-	9.5	-	-	-	-	-
21	2.50	43.2	5	CDEFG	3223	4.655	594	17.1	1049	1517	225	43.2	128	97	36	146	407
31	3.10	50.3	6	CDEFGH	3421	5.141	1356	26.0	1117	1664	217	50.3	108	109	39	156	412
41	3.50	"	"	"	"	"	1771	31.2	"	"	"	"	"	"	"	"	"
51	5.00	60.7	8	CDEFGHIJ	3576	8.966	3682	54.7	1204	1854	134	60.7	53	81	25	96	258
61	7.00	"	"	"	"	"	5919	81.7	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	8156	107.3	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	11511	142.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1934	-	-1097	0	-	-	-	0	-	-	-	-	-
22	2.50	33.1	4	CDEF	3013	3.936	-37	14.3	-	-	-	33.1	-	-	-	-	-
32	3.10	43.2	5	CDEFG	3223	4.655	575	24.1	1049	1517	225	43.2	128	97	36	146	407
42	3.50	"	"	"	"	"	867	28.9	"	"	"	"	"	"	"	"	"
52	5.00	60.7	8	CDEFGHIJ	3576	8.966	2522	54.7	1204	1854	134	60.7	53	81	25	96	258
62	7.00	"	"	"	"	"	4264	81.7	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	6005	107.3	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	8617	142.8	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1934	-	-1094	0	-	-	-	0	-	-	-	-	-
23	2.50	23.1	2	DE	2874	3.234	-433	11.0	-	-	-	23.1	-	-	-	-	-
33	3.10	33.1	4	CDEF	3013	3.936	27	20.5	909	1255	231	33.1	155	76	32	129	392
43	3.50	43.2	5	CDEFG	3223	4.655	451	28.9	1049	1517	225	43.2	128	97	36	146	407
53	5.00	50.3	6	CDEFGH	3421	5.141	1569	50.5	1117	1664	217	50.3	108	109	39	156	412
63	7.00	60.7	8	CDEFGHIJ	3576	8.966	3218	81.7	1204	1854	134	60.7	53	81	25	96	258
73	9.00	"	"	"	"	"	4643	107.3	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	6781	142.8	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-39

ECONOMICS SUMMARY,

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area 1 — FORMATION Almond A + Ericson, Rock Springs, Blair — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
0805211	1.50	43.2	5 CDEFG	3268	6.700	193	11.9	1517	1517	226	43.2	128	98	16	64	306
21	2.50	60.7	8 CDEFGHIJ	3576	8.966	2419	33.9	1854	1854	207	60.7	81	126	18	74	299
31	3.10	"	" "	"	"	3476	45.1	"	"	"	"	"	"	"	"	"
41	3.50	"	" "	"	"	4182	52.6	"	"	"	"	"	"	"	"	"
51	5.00	"	" "	"	"	6826	80.3	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	10353	115.4	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	13879	148.2	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	19168	193.3	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	33.1	4 CDEF	3071	5.205	-470	8.6	-	-	-	33.1	-	-	-	-	-
22	2.50	50.3	6 CDEFGH	3496	7.820	1090	29.4	1664	1664	213	50.3	106	107	18	72	303
32	3.10	60.7	8 CDEFGHIH	3576	8.966	2240	45.1	1854	1854	207	60.7	81	126	18	74	299
42	3.50	"	" "	"	"	2778	52.6	"	"	"	"	"	"	"	"	"
52	5.00	"	" "	"	"	4795	80.3	"	"	"	"	"	"	"	"	"
62	7.00	"	" "	"	"	7483	115.4	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	10172	148.2	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	14205	193.3	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	23.1	2 DE	2961	3.888	-865	5.0	-	-	-	23.1	-	-	-	-	-
23	2.50	43.2	5 CDEFG	3268	6.700	340	25.8	1517	1517	226	43.2	128	98	16	64	306
33	3.10	54.1	7 CDEFGHI	3527	8.236	1275	41.4	1744	1744	212	54.1	97	115	18	73	303
43	3.50	60.7	8 CDEFGHIJ	3576	8.966	1928	52.6	1854	1854	207	60.7	81	126	18	74	299
53	5.00	"	" "	"	"	3558	80.3	"	"	"	"	"	"	"	"	"
63	7.00	"	" "	"	"	5731	115.4	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	7904	148.2	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	11164	193.2	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-40

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: Lewin Area I
FORMATION: Almond B + Ericson, Rock Sprgs., Blair

DEPTH (FT.): 11,000
PRESSURE (PSIA): 5500
TEMPERATURE (°F): 225

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	11	*	*	219.37	155	*	*	*
0.01	45			1030.39	729			
0.003	64			1718.99	1143			
0.001	30			898.57	567			
0.0003	28			969.0	554			
0.0001	15			578.73	312			
0.00003	9			343.22	169			
0.00001	13			495.74	226			
	215			6254.	3855			

* Refer to individual formations for these data.

TABLE 11-41

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND B + ERICKSON-ROCK SPRGS-BLR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			856	741	638	568	507	465	430	410
2			380	344	293	256	226	205	184	173
5			145	155	136	117	98	87	76	70
10			60	74	73	65	53	44	37	32
15			33	46	53	46	37	30	25	21
20			20	32	39	37	29	23	18	16
30			10	17	25	26	21	17	12	10
30-YEAR CUMM. PROD. (MMCF)			2700	2870	2739	2430	2069	1799	1560	1409

TABLE II-42

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, ALMOND B + ERICKSON-ROCK SPRGS-BLR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			980	887	744	719	638	580	523	486
2			359	356	303	274	234	209	184	169
5			108	134	132	118	96	84	70	61
10			37	54	66	60	48	43	35	28
15			19	30	43	38	33	30	23	19
20			11	20	32	28	22	21	18	14
30			5	9	18	16	14	15	12	8
30-YEAR CUMM. PROD. (MMCF)			2359	2620	2640	2430	2060	1880	1590	1390

TABLE 11-43

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin Area 1
FORMATION: Almond B + Ericson, Rock Sprgs.,Blair

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.03	5.36	4	116	6.14	6.14	155
0.01	5.65	4	516	6.19	6.19	729
0.003	6.51	4	702	6.75	6.75	1143
0.001	7.78	4	292	7.79	7.79	567
0.0003	9.64	4	230	9.65	9.65	554
0.0001	11.59	4	108	11.09	11.09	312
0.00003	12.69	4	53	12.38	12.0	164
0.00001	12.44	4	73	12.67	12.0	214
			2090			3838

TABLE 11-44

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin Area 1
FORMATION: Almond B + Ericson, Rock Sprgs.,Blair

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,193,919
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	350,020 - 1,169,960
- Advanced Case [2000/4000 Ft. Fracture]	699,050 - 2,175,360
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-45

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 1 — FORMATION Almond B + Ericson, Rock Springs, Blair — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0806111	1.50	0	0	-	2015	0	-1147	0	-	-	0	-	0	0	0	0	0
21	2.50	33.1	4	CDEF	3847	3.773	84	11.0	1626	2554	431	33.1	289	142	98	389	918
31	3.10	"	"	"	"	"	594	17.3	"	"	"	"	"	"	"	"	"
41	3.50	43.2	5	CDEFG	4546	4.615	1316	25.1	1856	3108	402	43.2	228	174	120	481	1003
51	5.00	50.3	6	CDEFGH	4876	5.112	3181	47.1	1964	3420	384	50.3	191	193	126	504	1014
61	7.00	60.7	8	CDEFGHI	5301	5.512	5956	79.3	2090	3855	379	60.7	149	230	138	549	1066
71	9.00	"	"	"	"	"	8440	107.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	12165	147.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2015	0	-1144	0	-	-	0	-	0	0	0	0	0
22	2.50	23.1	2	DE	3340	2.804	-443	7.6	0	-	"	23.1	"	"	"	"	"
32	3.10	33.1	4	CDEF	3847	3.773	145	17.3	1626	2554	431	33.1	289	142	98	389	918
42	3.50	"	"	"	"	"	415	21.6	"	"	"	"	"	"	"	"	"
52	5.00	43.2	5	CDEFG	4546	4.615	1933	44.5	1856	3108	402	43.2	228	174	120	481	1003
62	7.00	60.7	8	CDEFGHIJ	5301	5.512	4341	79.3	2090	3855	379	60.7	149	230	138	549	1066
72	9.00	"	"	"	"	"	6332	107.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	9303	147.8	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	2015	0	-1140	0	-	-	0	-	0	0	0	0	0
23	2.50	9.5	1	0	2507	1.064	-890	0	-	-	"	9.5	"	"	"	"	"
33	3.10	23.1	2	DE	3340	2.804	-352	12.7	-	-	"	23.1	"	"	"	"	"
43	3.50	33.1	4	CDEF	3847	3.773	85	21.6	1626	2554	431	33.1	289	142	98	389	918
53	5.00	48.2	5	CDEFG	4546	4.615	1317	44.5	1856	3108	402	43.2	228	174	120	481	1003
63	7.00	54.1	7	CDEFGHI	4986	5.260	3104	76.6	2019	3629	384	54.1	191	193	126	504	1014
73	9.00	60.7	8	CDEFGHIJ	5301	5.512	4955	107.9	2090	3855	379	60.7	149	230	138	549	1066
83	12.00	"	"	"	"	"	7425	147.8	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-46

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area 1 — FORMATION Almond B + Ericson, Rock Springs, Blair — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
08062 11	1.50	0	0	-	2556	0	-1454	0	-	-	0	-	0	0	0	0	0
21	2.50	23.1	2	DE	5969	4.246	-97	9.0	1872	1872	0	23.1	"	"	"	"	"
31	3.10	33.1	4	CDEF	7571	5.960	1268	20.9	2594	2594	435	33.1	292	143	219	873	1527
41	3.50	"	"	"	"	"	1919	26.9	"	"	"	"	"	"	"	"	"
51	5.00	43.2	5	CDEFG	10428	7.990	5764	55.2	3148	3148	394	43.2	224	170	285	1142	1821
61	7.00	50.3	6	CDEFGH	12386	9.013	11082	93.4	3460	3460	384	50.3	191	193	323	1292	1999
71	9.00	60.7	8	CDEFGHIJ	15444	10.324	17622	153.0	3839	3855	372	60.7	146	226	380	1517	2269
81	12.00	"	"	"	"	"	25962	194.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2556	0	-1444	0	-	-	0	-	0	0	0	0	0
22	2.50	0	0	-	2556	0	-1444	0	-	-	0	-	0	0	0	0	0
32	3.10	23.1	2	DE	5969	4.246	86	16.0	1872	1872	441	23.1	339	102	155	622	1218
42	3.50	33.1	4	CDEF	7571	5.960	1073	26.9	2594	2594	435	33.1	292	143	219	873	1527
52	5.00	43.2	5	CDEFG	10428	7.990	4059	55.2	3148	3148	394	43.2	224	170	285	1142	1821
62	7.00	"	"	"	"	"	7557	92.8	"	"	"	"	"	"	"	"	"
72	9.00	60.7	8	CDEFGHIJ	15444	10.324	13465	133.0	3839	3855	372	60.7	146	226	380	1517	2269
82	12.00	"	"	"	"	"	20234	194.8	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	2556	0	-1434	0	-	-	0	-	0	0	0	0	0
23	2.50	0	0	-	2556	"	-1434	0	-	-	"	-	"	"	"	"	"
33	3.10	9.5	1	D	3780	1.531	-906	1.4	0	-	"	9.5	"	"	"	"	"
43	3.50	23.1	2	DE	5969	4.246	612	20.9	1872	1872	441	23.1	339	102	155	622	1218
53	5.00	33.1	4	CDEF	7571	5.960	2172	50.5	2594	2594	435	33.1	292	143	219	873	1527
63	7.00	43.2	5	CDEFG	10428	7.990	5843	92.8	3148	3148	394	43.2	224	170	285	1142	1821
73	9.00	50.3	6	CDEFGH	12385	9.013	9686	133.0	3460	3460	384	50.3	191	193	323	1292	1999
83	12.00	60.7	8	CDEFGHIJ	15444	10.324	16328	194.8	3839	3855	372	60.7	146	226	380	1517	2269

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-47

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUB-BASIN: Lewin I
FORMATION: Lance & Lewis

DEPTH (FT.): 9000
PRESSURE (PSIA): 4950
TEMPERATURE (°F): 200

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS-IN-PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE-OF-NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE-OF-NATURE IS PROD: 1st W/C	2nd W/C
.1	14	5.1	15	79.21	64	.15	1.0	-
.03	48	4.6	22	359.28	274	.35	1.0	-
.01	82	4.2	30	764.16	548	.45	1.0	-
.003	74	3.8	36	748.73	503	.55	1.0	-
.001	32	3.4	42	418.43	262	.65	1.0	-
.0003	17	3.1	50	233.85	136	.75	1.0	-
	267				1787			

TABLE 11-48

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN AREA 1, LANCE AND LEWIS

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		463	402	302	188	132	78			
2		136	172	152	97	68	41			
5		26	57	72	54	39	23			
10		5	19	36	33	27	16			
15		1	9	22	24	21	13			
20		0	5	14	18	18	11			
30		0	2	7	12	14	9			
30-YEAR CUMM. PROD. (MMCF)		809	1109	1280	1070	859	530			

TABLE 11-49

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN AREA 1, LANCE AND LEWIS

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		533	486	365	244	207	136			
2		78	209	183	119	92	58			
5		10	69	87	59	50	32			
10		2	23	43	32	28	18			
15		0	11	26	20	19	13			
20		0	6	17	14	14	10			
30		0	2	9	8	8	6			
30-YEAR CUMM. PROD. (MMCF)		710	1340	1539	1090	960	649			

TABLE 11-50

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Lance & Lewis

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.1	5.64	4	45	6.42	6.42	64
0.03	5.14	4	214	4.25	4.25	274
0.01	5.22	4	416	4.34	4.34	548
0.003	6.35	4	317	6.24	6.24	503
0.001	9.55	4	110	8.54	8.54	262
0.0003	15.11	4	37	12.34	12.00	132
			1139			1783

TABLE 11-51

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 1
FORMATION: Lance & Lewis

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	749,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	167,000 - 213,000
- Advanced Case [2000/4000 Ft. Fracture]	332,000 - 425,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-52

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 1 — FORMATION Lance, Lewis — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08071 11	1.50	0	0	-	1080	0	-617	-	-	-	0	-	0	0	0	0	0
21	2.50	19.8	2	CD	3355	"	-36	9.3	-	-	"	-	"	"	"	"	"
31	3.10	20.8	3	BCD	3440	2.834	378	16.4	675	886	238	20.8	189	49	117	471	827
41	3.50	36.0	4	BCDE	5204	4.875	1098	23.1	992	1389	203	36.0	130	73	176	702	1080
51	5.00	44.3	5	BCDEF	5814	5.510	2840	41.2	1102	1651	200	44.3	112	89	198	792	1189
61	7.00	44.3	5	BCDEF	5814	"	5074	65.1	1102	1651	"	44.3	"	"	"	"	"
71	9.00	44.4	6	BCDEFG	6223	5.764	7468	85.7	1139	1787	198	49.4	100	98	212	847	1256
81	12.00	49.4	6	BCDEFG	6223	"	10936	114.6	1139	1787	"	49.4	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1080	0	-616	0	-	-	0	-	0	0	0	0	0
22	2.50	0	0	-	1080	"	-616	0	-	-	"	-	"	"	"	"	"
32	3.10	19.8	2	CD	3355	2.767	44	15.9	630	822	228	19.8	182	44	109	433	767
42	3.50	20.8	3	BCD	3440	2.834	274	20.9	675	886	238	20.8	189	49	117	471	827
52	5.00	36.0	4	BCDE	5204	4.875	1666	41.5	992	1389	203	36.0	130	73	176	702	1080
62	7.00	44.3	5	BCDEF	5814	5.510	3474	65.1	1102	1651	200	44.3	112	89	198	792	1189
72	9.00	"	"	"	"	"	5163	86.6	"	"	"	"	"	"	"	"	"
82	12.00	49.4	6	BCDEFG	6223	5.764	7869	114.6	1139	1787	198	49.4	100	98	212	847	1256
Discount Rate 20%																	
13	1.50	0	0	-	1080	0	-615	0	-	-	0	-	0	0	0	0	0
23	2.50	0	0	-	1080	"	-615	0	-	-	"	-	"	"	"	"	"
33	3.10	6.1	1	C	1729	"	-447	0	-	-	"	-	"	"	"	"	"
43	3.50	20.8	3	BCD	3440	2.834	36	20.9	675	886	238	20.8	189	49	117	471	827
53	5.00	36.0	4	BCDE	5204	4.875	1070	41.5	992	1389	203	36.0	130	73	176	702	1080
63	7.00	44.3	5	BCDEF	5814	5.510	2471	65.1	1102	1651	200	44.3	112	89	198	792	1189
73	9.00	44.3	5	BCDEF	5814	5.510	3807	86.6	1102	1651	"	44.3	"	"	"	"	"
83	12.00	44.4	6	BCDEFG	6223	5.764	5927	114.6	1139	1787	198	49.4	100	98	212	847	1256

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-53

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area I — FORMATION Lance, Lewis — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	OCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0807211	1.50	0	0	-	1249	0	-713	0	-	-	0	-	0	0	0	0	0
21	2.50	19.8	2	CD	3782	3.189	17	10.2	822	822	257	19.8	206	51	110	466	841
31	3.10	"	"	"	"	"	459	16.9	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	754	21.3	"	"	"	"	"	"	"	"	"
51	5.00	44.3	5	BCOEF	8758	7.445	4126	45.3	1651	1651	222	44.3	124	98	297	1186	1704
61	7.00	"	"	"	"	"	7378	73.3	"	"	"	"	"	"	"	"	"
71	9.00	49.4	6	BCOEFG	10369	8.214	11324	96.5	1787	1787	217	49.4	110	108	349	1395	1961
81	12.00	"	"	"	"	"	16672	131.3	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1249	0	-710	0	-	-	0	-	0	0	0	0	0
22	2.50	0	0	-	"	0	-710	0	-	-	0	-	0	0	0	0	0
32	3.10	19.8	2	CD	3782	3.189	100	16.9	822	822	257	19.8	206	51	116	466	841
42	3.50	"	"	"	"	"	328	21.3	"	"	"	"	"	"	"	"	"
52	5.00	36.0	4	BCDE	7230	6.208	2316	45.1	1389	1389	224	36.0	143	80	239	956	1419
62	7.00	44.3	5	BCDEF	8758	7.445	5136	73.3	1651	1651	222	44.3	124	98	297	1186	1704
72	9.00	49.4	6	BCOEFG	10369	8.214	8046	96.5	1787	1787	217	49.4	110	108	349	1395	1961
82	12.00	"	"	"	"	"	12112	131.3	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1249	0	-706	0	-	-	0	-	0	0	0	0	0
23	2.50	0	0	-	1249	"	-706	0	-	-	"	-	"	"	"	"	"
33	3.10	6.1	1	C	1968	.791	-500	0	-	-	"	-	"	"	"	"	"
43	3.50	19.8	2	CD	3782	3.189	56	21.3	822	822	257	19.8	206	51	116	466	841
53	5.00	36.0	4	BCOE	7230	6.208	1527	45.1	1389	1389	224	36.0	143	80	239	956	1419
63	7.00	44.3	5	BCOEF	8758	7.445	3708	73.3	1651	1651	222	44.3	124	98	297	1186	1704
73	9.00	"	"	"	"	"	5674	98.6	1651	1651	"	44.3	"	"	"	"	"
83	12.00	49.4	6	BCOEFG	10369	8.214	9177	131.3	1787	1787	217	49.4	110	108	349	1395	1961

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-54

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin 2 & 3
FORMATION: Almond A

DEPTH (FT.): 9000
PRESSURE (PSIA): 4680
TEMPERATURE (°F): 195

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	22	6.6	7	72.12	54	0.50	1.0	-
0.1	39	4.7	9	117.0	90	0.60	1.0	-
0.03	83	4.1	13	313.74	225	0.75	1.0	-
0.01	100	3.7	18	472.00	340	0.80	1.0	-
0.003	105	3.4	23	496.18	392	0.85	1.0	-
0.001	52	3.2	30	354.12	225	0.85	1.0	-
0.0003	35	3.0	31	238.7	139	0.90	1.0	-
	436			2064.	1465			

TABLE 11-55

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND A

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	494	333	233	171	107	75	40			
2	352	233	151	103	62	41	21			
5	188	144	106	70	39	26	13			
10	97	85	78	55	30	19	9			
15	60	56	61	47	26	16	8			
20	39	42	48	42	24	14	7			
30	26	24	35	34	21	12	6			
30-YEAR CUMM. PROD. (MMCF)	3048	2472	2188	1654	963	617	304			

TABLE 11-56

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND A

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	686	514	571	474	363	272	153			
2	492	343	378	300	208	150	82			
5	305	222	245	191	128	90	47			
10	185	146	169	138	92	64	33			
15	126	106	129	111	77	53	28			
20	91	83	101	96	67	47	24			
30	55	53	71	74	55	39	20			
30-YEAR CUMM. PROD. (MMCF)	5264	4183	4850	4147	2903	2054	1094			

TABLE 11-57

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Almond A

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	.82	.82	54	.474	.474	54
.1	.92	.92	90	.545	.545	90
.03	1.24	1.24	225	.561	.561	225
.01	2.05	2.05	340	.817	.817	340
.003	3.88	3.88	392	1.288	1.288	392
.001	6.93	4.	130	2.084	2.084	225
.0003	13.05	4.	43	3.638	3.638	139
			1274			1465

TABLE 11-58

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Almond A

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	736,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	103,431
- Advanced Case [2000/4000 Ft. Fracture]	131,000 - 340,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-59

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Lewin Area 2 & 3
FORMATION Almond A
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0821111	1.50	6.3	2	AB	1049	.440	-432	0	0	0	0	6.3	0	0	0	0	0
21	2.50	20.9	3	ABC	1444	1.457	-371	9.1	0	0	0	20.9	0	0	0	0	0
31	3.10	37.5	4	ABCD	2186	2.827	499	18.0	709	709	251	37.5	156	95	72	285	606
41	3.50	"	"	"	"	"	707	21.3	"	"	"	"	"	"	"	"	"
51	5.00	58.7	5	ABCDE	4071	4.640	2145	32.4	1101	1101	236	58.7	98	139	169	676	1082
61	7.00	68.9	6	ABCDEF	4751	5.203	4026	49.8	1231	1231	236	68.9	74	163	205	819	1261
71	9.00	"	"	"	"	"	5841	69.6	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	8564	98.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	2.5	1	A	961	.160	-488	0	0	0	0	2.5	0	0	0	0	0
22	2.50	20.9	3	ABC	1444	1.457	-193	0	0	0	0	20.9	0	0	0	0	0
32	3.10	"	"	"	"	"	-63	13.1	"	"	"	"	"	"	"	"	"
42	3.50	37.5	4	ABCD	2186	2.827	288	21.3	709	709	251	37.5	156	95	722	285	606
52	5.00	"	"	"	"	"	857	33.8	"	"	"	"	"	"	"	"	"
62	7.00	58.7	5	ABCDE	4071	4.640	2375	51.4	1101	1101	236	58.7	98	139	169	676	1082
72	9.00	68.9	6	ABCDEF	4751	5.203	3784	69.6	1231	1231	236	68.9	74	163	205	819	1261
82	12.00	"	"	"	"	"	5741	98.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	2.5	1	A	961	.160	-493	0	0	0	0	2.5	0	0	0	0	0
23	2.50	6.3	2	AB	1049	.440	-411	"	"	"	"	6.3	"	"	"	"	"
33	3.10	20.9	3	ABC	1444	1.457	-183	13.1	"	"	"	20.9	"	"	"	"	"
43	3.50	"	"	"	"	"	-115	15.7	"	"	"	"	"	"	"	"	"
53	5.00	37.4	4	ABCD	2186	2.827	486	33.8	709	709	251	37.5	156	95	72	285	606
63	7.00	58.7	5	ABCDE	4071	4.640	1550	51.4	1101	236	236	58.7	98	139	169	676	1082
73	9.00	"	"	"	"	"	2468	70.5	"	"	"	"	"	"	"	"	"
83	12.00	68.9	6	ABCDEF	4751	5.203	4095	98.4	1231	1231	236	68.9	74	163	205	819	1261

* CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-60

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Lewin Areas 2 & 3
FORMATION Almond A
TECHNOLOGY Advanced
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08212 1	1.50	37.5	3	BCD	1520	2.813	-3	9.9	0	0	0	37.5	0	0	0	0	0
21	2.50	68.9	6	ABCDEF	2559	5.437	1289	30.6	1326	1326	244	68.9	76	168	62	245	551
31	3.10	"	"	"	"	"	1916	41.2	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	2335	48.4	"	"	"	"	"	"	"	"	"
51	5.00	76.6	7	ABCDEFG	3257	6.020	4152	72.3	1465	1465	243	76.6	56	187	91	366	702
61	7.00	"	"	"	"	"	6472	107.4	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	8793	139.7	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	12273	188.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	20.9	2	BC	1315	1.444	-354	3.4	0	0	0	20.9	0	0	0	0	0
22	2.50	58.7	5	ABCDE	2118	4.627	611	29.6	1101	1101	237	58.7	98	140	41	165	444
32	3.10	68.9	6	ABCDEF	2559	5.437	1181	41.2	1326	1326	244	68.9	76	168	62	245	551
42	3.50	"	"	"	"	"	1492	48.4	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	2659	74.8	"	"	"	"	"	"	"	"	"
62	7.00	76.6	7	ABCDEFG	3257	6.020	4519	107.4	1465	1465	243	76.6	56	187	91	366	702
72	9.00	"	"	"	"	"	6243	139.7	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	8827	183.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	6.3	1	B	1182	.432	-562	0	0	0	0	6.3	0	0	0	0	0
23	2.50	37.5	3	BCD	1520	2.813	52	21.8	655	655	232	37.5	145	87	15	63	311
33	3.10	58.7	5	ABCDE	2118	4.627	631	39.4	1101	1101	238	58.7	98	140	41	165	444
43	3.50	"	"	"	"	"	841	45.9	"	"	"	"	"	"	"	"	"
53	5.00	68.9	6	ABCDEF	2559	5.437	1909	74.8	1326	1326	244	68.9	76	168	62	245	551
63	7.00	76.6	7	ABCDEFG	3257	6.020	3341	107.4	1465	1465	243	76.6	56	187	91	366	702
73	9.00	"	"	"	"	"	4696	139.7	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	6730	183.2	"	"	"	"	"	"	"	"	"

* CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001 G 0.0003

TABLE 11-61

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin 2 & 3
FORMATION: Almond B

DEPTH (FT.): 9200
PRESSURE (PSIA): 4780
TEMPERATURE (°F): 200

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	11	6.6	8	42.13	31	0.35	1.0	-
0.1	21	4.7	15	91.35	64	0.45	1.0	-
0.03	43	4.1	30	383.56	259	0.55	1.0	-
0.01	52	3.7	35	488.28	330	0.60	1.0	-
0.003	55	3.4	38	515.35	322	0.75	1.0	-
0.001	27	3.2	40	250.56	150	0.80	1.0	-
0.0003	18	3.1	41	165.96	91	0.85	1.0	-
	228			1937.	1247			

TABLE 11-62

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	380	410	445	289	164	96	52			
2	71	125	200	148	85	49	27			
5	8	24	70	70	48	28	15			
10	1	4	25	36	30	19	11			
15	0	1	13	22	21	15	8			
20	0	0	7	15	17	13	7			
30	0	0	3	7	11	10	5			
30-YEAR CUMM. PROD. (MMCF)	519	719	1310	1259	960	620	349			

TABLE 11-63

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	352	579	532	350	199	147	82			
2	15	240	259	178	103	65	35			
5	1	76	107	84	58	35	19			
10	0	24	46	43	37	21	11			
15	0	9	26	26	25	13	9			
20	0	5	15	18	21	10	6			
30	0	0	7	9	14	6	4			
30-YEAR CUMM. PROD. (MMCF)	380	1450	1909	1530	1159	690	410			

TABLE 11-64

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Almond B

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	5.97	4	21	8.15	8.15	31
.1	4.38	4	59	2.17	2.17	64
.03	4.64	4	223	3.18	3.18	259
.01	5.08	4	261	4.18	4.18	330
.003	6.24	4	206	5.17	5.17	322
.001	8.94	4	68	8.03	8.03	150
.0003	14.61	4	41	12.44	12.	87
			880			1243

TABLE 11-65

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Almond B

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	770,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	167,000
- Advanced Case [2000/4000 Ft. Fracture]	332,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0303

TABLE 11-66

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Lewin Area 2 & 3
FORMATION Almond B
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2422111	1.50	0	0	-	1017	0	-587	0	0	0	0	0	0	0	0	0	0
21	2.50	11.3	1	C	1411	.590	-352	0	0	0	0	0	0	0	0	0	0
31	3.10	23.3	2	CD	1676	1.053	-40	8.7	0	0	0	0	0	0	0	0	0
41	3.50	27.1	3	BCD	2117	1.327	217	16.9	543	653	409	27.1	298	111	90	358	856
51	5.00	46.6	5	ABCDE	3225	2.493	1402	41.9	770	1006	309	46.7	165	144	138	549	995
61	7.00	56.5	6	ABCDEF	3784	2.930	2871	69.2	838	1156	286	56.6	124	162	160	639	1084
71	9.00	"	"	"	"	"	4255	100.4	"	"	"	"	"	"	"	"	"
81	12.00	64.7	7	ABCDEFG	4139	3.095	6480	140.8	879	1247	284	64.8	100	184	179	716	1179
Discount Rate 15%																	
12	1.50	0	0	-	1017	0	-584	0	0	0	0	0	0	0	0	0	0
22	2.50	11.3	1	C	1411	.590	-400	0	0	0	0	0	0	0	0	0	0
32	3.10	23.3	2	CD	1676	1.053	-160	8.7	0	0	0	0	0	0	0	0	0
42	3.50	"	"	"	"	"	-66	2.4	0	0	0	0	0	0	0	0	0
52	5.00	46.6	5	ABCDE	3225	2.493	959	41.9	770	1006	309	46.6	165	144	137	549	995
62	7.00	"	"	"	"	"	1928	72.8	"	"	"	"	"	"	"	"	"
72	9.00	56.5	6	ABCDEF	3784	2.930	3189	100.4	838	1156	286	56.6	124	162	160	639	1084
82	12.00	"	"	"	"	"	4860	145.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1017	0	-580	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
33	3.10	11.3	1	C	1411	.590	-360	0	0	0	0	0	0	0	0	0	0
43	3.50	"	"	"	"	"	-310	2.9	0	0	0	0	0	0	0	0	0
53	5.00	28.6	4	ABCD	2235	1.398	393	37.9	564	684	403	28.5	288	115	100	402	906
63	7.00	46.6	5	ABCDE	3225	2.493	1471	72.8	770	1006	309	46.6	165	144	137	549	995
73	9.00	"	"	"	"	"	2311	103.2	"	"	"	"	"	"	"	"	"
83	12.00	56.5	6	ABCDEF	3784	2.930	3880	145.2	838	1156	286	56.6	124	162	160	639	1084

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-67

BASIN Green River
SUB BASIN Lewin 2 & 3
FORMATION Almond B
TECHNOLOGY Advanced
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2422211	1.50	0	0	-	1207	0	-681	0	0	0	0	0	0	0	0	0	0
21	2.50	15.1	2	BC	1708	.921	-275	1.1	0	0	0	0	0	0	0	0	0
31	3.10	27.1	3	BCD	2011	1.465	142	13.8	653	653	446	0	325	121	62	248	756
41	3.50	"	"	"	"	"	301	18.2	"	"	"	27.1	"	"	"	"	"
51	5.00	45.1	4	BCDE	3303	2.956	1659	40.7	975	975	330	45.1	181	149	120	481	931
61	7.00	56.5	6	ABCDEF	5114	3.893	3717	65.9	1156	1156	297	56.5	129	168	202	810	1309
71	9.00	"	"	"	"	"	5527	98.0	"	"	"	"	"	"	"	"	"
81	12.00	64.7	7	ABCDEFG	6602	4.386	8803	131.7	1243	1247	283	64.7	100	183	267	1068	1619
Discount Rate 15%																	
12	1.50	0	0	-	1207	0	-675	0	-	-	-	-	-	-	-	-	-
22	2.50	15.1	2	BC	1708	.921	-357	1.1	-	-	-	-	-	-	-	-	-
32	3.10	27.1	3	BCD	2011	1.465	-33	13.8	-	-	-	-	-	-	-	-	-
42	3.50	"	"	"	"	"	97	18.2	653	653	446	45.1	325	121	62	248	756
52	5.00	45.1	4	BCDE	3303	2.956	1082	40.7	975	975	330	46.6	181	149	120	481	931
62	7.00	46.6	5	ABCDE	3671	3.060	2250	70.5	1006	1006	329	46.5	176	153	141	564	1034
72	9.00	56.5	6	ABCDEF	5114	3.893	4075	98.0	1156	1156	297	56.5	129	168	202	810	1309
82	12.00	"	"	"	"	"	6242	145.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1207	0	-670	0	-	-	-	-	-	-	-	-	-
23	2.50	11.3	1	C	1528	.683	-484	0	-	-	-	-	-	-	-	-	-
33	3.10	15.1	2	BC	1708	.921	-302	6.3	-	-	-	-	-	-	-	-	-
43	3.50	27.1	3	BCD	2011	1.465	-43	18.2	-	-	-	-	-	-	-	-	-
53	5.00	"	"	"	"	"	370	35.0	653	653	446	45.1	325	121	62	248	756
63	7.00	45.1	4	BCDE	33803	2.956	1595	68.0	975	975	330	46.6	181	149	120	481	931
73	9.00	56.5	6	ABCDEF	5114	3.893	3129	98.0	1156	1156	297	56.5	129	168	202	810	1309
83	12.00	"	"	"	"	"	4928	145.9	"	"	"	"	"	"	"	"	"

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-68

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin 2 & 3
FORMATION: Ericson, Rock Sprgs.,Blair

DEPTH (FT.): 10700
PRESSURE (PSIA): 5560
TEMPERATURE (°F): 220

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	80	5.9	25	906.4	682	0.30	1.0	-
0.01	263	5.2	35	3676.74	2604	0.45	1.0	-
0.003	297	4.5	50	5132.16	3414	0.60	1.0	-
0.001	194	3.8	70	3963.42	2464	0.70	1.0	-
0.0003	126	3.1	100	3000.06	1721	0.80	1.0	-
0.0001	68	2.4	150	1880.2	1014	0.90	1.0	-
0.00003	46	1.8	200	1271.9	613	0.95	1.0	-
0.00001	69	1.2	280	1780.2	789	0.95	1.0	-
	1142			21612.	13301			

TABLE 11-69

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ERICKSON-ROCK SPRGS-BLAIR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			495	354	256	188	131	99	62	42
2			230	181	132	98	70	52	32	21
5			88	94	75	56	39	31	19	12
10			35	50	47	38	27	20	13	7
15			18	32	37	30	22	16	10	7
20			10	24	29	26	18	14	9	6
30			4	13	20	20	15	12	6	5
30-YEAR CUMM. PROD. (MMCF)			1579	1700	1539	1229	890	670	419	279

TABLE 11-70

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ERICKSON-ROCK SPRGS-BLAIR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			568	437	319	273	217	167	103	69
2			221	209	162	127	94	73	45	30
5			64	90	87	70	52	41	25	17
10			20	39	49	43	31	27	18	12
15			10	22	34	28	23	22	14	10
20			5	14	26	22	17	16	12	9
30			2	7	15	15	11	13	9	6
30-YEAR CUMM. PROD. (MMCF)			1369	1590	1630	1380	1060	910	589	400

TABLE 11-71

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Ericson,Rock Sprgs.,Blair

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.434	4	505	6.267	6.267	682
.01	5.859	4	1771	6.264	6.264	2604
.003	7.505	4	1809	7.086	7.086	3414
.001	10.366	4	961	9.232	9.232	2464
.0003	15.494	4	447	13.00	12	1583
.0001	22.060	4	182	16.242	12	750
.00003	32.339	4	80	23.00	12	319
.00001	41.219	4	79	28.75	12	331
			5834			12147

TABLE II-72

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Ericson, Rock Sprgs.,Blair

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,080,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	176,000 - 993,000
- Advanced Case [2000/4000 Ft. Fracture]	350,000 - 1,823,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-73

ECONOMICS SUMMARY

BASIN Green River

SUB BASIN Lewin Areas 2 & 3

FORMATION Ericson, Rock Springs, Blair

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
08231 11	1.50	0	0 -	1759	0	-1006	0	-	-	-	-	-	-	-	-	-
21	2.50	2.0	1 C	1924	0	-944	0	-	-	-	-	-	-	-	-	-
31	3.10	12.4	2 CD	3531	0	-329	6.1	-	-	-	-	-	-	-	-	-
41	3.50	26.9	3 CDE	6337	5.702	593	14.3	4085	6700	642	26.9	469	173	454	1815	2911
51	5.00	39.6	4 CDEF	8352	7.616	2661	26.5	5046	9164	663	39.6	400	263	658	2633	3954
61	7.00	"	" "	"	"	5208	43.3	"	"	"	"	"	"	"	"	"
71	9.00	48.5	5 CDEFG	9571	8.387	8251	59.6	5493	10885	655	48.5	338	317	751	3001	4407
81	12.00	"	" "	"	"	12400	84.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	0	0 -	1759	0	-1009	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0 -	1759	0	-1009	0	-	-	-	-	-	-	-	-	-
32	3.10	2.0	1 C	1924	0	-936	0	-	-	-	-	-	-	-	-	-
42	3.50	12.4	2 CD	3531	0	-435	0	-	-	-	-	-	-	-	-	-
52	5.00	26.9	3 CDE	6337	5.702	1043	25.7	4085	6700	642	26.9	469	173	454	1815	2911
62	7.00	39.6	4 CDEF	8352	7.616	3185	43.3	5046	9164	663	39.6	400	263	658	2633	3954
72	9.00	"	" "	"	"	5041	60.1	"	"	"	"	"	"	"	"	"
82	12.00	48.5	5 CDEFG	9571	8.387	8338	84.9	5493	10885	655	48.5	338	317	751	3001	4407
Discount Rate 20%																
13	1.50	0	0 -	1759	0	-1010	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0 -	1759	0	-1010	0	-	-	-	-	-	-	-	-	-
33	3.10	0	0 -	1759	0	-1010	0	-	-	-	-	-	-	-	-	-
43	3.50	2.0	1 C	1924	0	-937	0	505	682	-	-	-	-	-	-	-
53	5.00	2.0	3 CDE	6337	5.702	432	25.7	4085	6700	642	26.9	469	173	454	1815	2911
63	7.00	"	" "	"	"	1585	41.0	"	"	"	"	"	"	"	"	"
73	9.00	39.6	4 CDEF	8352	7.616	3458	60.1	5046	9164	663	39.6	400	263	658	2633	3954
83	12.00	48.5	5 CDEFG	9571	8.387	5965	84.9	5493	10885	655	48.5	338	317	750	3001	4407

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-74

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Advanced

SUB BASIN Lewin 2 & 3 — FORMATION Ericson, Rock Spring, Blair — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0823211	1.50	0	0	-	2112	0	-1206	0	-	-	-	-	-	-	-	-	-
21	2.50	0	0	-	2112	0	-1206	0	-	-	-	-	-	-	-	-	-
31	3.10	12.4	2	CD	5130	0	-334	6.5	-	-	-	-	-	-	-	-	-
41	3.50	26.9	3	CDE	10194	8.293	1228	17.0	6700	6700	808	26.9	591	217	890	3884	5256
51	5.00	39.6	4	CDEF	15270	12.325	5096	32.9	9164	9164	743	39.6	449	294	1269	5076	7088
61	7.00	"	"	"	"	"	9715	56.1	"	"	"	"	"	"	"	"	"
71	9.00	48.5	5	CDEFG	20777	14.903	16278	75.6	10747	10885	721	48.5	372	350	1610	8442	8773
81	12.00	"	"	"	"	"	24573	112.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2112	0	-1204	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0	-	2112	0	-1204	0	-	-	-	-	-	-	-	-	-
32	3.10	0	0	-	2112	0	-1204	0	-	-	-	-	-	-	-	-	-
42	3.50	12.4	2	CD	5130	0	-421	9.4	-	-	-	-	-	-	-	-	-
52	5.00	26.9	3	CDE	1019	8.293	2112	32.0	6700	6700	808	26.9	591	217	890	3884	5256
62	7.00	39.6	4	CDEF	1527	12.325	6315	56.1	9164	9164	743	39.6	449	294	1269	5076	7088
72	9.00	"	"	"	"	"	9742	79.7	"	"	"	"	"	"	"	"	"
82	12.00	48.5	5	CDEFG	2077	14.903	17021	112.7	10747	10747	721	48.5	372	350	1610	6442	8773
Discount Rate 20%																	
13	1.50	0	0	-	2112	0	-1201	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	2112	0	-1201	0	-	-	-	-	-	-	-	-	-
33	3.10	0	0	-	2112	0	-1201	0	-	-	-	-	-	-	-	-	-
43	3.50	0	0	-	2112	0	-1201	0	-	-	-	-	-	-	-	-	-
53	5.00	26.9	3	CDE	10194	8.293	1166	32.0	6700	6700	808	26.9	591	217	890	3884	5256
63	7.00	39.6	4	CDEF	15270	12.325	4288	56.1	9164	9164	743	39.6	449	294	1269	5076	7088
73	9.00	"	"	"	"	"	6973	79.7	"	"	"	"	"	"	"	"	"
83	12.00	48.5	5	CDEFG	20777	14.903	12475	112.7	10747	10747	721	48.5	372	350	1610	6442	8773

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-75

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin 2 & 3
FORMATION: Ft. Union

DEPTH (FT.): 8000
PRESSURE (PSIA): 3840
TEMPERATURE (°F): 175

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	2	6.7	7	6.18	5	0.20	1.0	-
0.03	12	5.9	14	65.28	47	0.35	1.0	-
0.01	33	5.2	25	282.81	205	0.45	1.0	-
0.003	48	4.4	48	667.2	454	0.65	1.0	-
0.001	33	3.8	70	578.16	367	0.75	1.0	-
0.0003	14	3.1	88	251.72	148	0.80	1.0	-
	142			1851.	1226			

TABLE 11-76

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		209	216	210	188	145	89			
2		82	106	108	97	76	47			
5		23	47	56	56	43	27			
10		7	21	33	37	30	18			
15		3	12	22	28	24	15			
20		1	7	17	24	20	13			
30		0	3	10	17	16	10			
30-YEAR CUMM. PROD. (MMCF)		500	829	1100	1189	969	600			

TABLE 11-77

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		249	253	254	242	211	148			
2		112	129	130	122	98	64			
5		41	64	68	67	55	36			
10		15	33	39	40	33	23			
15		7	21	27	29	26	17			
20		4	13	20	23	20	14			
30		1	7	12	15	15	9			
30-YEAR CUMM. PROD. (MMCF)		739	1159	1320	1329	1149	769			

TABLE 11-78

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Ft. Union

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	4.76	4	4	3.22	3.22	5
.03	4.75	4	39	3.40	3.40	47
.01	5.64	4	146	4.697	4.697	205
.003	7.96	4	227	7.118	7.118	454
.001	11.78	4	128	9.678	9.678	367
.0003	17.65	4	34	13.77	12.	129
			578			1207

TABLE 11-79

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin 2 & 3
FORMATION: Ft. Union

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	588,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	159,300 - 360,490
- Advanced Case [2000/4000 Ft. Fracture]	317,000 - 726,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-80

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Lewin Area 2 & 3
FORMATION Ft. Union
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0824111	1.50	0	0	0	876	0	-496	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	33.3	3	CDE	1814	1.700	18	10.4	412	706	242	33.3	162	80	61	228	528
41	3.50	"	"	"	"	"	145	13.2	"	"	"	"	"	"	"	"	"
51	5.00	51.8	4	CDEF	2105	2.234	908	29.3	540	1073	242	51.8	116	125	73	290	604
61	7.00	"	"	"	"	"	1715	46.9	"	"	"	"	"	"	"	"	"
71	9.00	61.0	6	BCDEFG	2235	2.384	2675	66.1	578	1226	"	61.0	95	148	79	316	637
81	12.00	"	"	"	"	"	3958	91.1	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	876	0	-493	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	31.6	2	CD	1742	1.621	-82	12.5	"	"	"	31.6	"	"	"	"	"
52	5.00	51.8	4	CDEF	2105	2.234	500	29.3	540	1073	242	51.8	116	125	73	290	604
62	7.00	"	"	"	"	"	1107	46.9	"	"	"	"	"	"	"	"	"
72	9.00	61.0	6	BCDEFG	2235	2.384	1821	66.1	578	1226	"	61.0	95	148	79	316	637
82	12.00	"	"	"	"	"	2787	91.1	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	876	0	-489	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	33.3	3	CDE	1814	1.700	108	24.1	412	706	242	33.3	162	80	61	228	528
63	7.00	51.8	4	CDEF	2105	2.234	739	46.9	540	1073	242	51.8	116	125	73	290	604
73	9.00	"	"	"	"	"	1223	63.8	"	"	"	"	"	"	"	"	"
83	12.00	61.0	6	BCDEFG	2235	2.384	2072	91.1	578	1226	"	61.0	95	148	79	316	637

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-81

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Lewin Area 2 & 3

FORMATION Ft. Union

TECHNOLOGY Advanced

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08242 11	1.50	0	0	0	1079	0	-611	0	0	0	0	0	0	0	0	0	0
21	2.50	0	0	0	"	0	"	0	0	0	0	0	0	0	0	0	0
31	3.10	33.3	3	CDE	2532	2.400	126	12.1	706	706	294	33.3	197	98	90	360	744
41	3.50	"	"	"	"	"	311	15.4	"	"	"	"	"	"	"	"	"
51	5.00	51.8	5	BCDEF	3710	3.802	1709	34.5	1078	1078	284	51.8	137	147	146	582	1101
61	7.00	"	"	"	"	"	3129	56.0	"	"	"	"	"	"	"	"	"
71	9.00	61.0	6	BCDEFG	4732	4.434	5124	77.4	1207	1226	273	61.0	106	166	181	723	1176
81	12.00	"	"	"	"	"	7602	109.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1079	0	-605	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	33.3	3	CDE	2532	2.400	17	15.4	706	706	294	33.3	197	98	90	360	744
52	5.00	51.8	5	BCDEF	3710	3.802	1004	34.5	1078	1078	284	51.8	137	147	146	582	1101
62	7.00	"	"	"	"	"	2073	56	"	"	"	"	"	"	"	"	"
72	9.00	61.0	6	BCDEFG	4732	4.434	3515	77.4	1207	1226	273	61.0	106	166	181	723	1176
82	12.00	"	"	"	"	"	5378	109.0	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	1079	0	-599	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	33.5	4	BCDE	2544	2.408	266	27.9	711	711	295	33.5	197	99	91	364	750
63	7.00	51.8	5	BCDEF	3710	3.802	1432	56.0	1078	1078	284	51.8	137	147	146	582	1101
73	9.00	"	"	"	"	"	2279	76.6	"	"	"	"	"	"	"	"	"
83	12.00	61.0	6	BCDEFG	4732	4.434	4013	109.0	1207	1226	273	61.0	106	166	181	723	1176

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-82

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin Areas 2 & 3
FORMATION: Almond A + Almond B

DEPTH (FT.): 9200
PRESSURE (PSIA): 4780
TEMPERATURE (°F): 200

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket + Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	9	*	*	78.82	58	*	*	*
0.1	17			157.01	110			
0.03	36			503.53	340			
0.01	43			628.85	425			
0.003	45			680.20	425			
0.001	22			335.75	201			
0.0003	15			233.44	128			
	187			2618.	1687			

* Refer to individual formations for these data.

TABLE 11-83

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND A + ALMOND B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	557	586	622	466	341	272	228			
2	184	238	313	260	198	162	140			
5	80	97	142	142	120	101	88			
10	51	54	76	86	81	70	61			
15	40	41	52	61	61	55	48			
20	33	33	40	48	50	46	40			
30	25	25	28	33	37	35	31			
30-YEAR CUMM. PROD. (MMCF)	2019	2219	2810	2760	2459	2120	1850			

TABLE 11-84

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND A + ALMOND B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	783	1010	963	781	629	578	512			
2	287	512	530	450	374	337	306			
5	172	247	278	256	229	207	191			
10	119	143	166	162	156	140	130			
15	93	103	120	119	119	107	102			
20	77	82	93	95	98	88	84			
30	57	58	65	67	72	64	62			
30-YEAR CUMM. PROD. (MMCF)	3930	5000	5460	5069	4699	4229	3959			

TABLE 11-85

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin Areas 2 & 3
FORMATION: Almond A + Almond B

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.3	3.07	3.07	58	1.58	1.58	58
0.1	2.94	2.94	110	1.31	1.31	110
0.03	3.40	3.40	340	1.75	1.75	340
0.01	3.57	3.57	425	1.95	1.95	425
0.003	3.85	3.85	425	2.01	2.01	425
0.001	4.22	4.0	191	2.12	2.12	201
0.0003	4.62	4.0	111	2.16	2.16	128
			1659			1687

TABLE 11-86

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin Areas 2 & 3
FORMATION: Almond A + Almond B

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	770,411
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	270,112
- Advanced Case [2000/4000 Ft. Fracture]	642,436
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-87

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Lewin Area 2 & 3
FORMATION Almond A + B
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2425111	1.50	11.3	1	C	2250	2.407	-289	4.2	0	0	0	0	0	0	0	0	0
21	2.50	56.5	6	ABCDEF	5581	9.579	2478	34.1	1549	1559	162	56.5	70	91	131	522	815
31	3.10	64.7	7	ABCDEFG	5968	10.440	3995	48.2	1660	1687	159	64.8	56	103	140	559	858
41	3.50	"	"	"	"	"	4902	58.2	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	8305	96.9	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	12841	147.4	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	17378	194.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	24182	256.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	0	0	-683	0	0	0	0	0	0	0	0	0	0
22	2.50	46.6	5	ABCDE	4949	8.204	1301	33.8	1349	1349	164	46.7	88	77	114	455	733
32	3.10	56.5	6	ABCDEF	5581	9.579	2458	48.3	1549	1559	162	56.5	70	91	131	522	815
42	3.50	64.7	7	ABCDEFG	5968	10.440	3305	58.2	1660	1687	159	64.8	56	103	140	559	858
52	5.00	"	"	"	"	"	5922	96.9	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	9412	147.4	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	12902	194.2	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	18136	256.5	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	0	0	-681	0	0	0	0	0	0	0	0	0	0
23	2.50	27.1	4	ABCD	3264	4.672	346	28.6	933	933	200	27.0	146	54	76	304	579
33	3.10	46.6	5	ABCDE	4949	8.204	1463	47.6	1349	1349	164	46.7	88	77	114	455	733
43	3.50	56.5	6	ABCDEF	5581	9.579	2184	58.2	1549	1559	162	56.5	70	91	131	522	815
53	5.00	64.7	7	ABCDEFG	5968	10.440	4428	96.9	1660	1687	159	64.8	56	103	140	559	858
63	7.00	"	"	"	"	"	7246	147.4	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	10065	194.2	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	14292	256.5	"	"	"	"	"	"	"	"	"

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.05	0.01	0.003	0.001	0.0003

TABLE 11-88

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Areas 2 & 3 — FORMATION Almond A + Almond B — DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
2425211	1.50	55.0	5	BCDEF	4049	9.801	934	20.0	1501	1501	160	55.0	72	88	54	215	429
21	2.50	64.7	7	ABCDEFG	4441	10.921	3408	47.2	1687	1687	161	64.7	56	104	63	252	476
31	3.10	"	"	"	"	"	4779	63.6	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	5693	74.6	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	9120	115.3	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	13688	165.9	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	18257	211.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	25111	273.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	27.1	3	BCD	2736	4.870	-143	12.2	0	0	0	27.1	0	0	0	0	0
22	2.50	64.7	7	ABCDEFG	4441	10.921	2225	47.2	1687	1687	161	64.7	56	104	63	252	476
32	3.10	"	"	"	"	"	3277	63.6	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	3979	74.6	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	6610	115.3	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	10118	165.9	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	13627	211.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	18889	273.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	11.3	1	C	2194	2.508	-598	3.9	0	0	0	11.3	0	0	0	0	0
23	2.50	64.7	7	ABCDEFG	4441	10.921	1493	47.2	1687	1687	161	64.7	56	104	63	252	476
33	3.10	"	"	"	"	"	2343	63.6	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	2909	74.6	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	5032	115.3	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	7864	165.9	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	10695	211.9	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	14943	273.2	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-89

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin Areas 2 & 3
FORMATION: Almond B + Ericson, Rock Springs, Blair

DEPTH (FT.): 10,700
PRESSURE (PSIA): 5560
TEMPERATURE (°F): 220

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	29	*	*	531.61	400	*	*	*
0.01	96			2109.47	1494			
0.003	108			2800.59	1863			
0.001	11			2097.52	1304			
0.0003	45			1553.20	891			
0.0001	25			951.23	513			
0.00003	17			661.89	319			
0.00001	25			970.20	430			
	416			11676.70	7214			

* Refer to individual formations for these data.

TABLE 11-90

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND B + ERIKSON-ROCK SPRGS-BLAR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			758	616	518	451	394	361	324	304
2			346	297	248	214	185	167	147	137
5			136	142	123	104	87	79	67	61
10			59	74	71	62	51	44	38	31
15			33	48	52	46	37	31	26	22
20			21	35	41	37	30	26	20	18
30			11	20	27	27	22	18	13	12
30-YEAR CUMM. PROD. (MMCF)			2540	2659	2500	2189	1850	1640	1390	1240

TABLE 11-91

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, ALMOND B + ERIKSON-ROCK SPRGS-BLAR

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			892	760	642	597	541	491	427	393
2			370	357	310	275	242	221	193	179
5			131	157	154	137	119	108	92	84
10			54	72	83	76	65	61	51	45
15			30	42	55	49	44	42	34	30
20			19	29	40	37	32	31	26	23
30			10	15	24	23	19	21	18	14
30-YEAR CUMM. PROD. (MMCF)			2629	2849	2890	2640	2319	2170	1850	1659

TABLE 11-92

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin Areas 2 & 3
FORMATION: Almond B + Ericson, Rock Sprgs.,Blair

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.03	5.40	4	296	5.23	5.23	400
0.01	5.86	4	1019	5.48	5.48	1494
0.003	6.88	4	1083	5.96	5.96	1863
0.001	8.40	4	621	6.98	6.98	1304
0.0003	10.53	4	338	8.40	8.40	891
0.0001	12.57	4	163	9.47	9.47	513
0.00003	13.82	4	92	10.37	10.37	319
0.00001	13.85	4	124	10.39	10.39	430
			3737			7214

TABLE 11-93

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin Area 2 & 3
FORMATION: Almond B + Ericson,Rock Sprgs.,Blair

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,080,170
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	342,507 - 1,159,452
- Advanced Case [2000/4000 Ft. Fracture]	681,804 - 2,154,659
Surface Equipment ($/Well)	42,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	0.0303

TABLE 11-94

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Lewin Areas 2 & 3
FORMATION Almond B + Ericson,Rock Sprgs.,Blair
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0826111	1.50	0	0	0	1837	0	-1043	0	0	0	0	0	0	0	0	0	0
21	2.50	26.9	3	CDE	3375	3.249	-38	9.5	0	0	0	26.9	0	0	0	0	0
31	3.10	39.6	4	CDEF	4090	4.526	801	19.2	3019	5061	667	39.6	403	264	200	799	1666
41	3.50	"	"	"	"	"	1176	23.8	"	"	"	"	"	"	"	"	"
51	5.00	53.4	6	CDEFGH	5270	5.884	3336	46.1	3522	6465	599	53.4	279	319	255	1021	1875
61	7.00	64.1	8	CDEFGHIJ	6103	6.486	6231	75.3	3740	7214	577	64.1	207	369	287	1151	2016
71	9.00	"	"	"	"	"	8864	103.5	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	12812	143.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1837	0	-1039	0	0	0	0	0	0	0	0	0	0
22	2.50	12.4	2	CD	2541	1.494	-657	2	0	0	0	12.4	0	0	0	0	0
32	3.10	26.9	3	CDE	3375	3.249	-5	0	0	0	0	26.9	0	0	0	0	0
42	3.50	39.6	4	CDEF	4090	4.526	573	23.8	3019	5061	667	39.6	403	264	200	799	1666
52	5.00	48.5	5	CDEFG	4928	5.546	2058	45.1	3358	5952	605	48.5	312	293	239	956	1801
62	7.00	53.4	6	CDEFGH	5270	5.884	4019	73.2	3522	6465	599	53.4	279	319	255	1021	1875
72	9.00	64.1	8	CDEFGHIJ	6103	6.486	6431	103.5	3740	7214	577	64.1	207	369	287	1151	2016
82	12.00	"	"	"	"	"	9492	143.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	1837	0	-1035	0	0	0	0	0	0	0	0	0	0
23	2.50	2.0	1	C	1938	2.04	- 981	"	"	"	"	2.0	"	"	"	"	"
33	3.10	26.9	3	CDE	3375	3.249	-244	14.9	"	"	"	26.9	"	"	"	"	"
43	3.50	"	"	"	"	"	-65	18.6	"	"	"	"	"	"	"	"	"
53	5.00	48.5	5	CDEFG	4928	5.546	1379	45.1	3358	5952	605	48.5	312	293	239	956	1801
63	7.00	53.4	6	CDEFGH	5270	5.884	2963	73.2	3522	6465	599	53.4	279	319	255	1021	1875
73	9.00	64.1	8	CDEFGHIJ	6103	6.486	4903	103.5	3740	7214	577	64.1	207	369	287	1151	2016
83	12.00	"	"	"	"	"	7395	143.2	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-95

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Lewin 2 & 3

FORMATION Almond B + Ericson, Rock Sprgs., Blair

TECHNOLOGY Advanced

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08262 11	1.50	0	0	0	2353	0	-1336	0	0	0	0	0	0	0	0	0	0
21	2.50	26.9	3	CDE	5712	5.012	305	12.8	3757	3757	750	26.9	547	202	279	1117	2144
31	3.10	39.6	4	CDEF	7735	7.426	1964	25.3	5061	5061	681	39.6	412	269	391	1564	2636
41	3.50	"	"	"	"	"	2703	31.5	"	"	"	"	"	"	"	"	"
51	5.00	48.5	5	CDEFG	10862	10.057	7073	58.8	5952	5952	592	48.5	305	287	492	1967	3051
61	7.00	57.8	7	CDEFGHI	14498	12.030	13589	93.0	6784	6784	564	57.8	238	326	594	2376	3534
71	9.00	64.1	8	CDEFGHIJ	16911	13.113	20672	130.0	7214	7214	550	64.1	197	353	660	2642	3853
81	12.00	"	"	"	"	"	30134	189.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	2353	0	-1325	0	0	0	0	0	0	0	0	0	0
22	2.50	12.4	2	CD	3923	2.213	-726	3.3	0	0	0	12.4	0	0	0	0	0
32	3.10	26.9	3	CDE	5712	5.012	472	20.2	3757	3757	750	26.9	547	202	279	1117	2144
42	3.50	39.6	4	CDEF	7735	7.426	1610	31.5	5061	5061	681	39.6	412	269	391	1564	2636
52	5.00	48.5	5	CDEFG	10862	10.057	4871	58.8	5952	5952	592	48.5	305	287	492	1967	3051
62	7.00	53.4	6	CDEFGH	12750	11.140	9332	95.2	6465	6465	580	53.4	270	310	550	2198	3325
72	9.00	64.1	8	CDEFGHIJ	16911	13.113	15201	130.0	7214	7214	550	64.1	197	353	660	2642	3853
82	12.00	"	"	"	"	"	22605	189.7	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	2353	0	-1315	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	26.9	3	CDE	5712	5.012	14	20.2	3757	3757	750	26.9	547	202	279	1117	2144
43	3.50	"	"	"	"	"	347	25.2	"	"	"	"	"	"	"	"	"
53	5.00	39.6	4	CDEF	7735	7.426	2708	55.7	5061	5061	681	39.6	412	269	391	1564	2636
63	7.00	48.5	5	CDEFG	10862	10.057	6555	95.8	5952	5952	592	46.5	305	287	492	1967	3051
73	9.00	57.8	7	CDEFGHI	14498	12.030	11010	132.5	6784	6784	564	57.8	238	326	594	2376	3534
83	12.00	64.1	8	CDEFGHIJ	16911	13.113	17694	189.7	7214	7214	550	64.1	197	353	660	2642	3853

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-96

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Lewin Area 2 & 3
FORMATION: Lance and Lewis

DEPTH (FT.): 8500
PRESSURE (PSIA): 4415
TEMPERATURE (°F): 180

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	36	5.1	15	197.60	160	0.15	1.0	-
0.03	131	4.6	22	951.32	728	0.35	1.0	-
0.01	225	4.2	30	2034.45	1467	0.45	1.0	-
0.003	204	3.8	36	2002.67	1353	0.55	1.0	-
0.001	87	3.4	42	1103.77	696	0.65	1.0	-
0.0003	44	3.1	50	587.27	344	0.75	1.0	-
	727			6877.	5092			

TABLE 11-97

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, LANCE AND LEWIS

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		471	409	283	181	131	73			
2		138	177	144	93	68	38			
5		25	58	70	52	39	21			
10		5	20	34	31	27	15			
15		1	9	21	23	21	12			
20		0	5	15	17	17	10			
30		0	2	8	11	13	8			
30-YEAR CUMM. PROD. (MMCF)		820	1119	1250	1030	850	490			

TABLE 11-98

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, LEWIN 2 AND 3, LANCE AND LEWIS

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		544	494	343	249	210	120			
2		78	214	174	118	93	51			
5		10	70	85	60	50	29			
10		2	24	42	31	30	18			
15		1	11	26	20	20	13			
20		0	6	18	14	15	10			
30		0	2	9	8	9	7			
30-YEAR CUMM. PROD. (MMCF)		719	1350	1509	1100	980	600			

TABLE 11-99

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Lewin Areas 2 & 3
FORMATION: Lance & Lewis

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	5.427	4	118	6.189	6.189	160
.03	4.969	4	582	4.119	4.119	728
.01	5.216	4	1130	4.321	4.321	1467
.003	6.437	4	839	6.027	6.027	1353
.001	9.412	4	299	8.163	8.163	696
.0003	15.959	4	258	13.03	12.	313
			3256			4717

TABLE 11-100

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Lewin Area 2 & 3
FORMATION: Lance & Lewis

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	666,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	163,350
- Advanced Case [2000/4000 Ft. Fracture]	325,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-101

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Lewin Area 2 & 3 — FORMATION Lance + Lewis — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0827111	1.50	0	0	0	1031	0	-594	0	0	0	0	0	0	0	0	0	0
21	2.50	19.8	2	CD	3826	3.603	175	12.7	1742	2539	483	19.8	388	96	312	1244	2040
31	3.10	20.8	3	BCD	3927	3.688	692	20.6	1860	2699	504	20.8	400	105	337	1346	2187
41	3.50	36.0	4	BCDE	6367	6.562	1638	26.8	2699	4052	412	36.0	263	148	505	2023	2939
51	5.00	44.3	5	BCDEF	7155	7.416	3872	46.0	2998	4748	404	44.3	225	179	570	2281	3256
61	7.00	"	"	"	"	"	6711	70.4	"	"	"	"	"	"	"	"	"
71	9.00	49.4	6	BCDEFG	7446	7.614	9690	91.2	3256	5092	428	49.4	216	211	631	2526	3586
81	12.00	"	"	"	"	"	14043	119.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1031	0	-596	0	0	0	0	0	0	0	0	0	0
22	2.50	6.1	1	C	1893	1.067	-396	0	0	0	0	6.1	0	0	0	0	0
32	3.10	20.8	3	BCD	3927	3.688	283	20.6	1860	2699	504	20.8	400	105	337	1346	2187
42	3.50	"	"	"	"	"	533	25.4	"	"	"	"	"	"	"	"	"
52	5.00	36.0	4	BCDE	6367	6.562	2285	46.4	2699	4052	412	36.0	263	148	505	2023	2939
62	7.00	44.3	5	BCDEF	7155	7.416	4556	70.4	2998	4748	404	44.3	225	179	570	2281	3256
72	9.00	"	"	"	"	"	6658	91.7	"	"	"	"	"	"	"	"	"
82	12.00	49.4	6	BCDEFG	7446	7.614	9962	119.0	3256	5092	428	49.4	216	211	631	2526	3586
Discount Rate 20%																	
13	1.50	0	0	0	1031	0	-597	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	1031	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	7.1	2	BC	1994	1.067	-322	6.6	"	"	"	7.1	"	"	"	"	"
43	3.50	20.8	3	BCD	3927	3.688	223	25.4	1860	2699	504	20.8	400	105	337	1346	2187
53	5.00	36.0	4	BCDE	6367	6.562	1500	46.4	2699	4052	412	36.0	263	148	505	2023	2939
63	7.00	44.3	5	BCDEF	7155	7.416	3231	70.4	2998	4748	404	44.3	225	179	570	2281	3256
73	9.00	"	"	"	"	"	4866	91.7	"	"	"	"	"	"	"	"	"
83	12.00	49.4	6	BCDEFG	7446	7.614	7422	119.0	3256	5092	428	49.4	216	211	631	2526	3586

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-102

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Lewin Area 2 & 3 — FORMATION Lance & Lewis — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0827211	1.50	0	0	0	1193	0	-685	0	0	0	0	0	0	0	0	0	0
21	2.50	19.8	2	CD	4475	4.307	291	13.9	2195	2195	509	19.8	408	101	325	1299	2134
31	3.10	"	"	"	"	"	860	21.3	"	"	"	"	"	"	"	"	"
41	3.50	36.0	4	BCDE	9196	8.472	2388	29.6	3708	3708	438	36.0	280	158	681	2223	3842
51	5.00	44.3	5	BCDEF	11125	10.116	5946	52.7	4404	4404	436	44.3	242	193	840	3361	4637
61	7.00	49.4	6	BCDEFG	12290	10.754	10590	79.5	4717	4748	439	49.4	222	216	946	3783	5168
71	9.00	"	"	"	"	"	15153	106.1	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	21997	139.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1193	0	-685	0	0	0	0	0	0	0	0	0	0
22	2.50	6.1	1	C	2185	1.155	-436	.2	0	0	0	6.1	0	0	0	0	0
32	3.10	19.8	2	CD	4475	4.307	370	21.3	2195	2195	509	19.8	408	101	325	1299	2134
42	3.50	"	"	"	"	"	657	26.1	"	"	"	"	"	"	"	"	"
52	5.00	44.3	5	BCDEF	11125	10.116	3883	52.7	4404	4404	436	44.3	242	193	840	3361	4637
62	7.00	"	"	"	"	"	7107	82.1	"	"	"	"	"	"	"	"	"
72	9.00	49.4	6	BCDEFG	12290	10.754	10698	106.1	4717	4748	439	49.4	222	216	946	3783	5168
82	12.00	"	"	"	"	"	15814	139.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	1193	0	-684	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	6.1	1	C	2185	1.155	-381	6.1	0	0	0	6.1	0	0	0	0	0
43	3.50	19.8	2	CD	4475	4.307	291	26.1	2195	2195	509	19.8	408	101	325	1299	2134
53	5.00	36.0	4	BCDE	9196	8.472	2272	52.1	3708	3708	438	36.0	280	158	681	2723	3842
63	7.00	44.3	5	BCDEF	11125	10.116	5126	82.1	4404	4404	436	44.3	242	193	840	3361	4637
73	9.00	"	"	"	"	"	7643	107.5	"	"	"	"	"	"	"	"	"
83	12.00	49.4	6	BCDEFG	12290	10.754	11881	139.9	4717	4748	439	49.4	222	216	946	3783	5168

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-103

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Washakie
FORMATION: Almond

DEPTH (FT.): 12000
PRESSURE (PSIA): 7200
TEMPERATURE (°F): 240

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	2	4.7	13	10.46	7	0.50	1.0	-
0.03	6	4.0	19	39.06	30	0.60	1.0	-
0.01	9	3.6	25	69.3	55	0.70	1.0	-
0.003	7	3.4	33	67.2	47	0.75	1.0	-
0.001	3	3.2	42	34.5	20	0.80	1.0	-
	27			221.	159			

TABLE 11-104

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, WASHAKIE , ALMOND

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		712	485	331	211	144				
2		484	323	202	128	80				
5		261	218	141	81	52				
10		135	143	109	63	39				
15		81	107	90	56	33				
20		57	78	77	50	30				
30		28	53	58	43	26				
30-YEAR CUMM. PROD. (MMCF)		4235	4072	3147	1987	1228				

TABLE 11-105

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, WASHAKIE , ALMOND

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		1081	1205	933	723	524				
2		711	786	582	419	286				
5		425	481	364	258	177				
10		254	302	255	184	123				
15		170	219	201	151	103				
20		127	153	168	131	90				
30		73	105	120	105	75				
30-YEAR CUMM. PROD. (MMCF)		7485	8824	7596	5711	3957				

TABLE 11-106

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Almond

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	.973	.973	7	.550	.550	7
.03	1.189	1.189	30	.548	.548	30
.01	1.912	1.912	55	.792	.792	55
.003	3.174	3.174	47	1.105	1.105	47
.001	5.736	4.00	15	1.781	1.781	20
			154			159

TABLE 11-107

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Almond

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,220,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	110,000
- Advanced Case [2000/4000 Ft. Fracture]	140,000 - 360,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-108

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Washakie
FORMATION Almond
TECHNOLOGY Base Case
DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0831111	1.50	16.2	2	BC	1929	1.950	-440	2.2	-	-	-	16.2	-	-	-	-	-
21	2.50	37.9	3	BCD	2567	3.752	545	17.3	92	92	25	37.9	16	9	4	16	45
31	3.10	37.9	3	BCD	2567	3.752	1012	23.8	92	92	25	37.9	16	9	4	16	45
41	3.50	57.1	4	BCDE	4418	6.284	2049	28.1	139	139	22	57.1	9	12	10	38	70
51	5.00	57.1	4	BCDE	4418	6.284	3923	46.9	139	139	22	57.1	9	12	10	38	70
61	7.00	66.5	5	BCDEF	5195	7.194	6964	71.7	154	159	21	66.5	7	14	11	46	78
71	9.00	66.5	5	BCDEF	5195	7.194	9731	100.5	154	159	21	66.5	7	14	11	46	78
81	12.00	66.5	5	BCDEF	5195	7.194	13883	144.	154	159	21	66.5	7	14	11	46	78
Discount Rate 15%																	
12	1.50	4.1	1	B	1550	.412	-719	0	-	-	-	4.1	-	-	-	-	-
22	2.50	16.2	2	BC	1929	1.950	-235	9.5	-	-	-	16.2	-	-	-	-	-
32	3.10	37.9	3	BCD	2567	3.752	488	23.8	92	92	25	37.9	16	9	4	16	45
42	3.50	37.9	3	BCD	2567	3.752	725	28.2	92	92	25	37.9	16	9	4	16	45
52	5.00	57.1	4	BCDE	4418	6.284	2501	46.9	139	139	22	57.1	9	12	10	38	70
62	7.00	66.5	5	BCDEF	5195	7.194	4707	71.7	154	159	21	66.5	7	14	11	46	78
72	9.00	66.5	5	BCDEF	5195	7.194	6785	100.5	154	159	21	66.5	7	14	11	46	78
82	12.00	66.5	5	BCDEF	5195	7.194	9903	144.	154	159	21	66.5	7	14	11	46	78
Discount Rate 20%																	
13	1.50	0	0	-	1439	-	-797	0	-	-	-	0	-	-	-	-	-
23	2.50	16.2	2	BC	1929	1.950	-366	9.5	-	-	-	16.2	-	-	-	-	-
33	3.10	16.2	2	BC	1929	1.950	-205	14.0	-	-	-	16.2	-	-	-	-	-
43	3.50	37.9	3	BCD	2567	3.752	359	28.2	92	92	25	37.9	16	9	4	16	45
53	5.00	37.9	3	BCD	2567	3.752	1074	45.0	92	92	25	37.9	16	9	4	16	45
63	7.00	57.1	4	BCDE	4418	6.284	3149	74.1	139	139	22	57.1	9	12	10	38	70
73	9.00	66.5	5	BCDEF	5195	7.194	5010	100.5	154	159	21	66.5	7	14	11	46	78
83	12.00	66.5	5	BCDEF	5195	7.194	7494	144.	154	159	21	66.5	7	14	11	46	78

* CODE:

B	C	D	E	F
0.1	0.03	0.01	0.003	0.001

TABLE 11-109

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advance Case

SUB BASIN Washakie — FORMATION Almond — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08312 11	1.50	57.1	4	BCDE	2494	6.274	741	20.9	139	139	22	57.1	9	12	2	9	33
21	2.50	66.5	5	BCDEF	2924	7.331	2554	45.8	159	159	22	66.5	7	15	3	13	39
31	3.10	"	"	"	"	"	3553	61.1	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	4219	71.4	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	6718	109.8	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	10050	158.4	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	13382	203.4	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	18379	264.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	37.9	3	BCD	1899	3.743	-51	13.8	-	-	-	37.9	-	-	-	-	-
22	2.50	66.5	5	BCDEF	2924	7.331	1682	45.8	159	159	22	66.5	7	15	3	13	39
32	3.10	"	"	"	"	"	2458	61.1	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	2976	71.4	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	4916	109.8	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	7504	158.4	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	10091	203.4	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	13973	264.5	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	37.9	3	BCD	1899	3.743	-215	13.8	-	-	-	37.9	-	-	-	-	-
23	2.50	57.1	4	BCDE	2494	6.274	940	43.4	139	139	22	57.1	9	12	2	9	33
33	3.10	66.5	5	BCDEF	2924	7.331	1766	61.1	159	159	22	66.5	7	15	3	13	39
43	3.50	"	"	"	"	"	2188	71.4	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	3769	109.8	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	5876	158.4	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	7986	203.4	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	11149	264.5	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F
0.1	0.03	0.01	0.003	0.001

TABLE 11-110

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Washakie
FORMATION: Lance, Lewis

DEPTH (FT.): 11,000
PRESSURE (PSIA): 6600
TEMPERATURE (°F): 223

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	6	5.6	12	34	31	0.10	1.0	-
0.1	13	4.7	16	82.45	82	0.30	1.0	-
0.03	31	4.0	23	240.50	214	0.50	1.0	-
0.01	42	3.6	30	382.54	335	0.55	1.0	-
0.003	46	3.4	46	606.69	472	0.60	1.0	-
0.001	30	3.2	56	453.36	335	0.65	1.0	-
0.0003	17	3.0	76	326.86	239	0.70	1.0	-
0.0001	8	2.9	100	195.65	115	0.80	1.0	-
	192			2322.	1823			

TABLE 11-111

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, WASHAKIE , LANCE-LEWIS

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	530	507	430	309	253	171	112	82		
2	72	133	172	151	130	88	59	44		
5	6	21	50	66	72	51	33	25		
10	1	4	15	30	42	34	23	17		
15	0	1	6	17	29	25	19	13		
20	0	0	3	10	22	22	16	12		
30	0	0	1	5	14	15	13	9		
30-YEAR CUMM. PROD. (MMCF)	660	820	1049	1170	1369	1090	760	559		

TABLE 11-112

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, WASHAKIE , LANCE-LEWIS

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	345	378	426	408	401	290	190	136		
2	3	14	33	72	124	115	82	59		
5	0	1	5	11	33	45	44	33		
10	0	0	1	3	10	19	26	22		
15	0	0	0	1	4	11	18	17		
20	0	0	0	1	3	6	13	13		
30	0	0	0	0	1	3	8	10		
30-YEAR CUMM. PROD. (MMCF)	349	410	510	600	829	879	879	739		

TABLE 11-113

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Lance & Lewis

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	8.456	4	15	15.99	12	23
.1	7.368	4	44	14.74	12	66
.03	6.73	4	126	13.84	12	184
.01	6.749	4	198	13.16	12	305
.003	7.426	4	255	12.26	12	463
.001	10.686	4	124	13.25	12	305
.0003	17.875	4	53	15.45	12	186
.0001	28.569	4	16	21.61	12	64
			831			1596

TABLE 11-114

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Lance & Lewis

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,006,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	176,000 - 473,000
- Advanced Case [2000/4000 Ft. Fracture]	351,000 - 979,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-115

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Washakie — FORMATION Lance & Lewis — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0832111	1.50	0	0	0	1388	0	-788	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
41	3.50	36.0	3	CDE	4253	2.983	361	14.9	579	1021	194	36.0	124	70	91	363	648
51	5.00	47.5	6	ABCDEF	5428	4.058	1929	33.5	762	1469	188	47.5	99	89	123	492	804
61	7.00	"	"	"	"	"	3810	60.1	"	"	"	"	"	"	"	"	"
71	9.00	53.4	7	ABCDEFG	5639	4.235	5849	87.2	815	1708	192	53.4	90	103	133	528	853
81	12.00	57.4	8	ABCDEFGH	5732	4.298	8841	127.2	831	1823	193	57.4	83	111	135	540	868
Discount Rate 15%																	
12	1.50	0	0	0	1388	0	-786	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	8.4	1	C	2153	.623	-534	0	0	0	0	8.4	0	0	0	0	0
52	5.00	38.0	4	BCDE	4432	3.090	989	33.5	623	1103	202	38.0	125	77	100	401	703
62	7.00	47.5	6	ABCDEF	5428	4.058	2684	60.1	762	1469	188	47.5	99	89	123	492	804
72	9.00	"	"	"	"	"	4188	87.4	"	"	"	"	"	"	"	"	"
82	12.00	53.4	7	ABCDEFG	5639	4.235	6614	127.5	815	1708	192	53.4	90	103	133	528	853
Discount Rate 20%																	
13	1.50	0	0	0	1388	0	-783	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	38.0	4	BCDE	4432	3.090	597	33.5	623	1103	202	38.0	125	77	100	401	703
63	7.00	47.5	6	ABCDEF	5428	4.058	1952	60.1	762	1469	188	47.5	99	89	123	492	804
73	9.00	"	"	"	"	"	3203	87.4	"	"	"	"	"	"	"	"	"
83	12.00	53.4	7	ABCDEFG	5639	4.235	5206	127.5	815	1708	192	53.4	90	103	133	528	853

* CODE:

A	B	C	D	E	F	G	H
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-116

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Washakie

FORMATION Lance & Lewis

TECHNOLOGY Advanced

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0832211	1.50	0	0	0	1594	0	-905	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
51	5.00	25.2	2	EF	10355	4.636	1704	26.9	768	807	166	25.2	124	41	204	817	1186
61	7.00	45.5	4	CDEF	17430	7.034	7181	83.5	1257	1356	179	45.5	98	81	402	1607	2187
71	9.00	53.4	7	ABCDEFG	19368	7.860	12575	139.8	1532	1708	194	53.4	91	104	487	1945	2627
81	12.00	57.4	8	ABCDEFGH	20040	8.140	20191	225.3	1596	1823	196	57.4	84	113	502	2008	2707
Discount Rate 15%																	
12	1.50	0	0	0	1594	0	-900	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
52	5.00	15.7	1	E	6303	2.447	348	21.6	463	472	189	15.7	160	29	128	511	828
62	7.00	45.5	4	CDEF	17430	7.034	5553	83.5	1257	1356	179	45.5	98	81	402	1607	2187
72	9.00	53.0	6	BCDEFG	19229	7.831	9983	139.5	1509	1677	192	53.0	90	102	477	1907	2578
82	12.00	53.4	7	ABCDEFG	19368	7.860	16222	230.3	1532	1708	194	53.4	91	104	487	1945	2627
Discount Rate 20%																	
13	1.50	0	0	0	1594	0	-895	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
63	7.00	37.1	3	DEF	14290	6.073	3572	74.0	1073	1142	177	37.1	111	65	317	1270	1764
73	9.00	47.1	5	BCDEF	17994	7.173	7819	143.8	1323	1438	185	47.1	98	87	429	1717	2331
83	12.00	53.4	7	ABCDEFG	19368	7.860	13525	230.3	1532	1708	194	53.4	91	104	487	1945	2627

* CODE:

A	B	C	D	E	F	G	H
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-117

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Washakie
FORMATION: Lower Mesaverde

DEPTH (FT.): 14,500
PRESSURE (PSIA): 8700
TEMPERATURE (°F): 277

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	9	5.7	20	92.61	66	0.30	1.0	-
0.01	40	5.1	31	570.8	395	0.45	1.0	-
0.003	91	4.4	50	1806.35	1202	0.65	1.0	-
0.001	88	3.8	80	2413.84	1513	0.70	1.0	-
0.0003	43	3.1	130	1563.91	886	0.75	1.0	-
0.0001	14	2.5	200	631.68	339	0.80	1.0	-
	285			7079.	4401			

TABLE 11-118

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, WASHAKIE , LOWER MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			512	418	365	311	232	182		
2			216	209	189	162	121	97		
5			68	98	104	92	69	55		
10			22	47	61	62	47	37		
15			10	28	43	46	38	30		
20			5	19	33	40	33	26		
30			2	9	21	28	27	21		
30-YEAR CUMM. PROD. (MMCF)			1329	1729	1990	1960	1549	1229		

TABLE 11-119

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, WASHAKIE , LOWER MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			609	526	534	452	390	302		
2			119	228	217	203	168	131		
5			19	83	88	100	88	74		
10			5	31	36	54	51	49		
15			2	16	19	36	34	35		
20			1	9	12	26	24	29		
30			0	4	6	15	15	20		
30-YEAR CUMM. PROD. (MMCF)			910	1560	1649	1950	1710	1579		

TABLE 11-120

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Lower Mesa Verde

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.696	4	47	8.318	8.318	66
.01	5.784	4	273	6.410	6.410	395
.003	6.653	4	721	8.029	8.029	1202
.001	8.724	4	696	8.769	8.769	1513
.0003	13.421	4	266	12.158	12.	877
.0001	19.398	4	71	15.098	12.	271
			2074			4324

TABLE 11-121

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Lower Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	2,704,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	188,000 - 1,064,000
- Advanced Case [2000/4000 Ft. Fracture]	375,000 - 1,953,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-122

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Washakie
FORMATION Lower Mesa Verde
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0833111	1.50	0	0	0	3275	0	-1833	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
61	7.00	48.2	4	CDEF	11983	6.325	2436	20.0	1737	3176	275	48.2	142	133	160	638	1071
71	9.00	"	"	"	"	"	"	29.8	"	"	"	"	"	"	"	"	"
81	12.00	59.9	6	CDEFGH	13885	7.391	9075	47.2	2074	4401	280	59.9	113	168	193	773	1248
Discount Rate 15%																	
12	1.50	0	0	0	3275	0	-1818	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
62	7.00	27.4	3	CDE	8724	3.857	26	15.1	1041	1663	269	27.4	196	74	100	401	771
72	9.00	48.2	4	CDEF	11983	6.325	2503	29.8	1737	3176	275	48.2	142	133	160	638	1071
82	12.00	59.9	6	CDEFGH	13885	7.391	5621	47.2	2074	4401	280	59.9	113	168	193	773	1248
Discount Rate 20%																	
13	1.50	0	0	0	3275	0	-1803	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
73	9.00	27.4	3	CDE	8724	3.857	303	22.7	1041	1663	269	27.4	196	74	100	401	771
83	12.00	48.2	4	CDEF	11983	6.325	3170	44.8	1737	3176	275	48.2	142	133	160	638	1071

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-123

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Washakie

FORMATION Lower Mesa Verde

TECHNOLOGY Advanced

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0833211	1.50	0	0	0	3657	0	-2049	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
61	7.00	46.7	3	DEF	23905	10.073	5830	29.0	3110	3110	308	46.7	164	144	384	1536	2229
71	9.00	48.2	4	CDEF	24435	10.211	10550	45.9	3176	3176	311	48.2	161	150	398	1589	2297
81	12.00	64.3	6	CDEFGH	35711	14.231	22254	71.9	4324	4401	304	64.3	109	196	544	2176	3024
Discount Rate 15%																	
12	1.50	0	0	0	3657	0	-2030	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
62	7.00	25.9	2	DE	15556	5.467	1305	22.7	1597	1597	292	25.9	216	76	223	892	1407
72	9.00	48.2	4	CDEF	24435	10.211	6787	45.9	3176	3176	311	48.2	161	150	398	1589	2297
82	12.00	59.9	5	CDEFG	33555	13.461	14647	72.5	4053	4062	301	59.9	121	180	511	2045	2858
Discount Rate 20%																	
13	1.50	0	0	0	3657	0	-2010	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
73	9.00	46.7	3	DEF	23905	10.073	4315	45.1	3110	3110	308	46.7	164	144	384	1536	2229
83	12.00	48.2	4	CDEF	24435	10.211	8632	70.5	3176	3176	311	48.2	161	150	398	1589	2297

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-124

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular + Blanket

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: Washakie
FORMATION: Lance, Lewis + Almond

DEPTH (FT.): 12,000
PRESSURE (PSIA): 7200
TEMPERATURE (°F): 240

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	3	*	*	58.28	39	*	*	*
0.03	11			196.60	151			
0.01	16			318.78	253			
0.003	13			294.54	206			
0.001	5			148.35	86			
	48			1017.	735			

* Refer to individual formations for these data.

TABLE 11-125

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, WASHAKIE , LANCE-LEWIS + ALMOND

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		1000	773	619	500	433				
2		608	447	327	253	204				
5		314	272	195	135	106				
10		162	171	136	91	66				
15		99	125	108	74	51				
20		70	91	91	64	43				
30		37	62	67	52	35				
30-YEAR CUM. PROD. (MMCF)		5319	5159	4229	3069	2310				

TABLE 11-126

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, WASHAKIE , LANCE-LEWIS + ALMOND

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		1439	1562	1291	1081	882				
2		790	865	662	499	366				
5		449	505	388	282	201				
10		263	312	265	193	133				
15		175	224	207	156	109				
20		131	156	172	135	94				
30		76	107	123	107	77				
30-YEAR CUMM. PROD. (MMCF)		8180	9509	8290	6400	4650				

TABLE 11-127

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Lance & Lewis + Almond

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	2.55	2.55	39	1.66	1.66	39
.03	2.77	2.77	151	1.50	1.50	151
.01	3.66	3.66	253	1.87	1.87	253
.003	5.17	4.	159	2.48	2.48	206
.001	7.04	4.	49	3.50	3.50	86
			651			735

TABLE 11-128

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Lance & Lewis + Almond

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,508,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	316,000
- Advanced Case [2000/4000 Ft. Fracture]	549,000 - 770,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-129

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Washakie
FORMATION Lance, Lewis & Almond
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
0834111	1.50	16.2	2 BC	2628	2.283	-618	1.2	0	0	0	16.2	0	0	0	0	0
21	2.50	57.1	4 BCDE	4467	7.384	1398	23.1	602	649	81	57.1	35	47	22	87	191
31	3.10	"	" "	"	"	2301	32.5	"	"	"	"	"	"	"	"	"
41	3.50	66.5	5 BCDEF	4715	7.962	3157	41.0	651	735	81	66.5	27	54	24	97	202
51	5.00	"	" "	"	"	5580	68.6	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	8810	106.7	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	12040	143.9	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	16884	196.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	4.1	1 B	2055	4.41	-992	0	0	0	0	4.1	0	0	0	0	0
22	2.50	37.9	3 BCD	3607	5.194	318	19.5	443	443	86	37.9	53	33	15	60	161
32	3.10	57.1	4 BCDE	4467	7.384	1345	32.5	602	649	81	57.1	35	47	22	87	191
42	3.50	"	" "	"	"	1809	39.1	"	"	"	"	"	"	"	"	"
52	5.00	66.5	5 BCDEF	4715	7.962	3863	68.6	651	735	81	66.5	27	54	24	97	202
62	7.00	"	" "	"	"	6359	106.7	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	8855	143.9	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	12599	196.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	0	0 0	1951	0	-1077	0	0	0	0	0	0	0	0	0	0
23	2.50	16.2	2 BC	2628	2.283	-498	8.9	0	0	0	17.2	0	0	0	0	0
33	3.10	37.9	3 BCD	3607	5.194	399	27.3	443	443	86	37.9	53	33	15	60	161
43	3.50	"	" "	"	"	682	32.6	"	"	"	"	"	"	"	"	"
53	5.00	66.5	5 BCDEF	4715	7.962	2805	68.6	651	735	81	66.5	27	54	24	97	202
63	7.00	"	" "	"	"	4839	106.7	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	6872	143.9	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	9921	196.6	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F
0.1	0.03	0.01	0.003	0.001

TABLE 11-130

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Washakie — FORMATION Lance & Lewis + Almond — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
083421	1.50	37.9	3	BCD	2935	5.165	74	10.9	443	443	86	37.9	53	33	4	16	105
21	2.50	66.5	5	BCDEF	4056	8.754	2800	41.9	735	735	84	66.5	28	55	12	48	143
31	3.10	"	"	"	"	"	4000	57.3	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	4801	67.9	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	7802	107.6	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	11804	158.8	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	15805	206.7	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	21808	272.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	37.9	3	BCD	2935	5.165	-255	10.9	0	0	0	37.9	0	0	0	0	0
22	2.50	66.5	5	BCDEF	4056	8.754	1817	41.9	735	735	84	66.5	28	55	12	48	143
32	3.10	"	"	"	"	"	2763	57.3	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	3393	67.9	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	5757	107.6	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	8909	158.8	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	12061	206.7	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	16789	272.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.2	2	BC	2624	2.262	-891	1.0	0	0	0	16.2	0	0	0	0	0
23	2.50	57.1	4	BCDE	3745	7.761	984	38.5	649	649	84	57.1	36	48	10	39	131
33	3.10	66.5	5	BCDEF	4056	8.754	1977	57.3	735	735	84	66.5	28	55	12	48	143
43	3.50	"	"	"	"	"	2498	67.9	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	4448	107.6	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	7050	158.8	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	9651	206.7	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	13552	272.4	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F
0.1	0.03	0.01	0.003	0.001

TABLE 11-131

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Washakie
FORMATION: Almond + Lower Mesaverde

DEPTH (FT.): 14,500
PRESSURE (PSIA): 8700
TEMPERATURE (°F): 277

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket + Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	2	*	*	42.10	30	*	*	*
0.01	11			239.88	166			
0.003	24			691.28	460			
0.001	23			858.33	538			
0.0003	11			533.07	302			
0.0001	4			208.70	112			
	75			2573.	1608			

* Refer to individual formations for these data.

TABLE 11-132

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, WASHAKIE , LOWER MESA VERDE + ALMOND

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			847	753	701	646	567	517		
2			429	422	401	374	334	309		
5			208	238	244	232	209	195		
10			120	145	160	161	146	136		
15			88	106	121	124	116	108		
20			69	83	97	104	97	90		
30			50	57	69	76	75	69		
30-YEAR CUMM. PROD. (MMCF)			4229	4620	4879	4849	4439	4120		

TABLE 11-133

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, WASHAKIE , LOWER MESA VERDE + ALMOND

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			1510	1427	1435	1353	1291	1203		
2			677	787	776	762	726	690		
5			364	427	433	445	433	419		
10			237	263	268	285	283	281		
15			181	195	199	215	214	214		
20			145	154	157	170	168	173		
30			105	109	112	120	120	125		
30-YEAR CUMM. PROD. (MMCF)			7860	8509	8600	8899	8660	8529		

TABLE 11-134

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Almond + Lower Mesa Verde

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	3.15	3.15	30	1.70	1.70	30
.01	3.42	3.42	166	1.86	1.86	166
.003	3.93	3.93	460	2.23	2.23	460
.001	4.77	4.	451	2.60	2.60	538
.0003	6.04	4	200	3.10	3.10	302
.0001	7.24	4.	62	3.50	3.50	112
			1369			1608

TABLE 11-135

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Washakie
FORMATION: Almond + Lower Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	2,704,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	302,000 - 1,177,000
- Advanced Case [2000/4000 Ft. Fracture]	722,000 - 2,300,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-136

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Washakie
FORMATION Almond + Lower Mesa Verde
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08351 11	1.50	0	0	0	3347	0	-1870	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	50.0	4	CDEF	7567	8.250	1065	15.5	1108	1194	135	50.0	67	67	37	146	316
41	3.50	61.4	5	CDEFG	7966	9.393	2137	20.9	1307	1496	139	61.4	53	86	41	163	343
51	5.00	65.5	6	CDEFGH	8012	9.658	4890	36.1	1369	1608	141	65.5	49	92	42	167	351
61	7.00	"	"	"	"	"	8384	55.8	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	11878	75.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	17120	103.3	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	3347	0	-1852	0	0	0	0	0	0	0	0	0	0
22	2.50	0	0	0	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	28.6	3	CDE	6315	5.120	-296	12.6	0	0	0	28.6	0	0	0	0	0
52	5.00	61.4	5	CDEFG	7966	9.393	2723	34.9	1307	1496	139	61.4	53	86	41	163	343
62	7.00	65.5	6	CDEFGH	8012	9.658	5450	55.8	1369	1608	141	65.5	49	92	42	167	351
72	9.00	"	"	"	"	"	8029	75.2	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	11897	103.3	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	3347	0	-1834	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	0	"	0	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	50.0	4	CDEF	7567	8.250	1176	31.1	1108	1194	135	50.0	67	67	37	146	316
63	7.00	65.5	6	CDEFGH	8012	9.658	3714	55.8	1369	1608	141	65.5	49	92	42	167	351
73	9.00	"	"	"	"	"	5734	75.2	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	8763	103.3	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-137

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Washakie — FORMATION Almond + Lower Mesa Verde — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0835211	1.50	0	0	0	3958	0	-2215	0	0	0	0	0	0	0	0	0	0
21	2.50	61.4	5	CDEFG	6692	10.687	2139	23.3	1496	1496	140	61.4	54	86	21	80	241
31	3.10	65.5	6	CDEFGH	6757	11.162	3731	33.9	1608	1608	144	65.5	50	95	21	83	250
41	3.50	"	"	"	"	"	4651	40.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	8102	64.0	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	12702	95.4	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	17303	125.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	24205	169.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	3958	0	-2191	0	0	0	0	0	0	0	0	0	0
22	2.50	50.0	4	CDEF	6190	8.901	481	19.0	1194	1194	134	50.0	67	67	16	66	216
32	3.10	61.4	5	CDEFG	6692	10.687	2004	32.0	1496	1496	140	61.4	54	86	21	80	241
42	3.50	65.5	6	CDEFGH	6757	11.162	2909	40.1	1608	1608	144	65.5	50	95	21	83	250
52	5.00	"	"	"	"	"	5535	64.0	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	9037	95.4	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	12539	125.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	17792	169.5	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	3958	0	-2165	0	0	0	0	0	0	0	0	0	0
23	2.50	28.6	2	DE	5231	5.108	-944	9.3	0	0	0	28.6	0	0	0	0	0
33	3.10	50.0	4	CDEF	6190	8.901	583	26.3	1194	1194	134	50.0	67	67	16	66	216
43	3.50	61.4	5	CDEFG	6692	10.687	1660	38.0	1496	1496	140	61.4	54	86	21	80	241
53	5.00	65.5	6	CDEFGH	6757	11.162	3956	64.0	1608	1608	144	65.5	50	95	21	83	250
63	7.00	"	"	"	"	"	6766	95.4	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	9576	125.9	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	13791	169.5	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-138

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: E/2 Lewin 4
FORMATION: Mesaverde

DEPTH (FT.): 11,500
PRESSURE (PSIA): 7468
TEMPERATURE (°F): 216

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	6	5.0	30	78.24	63	0.20	1.0	-
0.01	21	4.4	40	321.72	239	0.35	1.0	-
0.003	73	3.9	55	1363.64	933	0.45	1.0	-
0.001	104	3.5	72	2279.68	1435	0.55	1.0	-
0.0003	83	3.1	100	2240.17	1311	0.65	1.0	-
0.0001	18	2.8	130	570.06	309	0.80	1.0	-
	305			6854.	4290			

TABLE 11-139

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, E/2 OF LEWIN 4, MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			672	501	356	252	178	116		
2			281	247	184	131	93	61		
5			87	111	102	75	53	35		
10			28	51	59	50	36	24		
15			12	30	42	37	30	19		
20			6	18	31	32	25	17		
30			2	9	19	23	20	13		
30-YEAR CUMM. PROD. (MMCF)			1729	1950	1929	1590	1189	789		

TABLE 11-140

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, E/2 OF LEWIN 4, MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			795	620	468	378	291	192		
2			152	258	227	169	125	83		
5			25	90	110	82	66	47		
10			6	33	54	45	38	32		
15			3	16	33	30	25	24		
20			1	10	22	21	19	19		
30			0	4	11	12	11	14		
30-YEAR CUMM. PROD. (MMCF)			1179	1740	1939	1619	1280	1030		

TABLE 11-141

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: E/2 Lewin 4
FORMATION: Mesa Verde

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	6.07	4	43	8.905	8.905	63
.01	5.83	4	167	6.540	6.540	239
.003	6.62	4	569	6.591	6.591	933
.001	8.69	4	660	8.524	8.524	1435
.0003	13.28	4	393	12.34	12.0	1272
.0001	21.76	4	56	16.67	12.0	222
			1888			4164

TABLE II-142

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: E/2 Lewin 4
FORMATION: Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,342,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	177,000 - 688,000
- Advanced Case [2000/4000 Ft. Fracture]	352,000 - 1,490,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-143

ECONOMICS SUMMARY

BASIN Green River

SUB BASIN ~~Eastern~~ 1/2 Lewin 4

FORMATION Mesa Verde

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *		AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
08411 11	1.50	0	0	-	1871	0	-1059	0	-	-	-	-	-	-	-	-	-
21	2.50	.6	1	C	1907	0	-1043	0	-	-	-	.6	-	-	-	-	-
31	3.10	15.4	3	CDE	3371	0	-530	4.1	-	-	-	15.4	-	-	-	-	-
41	3.50	"	"	"	"	"	-379	5.8	-	-	-	15.4	-	-	-	-	-
51	5.00	31.5	4	CDEF	4695	3.523	827	17.3	1439	2670	408	31.5	280	128	141	566	1117
61	7.00	50.0	5	CDEFG	6717	5.083	2821	30.6	1832	3981	361	50.0	180	180	813	813	1376
71	9.00	"	"	"	"	"	4494	43.3	"	"	"	50.0	"	"	"	"	"
81	12.00	56.3	6	CDEFGH	6944	5.234	7192	62.4	1888	4290	"	56.3	158	203	211	844	1416
Discount Rate 15%																	
12	1.50	0	0	-	1871	0	-1053	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0	-	1871	0	-1053	0	-	-	-	-	-	-	-	-	-
32	3.10	2.0	2	CD	1987	0	-997	0	-	-	-	2.0	-	-	-	-	-
42	3.50	"	"	"	"	"	-983	0	-	-	-	2.0	-	-	-	-	-
52	5.00	15.4	3	CDE	3371	"	-201	12.0	-	-	-	15.4	-	-	-	-	-
62	7.00	31.5	4	CDEF	4695	3.523	1087	28.2	1439	2670	408	31.5	280	128	141	566	1117
72	9.00	50.0	5	CDEFG	6717	5.083	2728	43.3	1832	3981	361	50.0	180	180	203	813	1376
82	12.00	"	"	"	"	"	4558	61.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1871	0	-1046	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	"	"	-1046	0	-	-	-	-	-	-	-	-	-
33	3.10	.6	1	C	1907	"	-1031	0	-	-	-	.6	-	-	-	-	-
43	3.50	2.0	2	CD	1987	"	-992	0	-	-	-	2.0	-	-	-	-	-
53	5.00	15.4	3	CDE	3371	"	-427	12.0	-	-	-	15.4	-	-	-	-	-
63	7.00	31.5	4	CDEF	4695	3.523	.528	28.2	1439	2670	408	31.5	280	128	141	566	1117
73	9.00	"	"	"	"	"	1223	38.9	"	"	"	"	"	"	"	"	"
83	12.00	50.0	5	CDEFG	6717	5.083	3134	61.6	1832	3981	361	50.0	180	180	203	813	1376

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-144

ECONOMICS SUMMARY

BASIN Green River

SUB BASIN Eastern 1/2 Lewin 4

FORMATION Mesa Verde

TECHNOLOGY Advanced

DATE June 1980

CASE NO.	GAS PRICE $/MCF	AVERAGE PER PROSPECT: PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0841211	1.50	0	-	-	2228	-	-1260	0	-	-	-	-	-	-	-	-	-
21	2.50	0	-	-	"	-	-1260	0	-	-	-	-	-	-	-	-	-
31	3.10	14.8	2	DE	4859	-	-491	5.3	-	-	-	-	-	-	-	-	-
41	3.50	"	"	"	"	"	-251	7.6	-	-	-	-	-	-	-	-	-
51	5.00	31.5	4	CDEF	8710	5.856	2127	24.7	2670	2670	456	31.5	313	143	314	1256	2026
61	7.00	50.0	5	CDEFG	17988	10.388	7129	41.4	3942	3942	379	50.0	190	190	559	2237	3176
71	9.00	"	"	"	"	"	11297	61.5	"	"	"	"	"	"	"	"	"
81	12.00	56.3	6	CDEFGH	19609	11.032	18193	88.7	4164	4164	377	56.3	165	213	599	2395	3372
Discount Rate 15%																	
12	1.50	0	-	-	2228	-	-1250	0	-	-	-	-	-	-	-	-	-
22	2.50	"	-	-	"	-	-1250	0	-	-	-	-	-	-	-	-	-
32	3.10	"	-	-	"	-	-1250	0	-	-	-	-	-	-	-	-	-
42	3.50	1.4	1	D	2395	-	-1186	0	-	-	-	-	-	-	-	-	-
52	5.00	15.4	3	CDE	4937	2.954	133	16.6	1235	1235	418	15.4	354	64	127	509	1055
62	7.00	31.5	4	CDEF	8710	5.856	2892	41.2	2670	2670	456	31.5	313	143	314	1256	2026
72	9.00	50.0	5	CDEFG	17988	10.388	7435	61.5	3942	3942	379	50.0	190	190	559	2237	3176
82	12.00	"	"	"	"	"	12079	90.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	-	-	2228	-	-1239	0	-	-	-	-	-	-	-	-	-
23	2.50	0	-	-	"	-	-1239	0	-	-	-	-	-	-	-	-	-
33	3.10	0	-	-	"	-	-1239	0	-	-	-	-	-	-	-	-	-
43	3.50	0	-	-	"	-	-1239	0	-	-	-	-	-	-	-	-	-
53	5.00	15.4	3	CDE	4937	-	-217	16.6	-	-	-	-	-	-	-	-	-
63	7.00	31.4	4	CDEF	8710	5.856	1841	41.2	2670	2670	456	31.5	313	143	314	1256	2026
73	9.00	"	"	"	"	"	3276	56.8	"	"	"	"	"	"	"	"	"
83	12.00	50.0	5	CDEFG	17988	10.388	8716	90.2	3942	3942	379	50.0	190	190	559	2237	3176

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-145

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: E/2 Lewin 4
FORMATION: Ft. Union

DEPTH (FT.): 8000
PRESSURE (PSIA): 5630
TEMPERATURE (°F): 189

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	3	5.0	25	30.51	26	0.15	1.0	-
0.01	12	4.4	35	149.76	113	0.25	1.0	-
0.003	43	3.9	50	681.98	454	0.35	1.0	-
0.001	61	3.5	72	1251.72	774	0.45	1.0	-
0.0003	48	3.1	105	1268.64	732	0.60	1.0	-
0.0001	11	2.8	150	374.55	199	0.70	1.0	-
	178			3756.	2298			

TABLE 11-146

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, E/2 OF LEWIN 4, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			574	364	268	210	155	111		
2			236	185	138	109	82	58		
5			70	86	77	62	46	35		
10			22	44	49	42	32	23		
15			10	27	34	33	26	18		
20			5	18	27	26	23	16		
30			2	9	18	21	18	12		
30-YEAR CUMM. PROD. (MMCF)			1429	1570	1539	1359	1049	760		

TABLE 11-147

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, E/2 OF LEWIN 4, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			744	432	344	329	261	185		
2			188	196	170	146	113	81		
5			35	77	82	77	61	46		
10			9	32	47	45	36	31		
15			4	17	29	29	25	24		
20			2	11	21	21	19	19		
30			1	4	12	13	11	15		
30-YEAR CUMM. PROD. (MMCF)			1250	1429	1590	1479	1219	1020		

TABLE 11-148

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: E/2 Lewin 4
FORMATION: Ft. Union

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	6.065	4	20	6.934	6.934	26
.01	5.9979	4	80	6.590	6.590	113
.003	6.860	4	263	6.640	6.640	454
.001	9.336	4	325	8.579	8.579	774
.0003	14.537	4	198	12.510	12.	703
.0001	23.804	4	34	17.736	12.	133
			920			2203

TABLE II-149

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: E/2 Lewin 4
FORMATION: Ft. Union

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	593,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	159,000 - 775,000
- Advanced Case [2000/4000 Ft. Fracture]	317,000 - 1,652,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-150
ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Eastern 1/2 + Lewin 4
FORMATION Ft. Union
TECHNOLOGY Base
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08421 11	1.50	0	0	-	1118	0	-644	0	-	-	0	-	0	0	0	0	0
21	2.50	11.3	3	CDE	1706	"	-332	3.2	-	-	"	-	"	"	"	"	"
31	3.10	25.3	4	CDEF	2520	2.665	114	11.7	688	1367	257	25.3	192	65	85	338	681
41	3.50	"	"	"	"	"	291	14.3	"	"	"	"	"	"	"	"	"
51	5.00	41.3	5	CDEFG	3910	4.190	1452	26.8	886	2099	212	41.3	124	87	123	492	827
61	7.00	"	"	"	"	"	2757	41.4	"	"	"	"	"	"	"	"	"
71	9.00	46.2	6	CDEFGH	4055	4.315	4177	55.7	906	2218	210	46.2	113	97	127	506	843
81	12.00	"	"	"	"	"	6196	74.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1118	0	-645	0	-	-	0	-	0	0	0	0	0
22	2.50	11.3	3	CDE	1706	"	-439	3.2	-	-	"	-	"	"	"	"	"
32	3.10	"	"	"	"	"	-335	6.1	-	-	"	-	"	"	"	"	"
42	3.50	25.3	4	CDEF	2520	2.665	-30	14.3	-	-	"	-	"	"	"	"	"
52	5.00	"	"	"	"	"	451	24.0	688	1367	257	25.3	192	65	85	338	681
62	7.00	41.3	5	CDEFG	3910	4.190	1659	41.4	886	2099	212	41.3	124	87	123	492	827
72	9.00	"	"	"	"	"	2594	54.9	"	"	"	"	"	"	"	"	"
82	12.00	46.2	6	CDEFGH	4055	4.315	4116	74.6	906	2218	210	46.2	113	97	127	506	843
Discount Rate 20%																	
13	1.50	0	0	-	1118	0	-644	0	-	-	0	-	0	0	0	0	0
23	2.50	1.7	1	C	1224	"	-600	0	-	-	"	-	"	"	"	"	"
33	3.10	11.3	3	CDE	1706	"	-420	6.1	363	593	"	-	"	"	"	"	"
43	3.50	"	"	"	"	"	-365	8.0	363	593	"	-	"	"	"	"	"
53	5.00	25.3	4	CDEF	2520	2.665	158	24.0	688	1367	257	25.3	192	65	85	338	681
63	7.00	41.3	5	CDEFG	3910	4.190	1033	41.4	886	2099	212	41.3	124	87	123	492	827
73	9.00	"	"	"	"	"	1756	54.9	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	2816	73.2	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-151

ECONOMICS SUMMARY

BASIN: Green River
SUB BASIN: Eastern 1/2 + Lewin 4
FORMATION: Ft. Union
TECHNOLOGY: Advanced
DATE: June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0842211	1.50	0	0	-	1454	-	-835	0	-	-	-	-	-	-	-	-	-
21	2.50	11.3	3	CDE	2623	-	-362	4.1	593	593	-	11.3	-	-	-	-	-
31	3.10	25.3	4	CDEF	5217	5.023	655	16.7	1367	1367	273	25.3	203	68	189	756	1218
41	3.50	25.3	"	"	"	"	1050	20.7	"	"	"	"	"	"	"	"	"
51	5.00	41.3	5	CDEFG	12371	9.923	4205	35.7	2070	2099	209	41.3	123	86	332	1331	1672
61	7.00	"	"	"	"	"	7929	59.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	11653	80.7	"	"	"	"	"	"	"	"	"
81	12.00	46.6	CDEFGH		13389	10.433	17825	108.9	2150	2218	206	46.2	111	96	347	1388	1941
Discount Rate 15%																	
12	1.50	0	0	-	1454	0	-831	0	-	-	0	-	0	0	0	0	0
22	2.50	1.7	2	CD	1663	"	-758	0	-	-	"	1.7	"	"	"	"	"
32	3.10	11.3	3	CDE	2623	"	-337	8.0	593	593	"	11.3	"	"	"	"	"
42	3.50	25.3	4	CDEF	5217	5.023	419	20.7	1367	1367	273	25.3	203	68	189	756	1218
52	5.00	"	"	"	"	"	1520	35.4	"	"	"	"	"	"	"	"	"
62	7.00	41.3	5	CDEFG	12371	9.923	5132	59.2	2070	2099	209	41.3	123	86	332	1331	1872
72	9.00	"	"	"	"	"	7846	80.7	"	"	"	"	"	"	"	"	"
82	12.00	46.2	6	CDEFGH	13389	10.433	12291	108.9	2150	2218	206	46.2	111	96	347	1388	1941
Discount Rate 20%																	
13	1.50	0	0	-	1454	0	-827	0	-	-	0	-	0	0	0	0	0
23	2.50	0.6	1	C	1583	"	-792	0	-	-	"	-	"	"	"	"	"
33	3.10	11.3	3	CDE	2663	"	-467	8.0	593	593	"	11.3	"	"	"	"	"
43	3.50	11.5	3	CDE	"	"	-372	10.5	"	"	"	11.3	"	"	"	"	"
53	5.00	25.3	4	CDEF	5217	5.023	904	35.4	1367	1367	273	25.3	203	68	189	756	1218
63	7.00	41.3	5	CDEFG	12371	9.923	3471	59.2	2070	2099	209	41.3	123	86	332	1331	1872
73	9.00	"	"	"	"	"	5556	80.7	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	8682	109.0	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-152

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

BASIN: Greater Green River
SUBBASIN: E/2 Lewin 4
FORMATION: Ft.Union + Mesaverde

DEPTH (FT.): 11,500
PRESSURE (PSIA): 7468
TEMPERATURE (°F): 216

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	1	*	*	19.87	16	*	*	*
0.01	2			82.11	61			
0.003	8			305.47	209			
0.001	12			489.30	308			
0.0003	9			451.11	264			
0.0001	2			110.69	60			
	34			1459.	918			

* Refer to individual formations for these data.

TABLE 11-153

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, E/2 OF LEWIN 4, FORT UNION + MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			894	723	578	474	400	338		
2			395	361	298	245	207	175		
5			150	173	164	137	115	98		
10			68	91	99	90	76	64		
15			43	60	72	67	60	49		
20			30	43	56	57	49	41		
30			20	27	37	41	38	31		
30-YEAR CUMM. PROD. (MMCF)			3030	3239	3230	2890	2489	2090		

TABLE 11-154

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, E/2 OF LEWIN 4, FORT UNION + MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			1117	942	789	700	613	513		
2			296	402	371	312	268	227		
5			97	162	182	154	138	119		
10			47	74	95	86	79	73		
15			30	43	61	57	52	51		
20			21	30	42	40	38	39		
30			12	16	24	24	23	26		
30-YEAR CUMM. PROD. (MMCF)			2579	3140	3340	3019	2680	2439		

TABLE 11-155

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: E/2 Lewin 4
FORMATION: Ft. Union + Mesa Verde

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	7.77	4	8	9.13	9.13	16
.01	7.90	4	31	8.16	8.16	61
.003	7.94	4	105	7.66	7.66	209
.001	9.22	4	134	8.82	8.82	308
.0003	11.55	4	91	10.73	10.73	264
.0001	14.04	4	17	12.08	12	60
			387			918

TABLE 11-156

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: E/2 Lewin 4
FORMATION: Ft. Union + Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,342,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	491,000 - 1,002,000
- Advanced Case [2000/4000 Ft. Fracture]	993,000 - 2,131,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-157

ECONOMICS SUMMARY

BASIN Green River

SUB BASIN Eastern 1/2 - Lewin 4

FORMATION Ft.Union + Mesa Verde

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08431 11	1.50	0	0	-	2129	0	-1200	0	-	-	-	-	-	-	-	-	-
21	2.50	14.3	3	CDE	2338	0	-864	0	-	-	-	14.3	-	-	-	-	-
31	3.10	30.5	4	CDEF	2527	0	-377	5.0	-	-	-	30.5	-	-	-	-	-
41	3.50	"	"	"	"	0	-244	6.7	-	-	-	30.5	-	-	-	-	-
51	5.00	55.6	6	CDEFGH	2823	2.782	1063	24.6	385	918	138	55.6	62	77	9	35	184
61	7.00	"	"	"	"	"	2111	40.4	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	3160	56.4	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	4732	80.3	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2129	0	-1187	0	-	-	-	-	-	-	-	-	-
22	2.50	1.7	1	C	"	0	-1153	0	-	-	-	1.7	-	-	-	-	-
32	3.10	14.3	3	CDE	2328	0	-852	0	-	-	-	14.3	-	-	-	-	-
42	3.50	30.5	4	CDEF	2527	0	-465	6.7	-	-	-	30.5	-	-	-	-	-
52	5.00	49.5	5	CDEFG	2793	2.599	411	22.4	368	858	141	49.5	72	70	9	36	187
62	7.00	55.6	6	CDEFGH	2823	2.782	1338	40.4	385	918	138	55.6	62	77	9	35	184
72	9.00	"	"	"	"	"	2149	56.4	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	3366	80.3	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	2129	0	-1174	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	"	0	-1174	0	-	-	-	-	-	-	-	-	-
33	3.10	1.7	1	C	"	0	-1137	0	-	-	-	1.7	-	-	-	-	-
43	3.50	14.3	3	CDE	2338	0	-860	.6	-	-	-	14.3	-	-	-	-	-
53	5.00	30.5	4	CDEF	2527	0	-281	13.5	-	-	-	30.5	-	-	-	-	-
63	7.00	55.6	6	CDEFGH	2823	2.782	867	40.4	385	918	138	55.6	62	77	9	35	184
73	9.00	"	"	"	"	"	1530	56.4	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	2524	80.3	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-158

ECONOMICS SUMMARY

BASIN Green River — TECHNOLOGY Advanced

SUB BASIN Eastern 1/2 Lewin 4 — FORMATION Ft. Union + Mesa Verde — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *		AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0843211	1.50	0	0	-	2815	0	-1588	0	-	-	-	-	0	0	0	0	0
21	2.50	1.3	2	CD	2913	0	-1533	0	-	-	-	1.3	"	"	"	"	"
31	3.10	30.5	4	CDEF	5743	3.987	82	10.7	594	594	149	30.5	103	46	35	138	322
41	3.50	"	"	"	"	"	464	14.0	"	"	"	"	"	"	"	"	"
51	5.00	49.5	5	CDEFG	8825	6.592	3738	36.4	858	858	130	49.5	66	64	56	228	415
61	7.00	55.6	6	CDEFGH	9517	7.208	7483	63.0	917	918	127	55.6	56	71	61	242	429
71	9.00	"	"	"	"	"	10912	87.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	16055	122.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2815	0	-1567	0	-	-	-	-	0	0	0	0	0
22	2.50	0	0	-	2815	0	-1567	0	-	-	-	-	0	0	0	0	0
32	3.10	14.3	3	CDE	4125	1.890	-920	2.6	-	-	-	14.3	"	"	"	"	"
42	3.50	"	"	"	"	"	-771	4.6	-	-	-	14.3	"	"	"	"	"
52	5.00	49.5	5	CDEFG	8825	6.592	2319	36.4	858	858	130	49.5	66	64	56	228	415
62	7.00	55.6	6	CDEFGH	9517	7.208	5199	63.0	917	918	127	55.6	56	71	61	242	429
72	9.00	"	"	"	"	"	7871	87.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	11878	122.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	2815	0	-1546	0	-	-	-	-	0	0	0	0	0
23	2.50	0	0	-	"	"	-1546	0	-	-	-	-	"	"	"	"	"
33	3.10	0	0	-	"	"	-1546	0	-	-	-	-	"	"	"	"	"
43	3.50	14.3	3	CDE	4125	1.890	-935	4.6	-	-	-	14.3	"	"	"	"	"
53	5.00	30.5	4	CDEF	5743	3.987	480	26.7	594	594	149	30.5	103	46	35	138	322
63	7.00	49.5	5	CDEFG	8825	6.592	3431	60.5	858	858	130	49.5	66	64	56	228	415
73	9.00	55.6	6	CDEFGH	9517	7.208	5898	87.9	917	918	127	55.6	56	71	61	242	429
83	12.00	"	"	"	"	"	9146	122.9	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-159

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Ft. Union

DEPTH (FT.): 8,000
PRESSURE (PSIA): 3600
TEMPERATURE (°F): 168

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	6	5.7	20	46.22	36	0.10	1.0	-
0.01	23	5.0	27	211.09	140	0.20	1.0	-
0.003	77	4.5	38	890.24	573	0.35	1.0	-
0.001	109	4.1	52	1571.45	946	0.50	1.0	-
0.0003	87	3.8	72	1608.15	902	0.60	1.0	-
0.0001	19	3.3	100	423.84	280	0.65	1.0	-
	321			4751.	2877			

TABLE 11-160

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRIDGER, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			300	236	158	119	83	60		
2			147	121	82	62	43	31		
5			65	63	46	35	25	18		
10			29	35	31	24	17	13		
15			17	23	23	19	14	10		
20			10	17	20	16	11	8		
30			5	10	14	13	9	7		
30-YEAR CUMM. PROD. (MMCF)			1140	1189	989	789	559	410		

TABLE 11-161

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRIDGER, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			363	286	203	188	143	96		
2			178	147	102	84	62	42		
5			79	76	56	47	35	24		
10			36	42	32	30	22	16		
15			21	28	24	22	17	13		
20			13	21	18	17	13	11		
30			6	12	12	11	10	9		
30-YEAR CUMM. PROD. (MMCF)			1380	1439	1109	969	750	550		

TABLE 11-162

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Ft. Union

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.263	4	29	4.348	4.348	36
.01	5.119	4	106	4.230	4.230	140
.003	7.524	4	304	6.710	6.710	573
.001	11.000	4	341	8.957	8.957	946
.0003	18.547	4	198	13.824	12.	794
.0001	35.944	4	45	26.794	12	176
			1023			2665

TABLE 11-163

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Ft. Union

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	593,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	159,300 - 428,000
- Advanced Case [2000/4000 Ft. Fracture]	317,000 - 885,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-164

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Bridger,Lewin 5 W/2 Lewin 4

FORMATION Ft. Union

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0851111	1.50	0	0	0	989	0	-569	0	0	0	0	0	0	0	0	0	0
21	2.50	2.2	2	CD	1228	.351	-506	"	"	"	"	2.2	"	"	"	"	"
31	3.10	"	"	"	"	"	-464	"	"	"	"	"	"	"	"	"	"
41	3.50	10.9	3	CDE	1879	1.246	-230	5.7	0	0	0	10.9	0	0	0	0	0
51	5.00	26.7	4	CDEF	3326	2.812	585	17.2	780	1695	277	26.7	203	74	163	650	1089
61	7.00	43.8	5	CDEFG	5100	4.027	1899	28.2	978	2597	243	43.8	137	106	238	952	1432
71	9.00	"	"	"	"	"	3107	40.0	"	"	"	"	"	"	"	"	"
81	12.00	47.8	6	CDEFGH	5302	4.128	5012	56.6	1023	2877	247	47.8	129	118	252	1008	1508
Discount Rate 15%																	
12	1.50	0	0	0	989	0	-570	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	2.2	2	CD	1228	.351	-503	"	"	"	"	2.2	"	"	"	"	"
42	3.50	"	"	"	"	"	-482	"	"	"	"	"	"	"	"	"	"
52	5.00	10.9	3	CDE	1879	1.246	-136	11.6	"	"	"	10.9	"	"	"	"	"
62	7.00	26.7	4	CDEF	3326	2.812	751	27.9	780	1695	277	26.7	203	74	163	650	1089
72	9.00	43.8	5	CDEFG	5100	4.027	1818	40.0	978	2597	243	43.8	137	106	238	952	1432
82	12.00	"	"	"	"	"	3102	56.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	989	0	-571	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	.4	1	C	1016	.43	-562	"	"	"	"	.4	"	"	"	"	"
43	3.50	2.2	2	CD	1228	.351	-510	0	"	"	"	2.2	"	"	"	"	"
53	5.00	10.9	3	CDE	1879	1.246	-268	11.6	0	0	0	10.9	0	0	0	0	0
63	7.00	26.7	4	CDEF	3326	2.812	354	27.9	780	1695	277	26.7	203	74	163	650	1089
73	9.00	"	"	"	"	"	828	38.1	"	"	"	"	"	"	"	"	"
83	12.00	43.8	5	CDEFG	5100	4.027	2071	56.6	978	2597	243	43.8	137	106	238	952	1432

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-165

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Bridger,Lewin 5 W/2 Lewin 4 — FORMATION Ft. Union — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
085121 1	1.50	0	0	0	1193	0	-685	0	0	0	0	0	0	0	0	0	0
21	2.50	2.2	2	CD	1480	.420	-605	0	0	0	0	2.2	0	0	0	0	0
31	3.10	"	"	"	"	"	-554	0	0	0	0	"	0	0	0	0	0
41	3.50	10.9	3	CDE	2742	1.871	-158	7.7	0	0	0	10.9	0	0	0	0	0
51	5.00	26.7	4	CDEF	6514	5.503	1845	25.3	1695	1695	308	26.7	226	82	341	1364	2014
61	7.00	43.8	5	CDEFG	14140	10.232	6003	40.2	2489	2597	243	43.8	136	106	591	2363	3196
71	9.00	"	"	"	"	"	9421	59.1	"	"	"	"	"	"	"	"	"
81	12.00	47.8	6	CDEFGH	15262	10.670	14883	83.8	2665	2877	250	47.8	130	119	643	2573	3466
Discount Rate 15%																	
12	1.50	0	0	0	1193	0	-684	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	2.2	2	CD	1480	.420	-600	0	0	0	0	2.2	0	0	0	0	0
42	3.50	"	"	"	"	"	-574	0	0	0	0	"	0	0	0	0	0
52	5.00	26.7	4	CDEF	6514	5.503	888	25.3	1695	1695	308	26.7	226	82	341	1364	2014
62	7.00	"	"	"	"	"	2264	41.1	"	"	"	"	"	"	"	"	"
72	9.00	43.8	5	CDEFG	14140	10.232	5927	59.1	2489	2597	243	43.8	136	106	591	2363	3196
82	12.00	"	"	"	"	"	9594	85.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	1193	0	-682	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	.4	1	C	1224	.44	-672	"	"	"	"	.4	"	"	"	"	"
43	3.50	2.2	2	CD	1480	.420	-606	"	"	"	"	2.2	"	"	"	"	"
53	5.00	10.9	3	CDE	2742	1.871	-198	15.1	"	"	"	10.9	"	"	"	"	"
63	7.00	26.7	4	CDEF	6514	5.503	1400	41.1	1695	1695	308	26.7	226	82	341	1364	2014
73	9.00	43.8	5	CDEFG	14140	10.232	3927	59.1	2489	2597	243	43.8	136	106	591	2363	3196
83	12.00	"	"	"	"	"	6710	85.9	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 11-166

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Lance-Mesaverde

DEPTH (FT.): 11,000
PRESSURE (PSIA): 5500
TEMPERATURE (°F): 200

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	21	5.0	20	125.055	91	0.20	1.0	-
0.01	78	4.6	30	640.996	438	0.30	1.0	-
0.003	264	3.9	41	2513.820	1610	0.40	1.0	-
0.001	375	3.5	55	4790.053	2865	0.60	1.0	-
0.0003	210	3.1	68	2632.98	1464	0.75	1.0	-
0.0001	99	2.8	80	1320.0	677	0.85	1.0	-
0.00003	57	2.5	100	848.667	399	0.90	1.0	-
	1104			12872.	7544			

TABLE 11-167

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRIDGER, MESA VERDE-LANCE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			415	330	244	160	101	61	39	
2			176	167	125	83	53	32	20	
5			57	79	68	47	30	18	12	
10			13	37	42	32	21	13	8	
15			4	15	28	25	17	10	6	
20			1	11	22	20	14	9	5	
30			0	4	12	16	11	7	5	
30-YEAR CUMM. PROD. (MMCF)			1020	1310	1310	1030	679	419	269	

TABLE 11-168

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRIDGER, MESA VERDE-LANCE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			584	430	269	205	135	100	68	
2			287	222	139	103	67	43	29	
5			122	119	79	58	39	24	17	
10			56	72	53	37	27	17	11	
15			26	50	39	26	20	13	9	
20			12	38	32	21	18	11	8	
30			5	22	23	14	14	8	6	
30-YEAR CUMM. PROD. (MMCF)			2090	2310	1659	1179	859	550	390	

TABLE 11-169

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin A, Lewin 5, Bridger
FORMATION: Lance - Mesa Verde

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
0.03	4.245	4	86	2.072	2.072	91
0.01	4.290	4	407	2.433	2.433	438
0.003	4.656	4	1385	3.677	3.677	1610
0.001	7.417	4	1547	6.48	6.48	2865
0.0003	10.265	4	571	8.114	8.114	1464
0.0001	16.324	4	169	12.436	12.000	657
0.00003	26.022	4	64	17.949	12.000	267
			4229			7392

TABLE 11-170

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Lance - Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,194,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	176,000 - 473,000
- Advanced Case [2000/4000 Ft. Fracture]	351,000 - 979,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-171

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Bridger,Lewin 5,W/2 Lewin 4

FORMATION Lance & Mesa Verde

TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2452111	1.50	0	0	0	1605	0	-907	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
31	3.10	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
41	3.50	1.7	1	D	1899	.246	-843	0	0	0	0	1.7	0	0	0	0	0
51	5.00	11.4	3	CDE	3883	1.846	-43	9.5	0	0	0	11.4	0	0	0	0	0
61	7.00	31.6	4	CDEF	7378	4.279	1891	22.9	3425	5004	800	31.6	547	253	649	2595	4045
71	9.00	"	"	"	"	"	3446	34.8	"	"	"	"	"	"	"	"	"
81	12.00	45.7	5	CDEFG	9908	5.414	6769	50.4	3996	6468	738	45.7	401	337	846	3383	4967
Discount Rate 15%																	
12	1.50	0	0	0	1605	0	-903	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
32	3.10	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
42	3.50	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
52	5.00	11.4	3	CDE	3883	1.846	-372	9.5	0	0	0	11.4	0	0	0	0	0
62	7.00	"	"	"	"	"	231	18.5	1878	2139	1017	11.4	901	116	329	1515	2661
72	9.00	31.6	4	CDEF	7378	4.279	2015	34.8	3425	5004	800	31.6	547	253	649	2595	4045
82	12.00	45.7	5	CDEFG	9908	5.414	4317	50.4	3996	6468	738	45.7	401	337	846	3383	4967
Discount Rate 20%																	
13	1.50	0	0	0	1605	0	-897	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
33	3.10	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
43	3.50	"	"	"	"	"	"	"	0	0	0	0	0	0	0	0	0
53	5.00	2.3	2	CD	1991	.279	-792	0	0	0	0	2.3	0	0	0	0	0
63	7.00	11.4	3	CDE	3883	1.846	-791	18.5	0	0	0	11.4	0	0	0	0	0
73	9.00	31.6	4	CDEF	7378	4.279	1174	34.8	3425	5004	800	31.6	547	253	649	2595	4045
83	12.00	"	"	"	"	"	2574	53.9	"	"	"	"	"	"	"	"	"

*CODE:

C	D	E	F	G
0.03	0.01	0.003	0.001	0.0003

TABLE 11-172

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Bridger, Lewin-5, W/2 Lewin 4
FORMATION Lance & Mesa Verde

TECHNOLOGY Advanced
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2452211	1.50	0	0	0	1838	0	-1039	0	0	0	0	0	0	0	0	0	0
21	2.50	.6	1	C	1876	.049	-1024	0	"	"	"	.6	"	"	"	"	"
31	3.10	2.3	2	CD	2009	.248	-953	0	"	"	"	2.3	"	"	"	"	"
41	3.50	"	"	"	"	"	-931	0	"	"	"	"	"	"	"	"	"
51	5.00	11.4	3	CDE	3507	1.781	-217	7.8	"	"	"	11.4	"	"	"	"	"
61	7.00	31.6	4	CDEF	9629	5.539	2569	23.7	5004	5004	903	31.6	618	285	868	3471	5243
71	9.00	45.7	5	CDEFG	14356	7.751	5637	32.2	6468	6468	834	45.7	453	381	1248	4993	7075
81	12.00	"	"	"	"	"	9748	52.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1838	0	-1032	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	.6	1	C	1876	.049	-1014	0	"	"	"	.6	0	0	0	0	0
42	3.50	2.3	2	CD	2009	.248	-957	0	"	"	"	2.3	"	"	"	"	"
52	5.00	11.4	3	CDE	3507	1.781	-523	7.8	"	"	"	11.4	"	"	"	"	"
62	7.00	31.6	4	CDEF	9629	5.539	1180	23.7	5004	5004	903	31.6	618	285	868	3471	5243
72	9.00	"	"	"	"	"	2692	36.1	"	"	"	"	"	"	"	"	"
82	12.00	45.7	5	CDEFG	14356	7.751	6191	52.5	6468	6468	834	45.7	453	381	1248	4993	7075
Discount Rate 20%																	
13	1.50	0	0	0	1838	0	-1024	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	.6	1	C	1876	.049	-1010	0	"	"	"	.6	"	"	"	"	"
43	3.50	.6	1	C	"	"	-1006	0	"	"	"	.6	"	"	"	"	"
53	5.00	2.3	2	CD	2009	.248	-916	0	"	"	"	2.3	"	"	"	"	"
63	7.00	11.4	3	CDE	3507	1.781	-307	14.4	"	"	"	11.4	"	"	"	"	"
73	9.00	31.6	4	CDEF	9629	5.539	1587	36.1	5004	5004	903	31.6	618	285	868	3471	5243
83	12.00	"	"	"	"	"	3382	56.3	"	"	"	"	"	"	"	"	"

*CODE:

C	D	E	F	G	H	I
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 11-173

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Frontier

DEPTH (FT.): 14,000
PRESSURE (PSIA): 7700
TEMPERATURE (°F): 242

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	8	6.4	10	56.64	36	0.10	1.0	-
0.1	63	5.7	14	558.81	350	0.20	1.0	-
0.03	188	5.0	20	1834.88	1238	0.30	1.0	-
0.01	266	4.4	25	2596.16	1815	0.50	1.0	-
0.003	149	3.9	27	1391.66	910	0.60	1.0	-
0.001	70	3.5	29	630	388	0.70	1.0	-
0.003	39	3.1	30	321.75	184	0.80	1.0	-
	783			7390.	4921			

TABLE 11-174

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRIDGER, FRONTIER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1165	866	587	380	194	110	56			
2	768	596	388	231	117	60	30			
5	351	335	267	160	74	40	18			
10	158	178	181	124	58	29	14			
15	86	117	133	104	51	25	12			
20	69	73	106	89	46	22	10			
30	50	44	69	67	39	20	9			
30-YEAR CUMM. PROD. (MMCF)	5861	5502	5133	3643	1816	931	442			

TABLE 11-175

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRIDGER, FRONTIER

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1618	1322	1454	1067	664	398	217			
2	1114	873	955	670	384	218	116			
5	617	536	595	422	236	134	67			
10	333	328	383	296	168	93	48			
15	205	235	272	238	138	79	40			
20	146	161	213	195	121	68	34			
30	76	109	133	144	97	57	28			
30-YEAR CUMM. PROD. (MMCF)	10139	9608	11206	8887	5254	3004	1546			

TABLE 11-176

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Frontier

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	.768	.768	36	.444	.444	36
.1	1.0097	1.010	350	.578	.578	350
.03	1.283	1.283	1238	.588	.588	1238
.01	1.873	1.873	1815	.768	.768	1815
.003	3.363	3.363	910	1.162	1.162	910
.001	5.954	4.	262	1.845	1.845	388
.0003	10.674	4.	70	3.052	3.052	184
			4681			4921

TABLE 11-177

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Frontier

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	2,272,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	115,575
- Advanced Case [2000/4000 Ft. Fracture]	147,000 - 380,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0303

TABLE 11-178

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Bridger,Lewin 5,W/2 Lewin 4
FORMATION Frontier
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2453111	1.50	.1	1	A	2661	.13	-1498	0	0	0	0	.1	0	0	0	0	0
21	2.50	9.1	3	ABC	5929	5.331	-506	7.0	0	0	0	9.1	0	0	0	0	0
31	3.10	25.1	4	ABCD	11396	11.851	964	13.2	3439	3439	290	25.1	217	73	209	836	1335
41	3.50	"	"	"	"	"	1714	15.8	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	4530	25.4	"	"	"	"	"	"	"	"	"
61	7.00	37.1	5	ABCDE	17537	15.310	9678	33.4	4349	4349	284	37.1	179	105	349	1394	2026
71	9.00	"	"	"	"	"	14579	46.3	"	"	"	"	"	"	"	"	"
81	12.00	43.0	6	ABCDEF	19919	16.247	22405	61.3	4611	4737	284	43.0	162	122	404	1615	2303
Discount Rate 15%																	
12	1.50	0	0	0	2655	0	-1492	0	0	0	0	0	0	0	0	0	0
22	2.50	1.7	2	AB	2832	.358	-1400	0	0	0	0	1.7	0	0	0	0	0
32	3.10	9.1	3	ABC	5929	5.331	-619	10.1	0	0	0	9.1	0	0	0	0	0
42	3.50	"	"	"	"	"	-373	12.1	0	0	0	"	0	0	0	0	0
52	5.00	25.1	4	ABCD	11396	11.851	2108	25.4	3439	3439	290	25.1	217	73	209	836	1335
62	7.00	"	"	"	"	"	4693	38.2	"	"	"	"	"	"	"	"	"
72	9.00	37.1	5	ABCDE	17537	15.310	8595	46.3	4349	4349	284	37.1	179	105	349	1394	2026
82	12.00	"	"	"	"	"	13688	66.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	2655	0	-1482	0	0	0	0	0	0	0	0	0	0
23	2.50	1.7	2	AB	2832	.358	-1416	0	0	0	0	1.7	0	0	0	0	0
33	3.10	9.1	3	ABC	5929	5.331	-960	10.1	0	0	0	9.1	0	0	0	0	0
43	3.50	"	"	"	"	"	-778	12.1	0	0	0	"	0	0	0	0	0
53	5.00	25.1	4	ABCD	11396	11.851	810	25.4	3439	3439	290	25.1	217	73	209	836	1335
63	7.00	"	"	"	"	"	2723	38.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	4637	50.9	"	"	"	"	"	"	"	"	"
83	12.00	37.1	5	ABCDE	17537	15.310	9098	66.6	4349	4349	284	37.1	179	105	349	1394	2026

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-179

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN W/2 Lewin 4,Bridger, Lewin Area 5, & West of Moxa Arch
FORMATION Frontier
TECHNOLOGY Advanced
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2453211	1.50	25.1	4	ABCD	6516	11.844	-37	9.8	-	-	-	25.1	-	-	-	-	-
21	2.50	37.1	5	ABCDE	8666	15.303	2629	21.5	4349	4349	284	37.1	179	105	122	487	893
31	3.10	"	"	"	"	"	4204	28.6	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	5253	33.4	"	"	"	"	"	"	"	"	"
51	5.00	43.0	6	ABCDEF	9821	16.383	9709	50.3	4737	4737	289	43.0	165	124	149	594	1032
61	7.00	"	"	"	"	"	15381	75.1	"	"	"	"	"	"	"	"	"
71	9.00	48.2	7	ABCDEFG	10909	16.929	21489	95.5	4921	4921	291	48.2	151	140	173	692	1155
81	12.00	"	"	"	"	"	30318	131.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	9.1	3	ABC	4366	5.325	-1119	4.1	-	-	-	9.1	-	-	-	-	-
22	2.50	25.1	4	ABCD	6516	11.844	707	20.2	3439	3439	290	25.1	217	73	78	312	681
32	3.10	37.1	5	ABCDE	8666	15.303	2179	28.6	4349	4349	284	37.1	179	105	122	487	893
42	3.50	"	"	"	"	"	2935	33.4	"	"	"	"	"	"	"	"	"
52	5.00	43.0	6	ABCDEF	9821	16.383	6022	50.3	4737	4737	289	43.0	165	124	149	594	1032
62	7.00	"	"	"	"	"	10072	75.1	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	14123	99.6	"	"	"	"	"	"	"	"	"
82	12.00	48.2	7	ABCDEFG	10909	16.929	20681	131.6	4921	4921	291	48.2	151	140	173	692	1155
Discount Rate 20%																	
13	1.50	9.1	3	ABC	4366	5.325	-1280	4.1	-	-	-	9.1	-	-	-	-	-
23	2.50	25.1	4	ABCD	6516	11.844	22	20.2	3439	3439	290	25.1	217	73	78	312	681
33	3.10	"	"	"	"	"	656	26.3	"	"	"	"	"	"	"	"	"
43	3.50	37.1	5	ABCDE	8666	15.303	1614	33.4	4349	4349	284	37.1	179	105	122	487	893
53	5.00	"	"	"	"	"	3745	51.3	"	"	"	"	"	"	"	"	"
63	7.00	43.0	6	ABCDEF	9821	16.383	7007	75.1	4737	4737	289	43.0	165	124	149	594	1032
73	9.00	"	"	"	"	"	10100	99.6	"	"	"	"	"	"	"	"	"
83	12.00	48.2	7	ABCDEFG	10909	16.929	15060	131.6	4921	4921	291	48.2	151	140	173	692	1155

*CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001 G 0.0003

TABLE II-180

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Mesaverde Lance + Frontier

DEPTH (FT.): 14,000
PRESSURE (PSIA): 7700
TEMPERATURE (°F): 242

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular + Blanket

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	1	*	*	23.60	15	*	*	*
0.1	11			218.73	137			
0.03	33			658.07	444			
0.01	47			916.88	641			
0.003	26			519.96	340			
0.001	12			258.17	159			
0.0003	7			138.14	79			
	138			2734.	1809			

* Refer to individual formations for these data.

TABLE 11-181

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRDGER, M.VERDE-LANCE + FRNTR.

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1336	1037	758	551	365	281	228			
2	856	684	476	319	205	148	118			
5	398	382	314	207	122	87	65			
10	188	208	211	154	88	59	44			
15	107	139	154	126	72	46	33			
20	86	90	123	106	63	39	27			
30	62	56	81	80	51	32	21			
30-YEAR CUMM. PROD. (MMCF)	6819	6460	6090	4599	2769	1890	1399			

TABLE 11-182

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRDGER, M.VERDE-LANCE + FRNTR.

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1833	1536	1669	1281	879	613	431			
2	1223	981	1063	779	493	326	224			
5	677	596	656	482	296	195	127			
10	372	367	422	335	208	132	88			
15	234	263	300	266	166	107	68			
20	169	185	236	218	144	91	57			
30	92	125	149	160	113	73	44			
30-YEAR CUMM. PROD. (MMCF)	11379	10839	12439	10120	6490	4240	2780			

TABLE 11-183

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Mesa Verde-Lance + Frontier

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.59	1.59	15	.96	.96	15
.1	1.92	1.92	137	1.14	1.14	137
.03	2.20	2.20	444	1.08	1.08	444
.01	2.97	2.97	641	1.35	1.35	641
.003	4.67	4.	291	2.00	2.00	340
.001	6.52	4.	94	2.90	2.90	153
.0003	8.17	4.	39	4.11	4.11	79
			1661			1809

TABLE 11-184

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Mesa Verde - Lance + Frontier

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	2,272,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	349,000
- Advanced Case [2000/4000 Ft. Fracture]	610,000 - 843,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-185

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Bridger,Lewin 5,W/2 Lewin 4 FORMATION Mesa Verde,Lance + Frontier

TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	MAX RECOV. GIP,BCF	MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT Dry	WILDCAT Prod.	DEVELOPMENT Dry	DEVELOPMENT Prod.	Total
Discount Rate 10%																	
2454111	1.50	1.7	1	A	2873	.217	-1521	0	0	0	0	1.7	0	0	0	0	0
21	2.50	9.0	3	ABC	3488	1.516	-1041	0	0	0	0	9.0	0	0	0	0	0
31	3.10	25.2	4	ABCD	5046	4.156	-23	9.8	0	0	0	25.2	0	0	0	0	0
41	3.50	"	"	"	"	"	310	12.1	1237	1237	298	"	223	75	50	202	549
51	5.00	37.5	5	ABCDE	6231	5.586	2203	23.1	1529	1577	274	37.5	171	103	71	282	627
61	7.00	43.3	6	ABCDEF	6848	6.107	4675	37.2	1622	1730	266	43.3	151	115	81	323	670
71	9.00	48.3	7	ABCDEFG	7206	6.350	7252	52.3	1661	1809	262	48.3	135	126	87	346	694
81	12.00	"	"	"	"	"	10864	76.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	2786	0	-1550	0	0	0	0	0	0	0	0	0	0
22	2.50	9.0	3	ABC	3488	1.516	-1197	0	0	0	0	9.0	0	0	0	0	0
32	3.10	"	"	"	"	"	-1041	1.6	0	0	0	"	0	0	0	0	0
42	3.50	25.2	4	ABCD	5046	4.156	-313	12.1	0	0	0	25.2	0	0	0	0	0
52	5.00	"	"	"	"	"	622	20.7	1237	1237	298	"	223	75	50	202	549
62	7.00	37.5	5	ABCDE	6231	5.586	2615	36.9	1529	1577	274	37.5	171	103	71	282	627
72	9.00	43.3	6	ABCDEF	6848	6.107	4552	52.3	1622	1730	266	43.3	151	115	81	323	670
82	12.00	48.3	7	ABCDEFG	7206	6.350	7421	76.2	1661	1809	262	48.3	135	126	87	346	694
Discount Rate 20%																	
13	1.50	0	0	-	2786	0	-1533	0	0	0	0	0	0	0	0	0	0
23	2.50	1.7	1	A	2873	.217	-1472	0	0	0	0	1.7	0	0	0	0	0
33	3.10	9.0	3	ABC	3488	1.516	-1161	1.6	0	0	0	9.0	0	0	0	0	0
43	3.50	"	"	"	"	"	-1078	5.0	0	0	0	"	0	0	0	0	0
53	5.00	25.2	4	ABCD	5046	4.156	67	20.7	1237	1237	298	25.2	223	75	50	202	549
63	7.00	37.5	5	ABCDE	6231	5.586	1580	36.9	1529	1577	274	37.5	171	103	71	282	627
73	9.00	43.3	6	ABCDEF	6848	6.107	3085	52.3	1622	1730	266	43.3	151	115	81	323	670
83	12.00	48.3	7	ABCDEFG	7206	6.350	5350	76.2	1661	1809	262	48.3	135	126	87	346	694

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-186

ECONOMICS SUMMARY

BASIN Green River
SUB BASIN Bridger, Lewin 5, W/2 Lewin 4
FORMATION Mesaverde,Lance + Frontier
TECHNOLOGY Advanced
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT E & P INVEST. $M	AVERAGE PER PROSPECT GAS PROD. BCF	AVERAGE PER PROSPECT NET PRES. VALUE $M	AVERAGE PER PROSPECT DCF RATE OF RETURN %	BASIN TOTALS GAS RECOVER. AT PRICE,BCF	BASIN TOTALS MAX RECOV. GIP,BCF	BASIN TOTALS MAX. NO. PROSP. AT PRICE	WELLS WILDCAT SUCCESS %	WELLS WILDCAT Dry	WELLS WILDCAT Prod.	WELLS DEVELOPMENT Dry	WELLS DEVELOPMENT Prod.	WELLS Total
Discount Rate 10%																	
2454211	1.50	9.0	1	C	3862	1.503	-1629	0	0	0	0	9.0	0	0	0	0	0
21	2.50	37.5	5	ABCDE	5199	5.577	296	12.0	0	0	0	25.2	0	0	0	0	0
31	3.10	"	"	"	"	"	1038	17.2	1577	1577	283	37.5	177	106	25	101	410
41	3.50	"	"	"	"	"	1532	20.8	"	"	"	"	"	"	"	"	"
51	5.00	43.3	6	ABCDEF	5745	6.302	3848	36.4	1730	1730	275	43.3	155	119	33	131	440
61	7.00	48.3	7	ABCDEFG	6440	6.768	7049	57.0	1809	1809	267	48.3	138	129	42	171	480
71	9.00	"	"	"	"	"	10033	78.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	14509	112.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	9.0	1	C	3862	1.503	-1708	0	0	0	0	9.0	0	0	0	0	0
22	2.50	25.2	4	ABCD	4461	4.141	-654	8.5	"	"	"	25.2	"	"	"	"	"
32	3.10	37.5	5	ABCDE	5199	5.577	247	17.2	1577	1577	283	37.5	177	106	25	101	410
42	3.50	"	"	"	"	"	628	20.8	1730	1730	275	43.3	155	119	33	131	440
52	5.00	43.3	6	ABCDEF	5745	6.302	2366	36.4	1809	1809	267	48.3	138	129	42	171	480
62	7.00	48.3	7	ABCDEFG	6440	6.768	4783	57.0	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	7082	78.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"		10530	112.0	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	3610	0	-1980	0	0	0	0	0	0	0	0	0	0
23	2.50	25.2	4	ABCD	4461	4.141	-927	8.5	0	0	0	25.2	0	0	0	0	0
33	3.10	"	"	"	"	"	-596	12.5	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	-376	15.3	"	"	"	"	"	"	"	"	"
53	5.00	37.5	5	ABCDE	5199	5.577	1227	34.6	1577	1577	283	37.5	177	106	25	101	410
63	7.00	43.3	6	ABCDEF	5745	6.302	3167	57.0	1730	1730	275	43.3	155	119	33	131	440
73	9.00	48.3	7	ABCDEFG	6440	6.768	5230	78.9	1809	1809	267	48.3	138	129	42	171	480
83	12.00	"	"	"	"	"	8022	112.0	"	"	"	"	"	"	"	"	"

*CODE: A B C D E F G
0.3 0.1 0.03 0.01 0.003 0.001 0.0003

TABLE 11-187

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Ft. Union + Mesaverde Lance

DEPTH (FT.): 11,000
PRESSURE (PSIA): 5500
TEMPERATURE (°F): 200

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	3	*	*	50.82	37	*	*	*
0.01	10			204.88	140			
0.003	33			779.13	499			
0.001	47			1300.75	778			
0.0003	26			749.97	417			
0.0001	12			382.16	196			
0.00003	7			233.97	110			
	138			3701.68	2177			

* Refer to individual formations for these data.

TABLE 11-188

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRDGER, FT UNION + M.VERDE-LNCE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			542	457	371	287	228	189	167	
2			243	233	192	149	119	98	86	
5			94	116	105	84	67	55	49	
10			37	62	66	57	45	37	33	
15			22	34	47	44	35	29	25	
20			17	27	38	36	29	24	21	
30			12	16	24	28	23	19	16	
30-YEAR CUMM. PROD. (MMCF)			1810	2099	2099	1820	1469	1210	1060	

TABLE 11-189

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, W/2 LEWIN 4 AND 5-BRDGER, FT UNION + M.VERDE-LNCE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			769	615	454	390	320	285	253	
2			373	308	226	189	154	130	116	
5			170	167	127	106	87	72	64	
10			85	101	82	66	56	46	40	
15			48	72	60	47	41	34	31	
20			29	55	49	38	35	28	24	
30			16	34	35	25	26	19	17	
30-YEAR CUMM. PROD. (MMCF)			3049	3269	2620	2140	1820	1509	1350	

TABLE 11-190

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Ft.Union + Mesa Verde-Lance

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	7.43	4	20	4.39	4.39	37
.01	6.90	4	81	4.43	4.43	140
.003	7.17	4	279	5.74	5.74	499
.001	9.11	4	342	7.75	7.75	778
.0003	10.84	4	154	8.74	8.74	417
.0001	13.05	4	60	10.45	10.45	196
.00003	15.03	4	29	11.78	11.78	110
			964			2177

TABLE 11-191

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: W/2 Lewin 4, Lewin 5, Bridger
FORMATION: Ft. Union + Mesa Verde - Lance

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,194,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	388,000 - 685,000
- Advanced Case [2000/4000 Ft. Fracture]	770,000 - 1,398,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-192

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Bridger ,Lewin 5 & W/2 Lewin 4

FORMATION Ft.Union + Mesa Verde,Lance

TECHNOLOGY Base

DATE September 1980

					AVERAGE PER PROSPECT				BASIN TOTALS			WELLS					
CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
2455111	1.50	0	0	0	1810	0	-1023	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	13.0	2	DE	2700	1.240	-669	1.2	"	"	"	13.0	"	"	"	"	"
41	3.50	"	"	"	"	"	-590	2.4	"	"	"	"	"	"	"	"	"
51	5.00	47.8	5	CDEFG	4937	3.803	896	17.8	876	1871	230	47.8	120	110	86	344	661
61	7.00	54.4	6	CDEFGH	5229	4.067	2435	31.9	937	2067	"	54.4	105	125	94	374	698
71	9.00	59.2	7	CDEFGHI	5368	4.192	4019	47.4	967	2177	231	59.2	94	137	97	388	715
81	12.00	"	"	"	"	"	6268	71.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1810	0	-1016	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	2.5	1	D	1941	1.80	-955	"	"	"	"	2.5	"	"	"	"	"
52	5.00	33.9	4	CDEF	3734	2.670	33	15.4	722	1454	270	33.9	179	92	63	253	587
62	7.00	47.8	5	CDEFG	4937	3.803	1268	31.0	876	1871	230	47.8	120	110	86	344	661
72	9.00	54.4	6	CDEFGH	5229	4.067	2487	46.7	937	2067	"	54.4	105	125	94	374	698
82	12.00	59.2	7	CDEFGHI	5368	4.192	4285	71.0	967	2177	231	59.2	94	137	97	388	715
Discount Rate 20%																	
13	1.50	0	0	0	1810	0	-1008	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	13.0	2	DE	2700	1.240	-589	7.0	"	"	"	13.0	"	"	"	"	"
63	7.00	33.9	4	CDEF	3734	2.670	363	26.8	722	1454	270	33.9	179	92	63	253	587
73	9.00	47.8	5	CDEFG	4937	3.803	1517	45.3	876	1871	230	47.8	120	110	86	344	661
83	12.00	59.2	7	CDEFGHI	5368	4.192	3094	71.0	967	2177	231	59.2	94	137	97	388	715

* CODE:

C	D	E	F	G	H	I
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 11-193

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Bridger, Lewin 5 & W/2 Lewin 4

FORMATION Ft. Union + Mesa Verde, Lance

TECHNOLOGY Advanced

DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
24552 11	1.50	0	0	0	2250	0	-1272	0	0	0	0	0	0	0	0	0	0
21	2.50	2.5	2	CD	2474	.323	-1181	0	"	"	"	2.5	"	"	"	"	"
31	3.10	13.0	3	CDE	4154	2.105	-695	3.4	"	"	"	13.0	"	"	"	"	"
41	3.50	"	"	"	"	"	-506	5.2	"	"	"	"	"	"	"	"	"
51	5.00	47.8	5	CDEFG	11837	7.780	2876	23.3	1871	1871	240	47.8	126	115	219	879	1338
61	7.00	54.4	6	CDEFGH	13455	8.587	6843	41.7	2067	2067	241	54.4	110	131	253	1012	1507
71	9.00	59.2	7	CDEFGHI	14505	9.048	11051	62.2	2177	2177	241	59.2	98	142	273	1088	1601
81	12.00	"	"	"	"	"	17043	98.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	2250	0	-1259	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	2.5	2	CD	2474	.323	-1163	0	"	"	"	2.5	"	"	"	"	"
42	3.50	"	"	"	"	"	-1138	0	"	"	"	"	"	"	"	"	"
52	5.00	33.9	4	CDEF	7720	5.061	869	22.4	1454	1454	287	33.9	190	97	154	617	1058
62	7.00	47.8	5	CDEFG	11837	7.780	3936	42.3	1871	1871	240	47.8	126	115	219	879	1338
72	9.00	54.4	6	CDEFGH	13455	8.587	7174	63.7	2067	2067	241	54.4	110	131	253	1012	1507
82	12.00	59.2	7	CDEFGHI	14505	9.048	12036	98.8	2177	2177	241	59.2	98	142	273	1088	1601
Discount Rate 20%																	
13	1.50	0	0	0	2250	0	-1246	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	.7	1	C	2298	.70	-1224	0	"	"	0	.7	"	"	"	"	"
43	3.50	2.5	2	CD	2474	.323	-1156	0	"	"	"	2.5	"	"	"	"	"
53	5.00	13.0	3	CDE	4254	2.105	-513	11.9	"	"	"	13.0	"	"	"	"	"
63	7.00	47.8	5	CDEFG	11837	7.780	2513	42.9	1871	1871	240	47.8	126	115	219	879	1338
73	9.00	54.4	6	CDEFGH	13455	8.587	5049	63.7	2067	2067	241	54.4	110	131	253	1012	1507
83	12.00	59.2	7	CDEFGHI	14505	9.048	8921	98.8	2177	2177	241	59.2	98	142	273	1088	1601

* CODE:

C	D	E	F	G	H	I
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 11-194

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Sandwash
FORMATION: Lewis 7000

DEPTH (FT.): 7000
PRESSURE (PSIA): 3080
TEMPERATURE (°F): 158

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	9	5.8	7	21.15	18	0.25	1.0	-
0.03	43	5.0	13	161.68	116	0.30	1.0	-
0.01	76	4.4	20	386.84	281	0.40	1.0	-
0.003	76	3.9	29	497.04	338	0.50	1.0	-
0.001	33	3.5	40	266.97	172	0.60	1.0	-
	237			1334.	925			

TABLE 11-195

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, SANDWASH, LEWIS 7000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		179	169	139	100	74				
2		125	106	85	56	40				
5		88	74	54	36	24				
10		61	58	42	27	19				
15		46	50	37	23	15				
20		37	43	33	20	13				
30		24	34	29	18	11				
30-YEAR CUM. PROD. (MMCF)		1716	1712	1322	856	585				

TABLE 11-196

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, SANDWASH, LEWIS 7000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		279	395	376	334	264				
2		190	272	238	194	148				
5		129	183	157	121	87				
10		94	135	115	86	63				
15		75	110	96	72	53				
20		63	94	84	63	45				
30		46	72	68	52	37				
30-YEAR CUMM. PROD. (MMCF)		2725	3927	3495	2713	2000				

TABLE 11-197

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Lewis 7000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	1.06	1.06	18	.668	.668	18
.03	1.6	1.6	116	.697	.697	116
.01	2.81	2.81	281	1.061	1.061	281
.003	5.21	4.0	259	1.647	1.647	338
.001	8.82	4.0	78	2.585	2.585	172
			752			925

TABLE 11-198

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Lewis 7000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	469,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	94,000
- Advanced Case [2000/4000 Ft. Fracture]	119,000 - 308,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-199

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base Case

SUB BASIN Sandwash — FORMATION Lewis 7000 — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08111 11	1.50	0	0	-	645	-	-368	0	-	-	-	0	-	-	-	-	-
21	2.50	20.1	3	BCD	1130	1.121	-99	7.2	-	-	-	20.1	-	-	-	-	-
31	3.10	20.1	3	BCD	1130	"	31	10.8	415	415	370	20.1	296	74	58	235	663
41	3.50	36.2	4	BCDE	1808	2.237	324	16.0	674	753	301	36.2	193	108	115	461	877
51	5.00	44.0	5	BCDEF	2093	2.564	990	27.4	752	925	293	44.0	164	129	140	559	992
61	7.00	44.0	5	BCDEF	2093	"	1856	44.5	"	"	"	44.0	"	"	"	"	"
71	9.00	44.0	5	BCDEF	2093	"	2721	62.7	"	"	"	44.0	"	"	"	"	"
81	12.00	44.0	5	BCDEF	2093	"	4020	90.1	"	"	"	44.0	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	645	-	-367	0	-	-	-	0	-	-	-	-	-
22	2.50	6.8	2	BC	809	.440	-287	0.8	-	-	-	6.8	-	-	-	-	-
32	3.10	20.1	3	BCD	1130	1.121	-114	10.8	-	-	-	20.1	-	-	-	-	-
42	3.50	20.1	3	BCD	1130	"	-50	13.2	-	-	-	20.1	-	-	-	-	-
52	5.00	36.2	4	BCDE	1808	2.237	464	27.6	674	753	301	36.2	193	108	115	461	877
62	7.00	44.0	5	BCOEF	2093	2.564	1147	44.5	752	925	293	44.0	164	129	140	559	992
72	9.00	44.0	5	BCDEF	2093	"	1785	62.7	"	"	"	44.0	"	"	"	"	"
82	12.00	44.0	5	BCDEF	2093	"	2743	90.1	"	"	"	44.0	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	645	-	-365	0	-	-	-	0	-	-	-	-	-
23	2.50	1.9	1	B	682	.104	-349	0	-	-	-	1.9	-	-	-	-	-
33	3.10	6.8	2	BC	809	1.121	-282	3.0	-	-	-	6.8	-	-	-	-	-
43	3.50	20.1	3	BCD	1130	"	-146	13.2	"	"	"	20.1	"	"	"	"	"
53	5.00	36.2	4	BCDE	1808	2.237	217	27.6	674	753	301	36.2	193	108	115	461	877
63	7.00	36.2	4	BCDE	1808	"	661	44.1	"	"	"	36.2	"	"	"	"	"
73	9.00	44.0	5	BCDEF	2093	2.564	1242	62.7	752	925	293	44.0	164	129	140	559	992
83	12.00	44.0	5	BCDEF	2093	"	1998	90.1	"	"	"	44.0	"	"	"	"	"

* CODE:

B	C	D	E	F
0.1	0.03	0.01	0.003	0.001

TABLE 11-200

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced Case

SUB BASIN Sandwash — FORMATION Lewis 7000 — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
811211	1.50	36.2	4	BCDE	1326	2.284	-60	8.5	-	-	-	36.2	-	-	-	-	-
21	2.50	44.0	5	BCDEF	1575	2.831	572	22.9	925	925	327	44.0	183	144	57	227	611
31	3.10	44.0	5	BCDEF	1575	"	921	31.2	"	"	"	44.0	"	"	"	"	"
41	3.50	44.0	5	BCDEF	1575	"	1155	36.9	"	"	"	44.0	"	"	"	"	"
51	5.00	44.0	5	BCDEF	1575	"	2030	58.7	"	"	"	44.0	"	"	"	"	"
61	7.00	44.0	5	BCDEF	1575	"	3196	87.3	"	"	"	44.0	"	"	"	"	"
71	9.00	44.0	5	BCDEF	1575	"	4362	114.6	"	"	"	44.0	"	"	"	"	"
81	12.00	44.0	5	BCDEF	1575	"	6112	152.4	"	"	"	44.0	"	"	"	"	"
Discount Rate 15%																	
12	1.50	20.1	3	BCD	986	1.118	-313	2.6	-	-	363	20.1	-	-	-	-	-
22	2.50	44.0	5	BCDEF	1575	2.831	262	22.9	925	925	327	44.0	183	144	57	227	611
32	3.10	44.0	5	BCDEF	1575	"	526	31.2	"	"	"	44.0	"	"	"	"	"
42	3.50	44.0	5	BCDEF	1575	"	703	36.9	"	"	"	44.0	"	"	"	"	"
52	5.00	44.0	5	BCDEF	1575	"	1365	58.7	"	"	"	44.0	"	"	"	"	"
62	7.00	44.0	5	BCDEF	1575	"	2248	87.3	"	"	"	44.0	"	"	"	"	"
72	9.00	44.0	5	BCDEF	1575	"	3131	114.6	"	"	"	44.0	"	"	"	"	"
82	12.00	44.0	5	BCDEF	1575	"	4456	152.4	"	"	"	44.0	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	856	-	-479	0	-	-	-	0	-	-	-	-	-
23	2.50	36.2	4	BCDE	1326	2.284	0.53	20.0	753	753	330	36.2	210	120	37	148	515
33	3.10	44.0	5	BCDEF	1575	2.821	289	31.2	925	925	327	44.0	183	144	57	227	611
43	3.50	44.0	5	BCDEF	1575	"	430	36.9	"	"	"	44.0	"	"	"	"	"
53	5.00	44.0	5	BCDEF	1575	"	961	58.7	"	"	"	44.0	"	"	"	"	"
63	7.00	44.0	5	BCDEF	1575	"	1668	87.3	"	"	"	44.0	"	"	"	"	"
73	9.00	44.0	5	BCDEF	1575	"	2376	114.6	"	"	"	44.0	"	"	"	"	"
83	12.00	44.0	5	BCDEF	1575	"	3437	152.4	"	"	"	44.0	"	"	"	"	"

* CODE:

B	C	D	E	F
0.1	0.03	0.01	0.003	0.001

TABLE 11-201

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 25.

BASIN: Greater Green River
SUBBASIN: Sandwash
FORMATION: Lewis 9000

DEPTH (FT.): 9000
PRESSURE (PSIA): 3960
TEMPERATURE (°F): 186

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	4	5.8	7	10.76	8	0.20	1.0	-
0.03	22	5.0	13	94.6	69	0.25	1.0	-
0.01	61	4.4	20	355.63	258	0.40	1.0	-
0.003	89	3.9	29	667.5	453	0.50	1.0	-
0.001	61	3.5	40	566.08	359	0.60	1.0	-
0.0003	26	3.1	50	267.02	157	0.70	1.0	-
	263			1962.	1304			

TABLE 11-202

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, SANDWASH, LEWIS 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		232	213	174	124	91	57			
2		162	135	106	69	50	31			
5		110	96	69	46	30	18			
10		73	73	54	34	23	13			
15		52	60	47	29	19	10			
20		41	50	43	27	17	10			
30		25	37	36	23	15	8			
30-YEAR CUMM. PROD. (MMCF)		2016	2115	1677	1085	733	429			

TABLE 11-203

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, SANDWASH, LEWIS 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		360	511	477	417	327	217			
2		243	345	302	240	182	118			
5		163	229	194	149	107	68			
10		116	164	144	108	79	47			
15		89	132	119	89	63	39			
20		73	107	102	78	55	35			
30		51	77	83	64	47	29			
30-YEAR CUMM. PROD. (MMCF)		3286	4784	4335	3364	2469	1554			

TABLE 11-204

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Lewis 9000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	1.03	1.03	8	.63	.63	8
.03	1.47	1.47	69	.652	.652	69
.01	2.51	2.51	258	.973	.973	258
.003	4.69	4.	386	1.513	1.513	453
.001	8.02	4.	179	2.381	2.381	359
.0003	14.07	4.	45	3.893	3.893	157
			945			1304

TABLE 11-205

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Lewis 9000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	736,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	103,000
- Advanced Case [2000/4000 Ft. Fracture]	131,000 - 340,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0303

TABLE 11-206

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base Case

SUB BASIN Sandwash — FORMATION Lewis 9000' — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
812111	1.50	0	0	-	936	-	-531	0	-	-	-	0	-	-	-	-	-
21	2.50	13.3	3	BCD	1686	1.235	-331	3.7	-	-	-	13.3	-	-	-	-	-
31	3.10	13.3	3	BCD	1686	"	-198	6.3	-	-	-	13.3	-	-	-	-	-
41	3.50	13.3	3	BCD	1686	"	-109	8.0	-	-	-	13.3	-	-	-	-	-
51	5.00	27.8	4	BCDE	2590	2.349	666	18.6	721	788	307	27.8	221	86	115	460	882
61	7.00	41.7	5	BCDEF	3436	3.147	1842	30.4	900	1147	286	41.7	166	120	162	648	1096
71	9.00	41.7	5	BCDEF	3436	"	2855	42.1	900	1147	"	41.7	"	"	"	"	"
81	12.00	49.3	6	BCDEFG	3700	3.310	4537	59.6	945	1304	285	49.3	144	141	179	713	1177
Discount Rate 15%																	
12	1.50	0	0	-	936	-	-528	0	-	-	-	0	-	-	-	-	-
22	2.50	1.8	2	BC	982	.114	-509	0	-	-	-	1.8	-	-	-	-	-
32	3.10	1.8	2	BC	982	"	-499	0	-	-	-	1.8	-	-	-	-	-
42	3.50	13.3	3	BCD	1686	1.235	-283	8.0	-	-	-	13.3	-	-	-	-	-
52	5.00	27.8	4	BCDE	2590	2.349	199	18.6	721	788	307	27.8	221	86	115	460	882
62	7.00	41.7	5	BCDEF	3436	3.147	974	30.4	900	1147	285	41.7	166	120	162	648	1096
72	9.00	41.7	5	BCDEF	3436	"	1692	42.1	900	1147	"	41.7	"	"	"	"	"
82	12.00	41.7	5	BCDEF	3436	"	2869	59.6	900	1147	"	41.7	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	936	-	-525	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	936	-	-525	0	-	-	-	0	-	-	-	-	-
33	3.10	1.8	2	BC	982	.114	-505	0	-	-	-	1.8	-	-	-	-	-
43	3.50	1.8	2	BC	982	"	-500	0	-	-	-	1.8	-	-	-	-	-
53	5.00	13.3	3	BCD	1686	1.235	-197	13.8	-	-	-	13.3	-	-	-	-	-
63	7.00	27.8	4	BCDE	2590	2.349	373	29.0	721	788	307	27.8	221	86	115	460	882
73	9.00	41.7	5	BCDE	3436	3.147	1041	42.1	900	1147	285	41.7	166	120	162	648	1096
83	12.00	41.7	5	BCDEF	3436	"	1861	59.4	900	1147	"	41.7	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-207

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Sandwash
FORMATION Lewis 9000'
TECHNOLOGY Advanced Case
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILOCAT SUCCESS %	WELLS: WILOCAT DRY	WELLS: WILOCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
812211	1.50	13.3	3	BCD	1389	1.222	-440	.60	-	-	-	13.3	-	-	-	-	-
21	2.50	41.7	5	BCDEF	2335	3.631	522	17.9	1147	1147	316	41.7	185	131	65	260	641
31	3.10	41.7	5	BCDEF	2335	"	937	24.4	1147	1147	"	41.7	"	"	"	"	"
41	3.50	49.3	6	BCDEFG	1520	4.115	1372	29.7	1304	1304	317	49.3	161	156	86	341	744
51	5.00	49.3	6	BCDEFG	1520	"	2550	47.3	1304	1304	"	49.3	"	"	"	"	"
61	7.00	49.3	6	BCDEFG	1520	"	4121	70.1	1304	1304	"	49.3	"	"	"	"	"
71	9.00	49.3	6	BCDEFG	1520	"	5693	91.5	1304	1304	"	49.3	"	"	"	"	"
81	12.00	49.3	6	BCDEFG	1520	"	8050	121.2	1304	1304	"	49.3	"	"	"	"	"
Discount Rate 15%																	
12	1.50	1.2	2	BC	1186	.100	-643	0	-	-	-	1.2	-	-	-	-	-
22	2.50	27.8	4	BCDE	1733	2.338	-61	13.5	-	-	-	27.8	-	-	-	-	-
32	3.10	41.7	5	BCOEF	2335	3.651	448	24.4	1147	1147	316	41.7	185	131	65	260	641
42	3.50	41.7	5	BCDEF	2335	"	651	28.8	1147	1147	"	41.7	"	"	"	"	"
52	5.00	49.3	6	BCDEFG	1520	4.115	1611	47.3	1304	1304	317	49.3	161	156	86	341	744
62	7.00	49.3	6	BCDEFG	1520	"	2766	70.1	1304	1304	"	49.3	"	"	"	"	"
72	9.00	49.3	6	BCDEFG	1520	"	3922	91.5	1304	1304	"	49.3	"	"	"	"	"
82	12.00	49.3	6	BCDEFG	1520	"	5654	121.2	1304	1304	"	49.3	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1172	-	-652	0	-	-	-	0	-	-	-	-	-
23	2.50	27.8	4	BCDE	1733	2.338	-208	13.5	-	-	-	27.8	-	-	-	-	-
33	3.10	41.7	5	BCDEF	2335	3.631	164	24.4	1147	1147	316	41.7	185	131	65	260	641
43	3.50	41.7	5	BCDEF	2335	"	323	28.8	1147	1147	"	41.7	"	"	"	"	"
53	5.00	49.3	6	BCDEFG	1520	4.115	1057	47.3	1304	1304	317	49.3	161	156	86	341	744
63	7.00	49.3	6	BCDEFG	1520	"	1959	70.1	1304	1304	"	49.3	"	"	"	"	"
73	9.00	49.3	6	BCDEFG	1520	"	2860	91.5	1304	1304	"	49.3	"	"	"	"	"
83	12.00	49.3	6	BCOEFG	1520	"	4213	121.2	1304	1304	"	49.3	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 11-208

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Sandwash
FORMATION: Mesa Verde 9000

DEPTH (FT.): 9000
PRESSURE (PSIA):3960
TEMPERATURE (°F): 186

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	7	5.9	25	68.46	51	0.20	1.0	-
0.01	30	5.2	35	361.8	259	0.25	1.0	-
0.003	39	4.4	50	568.62	384	0.35	1.0	-
0.001	26	3.8	62	406.12	263	0.45	1.0	-
0.0003	21	3.1	80	346.24	206	0.50	1.0	-
0.0001	7	2.4	100	111.3	65	0.60	1.0	-
0.00003	7	1.9	125	109.9	54	0.70	1.0	-
0.00001	6	1.1	150	65.64	27	0.80	1.0	-
	143			2038.	1307			

TABLE 11-209

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, SANDWASH, MESA VERDE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			391	295	197	130	87	51	33	16
2			191	152	103	68	46	27	16	8
5			83	78	58	38	26	15	9	4
10			37	46	39	26	18	10	7	3
15			21	32	30	21	15	8	6	2
20			13	23	25	18	12	7	4	2
30			6	14	18	15	10	5	3	2
30-YEAR CUMM. PROD. (MMCF)			1469	1530	1240	870	589	349	219	120

TABLE 11-210

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, SANDWASH, MESA VERDE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			473	353	254	188	138	87	52	26
2			230	174	129	88	60	38	23	11
5			101	80	71	49	34	21	13	6
10			45	40	43	30	22	15	8	4
15			26	24	31	23	16	11	7	3
20			15	16	24	18	13	10	6	2
30			7	8	14	13	8	6	5	2
30-YEAR CUMM. PROD. (MMCF)			1780	1450	1390	1030	719	490	300	150

TABLE 11-211

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Mesa Verde 9000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.10	4	40	4.21	4.	48
.01	5.71	4	181	6.03	6.03	259
.003	7.98	4	192	7.12	6.	323
.001	11.38	4	92	9.61	8.	218
.0003	16.41	4	49	13.44	12.	183
.0001	24.69	4	10	17.63	12.	44
.00003	35.64	4	6	26.13	12.	25
.00001	41.25	4	3	33.00	12.	10
			573			1110

TABLE 11-212

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Mesa Verde 9000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	748,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	167,000 - 810,000
- Advanced Case [2000/4000 Ft. Fracture]	332,000 - 1,729,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-213

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Sandwash — FORMATION Mesa Verde 9000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
0813111	1.50	0	0	-	1182	-	-676	0	-	-	-	0	-	-	-	-	-
21	2.50	5.9	2	CD	1372	.370	-566	0	-	-	-	5.9	-	-	-	-	-
31	3.10	5.9	2	CD	"	"	-515	0	-	-	-	"	-	-	-	-	-
41	3.50	15.6	3	CDE	1685	.918	-303	3.8	-	-	-	15.6	-	-	-	-	-
51	5.00	24.3	4	CDEF	1921	1.221	99	11.8	505	957	414	24.3	313	101	62	249	725
61	7.00	"	"	"	"	"	566	21.1	"	"	"	"	"	"	"	"	"
71	9.00	30.9	5	CDEFG	2129	1.383	1166	31.9	554	1163	401	30.9	277	124	75	300	776
81	12.00	"	"	"	"	"	1946	47.1	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1182	-	-673	0	-	-	-	0	-	-	-	-	-
22	2.50	1.3	1	C	1244	.103	-647	0	-	-	-	1.3	-	-	-	-	-
32	3.10	5.9	2	CD	1372	.370	-556	0	-	-	-	5.9	-	-	-	-	-
42	3.50	"	"	"	"	"	-529	0	-	-	-	"	-	-	-	-	-
52	5.00	15.6	3	CDE	1685	.918	-204	9.3	-	-	-	15.6	-	-	-	-	-
62	7.00	24.3	4	CDEF	1921	1.221	236	21.1	505	957	414	24.3	313	101	62	249	725
72	9.00	"	"	"	"	"	598	30.7	"	"	"	"	"	"	"	"	"
82	12.00	30.9	5	CDEFG	2129	1.383	1284	47.1	554	1163	401	30.9	277	124	75	300	776
Discount Rate 20%																	
13	1.50	0	0	-	1182	-	-670	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-670	0	-	-	-	0	-	-	-	-	-
33	3.10	1.3	1	C	1244	.103	-639	0	-	-	-	1.3	-	-	-	-	-
43	3.50	5.9	2	CD	1372	.370	-599	0	-	-	-	5.9	-	-	-	-	-
53	5.00	15.6	3	CDE	1685	.918	-310	9.3	-	-	-	15.6	-	-	-	-	-
63	7.00	"	"	"	"	"	-78	17.2	-	-	-	"	-	-	-	-	-
73	9.00	24.3	4	CDEF	1921	1.221	330	30.7	505	957	414	24.3	313	101	62	249	725
83	12.00	30.9	5	CDEFG	2129	1.383	877	47.1	554	1163	401	30.9	277	124	75	300	776

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-214

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Sandwash — FORMATION Mesa Verde 9000' — DATE May, 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08132 11	1.50	0	0	-	1484	-	-847	0	-	-	-	0	-	-	-	-	-
21	2.50	1.3	1	C	1553	.118	-804	0	-	-	-	1.3	-	-	-	-	-
31	3.10	15.6	3	CDE	2442	1.353	-401	3.4	-	-	-	15.6	-	-	-	-	-
41	3.50	"	"	"	"	"	-280	5.3	-	-	-	"	-	-	-	-	-
51	5.00	"	"	"	"	"	171	12.9	630	694	466	"	393	73	79	317	863
61	7.00	24.3	4	CDEF	3220	2.041	1307	29.0	848	957	415	24.3	314	101	119	476	1010
71	9.00	30.9	5	CDEFG	4494	2.685	2700	42.4	1031	1163	384	30.9	265	119	178	713	1275
81	12.00	"	"	"	"	"	4380	64.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1484	-	-841	0	-	-	-	0	-	-	-	-	-
22	2.50	1.3	1	C	1553	.118	-809	0	-	-	-	1.3	-	-	-	-	-
32	3.10	5.9	2	CD	1826	.481	-683	0	-	-	-	5.9	-	-	-	-	-
42	3.50	"	"	"	"	"	-642	0	-	-	-	"	-	-	-	-	-
52	5.00	15.6	3	CDE	2442	1.353	-94	12.9	-	-	-	15.6	-	-	-	-	-
62	7.00	24.3	4	CDEF	3220	2.041	741	29.0	848	957	415	24.3	314	101	119	476	1010
72	9.00	"	"	"	"	"	1420	42.4	"	"	"	"	"	"	"	"	"
82	12.00	30.9	5	CDEFG	4494	2.685	3054	64.9	1031	1163	384	30.9	265	119	178	713	1275
Discount Rate 20%																	
13	1.50	0	0	-	1484	-	-834	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-834	0	-	-	-	0	-	-	-	-	-
33	3.10	1.3	1	C	1553	.118	-797	0	-	-	-	1.3	-	-	-	-	-
43	3.50	5.9	2	CD	1826	.481	-681	0	-	-	-	5.9	-	-	-	-	-
53	5.00	15.6	3	CDE	2442	1.353	-260	12.9	-	-	-	15.6	-	-	-	-	-
63	7.00	"	"	"	"	"	131	23.6	630	694	466	"	393	73	79	317	863
73	9.00	24.3	4	CDEF	3220	2.041	944	42.4	848	957	415	24.3	314	101	119	476	1010
83	12.00	30.9	5	CDEFG	4494	2.685	2221	64.9	1031	1163	384	30.9	265	119	178	713	1275

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-215

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Sandwash
FORMATION: Mesaverde 11000

DEPTH (FT.): 11,000
PRESSURE (PSIA): 4,840
TEMPERATURE (°F): 214

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	8	5.9	25	81.52	59	0.20	1.0	-
0.01	35	5.2	35	455.35	328	0.25	1.0	-
0.003	46	4.4	50	723.58	485	0.35	1.0	-
0.001	30	3.8	62	505.2	333	0.45	1.0	-
0.0003	25	3.1	80	443.25	260	0.50	1.0	-
0.0001	8	2.4	100	137.28	83	0.60	1.0	-
0.00003	8	1.9	125	135.84	67	0.70	1.0	-
0.00001	7	1.1	150	82.6	33	0.80	1.0	-
	169			2565.	1648			

TABLE 11-216

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, SANDWASH, MESA VERDE 11000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			449	340	228	160	94	59	35	19
2			214	174	118	83	50	31	18	10
5			86	91	67	47	28	18	11	6
10			36	49	43	32	20	12	7	3
15			19	33	34	26	15	9	6	3
20			11	23	26	22	13	8	5	2
30			5	13	18	16	10	7	3	2
30-YEAR CUMM. PROD. (MMCF)			1539	1649	1399	1049	640	400	240	129

TABLE II-217

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, SANDWASH, MESA VERDE 11000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			543	406	292	233	159	97	58	30
2			258	197	147	106	69	42	25	14
5			104	86	80	58	38	24	14	7
10			43	40	46	36	22	16	9	5
15			23	23	33	25	17	12	8	4
20			14	15	23	19	13	10	7	3
30			6	7	14	12	8	8	5	2
30-YEAR CUMM. PROD. (MMCF)			1859	1539	1520	1159	800	539	339	179

TABLE 11-218

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Mesa Verde 11000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.03	4	47	4.166	4.	57
.01	5.65	4	233	6.058	6.	325
.003	7.55	4	257	6.954	6.	417
.001	10.07	4	133	9.112	8.	293
.0003	16.14	4	65	12.91	12.	239
.0001	23.05	4	14	17.07	12.	58
.00003	34.88	4	8	24.62	12.	32
.00001	40.69	4	3	29.39	12.	14
			760			1435

TABLE 11-219

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Mesa Verde 11000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,194,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	176,000 - 856,000
- Advanced Case [2000/4000 Ft. Fracture]	351,000 - 1,827,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-220

ECONOMICS SUMMARY

BASIN Greater Green River
SUB BASIN Sandwash
FORMATION Mesa Verde 11000'
TECHNOLOGY Base
DATE May, 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0814111	1.50	0	0	-	1642	0	-933	0	-	-	-	0	-	-	-	-	-
21	2.50	"	"	-	"	0	-933	0	-	-	-	0	-	-	-	-	-
31	3.10	5.9	2	CD	1942	.412	-789	0	-	-	-	5.9	-	-	-	-	-
41	3.50	"	"	"	"	"	-751	0	-	-	-	5.9	-	-	-	-	-
51	5.00	15.6	3	CDE	2379	.993	-306	5.4	-	-	-	15.6	-	-	-	-	-
61	7.00	24.3	4	CDEF	2748	1.370	351	14.8	670	1205	489	24.3	370	119	75	300	865
71	9.00	"	"	"	"	"	878	22.5	"	"	"	"	"	"	"	"	"
81	12.00	30.9	5	CDEFG	2972	1.516	1842	35.7	735	1465	485	30.9	335	150	88	352	925
Discount Rate 15%																	
12	1.50	0	0	-	1642	0	-926	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0	-	"	0	-926	0	-	-	-	0	-	-	-	-	-
32	3.10	0	0	-	"	0	-926	0	-	-	-	0	-	-	-	-	-
42	3.50	1.3	1	C	1734	.106	-886	0	-	-	-	1.3	-	-	-	-	-
52	5.00	15.6	3	CDE	2379	.993	-485	5.4	-	-	-	15.6	-	-	-	-	-
62	7.00	"	"	"	"	"	-173	11.4	-	-	-	"	-	-	-	-	-
72	9.00	24.3	4	CDEF	2748	1.370	401	22.5	670	1205	489	24.3	370	119	75	300	865
82	12.00	"	"	"	"	"	1014	34.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1642	0	-919	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	0	-919	0	-	-	-	0	-	-	-	-	-
33	3.10	0	0	-	"	0	-919	0	-	-	-	0	-	-	-	-	-
43	3.50	0	0	-	"	0	-919	0	-	-	-	0	-	-	-	-	-
53	5.00	5.9	2	CD	1942	.412	-730	0	-	-	-	5.9	-	-	-	-	-
63	7.00	15.6	3	CDE	2379	.993	-337	11.4	-	-	-	15.6	-	-	-	-	-
73	9.00	24.3	4	CDEF	2748	1.370	110	22.5	670	1205	489	24.3	370	119	75	300	865
83	12.00	"	"	"	"	"	611	34.6	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-221

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Sandwash — FORMATION Mesa Verde 11000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0814211	1.50	0	0	-	1962	-	-1113	0	-	-	-	0	-	-	-	-	-
21	2.50	0	0	-	1962	-	-1113	0	-	-	-	0	-	-	-	-	-
31	3.10	1.3	1	C	2059	.122	-1056	0	-	-	-	1.3	-	-	-	-	-
41	3.50	5.9	2	CD	2397	.476	-885	0	-	-	-	5.9	-	-	-	-	-
51	5.00	15.6	3	CDE	3123	1.288	-206	7.2	-	-	-	15.6	-	-	-	-	-
61	7.00	24.3	4	CDEF	4161	2.025	944	20.7	1092	1205	539	24.3	408	131	141	562	1241
71	9.00	"	"	"	"	"	1837	31.6	"	"	"	"	"	"	"	"	"
81	12.00	30.9	5	DEFG	5198	2.483	3810	50.1	1331	1465	536	30.9	370	166	198	790	1524
Discount Rate 15%																	
12	1.50	0	0	-	1962	-	-1103	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0	-	1962	-	-1103	0	-	-	-	0	-	-	-	-	-
32	3.10	1.3	1	C	2059	.122	-1060	0	-	-	-	1.3	-	-	-	-	-
42	3.50	1.3	"	"	"	"	-1049	0	-	-	-	1.3	-	-	-	-	-
52	5.00	15.6	3	CDE	3123	1.288	-449	7.2	-	-	-	15.6	-	-	-	-	-
62	7.00	15.6	"	"	"	"	20	15.3	799	872	620	15.6	523	97	91	362	1073
72	9.00	24.3	4	CDEF	4161	2.025	1094	31.6	1092	1205	539	24.3	408	131	141	562	1241
82	12.00	30.9	5	CDEFG	5198	2,483	2575	50.1	1331	1465	536	30.9	370	166	198	790	1524
Discount Rate 20%																	
13	1.50	0	0	-	1962	-	-1092	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	1962	-	-1092	0	-	-	-	0	-	-	-	-	-
33	3.10	0	0	-	1962	-	-1092	0	-	-	-	0	-	-	-	-	-
43	3.50	1.3	1	C	2059	.122	-1050	0	-	-	-	1.3	-	-	-	-	-
53	5.00	5.9	2	CD	2397	.476	-839	0	-	-	-	5.9	-	-	-	-	-
63	7.00	15.6	3	CDE	3123	1.288	-212	15.3	-	-	-	15.6	-	-	-	-	-
73	9.00	24.3	4	CDEF	4161	2.025	622	31.6	1092	1205	539	24.3	408	131	141	562	1241
83	12.00	"	"	"	"	"	1493	48.6	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-222

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Sandwash
FORMATION: Lewis 7000 + Mesaverde 9000

DEPTH (FT.): 9000
PRESSURE (PSIA):3960
TEMPERATURE (°F): 186

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular + Blanket

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	1	*	*	18.79	14	*	*	*
0.01	5			97.78	70			
0.003	7			146.60	99			
0.001	5			103.46	67			
0.0003	4			89.08	53			
0.0001	1			29.11	17			
0.00003	1			30.53	15			
0.00001	1			21.88	9			
	26			537.	344			

* Refer to individual formations for these data.

TABLE 11-223

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, SANDWASH, LEWIS 7000 + MESA VERDE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			516	419	322	255	212	176	158	140
2			266	227	178	143	121	102	92	83
5			133	128	108	88	76	65	59	54
10			75	84	77	64	56	48	45	41
15			54	64	62	53	47	40	38	35
20			42	52	54	47	41	36	33	31
30			30	38	42	39	34	29	27	26
30-YEAR CUMM. PROD. (MMCF)			2629	2680	2400	2019	1750	1509	1380	1270

TABLE 11-224

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, SANDWASH, LEWIS 7000 + MESA VERDE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			820	700	601	535	485	434	399	373
2			446	390	345	304	276	254	239	227
5			240	219	211	189	173	161	152	146
10			147	142	145	131	123	116	110	106
15			110	109	115	108	100	96	91	87
20			89	89	97	91	86	83	79	76
30			66	67	73	72	67	65	64	61
30-YEAR CUMM. PROD. (MMCF)			4870	4539	4469	4110	3799	3569	3390	3239

TABLE 11-225

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Lewis 7000 + Mesa Verde 9000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	4.09	4	14	2.21	2.21	14
.01	4.78	4	59	2.83	2.83	70
.003	5.87	4	67	3.15	3.15	99
.001	7.07	4	38	3.48	3.48	67
.0003	7.77	4	27	3.58	3.58	53
.0001	8.68	4	8	3.66	3.66	17
.00003	8.37	4	7	3.41	3.41	15
.00001	6.79	4	5	2.67	2.67	9
			225			344

TABLE 11-226

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Lewis 7000 + Mesa Verde 9000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	745,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	256,000 - 899,000
- Advanced Case [2000/4000 Ft. Fracture]	632,000 - 2,029,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-227

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Sandwash — FORMATION Lewis 7000' + Mesa Verde 9000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
0815111	1.50	0.8	1	C	1377	.100	-760	0	-	-	-	0.8	-	-	-	-	-
21	2.50	23.9	4	CDEF	1920	2.009	-232	6.4	-	-	-	23.9	-	-	-	-	-
31	3.10	"	"	"	"	"	-24	9.6	-	-	-	"	-	-	-	-	-
41	3.50	31.0	5	CDEFG	2206	2.609	286	14.1	205	303	78	31.0	54	24	12	48	138
51	5.00	34.7	6	CDEFGH	2451	2.979	1096	25.2	213	320	72	34.7	47	25	14	55	141
61	7.00	43.2	8	CDEFGHIJ	3029	3.640	2480	40.6	225	344	62	43.2	35	27	16	65	144
71	9.00	"	"	"	"	"	3665	56.4	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	5444	79.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1345	-	-773	0	-	-	-	0	-	-	-	-	-
22	2.50	14.5	3	CDE	1735	1.404	-493	3.8	-	-	-	14.5	-	-	-	-	-
32	3.10	"	"	"	"	"	-379	6.3	-	-	-	"	-	-	-	-	-
42	3.50	23.9	4	CDEF	1920	2.009	-147	11.8	-	-	-	23.9	-	-	-	-	-
52	5.00	31.0	5	CDEFG	2206	2.609	452	24.1	205	303	78	31.0	54	24	12	48	138
62	7.00	38.1	7	CDEFGHI	2705	3.291	1411	40.6	220	335	67	38.1	41	26	15	60	142
72	9.00	43.2	8	CDEFGHIJ	3029	3.640	2418	56.4	225	344	62	43.2	35	27	16	65	144
82	12.00	"	"	"	"	"	3756	79.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1345	-	-772	0	-	-	-	0	-	-	-	-	-
23	2.50	6.0	2	CD	1557	.722	-654	0	-	-	-	6.0	-	-	-	-	-
33	3.10	14.5	3	CDE	1735	1.404	-475	6.3	-	-	-	14.5	-	-	-	-	-
43	3.50	"	"	"	"	"	-413	7.9	-	-	-	"	-	-	-	-	-
53	5.00	31.0	5	CDEFG	2206	2.609	164	24.1	205	303	78	31.0	54	24	12	48	138
63	7.00	34.7	6	CDEFGH	2451	2.979	821	40.0	213	320	72	34.7	47	25	14	55	141
73	9.00	38.1	7	CDEFGHI	2705	3.291	1556	56.0	220	335	67	38.1	41	26	15	60	142
83	12.00	43.2	8	CDEFGHIJ	3029	3.640	2761	79.9	225	344	62	43.2	35	27	16	65	144

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-228

ECONOMICS SUMMARY

BASIN Greater Green River

SUB BASIN Sandwash

FORMATION Lewis 7000' + Mesa Verde 9000'

TECHNOLOGY Advanced

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08152 11	1.50	14.5	3	CDE	2261	1.753	-732	0	-	-	-	14.5	-	-	-	-	-
21	2.50	31.0	5	CDEFG	2926	3.707	273	13.1	303	303	82	31.0	57	25	11	44	137
31	3.10	34.7	6	CDEFGH	3299	4.337	956	20.4	320	320	74	34.7	48	26	13	50	137
41	3.50	38.1	7	CDEFGHI	3607	4.847	1488	25.4	335	335	69	38.1	43	26	14	54	136
51	5.00	43.2	8	CDEFGHIJ	3968	5.357	3293	43.3	344	344	64	43.2	36	28	14	57	135
61	7.00	"	"	"	"	"	5467	67.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	7640	90.8	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	10901	124.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0.8	1	C	1894	.112	-1043	0	-	-	-	0.8	-	-	-	-	-
22	2.50	23.9	4	CDEF	2533	2.816	-307	9.7	-	-	-	23.9	-	-	-	-	-
32	3.10	31.0	5	CDEFG	2926	3.707	232	18.6	303	303	82	31.0	57	25	11	44	137
42	3.50	34.7	6	CDEFGH	3299	4.337	648	24.5	320	320	74	34.7	48	26	13	50	137
52	5.00	38.1	7	CDEFGHI	3607	4.847	1881	42.0	335	335	69	38.1	43	26	14	54	136
62	7.00	43.2	8	CDEFGHIJ	3968	5.357	3757	67.2	344	344	64	43.2	36	28	14	57	135
72	9.00	"	"	"	"	"	5416	90.8	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	7906	124.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1865	-	-1054	0	-	-	-	0	-	-	-	-	-
23	2.50	14.5	3	CDE	2261	1.753	-661	4.8	-	-	-	14.5	-	-	-	-	-
33	3.10	23.9	4	CDEF	2533	2.816	-270	14.1	-	-	-	23.9	-	-	-	-	-
43	3.50	31.0	5	CDEFG	2926	3.707	122	22.4	303	303	82	31.0	57	25	11	44	137
53	5.00	34.7	6	CDEFGH	3299	4.337	1075	40.4	320	320	74	34.7	48	26	13	50	137
63	7.00	43.2	8	CDEFGHIJ	3968	5.357	2713	67.2	344	344	64	43.2	36	28	14	57	135
73	9.00	"	"	"	"	"	4052	90.8	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	6062	124.6	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-229

GEOLOGICAL DATA SUMMARY

BASIN: Greater Green River
SUBBASIN: Sandwash
FORMATION: Mesaverde 9000 + Mesaverde 11000

DEPTH (FT.): 11,000
PRESSURE (PSIA):4840
TEMPERATURE (°F):214

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	1	*	*	22.11	16	*	*	*
0.01	4			99.95	72			
0.003	5			149.19	100			
0.001	3			103.16	68			
0.0003	3			93.76	55			
0.0001	1			29.77	18			
0.00003	1			34.47	17			
0.00001	1			27.53	11			
	19			559.95	357			

* Refer to individual formations for these data.

TABLE 11-230

WELL PRODUCTION SUMMARY--BASE CASE

GREATER GREEN RIVER, SANDWASH, MESA VERDE 9000 + MESA VERDE 11000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			625	516	404	336	271	235	212	195
2			305	266	209	174	141	122	110	101
5			135	140	116	96	77	66	60	55
10			67	80	74	63	50	43	38	34
15			41	55	57	49	38	32	29	26
20			30	41	44	40	32	26	24	21
30			18	26	31	29	23	20	16	15
30-YEAR CUMM. PROD. (MMCF)			2549	2659	2400	2060	1649	1409	1250	1140

TABLE 11-231

WELL PRODUCTION SUMMARY--ADVANCED CASE

GREATER GREEN RIVER, SANDWASH, MESA VERDE 9000 + MESA VERDE 11000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			772	635	522	462	389	326	288	260
2			370	309	259	217	180	154	137	125
5			162	144	138	116	96	81	72	65
10			76	73	79	69	55	49	42	38
15			45	46	56	48	40	35	30	27
20			31	32	40	36	30	27	24	20
30			17	18	25	23	19	19	16	13
30-YEAR CUMM. PROD. (MMCF)			2969	2650	2629	2269	1899	1640	1439	1289

TABLE 11-232

PRODUCTION WELL REQUIREMENTS

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Mesa Verde 9000 + Mesa Verde 11000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	6.61	4	10	5.67	5.67	16
.01	6.78	4	42	6.81	6.81	72
.003	8.11	4	49	7.41	7.41	100
.001	9.67	4	28	8.75	8.75	68
.0003	11.72	4	19	10.14	10.14	55
.0001	13.45	4	5	11.52	11.52	18
.00003	14.28	4	5	12.39	12.	16
.00001	12.67	4	3	11.24	11.24	11
			102			356

TABLE 11-233

INVESTMENT AND OPERATING EXPENSES

BASIN: Greater Green River
SUB-BASIN: Sandwash
FORMATION: Mesa Verde 9000 + Mesa Verde 11000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,194,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	440,000 - 1,120,000
- Advanced Case [2000/4000 Ft. Fracture]	903,000 - 2,380,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 11-234

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Base

SUB BASIN Sandwash — FORMATION Mesa Verde 9000' + Mesa Verde 11000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
08161 11	1.50	0	0	-	1979	-	-1128	0	-	-	-	0	-	-	-	-	-
21	2.50	6.0	2	CD	2159	.444	-977	0	-	-	-	6.0	-	-	-	-	-
31	3.10	14.5	3	CDE	2245	.809	-750	0	-	-	-	14.5	-	-	-	-	-
41	3.50	23.9	4	CDEF	2485	1.327	-472	3.7	-	-	-	23.9	-	-	-	-	-
51	5.00	31.0	5	CDEFG	2718	1.677	132	11.7	148	311	88	31.0	61	27	7	29	125
61	7.00	38.1	7	CDEFGHI	3086	2.027	1076	23.8	159	346	78	38.1	48	30	9	37	124
71	9.00	43.2	8	CDEFGHIJ	3238	2.171	2046	36.7	162	357	75	43.2	43	32	10	39	124
81	12.00	"	"	"	"	"	3328	54.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1979	-	-1121	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0	-	"	-	-1121	0	-	-	-	0	-	-	-	-	-
32	3.10	6.0	2	CD	2159	.444	-965	0	-	-	-	6.0	-	-	-	-	-
42	3.50	14.5	3	CDE	2245	.809	-786	0.2	-	-	-	14.5	-	-	-	-	-
52	5.00	23.9	4	CDEF	2485	1.327	-327	9.0	-	-	-	23.9	-	-	-	-	-
62	7.00	34.7	6	CDEFGH	2902	1.870	447	22.8	153	329	82	34.7	54	28	8	33	124
72	9.00	38.1	7	CDEFGHI	3086	2.027	1150	35.1	159	346	78	38.1	48	30	9	37	124
82	12.00	43.2	8	CDEFGHIJ	3238	2.171	2279	54.9	162	357	75	43.2	43	32	10	39	124
Discount Rate 20%																	
13	1.50	0	0	-	1979	-	-1114	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	1979	-	-1114	0	-	-	-	0	-	-	-	-	-
33	3.10	0.8	1	C	2013	.068	-1092	0	-	-	-	0.8	-	-	-	-	-
43	3.50	6.0	2	CD	2159	.444	-966	0	-	-	-	6.0	-	-	-	-	-
53	5.00	23.9	4	CDEF	2585	1.327	-483	9.0	-	-	-	23.9	-	-	-	-	-
63	7.00	31.0	5	CDEFG	2718	1.677	50	21.1	148	311	88	31.0	61	27	7	29	125
73	9.00	34.7	6	CDEFGH	2902	1.870	611	33.6	153	329	82	34.7	54	28	8	33	124
83	12.00	38.1	7	CDEFGHI	3086	2.027	1479	52.4	159	346	78	38.1	48	30	9	37	124

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 11-235

ECONOMICS SUMMARY

BASIN Greater Green River — TECHNOLOGY Advanced

SUB BASIN Sandwash — FORMATION Mesa Verde 9000' + Mesa Verde 11000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
08162 11	1.50	0	0 -	2595	-	-1477	0	-	-	-	0	-	-	-	-	-
21	2.50	0.8	1 C	2680	.128	-1436	0	-	-	-	0.8	-	-	-	-	-
31	3.10	14.5	3 CDE	4012	1.749	-748	1.9	-	-	-	14.5	-	-	-	-	-
41	3.50	"	" "	"	"	-564	3.8	-	-	-	"	-	-	-	-	-
51	5.00	31.0	5 CDEFG	6219	3.702	1349	20.9	311	311	84	31.0	58	26	26	106	216
61	7.00	34.7	6 CDEFGH	7498	4.369	3696	38.2	329	329	75	34.7	49	26	31	122	228
71	9.00	38.1	7 CDEFGHI	8581	4.879	6301	56.2	345	346	71	38.1	44	27	34	135	240
81	12.00	43.2	8 CDEFGHIJ	10195	5.390	10645	83.3	356	357	66	43.2	37	29	37	149	252
Discount Rate 15%																
12	1.50	0	0 -	2595	-	-1462	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0 -	"	-	-1462	0	-	-	-	0	-	-	-	-	-
32	3.10	0.8	1 C	2680	.128	-1416	0	-	-	-	0.8	-	-	-	-	-
42	3.50	6.0	2 CD	3188	.743	-1146	0	-	-	-	6.0	-	-	-	-	-
52	5.00	23.9	4 CDEF	5031	2.811	263	18.1	256	256	91	23.9	69	22	20	79	190
62	7.00	31.0	5 CDEFG	6219	3.702	2041	37.7	311	311	84	31.0	58	26	26	106	216
72	9.00	34.7	6 CDEFGH	7498	4.369	4078	57.0	329	329	75	34.7	49	26	31	122	228
82	12.00	38.1	7 CDEFGHI	8581	4.879	7187	86.4	345	346	71	38.1	44	27	34	135	240
Discount Rate 20%																
13	1.50	0	0 -	2595	-	-1448	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0 -	"	-	-1448	0	-	-	-	0	-	-	-	-	-
33	3.10	0	0 -	"	-	-1448	0	-	-	-	0	-	-	-	-	-
43	3.50	0.8	1 C	2680	.128	-1403	-	-	-	-	0.8	-	-	-	-	-
53	5.00	14.5	3 CDE	4012	1.749	-502	11.4	-	-	-	14.5	-	-	-	-	-
63	7.00	31.0	5 CDEFG	6219	3.702	1300	37.7	311	311	84	31.0	58	26	26	106	216
73	9.00	"	" "	"	"	2522	55.5	"	"	"	"	"	"	"	"	"
83	12.00	38.1	7 CDEFGHI	8581	4.879	5451	86.4	345	346	71	38.1	44	27	34	135	240

* CODE:

C	D	E	F	G	H	I	J
0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

Chapter Twelve

WIND RIVER BASIN

LIST OF TABLES

	Page
Wind River Basin Properties	12-4
Formation Areas	12-5
Summary of Gas Potential	12-5

In addition, each subbasin within the basin has a series of these specific tables:

- Geological Data Summary
- Well Production Summary -- Base Case
- Well Production Summary -- Advanced Case
- Production Well Requirements
- Investment and Operating Expenses
- Economics Summary -- Base Case
- Economics Summary -- Advanced Case

Formation	Pages
Lower Fort Union	12- 7 - 12-18
Lance 9,000	12-19 - 12-25
Lance 14,000	12-26 - 12-32
Mesaverde	12-33 - 12-39
Lower Fort Union + Lance 9,000	12-40 - 12-46
Lance 14,000 + Mesaverde 15,000	12-47 - 12-53
Frontier/Muddy	12-54 - 12-60

LIST OF FIGURES

Figure		Page
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12-2	Field Size Distribution of Producible Gas	12-6

Chapter Twelve

WIND RIVER BASIN

GEOLOGY

The Wind River basin is a geologically and topographically defined area in central Wyoming, with Cretaceous rocks occupying a surface area of approximately 5,500 square miles, although a much smaller area than this was considered to be prospective for tight gas sands. Cretaceous and Tertiary formations, with tight sandstones, have an average thickness of 13,000 feet and a rock volume of 12,000 cubic miles.

The basin is bounded on the south and west by the Sweetwater and Wind River uplifts, on the north by the Owl Creek uplift, and on the northeast by the subsurface Casper arch. The deepest potentially productive gas-bearing formations are along the northern border of the basin (see Fig. 12-1).

A significant portion of the basin has had extensive exploration and a portion of the basin has been previously analyzed by Lewin and Associates (1978). To gain a more complete estimate of the undeveloped gas potential, an additional 1,600 square miles of Cretaceous and Tertiary rocks have been analyzed. This area has an estimated 2 TCF of gas in place in tight blanket sandstones and 32 TCF in place in tight lenticular sandstones.

As in other Rocky Mountain basins, early drilling in the Wind River basin was concentrated on structures that could be mapped with surface geology. Later exploration pursued stratigraphic traps, and tight gas sands have been exploited only in the last few years. Regarding gas exploration in general during the years 1970 through 1977, 260 exploratory wells were drilled, resulting in nine discoveries, a rather poor success ratio. However, the recent development of new completion technology in low permeability sandstones indicates a future improvement in these statistics.

The Tertiary Lower Fort Union and Upper Cretaceous Lance are considered to have the greatest potential for development of tight gas sands. The Fort Union is a fluvial channel system with rather high porosities in the sands, considering their low permeability. The Lance sands are also nonmarine and have a more normal porosity/permeability relationship. Gas shows are ubiquitous in both objectives but swept spots in reservoir quality are not easy to predict.

The Mesaverde section is nonmarine to transitional to marine in depositional environment, and the sands are generally lenticular in geometry. Exploratory success is predicted to be poorer than in the shallower Fort Union and Lance.

The Lower Cretaceous Frontier and Muddy sands are considered prospective in the shallower portions of the basin. These sands

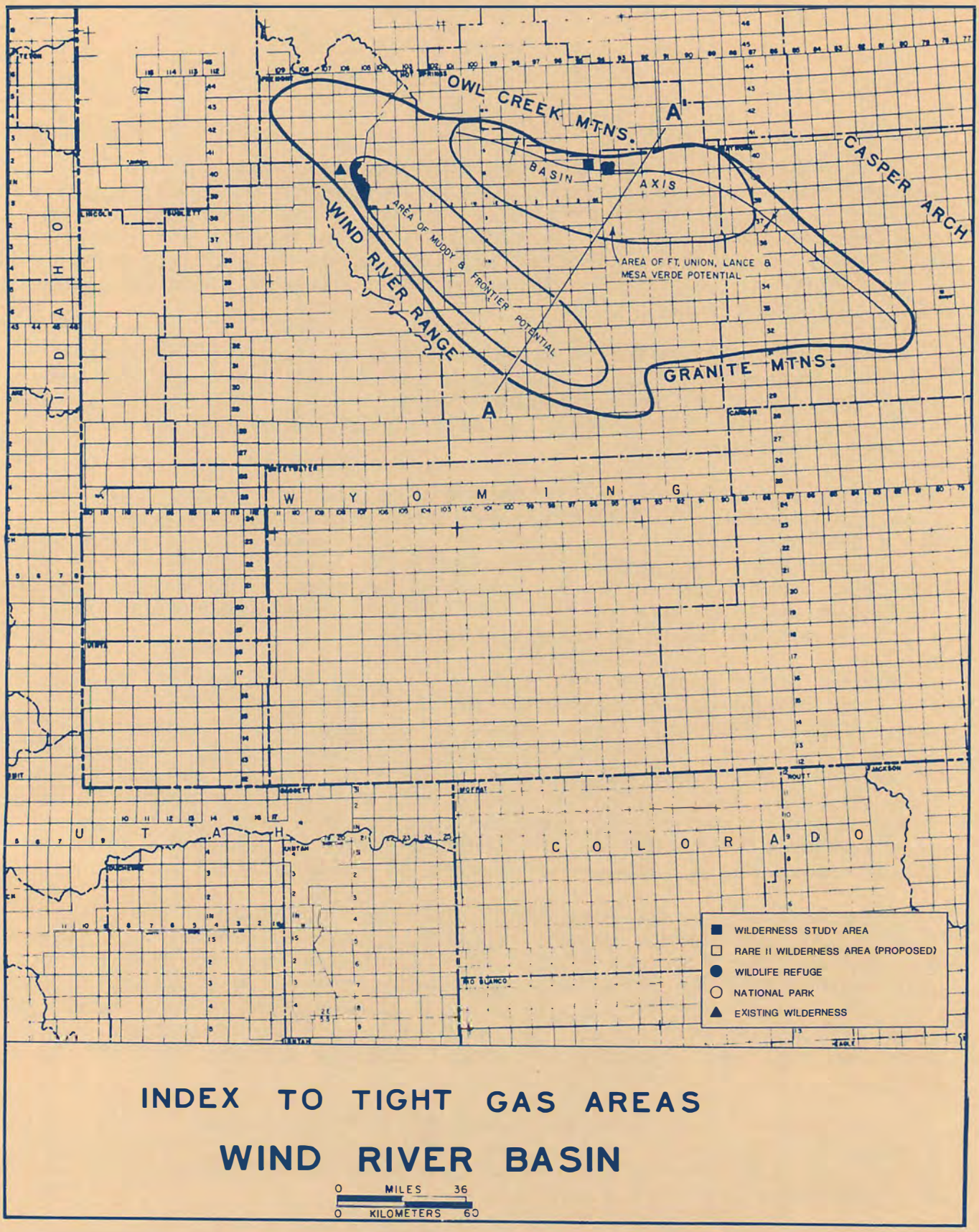


Figure 12-1. Index to Tight Gas Areas -- Wind River Basin.

are blanket in nature and rather widespread. They were analyzed by Lewin and Associates, and reservoir characteristics from Lewin's report were used for subsequent economic analysis.

As a general rule, pay thickness (h) was increased as permeability decreased because there are more sands at the lower end of the permeability spectrum. A logarithmic relationship was assumed for permeability vs. areal extent; i.e., 33 percent of the basin was assumed to have at least the average permeability, 10 percent to have at least triple the average k, and 67 percent to have at least one third the average k.

Costs for geology and geophysics are expected to be low in terms of overall exploration and development because the traps and reservoirs are difficult to predict and the burden of discovery costs will probably be borne by drilling.

According to their geographic distribution, some reservoirs were "stacked;" i.e., it was assumed that more than one formation may produce from one well if the pressures are reasonably similar. In the case of the Wind River basin, it was predicted that 30 percent of the Lower Fort Union production will coincide with the 9,000-foot depth Lance production and that 40 percent of the 14,000-foot Lance production will coincide with 15,000-foot Mesaverde production. This stacking has the effect of reducing exploration and development costs.

PRODUCTION

Five formations in the Wind River basin are considered potentially productive of tight gas. Depths and reservoir properties of each are listed in Table 12-1. Some of these formations overlap in approximately 20 percent of the total productive area, and dual completions could possibly be used for nearly 38 percent of the 23 TCF maximum recoverable gas in the basin. The areas for each of the individual formations and the two combinations considered are shown in Table 12-2.

This study treats each of the five formations plus the two combinations separately. A full set of tables is presented for each of the seven cases, and the production potential and economics of each can be obtained by analyzing the appropriate set. The gas potential for the whole basin as a function of gas price is summarized in Table 12-3. Field size distributions of producible gas for the areas studied in the Wind River basin are shown in graph form in Figure 12-2.

Using the Lower Fort Union formation as an example, the geological data used in both the reservoir and exploration simulators are shown in Table 12-4. The production rates estimated with the reservoir simulator for each permeability level are shown in Table 12-5. These rates are for base case technology with a fracture half-length of 1,000 feet. Annual gas production in millions of cubic feet per year per well and the cumulative production over a

TABLE 12-1

Wind River Basin Properties

FORMATION	TYPE SAND*	DEPTH	PRES (psi)	TEMP (°F)	PERM (md)	GAS-FILLED POROSITY (%)	NET PAY (ft)
Frontier and Muddy	B	2,000'	775	104	.3 -.003	10.5-7.0	10-45
Lower Ft. Union	L	7,500'	3750	180	.3 -.001	6.8-3.5	10-150
Lance	L	9,000'	4500	204	.3 -.0003	6.8-3.1	6-200
Lance	L	14,000'	7000	284	.1 -.0001	5.8-2.8	15-200
Mesa Verde	L	15,000'	7500	300	.03-.0001	5.0-2.8	24-100

*B-Blanket
L-Lenticular

TABLE 12-2

Formation Areas

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
Wind River		Lower Fort Union	630	5,115
		Lance 9000	180	1,740
		Lance 14000	270	3,306
		Mesa Verde 15000	270	2,744
		Lower Fort Union + Lance 9000	270	4,800
		Lance 14000 + Mesa Verde 15000	180	4,034
		Frontier/Muddy	480	1,547
Basin Total			2,280	23,286

TABLE 12-3

SUMMARY OF WIND RIVER BASIN GAS POTENTIAL

(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Wind River		Lower Fort Union	3355	3709	3709	3677	5115	5115
		Lance 9000	0	860	918	0	1172	1642
		Lance 14000	0	1200	1687	0	1778	2495
		Mesa Verde 15000	0	0	0	0	0	0
		Lower Ft.Union + Lance 9000	2789	2971	2971	3718	4800	4800
		Lance 14000 + Mesa Verde 15000	0	0	1279	0	0	3179
		Frontier/Muddy	895	1111	1163	1377	1547	1547
Basin Total			7039	9851	11727	8772	14412	18778

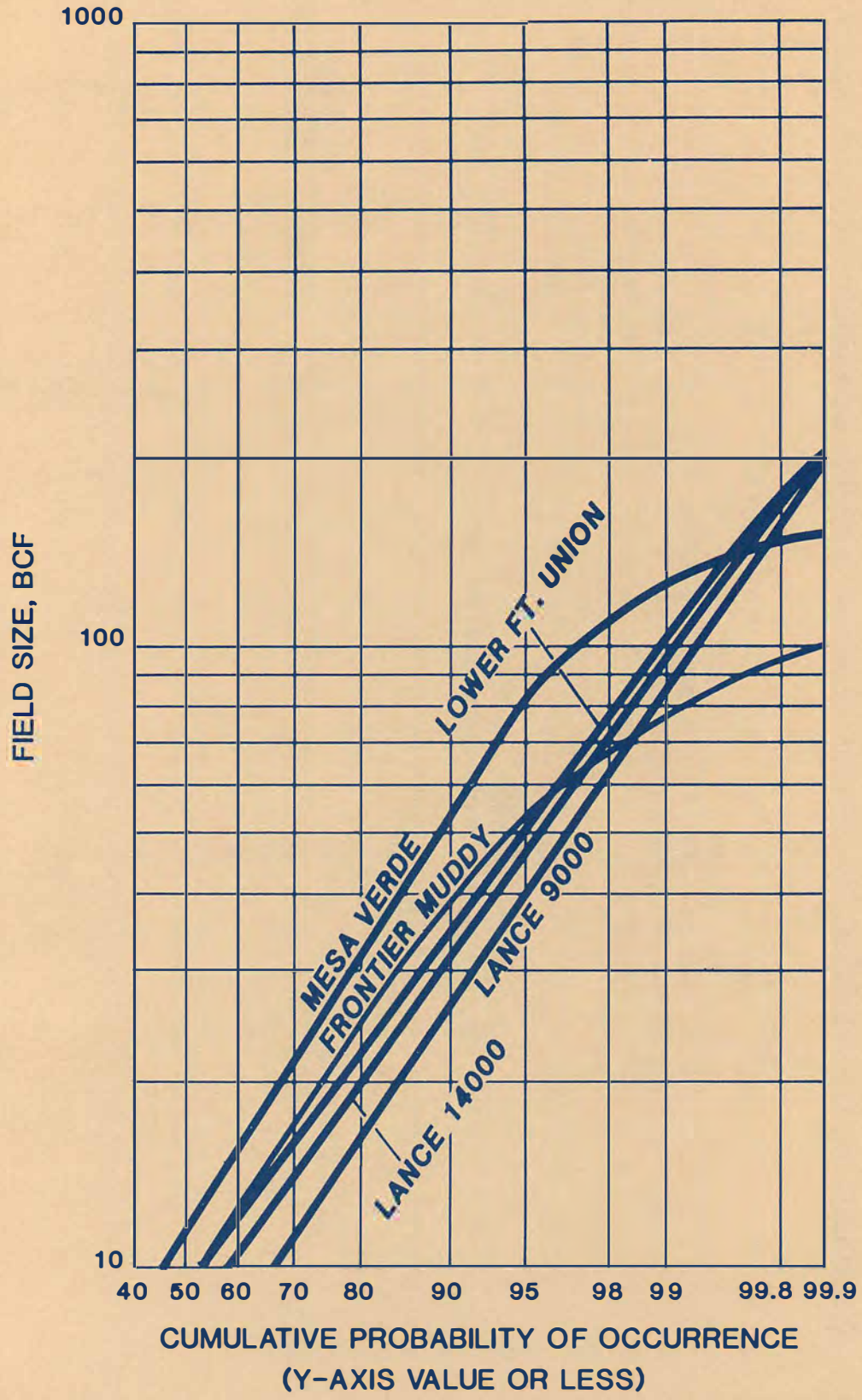


Figure 12-2. Field Size Distribution of Producible Gas, Wind River Basin.

TABLE 12-4

GEOLOGICAL DATA SUMMARY

BASIN: Wind River
SUBBASIN: -
FORMATION: Lower Ft. Union

DEPTH (FT.): 7500
PRESSURE (PSIA): 3750
TEMPERATURE (°F): 180

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 10.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE-OF-NATURE IS PROD 1st W/C	2nd W/C
0.3	63	6.8	10	225.54	194	0.25	1.0	-
0.1	145	5.8	17	833.75	680	0.55	1.0	-
0.03	214	5.0	30	1966.66	1519	0.65	1.0	-
0.01	126	4.4	50	1770.3	1284	0.75	1.0	-
0.003	57	3.9	90	1310.43	886	0.85	1.0	-
0.001	25	3.5	150	862.	552	0.90	1.0	-
	630			6969.	5115			

TABLE 12-5

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, LOWER FORT UNION 7500

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	490	522	461	386	343	291				
2	85	178	217	199	178	151				
5	6	39	85	101	101	87				
10	0	8	36	58	67	59				
15	0	3	18	39	52	47				
20	0	1	11	27	42	40				
30	0	0	4	16	29	31				
30-YEAR CUMM. PROD. (MMCF)	640	1020	1539	1920	2120	1929				

30-year period are given. The 30-year cumulatives range from 0.64 to 2.2 BCF per well for the six permeability levels studied. Table 12-6 shows the data for the advanced technology case with fracture half-lengths of up to 4,000 feet. The 30-year cumulatives for the advanced technology case are from five to more than 50 percent higher than for the base technology case.

TABLE 12-6

Lenticular Recovery Factors
Percentage of Total Producible
Gas Recoverable in 30 Years
(Base Case-Wind River, Lance 9000' Formation)

Wells/Section	1	2	3	4
Perm.(md)				
.3	27	56	70	78 *
.1	24	49	61	69 *
.03	20	45	60	73 *
.01	15	35	51	67 *
.003	10	24	36	52 *
.001	7	15	24	34 *
.0003	4	10	15	22 *

* Values used in estimating gas recovery in Table 12-16.

Production rates for the Fort Union wells will range from about 800 MCF/D to 1,400 MCF/D for the first year with base technology, depending on permeability level and net pay thickness. With longer fractures, average daily production rates in the first year should exceed 1 MMCF/D for all permeability levels. Rates will decline rapidly, however, and by the fifth year even the best well with advanced technology will be producing only 300 MCF/D. The highest permeability wells, declining rapidly, will be producing at only 50 MCF/D.

The Fort Union is a lenticular sand and the number of wells per section actually drilled will affect the ultimate recovery drastically. Table 12-7 shows the number of wells per section with both base and advanced technology. With base technology, the number of

TABLE 12-7

Lenticular Recovery Factors
Percentage of Total Producible
Gas Recoverable in 30 Years
(Advanced Case-Wind River, Lance 9000' Formation)

Wells/Section	1	2	3	4	6	8	12
Perm.(md)							
.3	56	84	93	94	99 *	100	100
.1	52	74	81	83	93	96	99 *
.03	43	67	80	88	96 *	100	100
.01	33	52	68	81	95 *	100	100
.003	22	36	48	63	82	97 *	100
.001	14	23	32	42	60	79 *	100
.0003	9	14	20	26	40	56	81 *

* Values used for estimating gas recovery in Table 12-17.

wells required ranges from 4.6 to 11.3 wells per section. However, with base technology and thus current well spacing restrictions, only four wells per section are permitted. The effect is to reduce recoverable gas from the maximum of 5,115 BCF, shown in Table 12-4, to only 3,709 BCF. With advanced technology, well spacing could be varied so that the actual number of wells needed could be drilled. For the Fort Union, this would range from 3.0 to 9.5 wells per section. With advanced technology, the full 5,115 BCF could be recovered.

Lenticular recovery factors for the Wind River were calculated using the lens size distributions observed in the Uinta basin (Table 16, Part I). These recovery factors are given in Tables 12-6 and 12-7 for the Lance 9,000 ft. formation. They are very similar to those recovery factors in Tables 17 and 18.

A cursory examination of Tables 12-6 and 12-7 for the Lance 9,000 ft. formation could lead to an incorrect conclusion that a base case well is more effective over its 30-year life than an advanced case well. These tables cannot be directly compared because different well densities are involved. The base case table displays the gas produced by each well when only 4 wells/section in

each permeability level are allowed. However, in the advanced case, well densities of 6, 12, 6, 6, 8, 8, 12 wells/section are used in the permeability levels from K = 0.3 to 0.0003 md respectively. These well densities were calculated within the lenticular production model so as to maximize the amount of gas recovered. As shown in Table 12-14, the number of wells actually used was sometimes increased to recover all the gas possible. Therefore, because many more wells per section are used in the advanced case, the ultimate gas recovery on a per-well basis is lower than that of the base case. This is true for almost all the lenticular formations, even though more gas is produced in the advanced case.

Using the Lance 9,000 ft. formation of the Wind River basin as an example, a comparison can be made of the percent recovery and the ultimate recovery per well when only 4 wells/section are allowed in both the base and the advanced case.

As shown in Table 12-8, the advanced case wells have both a higher ultimate recovery per well and a higher percent recovery than the base case wells when compared on an equal basis.

TABLE 12-8

Wind River Basin, Lance 9000 ft. Formation,
Four Wells/Section

Perm.(md)	Base Case		Advanced Case	
	Ult.Recovery Per Well (MMCF)	% Recovery of Gas in Section	Ult.Recovery Per Well (MMCF)	% Recovery of Gas in Section
0.3	400	78	489	94
0.1	620	69	745	83
0.03	1009	73	1227	88
0.01	1340	67	1618	81
0.003	1600	52	1932	63
0.001	1600	34	1930	42
0.0003	1509	22	1824	26

Finally, a comparison of the well production for both base and advanced case wells in the 0.1 permeability level is shown in Table 12-9. When only four wells/section are used in each case, the advanced technology well is, of course, an improvement.

TABLE 12-9

Wind River Basin, Lance 9000 ft. Formation
Four Wells/Section, 0.1 Permeability

Year of Production	Base Case Production (MMCF/Well/Year)	Advanced Case Prod. (MMCF/Well/Year)
1	367	445
2	98	119
5	17	21
10	4	5
15	1	2
20	0	1
30	0	0
30-Year Cumn.Prod.(MMCF)	620	745

In lenticular reservoirs the long fractures are used as means to connect lenses to the well. These long fractures are not used, as in blanket formations, to increase the efficiency of production of each individual well. All the wells in a section of lenticular reservoirs act in consort to increase the overall effectiveness of draining the section of its gas. To do so, the amount of gas produced by each individual well may be less.

ECONOMICS

The basic geologic and production data for all five formations plus the two combinations for dual completions were processed with the full cycle exploration and production simulator described in Chapter Four. Each of the seven sets of data was evaluated separately to determine the economics of finding and developing the gas in that particular formation or combination of formations. The investment required and economics of gas production vary substantially from one formation to another.

Continuing with the Fort Union example, the investment and operating expenses used to evaluate the Fort Union are shown in Table 12-12. Fracturing costs are a function of the net pay thickness and fracture length and are presented as ranges in this table. The appropriate values for each case, however, were calculated and used in the simulator.

TABLE 12-10

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, LOWER FORT UNION 7500

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	644	619	523	467	413	421				
2	183	260	265	240	209	198				
5	19	82	122	123	116	111				
10	3	24	65	71	69	66				
15	0	9	38	47	49	52				
20	0	4	26	33	38	39				
30	0	1	13	19	24	27				
30-YEAR CUMM. PROD. (MMCF)	1009	1560	2239	2319	2239	2290				

TABLE 12-11

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN:
FORMATION: Lower Ft. Union

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	4.8125	4	161	3.053	3.053	194
.1	4.598	4	592	3.006	3.006	680
.03	4.607	4	1322	3.166	3.166	1519
.01	5.307	4	963	4.394	4.394	1284
.003	7.090	4	478	6.713	6.713	886
.001	11.343	4	193	9.554	9.554	552
			3709			5115

TABLE 12-12

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Lower Ft. Union

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	541,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	155,000 - 755,000
- Advanced Case [2000/4000 Ft. Fracture]	309,000 - 1,610,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0291

The output from the simulator is shown in two tables: the economic summary for the base technology case is shown in Table 12-13; advanced technolgy economics are summarized in Table 12-14. Evaluations are made at discount rates of 10, 15, and 20 percent at several gas prices. Each of the 24 cases shown on each table is a complete evaluation. In other words, the entire basin is drilled and developed assuming that this gas price and discount factor prevail. In each case the table shows the rate of return and the net present value (positive only when the rate of return exceeds the discount rate). When the net present value is not positive, this simply means that none of the gas will be recoverable at this price and discount rate. In Table 12-13, this occurs only at the lowest price of $1.50/MCF and at discount rates above 10 percent. As price increases, net present value becomes positive and some gas becomes recoverable. For example, in Case 22, at a 15 percent rate of return and $2.50/MCF, present value is $1.437 million and 3,355 BCF of gas become recoverable. Note also that permeability levels from 0.1 to 0.003 md will be economic. All other permeability levels were tested but proved uneconomic. As price increases, both net present worth and recoverable gas increase until, at $5.00/MCF, gas from all permeability levels is recoverable. However, the 3,709 BCF recoverable is still less than the maximum which could be recovered with advanced technology, as shown in Table 12-14.

The tables also show the investment required per prospect and the maximum number of prospects available in the basin at the price. The total number of wells required is also shown. Comparison of Tables 12-13 and 12-14 will show the effect of advanced technology. Similar economic summaries are shown for the other four formations plus the two combinations. An overall summary of the Wind River basin undiscovered tight gas that is potentially productive is shown in Table 12-3. These estimates for both base and advanced technology cases are calculated for gas prices of $2.50, $5.00, and $9.00/MCF at a 15 percent discount rate.

TABLE 12-13

ECONOMICS SUMMARY

BASIN Wind River

SUB BASIN

FORMATION Lower Ft.Union 7500'

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
1101111	1.50	34.5	2 CD	3536	5.685	97	11.7	2285	2803	402	34.5	263	137	287	1146	1833
21	2.50	56.1	4 BCDE	5424	8.436	2172	43.1	3355	4369	398	56.1	175	223	481	1923	2801
31	3.10	62.6	6 ABCDEF	5893	8.902	3496	61.8	3709	5115	417	62.6	156	261	555	2218	3189
41	3.50	"	" "	"	"	4307	72.6	"	"	"	"	"	"	"	"	"
51	5.00	"	" "	"	"	7345	108.4	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	11396	146.7	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	15447	178.5	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	21523	218.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	0	0 -	911	0	-524	0	-	-	-	-	-	-	-	-	-
22	2.50	56.1	4 BCDE	5424	8.436	1437	43.1	3355	4369	398	56.1	175	223	481	1923	2801
32	3.10	59.0	5 ABCDE	5850	8.753	2433	61.2	3516	4563	402	59.0	165	237	532	2128	3062
42	3.50	"	" "	"	"	3058	71.9	"	"	"	"	"	"	"	"	"
52	5.00	62.6	6 ABCDEF	5893	8.902	5475	108.4	3709	5115	417	62.6	156	261	555	2218	3189
62	7.00	"	" "	"	"	8639	146.7	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	11803	178.5	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	16549	218.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	0	0 -	911	0	-525	0	-	-	-	-	-	-	-	-	-
23	2.50	47.9	3 BCD	5142	7.614	863	41.7	2877	3483	378	47.9	197	181	435	1737	2550
33	3.10	59.0	5 ABCDE	5850	8.753	1757	61.2	3516	4563	402	59.0	165	237	532	2128	3062
43	3.50	"	" "	"	"	2263	71.9	"	"	"	"	"	"	"	"	"
53	5.00	62.6	6 ABCDEF	5893	8.902	4215	108.4	3709	5115	417	62.6	156	261	555	2218	3189
63	7.00	"	" "	"	"	6773	146.7	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	9331	178.5	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	13168	218.4	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 12-14

ECONOMICS SUMMARY

BASIN Wind River

SUB BASIN

FORMATION Lower Ft. Union 7500'

TECHNOLOGY Advanced

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *		AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1101211	1.50	34.5	2	CD	3574	6.327	122	11.7	2802	2802	443	34.5	290	153	244	976	1663
21	2.50	59.0	5	ABCDE	6064	10.222	2632	42.8	4563	4563	446	59.0	183	263	474	1894	2814
31	3.10	"	"	"	"	"	3940	58.7	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	4812	68.7	"	"	"	"	"	"	"	"	"
51	5.00	62.6	6	ABCDEF	6374	10.628	8297	103.0	5115	5115	481	62.6	180	301	524	2096	3102
61	7.00	"	"	"	"	"	12798	141.1	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	17299	173.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	24050	214.1	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	1116	0	-638	0	0	0	0	0	0	0	0	0	0
22	2.50	50.8	4	ABCD	5380	8.928	1547	42.2	3677	3677	412	50.8	203	209	394	1577	2383
32	3.10	59.0	5	ABCDE	6064	10.222	2711	58.7	4563	4563	446	59.0	183	263	474	1894	2814
42	3.50	"	"	"	"	"	3381	68.7	"	"	"	"	"	"	"	"	"
52	5.00	62.6	6	ABCDEF	6374	10.628	6041	103.0	5115	5115	481	62.6	180	301	524	2096	3102
62	7.00	"	"	"	"	"	9499	141.1	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	12957	173.2	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	18144	214.1	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	1116	0	-636	0	0	0	0	0	0	0	0	0	0
23	2.50	50.8	4	ABCD	5380	8.928	1013	42.2	3677	3677	412	50.8	203	209	394	1577	2383
33	3.10	"	"	"	"	"	1739	57.1	"	"	"	"	"	"	"	"	"
43	3.50	59.0	5	ABCDE	6064	10.222	2455	68.7	4563	4563	446	59.0	183	263	474	1894	2814
53	5.00	"	"	"	"	"	4464	102.2	"	"	"	"	"	"	"	"	"
63	7.00	62.6	6	ABCDEF	6374	10.628	7334	141.1	5115	5115	481	62.6	180	301	524	2096	3102
73	9.00	"	"	"	"	"	10098	173.2	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	14244	214.1	"	"	"	"	"	"	"	"	"

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 12-15

GEOLOGICAL DATA SUMMARY

BASIN: Wind River
SUBBASIN: -
FORMATION: Lance 9000

DEPTH (FT.): 9000
PRESSURE (PSIA): 4500
TEMPERATURE (°F): 204

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 10.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	2	6.8	6	5.64	5	0.20	1.0	-
0.1	14	5.8	10	56.	52	0.40	1.0	-
0.03	43	5.0	19	282.08	240	0.60	1.0	-
0.01	61	4.4	33	611.22	490	0.70	1.0	-
0.003	36	3.9	61	591.12	442	0.75	1.0	-
0.001	14	3.5	110	372.12	267	0.80	1.0	-
0.0003	9	3.1	200	385.2	244	0.80	1.0	
	180			2303.	1740			

TABLE 12-16

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, LANCE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	285	367	330	282	266	243	223			
2	59	98	150	144	138	126	118			
5	7	17	56	74	78	73	67			
10	1	4	21	38	48	49	46			
15	0	1	10	25	38	40	37			
20	0	0	6	17	29	33	32			
30	0	0	2	10	20	25	26			
30-YEAR CUMM. PRCD. (MMCF)	400	620	1009	1340	1600	1600	1509			

TABLE 12-17

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, LANCE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	290	276	434	368	398	352	367			
2	27	10	142	171	175	164	159			
5	2	1	35	71	81	92	89			
10	0	0	10	29	39	58	56			
15	0	0	4	17	24	41	44			
20	0	0	2	9	15	31	32			
30	0	0	1	5	8	20	23			
30-YEAR CUMM. PROD. (MMCF)	339	300	890	1270	1490	1840	1859			

TABLE 12-18

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN:
FORMATION: Lance 9000

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	6.675	4	4	7.876	7.876	5
.1	5.99 *	4	36	12.38 *	12.000	52
.03	5.51	4	175	6.247	6.247	240
.01	5.97	4	328	6.299	6.299	490
.003	7.68	4	230	8.241	8.241	442
.001	11.59	4	91	10.08	10.08	267
.0003	18.38	4	54	14.92	12.	198
			918			1694

* Sample calculation for 0.1 permeability
Max Recoverable Gas BCF/Section = 52/14 = 3.714 (Table 12-11)
Gas Production MMCF/year/well, Base Case = 620 (Table 12-12), Advanced Case = 300 (Table 12-13)
Number of wells per section to produce all gas, Base Case = $\frac{3.714}{0.620}$ = 5.99, Advanced Case = $\frac{3.714}{0.300}$ = 12.38
Recoverable gas from actual wells = 4 x 0.620 x 14 sections = 36 BCF
12 x 0.300 x 14 = 52 BCF
Lenticular Recovery Factor or Well Drainage Efficiency = $\frac{4}{5.99}$ = 67%
$\frac{12}{12.38}$ = 97%
See Table 12-53 for LRF = 69%
See Table 12-54 for LRF = 99%.
Rounding in these tables and in the computer does not always allow a exact match of numerical values.

TABLE 12-19

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Lance 9000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	810,222
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	167,000 - 942,000
- Advanced Case [2000/4000 Ft. Fracture]	332,000 - 1,729,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0291

TABLE 12-20

BASIN Wind River
SUB BASIN

ECONOMICS SUMMARY

FORMATION Lance 9000

TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2502111	1.50	0	0	-	1219	0	-691	0	0	0	0	0	0	0	0	0	0
21	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
31	3.10	55.9	3	CDE	5825	5.785	952	20.2	733	1172	127	55.9	56	71	113	453	694
41	3.50	"	"	"	"	"	1460	26.2	"	"	"	"	"	"	"	"	"
51	5.00	63.9	5	BCDEF	6729	6.442	3789	54.0	860	1491	133	63.9	48	85	142	569	845
61	7.00	68.6	7	ABCDEFG	6779	6.560	6796	94.7	918	1740	140	68.6	44	96	150	601	891
71	9.00	"	"	"	"	"	9727	134.7	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	14124	190.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1219	0	-689	0	0	0	0	0	0	0	0	0	0
22	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
32	3.10	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
42	3.50	55.9	3	CDE	5825	5.785	782	26.2	733	1172	127	55.9	56	71	113	453	694
52	5.00	63.9	5	BCDEF	6729	6.442	2623	54.0	860	1492	133	63.9	48	85	142	569	845
62	7.00	68.6	7	ABCDEFG	6779	6.560	5025	94.7	918	1740	140	68.6	44	96	150	601	891
72	9.00	"	"	"	"	"	7370	134.7	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	10888	190.8	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1219	0	-687	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
33	3.10	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
43	3.50	0	0	0	"	0	"	0	0	0	0	0	0	0	0	0	0
53	5.00	59.0	4	BCDE	6586	6.176	1789	53.2	769	1224	125	59.0	51	74	130	520	775
63	7.00	64.1	6	ABCDEF	6754	6.451	3791	93.5	864	1496	134	64.1	48	86	143	573	851
73	9.00	68.6	7	ABCDEFG	6779	6.560	5806	134.7	918	1740	140	68.6	44	96	150	601	891
83	12.00	"	"	"	"	"	8731	190.8	"	"	"	"	"	"	"	"	"

*CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001 G 0.0003

TABLE 12-21

ECONOMICS SUMMARY

BASIN Wind River
SUB BASIN

FORMATION Lance 9000

TECHNOLOGY Advanced
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2502211	1.50	0	0	-	1460	0	-827	0	0	0	0	0	0	0	0	0	0
21	2.50	0	0	0	"	0	"	0	"	"	"	"	"	"	"	"	"
31	3.10	38.8	2	DE	7254	6.066	941	19.1	932	932	154	38.8	94	60	145	580	879
41	3.50	55.9	3	DCE	10931	8.480	2374	30.6	1172	1172	138	55.9	61	77	217	866	1221
51	5.00	60.8	4	CDEF	11384	8.985	5976	66.3	1439	1439	160	60.8	63	97	258	1034	1452
61	7.00	65.3	5	CDEFG	11921	9.459	10982	119.8	1637	1683	173	65.3	60	113	286	1146	1605
71	9.00	68.6	7	ABCDEFG	14688	10.027	16371	174.8	1694	1740	169	68.6	53	116	359	1436	1964
81	12.00	"	"	"	"	"	24228	260.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1460	0	-823	0	0	0	0	0	0	0	0	0	0
22	2.50	0	0	-	"	0	"	0	"	"	"	"	"	"	"	"	"
32	3.10	0	0	-	"	0	"	0	"	"	"	"	"	"	"	"	"
42	3.50	38.8	2	DE	7254	6.066	811	25.3	"	"	154	38.8	94	60	145	580	879
52	5.00	55.9	3	CDE	10931	8.480	4178	66.2	1172	1172	138	55.9	61	77	217	866	1221
62	7.00	65.3	5	CDEFG	11921	9.459	8408	119.8	1637	1683	173	65.3	60	113	286	1146	1605
72	9.00	65.5	6	ACDEFG	11966	9.470	12364	175.9	1642	1688	"	65.5	60	114	288	1153	1015
82	12.00	68.6	7	ABCDEFG	14688	10.027	19295	260.7	1694	1740	169	68.6	53	116	359	1436	1964
Discount Rate 20%																	
13	1.50	0	0	-	1460	0	-818	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	-	"	0	"	0	"	"	"	"	"	"	"	"	"
33	3.10	0	0	-	"	0	"	0	"	"	"	"	"	"	"	"	"
43	3.50	0	0	-	"	0	"	0	"	"	"	"	"	"	"	"	"
53	5.00	55.9	3	CDE	10931	8.480	3120	66.2	1172	1172	138	55.9	61	77	217	866	1221
63	7.00	60.8	4	CDEF	11384	8.985	6453	120.7	1439	1439	160	60.8	63	97	258	1034	1452
73	9.00	65.5	6	ACDEFG	11966	9.470	9969	175.9	1642	1688	173	65.5	60	114	288	1153	1615
83	12.00	68.6	7	ABCDEFG	14688	10.027	15839	260.7	1694	1740	169	68.6	53	116	359	1436	1964

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.05	0.01	0.005	0.001	0.0003

TABLE 12-22

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 10.

BASIN: Wind River
SUBBASIN:
FORMATION: Lance 14000

DEPTH (FT.): 14000
PRESSURE (PSIA): 7000
TEMPERATURE (°F): 284

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.10	3	5.8	15	20.79	16	0.20	1.0	-
0.03	24	5.0	24	229.2	176	0.40	1.0	-
0.01	62	4.4	36	781.82	549	0.60	1.0	-
0.003	92	3.9	56	1598.96	1053	0.70	1.0	-
0.001	49	3.5	84	1146.6	701	0.75	1.0	-
0.0003	30	3.1	130	962.4	551	0.80	1.0	-
0.0001	11	2.8	200	490.38	260	0.80	1.0	-
	270			5230.	3306			

TABLE 12-23

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, LANCE 14000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		529	485	429	322	262	192	160		
2		158	211	213	166	136	102	84		
5		29	69	94	92	78	57	48		
10		6	23	43	57	53	39	34		
15		2	10	25	39	41	32	26		
20		1	6	15	30	33	27	24		
30		0	2	8	19	25	23	19		
30-YEAR CUMM. PROD. (MMCF)		929	1320	1679	1789	1670	1289	1090		

TABLE 12-24

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, LANCE 14000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		529	565	519	407	386	324	266		
2		50	185	257	200	174	140	115		
5		6	44	113	96	86	77	66		
10		1	12	52	52	50	45	44		
15		0	5	31	32	33	31	34		
20		0	3	19	22	24	23	26		
30		0	1	10	12	14	15	20		
30-YEAR CUMM. PROD. (MMCF)		640	1130	2030	1799	1719	1509	1450		

TABLE 12-25

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN:
FORMATION: Lance 14000

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	5.899	4	11	8.562	8.562	16
.03	5.409	4	130	6.318	6.318	176
.01	5.289	4	417	4.374	4.374	549
.003	6.411	4	653	6.376	6.376	1053
.001	8.635	4	322	8.388	8.388	701
.0003	14.236	4	154	12.16	12.	544
.0001	21.587	4	49	16.227	12.	192
			1736			3231 *

* Economic Summary 3306 (error in WDF)

TABLE 12-26

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Lance 14000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	1,467,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	115,000 - 500,000
- Advanced Case [2000/4000 Ft. Fracture]	371,000 - 1,932,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0291

TABLE 12-27

ECONOMICS SUMMARY

BASIN Wind River
SUB BASIN
FORMATION Lance 14000
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2503111	1.50	0	0	-	1829	0	-1027	0	0	0	0	0	0	0	0	0	0
21	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
31	3.10	16.3	1	D	3815	2.068	-452	4.1	0	0	0	16.3	0	0	0	0	0
41	3.50	43.3	2	DE	6191	4.891	546	14.7	1070	1602	219	43.3	124	95	117	467	803
51	5.00	57.4	5	BCDEF	7569	6.481	2719	31.5	1533	2495	237	57.4	101	136	164	656	1056
61	7.00	64.9	6	BCDEFG	7939	6.862	5520	55.4	1687	3046	246	64.9	86	160	180	719	1145
71	9.00	69.0	7	BCDEFGH	8033	6.972	12392	120.5	1736	3306	249	69.0	77	172	185	738	1171
81	12.00								"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1829	0	-1022	0	0	0	0	0	0	0	0	0	0
22	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
32	3.10	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
42	3.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
52	5.00	43.5	3	CDE	6195	4.895	1212	29.7	1200	1778	245	43.5	139	107	131	524	900
62	7.00	57.4	5	BCDEF	7569	6.481	3568	55.2	1533	2495	237	57.4	101	136	164	656	1056
72	9.00	64.9	6	BCDEFG	7939	6.862	5803	81.0	1687	3046	246	64.9	86	160	180	719	1145
82	12.00	69.0	7	BCDEFGH	8033	6.972	9048	120.5	1736	3306	249	69.0	77	172	185	738	1171
Discount Rate 20%																	
13	1.50	0	0	-	1829	0	-1016	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
33	3.10	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
43	3.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
53	5.00	43.5	3	CDE	6195	4.895	647	29.7	1200	1778	245	43.5	139	107	131	524	900
63	7.00	57.4	5	BCDEF	7569	6.481	2498	55.2	1533	2495	237	57.4	101	136	164	656	1056
73	9.00	"	"	"	"	"	4125	80.3	"	"	"	"	"	"	"	"	"
83	12.00	69.0	7	BCDEFGH	8033	6.972	6938	120.5	1736	3306	249	69.0	77	172	185	738	1171

*CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 12-28

ECONOMICS SUMMARY

BASIN Wind River
SUB BASIN
FORMATION Lance 14000

TECHNOLOGY Advanced
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2503211	1.50	0	0	-	2308	0	1298	0	0	0	0	0	0	0	0	0	0
21	2.50	0	0	-	"	0	"	0	0	0	0	0	0	0	0	0	0
31	3.10	16.3	1	D	4597	2.491	-543	4.1	0	0	0	16.3	0	0	0	0	0
41	3.50	"	"	"	"	"	-305	6.6	0	0	0	"	0	0	0	0	0
51	5.00	57.2	4	CDEF	13842	9.813	4259	32.6	2479	2479	253	57.2	108	145	285	1140	1678
61	7.00	57.4	5	BCDEF	13861	9.819	8559	60.9	2495	2495	254	57.4	"	146	287	1149	1691
71	9.00	64.9	6	BCDEFG	16281	10.966	13919	88.1	3046	3046	278	64.9	97	180	358	1431	2066
81	12.00	69.0	7	BCDEFGH	17335	11.475	21662	135.6	3306	3306	288	69.0	89	199	389	1555	2231
Discount Rate 15%																	
12	1.50	0	0	-	2308	0	-1287	0	0	0	0	0	0	0	0	0	0
22	2.50	0	0	-	"	"	"	"	0	0	0	0	0	0	0	0	0
32	3.10	0	0	-	"	"	"	"	0	0	0	0	0	0	0	0	0
42	3.50	16.3	1	D	4597	2.491	-605	6.6	0	0	0	0	0	0	0	0	0
52	5.00	43.3	3	CDE	9429	6.684	1811	31.7	1778	1778	266	43.3	151	115	198	791	1255
62	7.00	57.2	4	CDEF	13842	9.813	5899	60.8	2479	2479	253	57.2	108	145	285	1140	1678
72	9.00	57.4	5	BCDEF	13861	9.819	9289	92.0	2495	2495	254	57.4	"	146	287	1149	1691
82	12.00	69.0	7	BCDEFGH	17335	11.475	15981	135.6	3306	3306	288	69.0	89	199	389	1555	2231
Discount Rate 20%																	
13	1.50	0	0	-	2308	0	-1276	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	-	"	"	"	"	0	0	0	0	0	0	0	0	0
33	3.10	0	0	-	"	"	"	"	0	0	0	0	0	0	0	0	0
43	3.50	0	0	-	"	"	"	"	0	0	0	0	0	0	0	0	0
53	5.00	16.3	1	D	4597	2.491	-198	16.5	0	0	0	16.3	0	0	0	0	0
63	7.00	57.2	4	CDEF	13842	9.813	4209	60.8	2479	2479	253	57.2	108	145	285	1140	1678
73	9.00	57.4	5	BCDEF	13861	9.819	6990	92.0	2495	2495	254	57.4	"	146	287	1149	1691
83	12.00	64.9	6	BCDEFG	16281	10.966	12076	138.4	3046	3046	278	64.9	97	180	358	1431	2066

*CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001, G 0.0003

TABLE 12-29

GEOLOGICAL DATA SUMMARY

BASIN: Wind River
SUBBASIN: -
FORMATION: Mesaverde

DEPTH (FT.): 15,000
PRESSURE (PSIA): 7500
TEMPERATURE (°F): 300

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 10.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	8	5.0	24	77.52	61	0.20	1.0	-
0.01	38	4.4	36	486.02	338	0.35	1.0	-
0.003	86	3.9	48	1299.46	857	0.50	1.0	-
0.001	84	3.5	60	1424.64	866	0.60	1.0	-
0.0003	41	3.1	80	820.82	458	0.70	1.0	-
0.0001	14	2.8	100	316.54	164	0.75	1.0	-
	270			4425.	2744			

TABLE 12-30

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, MESA VERDE 15000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			505	420	289	203	133	89		
2			216	209	149	105	69	48		
5			69	95	82	60	39	27		
10			23	44	51	40	26	18		
15			10	26	35	30	22	15		
20			5	16	27	26	19	13		
30			2	8	17	17	15	10		
30-YEAR CUMM. PROD. (MMCF)			1340	1670	1590	1280	890	609		

TABLE 12-31

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, MESA VERDE 15000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			607	508	380	266	200	142		
2			188	253	186	132	91	61		
5			41	115	89	72	51	35		
10			10	53	46	41	34	23		
15			4	31	28	31	24	18		
20			2	20	19	25	20	14		
30			1	10	10	15	13	10		
30-YEAR CUMM. PROD. (MMCF)			1149	2019	1619	1439	1079	769		

TABLE 12-32

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN: -
FORMATION: Mesa Verde

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	5.381	4	46	6.275	6.275	61
.01	5.359	4	254	4.433	4.433	338
.003	6.239	4	548	6.127	6.127	857
.001	8.117	4	424	7.220	7.220	866
.0003	12.798	4	142	10.556	10.556	458
.0001	19.491	4	33	15.436	12.	126
			1447			2706

TABLE 12-33

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	2,846,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	963,000 - 2,608,000
- Advanced Case [2000/4000 Ft. Fracture]	1,925,000 - 5,303,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0291

TABLE 12-34

ECONOMICS SUMMARY

BASIN Wind River

SUB BASIN

FORMATION Mesa Verde 15000'

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1104111	1.50	0	0	-	4295	0	-2414	0	-	-	-	-	-	-	-	-	-
21	2.50	0	0	-	"	0	-2414	0	-	-	-	-	-	-	-	-	-
31	3.10	0	0	-	"	0	-2414	0	-	-	-	-	-	-	-	-	-
41	3.50	0	0	-	"	0	-2414	0	-	-	-	-	-	-	-	-	-
51	5.00	0	0	-	"	0	-2414	0	-	-	-	-	-	-	-	-	-
61	7.00	0	0	-	"	0	-2414	0	-	-	-	-	-	-	-	-	-
71	9.00	5.1	1	D	5393	0	-1873	0	-	-	-	-	-	-	-	-	-
81	12.00	20.9	3	CDE	9270	2.260	561	12.5	724	1256	320	20.9	253	67	83	331	734
Discount Rate 15%																	
12	1.50	0	0	-	4295	0	-2384	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
32	3.10	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
42	3.50	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
52	5.00	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
62	7.00	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
72	9.00	5.1	1	D	5393	0	-2003	0	-	-	-	-	-	-	-	-	-
82	12.00	20.9	3	CDE	9270	2.260	-389	12.5	-	-	-	-	-	-	-	-	-
Discount Rate 20%																	
13	1.50	0	0	-	4295	0	-2384	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
33	3.10	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
43	3.50	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
53	5.00	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
63	7.00	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
73	9.00	0	0	-	"	0	-2384	0	-	-	-	-	-	-	-	-	-
83	12.00	5.1	1	D	5393	0	-1854	0	-	-	-	-	-	-	-	-	-

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 12-35

ECONOMICS SUMMARY

BASIN Wind River — TECHNOLOGY Advanced

SUB BASIN — FORMATION Mesa Verde 15000' — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1104211	1.50	0	0	0	5565	0	-3133	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
71	9.00	4.0	1	D	6660	"	-2616	"	"	"	"	4.0	"	"	"	"	"
81	12.00	20.9	3	COE	15159	3.174	1053	13.6	1256	1256	396	20.9	313	83	158	631	1185
Discount Rate 15%																	
12	1.50	0	0	0	5565	0	-3087	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
82	12.00	5.1	2	CD	7123	0	-2328	0	0	0	0	5.1	0	0	0	0	0
Discount Rate 20%																	
13	1.50	0	0	0	5565	0	-3042	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
83	12.00	4.0	1	D	6660	0	-2575	0	0	0	0	4.0	0	0	0	0	0

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 12-36

GEOLOGICAL DATA SUMMARY

BASIN: Wind River
SUBBASIN: -
FORMATION: Lower Ft. Union + Lance 9000

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 10.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	3	*	*	33.84	30	*	*	*
0.1	22			271.38	252			
0.03	65			1041.35	886			
0.01	92			1844.89	1479			
0.003	54			1472.45	1101			
0.001	22			802.78	576			
0.0003	14			751.46	476			
	270			6218.	4800			

* Refer to individual formations for these data.

TABLE 12-37

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, LOWER FORT UNION + LANCE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	731	813	776	728	712	689	669			
2	244	283	336	330	323	312	304			
5	79	88	127	146	149	144	138			
10	35	38	55	73	82	84	81			
15	21	23	32	47	59	61	58			
20	15	16	21	33	44	49	47			
30	9	9	11	19	29	34	35			
30-YEAR CUMM. PROD. (MMCF)	1880	2090	2489	2810	3069	3069	2980			

TABLE 12-38

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, LOWER FORT UNION + LANCE 9000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	822	809	967	901	930	884	899			
2	271	253	386	415	418	408	402			
5	105	103	137	173	183	194	191			
10	51	51	61	80	90	109	107			
15	31	31	35	48	55	72	75			
20	21	21	24	31	37	53	53			
30	12	12	13	17	20	32	35			
30-YEAR CUMM. PROD. (MMCF)	2319	2269	2870	3250	3469	3819	3840			

TABLE 12-39

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN: -
FORMATION: Lower Ft. Union + Lance 9000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	5.91	4	20	4.79	4.79	30
.1	5.58	4	181	5.13	5.13	252
.03	5.49	4	645	4.77	4.77	886
.01	5.73	4	1033	4.96	4.96	1479
.003	6.63	4	664	5.87	5.87	1101
.001	8.68	4	265	6.99	6.99	576
.0003	11.82	4	161	9.18	9.18	476
			2969			4800

TABLE 12-40

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Lower Ft. Union + Lance 9000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	810,222
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	365,000 - 1,139,000
- Advanced Case [2000/4000 Ft. Fracture]	731,000 - 2,128,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0291

TABLE 12-41

BASIN Wind River
SUB BASIN

ECONOMICS SUMMARY

FORMATION Lower Ft.Union + Lance 9000

TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE,BCF	BASIN TOTALS: MAX RECOV. GIP,BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2505111	1.50	39.2	2	DE	3561	5.744	-23	9.6	0	0	0	39.2	0	0	0	0	0
21	2.50	64.0	5	BCDEF	5125	9.137	2444	43.7	2789	4294	305	64.0	110	195	181	725	1212
31	3.10	69.0	7	ABCDEFG	5149	9.349	3754	63.3	2971	4800	318	69.0	99	219	189	758	1265
41	3.50	"	"	"	"	"	4565	75.3	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	7607	118.4	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	11662	170.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	15718	216.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	21802	276.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1446	0	-818	0	0	0	0	0	0	0	0	0	0
22	2.50	64.0	5	BCDEF	5125	9.137	1615	43.7	2789	4294	305	64.0	110	195	181	725	1212
32	3.10	69.0	7	ABCDEFG	5149	9.349	2651	63.3	2971	4800	318	69.0	99	219	189	758	1265
42	3.50	"	"	"	"	"	3292	75.3	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	5696	118.4	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	8902	170.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	12107	216.2	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	16915	276.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1446	0	-814	0	0	0	0	0	0	0	0	0	0
23	2.50	59.1	4	BCDE	5039	8.803	1006	42.0	2524	3718	287	59.1	117	169	167	669	1123
33	3.10	64.0	5	BCDEF	5125	9.137	1856	61.2	2789	4294	305	64.0	110	195	181	725	1212
43	3.50	69.0	7	ABCDEFG	5149	9.349	2464	75.3	2971	4800	318	69.0	99	219	189	758	1265
53	5.00	"	"	"	"	"	4443	118.4	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	7082	170.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	9721	216.2	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	13679	276.6	"	"	"	"	"	"	"	"	"

*CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003 F 0.001 G 0.0003

TABLE 12-42

ECONOMICS SUMMARY

BASIN Wind River — TECHNOLOGY Advanced

SUB BASIN — FORMATION Lower Ft.Union + Lance 9000' — DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
2505211	1.50	0	0	-	1891	0	-1073	0	0	0	0	0	0	0	0	0	0
21	2.50	64.	6	ABCOEF	9587	13.941	4093	46.6	4324	4324	310	64.0	112	199	290	1161	1762
31	3.10	69.0	7	ABCDEFG	10055	14.556	6441	68.3	4800	4800	330	69.0	102	228	319	1275	1924
41	3.50	"	"	"	"	"	7884	83.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	13295	137.8	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	20510	205.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	27725	265.3	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	38548	344.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	1891	0	-1065	0	0	0	0	0	0	0	0	0	0
22	2.50	59.1	4	BCDE	9103	13.164	2573	45.5	3718	3718	283	59.1	116	167	253	1010	1546
32	3.10	64.0	6	ABCDEF	9587	13.941	4407	67.6	4324	4324	310	64.0	112	199	290	1161	1762
42	3.50	69.0	7	ABCDEFG	10055	14.556	5765	83.1	4800	4800	330	69.0	102	228	319	1275	1924
52	5.00	"	"	"	"	"	10089	137.8	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	15853	205.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	21617	265.3	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	30264	344.0	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	1891	0	-1056	0	0	0	0	0	0	0	0	0	0
23	2.50	56.3	3	CDE	8784	12.723	1668	44.8	3466	3466	273	56.3	119	154	233	930	1436
33	3.10	64.0	6	ABCDEF	9587	13.941	3244	67.6	4324	4324	310	64.0	112	199	290	1161	1762
43	3.50	"	"	"	"	"	4153	81.8	"	"	"	"	"	"	"	"	"
53	5.00	69.0	7	ABCDEFG	10055	14.556	7928	137.8	4800	4800	330	69.0	102	228	319	1275	1924
63	7.00	"	"	"	"	"	12695	205.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	17462	265.3	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	24613	344.0	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F	G
0.3	0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 12-43

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 10.

BASIN: Wind River
SUBBASIN: -
FORMATION: Lance 14000 + Mesaverde 15000

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.03	5	*	*	134.71	106	*	*	*
0.01	25			769.29	535			
0.003	58			1936.30	1277			
0.001	56			2074.45	1261			
0.0003	27			1181.49	636			
0.0001	9			422.70	219			
	180			6519.	4034			

* Refer to individual formations for these data.

TABLE 12-44

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, LANCE 14000 + MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			838	752	621	535	465	422		
2			382	375	315	271	234	213		
5			151	177	165	142	122	109		
10			70	91	98	87	73	65		
15			43	58	68	63	54	48		
20			30	41	51	50	44	38		
30			18	25	33	34	32	27		
30-YEAR CUMM. PROD. (MMCF)			2950	3280	3200	2890	2500	2219		

TABLE 12-45

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, LANCE 14000 + MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1			1037	938	810	696	630	572		
2			384	449	382	328	287	258		
5			130	205	179	162	141	124		
10			57	100	92	88	81	70		
15			34	61	57	61	53	47		
20			23	41	39	45	40	34		
30			12	22	22	27	25	22		
30-YEAR CUMM. PROD. (MMCF)			2870	3739	3329	3159	2799	2480		

TABLE 12-46

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN:
FORMATION: Lance 14000 + Mesa Verde 15000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.03	6.65	4	64	6.84	6.84	106
.01	6.46	4	331	5.67	5.67	535
.003	6.93	4	737	6.65	6.65	1277
.001	7.82	4	645	7.15	7.15	1261
.0003	9.43	4	270	8.40	8.40	636
.0001	10.98	4	80	9.79	9.79	219
			2127			4034

TABLE 12-47

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Lance 14000 + Mesa Verde 15000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	2,846,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	1,151,400 - 2,795,400
- Advanced Case [2000/4000 Ft. Fracture]	2,600,000 - 5,978,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0291

TABLE 12-48

ECONOMICS SUMMARY

BASIN Wind River

SUB BASIN

FORMATION Lance 14000' + Mesa Verde 15000'

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
110611	1.50	0	0	-	4497	0	-2546	0	-	-	-	-	-	-	-	-	-
21	2.50	0	0	-	"	0	-2546	0	-	-	-	-	-	-	-	-	-
31	3.10	0	0	-	"	0	-2546	0	-	-	-	-	-	-	-	-	-
41	3.50	4.0	1	D	5367	0	-2350	0	-	-	-	4.0	-	-	-	-	-
51	5.00	20.9	3	CDE	15579	8.991	542	11.6	557	1918	62	20.9	49	13	35	141	238
61	7.00	38.4	5	CDEFG	19186	11.818	5063	23.9	1200	3179	102	38.4	63	39	75	299	475
71	9.00	53.2	6	CDEFGH	21874	13.484	10093	36.7	1546	4034	115	53.2	54	61	97	386	597
81	12.00	"	"	"	"	"	16341	52.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	4497	0	-2526	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0	-	4497	0	-2526	0	-	-	-	-	-	-	-	-	-
32	3.10	0	0	-	"	0	-2526	0	-	-	-	-	-	-	-	-	-
42	3.50	0	0	-	"	0	-2526	0	-	-	-	-	-	-	-	-	-
52	5.00	20.9	3	CDE	15579	8.991	-7979	11.6	-	-	-	20.9	-	-	-	-	-
62	7.00	38.4	4	CDEF	19186	11.818	2272	23.9	1200	3179	102	38.4	63	39	75	299	475
72	9.00	42.6	5	CDEFG	19571	12.079	5013	34.5	1279	3398	106	42.6	61	45	79	317	503
82	12.00	53.2	6	CDEFGH	21874	13.484	10176	52.9	1546	4034	115	53.2	54	61	97	386	597
Discount Rate 20%																	
13	1.50	0	0	-	4497	0	-2505	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	"	0	-2505	0	-	-	-	-	-	-	-	-	-
33	3.10	0	0	-	"	0	-2505	0	-	-	-	-	-	-	-	-	-
43	3.50	0	0	-	"	0	-2505	0	-	-	-	-	-	-	-	-	-
53	5.00	5.1	2	CD	5572	0	-2247	0	-	-	-	5.1	-	-	-	-	-
63	7.00	20.9	3	CDE	15579	8.991	-26	19.8	-	-	-	20.9	-	-	-	-	-
73	9.00	38.4	4	CDEF	19186	11.818	2670	33.7	1200	3179	102	38.4	63	39	75	299	475
83	12.00	53.2	6	CDEFGH	21874	13.484	6656	52.9	1546	4034	115	53.2	54	61	97	386	597

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 12-49

ECONOMICS SUMMARY

BASIN Wind River
SUB BASIN
FORMATION Lance 14000' + Mesa Verde 15000'
TECHNOLOGY Advanced
DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *		AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
11062 11	1.50	0	0	-	6460	0	-3658	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	-3658	"	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
51	5.00	4.0	1	D	8580	1.281	-3052	"	"	"	"	"	"	"	"	"	"
61	7.00	38.4	4	CDEF	45404	19.428	8484	23.4	3179	3179	164	38.4	101	63	226	906	1296
71	9.00	"	"	"	"	"	15786	35.3	"	"	"	"	"	"	"	"	"
81	12.00	49.0	5	CDEFG	55135	22.642	30734	54.7	3815	3815	168	49.0	84	83	278	1112	1559
Discount Rate 15%																	
12	1.50	0	0	-	6460	0	-3613	0	0	0	0	0	0	0	0	0	0
22	2.50	0	0	-	"	"	-3613	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	-	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	"	"	-	"	"	"	"	"	"	"	"	"	"	"	"	"
52	5.00	"	"	-	"	"	"	"	"	"	"	"	"	"	"	"	"
62	7.00	20.9	3	CDE	34109	14.074	2085	20.4	1918	1918	136	20.9	108	28	137	550	823
72	9.00	38.4	4	CDEF	45404	19.428	9036	35.3	3179	3179	164	38.4	101	63	226	906	1296
82	12.00	49.0	5	CDEFG	55135	22.642	19472	54.7	3815	3815	168	49.0	84	83	278	1112	1559
Discount Rate 20%																	
13	1.50	0	0	-	6460	0	-3570	0	0	0	0	0	0	0	0	0	0
23	2.50	0	0	-	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
63	7.00	4.0	1	D	8580	1.281	-2981	0	0	0	0	0	0	0	0	0	0
73	9.00	20.9	3	CDE	34109	14.074	3015	30.0	1918	1918	136	20.9	108	28	137	550	823
83	12.00	38.4	4	CDEF	45404	19.428	11086	52.5	3179	3179	164	38.4	101	63	226	906	1296

* CODE:

C	D	E	F	G	H
0.03	0.01	0.003	0.001	0.0003	0.0001

TABLE 12-50

GEOLOGICAL DATA SUMMARY

BASIN: Wind River
SUBBASIN: -
FORMATION: Frontier/Muddy

DEPTH (FT.): 2000
PRESSURE (PSIA): 775
TEMPERATURE (°F):104

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 10.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	34	10.5	10	54.4	47	0.10	1.0	-
0.1	101	9.7	23	343.4	281	0.30	1.0	-
0.03	178	8.8	35	834.82	646	0.40	1.0	-
0.01	115	7.9	40	553.15	403	0.45	1.0	-
0.003	52	7.0	45	249.6	170	0.50	1.0	-
	480			2035.	1547			

TABLE 12-51

WELL PRODUCTION SUMMARY--BASE CASE

WIND RIVER, FRONTIER / MUDDY 2000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	62	93	79	55	32					
2	46	64	49	31	18					
5	36	45	33	19	10					
10	29	36	25	15	7					
15	24	32	22	12	6					
20	21	29	20	11	6					
30	16	24	18	9	5					
30-YEAR CUMM. PROD. (MMCF)	815	1094	795	467	250					

TABLE 12-52

WELL PRODUCTION SUMMARY--ADVANCED CASE

WIND RIVER, FRONTIER / MUDDY 2000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	88	142	160	125	93					
2	66	99	118	84	59					
5	49	70	83	57	37					
10	40	54	65	42	26					
15	34	47	56	36	22					
20	31	42	50	33	19					
30	25	36	43	27	16					
30-YEAR CUMM. PROD. (MMCF)	1161	1643	1938	1302	832					

TABLE 12-53

PRODUCTION WELL REQUIREMENTS

BASIN: Wind River
SUB-BASIN:
FORMATION: Frontier/Muddy

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.7	1.7	47	1.2	1.2	47
.1	2.6	2.6	281	1.7	1.7	281
.03	4.6	4.	567	1.9	1.9	646
.01	7.5	4.	216	2.7	2.7	403
.003	13.1	4.	52	3.9	3.9	170
			1163			1547

TABLE 12-54

INVESTMENT AND OPERATING EXPENSES

BASIN: Wind River
SUB-BASIN:
FORMATION: Frontier/Muddy

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	123,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000
- Advanced Case [2000/4000 Ft. Fracture]	106,000 - 275,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0291

TABLE 12-55

ECONOMICS SUMMARY

BASIN Wind River
SUB BASIN
FORMATION Frontier/Muddy 2000 ft.
TECHNOLOGY Base Case
DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1107111	1.50	5.3	1	B	541	.700	-160	1.6	-	-	-	5.3	-	-	-	-	-
21	2.50	20.2	3	ABC	1383	3.340	402	19.4	895	974	268	20.2	214	54	223	893	1384
31	3.10	31.5	4	ABCD	1982	4.617	858	25.7	1111	1377	241	31.5	165	76	319	1274	1834
41	3.50	31.5	4	ABCD	1982	4.617	1129	30.8	1111	1377	241	31.5	165	76	319	1274	1834
51	5.00	37.6	5	ABCDE	2260	4.938	2194	47.2	1163	1547	236	37.6	147	89	365	1461	2063
61	7.00	"	"	"	"	"	3643	72.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	5093	95.7	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	7267	127.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	361	-	-221	0	-	-	-	0	-	-	-	-	-
22	2.50	20.2	3	ABC	1383	3.340	135	19.4	895	974	268	20.2	214	54	223	893	1384
32	3.10	20.2	3	ABC	1383	3.340	353	26.4	895	974	268	20.2	214	54	223	893	1384
42	3.50	31.5	4	ABCD	1982	4.617	612	30.8	1111	1377	241	31.5	165	76	319	1274	1834
52	5.00	31.5	4	ABCD	1982	4.617	1341	50.0	1111	1377	241	31.5	165	76	319	1274	1834
62	7.00	37.6	5	ABCDE	2260	4.938	2394	72.2	1163	1574	236	37.6	147	89	365	1461	2063
72	9.00	"	"	"	"	"	3435	95.7	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	4995	127.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	361	-	-226	0	-	-	-	0	-	-	-	-	-
23	2.50	20.2	3	ABC	1383	3.340	- 14	19.4	-	-	-	20.2	-	-	-	-	-
33	3.10	20.2	3	ABC	1383	3.340	154	26.4	895	974	268	20.2	214	54	223	893	1384
43	3.50	20.2	3	ABC	1383	3.340	265	31.1	895	974	268	20.2	214	54	223	893	1384
53	5.00	31.5	4	ABCD	1982	4.617	882	50.0	1111	1377	241	31.5	165	76	319	1274	1834
63	7.00	37.6	5	ABCDE	2260	4.938	1680	72.2	1163	1547	236	37.6	147	89	365	1461	2063
73	9.00	"	"	"	"	"	2483	95.7	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	3688	127.6	"	"	"	"	"	"	"	"	"

* CODE: A B C D E
0.3 0.1 0.03 0.01 0.003

TABLE 12-56

ECONOMICS SUMMARY

BASIN Wind River — TECHNOLOGY Advanced Case

SUB BASIN — FORMATION Frontier/Muddy 2000 ft. — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1107211	1.50	20.2	3	ABC	1295	3.340	76	11.7	974	974	292	20.2	233	59	117	469	878
21	2.50	31.5	4	ABCD	2027	5.189	1019	27.1	1377	1377	265	31.5	182	83	195	780	1240
31	3.10	37.6	5	ABCDE	2521	5.990	1717	35.0	1547	1547	258	37.6	161	97	248	993	1499
41	3.50	"	"	"	"	"	2123	41.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	3644	64.1	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	5672	93.3	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	7700	120.1	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	10743	155.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	5.3	1	B	630	.699	-242	1.1	-	-	-	5.3	-	-	-	-	-
22	2.50	31.5	4	ABCD	2027	5.189	518	27.1	1377	1377	265	31.5	182	83	195	780	1240
32	3.10	31.5	4	ABCD	2027	5.189	891	35.9	1377	1377	265	31.5	182	83	195	780	1240
42	3.50	37.6	5	ABCDE	2521	5.990	1278	41.1	1547	1547	258	37.6	161	97	248	993	1499
52	5.00	"	"	"	"	"	2377	64.1	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	3841	93.3	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	5306	120.1	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	7506	155.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	5.3	1	B	630	.699	-267	1.1	-	-	-	5.3	-	-	-	-	-
23	2.50	20.2	3	ABC	1295	3.340	102	24.0	974	974	292	20.2	233	59	117	469	878
33	3.10	31.5	4	ABCD	2027	5.189	520	35.9	1377	1377	265	31.5	182	83	195	780	1240
43	3.50	31.5	4	ABCD	2027	5.189	711	41.8	1377	1377	265	31.5	182	83	195	780	1240
53	5.00	37.6	5	ABCDE	2521	5.990	1639	64.1	1547	1547	258	37.6	161	97	248	993	1499
63	7.00	"	"	"	"	"	2769	93.3	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	3899	120.1	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	5594	155.9	"	"	"	"	"	"	"	"	"

* CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003

Chapter Thirteen

UINTA BASIN

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In addition, each subbasin within the basin has a series of these specific tables:

- Geological Data Summary
- Well Production Summary -- Base Case
- Well Production Summary -- Advanced Case
- Production Well Requirements
- Investment and Operating Expenses
- Economics Summary -- Base Case
- Economics Summary -- Advanced Case

Formation	Pages
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Coaly + Castlegate	13-30 - 13-36
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Chapter Thirteen

UINTA BASIN

GEOLOGY

General Description

The Uinta Basin, located in northeast Utah, is a major sedimentary basin of the western-central Rocky Mountain Province. The margins are sharply defined to the north and west by the Uinta and Wasatch Mountains. The south flank rises gently to the San Rafael swell on the southwest and the Uncompahgre uplift on the southeast. The eastern side of the basin is defined by the Douglas Creek arch which separates the Uinta from the Piceance Creek basin to the east. The area within the basin is approximately 9,500 square miles and is almost completely defined by the limit of Tertiary rock outcrop. It is a topographic as well as structural basin and is strongly asymmetric with the structural axis very close to the north margin. In its northern and deepest portion the basin is filled with 30,000 to 32,000 feet of Tertiary, Mesozoic and Paleozoic sedimentary rocks. Upper Cretaceous and Tertiary rocks comprise around 80 percent of the total. (Ritzma, 1972).

The configuration of the Uinta Basin was controlled in part by earlier structural features but the dominant factor in basin formation was the rise of the Uinta Mountain block on the north accompanied by simultaneous basin subsidence. This process began by the late Cretaceous-early Tertiary Laramide orogeny. Continued differential downwarping accentuated basin development throughout Tertiary time. In eastern Utah sedimentation during the Paleozoic took place in a predominantly marine shelf environment. This table pattern of deposition was interrupted during Pennsylvanian time by the elevation of the Uncompahgre uplift, part of which underlies the southeast portion of the present basin. A series of northwest trending small folds and faults extend into the eastern portion of the basin. These structures have been largely masked by later sedimentation.

In Cretaceous time the area was a part of the Rocky Mountain geosyncline and received 6,000 to 12,000 feet of sandstone and shale predominantly of the Mancos and Mesaverde formations, nonmarine in the west grading to marine in the east.

Tertiary sedimentary rocks comprised mainly of the Green River, Colton, North Horn and Wasatch formations reached thicknesses of 18,000 feet or more. The Colton, North Horn and Wasatch sediments, derived from highlands to the north and west, were deposited by mixed meandering and braided streams on a broad plain under fluvial, floodplain and lacustrine environments. The pattern of deposition resulted in highly lenticular and irregular beds, both laterally and vertically, of sandstone, shale, mudstone, siltstone and some carbonate units. Green River deposition was characterized

by a complex mixture of lacustrine shales including major deposits of carbonates and fluvial lenticular sandstones. Marginal lacustrine sandstones form stratigraphic reservoirs adjacent to the highly organic, fine grained sedimentary rocks which accumulated under reducing conditions in the interior of a very extensive lake.

The geology of the basin is illustrated by the following exhibits:

- A base map showing basin outline with bordering structures and outlined areas of tight gas formation potential (Figure 13-1)
- An oil and gas field map (Figure 13-2)
- A diagrammatic cross-section (Figure 13-3)
- A correlation chart (Figure 13-4).

Tight Gas Formations

Formations containing unconventional gas potential include sandstone reservoirs within the Mesaverde Group and North Horn, Wasatch, Colton and Green River formations that are characterized by high shaliness or extensive cementation, low permeability, low gas-filled porosity and commonly by high water saturation. These formations, nevertheless, do contain a large resource of gas-in-place disseminated widely both laterally over the basin and vertically through thousands of feet of rock.

Specific definition of formations which should qualify as tight formations with unconventional gas potential will be a task of state regulatory agencies. For the general purpose of estimating gas resource and the effect of gas price on recovery, this study adopted the rather arbitrary tight formation nomenclature or classification employed by Lewin and Associates, 1978. However, it should be noted that these formations are too restrictive. Table 13-1 lists both the Lewin formation names and the more inclusive formations intended to be covered under this study.

Hydrocarbon Potential

Estimates of potential area for the tight gas formations are based on the concept that gas saturation in these reservoirs is extensive. Dry holes drilled in earlier years do not necessarily condemn the possibility of future production with the incentive of higher gas price and new completion technology.

Resource estimates in a previous tight gas study (Lewin, 1978) are compared with the present study findings in Part I of this report, Chapter Nine. Estimates in both cases are restricted to depths of about 9,500 feet covering the shallower half of the basin. Because of lack of information on sandstone distribution and reservoir properties, deeper gas potential from 9,500 feet to

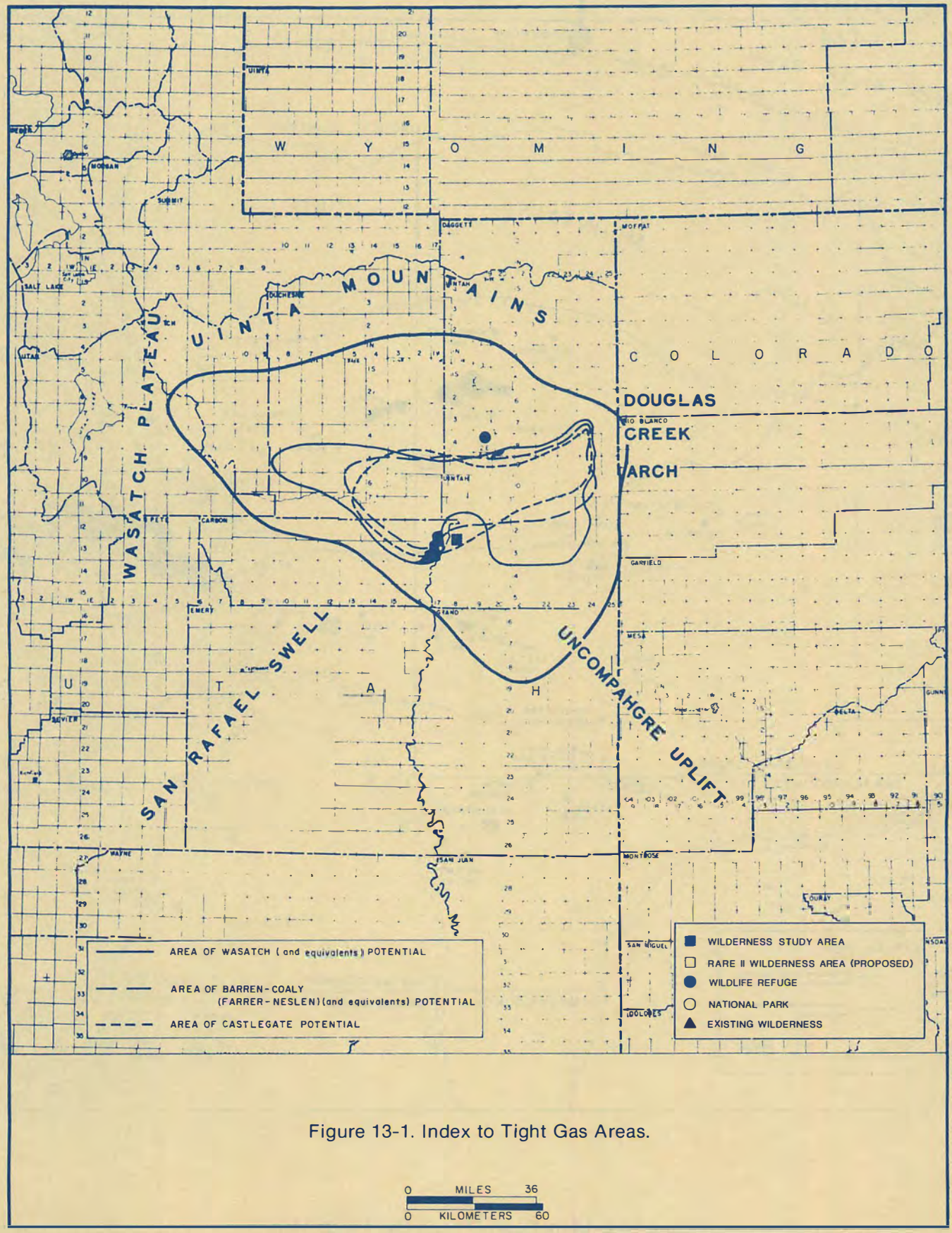


Figure 13-1. Index to Tight Gas Areas.

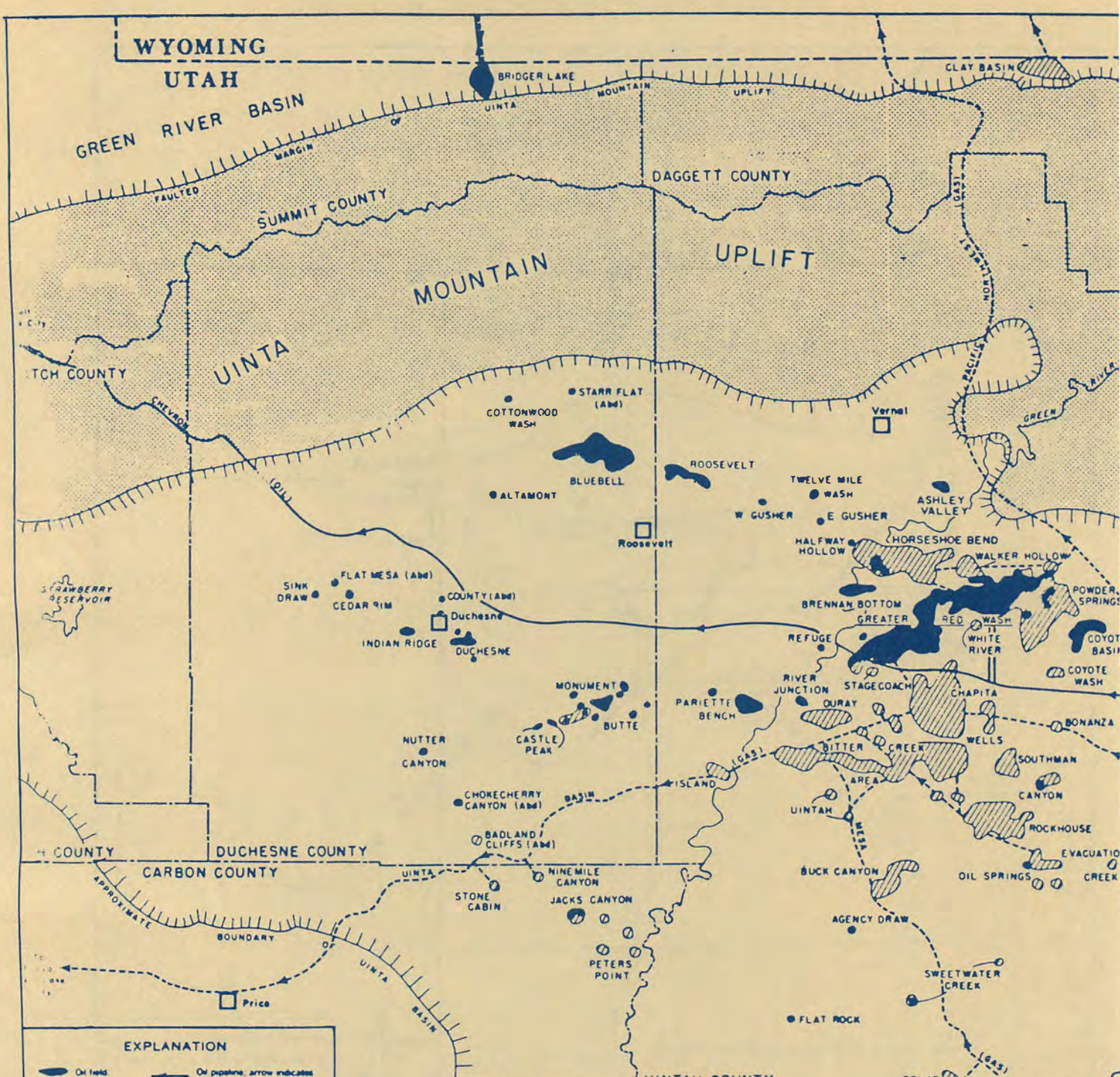


Figure 13-2. Uinta Basin Oil and Gas Fields Map.

(RITZMA, 1972)

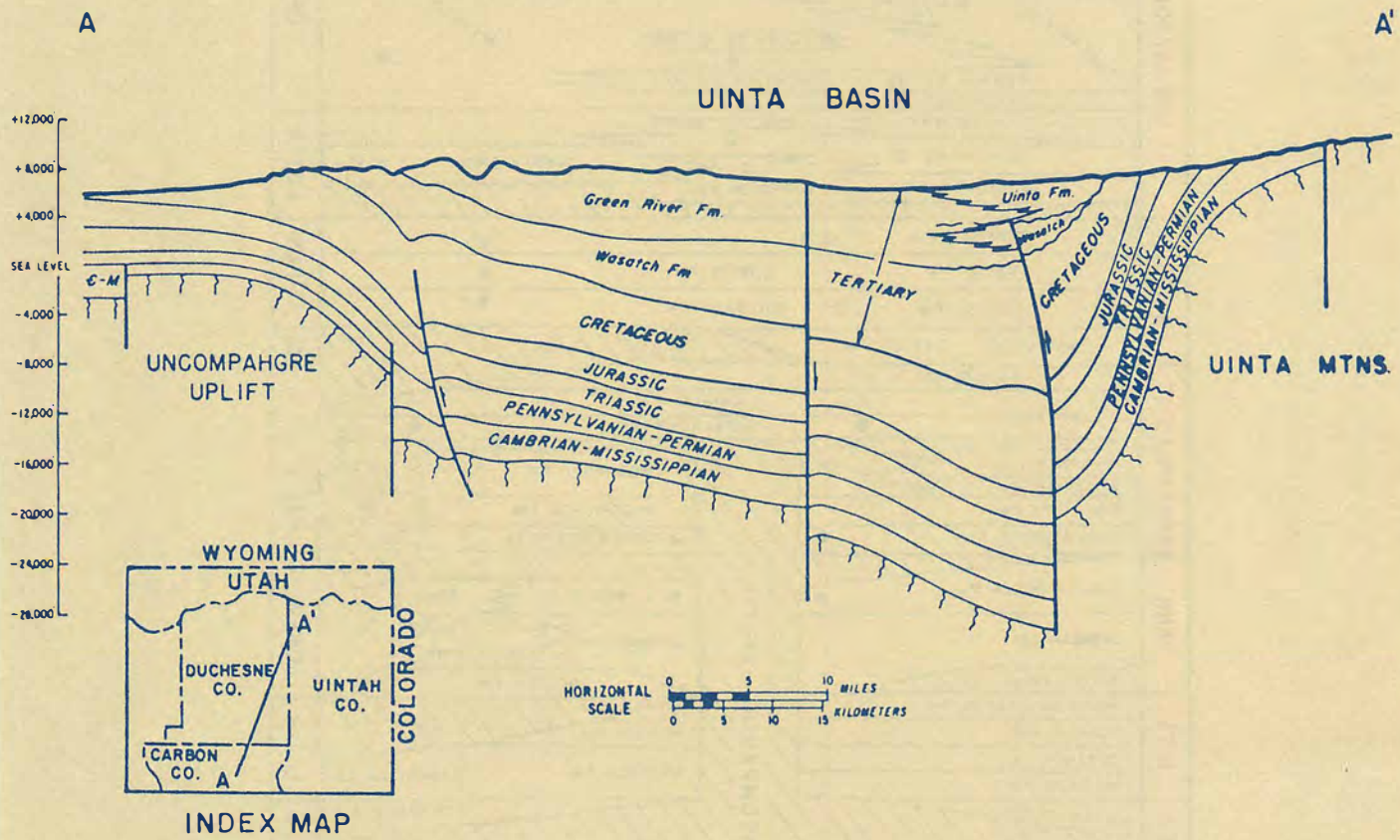


Figure 13-3. S-N Diagrammatic Cross Section Uinta Basin.

(SANBORN, 1977)

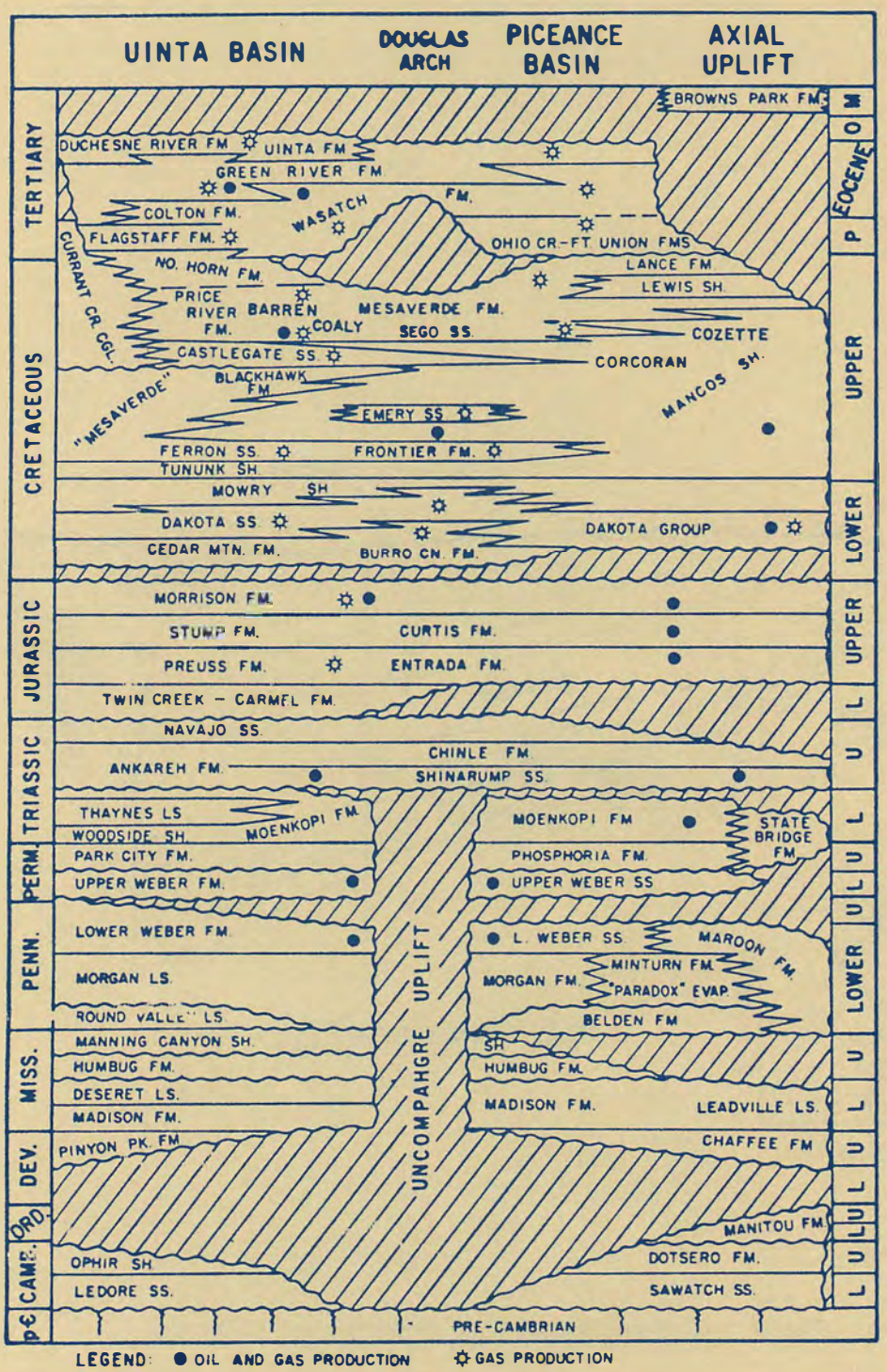


Figure 13-4. Correlation Diagram Northeast Utah and Northwest Colorado.

(AFTER SANBORN, 1977)

TABLE 13-1

Tight Gas Formations

Formation (Lewin)	Formation (This study)	Rock Type	Age	Trap Type	Depth
Wasatch	Green River Colton Wasatch North Horn	SS	Paleocene Eocene	Strat. (Lenticular)	6,500'
Barren	Tusher- Farrer	SS	U. Cret.	Strat. (Lenticular)	7,500'
Coaly	Nelsen	SS	U. Cret.	Strat. (Lenticular)	8,500'
Castlegate	Castlegate	SS	U. Cret.	Strat. (Blanket)	9,500'

below 20,000 feet is not included in the estimates. To this extent estimates are conservative. Tertiary reservoirs will probably have the best potential for development of tight gas for the formations evaluated.

Exploration History

Shallow wells were drilled in the basin as long ago as 1891 but the first commerical oil well was drilled by Equity Oil Co. in 1948 on the Ashley anticline producing at the rate of 300 BOPD from the Paleozoic Weber Sandstone. Other significant early fields included Roosevelt (1949), Red Wash (1951) and Blue Bell (1954) all producing from the Green River. Altamont was discovered in 1969 and is actually a distinct entity from Bluebell although they are commonly grouped. Old Bluebell production was all from above Colton or Wasatch. The original Altamont production was from above, equivalent to and below Colton and was over-pressured (Tom Fouch, personal communication).

Some shallow gas was found in wells drilled along Asphalt Ridge prior to 1918. In 1925 a well with an initial volume of 15 MMCFGPD was completed on the Ashley anticline from the Jurassic Morrison. Gas production was established in the east end of the basin by the early 1950's. Accumulations of gas are nearly all stratigraphic. Production tends to be restricted because of low porosity and permeability.

Exploration to date has resulted in the discovery of six large fields and 85 smaller fields. Cumulative gas production is 690 BCF with reserves of 340 BCF. This is commonly referred to as conventional gas though some of the gas has probably been produced from reservoirs with low enough permeability to qualify as tight formation gas. Future potential for conventional gas has been estimated at about 1.7 TCF. (Baker, Draft Report, June 1979).

A summary of recent exploration drilling for the 1960-1977 period is presented in Table 13-2. During this period an average of 20 wildcats per year were drilled. Of the wildcats drilled for gas, 26 percent were successful finding an average of 5.9 BCF per well. With higher prices a larger proportion of wildcats will be successful; however, for completions in tight gas reservoirs the amount found per successful well may be expected to decline.

Gilsonite

Most of the world's economic deposits of gilsonite are found in the Uinta Basin. Gilsonite is one of several varieties of bitumen commonly occurring as a solid, black, coal-like substance. Development began as early as the 1880's. By 1889, 2,000 tons of gilsonite at $50 per ton were shipped from a large mine northeast of Duchesne, Utah. Gilsonite occurs in vertical fissures or veins varying in width from a few inches to 22 feet. Some veins have been mined as deep as 1,800 feet. In 1951 annual production reached 81,000 tons. Reserves have been estimated in excess of 30 million tons. The primary source is believed to be in the Green River Formation (Wells, 1958) with emplacement in younger formations through tensional fractures or shear planes (Osmond, 1965).

Characteristics of Traps and Reservoirs

Stratigraphic trapping will control most of the gas accumulations expected in tight gas reservoirs. Primary depositional patterns imposed abrupt facies changes from sandstone and siltstone to shale. Diagenesis modified the original porosity and permeability characteristics. The result is high variability in reservoir distribution with moderate, low and relatively unproductive areas in close proximity. The presence of a broad spectrum of low permeabilities dictates that the basic trap be defined in terms of permeability. The permeability trap distribution ranges from 1.0 to 0.0003 millidarcies. Traps consist of areas of gas-filled rock having higher permeability than the surrounding rock. In general the productivity will be proportional to pay thickness, permeability and gas-filled porosity. Other reservoir characteristics being equal, the permeability trap class will determine the gas price required to achieve economic production.

An exception to the predominantly lenticular tight gas reservoirs is the marine part of the Castlegate Sandstone which tends to be a blanket-type reservoir. This does not preclude lateral or updip stratigraphic trapping due to depositional or diagenetic changes.

Table 13-3 summarizes the basic reservoir parameters.

PRODUCTION

The location of the productive formations in the Uinta basin were shown in Figure 13-1. There is considerable overlap of the productive formations and much of the area could be produced by

TABLE 13-2

EXPLORATION PERFORMANCE IN THE UINTA BASIN

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	55	47	8	39	35	4	94	82	12
Gas	30	26	4	21	20	1	51	46	5
Oil	25	21	4	18	15	3	43	36	7
Amount of Petroleum Found									
Total, MMBOE **	72	65	7	470	469	1	542	534	8
Gas, BCF	256	218	38	45	40	5	301	258	43
Oil, MMBbls.	24	23	1	384	384	0.2	408	407	1
Number of Wildcat Wells									
Total	233	216	17	127	118	9	360	334	26
Gas *	128	119	9	68	66	2	196	185	11
Oil *	105	97	8	59	52	7	164	149	15
Number Wildcats/year	23	21	2	16	15	1	20	19	1
Percent Wildcats Successful									
Total	23.6	21.8	47.1	30.7	29.7	44.4	26.1	24.6	46.2
Gas	23.4	21.8	44.4	30.9	30.3	50.0	26.0	24.9	45.5
Oil	23.8	21.6	50.0	30.5	28.8	42.9	26.2	24.2	46.7
Amount Found/Successful Wildcat									
Total, MMBOEE	1.3	1.4	0.9	12.1	13.4	0.3	5.8	6.5	0.7
Gas, BCF	8.5	8.4	9.5	2.1	2.0	5.0	5.9	5.6	8.6
Oil MMBbls.	1.0	1.1	0.3	21.3	25.6	0.07	9.5	11.3	0.1
Average Depth of Wells, feet									
Gas	6800	6800	6800	8300	8300	9700	7400	7400	7400
Oil	7300	7200	7900	12400	12000	14200	9400	9200	10600

* Estimated by multiplying the number of wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

TABLE 13-3

TIGHT FORMATION RESERVOIR PARAMETERS

Formation	Permeability Range (md)	Press (Psi)	Temp. (°F)	Gas-filled Porosity Range (%)	Net Pay Range (ft.)
Wasatch-Green River-Colton-North Horn	1.0-.003	2795	175	6.4-3.9	20-100
Barren-Farrer-Tusher	0.3-.003	3225	195	5.3-3.9	30-100
Coaly-Neslen	0.3-.001	3655	214	5.6-3.3	25-100
Castlegate	0.1-.0003	4275	233	4.2-2.3	25-60

completing development wells in more than one formation. Based on in-place gas estimates, about 40 percent of the gas could be produced through dual completions. The areas and formations involved were listed in Table 13-4 with the average producing depths of these formations, given in Table 13-1, in the range of 6,500-9,500 feet. A basin cross-section was shown in Figure 13-3.

The sizes of the tight gas fields in the Uinta basin are estimated to be in the range of 10 to 200 BCF. Their sizes and their cumulative probability of occurrence are shown in Figure 13-5 for reservoirs in the various tight gas formations. The maximum field size will tend to be smaller for permeabilities in the range of 0.3 to 1 millidarcy and for permeabilities less than 0.001 millidarcy. The Coaly formation yields the largest fields with 50 percent being in the 34 BCF or less category. Two percent of the fields in three of the formations will be 100 BCF or larger. Maximum recoverable gas from the Uinta basin will be shown to be 15.3 TCF with the Wasatch alone containing approximately one third of this (5 TCF) in 36 percent of the productive area.

Geological data estimates for permeability porosity, pay, estimated gas in place, reservoir pressure, and other factors defining these Uinta formations are shown in Tables 13-6, 13-13, 13-20, 13-27, 13-34, 13-41, and 13-48. These data were used to define production rate versus time characteristics shown in Tables 13-7, 13-8, 13-14, 13-15, 13-21, 13-22, 13-28, 13-29, 13-35, 13-36, 13-42, 13-43, 13-49, and 13-50 for the four formations (Coaly, Castelgate, Wasatch, and Barron) and for the three stacked formation combinations. The base case tables (13-7, 13-14, 13-21,

TABLE 13-4

SUB BASIN OF UINTA

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
Uinta		Coaly	102	1,155
		Castlegate	180	1,131
		Coaly + Castlegate	77	1,359
		Wasatch + Coaly	96	2,199
		Wasatch + Barren	105	2,099
		Wasatch	428	5,017
		Barren	196	2,309
Basin Total			1,184	15,269

13-28, 13-35, 13-42, and 13-49) show production rates for wells with 1,000-foot fracture lengths. The annual gas production in millions of standard cubic feet per year per well and the cumulative production over a 30 year period are given. The advanced case Tables (13-8, 13-15, 13-22, 13-29, 13-36, 13-43, and 13-50) show the data for fractures up to 4,000 feet in length. In most cases, production for the advanced case was 1.5 to 2 times the production for the base case. Exceptions to this were generally in the higher permeability areas where fractures gave greater initial production but very rapid declines.

Estimated field size and ultimate production per well were used to compute the number of wells per section required to produce all of the gas, and are presented in Tables 13-9, 13-16, 13-23, 13-30, 13-37, 13-44, and 13-51. These tables show comparison of recovery of gas from actual wells under current drilling practice of no more than four wells per section (base case) with up to 12 wells per section (advanced case).

The Uinta basin is primarily composed of lenticular sands. The common practice today of drilling only one or two wells per section cannot recover reasonable percentages of the in-place gas, particularly for these lenticular formations. Additional wells and fractures are necessary to connect small lenses to the wells.

ECONOMICS

Economic summaries have been calculated using an E&P full cycle simulator model. This full cycle model generates a set of data

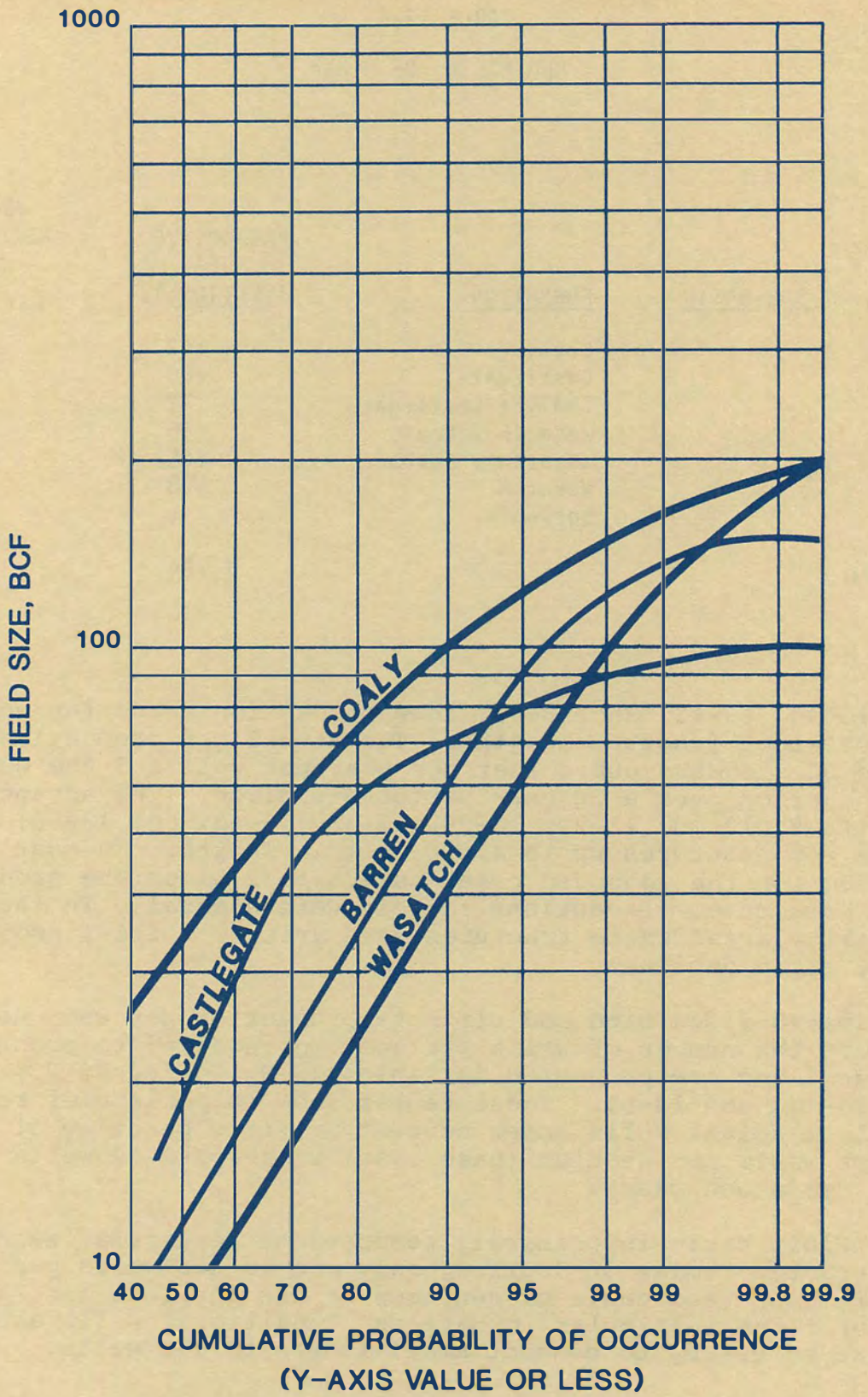


Figure 13-5. Field Size Distribution of Producible Gas, Uinta Basin.

which includes prospect averages, basin totals and drilling records for eight gas price levels and for discount rates of 10, 15, and 20 percent. The range of information available from these tables may be illustrated by the Wasatch, base case model input data as is illustrated in Tables 13-41, 13-42, 13-44, and 13-45. Table 13-46 shows the results. For Case No. 52, under a minimum acceptable discount rate of 15 percent and a gas price of $5.00 per MCF, the expected amount of gas recoverable from the Wasatch formation alone would be 4,105 BCF. In developing this amount of gas a total of 559 prospects would have been tested with a 42 percent success requiring a total of 2,250 wells of which 1,353 would be producers. Under the base case a maximum of four holes would be drilled per section with a frac length of 1,000 feet. Permeability traps as low as 0.003 md would be drilled. The average E&P investment for the total prospects drilled, both successful and unsuccessful, would be 2.833 MM$ with average reserves of 7.3 BCF per prospect. The average recovery per successful prospect can be obtained as follows:

559 (max. no. prosp. @ $5.00/MCF) times .423 (% successful prosp.) = 236 then: 4,105 BCF divided by 236 (total successful prosp.) = 174 BCF/prospect

At the price of $5.00 per MCF the maximum recoverable GIP would be 5,017 BCF. However, this amount would be recovered only if up to 12 wells per section were to be drilled with frac capability of 4,000' length - the advanced case fully developed.

REFERENCES

Ritzman, Howard R., 1972, "The Uinta Basin," Geologic Atlas of the Rocky Mountain Region, RMAG, p. 276.

Covington, Robert E., 1964, "A Brief History of Early Mineral Exploration in the Uinta Basin." Guidebook to the geology and mineral resources of the Uinta Basin, Thirteenth Annual Field Conference, Inter-Mountain Association Petroleum Geology.

Wells, Lewis F., 1958, "Petroleum Occurrence in the Uinta Basin," Habitat of Oil, Am. Assoc. Petr. Geol., p. 358.

Osmond, John C., 1965, "Geologic History of Site of Uinta Basin," Bull., Am. Assoc. Petr. Geol., Vol. 49, No. 11.

Lewin and Associates, Inc., 1978, "Enhanced Recovery of Natural Gas," DOE.

Fouch, T. D., and Cashion, W. B., 1979, Distribution of rock types, lithologic groups, and depositional environments for some Lower Tertiary and Upper and Lower Cretaceous, and Upper and Middle Jurassic rocks in the subsurface between Altamont oil field and San Arroyo gas field, north-central to southeastern Uinta Basin, Utah: U.S. Geological Survey Open-File Report 79-365, 2 sheets.

TABLE 13-5

SUMMARY OF UINTA BASIN GAS POTENTIAL
(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Uinta		Coaly	1031	1079	1079	1155	1155	1155
		Castlegate	0	835	979	1060	1131	1131
		Coaly + Castlegate	1359	1359	1359	1359	1359	1359
		Wasatch + Coaly	2067	2067	2067	2199	2199	2199
		Wasatch + Barren	1986	1986	1986	2099	2099	2099
		Wasatch	4105	4105	4105	4833	5017	5017
		Barren	1672	1805	1805	2054	2309	2309
Basin Total			12220	13236	13380	14759	15269	15269

TABLE 13-6

GEOLOGICAL DATA SUMMARY

BASIN: Uinta
SUBBASIN: -
FORMATION: Coaly

DEPTH (FT.): 8500
PRESSURE (PSIA): 3655
TEMPERATURE (°F): 214

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 5.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	1	5.6	25	8.08	8	0.10	1.0	-
0.1	8	4.8	38	84.18	70	0.30	1.0	-
0.03	24	4.0	60	332.29	260	0.45	1.0	-
0.01	35	3.7	76	567.78	408	0.55	1.0	-
0.003	26	3.5	90	472.48	315	0.65	1.0	-
0.001	8	3.3	100	152.30	94	0.70	1.0	-
	102			1617.	1155			

TABLE 13-7
WELL PRODUCTION SUMMARY--BASE CASE

UINTA, COALY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1200	1019	782	535	319	194				
2	871	714	499	325	179	105				
5	489	476	355	213	118	64				
10	253	302	271	169	88	49				
15	161	219	219	147	76	41				
20	109	159	185	132	69	36				
30	68	99	136	109	61	31				
30-YEAR CUMM. PROD. (MMCF)	7963	8605	7656	5157	2790	1548				

TABLE 13-8

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, COALY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1675	1581	1891	1467	1073	693				
2	1207	1064	1265	929	617	385				
5	769	710	839	598	384	227				
10	470	491	598	437	278	127				
15	331	382	469	361	229	185				
20	243	298	390	311	201	147				
30	144	208	276	247	165	100				
30-YEAR CUMM. PROD. (MMCF)	13632	14122	17206	13252	8646	5227				

TABLE 13-9

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN: -
FORMATION: Coaly

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	.8714	.8714	8	.5091	.5091	8
.1	.9959	.9959	70	.6068	.6068	70
.03	1.391	1.391	260	.6189	.6189	260
.01	2.278	2.278	408	.8866	.8866	408
.003	4.419	4.	285	1.4259	1.4259	315
.001	7.791	4.	48	2.307	2.307	94
			1079			1155

TABLE 13-10

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Coaly

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	666,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	104,000 - 251,000
- Advanced Case [2000/4000 Ft. Fracture]	132,000 - 930,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0274

TABLE 13-11

ECONOMICS SUMMARY

BASIN Uinta — FORMATION Coaly — TECHNOLOGY Base Case — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1003111	1.50	30.6	4	ABCD	3268	10.502	1249	21.0	746	746	71	30.6	49	22	34	135	240
21	2.50	48.2	5	ABCDE	6188	17.020	4495	37.0	1031	1061	61	48.2	32	29	68	271	399
31	3.10	54.8	6	ABCDEF	7066	18.243	6427	45.2	1079	1155	59	54.8	27	32	76	305	440
41	3.50	54.8	6	ABCDEF	7066	18.243	7658	51.4	1079	1155	59	54.8	27	32	76	305	440
51	5.00	54.8	6	ABCDEF	7066	18.243	12276	72.2	1079	1155	59	54.8	27	32	76	305	440
61	7.00	54.8	6	ABCDEF	7066	18.243	18433	95.8	1079	1155	59	54.8	27	32	76	305	440
71	9.00	54.8	6	ABCDEF	7066	18.243	24590	115.9	1079	1155	59	54.8	27	32	76	305	440
81	12.00	54.8	6	ABCDEF	7066	18.243	33825	141.9	1079	1155	59	54.8	27	32	76	305	440
Discount Rate 15%																	
12	1.50	30.6	4	ABCD	3268	10.502	481	21.0	746	746	71	30.6	49	22	34	135	240
22	2.50	48.2	5	ABCDE	6188	17.020	2489	37.0	1031	1061	61	48.2	32	29	68	271	399
32	3.10	48.2	5	ABCDE	6188	17.020	3660	46.4	1031	1061	61	48.2	32	29	68	271	399
42	3.50	48.2	5	ABCDE	6188	17.020	4441	52.4	1031	1061	61	48.2	32	29	68	271	399
52	5.00	54.8	6	ABCDEF	7066	18.243	7684	72.2	1079	1155	59	54.8	27	32	76	305	440
62	7.00	54.8	6	ABCDEF	7066	18.243	11840	95.8	1079	1155	59	54.8	27	32	76	305	440
72	9.00	54.8	6	ABCDEF	7066	18.243	15996	115.9	1079	1155	59	54.8	27	32	76	305	440
82	12.00	54.8	6	ABCDEF	7066	18.243	22229	141.9	1079	1155	59	54.8	27	32	76	305	440
Discount Rate 20%																	
13	1.50	30.6	4	ABCD	3268	10.502	65	21.0	746	746	71	30.6	49	22	34	135	240
23	2.50	48.2	5	ABCDE	6188	17.020	1412	37.0	1031	1061	61	48.2	32	29	68	271	399
33	3.10	48.2	5	ABCDE	6188	17.020	2265	46.4	1031	1061	61	48.2	32	29	68	271	399
43	3.50	48.2	5	ABCDE	6188	17.020	2833	52.4	1031	1061	61	48.2	32	29	68	271	399
53	5.00	54.8	6	ABCDEF	7066	18.243	5159	72.2	1079	1155	59	54.8	27	32	76	305	440
63	7.00	54.8	6	ABCDEF	7066	18.243	8186	95.8	1079	1155	59	54.8	27	32	76	305	440
73	9.00	54.8	6	ABCDEF	7066	18.243	11213	115.9	1079	1155	59	54.8	27	32	76	305	440
83	12.00	54.8	6	ABCDEF	7066	18.243	15753	141.9	1079	1155	59	54.8	27	32	76	305	440

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 13-12

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Coaly

TECHNOLOGY Advanced Case

DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1003211	1.50	54.8	6	ABCDEF	5036	18.824	3256	34.4	1155	1155	61	54.8	28	33	28	112	201
21	2.50	54.8	6	ABCDEF	5036	18.824	6983	59.9	1155	1155	61	54.8	28	33	28	112	201
31	3.10	54.8	6	ABCDEF	5036	18.824	9219	73.7	1155	1155	61	54.8	28	33	28	112	201
41	3.50	54.8	6	ABCDEF	5036	18.824	10709	82.3	1155	1155	61	54.8	28	33	28	112	201
51	5.00	54.8	6	ABCDEF	5036	18.824	16300	111.6	1155	1155	61	54.8	28	33	28	112	201
61	7.00	54.8	6	ABCDEF	5036	18.824	23753	145.2	1155	1155	61	54.8	28	33	28	112	201
71	9.00	54.8	6	ABCDEF	5036	18.824	31207	174.8	1155	1155	61	54.8	28	33	28	112	201
81	12.00	54.8	6	ABCDEF	5036	18.824	42387	213.8	1155	1155	61	54.8	28	33	28	112	201
Discount Rate 15%																	
12	1.50	48.2	5	ABCDE	4182	16.907	1728	34.6	1061	1061	63	48.2	33	30	22	90	175
22	2.50	54.8	6	ABCDEF	5036	18.824	4468	59.9	1155	1155	61	54.8	28	33	28	112	201
32	3.10	54.8	6	ABCDEF	5036	18.824	6048	73.7	1155	1155	61	54.8	28	33	28	112	201
42	3.50	54.8	6	ABCDEF	5036	18.824	7101	82.3	1155	1155	61	54.8	28	33	28	112	201
52	5.00	54.8	6	ABCDEF	5036	18.824	11050	111.6	1155	1155	61	54.8	28	33	28	112	201
62	7.00	54.8	6	ABCDEF	5036	18.824	16316	145.2	1155	1155	61	54.8	28	33	28	112	201
72	9.00	54.8	6	ABCDEF	5036	18.824	21582	174.8	1155	1155	61	54.8	28	33	28	112	201
82	12.00	54.8	6	ABCDEF	5036	18.824	29481	213,8	1155	1155	61	54.8	28	33	28	112	201
Discount Rate 20%																	
13	1.50	48.2	5	ABCDE	4182	16.907	985	34.6	1061	1061	63	48.2	33	30	22	90	175
23	2.50	54.8	6	ABCDEF	5036	18.824	3025	59.9	1155	1155	61	54.8	28	33	28	112	201
33	3.10	54.8	6	ABCDEF	5036	18.824	4219	73.7	1155	1155	61	54.8	28	33	28	112	201
43	3.50	54.8	6	ABCDEF	5036	18.824	5015	82.3	1155	1155	61	54.8	28	33	28	112	201
53	5.00	54.8	6	ABCDEF	5036	18.824	8000	111.6	1155	1155	61	54.8	28	33	28	112	201
63	7.00	54.8	6	ABCDEF	5036	18.824	11981	145.2	1155	1155	61	54.8	28	33	28	112	201
73	9.00	54.8	6	ABCDEF	5036	18.824	15961	174.8	1155	1155	61	54.8	28	33	28	112	201
83	12.00	54.8	6	ABCDEF	5036	18.824	21931	213.8	1155	1155	61	54.8	28	33	28	112	201

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 13-13

GEOLOGICAL DATA SUMMARY

BASIN: Uinta
SUBBASIN: -
FORMATION: Castlegate

DEPTH (FT.): 9500
PRESSURE (PSIA): 4275
TEMPERATURE (°F): 233

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 5.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	3	4.2	25	19.75	11	0.10	1.0	-
0.03	16	3.6	36	130.01	100	0.20	1.0	-
0.01	41	3.2	50	411.31	298	0.35	1.0	-
0.003	67	2.8	54	635.18	426	0.45	1.0	-
0.001	39	2.55	57	355.42	225	0.55	1.0	-
0.0003	14	2.3	60	121.14	71	0.65	1.0	-
	180			1673.	1131			

TABLE 13-14
WELL PRODUCTION SUMMARY--BASE CASE

UINTA, CASTLEGATE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		755	523	383	198	111	59			
2		528	339	232	115	61	32			
5		329	239	157	74	40	19			
10		194	175	124	56	29	13			
15		128	138	106	49	24	12			
20		96	110	94	45	22	10			
30		55	80	76	39	19	9			
30-YEAR CUMM. PROD. (MMCF)		5643	4913	3701	1793	917	452			

TABLE 13-15

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, CASTLEGATE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		1164	1283	1062	672	402	225			
2		776	850	673	386	221	121			
5		504	550	428	237	134	70			
10		332	381	309	171	94	49			
15		240	291	250	142	78	41			
20		190	228	216	123	70	36			
30		122	161	166	102	57	29			
30-YEAR CUMM. PROD. (MMCF)		9529	10894	9274	5370	3030	1610			

TABLE 13-16

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN: -
FORMATION: Castlegate

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	.94	.94	11	.5593	.5593	11
.03	1.266	1.266	100	.5709	.5709	100
.01	1.95	1.95	298	.7784	.7784	298
.003	3.567	3.567	426	1.1918	1.1918	426
.001	6.259	4.	144	1.8944	1.8944	225
.0003	11.17	4.	26	3.1409	3.1409	71
			1005			1131

TABLE 13-17

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Castlegate

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	841,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	109,000 - 135,000
- Advanced Case [2000/4000 Ft. Fracture]	138,000 - 462,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0274

TABLE 13-18

ECONOMICS SUMMARY

BASIN Uinta — TECHNOLOGY Base Case

SUB BASIN — FORMATION Castlegate — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1004111	1.50	10.6	3	BCD	2592	3.390	-367	5.7	-	-	-	10.6	-	-	-	-	-
21	2.50	10.6	3	BCD	2592	3.390	236	12.5	409	409	121	10.6	108	13	33	132	285
31	3.10	25.6	4	BCDE	5823	7.190	1355	18.4	835	835	116	25.6	86	30	107	427	650
41	3.50	25.6	4	BCDE	5823	7.190	1866	21.5	835	835	116	25.6	86	30	107	427	650
51	5.00	38.9	5	BCDEF	9701	10.110	4298	28.6	979	1060	99	38.9	60	39	168	670	937
61	7.00	38.9	5	BCDEF	9701	10.110	7704	43.6	979	1060	99	38.9	60	39	168	670	937
71	9.00	38.9	5	BCDEF	9701	10.110	11110	57.8	979	1060	99	38.9	60	39	168	670	937
81	12.00	44.4	6	BCDEFG	10220	10.320	16395	75.8	1005	1131	97	44.4	54	43	174	696	967
Discount Rate 15%																	
12	1.50	1.2	2	BC	1279	0.140	-705	0	-	-	-	1.2	-	-	-	-	-
22	2.50	10.6	3	BCD	2592	3.390	-167	12.5	-	-	-	-	-	-	-	-	-
32	3.10	10.6	3	BCD	2592	3.390	77	16.1	409	409	121	10.6	108	13	33	132	285
42	3.50	25.6	4	BCDE	5823	7.190	723	21.5	835	835	116	25.6	86	30	107	427	650
52	5.00	25.6	4	BCDE	5823	7.190	2016	32.8	835	835	116	25.6	86	30	107	427	650
62	7.00	38.9	5	BCDEF	9701	10.110	4403	43.6	979	1060	99	38.9	60	39	168	670	937
72	9.00	38.9	5	BCDEF	9701	10.110	6702	57.8	979	1060	99	38.9	60	39	168	670	937
82	12.00	38.9	5	BCDEF	9701	10.110	10150	76.9	979	1060	99	38.9	60	39	168	670	937
Discount Rate 20%																	
13	1.50	1.2	2	BC	1279	0.140	-715	0	-	-	-	1.2	-	-	-	-	-
23	2.50	10.6	3	BCD	2592	3.390	-381	12.5	-	-	-	10.6	-	-	-	-	-
33	3.10	10.6	3	BCD	2592	3.390	-204	16.1	-	-	-	10.6	-	-	-	-	-
43	3.50	10.6	3	BCD	2592	3.390	-87	18.3	-	-	-	10.6	-	-	-	-	-
53	5.00	25.6	4	BCDE	5823	7.190	1066	32.8	835	835	116	25.6	86	30	107	427	650
63	7.00	25.6	4	BCDE	5823	7.190	2317	46.5	835	835	116	25.6	86	30	107	427	650
73	9.00	38.9	5	BCDEF	9701	10.110	4304	57.8	979	1060	99	38.9	60	39	168	670	937
83	12.00	38.9	5	BCDEF	9701	10.110	6810	76.9	979	1060	99	38.9	60	39	168	670	937

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 13-19

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Castlegate

TECHNOLOGY Advanced Case

DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
10042 11	1.50	25.6	4	BCDE	3388	7.190	501	14.7	835	835	116	25.6	86	28	34	136	285
21	2.50	38.9	5	BCDEF	5682	10.790	2749	28.9	1060	1060	98	38.9	60	38	63	252	413
31	3.10	38.9	5	BCDEF	5682	10.790	4033	37.5	1060	1060	98	38.9	60	38	63	252	413
41	3.50	38.9	5	BCDEF	5682	10.790	4890	43.1	1060	1060	98	38.9	60	38	63	252	413
51	5.00	44.4	6	BCDEFG	6240	11.280	8378	62.1	1131	1131	100	44.4	56	44	73	290	463
61	7.00	44.4	6	BCDEFG	6240	11.280	12873	85.8	1131	1131	100	44.4	56	44	73	290	463
71	9.00	44.4	6	BCDEFG	6240	11.280	17368	106.7	1131	1131	100	44.4	56	44	73	290	463
81	12.00	44.4	6	BCDEFG	6240	11.280	24111	134.3	1131	1131	100	44.4	56	44	73	290	463
Discount Rate 15%																	
12	1.50	25.6	4	BCDE	3388	7.190	-18	14.7	-	-	-	25.6	-	-	-	-	-
22	2.50	38.9	5	BCDEF	5682	10.790	1421	28.9	1060	1060	98	38.9	60	38	63	252	413
32	3.10	38.9	5	BCDEF	5682	10.790	2323	37.5	1060	1060	98	38.9	60	38	63	252	413
42	3.50	38.9	5	BCDEF	5682	10.790	2924	43.1	1060	1060	98	38.9	60	38	63	252	413
52	5.00	44.4	6	BCDEFG	6240	11.280	5343	62.1	1131	1131	100	44.4	56	44	73	290	463
62	7.00	44.4	6	BCDEFG	6240	11.280	8504	85.8	1131	1131	100	44.4	56	44	73	290	463
72	9.00	44.4	6	BCDEFG	6240	11.280	11665	106.7	1131	1131	100	44.4	56	44	73	290	463
82	12.00	44.4	6	BCDEFG	6240	11.280	16406	134.3	1131	1131	100	44.4	56	44	73	290	463
Discount Rate 20%																	
13	1.50	10.6	3	BCD	2119	3.380	-524	8.5	-	-	-	10.6	-	-	-	-	-
23	2.50	25.6	4	BCDE	3388	7.190	454	27.4	835	835	116	25.6	86	28	34	136	285
33	3.10	38.9	5	BCDEF	5682	10.790	1360	37.5	1060	1060	98	38.9	60	38	63	252	413
43	3.50	38.9	5	BCDEF	5682	10.790	1810	43.1	1060	1060	98	38.9	60	38	63	252	413
53	5.00	38.9	5	BCDEF	5682	10.790	3498	62.4	1060	1060	98	38.9	60	38	63	252	413
63	7.00	44.4	6	BCDEFG	6240	11.280	5974	85.8	1131	1131	100	44.4	56	44	73	290	463
73	9.00	44.4	6	BCDEFG	6240	11.280	8346	106.7	1131	1131	100	44.4	56	44	73	290	463
83	12.00	44.4	6	BCDEFG	6240	11.280	11904	134.3	1131	1131	100	44.4	56	44	73	290	463

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 13-20

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

BASIN: Uinta
SUBBASIN: -
FORMATION: Coaly + Castlegate

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

NGL(BBL/MMCF): 1.2

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	1	*	*	21.6	13	*	*	*
0.02	7			159.18	120			
0.01	18			505.08	358			
0.003	28			746.76	512			
0.001	17			428.91	270			
0.0003	6			141.54	85			
	77			2003.	1359			

* Refer to individual formations for these data.

TABLE 13-21

WELL PRODUCTION SUMMARY--BASE CASE

UINTA, COALY + CASTLEGATE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		1313	1081	941	756	669	617			
2		877	689	581	465	410	381			
5		564	475	392	309	275	254			
10		369	351	299	232	204	189			
15		272	282	250	193	169	156			
20		219	233	218	169	145	134			
30		151	177	172	136	115	105			
30-YEAR CUMM. PROD. (MMCF)		10819	10089	8879	6969	6090	5629			

TABLE 13-22

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, COALY + CASTLEGATE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		2585	2703	2482	2092	1823	1646			
2		1679	1752	1575	1289	1123	1023			
5		1087	1133	1012	820	718	654			
10		748	797	726	588	511	465			
15		582	633	592	484	419	383			
20		478	516	504	412	358	324			
30		340	379	384	320	275	247			
30-YEAR CUMM. PROD. (MMCF)		22019	23370	21759	17850	15509	14089			

TABLE 13-23

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN: -
FORMATION: Coaly + Castlegate

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	1.62	1.62	13	.74	.79	13
.03	1.72	1.72	120	.74	.74	120
.01	2.28	2.28	358	.93	.93	358
.003	2.58	2.58	512	1.01	1.01	512
.001	2.62	2.62	270	1.03	1.03	270
.0003	2.45	2.45	85	.98	.98	85
			1359			1359

TABLE 13-24

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Coaly + Castlegate

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	842,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	302,000 - 328,000
- Advanced Case [2000/4000 Ft. Fracture]	823,000 - 1,148,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0274

TABLE 13-25

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Coaly+Castlegate

TECHNOLOGY Base Case

DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1005111	1.50	44.4	6	BCDEFG	3903	14.734	1381	21.6	1359	1359	92	44.4	51	41	38	151	281
21	2.50	"	"	"	"	"	3562	38.7	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	4870	48.3	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	5742	54.3	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	9013	75.1	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	13374	99.3	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	17735	120.8	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	24276	149.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	44.4	6	BCDEFG	3903	14.734	557	21.6	1359	1359	92	44.4	51	41	38	151	281
22	2.50	"	"	"	"	"	2080	38.7	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	2994	48.3	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	3603	54.3	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	5888	75.1	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	8935	99.3	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	11981	120.8	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	16551	149.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	38.9	5	BCDEF	3801	14.095	43	20.6	1274	1274	90	38.9	55	35	35	142	267
23	2.50	44.4	6	BCDEFG	3903	14.734	1243	38.7	1359	1359	92	44.4	51	41	38	151	281
33	3.10	"	"	"	"	"	1927	48.3	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	2383	54.3	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	4092	75.1	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	6371	99.3	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	8651	120.8	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	12070	149.4	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 13-26

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Coaly+Castlegate

TECHNOLOGY Advanced Case

DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
100521	1.50	44.4	6	BCDEFG	3321	14.433	2200	31.3	1359	1359	94	44.4	52	42	10	41	146
21	2.50	"	"	"	"	"	4862	56.0	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	6459	69.9	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	7523	78.9	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	11516	110.2	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	16839	147.7	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	22162	181.5	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	30147	227.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	44.4	6	BCDEFG	3321	14.433	1263	31.3	1359	1359	94	44.4	52	42	10	41	146
22	2.50	"	"	"	"	"	3252	56.0	1359	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	4445	69.9	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	5241	78.9	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	8224	110.2	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	12202	147.7	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	16180	181.5	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	22147	227.0	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	44.4	6	BCDEFG	3321	14.433	695	31.3	1359	1359	94	44.4	52	42	10	41	146
23	2.50	"	"	"	"	"	2266	56.0	1359	1359	94	44.4	52	42	"	"	"
33	3.10	"	"	"	"	"	3208	69.9	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	3836	78.9	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	6193	110.2	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	9334	147.7	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	12476	181.5	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	17189	227.0	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 13-27

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular + Blanket

BASIN: Uinta
SUBBASIN: -
FORMATION: Wasatch + Coaly

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

NGL(BBL/MMCF): 5.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	1	*	*	18.17	18	*	*	*
0.1	8			184.00	153			
0.03	23			654.36	512			
0.01	33			1061.80	763			
0.003	24			862.46	575			
0.001	8			288.40	178			
	96			3069.	2199			

* Refer to individual formations for these data.

TABLE 13-28

WELL PRODUCTION SUMMARY--BASE CASE

UINTA, WASATCH + COALY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	2085	1904	1668	1421	1205	1079				
2	1214	1056	842	668	522	448				
5	606	594	472	330	235	181				
10	299	347	316	215	133	95				
15	186	244	244	173	101	67				
20	124	174	200	146	84	51				
30	76	107	143	117	68	39				
30-YEAR CUMM. PROD. (MMCF)	10360	11000	10050	7560	5189	3950				

TABLE 13-29

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, WASATCH + COALY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	2728	2634	2945	2521	2126	1746				
2	1635	1493	1693	1357	1045	814				
5	938	878	1007	766	552	395				
10	545	566	673	512	353	202				
15	373	424	511	403	271	227				
20	271	326	418	339	229	175				
30	158	223	291	261	180	114				
30-YEAR CUMM. PROD. (MMCF)	16919	17409	20490	16539	11930	8509				

TABLE 13-30

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN: -
FORMATION: Wasatch + Coaly

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.81	1.81	18	1.11	1.11	18
.1	1.81	1.81	153	1.14	1.14	153
.03	2.21	2.21	512	1.08	1.08	512
.01	3.09	3.09	763	1.41	1.41	763
.003	4.62	4.	498	2.01	2.01	575
.001	5.87	4.	121	2.72	2.72	178
			2065			2199

TABLE 13-31

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Wasatch + Coaly

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	666,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	309,000
- Advanced Case [2000/4000 Ft. Fracture]	539,000 - 1,337,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0274

TABLE 13-32

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Wasatch + Coaly

TECHNOLOGY Base

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
10061 11	1.50	54.8	6 ABCDEF	2776	12.174	1809	38.9	2067	2199	170	54.8	77	93	46	185	401
21	2.50	"	" "	"	"	3957	70.9	"	"	"	"	"	"	"	"	"
31	3.10	"	" "	"	"	5245	88.2	"	"	"	"	"	"	"	"	"
41	3.50	"	" "	"	"	6104	99.0	"	"	"	"	"	"	"	"	"
51	5.00	"	" "	"	"	9326	136.1	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	13621	178.6	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	17916	215.9	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	24359	264.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	54.8	6 ABCDEF	2776	12.174	1122	38.9	2067	2199	170	54.8	77	93	46	185	401
22	2.50	"	" "	"	"	2742	70.9	"	"	"	"	"	"	"	"	"
32	3.10	"	" "	"	"	3714	88.2	"	"	"	"	"	"	"	"	"
42	3.50	"	" "	"	"	4362	99.0	"	"	"	"	"	"	"	"	"
52	5.00	"	" "	"	"	6792	136.1	"	"	"	"	"	"	"	"	"
62	7.00	"	" "	"	"	10032	178.6	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	13272	215.9	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	18132	264.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	54.8	6 ABCDEF	2776	12.174	706	38.9	2067	2199	170	54.8	77	93	46	185	401
23	2.50	"	" "	"	"	1996	70.9	"	"	"	"	"	"	"	"	"
33	3.10	"	" "	"	"	2770	88.2	"	"	"	"	"	"	"	"	"
43	3.50	"	" "	"	"	3286	99.0	"	"	"	"	"	"	"	"	"
53	5.00	"	" "	"	"	5221	136.1	"	"	"	"	"	"	"	"	"
63	7.00	"	" "	"	"	7801	178.6	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	10381	215.9	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	14251	264.9	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 13-33

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Wasatch + Coaly

TECHNOLOGY Advanced

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
10062 11	1.50	54.8	6	ABCDEF	2894	12.827	2460	46.0	2199	2199	171	54.8	77	94	18	73	262
21	2.50	"	"	"	"	"	5136	83.4	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	6741	104.2	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	7811	117.5	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	11824	163.2	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	17176	216.8	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	22527	264.1	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	30553	326.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	54.8	6	ABCDEF	2894	12.827	1646	46.0	2199	2199	171	54.8	77	94	18	73	262
22	2.50	"	"	"	"	"	3733	83.4	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	4985	104.2	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	5820	117.5	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	8950	183.2	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	13125	216.8	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	17300	264.1	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	23561	326.5	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	54.8	6	ABCDEF	2894	12.827	1123	46.0	2199	2199	171	54.8	77	94	18	73	262
23	2.50	"	"	"	"	"	2825	83.4	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	3847	104.2	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	4528	117.5	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	7081	163.2	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	10486	216.8	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	13891	264.1	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	18998	326.5	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E	F
0.3	0.1	0.03	0.01	0.003	0.001

TABLE 13-34

GEOLOGICAL DATA SUMMARY

BASIN: Uinta
SUBBASIN: -
FORMATION: Wasatch + Barren

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

TOTAL BASIN AREA (SECTIONS):
TYPE:

NGL(BBL/MMCF): 5.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	9	*	*	175.07	148	*	*	*
0.1	23			531.03	434			
0.03	38			979.18	760			
0.01	25			747.73	542			
0.003	9			323.17	215			
	105			2756.	2099			

* Refer to individual formations for these data.

TABLE 13-35

WELL PRODUCTION SUMMARY--BASE CASE

UINTA, WASATCH + BARREN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	1841	1872	1593	1369	1181					
2	562	720	685	592	497					
5	146	219	263	248	205					
10	50	74	110	121	105					
15	27	37	62	78	70					
20	15	20	32	53	53					
30	7	9	17	32	35					
30-YEAR CUMM. PROD. (MMCF)	3810	4629	4960	4919	4280					

TABLE 13-36

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, WASATCH + BARREN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	2000	2234	1874	1638	1432					
2	548	954	847	731	620					
5	183	350	371	326	275					
10	77	136	181	167	138					
15	42	70	107	106	90					
20	28	42	72	75	67					
30	14	19	37	43	39					
30-YEAR CUMM. PROD. (MMCF)	4479	6629	6949	6340	5409					

TABLE 13-37

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN:
FORMATION: Wasatch + Barren

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	4.11	4	144	3.50	3.5	148
.1	4.05	4	428	2.83	2.83	434
.03	4.06	4	749	2.89	2.89	760
.01	4.37	4	496	3.39	3.39	542
.003	5.31	4	162	4.20	4.20	215
			1980			2099

TABLE 13-38

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Wastach + Barren

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	528,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	364,000 - 632,000
- Advanced Case (2000/4000 Ft. Fracture)	724,000 - 1,290,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0274

TABLE 13-39

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Wasatch + Barren

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
10071 11	1.50	42.6	5	ABCDE	2874	9.034	1657	45.0	1986	2099	220	42.6	120	94	73	293	586
21	2.50	"	"	"	"	"	3749	84.3	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	5004	105.4	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	5841	118.6	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	8978	163.0	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	13161	213.3	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	17344	256.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	23620	313.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	42.6	5	ABCDE	2874	9.034	1147	45.0	1986	2099	220	42.6	120	94	73	293	586
22	2.50	"	"	"	"	"	2827	84.3	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	3835	105.4	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	4507	118.6	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	7027	163.0	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	10387	213.3	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	13748	256.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	18789	313.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	42.6	5	ABCDE	2874	9.034	797	45.0	1986	2099	220	42.6	120	94	73	293	586
23	2.50	"	"	"	"	"	2192	84.3	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	3029	105.4	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	3588	118.6	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	5680	163.0	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	8470	213.3	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	11261	256.9	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	15446	313.4	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E
0.3	0.1	0.03	0.01	0.003

TABLE 13-40

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Wasatch + Barren

TECHNOLOGY Advance

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
10072 11	1.50	42.6	5	ABCDE	3990	10.666	1916	39.9	2099	2099	197	42.6	113	84	63	253	514
21	2.50	"	"	"	"	"	4546	80.1	"	"	"	"	"	"	"	"	"
31	3.10	"	"	"	"	"	6124	102.5	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	7176	116.6	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	11120	165.2	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	16380	221.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	21639	269.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	29529	333.6	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	42.6	5	ABCDE	3990	10.666	1282	39.9	2099	2099	197	42.6	113	84	63	253	514
22	2.50	"	"	"	"	"	3405	80.1	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	4679	102.5	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	5529	116.6	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	8714	165.2	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	12961	221.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	17208	269.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	23578	333.6	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	37.1	4	ABCD	3800	9.949	742	37.7	1884	1884	189	37.1	119	70	57	229	475
23	2.50	42.6	5	ABCDE	3990	10.666	2620	80.1	2099	2099	197	42.6	113	84	63	253	514
33	3.10	"	"	"	"	"	3681	102.5	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	4389	116.6	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	7042	165.2	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	10580	221.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	14118	269.9	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	19425	333.6	"	"	"	"	"	"	"	"	"

* CODE: A B C D E
0.3 0.1 0.03 0.01 0.003

TABLE 13-41

GEOLOGICAL DATA SUMMARY

BASIN: Uinta
SUBBASIN: -
FORMATION: Wasatch

DEPTH (FT.): 6500
PRESSURE (PSIA): 2795
TEMPERATURE (°F): 175

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 5.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
1.0	21	6.4	20	136.46	119	0.05	1.0	-
0.3	77	5.7	44	980.41	846	0.30	1.0	-
0.1	137	5.2	56	2025.35	1664	0.40	1.0	-
0.03	133	4.7	65	2062.78	1592	0.50	1.0	-
0.01	47	4.3	82	841.34	612	0.60	1.0	-
0.003	13	3.9	100	257.39	184	0.70	1.0	-
	428			6304.	5017			

TABLE 13-42

WELL PRODUCTION SUMMARY--BASE CASE

UINTA, WASATCH

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 1.0	0.3	0.1	0.03	0.01	0.003
1	846	1388	1043	650	449	282
2	110	367	437	326	232	147
5	8	58	135	148	129	83
10	0	9	36	70	77	57
15	0	2	14	42	54	45
20	0	0	7	21	41	35
30	0	0	2	10	25	27
30-YEAR CUMM. PROD. (MMCF)	1030	2209	2599	2560	2450	1810

TABLE 13-43

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, WASATCH

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 1.0	0.3	0.1	0.03	0.01	0.003
1	787	1678	1259	769	543	341
2	43	443	586	395	281	172
5	4	70	225	202	156	96
10	0	11	84	107	93	60
15	0	2	33	70	66	47
20	0	0	18	49	50	34
30	0	0	6	26	31	24
30-YEAR CUMM. PROD. (MMCF)	859	2670	3870	3670	2969	1960

TABLE 13-44

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN:
FORMATION: Wasatch

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
1	5.466	4	87	6.554	6.554	119
.3	4.993	4	677	4.131	4.131	846
.1	4.667	4	1431	3.134	3.134	1664
.03	4.695	4	1353	3.275	3.275	1592
.01	5.331	4	459	4.399	4.399	612
.003	7.481	4	98	6.908	6.908	184
			4105			5017

TABLE 13-45

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Wasatch

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	418,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	151,000 - 405,000
- Advanced Case (2000/4000 Ft. Fracture)	301,000 - 839,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0274

TABLE 13-46

ECONOMICS SUMMARY

BASIN Uinta — TECHNOLOGY Base

SUB BASIN — FORMATION Wasatch — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1001111	1.50	40.6	5	BCOEF	2770	7.171	1046	35.2	4007	4833	559	40.6	332	227	330	1319	2207
21	2.50	42.3	6	BCOEFG	2833	7.338	2682	66.5	4105	5017	559	42.3	323	237	338	1353	2250
31	3.10	"	"	"	"	"	3659	82.4	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	4311	92.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	6755	123.8	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	10013	158.6	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	13271	188.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	18158	226.3	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	40.6	5	BCOEF	2770	7.171	672	35.2	4007	4833	559	40.6	332	227	330	1319	2207
22	2.50	42.3	6	BCOEFG	2833	7.338	1948	66.5	4105	5017	559	42.3	323	237	338	1353	2250
32	3.10	"	"	"	"	"	2713	82.4	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	3223	92.1	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	5136	123.8	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	7686	158.6	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	10237	188.2	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	14062	226.3	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	33.1	4	BCDE	2463	6.053	361	34.1	3548	4221	586	33.1	392	194	300	1197	2082
23	2.50	40.6	5	BCDEF	2770	7.171	1435	66.5	4007	4833	559	40.6	332	227	330	1319	2207
33	3.10	42.3	6	BCDEFG	2833	7.338	2067	82.4	4105	5017	559	42.3	323	237	338	1353	2250
43	3.50	"	"	"	"	"	2480	92.1	"	"	"	"	"	"	"	"	"
53	5.00	"	"	"	"	"	4028	123.8	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	6092	158.6	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	8156	188.2	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	11252	226.3	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
1.0	0.3	0.1	0.03	0.01	0.003

TABLE 13-47

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Wasatch

TECHNOLOGY Advance

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
10012 11	1.50	40.3	4 CDEF	2925	7.756	1027	31.2	4714	4714	608	40.3	363	245	269	1073	1950
21	2.50	40.6	5 BCDEF	2954	7.784	2670	60.5	4833	4833	621	40.6	369	252	279	1115	2015
31	3.10	42.3	6 BCDEFG	3110	8.046	3713	75.5	5017	5017	624	42.3	360	264	295	1180	2098
41	3.50	"	" "	"	"	4387	85.0	"	"	"	"	"	"	"	"	"
51	5.00	"	" "	"	"	6911	116.8	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	10276	152.4	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	13642	183.0	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	18690	222.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	32.8	3 CDE	2558	6.578	536	30.2	4102	4102	624	32.8	419	205	233	931	1787
22	2.50	40.6	5 BCDEF	2954	7.784	1892	60.5	4833	4833	621	40.6	369	252	279	1115	2015
32	3.10	"	" "	"	"	2657	75.7	"	"	"	"	"	"	"	"	"
42	3.50	42.3	6 BCDEFG	3110	8.046	3214	85.0	5017	5017	624	42.3	360	264	295	1180	2098
52	5.00	"	" "	"	"	5172	116.8	"	"	"	"	"	"	"	"	"
62	7.00	"	" "	"	"	7782	152.4	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	10392	183.0	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	14307	222.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	32.8	3 CDE	2558	6.578	296	30.2	4102	4102	624	32.8	419	205	233	931	1787
23	2.50	40.6	5 BCDEF	2954	7.784	1377	60.5	4833	4833	621	40.6	369	252	279	1115	2015
33	3.10	"	" "	"	"	1993	75.7	"	"	"	"	"	"	"	"	"
43	3.50	"	" "	"	"	2403	85.1	"	"	"	42.3	"	"	"	"	"
53	5.00	42.3	6 BCDEFG	3110	8.046	4012	116.8	5017	5017	624	"	360	264	295	1180	2098
63	7.00	"	" "	"	"	6114	152.4	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	8216	183.0	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	11369	222.9	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
1.0	0.3	0.1	0.03	0.01	0.003

TABLE 13-48

GEOLOGICAL DATA SUMMARY

BASIN: Uinta
SUBBASIN: -
FORMATION: Barren

DEPTH (FT.): 7500
PRESSURE (PSIA): 3225
TEMPERATURE (°F): 195

TOTAL BASIN AREA (SECTIONS):
TYPE: Lenticular

NGL(BBL/MMCF): 5.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	18	5.3	30	156.14	132	0.10	1.0	-
0.1	43	4.85	49	557.95	456	0.30	1.0	-
0.03	70	4.5	63	1083.54	841	0.45	1.0	-
0.01	47	4.2	80	862.24	625	0.55	1.0	-
0.003	18	3.9	100	383.29	255	0.65	1.0	-
	196			3043.	2309			

TABLE 13-49
WELL PRODUCTION SUMMARY--BASE CASE

UINTA, BARREN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	955	986	707	483	296					
2	219	377	342	250	154					
5	29	102	146	131	88					
10	4	28	64	76	60					
15	1	12	36	53	44					
20	0	6	18	39	38					
30	0	2	9	24	28					
30-YEAR CUMM. PROD. (MMCF)	1420	2239	2560	2530	1880					

TABLE 13-50

WELL PRODUCTION SUMMARY--ADVANCED CASE

UINTA, BARREN

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	947	1181	821	585	379					
2	119	525	418	302	192					
5	15	182	202	158	107					
10	3	62	106	92	64					
15	0	28	65	64	48					
20	0	14	44	47	39					
30	0	5	23	29	25					
30-YEAR CUMM. PROD. (MMCF)	1189	3349	3670	3060	2129					

TABLE 13-51

PRODUCTION WELL REQUIREMENTS

BASIN: Uinta
SUB-BASIN:
FORMATION: Barren

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	5.289	4	99	6.316	6.316	132
.1	4.747	4	383	3.174	3.174	456
.03	4.680	4	715	3.264	3.264	841
.01	5.281	4	475	4.366	4.366	625
.003	7.734	4	133	6.829	6.829	255
			1805			2309

TABLE 13-52

INVESTMENT AND OPERATING EXPENSES

BASIN: Uinta
SUB-BASIN: -
FORMATION: Barren

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	528,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	159,000 - 427,000
- Advanced Case (2000/4000 Ft. Fracture)	317,000 - 884,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0274

TABLE 13-53

ECONOMICS SUMMARY

BASIN Uinta

SUB BASIN

FORMATION Barren

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1002111	1.50	37.1	4	ABCD	2900	6.086	552	22.1	1672	2054	275	37.1	173	102	135	540	949
21	2.50	42.6	5	ABCDE	3034	6.473	2007	52.4	1805	2309	279	42.6	160	119	144	577	1000
31	3.10	"	"	"	"	"	2868	70.2	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	3442	81.6	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	5596	121.2	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	8467	167.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	11339	207.1	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	15646	259.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	23.5	2	BC	2430	4.465	119	18.8	1098	1297	246	23.5	188	58	95	379	720
22	2.50	37.1	4	ABCD	2900	6.086	1361	52.3	1672	2054	275	37.1	173	102	135	540	949
32	3.10	42.6	5	ABCDE	3034	6.573	2101	70.2	1805	2309	279	42.6	160	119	144	577	1000
42	3.50	"	"	"	"	"	2560	81.6	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	4282	121.2	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	6578	167.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	8874	207.1	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	12318	259.0	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	23.5	2	BC	2430	0	-30	18.8	0	-	-	23.5	-	-	-	-	-
23	2.50	37.1	4	ABCD	2900	6.086	977	52.3	1672	2054	275	37.1	173	102	135	540	949
33	3.10	37.1	4	ABCD	2900	6.086	1525	69.7	"	"	"	"	"	"	"	"	"
43	3.50	42.6	5	ABCDE	3034	6.473	1964	81.6	1805	2309	279	42.6	160	119	144	577	1000
53	5.00	"	"	"	"	"	3390	121.2	"	"	"	"	"	"	"	"	"
63	7.00	"	"	"	"	"	5293	167.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	7195	207.1	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	10049	259.0	"	"	"	"	"	"	"	"	"

* CODE:

A	B	C	D	E
0.3	0.1	0.03	0.01	0.003

TABLE 13-54

ECONOMICS SUMMARY

BASIN Uinta — TECHNOLOGY Advance

SUB BASIN — FORMATION Barren — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
100221	1.50	35.7	3 BCD	2864	6.264	438	17.9	1922	1922	307	35.7	197	110	100	399	806
21	2.50	37.1	4 ABCD	3047	6.479	1813	43.8	2054	2054	317	37.1	199	118	116	465	899
31	3.10	42.6	5 ABCDE	3465	7.188	2815	58.1	2309	2309	321	42.6	184	137	137	545	1003
41	3.50	"	" "	"	"	3408	68.3	"	"	"	"	"	"	"	"	"
51	5.00	"	" "	"	"	5635	104.9	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	8603	148.7	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	11571	187.7	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	16023	239.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	22.1	2 BC	2382	-	-13	14.6	1297	1297	-	22.1	-	-	-	-	-
22	2.50	37.1	4 ABCD	3046	6.479	1214	43.8	2054	2054	317	37.1	199	118	116	465	899
32	3.10	"	" "	"	"	1857	58.9	"	"	"	"	"	"	"	"	"
42	3.50	42.6	5 ABCDE	3465	7.188	2444	68.3	2309	2309	321	42.6	184	137	137	545	1003
52	5.00	"	" "	"	"	4201	104.9	"	"	"	"	"	"	"	"	"
62	7.00	"	" "	"	"	6545	148.7	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	8888	187.7	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	12403	239.0	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	22.1	2 BC	2382	-	-166	14.6	1297	1297	-	22.1	-	-	-	-	-
23	2.50	37.1	4 ABCD	3046	6.479	822	43.8	2054	2054	317	37.1	199	118	116	465	899
33	3.10	37.1	" "	"	"	1351	58.9	"	"	"	"	"	"	"	"	"
43	3.50	"	" "	"	"	1704	68.7	"	"	"	"	"	"	"	"	"
53	5.00	42.6	5 ABCDE	3465	7.188	3259	104.9	2309	2309	321	42.6	184	137	137	545	1003
63	7.00	"	" "	"	"	5186	148.7	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	7113	187.7	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	10004	239.0	"	"	"	"	"	"	"	"	"

* CODE: A 0.3 B 0.1 C 0.03 D 0.01 E 0.003

Chapter Fourteen

PICEANCE CREEK BASIN

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Geological Data Summary
Well Production Summary -- Base Case
Well Production Summary -- Advanced Case
Production Well Requirements
Investment and Operating Expenses
Economics Summary -- Base Case
Economics Summary -- Advanced Case

Formation	Pages
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Chapter Fourteen

PICEANCE CREEK BASIN

GEOLOGY

General Description

The Piceance Creek basin, located in northwest Colorado, encompasses some 4,500 square miles with Tertiary age sedimentary rocks at the surface. It is defined by bordering structures and the almost continuous exposure of the Tertiary-Cretaceous boundary. The basin is asymmetric with a steep east flank and a gentle west flank. It is bounded on the east by the Grand Hogback monocline of the White River uplift, on the southwest by the Uncompahgre uplift, on the west by the Douglas Creek arch and on the north by the Uinta Mountains and the Axial Basin uplift. More than 25,000 feet of sedimentary rocks are present in the deepest part of the basin which is parallel to and very close to its eastern margin.

The Piceance Creek basin was formed during the Laramide orogeny (late Cretaceous-early Tertiary) and gradually assumed its present physiography through progressive downwarping, deposition and erosion of the basin area differentially with respect to surrounding positive areas.

During the Paleozoic, marine shelf sedimentation was dominant in the area of northwest Colorado. An interruption occurred in Pennsylvanian time with the uplift of the ancestral Uncompahgres on the southwest and the Front Range on the northeast. These highlands were a source of sediments deposited under mixed marine and continental environments during the late Paleozoic and early Mesozoic.

During Cretaceous time, northwestern Colorado was again subject to marine trangression. The basal deposits were mainly conglomerates and coarse sandstones of the Cedar Mountain and the Dakota Group laid down under fluvial and flood-plain conditions with reworking by marine wave action. Upper Cretaceous sedimentary rocks totaling 6,000 to 11,000 feet included marine Mancos shale and marine and non-marine sandstone, shale and coal of the Mesaverde Group.

During the Tertiary the Piceance became a typical intermontane basin accumulating more than 8,000 feet of Paleocene and Eocene rocks of the Ft. Union, Wasatch and Green River (Sanborn, 1977). Thick wedges of continental clastic rocks around the flanks of the basin thin and interfinger with lacustrine shales and marlstones in the interior of the basin. Extensive Miocene volcanics spread across the filled basin. Remnants today form flat caps on the highest parts of the White River uplift and the Piceance Creek basin (Dunn, 1972).

The geology of the basin is illustrated by the following exhibits:

- A base map showing basin outline with bordering structures and outlined areas of tight gas formation potential (Figure 14-1)
- An oil and gas field map (Figure 14-2)
- A diagrammatic cross-section (Figure 14-3)
- A correlation chart (Figure 14-4).

Tight Gas Formations

The formations with major potential for unconventional tight gas include sandstone reservoirs within the Jurassic/Lower Cretaceous, Mancos and Mesaverde (Upper Cretaceous) and Fort Union (Paleocene/Eocene). These sandstones, although they carry a large resource of gas-in-place, have poor reservoir characteristics; that is, tight cementation, low permeability, and low gas-filled porosity. The formations evaluated in this report are listed in Table 14-1. Additional sandstones in the Mancos and in the post-Fort Union may be found to qualify as tight gas reservoirs in the future.

TABLE 14-1

Piceance Basin
Formations

Formation	Lithology	Age	Trap Type	Depth
Fort Union	SS	Paleocene	Strat. (Lenticular)	5,000'
Mesaverde Group	SS	U. Cret.	Strat. (Lenticular)	8,000'
Corcoran Cozette (Mancos)	SS	U. Cret.	Strat. (Blanket)	6,000'
Dakota-Cedar Mtn. Morrison	SS	L. Cret.-Jur.	Strat. (Lenticular)	7,000'

Hydrocarbon Potential

Gas reserves have been developed in the basin in sandstones from Pennsylvanian through Eocene age. The tight gas reservoirs are contained primarily within Cretaceous and Tertiary rocks. A study by Lewin and Associates (1978) covered some 4,000 square miles of the basin. The areal extent accepted in this study for the Fort Union Mesaverde and Corcoran-Cozette is the same as that

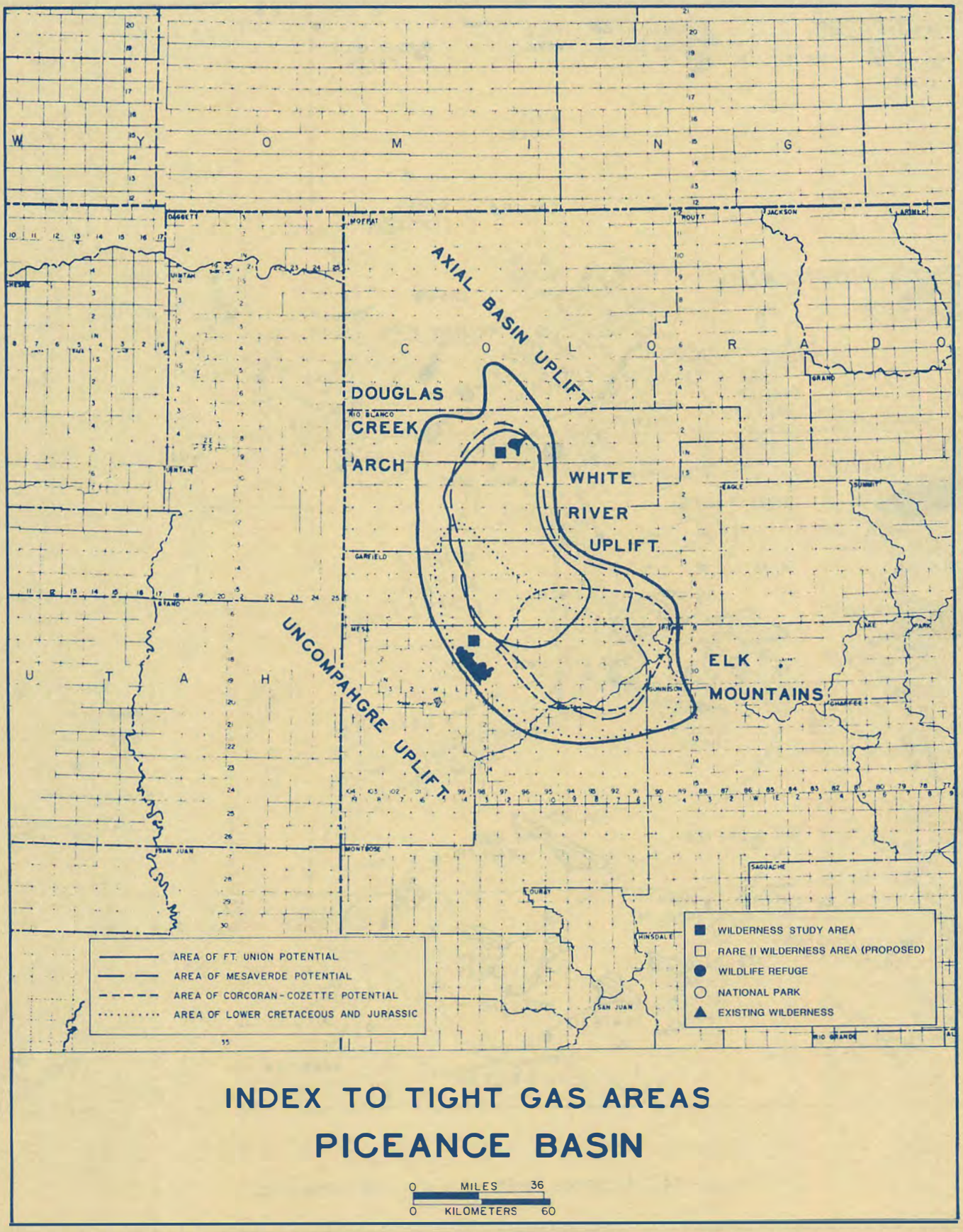


Figure 14-1. Index to Tight Gas Areas -- Piceance Basin.

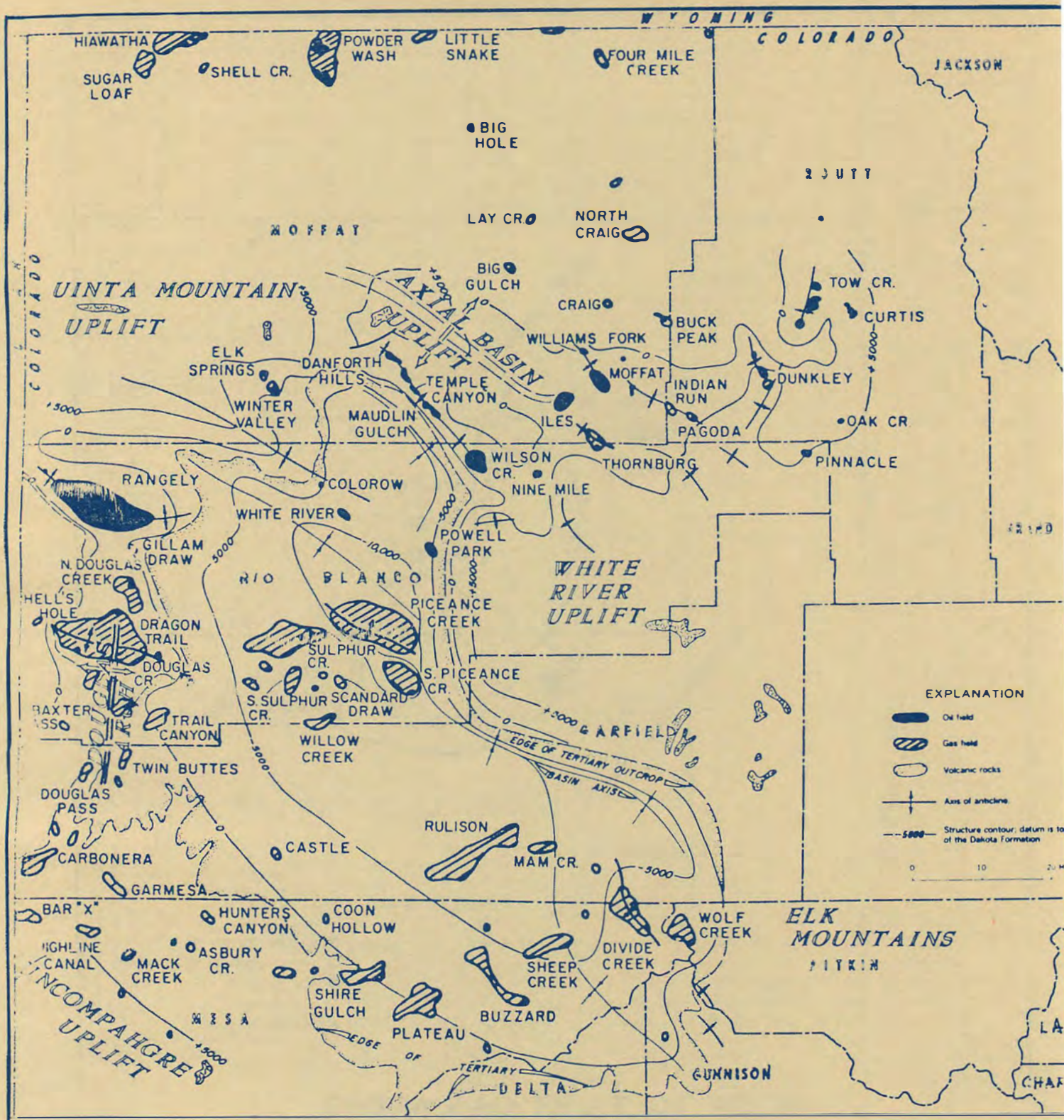


Figure 14-2. Piceance Basin -- Oil and Gas Fields Map.

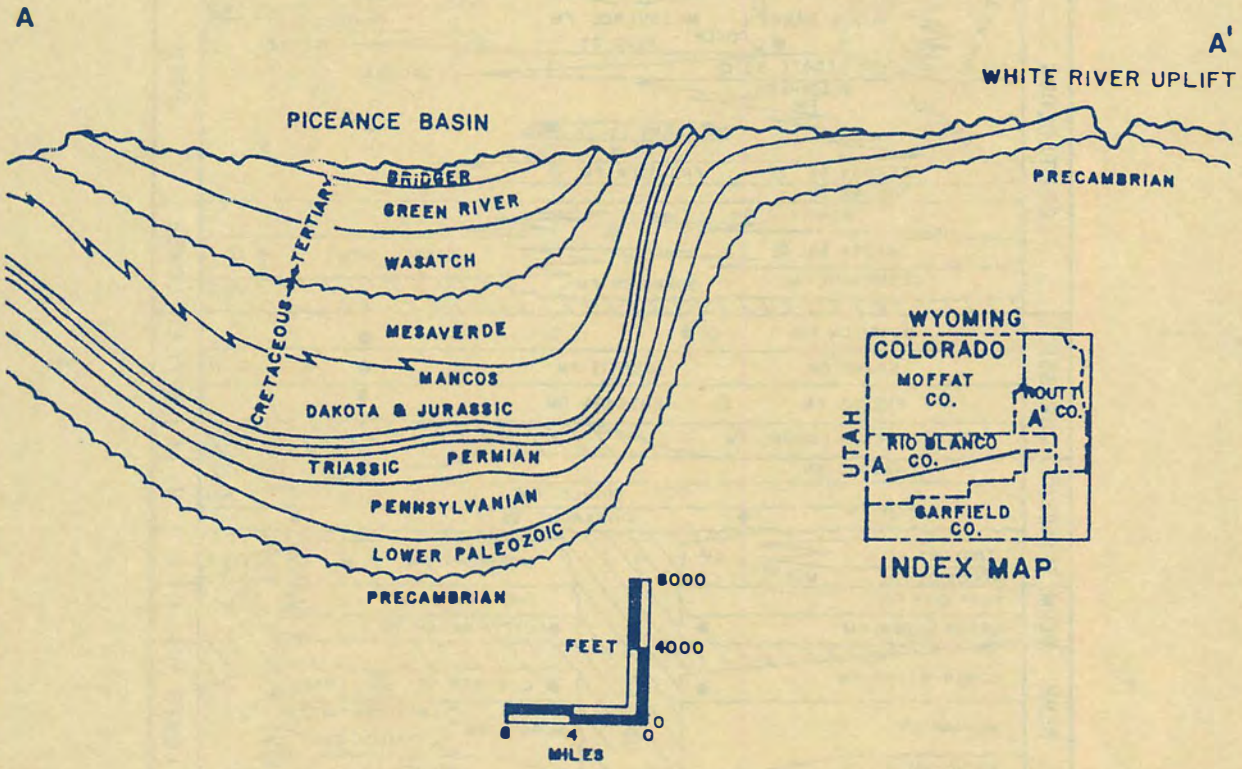


Figure 14-3. W-E Diagrammatic Cross Section -- Piceance Basin.

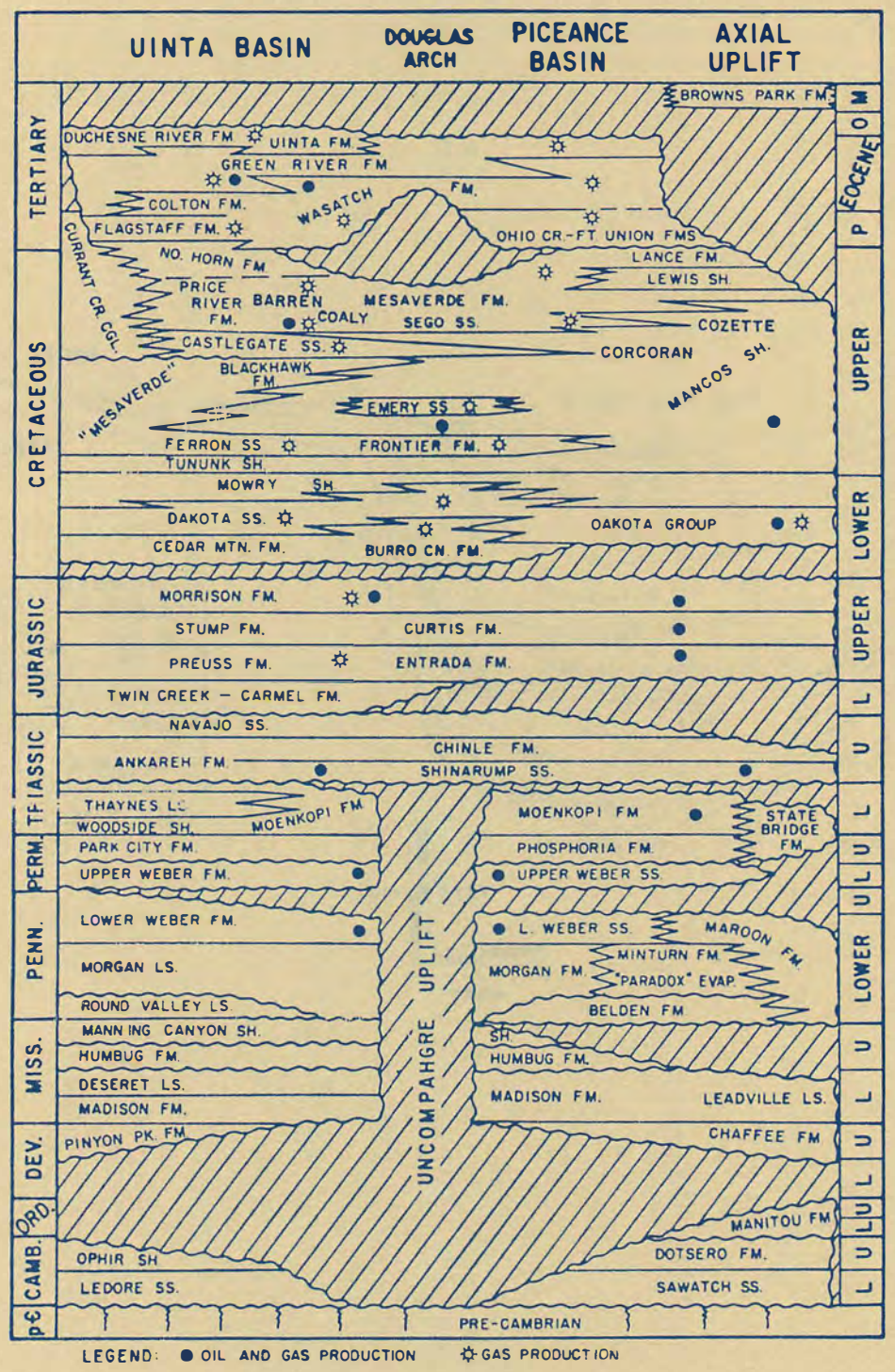


Figure 14-4. Correlation Diagram -- Northeast Utah and Northeast Colorado.

(AFTER SANBORN, 1977)

used in the Lewin report, although it is recognized that areas outside the boundaries as shown in Figure 14-1 may also be proven to contain unconventional gas resources. The Lewin reservoir parameters, with some modification, have been incorporated into the present study. Tight sandstones of the Lower Cretaceous and Jurassic (Dakota, Cedar Mountain and Morrison), not considered in the Lewin report, have been added in this study. The Upper Cretaceous Mesaverde lenticular sandstones have by far the greatest potential for development of tight gas among the formations evaluated. The maximum recoverable tight formation gas-in-place has been calculated to be about 33 TCF. Future economics will determine how much of this will actually be recovered.

Exploration History

Drilling for gas in the area dates back to 1890 when two wells were drilled encountering shallow gas in the vicinity of the White River gas seeps (Dunn, 1972). By the 1920's and 1930's surface mapping and anticlinal drilling were actively pursued in areas around the Piceance Creek basin including the Axial Basin uplift and Douglas Creek arch. A number of major discoveries including the giant Rangely field were made during this period. The first significant gas in the Piceance Creek basin proper was established in 1930 with the discovery of the Piceance Creek field. Most of the Piceance Creek basin gas was developed during the 1950's and 1960's. The majority of the production is from stratigraphic traps. Conventional development in the Piceance Creek basin to date has found 61 fields, almost entirely gas. In the central part of the basin most of the gas is produced from Eocene sandstones of the Wasatch and Green River. In the southern part the majority of the production is from Upper Cretaceous sandstones of the Mesaverde Group. Sandstone reservoirs of Pennsylvanian, Triassic, Jurassic and the Lower Cretaceous have been only moderately productive within the basin, although on the Axial Basin uplift and Douglas Creek arch they have been very productive. The Rangely field, for example, has produced more than 500 million barrels of oil and 700 billion cubic feet of gas from the Weber Sandstone of Pennsylvanian age.

A summary of recent exploration drilling for the period 1960-1977 is presented in Table 14-2. During this period an average of 10 wildcats per year were drilled. Approximately 31 percent of the gas wildcats were successful finding an average of 8.2 BCF per well. With higher prices a larger proportion of wildcats will be successful; however, for completions in tight gas reservoirs the reserves per successful wildcat may be expected to decline.

Characteristics of Traps and Reservoirs

A conceptual model for most of the Piceance Creek basin tight gas reservoirs is one of highly lenticular sandstones deposited in a complex series of trangressions and regressions under predominantly non-marine environments including fluvial channel and point bar, coastal swamp, deltaic and lacustrine. In addition to lenticularity the sandstones are characterized by rapid lateral and vertical changes in porosity and permeability. One result of the

TABLE 14-2

EXPLORATION PERFORMANCE - Piceance Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod
Number of Successful Wildcat Wells									
Total	29	19	10	29	25	4	58	44	14
Gas	28	18	10	25	22	3	53	40	13
Oil	1	1	0	4	3	1	5	4	1
Amount of Petroleum Found									
Total, MMBOE **	61.1	17.96	43.1	19.5	17.4	2.1	80.6	35.4	45.2
Gas, BCF	333.5	83.1	250.4	101.6	95.3	6.3	435.1	178.4	256.7
Oil, MM Bbls.	3.6	3.6	0	1.7	0.71	1.0	5.3	4.31	1.0
Number of Wildcat Wells									
Total	113	93	20	69	62	7	182	155	27
Gas *	109	90	19	59	53	6	168	143	25
Oil *	4	3	1	10	9	1	14	12	2
Number of Wildcats/Year	11	9	2	9	8	1	10	9	2
Percent Wildcats Successful									
Total	25.7	20.4	50.0	42.0	40.3	57.1	31.9	28.4	51.9
Gas	25.7	20.0	52.6	42.4	41.5	50.0	31.5	28.0	52.0
Oil	25.0	33.3	0	40.0	33.3	100.0	35.7	33.3	50.0
Amount Found/Successful Wildcat									
Total, MMBOEE	2.1	0.95	4.3	0.67	0.69	0.53	1.39	0.80	3.2
Gas, BCF	11.9	4.6	25.0	4.1	4.3	2.1	8.2	4.5	19.7
Oil, MM Bbls	3.6	3.6	0	0.43	0.24	1.0	1.1	1.08	1.0
Average Depth of Wells, feet									
Gas	5936	5477	6763	5773	5727	6105	5859	5615	6612
Oil	15857	15857	0	6373	6063	7304	8270	8512	7304

* Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

broad range of resevoir permeability is that the basic trap is defined in terms of permeability. Permeability trap distribution ranges from 0.1 to 0.00003 millidarcies. Traps consist of areas of gas-filled rock having higher permeability than surrounding rocks.

A partial exception to the lenticular model is the marine Corcoran-Cozette which tends to be a blanket-type reservoir. Trapping is basically stratigraphic within this unit also, because of lateral and vertical changes in permeability. Some of these marine continuous sandstones may locally develop good enough reservoir characteristics to be excluded from qualification for unconventional or tight gas classification.

Table 14-3 summarizes the basic reservoir parameters.

TABLE 14-3

Piceance Basin Tight Formation Reservoir Parameters

Formation	Permeability Range (md)	Press (psi)	Temp. (°F)	Gas-Filled Porosity Range (%)	Net Pay Range (ft)
Fort Union	0.1-.0003	2,100	135	7.0-3.2	12-80
Mesaverde Group	0.1-.00003	3,400	170	6.1-2.1	20-200
Corcoran Cozette	0.1-.0003	2,600	145	6.5-2.3	16-70
Dakota-Cedar Mtn. Morrison (Lower Cretaceous, Jurassic)	0.3-.001	2,900	158	6.0-3.5	7-35

The sizes of the tight gas fields in the Piceance Creek basin are estimated to be the range of 10 to 500 BCF. Their sizes and their cumulative probability of occurrence are shown in Figure 14-5 for reservoirs in the various tight gas formations. The maximum field size will tend to be smaller for permeabilities above 0.1 millidarcy and for permeabilities less than 0.001 millidarcy.

The general geological data and well experience in the Piceance basin have been combined into estimates of the future performance of tight gas plays. The geological and exploration performance are described for sub-basins and tight gas formations in the basin.

Table 14-4 is a geological data summary for the Fort Union formation in the Piceance basin. The productive area considered is 354 sections out of the 7,100-section basin. The Fort Union is divided into six average permeability zones with area, porosity, and net pay as shown for each. Reservoir pressure is 2,100 PSIA and temperature is 135°F. Gas in place can be estimated from these data. Maximum recoverable gas is based on recovery factors intended to compensate for lack of continuity in flow channels.

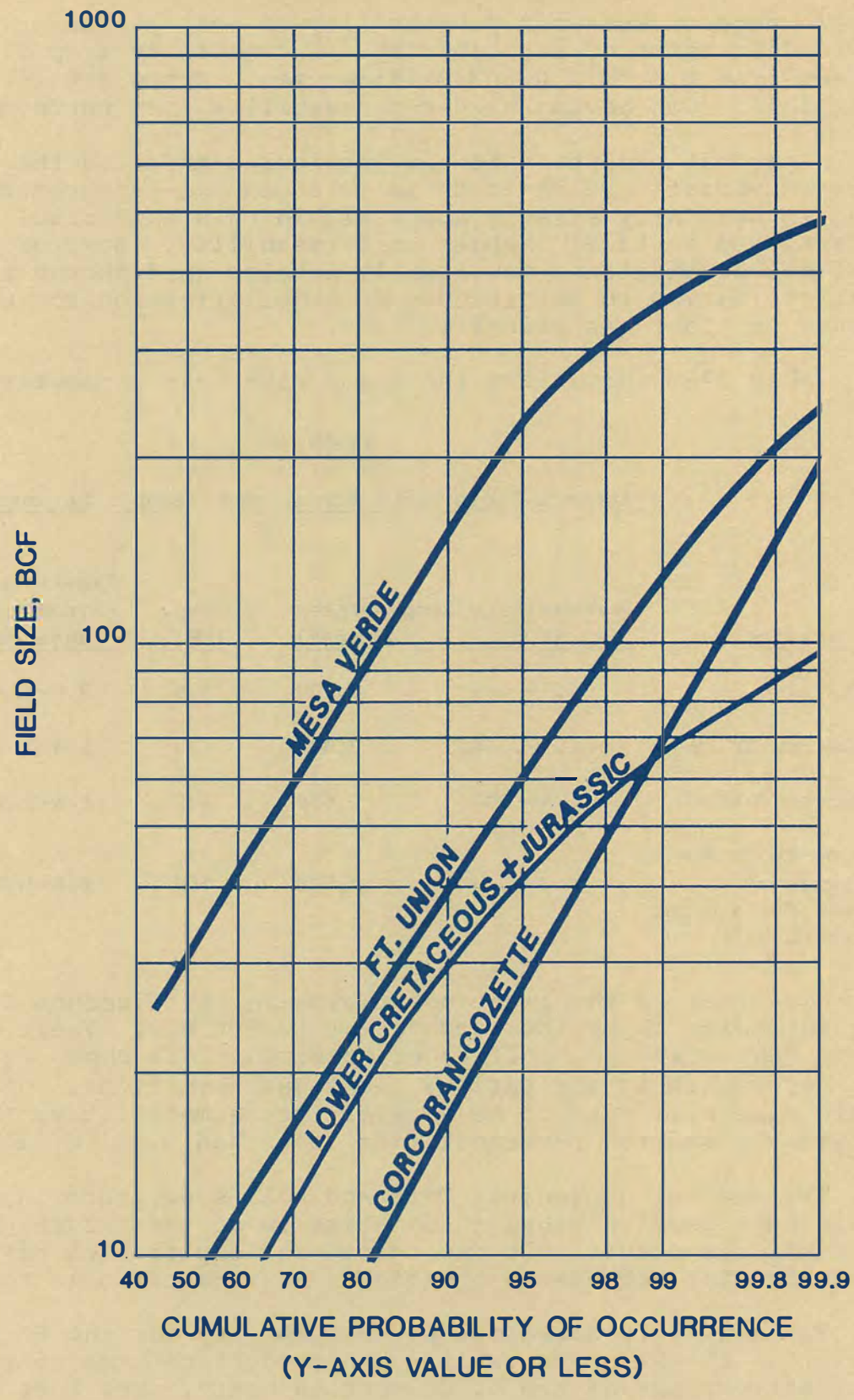


Figure 14-5. Field Size Distribution of Producible Gas, Piceance Basin.

TABLE 14-4

Geological Data Summary

Total Basin Area (Sections): 7100
Type: Lenticular

Basin: Piceance
Subbasin: -
Formation: Ft. Union

Depth (Ft.): 5000
Pressure (PSIA): 2100
Temperature (°F): 135

NGL(BBL/MMCF): 20.

Average Perm. (MD)	Productive Area (Sections)	H/C Gas Porosity (%)	Net Pay Thickness (Ft.)	Estimated Gas in Place at Reservoir Cond. (BCF)	Max. Recoverable Gas (BCF)	For Each Drilling Location W/C: Probability That State of Nature is Productive	Probability that W/C is Productive, Given that State of Nature is Prod. 1st W/C	2nd W/C
0.1	4	7	12	14	11	0.20	1.0	-
0.03	25	6	22	140	107	0.40	1.0	-
0.01	78	5.1	34	573	423	0.45	1.0	-
0.003	131	4.4	48	1,172	805	0.55	1.0	-
0.001	81	3.8	62	809	521	0.65	1.0	-
0.0003	35	3.2	80	380	230	0.75	1.0	-
	354			3,088	2,097			

Data for each drilling location includes probability distribution for state of nature, first wildcat, and second wildcat. For the 0.1 MD zone, the state of nature is 0.2 productive (and 0.8 dry). This means that eight out of ten wildcats drilled in 0.1 MD locations will be dry. The probability of the first wildcat drilled in aproductive area being productive is 1.0. A second wildcat is not necessary. As net pay increases, the probability that the state of nature will be productive increases.

GAS PRODUCTION

The production rates estimated for the range of reservoir characteristics are shown in Table 14-5 for the wells in the Fort Union formation. These rates are for the base case technology with fractures of 1,000 foot radius. The annual gas production in millions of standard cubic feet per year per well and the cumulative production over a 30 year period are given. Table 14-6 shows the data for the advanced technology using fractures up to 4,000 foot radius.

Well productivity data are tabulated in Tables 14-5 for the base case and Table 14-6 for the advanced case. Note that the 0.2 MD well has the best initial production rate (year 1) of all permeabilities, but that production declines rapidly to only 5 MMCF/yr. by year 10. Total production for 30 years is only 0.649 BCF. The advanced case 0.1 MD well, Table 14-6, is similar when compared to other advanced case wells.

The Fort Union formation reservoirs are small lenticular bodies many of which are connected to the wells only by the fractures. Depending on the size and area of field discovered the number of development wells needed for the field is calculated. These are estimated for each 640 acre section of the field. Ultimate production per well from Tables 14-5 and 14-6 were used to compute the number of wells per section required to produce all gas in Table 14-7.

Recoverable gas from an actual well, Table 14-7, for both base and advanced cases should be compared to the Maximum Recoverable Gas column in Table 14-4. The current practice of drilling no more than four wells per section (base case) reduces recoverable gas from 2,097 BCF to 1,130 BCF. The advanced case reduction in recovery is from the 2,097 BCF available to 1,835 BCF.

ECONOMICS

The basic geologic and production data have been used in a full-cycle exploration and production simulator model. This model considers all costs and risks associated with finding and producing tight gas from both blanket and lenticular reservoirs. There are four major producing formations for tight gas. Gas is produced in the model from each of these separately. Wells are also completed in two formations where geology and good well completion practices

TABLE 14-5

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		311	228	176	124	110	53			
2		122	117	91	65	57	28			
5		26	58	51	36	33	16			
10		5	30	30	25	22	11			
15		2	17	24	20	18	9			
20		1	7	18	16	15	7			
30		0	2	11	12	11	6			
30-YEAR CUMM. PROD. (MMCF)		649	949	1020	809	719	369			

TABLE 14-6

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, FORT UNION

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		348	283	213	149	159	88			
2		161	146	110	75	72	38			
5		60	75	62	42	41	21			
10		16	42	37	28	27	14			
15		6	27	29	21	21	11			
20		2	17	22	16	16	9			
30		0	7	14	11	12	6			
30-YEAR CUMM. PROD. (MMCF)		980	1350	1229	890	899	480			

TABLE 14-7

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Ft. Union

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	4.5	4	10	3.0	3	11
.03	4.6	4	93	3.2	3	96
.01	5.3	4	321	4.4	4	385
.003	7.7	4	419	6.9	6	700
.001	8.9	4	234	7.1	6	438
.0003	17.4	4	53	13.5	12	205
			1130			1835

permit. The Piceance is divided into seven tight gas sub-basins depending on the kinds of well completions. These are listed in Table 14-8.

The investment required and the economics of gas production varies substantially from one sub-basin to another.

Table 14-9 presents investment and operating expenses for the Fort Union P-1 sub-basin. The reason for the range of fracture costs is that net pay thickness increases as permeability decreases, requiring greater volumes of frac fluid and proppant. The reason advanced case fractures cost more than base case is that fracture length is greater for the advanced case.

We can discuss now the Fort Union economics summary, Tables 14-10, 14-11. After the customary identification entries, we find rows of entries beginning withe "case number" and continuing across the page. There are three sets of data corresponding to discount rates of 10 percent, 15 percent, and 20 percent. Each set has gas selling price from $1.50/MCF to $12.00/MCF. Case number 1302111, Table 14-10 is a base case at $1.50 per MCF price and 10 percent discount rate. Remember that the entire productive area is drilled in order to evaluate this $1.50 price. Only 13.2 percent of the prospects were profitable. Permeability levels 0.03 MD and 0.01 MD, coded C and D, came on stream. All other permeabilities were tested but were unprofitable. The investment averaged $1.583 million and net present value at 10% discount rate was negative $402 thousand. DCF rate of return was zero. No gas is recoverable in this formation at $1.50 per MCF if 10 percent rate of return is required.

The question may be asked why the best permeability Zone B (0.1 MD) was not on stream. A review of its performance on Table 14-5 shows it is inferior to zones at 0.03 and 0.01 MD and, therefore, it doesn't pay out.

For Case Number 1302121 the gas price is $2.50. Other permeability levels are still uneconomical, but the higher price does bring the DCF rate of return to 9.0 percent. The net present value is negative $38 thousand at 10 percent discount rate. For the purpose of this study, no gas is available at $2.50.

Continuing with Case Number 1302131 at $3.10, we find 30.9 percent of the prospects drilled to be profitable and that Zone E (0.003 MD) has joined C and D as profitable. This increases the gas per prospect to 4.176 BCF for an average investment of $2.871 million. Rate of return is 18.4 percent and net present value $533 thousand. From Table 14-4, it is learned that maximum recoverable gas for these zones is 1,335 BCF. From Table 14-7 base case, the recoverable gas from actual wells in these three zones is 833 BCF. These values are shown on Table 14-10. There are 199 prospects available in the productive area of the basin at the $3.10 price level. This number is obtained by dividing 833 BCF available by 4.176 BCF per prospect. The program lists the well requirements as 138 dry wildcats, 61 productive wildcats, 183 dry development wells, and 732 producers. This is a total of 1,114 wells.

Table 14-8

SUB-BASINS OF PICEANCE BASIN

Sub-Basin Number	Formations in Sub-Basin	Number of Productive Sections in Sub-Basin	Maximum Recoverable BCF
P-1	Fort Union	354	2,097
P-2	Mesa Verde 8000'	1443	20,155
P-3	Corcoran-Cozette	369	2,294
P-4	Fort Union, Mesa Verde	101	2,040
P-5	Fort Union, Corcoran Cozette	51	596
P-6	Corcoran-Cozette, Mesa Verde	180	3,509
P-7	Lower Cretaceous, Jurrasic (Dakota,Cedar Mt.,Morrison)	646	2,288
	TOTAL	3144	32,979

TABLE 14-9

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Ft. Union

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	294,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	142,000 - 282,000
- Advanced Case [2000/4000 Ft. Fracture]	283,000 - 553,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0311

TABLE 14-10

ECONOMICS SUMMARY,

BASIN Piceance

SUB BASIN

FORMATION Ft. Union

TECHNOLOGY Base

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1302111	1.50	13.2	2	CD	1583	1.892	-402	0	-	-	-	13.2	-	-	-	-	-
21	2.50	"	"	"	"	"	-38	9.0	-	-	-	13.2	-	-	-	-	-
31	3.10	30.9	3	CDE	2871	4.176	533	18.4	833	1335	199	30.9	138	61	183	732	1114
41	3.50	47.1	5	BCDEF	5570	7.960	1311	22.9	1077	1867	135	47.1	71	64	264	1054	1453
51	5.00	"	"	"	"	"	2993	39.8	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	5236	60.4	"	"	"	"	"	"	"	"	"
71	9.00	55.6	6	BCDEFG	6268	8.426	7719	76.7	1130	2097	134	55.6	59	75	292	1168	1594
81	12.00	"	"	"	"	"	11274	100.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	684	0	-408	0	-	-	-	0	-	-	-	-	-
22	2.50	13.2	2	CD	1583	1.892	-182	9.0	-	-	-	13.2	-	-	-	-	-
32	3.10	30.9	3	CDE	2871	4.176	158	18.4	833	1335	199	30.9	138	61	183	732	1114
42	3.50	"	"	"	"	"	343	22.4	"	"	"	"	"	"	"	"	"
52	5.00	47.1	5	BCDEF	5570	7.960	1746	39.8	1077	1867	135	47.1	71	64	264	1054	1453
62	7.00	"	"	"	"	"	3327	60.4	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	4908	78.3	"	"	"	"	"	"	"	"	"
82	12.00	55.6	6	BCDEFG	6268	8.426	7543	100.4	1130	2097	134	55.6	59	75	292	1168	1594
Discount Rate 20%																	
13	1.50	0	0	-	684	0	-413	0	-	-	-	0	-	-	-	-	-
23	2.50	2.0	1	C	836	.260	-376	0	-	-	-	2.0	-	-	-	-	-
33	3.10	13.2	2	CD	1583	1.892	-156	13.8	-	-	-	13.2	-	-	-	-	-
43	3.50	"	"	"	"	"	-81	16.8	-	-	-	"	-	-	-	-	-
53	5.00	47.1	5	BCDEF	5570	7.960	1048	39.8	1077	1867	135	47.1	71	64	264	1054	1453
63	7.00	"	"	"	"	"	2236	60.4	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	3427	78.3	"	"	"	"	"	"	"	"	"
83	12.00	55.6	6	BCDEFG	6268	8.426	5384	100.4	1130	2097	134	55.6	59	75	292	1168	1594

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 14-11

ECONOMICS SUMMARY,

BASIN Piceance

SUB BASIN

FORMATION Ft. Union

TECHNOLDGY Advanced

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
1302211	1.50	0	0 -	852	0	-497	0	-	-	-	0	-	-	-	-	-
21	2.50	13.2	2 CD	1960	2.192	-77	8.4	-	-	-	13.2	-	-	-	-	-
31	3.10	30.9	3 CDE	4582	5.940	693	17.6	1181	1335	199	30.9	138	61	241	965	1405
41	3.50	47.1	5 BCDEF	10196	12.856	2070	22.8	1630	1867	127	47.1	67	60	356	1418	1900
51	5.00	"	" "	"	"	4871	41.9	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	8606	66.3	"	"	"	"	"	"	"	"	"
71	9.00	55.6	6 BCDEFG	13416	14.497	13271	81.7	1835	2097	127	55.6	56	71	447	1788	2362
81	12.00	"	" "	"	"	19658	112.0	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	0	0 -	852	0	-501	0	-	-	-	0	-	-	-	-	-
22	2.50	13.2	2 CD	1960	2.192	-246	8.4	-	-	-	13.2	-	-	-	-	-
32	3.10	"	" "	"	"	-79	12.9	-	-	-	"	-	-	-	-	-
42	3.50	"	" "	"	"	33	15.8	481	530	219	"	190	29	79	315	613
52	5.00	47.1	5 BCDEF	10196	12.856	2844	41.9	1630	1867	127	47.1	67	60	356	1418	1900
62	7.00	"	" "	"	"	5479	66.3	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	8113	87.8	"	"	"	"	"	"	"	"	"
82	12.00	55.6	6 BCDEFG	13416	14.497	13126	112.0	1835	2097	127	55.6	56	71	447	1788	2362
Discount Rate 20%																
13	1.50	0	0 -	852	0	-504	0	-	-	-	0	-	-	-	-	-
23	2.50	2.0	1 C	994	.285	-465	0	-	-	-	2.0	-	-	-	-	-
33	3.10	13.2	2 CD	1960	2.192	-215	12.9	-	-	-	13.2	-	-	-	-	-
43	3.50	"	" "	"	"	-128	15.8	-	-	-	"	-	-	-	-	-
53	5.00	47.1	5 BCDEF	10196	12.856	1717	41.9	1630	1867	127	47.1	67	60	356	1418	1900
63	7.00	"	" "	"	"	3696	66.3	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	5675	87.8	"	"	"	"	"	"	"	"	"
83	12.00	55.6	6 BCDEFG	13416	14.497	9338	112.0	1835	2097	127	55.6	56	71	447	1788	2362

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

The 15 percent discount rate is similar to the 10 percent rate. However, $3.50 will not bring Zone F on stream at 15 percent as it did at 10 percent discount rate. At 20 percent rate, $5.00 per MCF is required to turn a profit in the net present value column.

The DCF rate of return at $12.00/MCF is 100.4 percent. This brings on all the gas available in the base case for the 15 percent and 20 percent discount rates. The $9.00 price will bring on all gas available at 10 percent discount rate.

The advanced case, Table 14-11, is interpreted in the same manner. One should contrast the amount of gas recoverable in the advanced case at each price with amount of gas recoverable in the base case. The E and P investment is greater for the advanced case, but rates of return are better than those of base case.

The basic geologic data presented in Table 14-4 have been run through a series of production, exploration and economic models.

The range of information available from these tables may be illustrated by the Fort Union, base case. For Case No. 1302152 under a minimum acceptable discount rate of 15 percent and a gas price of $5 per MCF, the expected amount of gas recoverable from the Fort Union formation alone would be 1,077 BCF. In developing this amount of gas a total of 135 prospects would have been tested with a 47 percent success requiring a total of 1,453 wells of which 1,118 would be producers. Under the base case a maximum of four holes would be drilled per section with a frac radius capability of 1,000 feet. Permeability traps as low as 0.001 MD would be drilled. The average E&P investment for the total prospects drilled, both succesful and unsuccessful, would be 5.57 MM$ with average reserves of 7.96 BCF. The average recovery per successful prospect can be obtained as follows:

> 135 (max. no. prosp. @ $5.00/MCF) times .471 (percentage successful prosp.) = 63 then: 1,077 BCF divided by 63 (total successful prosp.) = 17 BCF/successful prospect.

The table shows the lowest two price levels would generate rates of return less than 15 percent. At the price of $5.00 per MCF the maximum recoverable GIP would be 1,867 BCF. However, this amount would be recovered only if 12 wells or more per section were to be drilled with frac capability of 4,000' radius -- the advanced case fully developed.

PERFORMANCE OF THE PICEANCE BASIN AS A WHOLE

The text and tables covered thus far have concentrated on the sub-basin P-1, the Fort Union formation. Tables 14-13 to 14-54 give similar data for each of the remaining six sub-basins.

In summary, the Piceance undiscovered tight gas that is potentially productive is shown in Table 14-12. These estimates are for three prices for the gas in dollars per thousand cubic feet at the producing field. A 15 percent rate of return was used for these gas resource estimates.

REFERENCES

Dunn, Hal, 1972, "The Piceance Basin and the Axial Basin Uplift" Geologic Atlas of the Rocky Mountain Region, RMAG, p. 278.

Sanborn, Albert F., 1977, "Future Potential - NE Utah-NW Colorado" Exploration Frontiers of the Central and Southern Rockies, RMAG, 1977 Symposium.

National Petroleum Council, 1973, U.S. Energy Outlook: oil shale availability: a report by the Oil Shale Task Group of the Other Energy Resources Subcommittee of the National Petroleum Council's Committee on U.S. Energy Outlook, A.E. Kelley, Chmn. 88p.

Lewin and Associates, Inc., 1978 "Enhanced Recovery of Natural Gas" DOE

Johnson, R.C. 1979, Cross Section A-A' of upper Cretaceous and lower Tertiary rocks, northern Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Investigations Map MF-1129-A, 2 sheets.

Johnson, R.C., 1979, Cross Section B-B' of upper Cretaceous and lower Tertiary rocks, northern Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Investigations Map MF-1129-B, 2 sheets.

Johnson, R.C., 1979, Cross Section C-C' of upper Cretaceous and lower Tertiary rocks, northern Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Investigations Map MF-1129-C, 2 sheets.

TABLE 14-12

SUMMARY OF PICEANCE BASIN GAS POTENTIAL

(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Piceance		Corcoran Cozette	1291	1865	1884	2216	2294	2294
		Fort Union	0	1077	1077	0	1630	1630
		Mesa Verde 8000	8047	9851	10467	5579	15079	17413
		Corcoran Cozette, Mesa Verde	2288	2665	2665	3224	3509	3509
		Fort Union, Mesa Verde	772	1029	1072	1214	1619	1981
		Fort Union, Corcoran Cozette	475	482	482	596	596	596
		Lower Cretaceous, Jurasic	0	1454	1775	0	1700	2288
Basin Total			12873	18423	19422	12829	26427	29711

TABLE 14-13

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 7100
TYPE: Blanket

NGL(BBL/MMCF): 20.

BASIN: Piceance
SUBBASIN: -
FORMATION: Corcoran Cozette

DEPTH (FT.): 6000
PRESSURE (PSIA): 2600
TEMPERATURE (°F): 145

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	22	6.5	16	117	98	0.20	1.0	-
0.030	81	5.5	24	547	429	0.40	1.0	-
0.010	122	4.9	34	1038	764	0.50	1.0	-
0.003	100	4.2	46	987	681	0.60	1.0	-
0.001	33	3.7	60	374	244	0.70	1.0	-
0.0003	11	3.3	70	130	78	0.80	1.0	-
	369			3193	2294			

TABLE 14-14

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, CORCORAN-COZETTE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		353	270	210	141	98	57			
2		243	171	125	78	53	31			
5		176	117	80	51	32	18			
10		130	93	62	37	23	13			
15		105	80	54	31	20	10			
20		82	72	49	28	18	9			
30		62	58	43	24	15	7			
30-YEAR CUMM. PROD. (MMCF)		3638	2775	1951	1176	762	419			

TABLE 14-15

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, CORCORAN-COZETTE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		549	621	553	462	345	217			
2		375	432	356	272	195	119			
5		257	292	236	167	116	69			
10		195	220	173	120	81	48			
15		162	181	146	100	69	39			
20		135	159	128	89	61	34			
30		108	125	105	73	49	28			
30-YEAR CUMM. PROD. (MMCF)		5651	6455	5271	3781	2629	1554			

TABLE 14-16

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Corcoran-Cozette

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	1.2	1.2	98	.77	.77	98
.03	1.89	1.89	429	.81	.81	429
.01	3.19	3.19	764	1.18	1.18	764
.003	5.77	4	472	1.79	1.79	681
.001	9.54	4	102	2.76	2.76	244
.0003	16.71	4	19	4.5	4.5	78
			1884			2294

TABLE 14-17

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Corcoran-Cozette

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	375,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	92,000 - 142,000
- Advanced Case [2000/4000 Ft. Fracture]	116,000 - 504,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0311

TABLE 14-18

ECONOMICS SUMMARY

BASIN Piceance

SUB BASIN

FORMATION Corcoran Cozette

TECHNOLOGY Base

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1301111	1.50	25.2	3	BCD	1393	3.121	-1	9.9	1291	1291	414	25.2	310	104	133	534	1081
21	2.50	41.2	4	BCDE	2116	4.940	695	22.0	1763	1972	399	41.2	235	104	243	970	1612
31	3.10	"	"	"	"	"	1128	29.6	"	"	"	"	"	"	"	"	"
41	3.50	47.5	5	BCDEF	2315	5.259	1461	34.1	1865	2216	355	47.5	186	169	242	967	1563
51	5.00	"	"	"	"	"	2607	53.0	"	"	"	"	"	"	"	"	"
61	7.00	50.7	6	BCDEFG	2448	5.368	4172	75.5	1884	2294	351	50.7	173	178	256	1022	1629
71	9.00	"	"	"	"	"	5730	96.6	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	8068	124.1	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	11.0	2	BC	841	1.315	-214	5.1	527	527	401	11.0	357	44	42	168	611
22	2.50	25.2	c	BCD	1393	3.121	194	21.1	1291	1291	414	25.2	310	104	133	534	1081
32	3.10	41.2	4	BCDE	2116	4.940	591	29.6	1763	1972	399	41.2	235	164	243	970	1612
42	3.50	"	"	"	"	"	795	34.7	"	"	"	"	"	"	"	"	"
52	5.00	47.5	5	BCDEF	2315	5.259	1623	53.0	1865	2216	355	47.5	186	169	242	967	1563
62	7.00	"	"	"	"	"	2704	76.3	"	"	"	"	"	"	"	"	"
72	9.00	50.7	6	BCDEFG	2448	5.368	3824	96.6	1884	2294	351	50.7	173	178	256	1022	1629
82	12.00	"	"	"	"	"	5477	124.1	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	11.0	2	BC	841	1.315	-256	5.1	527	527	401	11.0	357	44	42	168	611
23	2.50	25.2	3	BCD	1393	3.121	28	21.1	1291	1291	414	25.2	310	104	133	534	1081
33	3.10	41.2	4	BCDE	2116	4.940	294	29.6	1763	1972	399	41.2	235	164	243	970	1612
43	3.50	"	"	"	"	"	448	34.7	"	"	"	"	"	"	"	"	"
53	5.00	47.5	5	BCDEF	2315	5.259	1067	53.0	1865	2216	355	47.5	186	169	242	967	1563
63	7.00	"	"	"	"	"	1887	76.3	"	"	"	"	"	"	"	"	"
73	9.00	50.7	6	BCDEFG	2448	5.368	2730	96.6	1884	2294	351	50.7	173	178	256	1022	1629
83	12.00	"	"	"	"	"	3985	124.1	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 14-19

ECONOMICS SUMMARY

BASIN Piceance — TECHNOLOGY Advanced

SUB BASIN — FORMATION Corcoran Cozette — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1301211	1.50	47.5	5	BCDEF	1788	5.781	596	21.9	2216	2216	383	47.5	201	182	103	414	901
21	2.50	"	"	"	"	"	1627	42.6	"	"	"	"	"	"	"	"	"
31	3.10	50.7	6	BCDEFG	2057	6.165	2325	53.6	2294	2294	372	50.7	183	189	121	489	984
41	3.50	"	"	"	"	"	2763	61.6	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	4409	89.5	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	6603	122.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	8796	150.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	12087	188.5	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	41.2	4	BCDE	1572	5.150	218	21.4	1972	1972	383	41.2	225	158	83	332	798
22	2.50	47.5	5	BCDEF	1788	5.781	1009	42.6	2216	2216	383	47.5	201	182	103	414	901
32	3.10	"	"	"	"	"	1462	54.6	"	"	"	"	"	"	"	"	"
42	3.50	50.7	6	BCDEFG	2057	6.165	1824	61.6	2294	2294	372	50.7	183	189	121	489	984
52	5.00	"	"	"	"	"	3028	89.5	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	4634	122.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	6240	150.9	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	8650	188.5	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	41.2	4	BCDE	1572	5.150	38	21.4	1972	1972	383	41.2	225	158	83	332	798
23	2.50	47.5	5	BCOEF	1788	5.781	643	42.6	2216	2216	383	47.5	201	182	103	414	901
33	3.10	"	"	"	"	"	994	54.6	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	1229	62.3	"	"	"	"	"	"	"	"	"
53	5.00	50.7	6	BCDEFG	2057	6.165	2199	89.5	2294	2294	372	50.7	183	189	121	489	984
63	7.00	"	"	"	"	"	3447	122.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	4694	150.9	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	6565	188.5	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 14-20

GEOLOGICAL DATA SUMMARY

BASIN: Piceance
SUBBASIN: -
FORMATION: Mesaverde 8000

DEPTH (FT.): 8000
PRESSURE (PSIA): 3400
TEMPERATURE (°F): 170

TOTAL BASIN AREA (SECTIONS): 7100
TYPE: Lenticular

NGL(BBL/MMCF): 20.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	29	6.1	20	219	166	0.10	1.0	-
0.03	144	5.3	40	1889	1380	0.30	1.0	-
0.01	347	4.5	64	6187	4511	0.50	1.0	-
0.003	375	4.0	90	8355	5720	0.70	1.0	-
0.001	260	3.6	112	6490	4165	0.75	1.0	-
0.0003	173	3.1	130	4316	2565	0.80	1.0	-
0.0001	72	2.6	170	1970	1079	0.85	1.0	-
0.00003	43	2.1	200	1118	569	0.90	1.0	-
	1443			30544	20155			

TABLE 14-21

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, MESA VERDE 8000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		573	735	515	359	242	133	94	53	
2		214	324	266	186	126	71	50	28	
5		52	119	133	105	72	40	29	16	
10		11	45	73	71	48	27	19	11	
15		4	21	48	50	40	22	15	10	
20		1	12	35	44	34	19	14	7	
30		0	4	19	29	27	15	10	6	
30-YEAR CUMM. PROD. (MMCF)		1200	2180	2510	2200	1600	899	640	359	

TABLE 14-22

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, MESA VERDE 8000

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		693	832	622	454	375	215	153	84	
2		259	407	321	223	166	93	66	37	
5		62	180	161	121	92	53	38	21	
10		14	79	88	71	55	34	25	14	
15		4	44	59	49	42	23	20	12	
20		2	27	42	40	31	20	17	10	
30		0	12	24	25	21	13	13	8	
30-YEAR CUMM. PROD. (MMCF)		1460	3099	3040	2370	1880	1119	859	490	

TABLE 14-23

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Mesa Verde 8000

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	4.87	4	138	4.	4	166
.03	4.38	4	1256	3.08	3	1339
.01	5.17	4	3473	4.27	4	4240
.003	6.91	4	3318	6.41	6	5377
.001	10.01 *	4	1666	8.45	8	3957
.0003	16.39	4	616	13.19	12	2334
.0001	23.33	4	183	17.36	12	745
.00003	36.14	4	63	26.55	12	257
			10713			18415

* Example calculation for 0.001 md permeability
Max recoverable gas in place = 4165 BCF (Table 14-20)
Number of sections with permeability of 0.001 md = 260 (Table 14-20)
BCF/Section = 4165/260 = 16.02
Gas production = 1600 MMCF/year/well (Table 14-21)
Number of wells/section to produce all gas = $\frac{16.02 \times 1000}{1600}$ = 10.01 wells/section

Actual wells used = 4
Recoverable gas from actual wells = 4 x 1600 x 260/1000 = 1666 BCF

TABLE 14-24

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Mesa Verde 8000

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	588,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	163,000 - 921,000
- Advanced Case [2000/4000 Ft. Fracture]	323,000 - 1,692,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0311

TABLE 14-25

ECONOMICS SUMMARY

BASIN Piceance — TECHNOLOGY Base

SUB BASIN — FORMATION Mesa Verde 8000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1303111	1.50	16.2	2	CD	4703	7.635	-81	9.2	0	-	-	16.2	-	-	-	-	-
21	2.50	32.4	3	CDE	7308	13.127	2356	25.2	8047	11611	613	32.4	414	199	759	3035	4407
31	3.10	"	"	"	"	"	3718	33.5	"	"	"	"	"	"	"	"	"
41	3.50	46.5	5	BCDEF	11429	18.636	5553	37.1	9851	15942	528	46.5	283	246	1034	4136	5699
51	5.00	"	"	"	"	"	9999	57.2	"	"	"	"	"	"	"	"	"
61	7.00	56.6	6	BCDEFG	13170	19.886	16445	78.6	10467	18507	526	56.6	228	298	1175	4699	6400
71	9.00	56.6	6	"	"	"	22723	100.1	"	"	"	"	"	"	"	"	"
81	12.00	61.7	7	BCDEFGH	14167	20.320	32469	126.8	10650	19586	524	61.7	201	323	1237	4948	6709
Discount Rate 15%																	
12	1.50	16.2	2	CD	4703	7.635	-464	9.2	0	-	-	-	-	-	-	-	-
22	2.50	32.4	3	CDE	7308	13.127	1160	25.2	8047	11611	613	32.4	414	199	759	3035	4407
32	3.10	32.4	3	CDE	7308	"	2149	33.5	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	2808	38.7	"	"	"	"	"	"	"	"	"
52	5.00	46.5	5	BCDEF	11429	18.636	6402	57.2	9851	15942	528	46.5	283	246	1034	4136	5699
62	7.00	"	"	"	"	"	10632	80.8	"	"	"	"	"	"	"	"	"
72	9.00	56.6	6	BCDEFG	13170	19.886	15374	100.1	10467	18507	526	56.6	228	298	1175	4699	6400
82	12.00	"	"	"	"	"	22090	128.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	2.5	1	C	2336	1.481	-916	0	0	-	-	-	-	-	-	-	-
23	2.50	16.2	2	CD	4703	7.635	124	21.7	4729	5891	619	16.2	519	100	446	1785	2850
33	3.10	32.4	3	CDE	7308	13.127	1222	33.5	8047	11611	613	32.4	414	199	759	3035	4407
43	3.50	32.4	"	"	"	"	1729	38.7	"	"	"	"	"	"	"	"	"
53	5.00	46.5	5	BCDEF	11429	18.636	4322	57.2	9851	15942	528	46.5	283	246	1034	4136	5699
63	7.00	"	"	"	"	"	7542	80.8	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	10762	101.5	"	"	"	"	"	"	"	"	"
83	12.00	56.6	6	BCDEFG	13170	19.886	16196	128.4	10647	18507	526	56.6	228	298	1175	4699	6400

* CODE:

B	C	D	E	F	G	H	I
0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 14-26

ECONOMICS SUMMARY

BASIN Piceance — TECHNOLOGY Advanced

SUB BASIN — FORMATION Mesa Verde 8000' — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
130321 1	1.50	16.2	2	CD	5670	-	-160	8.7	0	-	0	16.2	-	-	-	-	-
21	2.50	32.4	3	CDE	11411	17.247	2916	23.8	10956	11611	618	32.4	418	200	928	3713	5259
31	3.10	"	"	"	"	"	4806	37.6	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	6066	38.3	"	"	"	"	"	"	"	"	"
51	5.00	46.5	5	BCDEF	24195	28.796	15403	58.0	15079	15942	524	46.5	280	243	1568	6273	8366
61	7.00	"	"	"	"	"	25316	87.4	"	"	"	"	"	"	"	"	"
71	9.00	56.6	6	BCDEFG	33478	33.268	38309	105.4	17413	18507	523	56.6	227	296	2053	8213	10789
81	12.00	61.7	7	BCDEFGH	38515	35.042	56610	136.9	18158	19586	518	61.7	198	320	2257	9029	11804
Discount Rate 15%																	
12	1.50	2.5	1	C	2689	-	-1077	0	0	-	-	2.5	-	-	-	-	-
22	2.50	16.2	2	CD	5670	8.956	609	20.8	5579	5891	623	16.2	522	101	424	1696	2743
32	3.10	32.4	3	CDE	11411	17.241	2727	32.6	10956	11611	618	32.4	418	200	928	3713	5259
42	3.50	"	"	"	"	"	3643	38.3	"	"	"	"	"	"	"	"	"
52	5.00	46.5	5	BCDEF	24195	28.796	9764	58.0	15079	15942	524	46.5	280	243	1568	6273	8366
62	7.00	"	"	"	"	"	16853	87.4	"	"	"	"	"	"	"	"	"
72	9.00	56.6	6	BCDEFG	33478	33.268	25700	105.4	17413	18507	523	56.6	227	296	2053	8213	10789
82	12.00	"	"	"	"	"	37940	143.7	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	2.5	1	C	2689	-	-1143	0	-	-	-	-	-	-	-	-	-
23	2.50	16.2	2	CD	5670	8.956	67	20.8	5579	5891	623	16.2	522	101	424	1696	2743
33	3.10	"	"	"	"	"	632	27.3	"	"	"	"	"	"	"	"	"
43	3.50	32.4	3	CDE	11411	17.247	2213	38.3	10956	11611	618	32.4	418	200	928	3713	5259
53	5.00	"	"	"	"	"	4857	58.4	"	"	"	"	"	"	"	"	"
63	7.00	46.5	5	BCDEF	24195	28.796	11904	87.4	15079	15942	524	46.5	280	243	1568	6273	8366
73	9.00	"	"	"	"	"	17292	113.6	"	"	"	"	"	"	"	"	"
83	12.00	56.6	6	BCDEFG	33478	33.268	27651	143.7	17413	18507	523	56.6	227	296	2053	8213	10789

* CODE:

B	C	D	E	F	G	H	I
0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 14-27

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 7100
TYPE: Blanket + Lenticular

NGL(BBL/MMCF): 20.

BASIN: Piceance
SUBBASIN: -
FORMATION: Corcoran-Cozette + Mesaverde

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	4	*	*	55.41	42	*	*	*
0.03	18			376.43	275			
0.01	43			1101.34	803			
0.003	47			1416.84	970			
0.001	32			1084.52	696			
0.0003	22			737.20	438			
0.0001	9			335.94	184			
0.00003	5			198.45	101			
	180			5306.	3509			

* Refer to individual formations for these data.

TABLE 14-28

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, MESA VERDE + CORCORAN-COZETTE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		772	934	714	558	441	332	293	252	
2		335	444	386	307	247	191	170	149	
5		132	199	213	185	152	121	110	97	
10		73	106	135	132	110	88	81	73	
15		56	72	101	103	93	75	68	63	
20		48	58	82	90	81	66	61	54	
30		39	44	59	69	66	54	49	45	
30-YEAR CUMM. PROD. (MMCF)		3079	4030	4389	4069	3480	2769	2519	2230	

TABLE 14-29

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, MESA VERDE + CORCORAN-COZETTE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		1208	1347	1137	968	890	730	668	599	
2		589	737	651	553	496	423	396	367	
5		278	395	376	336	307	268	253	237	
10		172	238	247	230	214	193	184	173	
15		137	176	191	182	175	156	153	144	
20		118	143	159	156	147	136	133	126	
30		94	106	118	119	115	108	107	102	
30-YEAR CUMM. PROD. (MMCF)		6259	7900	7840	7180	6680	5919	5669	5289	

TABLE 14-30

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Corcoran-Cozette + Mesa Verde

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	3.8	3.8	42	1.86	1.86	42
.03	3.8	3.8	275	1.93	1.93	275
.01	4.2	4.	758	2.37	2.37	803
.003	5.1	4.	762	2.89	2.89	970
.001	6.2	4.	451	3.21	3.21	696
.0003	7.3	4.	239	3.43	3.43	438
.0001	8.1	4.	91	3.61	3.61	184
.00003	8.4	4.	48	3.53	3.53	101
			2665			3509

TABLE 14-31

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Corcoran Cozette + Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	588,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	259,000 - 1,016,600
- Advanced Case (2000/4000 Ft. Fracture)	625,800 - 1,994,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0311

TABLE 14-32

ECONOMICS SUMMARY

BASIN Piceance

SUB BASIN

FORMATION Corcoran Cozette Mesa Verde

TECHNOLOGY Base

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PR.CD.	WELLS: TOTAL
Discount Rate 10%																	
13041 11	1.50	32.4	3	CDE	2410	5.676	100	11.3	1795	2048	316	32.4	214	102	64	256	635
21	2.50	56.6	6	BCDEFG	4254	11.609	2127	30.5	2526	3224	218	56.6	95	123	107	429	754
31	3.10	"	"	"	"	"	3145	40.7	"	"	"	"	"	"	"	"	"
41	3.50	61.7	7	BCDEFGH	4318	11.881	3925	48.2	2617	3408	220	61.7	84	136	110	440	770
51	5.00	64.4	8	BCDEFGHI	4325	11.970	6587	73.7	2665	3509	223	64.4	79	144	112	446	781
61	7.00	"	"	"	"	"	10084	104.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	13580	131.6	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	18826	167.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	16.2	2	CD	2039	3.491	-391	6.7	-	-	-	16.2	-	-	-	-	-
22	2.50	46.5	5	BCDEF	3828	10.341	1020	29.6	2288	2786	221	46.5	118	103	95	380	696
32	3.10	56.6	6	BCDEFG	4254	11.609	1894	40.7	2526	3224	218	56.6	95	123	107	429	754
42	3.50	"	"	"	"	"	2388	47.5	"	"	"	"	"	"	"	"	"
52	5.00	64.4	8	BCDEFGHI	4325	11.970	4400	73.7	2665	3509	223	64.4	79	144	112	446	781
62	7.00	"	"	"	"	"	6950	104.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	9500	131.6	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	13326	167.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.2	2	CD	2039	3.491	-503	6.7	-	-	-	16.2	-	-	-	-	-
23	2.50	32.4	3	CDE	2410	5.676	192	24.5	1795	2048	316	32.4	214	102	64	256	635
33	3.10	46.5	5	BCDEF	3828	10.341	1041	39.3	2288	2786	221	46.5	118	103	95	380	696
43	3.50	"	"	"	"	"	1388	45.6	"	"	"	"	"	"	"	"	"
53	5.00	61.7	7	BCDEFGH	4318	11.881	3100	73.1	2617	3408	220	61.7	84	136	110	440	770
63	7.00	64.4	8	BCDEFGHI	4325	11.970	5126	104.2	2665	3509	223	64.4	79	144	112	446	781
73	9.00	"	"	"	"	"	7117	131.6	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	10103	167.6	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G	H	I
0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 14-33

ECONOMICS SUMMARY,

BASIN Piceance

SUB BASIN

FORMATION Corcoran Cozette+Mesa Verde

TECHNOLOGY Advanced

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1304211	1.50	46.5	5	BCDEF	4958	12.596	898	17.1	2786	2786	221	46.5	118	103	71	284	576
21	2.50	64.4	8	BCDEFGHI	5949	15.372	4000	39.6	3509	3509	228	64.4	81	147	92	368	687
31	3.10	"	"	"	"	"	5662	52.6	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	6770	61.3	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	10926	92.6	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	16467	130.9	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	22008	165.3	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	30320	211.1	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	32.4	3	CDE	2972	6.529	-210	11.8	-	-	-	32.4	-	-	-	-	-
22	2.50	56.6	6	BCDEFG	5625	14.449	2232	38.4	3224	3224	223	56.6	97	126	85	338	645
32	3.10	64.4	8	BCDEFGHI	5949	15.372	3666	52.6	3509	3509	228	64.4	81	147	92	368	687
42	3.50	"	"	"	"	"	4489	61.3	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	7575	92.6	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	11689	130.9	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	15804	165.3	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	21975	211.1	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	16.2	2	CD	2556	3.805	-715	5.6	-	-	-	16.2	-	-	-	-	-
23	2.50	46.5	5	BCDEF	4958	12.596	1095	35.7	2786	2786	221	46.5	118	103	71	284	576
33	3.10	56.6	6	BCDEFG	5625	14.449	2269	50.8	3224	3224	223	56.6	97	126	85	338	645
43	3.50	61.7	7	BCDEFGH	5853	15.091	3048	60.6	3408	3408	226	61.7	87	139	89	358	673
53	5.00	64.4	8	BCDEFGHI	5949	15.372	5555	92.6	3509	3509	228	64.4	81	147	92	368	687
63	7.00	"	"	"	"	"	8794	130.9	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	12032	165.3	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	16890	211.1	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G	H	I
0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 14-34

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 7100
TYPE: Lenticular

NGL(BBL/MMCF): 20.

BASIN: Piceance
SUBBASIN: -
FORMATION: Fort Union + Mesaverde

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	2	*	*	31.66	24	*	*	*
0.03	10			217.65	159			
0.01	24			639.14	466			
0.003	27			825.28	565			
0.001	18			631.08	405			
0.0003	12			429.08	255			
0.0001	5			195.36	107			
0.00003	3			115.93	59			
	101			3085.	2040			

* Refer to individual formations for these data.

TABLE 14-35

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, FORT UNION + MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		708	870	650	494	377	267	228	188	
2		284	394	335	256	196	140	119	98	
5		90	157	171	143	110	79	68	55	
10		36	69	98	95	73	51	44	36	
15		23	39	68	69	59	41	35	29	
20		16	27	50	59	49	34	29	22	
30		11	15	30	40	37	26	21	16	
30-YEAR CUMM. PROD. (MMCF)		2000	2959	3310	3000	2400	1689	1439	1159	

TABLE 14-36

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, FORT UNION + MESA VERDE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		864	1003	794	625	546	386	324	255	
2		344	492	406	307	251	178	151	122	
5		110	227	208	168	139	100	85	68	
10		43	109	118	101	85	64	55	44	
15		27	67	81	72	65	46	43	34	
20		19	44	60	57	48	37	34	27	
30		12	24	35	36	33	25	24	20	
30-YEAR CUMM. PROD. (MMCF)		2420	4060	4000	3329	2840	2069	1820	1450	

TABLE 14-37

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Fort Union + Mesa Verde

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	5.93	4	16	2.42	2.42	24
.03	5.32	4	120	3.88	3.88	159
.01	5.81	4	321	4.81	4.81	466
.003	7.18	4	315	6.46	6.46	565
.001	9.27	4	175	7.85	7.85	405
.0003	12.42	4	82	10.14	10.14	255
.0001	14.68	4	29	11.64	11.64	107
.00003	16.85	4	14	13.45	12.	53
			1072			2034

TABLE 14-38

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Fort Union + Mesa Verde

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	588,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	330,000 - 1,088,000
- Advanced Case [2000/4000 Ft. Fracture]	561,000 - 1,929,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0311

TABLE 14-39

ECONOMICS SUMMARY

BASIN Piceance
SUB BASIN
FORMATION Ft. Union + Mesa Verde
TECHNOLOGY Base
DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
13051 11	1.50	16.5	3	CDE	1989	2.264	-428	2.2	-	-	-	16.5	-	-	-	-	-
21	2.50	47.7	5	BCDEF	3450	6.137	872	21.1	947	1619	154	47.7	81	73	52	207	413
31	3.10	"	"	"	"	"	1513	29.7	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	1940	35.5	"	"	"	"	"	"	"	"	"
51	5.00	56.7	6	BCDEFG	3613	6.517	3772	59.2	1029	1874	158	56.7	68	90	57	227	442
61	7.00	64.2	8	BCDEFGHI	3702	6.704	6215	89.1	1072	2040	160	64.2	57	103	59	236	455
71	9.00	"	"	"	"	"	8543	115.6	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	12037	151.1	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	16.4	2	CD	1981	2.246	-540	2.1	-	-	-	16.4	-	-	-	-	-
22	2.50	33.3	4	BCDE	2297	3.626	125	17.7	772	1214	213	33.3	142	71	35	138	386
32	3.10	47.7	5	BCDEF	3450	6.137	847	29.7	947	1619	154	47.7	81	73	52	207	413
42	3.50	"	"	"	"	"	1173	35.5	"	"	"	"	"	"	"	"	"
52	5.00	56.7	6	BCDEFG	3613	6.517	2561	59.2	1029	1874	158	56.7	68	90	57	227	442
62	7.00	61.7	7	BCDEFGH	3643	6.630	4380	88.9	1058	1981	160	61.7	61	99	58	232	450
72	9.00	64.2	8	BCDEFGHI	3702	6.704	6202	115.6	1072	2040	160	64.2	57	103	59	236	455
82	12.00	"	"	"	"	"	8871	151.1	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	2.2	1	C	1472	.212	-782	0	-	-	-	2.2	-	-	-	-	-
23	2.50	33.3	4	BCDE	2297	3.626	-82	17.7	-	-	-	33.3	-	-	-	-	-
33	3.10	"	"	"	"	"	182	24.9	772	1214	213	"	142	71	35	138	386
43	3.50	47.7	5	BCDEF	3450	6.137	709	35.5	947	1619	154	47.7	81	73	52	207	413
53	5.00	"	"	"	"	"	1695	57.1	"	"	"	"	"	"	"	"	"
63	7.00	56.7	6	BCDEFG	3613	6.517	3215	87.5	1029	1874	158	56.7	68	90	57	227	442
73	9.00	61.7	7	BCDEFGH	3643	6.630	4707	115.2	1058	1981	160	61.7	61	99	58	232	450
83	12.00	64.2	8	BCDEFGHI	3702	6.704	6910	151.1	1072	2040	160	64.2	57	103	59	236	455

* CODE:

B	C	D	E	F	G	H	I
0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 14-40

ECONOMICS SUMMARY

BASIN Piceance
SUB BASIN
FORMATION Ft. Union + Mesa Verde
TECHNOLOGY Advanced
DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
13052 11	1.50	16.4	2	CD	2957	3.085	-525	2.5	-	-	-	16.4	-	-	-	-	-
21	2.50	33.3	4	BCDE	4265	5.770	1021	21.2	1214	1214	210	33.3	140	70	67	268	545
31	3.10	47.7	5	BCDEF	8313	10.850	3168	33.0	1619	1619	149	47.7	78	71	109	437	696
41	3.50	"	"	"	"	"	4091	40.4	"	"	"	"	"	"	"	"	"
51	5.00	56.7	6	BCDEFG	9850	12.149	8231	67.2	1874	1874	154	56.7	67	87	134	536	824
61	7.00	61.7	7	BCDEFGH	10587	12.696	13819	104.8	1981	1981	156	61.7	60	96	145	579	880
71	9.00	64.2	8	BCDEFGHI	11010	12.959	19455	141.4	2034	2040	157	64.2	56	101	151	604	911
81	12.00	"	"	"	"	"	27702	144.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	16.4	2	CD	2957	3.085	-695	2.5	-	-	-	16.4	-	-	-	-	-
22	2.50	33.3	4	BCDE	4265	5.770	441	21.2	1214	1214	210	33.3	140	70	67	268	545
32	3.10	"	"	"	"	"	1055	30.2	"	"	"	"	"	"	"	"	"
42	3.50	47.7	5	BCDEF	8313	10.850	2576	40.4	1619	1619	149	47.7	78	71	109	437	696
52	5.00	"	"	"	"	"	5248	69.1	"	"	"	"	"	"	"	"	"
62	7.00	56.7	6	BCDEFG	9850	12.149	9678	106.7	1874	1874	154	56.7	67	87	134	536	824
72	9.00	61.7	7	BCDEFGH	10587	12.696	14117	143.1	1981	1981	156	61.7	60	96	145	579	880
82	12.00	64.2	8	BCDEFGHI	11010	12.959	20644	194.4	2034	2040	157	64.2	56	101	151	604	911
Discount Rate 20%																	
13	1.50	2.2	1	C	1986	.288	-1043	0	-	-	-	2.2	-	-	-	-	-
23	2.50	16.5	3	CDE	2970	3.110	-326	12.9	-	-	-	16.5	-	-	-	-	-
33	3.10	33.3	4	BCDE	4265	5.770	575	30.2	1214	1214	210	33.3	140	70	67	268	545
43	3.50	"	"	"	"	"	911	36.2	"	"	"	"	"	"	"	"	"
53	5.00	47.7	5	BCDEF	8313	10.850	3794	69.1	1619	1619	149	47.7	78	71	109	437	696
63	7.00	56.7	6	BCDEFG	9850	12.149	7307	106.7	1874	1874	154	56.7	67	87	134	536	824
73	9.00	61.7	7	BCDEFGH	10587	12.696	10862	143.1	1981	1981	156	61.7	60	96	145	579	880
83	12.00	64.2	8	BCDEFGHI	11010	12.959	16121	194.4	2034	2040	157	64.2	56	101	151	604	911

* CODE:

S	C	D	E	F	G	H	I
0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 14-41

GEOLOGICAL DATA SUMMARY

BASIN: Piceance
SUBBASIN: -
FORMATION: Fort Union + Corcoran Cozette

DEPTH (FT.): *
PRESSURE (PSIA): *
TEMPERATURE (°F): *

TOTAL BASIN AREA (SECTIONS): 7100
TYPE: Lenticular + Blanket

NGL(BBL/MMCF): 20.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.1	3	*	*	37.01	31	*	*	*
0.03	11			154.28	121			
0.01	17			269.01	198			
0.003	14			244.94	169			
0.001	5			88.90	58			
0.0003	2			31.67	19			
	51			826.	596			

* Refer to individual formations for these data.

TABLE 14-42

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, FORT UNION + CORCORAN COZETTE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		488	405	345	276	233	192			
2		313	240	195	148	123	101			
5		214	155	119	90	70	56			
10		155	117	86	62	47	37			
15		124	99	73	51	39	30			
20		97	87	64	43	33	24			
30		72	69	54	35	25	18			
30-YEAR CUMM. PROD. (MMCF)		4439	3569	2750	1979	1560	1219			

TABLE 14-43

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, FORT UNION + CORCORAN COZETTE

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1		720	792	724	633	516	388			
2		460	517	441	356	280	204			
5		304	339	283	214	163	116			
10		224	250	202	149	111	78			
15		185	204	168	122	92	62			
20		152	176	145	106	78	51			
30		120	137	117	85	61	39			
30-YEAR CUMM. PROD. (MMCF)		6610	7419	6229	4740	3590	2510			

TABLE 14-44

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Fort Union + Corcoran Cozette

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.1	2.28	2.28	31	1.53	1.53	31
.03	3.02	3.02	121	1.45	1.45	121
.01	4.28	4.	185	1.89	1.89	198
.003	6.21	4.	109	2.59	2.59	169
.001	8.09	4.	29	3.52	3.52	58
.0003	10.19	4.	7	4.94	4.94	19
			482			596

TABLE 14-45

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Fort Union + Corcoran Cozette

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	375,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	277,700 - 309,200
- Advanced Case (2000/4000 Ft. Fracture)	353,300 - 741,100
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0311

TABLE 14-46

ECONOMICS SUMMARY

BASIN Piceance
SUB BASIN
FORMATION Ft. Union+Corcoran Cozette
TECHNOLOGY Base
DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
13061 11	1.50	24.7	3	BCD	1859	5.049	195	13.3	337	350	67	24.7	50	17	20	81	168
21	2.50	48.6	5	BCDEF	2465	7.289	1471	31.4	475	577	65	48.6	33	32	31	124	219
31	3.10	51.7	6	BCDEFG	2606	7.568	2195	40.9	482	596	64	51.7	31	33	33	132	228
41	3.50	"	"	"	"	"	2652	47.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	4367	68.4	"	"	"	"	"	"	"	"	"
61	7.00	"	"	"	"	"	6653	93.2	"	"	"	"	"	"	"	"	"
71	9.00	"	"	"	"	"	8940	114.8	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	12370	142.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	24.7	3	BCD	1859	5.049	-71	13.3	-	-	-	24.7	-	-	-	-	-
22	2.50	48.6	5	BCDEF	2465	7.289	805	31.4	475	577	65	48.6	33	32	31	124	219
32	3.10	51.7	6	BCDEFG	2606	7.568	1315	40.9	482	596	64	51.7	31	33	33	132	228
42	3.50	"	"	"	"	"	1642	47.1	"	"	"	"	"	"	"	"	"
52	5.00	"	"	"	"	"	2869	68.4	"	"	"	"	"	"	"	"	"
62	7.00	"	"	"	"	"	4504	93.2	"	"	"	"	"	"	"	"	"
72	9.00	"	"	"	"	"	6139	114.8	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	8592	142.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	10.6	2	BC	1435	3.024	-307	9.1	-	-	-	10.6	-	-	-	-	-
23	2.50	41.7	4	BCDE	2352	6.908	388	30.5	446	519	65	41.7	38	27	29	115	209
33	3.10	48.6	5	BCDEF	2465	7.289	789	40.7	475	577	65	48.6	33	32	31	124	219
43	3.50	"	"	"	"	"	1029	46.7	"	"	"	"	"	"	"	"	"
53	5.00	51.7	6	BCDEFG	2606	7.568	2000	68.4	482	596	64	51.7	31	33	33	132	228
63	7.00	"	"	"	"	"	3250	93.2	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	4500	114.8	"	"	"	"	"	"	"	"	"
83	12.00	"	"	"	"	"	6374	142.9	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 14-47

ECONOMICS SUMMARY,

BASIN Piceance

SUB BASIN

FORMATION Ft. Union+Corcoran Cozette

TECHNOLOGY Advanced

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																
13062 11	1.50	48.6	5 BCDEF	2321	8.321	972	24.7	577	577	69	48.6	35	34	17	67	156
21	2.50	51.7	6 BCDEFG	2635	8.910	2581	46.7	596	596	67	51.7	32	35	21	82	170
31	3.10	"	" "	"	"	3530	59.6	"	"	"	"	"	"	"	"	"
41	3.50	"	" "	"	"	4163	67.7	"	"	"	"	"	"	"	"	"
51	5.00	"	" "	"	"	6535	96.0	"	"	"	"	"	"	"	"	"
61	7.00	"	" "	"	"	9699	128.8	"	"	"	"	"	"	"	"	"
71	9.00	"	" "	"	"	12862	157.5	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	17607	195.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	41.7	4 BCDE	2091	7.482	386	23.3	519	519	69	41.7	40	29	14	58	141
22	2.50	51.7	6 BCDEFG	2635	8.910	1638	46.7	596	596	67	51.7	32	35	21	82	170
32	3.10	"	" "	"	"	2336	59.6	"	"	"	"	"	"	"	"	"
42	3.50	"	" "	"	"	2801	67.7	"	"	"	"	"	"	"	"	"
52	5.00	"	" "	"	"	4547	96.0	"	"	"	"	"	"	"	"	"
62	7.00	"	" "	"	"	6874	128.8	"	"	"	"	"	"	"	"	"
72	9.00	"	" "	"	"	9201	157.5	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	12692	195.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	41.7	4 BCDE	2091	7.482	121	23.3	519	519	69	41.7	40	29	14	58	141
23	2.50	48.6	5 BCDEF	2321	8.321	1021	46.5	577	577	69	48.6	35	34	17	67	156
33	3.10	51.7	6 BCDEFG	2635	8.910	1620	59.6	596	596	67	51.7	32	35	21	82	170
43	3.50	"	" "	"	"	1983	67.7	"	"	"	"	"	"	"	"	"
53	5.00	"	" "	"	"	3344	96.0	"	"	"	"	"	"	"	"	"
63	7.00	"	" "	"	"	5159	128.8	"	"	"	"	"	"	"	"	"
73	9.00	"	" "	"	"	6974	157.5	"	"	"	"	"	"	"	"	"
83	12.00	"	" "	"	"	9696	195.4	"	"	"	"	"	"	"	"	"

* CODE:

B	C	D	E	F	G
0.1	0.03	0.01	0.003	0.001	0.0003

TABLE 14-48

GEOLOGICAL DATA SUMMARY

BASIN: Piceance
SUBBASIN: -
FORMATION: Lower Cret. & Jurassic

DEPTH (FT.): 7000
PRESSURE (PSIA): 2900
TEMPERATURE (°F): 158

TOTAL BASIN AREA (SECTIONS): 7100
TYPE: Lenticular

NGL(BBL/MMCF): 20.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	32	6.0	7	74	64	0.15	1.0	-
0.1	71	5.4	11	232	191	0.30	1.0	-
0.03	214	4.8	17	962	746	0.40	1.0	-
0.01	188	4.4	21	957	699	0.45	1.0	-
0.003	104	3.9	28	626	428	0.50	1.0	-
0.001	37	3.5	35	250	160	0.55	1.0	-
	646			3101	2288			

* Refer to individual formations for these data.

TABLE 14-49

WELL PRODUCTION SUMMARY--BASE CASE

PICEANCE, LOWER CRETACEOUS + JURRASIC

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	293	299	237	169	99	64				
2	50	100	111	85	51	33				
5	5	20	44	44	29	19				
10	0	5	16	23	19	13				
15	0	1	8	15	15	10				
20	0	0	4	9	12	9				
30	0	0	1	5	8	7				
30-YEAR CUMM. PROD. (MMCF)	390	570	760	780	620	429				

TABLE 14-50

WELL PRODUCTION SUMMARY--ADVANCED CASE

PICEANCE, LOWER CRETACEOUS + JURRASIC

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	354	369	287	196	136	100				
2	61	149	143	101	64	44				
5	6	41	63	56	33	25				
10	0	11	28	32	20	16				
15	0	4	16	23	15	11				
20	0	1	9	17	10	9				
30	0	0	4	10	6	5				
30-YEAR CUMM. PROD. (MMCF)	470	850	1100	1049	679	519				

TABLE 14-51

PRODUCTION WELL REQUIREMENTS

BASIN: Piceance
SUB-BASIN: -
FORMATION: Lower Cret. & Jurassic

PERM. (MD)	BASE CASE			ADVANCED CASE		
	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	5.13	4	49	4.25	4.25	64
.1	4.72	4	162	3.16	3.16	191
.03	4.59	4	656	3.17	3.17	746
.01	4.77	4	587	3.54	3.54	699
.003	6.64	4	257	6.06	6.06	428
.001	10.08	4	64	8.33	8.33	160
			1775			2288

TABLE 14-52

INVESTMENT AND OPERATING EXPENSES

BASIN: Piceance
SUB-BASIN: -
FORMATION: Lower Cret. & Jurassic

Geology and Geophysics ($/Prospect)	20,000
Drilling Cost ($/Well)	469,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	155,000
- Advanced Case [2000/4000 Ft. Fracture]	308,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0303

TABLE 14-53

ECONOMICS SUMMARY

BASIN Piceance — TECHNOLOGY Base

SUB BASIN — FORMATION Lower Cretaceous & Jurassic — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1307111	1.50	0	0	-	780	-	-451	0	-	-	-	-	-	-	-	-	-
21	2.50	0	0	-	"	-	-451	0	-	-	-	-	-	-	-	-	-
31	3.10	29.6	3	BCD	5269	4.510	576	18.7	1405	1636	312	29.6	220	92	423	1692	2427
41	3.50	"	"	"	"	"	978	24.6	"	"	"	"	"	"	"	"	"
51	5.00	39.0	5	ABCDE	6616	5.684	2831	45.1	1711	2128	301	39.0	184	117	530	2122	2953
61	7.00	42.2	6	ABCDEF	6928	5.925	5296	72.0	1775	2288	300	42.2	173	127	557	2228	3085
71	9.00	"	"	"	"	"	7755	96.9	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	11443	128.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	780	-	-452	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0	-	780	-	-452	0	-	-	-	-	-	-	-	-	-
32	3.10	13.3	1	C	2816	-	-69	12.8	-	-	-	-	-	-	-	-	-
42	3.50	16.7	2	BC	3405	2.472	212	20.9	818	937	331	16.7	276	55	262	1050	1643
52	5.00	30.7	4	ABCD	5454	4.601	1721	47.3	1454	1700	316	30.7	219	97	446	1784	2546
62	7.00	39.0	5	ABCDE	6616	5.684	3698	73.3	1711	2128	301	39.0	184	117	530	2122	2953
72	9.00	42.2	6	ABCDEF	6928	5.925	5613	96.9	1775	2288	300	42.2	173	127	557	2228	3085
82	12.00	"	"	"	"	"	8440	128.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	780	-	-453	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	780	-	-453	0	-	-	-	-	-	-	-	-	-
33	3.10	0	0	-	780	-	-453	0	-	-	-	-	-	-	-	-	-
43	3.50	16.7	2	BC	3405	2.472	28	20.9	818	937	331	16.7	276	55	262	1050	1643
53	5.00	30.7	4	ABCD	5454	4.601	1172	47.3	1454	1700	316	30.7	219	97	446	1784	2546
63	7.00	39.0	5	ABCDE	6616	5.684	2698	73.3	1711	2128	301	39.0	184	117	530	2122	2953
73	9.00	"	"	"	"	"	4164	97.7	"	"	"	"	"	"	"	"	"
83	12.00	42.2	6	ABCDEF	6928	5.925	6462	128.2	1775	2288	300	42.2	173	127	557	2228	3085

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

TABLE 14-54

ECONOMICS SUMMARY

BASIN Piceance
SUB BASIN
FORMATION Lower Cretaceous and Jurassic
TECHNOLOGY Advanced
DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1307211	1.50	0	0	-	934	0	-538	0	-	-	-	-	-	-	-	-	-
21	2.50	13.3	1	C	2748	0	-147	6.8	-	-	-	13.3	-	-	-	-	-
31	3.10	29.6	3	BCD	5004	4.897	699	19.2	1636	1636	334	29.6	235	99	333	1332	1999
41	3.50	"	"	"	"	"	1097	24.5	"	"	"	"	"	"	"	"	"
51	5.00	39.0	5	ABCDE	7437	6.585	3171	42.4	2128	2128	323	39.0	197	126	515	2059	2897
61	7.00	42.2	6	ABCDEF	8238	7.036	6031	67.3	2288	2288	325	42.2	188	137	582	2328	3235
71	9.00	"	"	"	"	"	8850	92.2	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	13079	124.2	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	-	934	0	-537	0	-	-	-	-	-	-	-	-	-
22	2.50	0	0	-	"	0	-537	0	-	-	-	-	-	-	-	-	-
32	3.10	16.7	2	BC	3278	2.702	49	16.2	937	937	347	16.7	289	58	200	797	1344
42	3.50	"	"	"	"	"	242	20.8	"	"	"	"	"	"	"	"	"
52	5.00	30.7	4	ABCD	5226	5.004	1746	45.0	1700	1700	340	30.7	236	104	358	1430	2128
62	7.00	39.0	5	ABCDE	7437	6.585	4026	69.4	2128	2128	323	39.0	197	126	515	2059	2897
72	9.00	42.2	6	ABCDEF	8238	7.036	6271	92.2	2288	2288	325	42.2	188	137	582	2328	3235
82	12.00	"	"	"	"	"	9475	124.2	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	934	0	-536	0	-	-	-	-	-	-	-	-	-
23	2.50	0	0	-	934	0	-536	0	-	-	-	-	-	-	-	-	-
33	3.10	3.4	1	B	1464	0	-436	0	-	-	-	3.4	-	-	-	-	-
43	3.50	16.7	2	BC	3278	2.702	30	20.8	937	937	347	16.7	289	58	200	797	1344
53	5.00	30.7	4	ABCD	5226	5.004	1160	45.0	1700	1700	340	30.7	236	104	358	1430	2128
63	7.00	39.0	5	ABCDE	7437	6.585	2882	69.4	2128	2128	323	39.0	197	126	515	2059	2897
73	9.00	42.2	6	ABCDEF	8238	7.036	4625	92.2	2288	2288	325	42.2	188	137	582	2328	3235
83	12.00	"	"	"	"	"	7157	124.2	"	"	"	"	"	"	"	"	"

* CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001

Chapter Fifteen

DENVER BASIN

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In addition, each subbasin within the basin has a series of these specific tables:

- Geological Data Summary
- Well Production Summary -- Base Case
- Well Production Summary -- Advanced Case
- Production Well Requirements
- Investment and Operating Expenses
- Economics Summary -- Base Case
- Economics Summary -- Advanced Case

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Chapter Fifteen

DENVER BASIN
LOWER CRETACEOUS
J-SANDSTONE
TIGHT RESERVOIR GAS POTENTIAL

GEOLOGY

General Description

The Denver Basin is located in eastern Colorado, southeastern Wyoming and southwestern Nebraska (Figure 15-1). The area of the basin is about 45,000 square miles. It is an asymetrical structural depression formed during the Laramide orogeny late in the Cretaceous Period and early in the Tertiary Period. The structural axis is located near the western flank of the Basin, sub-parallel to the Front Range of the Central Rocky Mountains (Figure 15-2). Wattenburg Field, a big gas and condensate producer from the Lower Cretaceous J-SS, is a stratigraphic trap in the deep part of the Basin astride the structural axis between Greeley and Denver. Area A surrounding Wattenburg has the greatest tight reservoir potential for gas in the Denver Basin.

In addition to the Front Range, other bounding uplifts for the Denver Basin, listed clockwise from the Front Range, are the Laramie Range (northwest), Hartville Uplift (north), Chadron Arch and Cambridge Arch (northeast), Yuma Uplift (east), Los Animas Arch (southeast), Apishapa Uplift (south), and Wet Mountains Uplift (southwest).

Surface rocks are dominantly Late Cretaceous and Cenozoic in age. The Denver Basin is unique among Rocky Mountain basins in that a large area across the structural axis has been deeply dissected into Upper Cretaceous rocks, particularly through the hottest, deepest central part of the Basin from Denver to near the Wyoming line. It is in this anomalous area of high heat flow that Wattenburg Field and most of the remaining Cretaceous tight-reservoir gas prospects are situated. Surface cover in almost all of the Wyoming- and Nebraska-parts of the Basin, as well as in some of the southern one-third in Colorado, is comprised of sedimentary rock and sediment representing the various Tertiary and Quaternary stages.

The subsurface stratigraphic section includes all geological systems except the Silurian. The maximum thickness of sedimentary rock exceeds 12,000 feet, the section being dominated by the Cretaceous, Permian and Pennsylvanian Systems.

Maps

Figure 15-1. Rocky Mountain region map showing location of Denver Basin and Wattenberg area.

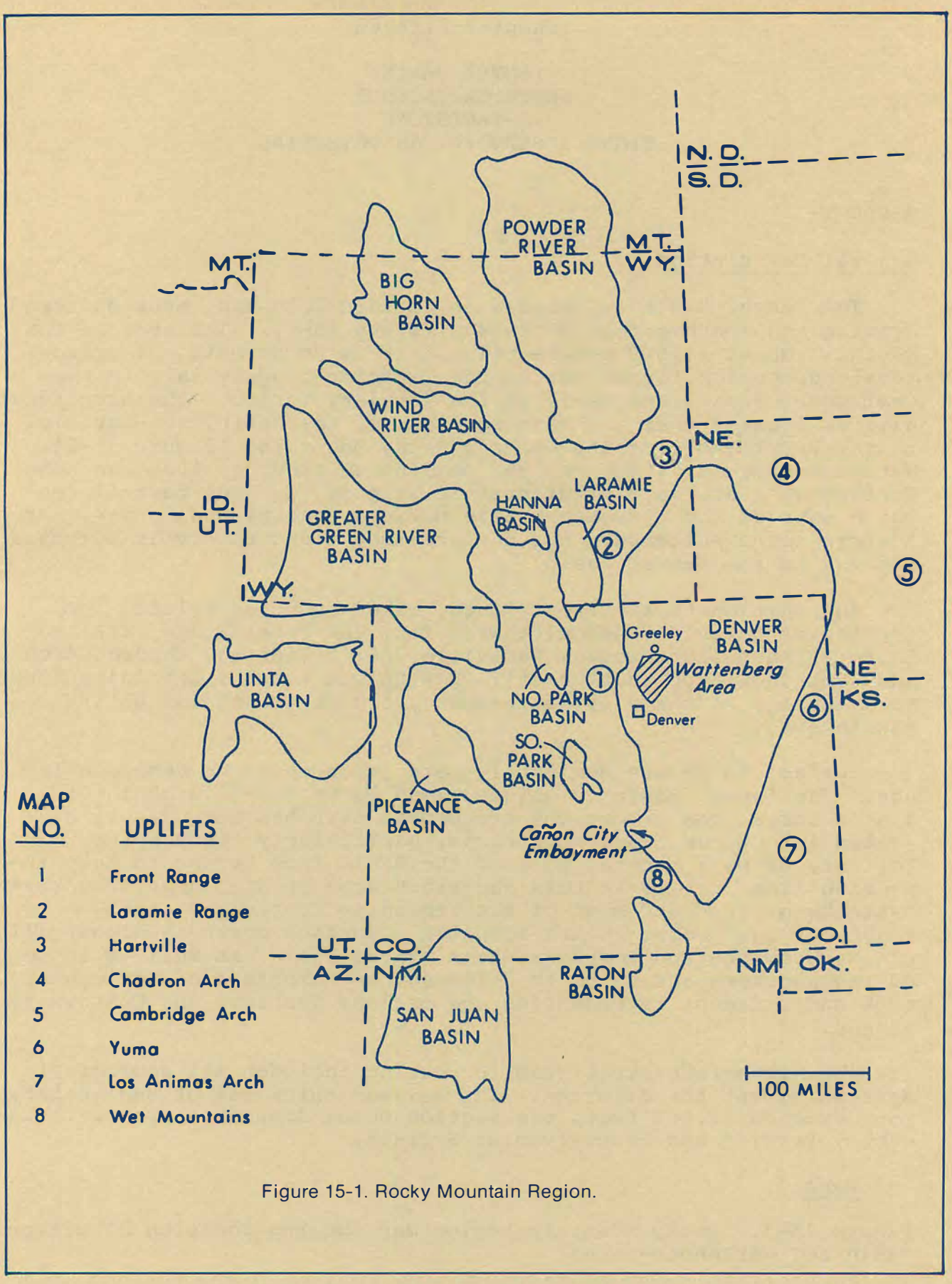


Figure 15-1. Rocky Mountain Region.

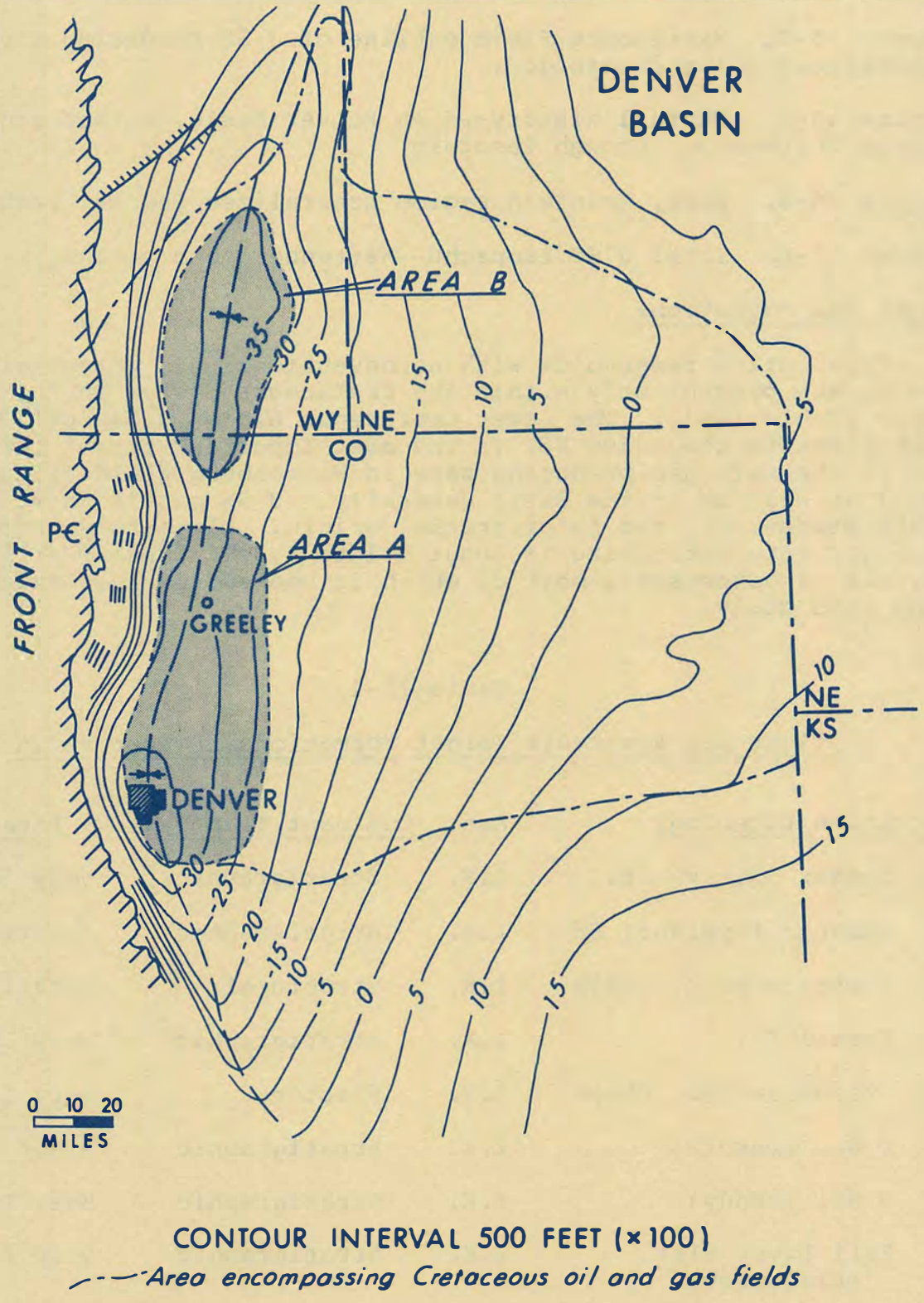


Figure 15-2. Structure Top Lower Cretaceous -- Contour Interval 500 Feet (x100).

Figure 15-2. Denver Basin structure on Lower Cretaceous, and outlines of prospective tight reservoir gas-bearing areas A and B.

Figure 15-3. Wattenberg Field outline of J SS producing area, and generalized columnar section.

Figure 15-4. Thermal history--deep Denver Basin, Wattenberg area; latest Cretaceous through Cenozoic.

Figure 15-5. Rocky Mountain region generalized thermal trends.

Figure 15-6. Total J SS isopachs--Wattenberg and vicinity.

Tight Gas Formations

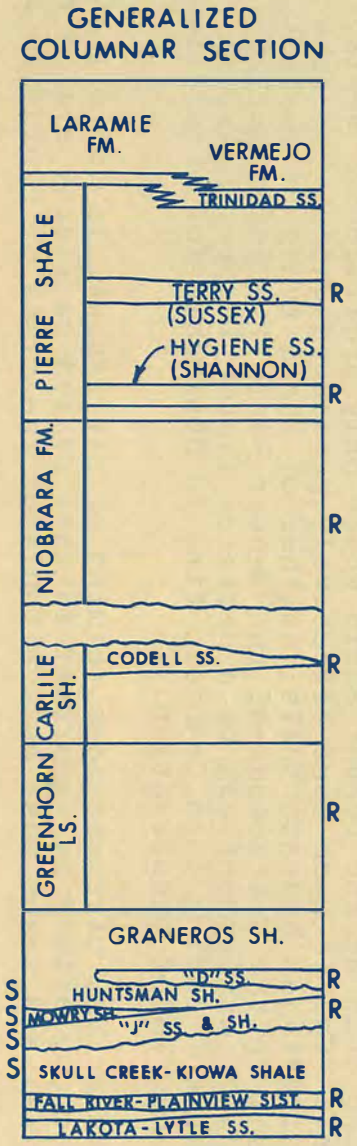
Prospective reservoirs with unconventional gas potential evidently are present only within the Cretaceous System in the Denver Basin (Table 15-1). The Lower Cretaceous Albian J Sandstone (SS), equivalent to the Muddy SS, is the most important target formation and is the main gas-producing zone in Wattenberg Field (Figure 15-3) as well as in the Basin generally. J SS gas is rated at 1,150 Btu/cu. ft. and is of thermal origin. Ultimately, recoverable gas from Wattenberg is about 1.1 to 1.3 TCF and 30 million barrels of condensate, most of which is booked reserves excluded from this study.

Table 15-1

Tight Gas Reservoir Target Formations, Denver Basin

Formation/Lithology	Age	Dominant Trap Type	Potential
1. Sussex (Terry) SS.	L.K.	Stratigraphic	Very Limited
2. Shannon (Hygiene) SS.	L.K.	Stratigraphic	Limited
3. Niobrara Marl, Chalk	L.K.	Structural	Locally Good
4. Codell SS.	L.K.	Stratigraphic	Very Limited
5. Greenhorn Ls., Chalk	L.K.	Fractures	Very Limited
6. D SS. (Dakota)	L.K.	Stratigraphic	Minor
7. J SS. (Muddy)	E.K.	Stratigraphic	Main Producer
8. Fall River Slst. (Plainview)	E.K.	Stratigraphic	Very Limited
9. Lakota-Lytle SS.	E.K.	Structural	Limited

Late Cretaceous - L.K.
Early Cretaceous - E.K.



Outline of Wattenberg J-SS (Lower Cretaceous) producing area as defined by 500 mcf/day I. P. Tight-gas-sandstone prospective area surrounds "conventional" accumulation.

R - Known & potential tight-gas-reservoirs
S - Source rocks for thermal gas in J ss.

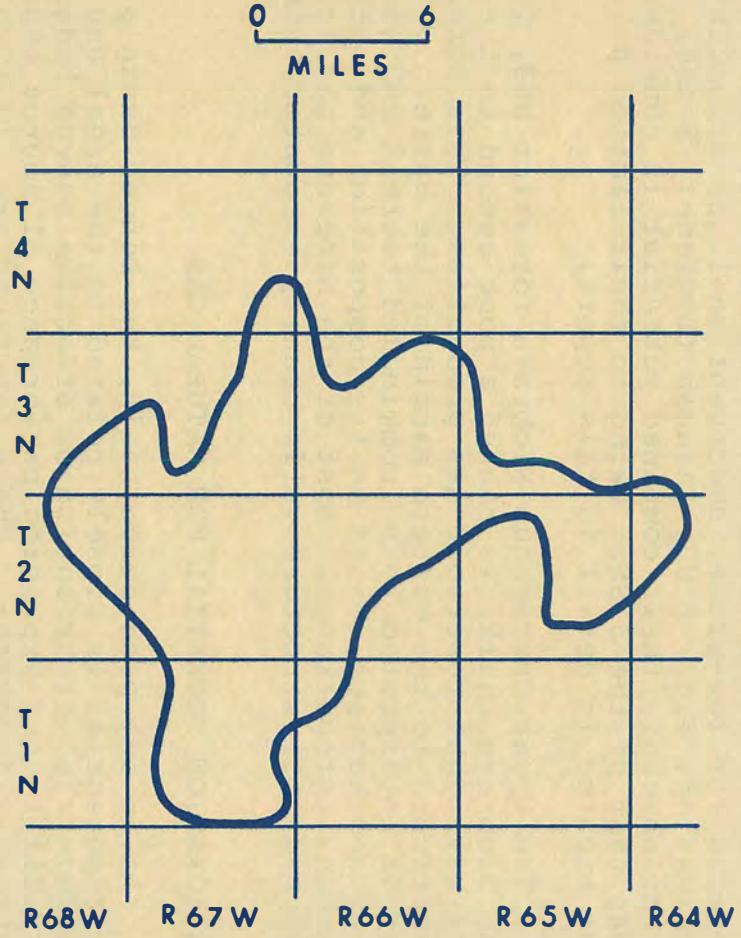


Figure 15-3. Eastern Colorado Wattenberg Field -- Denver Basin.

Several other formations (Figure 15-3) are considered prospective for low-grade, unconventional gas accumulations of thermal derivation, e.g., D SS, Shannon (Hygiene), Sussex (Terry), Greenhorn; however, their combined potential is considered to be less than that of the J SS. Owing to their limited potential, they are not treated in detail in this report.

The Upper Cretaceous Niobrara Formation and, in particular, the Niobrara chalk, is ranked a poor second to the J SS for economical tight reservoir gas production. This potential mainly is restricted to the eastern margin of the Basin. Producible Niobrara gas is interpreted to be commingled thermal and biogenic gas by many geochemists, based on its composition and methanes table-carbon-isotope range. Most of the Niobrara gas is structurally trapped; off-structure wells usually encounter water.

EXPLORATION POTENTIAL FOR NATURAL GAS

As in any productive basin, the Denver Basin's tight gas reservoir potential is closely related to the areal and stratigraphic (volumetric) distribution of effective source beds. The generating capability and expulsion performance of source beds also are extremely important. These functions are, in turn, related to the type, quantity, quality of source rocks and their contained organic matter, their fluid-pressure seals and their pressurizing capability, availability of carrier beds, and structural relationships.

The time of expulsion is also important, being related to burial history and thus to thermal history. Fortunately, the thermal history in the deep Cretaceous source rocks was satisfactory locally for gas generation and explusion, owing to high heat flow in part of the Basin.

In addition to source rocks and a carrier system, a number of other factors are essential for occurrences of commercial natural gas. Reservoirs and traps are needed for storage of gas. Carrier beds must be effectively sealed to transport gas from generation sites to entrapment sites and reservoirs must be effectively sealed to preserve gas. Preservation through time from accumulation to production is vital, and is especially difficult to achieve for gas over long periods of time. Owing to the small size of gas molecules, their mobility, and the relative ease with which they can migrate through fractures and even through the subcapillary pores of the argillaceous rock seals, gas has a high escape rate in a setting such as the Denver Basin where only argillaceous seals occur. (Gas is much more effectively preserved under evaporite or permafrost-gas hydrate seals; neither of these types of seals is present in the Cretaceous of the Denver Basin.) Consequently, timing of entrapment can be a decisive factor in preservation; entrapment during late Cenozoic time is desirable for a relatively high degree of preservation.

Under any circumstances, timing of all essentials for oil and gas accumulations is important in that sealed carriers, sealed reservoirs, and traps must be available at the times of explusion and

migration in order to transport and retain oil and gas. Because of the innate difficulties with preservation of gas, the best prospects for survival of natural gas accumulations occur where expulsion has been a comparatively recent geological event; that is, within the last 10 million years or so.

In the Wattenberg area and area A generally (Figure 15-2), source rocks, reservoirs and seals were deposited and lithified long before the Denver Basin formed. Many of the traps predate the Basin or evolved concurrently with basin-forming tectonism. However, peak gas generation and expulsion required the high temperatures associated with both deep burial (that ensued as a result of basin-formation) and the mid-Tertiary thermal event. Consequently, timing was quite favorable. Furthermore, the exposure time at the high temperatures necessary for the main phase of thermal gas generation was sufficient to delay expulsion in the Denver Basin until late in the Cenozoic Era. Hence, the Denver Basin became a significant habitat for natural gas recently enough to minimize the problem of preservation.

As described in the Carbonization Levels section, another factor may be involved in gas preservation in unconventional tight gas reservoirs such as occurred in the Denver Basin; the potential of Wattenberg and similar accumulations may result from the internal sealing capability of the tight reservoirs, as well as the quality of the overseal and the youthfulness of the gas itself.

Gas Source Rocks

The thermally generated gas trapped in the Lower Cretaceous J SS reservoirs of Area A (Wattenberg Field and surroundings) is believed to be principally from four source rock units (Figure 15-3). These sources are the Lower Cretaceous Skull Creek (Kiowa) Shale and the argillaceous parts of the J SS interval, as well as the thin Lower Cretaceous Mowry Shale, which rests directly on the J SS, and the overlying Upper Cretaceous Huntsman Shale.

Argillaceous and coaly deposits of shallow marine and coastal origin constituted the effective gas source rocks. Hydrocarbon gas is postulated to have been derived from these sources during several overlapping genetic stages: (1) initially, oil-generating Kiowa, Mowry, and Huntsman shales generated and expelled some gas along with oil during the main phase of oil-generation at about 83 wt. percentage carbon (this early oil and gas expulsion accounts for most of the associated gas that has been discovered in the basin); (2) much of the J reservoir-oil retained in this deep, hot area was then thermally cracked to gas and gas condensate; (3) concurrently, much of the unexpelled oil that remained in the Huntsman, Mowry, and Kiowa oil-source-rocks after oil expulsion had stopped was also thermally cracked to gas and gas condensate. Some of this fluid then was expelled, along with (4) much of the gas generated in both the former oil source rocks from Type II organic matter, and in the gas-generating argillaceous intervals of the J (Type III organic matter), as they attained the main phase of thermal gas generation at about 88 to 90 wt. percent C. The

overlapping of these stages resulted as the generation-expulsion front for oil (with some associated gas) moved up-dip and up-section; concurrently, thermal cracking and thermal gas generation and expulsion occurred down-dip and down-section. However, these fronts also expanded upward and outward through the source rocks until the processes terminated as a result of cooling. In any unit-volume of source rock, the main phase of gas generation occurred long after oil generation-expulsion.

Thermal cracking of oil to gas, and the main phase of thermal gas generation, were confined to deep, hot parts of the basin. Because gas generation requires a considerably higher input of thermal energy, and a higher carbonization stage, than either oil generation or thermal cracking of oil to gas, only a small area of the Denver Basin, and therefore only a small volume of Cretaceous source rock, has attained peak gas generation and gas-expulsion conditions. These conditions evidently were satisfied primarily, or perhaps exclusively, in the general Wattenberg area. Effective oil source rocks cover a considerably larger area; much of the associated gas in the Basin probably was expelled with oil in the first major fluid-expulsion stage but this gas is now widely dispersed, having migrated with the oil. It is found only in conventional reservoirs along oil-migrating paths, whereas the gas generated later is mainly in tight reservoirs within the source rock sequence where it was generated.

The localized high concentrations of gas in the prospective areas centered around the Wattenberg Field are attributable to unusually high subsurface temperatures at any given burial depth in comparison to the remainder of the Basin. Geothermal gradients as high as 30°F/1,000 feet of burial (Figure 15-4) at 48°F mean ambient surface temperature have been determined from careful equilibrium temperature measurements in and around Wattenberg (Area A, Figure 15-2). A gradient of 26°F/1,000 feet is commonplace in that area. These gradients are considerably above "normal", usually considered to be about 16°F/1,000 feet. Thus, Area A remains relatively hot despite substantial cooling since the end of Miocene time. Figure 15-4 is an interpretation of this cooling, following the mid-Tertiary thermal event. The cooling has affected the entire stratigraphic section including the J SS in the Lower Cretaceous (LK on Figure 15-4).

High temperatures evidently prevailed for millions of years during the Tertiary, particularly during the Late Oligocene and Miocene, before the Basin was cooled. The heat source is attributed to a "hot-spot" associated with intensive igneous and volcanic activity, hydrothermal activity and mineralization over the northeastern extension of the Colorado Mineral belt (Figure 15-5), where more than 90 percent of Colorado's metallic mineral wealth reportedly is concentrated. The Mineral belt is essentially congruent with the Transcontinental Arch across Colorado. The thermal energy from this mineralized trend was sufficiently high to enable gas to be generated and expelled in and near Wattenberg Field. Quite possibly, conditions were not favorable for gas generation and expulsion (other than in association with oil) in any other

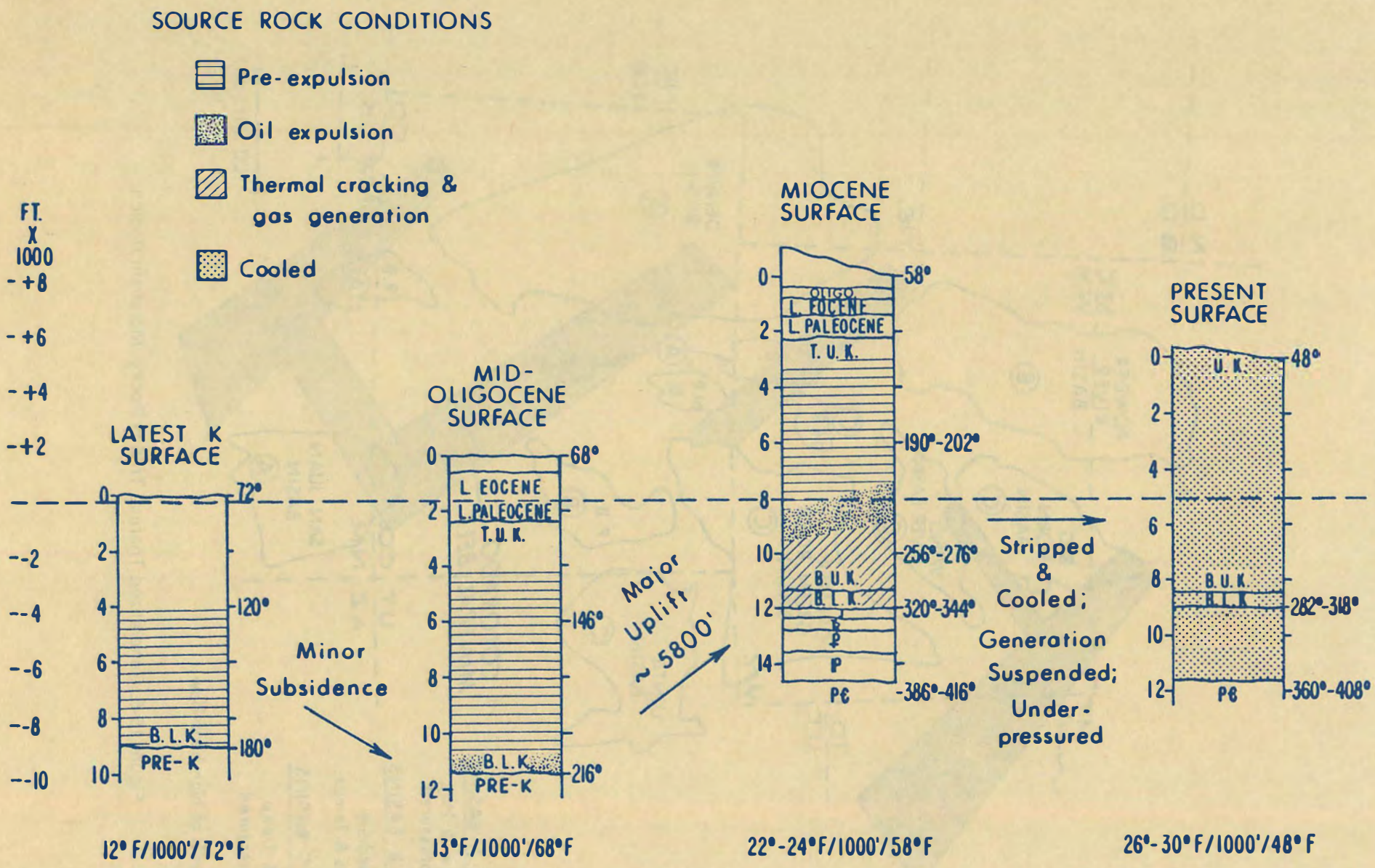


Figure 15-4. Thermal History -- Deep Denver Basin, Wattenberg Area.

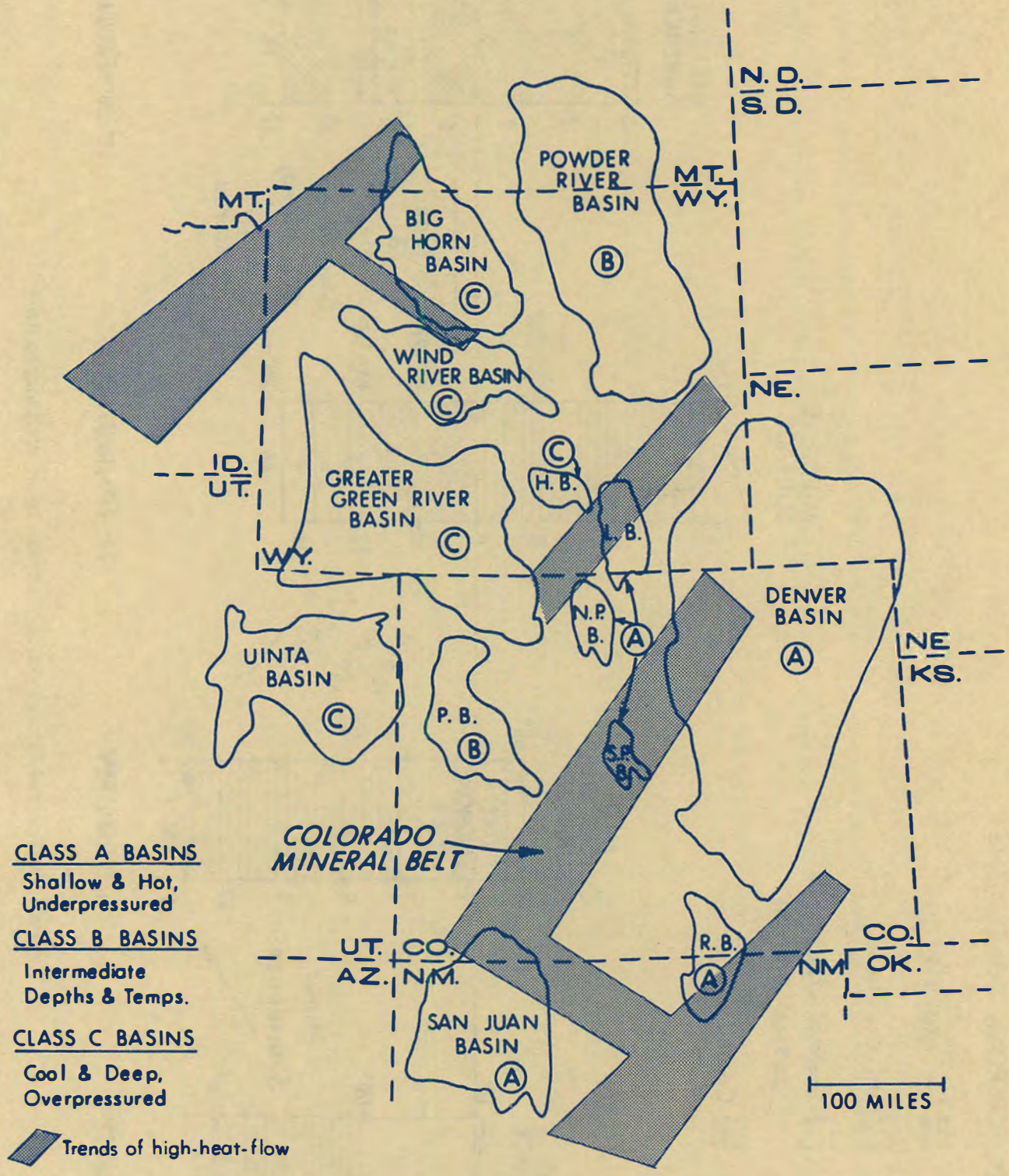


Figure 15-5. Generalized Thermal Trends Rocky Mountain Region.

part of the Basin. Because control is sparse and essential data are somewhat sketchy for Area B in southern Wyoming (Figure 15-2), the possibility of gas expulsion in that deep area is not precluded. However, it appears rather unlikely owing to somewhat lower thermal gradients than in Area A. For this reason, the potential for natural gas in southeastern Wyoming (Area B) is considered to be speculative in this study.

Carbonization Levels and Organic Carbon Content of Organic Matter

A sizeable area extending from near Denver northeastward to the vicinity of Greeley, encompassing Wattenberg Field (essentially Area A), is interpreted to be at or past the peak generation-expulsion stage for thermal gas. Elemental analyses of source rock cuttings and core samples indicate that typical carbon percentages in kerogens are in the range of 88 to 92 wt. percent carbon. These values apply to argillaceous rocks within the J interval and in contact with the J (Figure 15-3). Microscopic visual analyses and extract maturity determinations from gas chromatograms support the elemental analyses. Therefore, available geochemical data indicate that the main thermal gas source is confined to older Cretaceous rocks in Wattenberg Field and vicinity. Elsewhere, gas in J SS reservoirs resulted from thernal cracking of oil and expulsion of gas with oil.

Organic carbon contents for the effective gas source rock shales are:

Huntsman-Mowry	Range 1.0 to 3.6 wt. percent; Average 2.1 wt. percent
J Shale	Range 0.9 to 5.6 wt. percent; Average 2.0 wt. percent
Skull Creek-Kiowa	Range 0.8 to 2.5 wt. percent; Average 1.4 wt. percent

Allowing for loss resulting from product generation, these averages should be adjusted upward 10 percent to 20 percent for the quantities initially present. Organic carbon data are from Clayton & Swetland, 1977, and from Amoco Production Company files.

Preservation of Tight-Reservoir Gas

The Wattenberg area J SS gas deposits seem to have had a high degree of protection against escape. Calculations of estimated in-place reservoir gas versus generated and expelled (source rock) gas suggest that 20% or more of the expelled gas is still present in the tight reservoirs. This percentage is considerably higher than the percentage generally assignable to gas preserved in conventional gas-bearing reservoirs of similar age and history and with similar seals. In Wattenberg, a much greater percentage loss could have been anticipated because the high temperatures for the depth of burial should have expedited escape.

Were it not for the cooling of the Basin, the high concentration of gas could be attributed to geologically recent generation rather than to preservation. But the cooling has been adequate to

suspend generation and contributed to the decline of reservoir pressures below hydro-pressured levels. The arrested generation is believed to have persisted for the last several million years, ample time for much greater loss to have occurred. The amount and duration of cooling seems to be comparable to cooling in other Rocky Mountain Basins with poorer preservation. The low fluid pressure of the reservoir does not seem to account for the high level of preservation because more conventional gas reservoirs in other basins evidently sustained an appreciably greater loss of gas, commonly while becoming more anomalously underpressured. Quite likely, Wattenberg would be considerably more underpressured, had the loss of gas been greater.

These considerations suggest that preservation of gas is enhanced by entrapment in shale-like, low-porosity and low-permeability reservoirs (Wattenberg averages 0.0055 md) with pore throats sufficiently small to inhibit passage of gas molecules. In effect, this type of tight unconventional gas reservoir may perform more like myriads of microtraps rather than as a single, leaky trap such as characterizes most conventional gas-bearing sandstones with similar seals. In that part of Area A surrounding Wattenberg Field, the average in situ permeability for gas is even lower than in Wattenberg. Below about 1.0 md, the rocks begin to acquire shale-like properties in terms of pore-throat dimensions and fluid transmissibility.

The over-seal does not seem to be as decisive a factor in preservation within unconventional reservoirs as it is with conventional reservoirs. Rather, it is the intrinsic sealing properties of the entire reservoir body that appear to be decisive. Hence, the rate of escape of gas from unconventional reservoirs may be significantly lower than the rate from conventional reservoirs, all other factors being similar. If so, this greater capability for preservation may help account for long-term producibility, although at comparatively low rates.

Published Estimates of Denver Basin Gas Resources

Beebe, 1968, estimated that the volume of recoverable gas accumulated throughout the Denver Basin in Cretaceous D SS and J SS reservoirs was about 775 billion to 800 billion standard cubic feet, mainly dissolved or associated.

Volk, 1971, estimated probable and possible future discoveries of gas at 660 billion SCF in the entire Cretaceous section of the Denver Basin. As of 68-12-31, he estimated cumulative production at 540 billion SCF, and remaining recoverable reserves of 800 billion SCF. Therefore, Volk's total estimate was 2 trillion SCF, exclusive of an additional speculative volume estimated at 600 BCF that included prospects in the Raton Basin of south-central Colorado and on the Los Animas Arch.

The foregoing estimates of Beebe and Volk probably referred only to conventional gas resources; as such, they were unusually

realistic. Most estimates of recoverable domestic gas in conventional reservoirs were unduly optimistic during that period. A 1978 estimate of proven and probable ultimate gas recovery from 255 fields was 1,666 BCF, exclusive of Wattenberg, which is comparable to Volk's earlier estimate.

Developing these resources and the Basin's oil fields has required an enormous effort. Stout, 1975, reported that 21,371 wells had been drilled through September, 1972, based on Petroleum Information statistics. Of these, 12,238 were exploratory tests (extensions, new-pool wildcats, and new-field wildcats) that resulted in 1,457 discoveries including 1,265 oil and 192 gas, not all of which were commercial. Only 56.28 percent of discoveries were developed into 820 fields; 11.9 percent of all exploratory wells found oil and/or gas, but the percentage of gas discoveries was only 1.56 percent, even though the data include the early exploration around Wattenberg.

The sucess ratio for new-field wildcats, and the reserves discovered per successful wildcat, drilled for natural gas had improved during the 1970's, as compared to the previous decade, as shown by the following statistics:

1960-1969 336 wildcats, 6.5 percent (22) Successful; 2.6 BCF/success, 57.6 BCF

1970-1977 877 wildcats, 8.3 percent (73) Successful; 18.6 BCF/success, 1,357.8 BCF

1960-1977 1,213 wildcats, 7.8 percent (95) Successful; 14.9 BCF/success, 1,415.5 BCF

More recent data for years 1975/1977 (Lewin study) revealed that 826 wells were producing 48 BCFG annually from tight reservoirs. By comparison, prior data for 1974/1975 show 640 gas wells producing 51 BCF annually with cumulative production of 113 BCF. Thus, a 27.5 percent decline in producibility per well-year was reported, from 0.080 BCF/well to 0.058 BCF/well. Although a trend should not be inferred from this limited sampling, it is reasonable to expect a down-trend as poorer quality reservoirs are placed on production unless reversed by improved stimulation techniques.

The estimates from this study are substantially lower than those of the Lewin study of 1978:

	Area, mi.^{2}	Gas In Place	Technically Recoverable	Technical Recovery Efficiency (Percentage)
Lewin	2,591*	18.5 TCF	13.0 TCF	71
NPC	1,600**	13.3 TCF	7.9 TCF	59

*Probable, 1966 mi.^{2}; and possible, 625 mi.^{2} (Sussex, Niobrara, and J SS only).

**Probable and possible, 1,100 mi.^{2}; Speculative, 500 mi.^{2}

Estimates of technically recoverable gas per square mile of productive reservoir area are remarkably similar, i.e., 5.0 BCF per square mile in the Lewin study and 4.9 BCF/mi.^{2} in this study.

The apparent disparities in the above figures are considerably minimized when data for the Sussex and Niobrara are eliminated from the Lewin tabulation. As shown below, the tight reservoir gas potential of the Sussex and Niobrara are rated low. However, inclusion of data for these zones in the above tabulation would bring the areas and the gas-in-place values more closely into agreement.

Remaining Exploration Potential

Estimates of recoverable unconventional gas resources remaining to be discovered in the future, other than J SS, are listed by formation below:

Formation	Probable	Possible	Speculative
Sussex (Terry)	<0.1 TCF	<0.1 TCF	0.1 TCF
Shannon (Hygiene)	<0.1	0.1	0.2
Niobrara*	0.1	0.2	0.4
Greenhorn	<0.1	0.1	0.2
D SS	0.1	0.2	0.3
Fall River	<0.1	<0.1	0.1
Lakota-Lytle	<0.1	0.1	0.2
Totals	<0.4 TCF	<0.8 TCF	1.5 TCF

*Off-structure accumulations only; an additional 0.5 TCF is possible on structure, and is considered a conventional gas resource in this study.

Figures for the J SS are discussed in detail elsewhere. One or two of the above formations may do substantially better than estimated; the overall values are considered realistic, however, because only five new-pool gas discoveries were reported in the years 1960-1977 in the 6.427 wells drilled; 150 of these wells reportedly sought new-pool gas discoveries for a 3.3 percent success ratio, 4.2 BCF found, 0.8 BCF per successful well but only 0.028 BCF per attempt.

EXPLORATION HISTORY

The second oldest oil-producing region in the United States was established in the Canon City Embayment, a subsidiary basin within the southwestern part of the Denver Basin (Figure 15-2), in 1862, only three years after the Drake discovery in Pennsylvania. Oil was discovered near Canon City northwest of Pueblo at shallow depths. Fractured Upper Cretaceous Pierre shale was the productive zone. Florence Field, discovered in 1876 in the Embayment, is still producing oil from fractured Cretaceous shale. Only minor quantities of gas have been discovered in the area but other prospects may exist for gas production in the deep Cretaceous.

In 1919, the first Denver Basin gas field was discovered in a Yuma County Cretaceous reservoir along the eastern margin near the Kansas-Nebraska line. It was 1949, however, before exploration flourished, following a Cretaceous oil discovery on a small structure in western Nebraska, just north of the Colorado line. The delay in intensive successful exploration is attributable to the subtle nature of the predominant trapping mechanisms in the Basin. Most oil and gas accumulations are in small stratigraphic or combination traps (usually an anticlinal nose combined with a pore-throat barrier). These traps were undefinable by then-existing geological and geophysical technology. Even with abundant subsurface well and geophysical control, these subtle traps remain difficult to locate. As outlined in Figure 15-2, Cretaceous oil and gas fields are located in and up-dip from the deep, hot source rock areas along the axis of the Basin. Except for the isolated Canon City Embayment, the southern part of the Basin was too cool and shallow for effective Cretaceous source rocks. The thickest section of pre-Cretaceous sedimentary rocks occurs in this cool southern area.

Other than numerous Cretaceous oil and gas pools, significant production within the deep part of the Basin is confined to the Permian System, several small structurally controlled and facies-related oil fields having been discovered within the Lyons Sandstone. A recent oil discovery from the Permian Wolfcamp and/or Pennsylvanian Virgil has been reported by an operator in Cheyenne County, Nebraska. A number of oil and gas accumulations are being produced from pre-Permian reservoirs along the eastern and southeastern margins of the Basin and on the Las Animas Arch. Some of this oil and gas is correlatible to Denver Basin Pennsylvanian source rocks. Much of the Las Animas Arch production, however, correlates with source rocks in the Anadarko Basin in Oklahoma.

Prior to the discovery of sprawling Wattenberg Field in 1970, only about 1.5 TCF of recoverable natural gas, mainly associated, had been found in the Denver Basin. Wattenberg's unconventional tight reservoir reserves have almost doubled the ultimately recoverable volume of gas confirmed for the Basin. Wattenberg and many other fields were discovered primarily as a result of subsurface stratigraphic studies. Spindle, a large stratigraphic oil and gas accumulation, was discovered in 1972 by testing prospective zones in the Upper Cretaceous during development drilling of Wattenburg Field.

Characteristics of Traps and Reservoirs

Trapping mechanisms for petroleum and natural gas in the Cretaceous of the Denver Basin are of three types: stratigraphic, combination and structural. Stratigraphic traps are of depositional and diagenetic origin; depositional stratigraphic traps include facies (change in lithology) and paleogeomorphic, the latter mainly resulting from sandstone filling topographically low stream- and tidal-channels eroded into older deposits. Facies traps have resulted from deltaic and coastal marine sand deposits that grade laterally up-dip into siltstone and argillaceous rocks, mainly shales, with much smaller pore throats.

In some areas of the Basin, solution and flowage of Permian salt during the Cretaceous Period influenced deposition. Some of these higher energy deposits later developed into stratigraphic trap reservoirs. Other salt-related features provided structural traps or, where closure was absent, structural noses that constituted combination traps in association with suitable reservoir sandstone. Shallow Niobrara gas pools typically formed in salt-related anticlinal structures along the eastern margin.

A variety of diagenetic traps resulted from cementation, clay mineral formation and transformation and similar physiochemical processes. The importance of diagenetic effects in entrapment of oil and gas has been much more commonly recognized in recent years with the advent of scanning electron microscopy, not only in the Denver Basin but in many other producing provinces.

In addition to structures induced by halokinesis, some gentle small folds developed as a result of Laramide tectonism. Structural accumulations have been the easiest to find and also tend to be somewhat larger, on average, than stratigraphic accumulations. Wattenberg and the overlying Spindle pool are exceptions. For most traps in the Denver Basin, stratigraphy is the principal control and this is expected to hold true for the tight gas reservoir accumulations remaining to be found.

Table 15-2 is a summary of J SS reservoir properties determined from drilling in and near Wattenberg Field; as such, the data may reflect a bias resulting from the better-quality reservoir rocks within the confines of the production area outlined on Figure 15-2, wheremost of the control wells are located.

TABLE 15-2

J SS Reservoir Properties, Wattenberg Field and Environments

Field area as of mid-1979: 978 square miles productive
Age: L.K. Albian
Depth Range: 7,350-8,500 feet; Average 8,000 feet
Lithology: quartz sandstone, fine to very fine, argillaceous
Type: Upper J, delta plain, multi-bench, discontinuous, erratic lenticular
Lower J, delta front, single-bench blanket
Thickness: Gross interval 40 to 140 feet
Net SS range 4 to 58 feet; Average 27 feet
Upper bench pay 0 to 20 feet thick generally
Lower bench pay 20 to 25 feet thick generally
Porosity: Range 7.7 to 13.9 percent; Average 10.8 percent;
Conventional cutoff 8 percent
Permeability: Conventional reservoir CORES
Range 0.1 to 38 md; Average 5 md.
Unconventional reservoir CORES
Range 0.005 to 0.1 md; Average 0.02 md.
Unconventional reservoir PRESSURE BUILD-UP and TYPE-CURVE ANALYSIS in situ gas
Range 0.003 to 0.037 md; Average 0.0055 md

Water Saturation: Conventional cutoff 60 percent
Range 27 percent to 57 percent; Average 42 percent
Unconventional cutoff 99 percent
Range 40 percent(?) to 99 percent; Average 55 percent
Reservoir Temperature: Range 225° to 300°F; Average 260°F
Geothermal Gradient: Average 26°F/1,000 feet/45°F (surface temp.)
Reservoir fluid pressure (BHSIP) 2,750-3,000 psig; Average 2,900 psig (Reservoir is underpressured, gas-expansion drive.)

Natural gas liquids: 0.036 Bbl/MCF Condensate (Separator); 0.029 Bbl/MCF NGL (Plant)

Total NGL: 0.064 Bbl/MCF Condensate gravity 64° API.

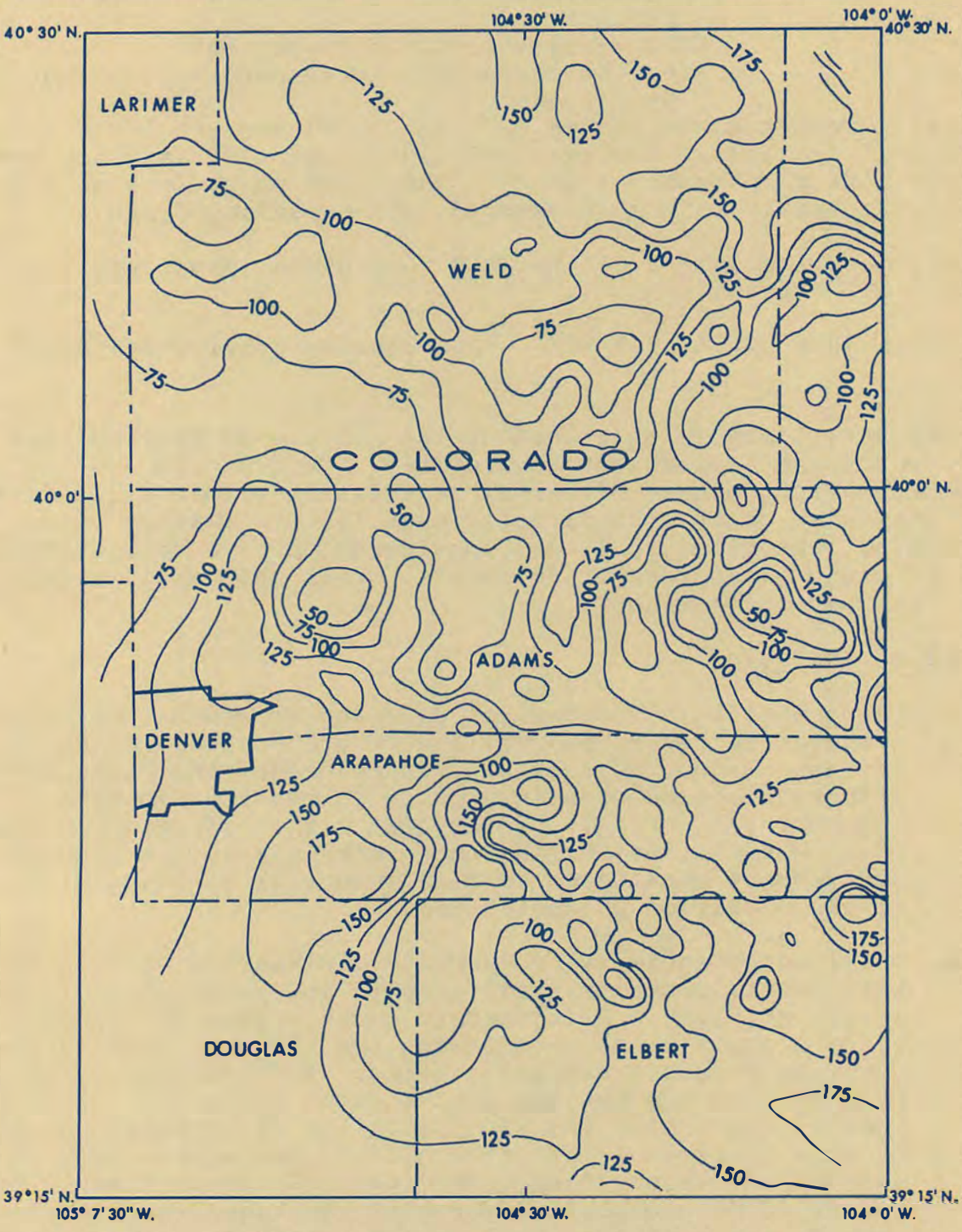
The variations in thickness of the gross J SS interval are depicted by the isopachs on Figure 15-6. Much of the J SS gas is produced where the gross interval is relatively thin (<100 feet). The lenticular upper J SS directly overlies the blanket lower J SS. Therefore, lenticularity is not considered to be a serious problem in J SS tight gas-reservoir economics, other than as it affects reservoir pay thicknesses.

Method of Analysis

- Using available geochemical data and exposure time-paleo-temperature relations, outlined Cretaceous-age effective thermal gas source rock area in Colorado, and possibly-effective source area in Wyoming (excluding Niobrara biogenic gas source). Reservoirs within effective source rock sequence, as well as those directly up-dip and up-section are considered to have potential as being along likely migration paths for gas.

- Outlined potentially prospective gas-bearing area in the Cretaceous, based on stratigraphic and geographic distribution of tight J SS reservoir rocks within the broader area (Item 1 above) that encompasses the effective gas source beds and possible migration paths. The outlined areas were then checked against the distribution of non-associated thermal gas pools, and also locations of reported gas shows. Because of lack of effective oil and gas source beds in much of the Denver Basin, only two relatively limited areas appear to be prospective for gas from tight reservoirs. Area B, the northern area, is considered speculative because of the uncertainties that gas expulsion in quantity occurred there.

- Estimated areal extent of tight gas reservoirs, based on available well-control of porous and permeable but relatively tight reservoirs. It was assumed that a dry hole that tested the J SS only condemned 160 acres, but a productive well "proved" the potential of all adjoining



25' CONTOURS

SCALE: 1" = 64,000' **FEB., 1979**

Figure 15-6. Total J SS. Isopachs -- Denver Basin -- Wattenberg and Vicinity.

untested 160 acre tracts, including diagonal offsets. Estimated capacity of tight reservoirs for in-place gas, based on available average porosity and water saturation data, and on lithofacies-isopachous maps.

- Estimated in-place gas in unexplored and undeveloped tight gas-reservoirs for each trap type (permeability category), based on data compiled from studies of productive tight gas reservoirs primarily in Wattenburg Field.

- Estimated recoverable gas and recovery rates for a given well spacing, before and after MHF stimulation, excluding Wattenberg Field's booked reserves, based on engineering reservoir performance tests and model studies, as well as percentages of dry exploratory and development wells.

PRODUCTION

Two formations in the Denver basin are considered potentially productive of tight gas. The areas for each of the individual formations and the two combinations considered are shown in Table 15-3. This study treats each formation separately. A full set of tables is presented for each of the cases, and the production potential and economics of each is obtained by analyzing the appropriate set. The gas potential for the whole basin as a function of gas price is summarized in Table 15-4.

TABLE 15-3

DENVER BASIN

MAXIMUM RECOVERABLE GAS
AND
PRODUCTIVE AREAS

PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)	BASIN	SUB-BASIN	FORMATION
1,100	5,539	Denver		Area A
500	2,379			Area B
1,600	7,918	Basin Total		

Using the Denver Area A formation as an example, the geological data used in both the reservoir and exploration simulators are shown in Table 15-6. The production rates estimated with the reservoir simulator for each permeability level are shown in Table 15-7. These rates are for base case technology with a fracture

TABLE 15-4

SUMMARY OF DENVER BASIN GAS POTENTIAL

(BCF)

BASE			ADVANCED					
$2.50	$5.00	$9.00	$2.50	$5.00	$9.00	FORMATION	SUB-BASIN	BASIN
0	0	1039	0	4518	5539	Area A		Denver
0	0	127	0	694	2057	Area B		
0	0	1166	0	5212	7596			Basin Total

half-length of 1,000 feet. Annual gas production in millions of cubic feet per year per well and the cumulative production over a 30-year period are given. The 30-year cumulatives range from 0.16 to 2.6 BCF per well for the five permeability levels studied. Table 15-8 shows the data for the advanced technology case with fracture half-lengths of up to 4,000 feet.

Production rates for the Denver A wells will range from about 65 MCF/D to 300 MCF/D for the first year with base technology, depending on permeability level and net pay thickness. With longer fractures, daily production rates from the best interval should exceed 750 MCF/D. Rates will decline rapidly, however, and by the fifth year even the best well with advanced technology will be producing only 300 MCF/D.

Table 15-9 shows the number of wells per section with both base and advanced technology. With base technology, the number of wells required to produce all gas ranges from 3.6 to 36.4 wells per section. However, with base technology and thus current well spacing restrictions, only four wells per section are permitted. The effect is to reduce recoverable gas from the maximum of 5,539 BCF, shown in Table 15-6, to only 1,525 BCF. With advanced technology, well spacing could be varied so that more wells could be drilled. For the Denver A, this would range from 1.3 to 9.68 wells per section. With advanced technology, the full 5,539 BCF could be recovered.

ECONOMICS

The basic geologic and production data for both formations were processed with the full cycle exploration and production simulator described in Chapter Four. Each of the sets of data was evaluated separately to determine the economics of finding and developing the gas in that particular formation. The investment required and economics of gas production vary substantially from one formation to another.

TABLE 15-5

EXPLORATION PERFORMANCE - Denver Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	300	274	26	258	241	17	558	515	43
Gas	27	22	5	73	73	0	100	95	5
Oil	269	248	21	182	165	17	451	413	38
Oil and Gas	4	4	0	3	3	0	7	7	0
Amount of Petroleum Found									
Total, MMBOE **	75	65	10	450	355	95	525	420	105
Gas, BCF	62	58	4	1356	1356	0	1418	1414	4
Oil, MM Bbls.	62	53	9	124	66	58	186	119	67
Number of Wildcat Wells									
Total	3898	3742	156	3140	3108	32	7038	6850	188
Gas *	350	336	14	885	877	8	1235	1213	22
Oil *	3497	3357	140	2214	2191	23	5711	5548	163
Oil and Gas	51	49	2	41	40	1	92	89	3
Number of Wildcats/year	390	374	16	393	389	4	783	763	20
Percent Wildcats Successful									
Total	7.7	7.3	16.6	8.2	7.8	53.1	7.9	7.5	22.9
Gas	7.7	6.5	35.7	8.2	8.3	0	8.1	7.8	22.7
Oil	7.7	7.4	15.0	8.2	7.5	73.9	7.9	7.4	23.3
Oil and Gas	7.8	8.2	-	7.3	7.5	-	7.6	7.9	-
Amount Found/Successful Wildcat									
Total, MMBOEE	0.3	0.2	0.4	1.7	1.5	5.6	0.9	0.8	2.4
Gas, BCF	2.3	2.6	0.8	18.6	18.6	-	14.2	14.9	0.8
Oil, MM Bbls	0.2	0.2	0.4	0.7	0.4	3.4	0.4	0.3	1.8
Average Depth of Wells, M ft.									
Gas	5670	5680	5620	5960	5960	-	5880	5890	5620
Oil	5620	5610	5590	6270	6230	6720	5880	5860	6090

* Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

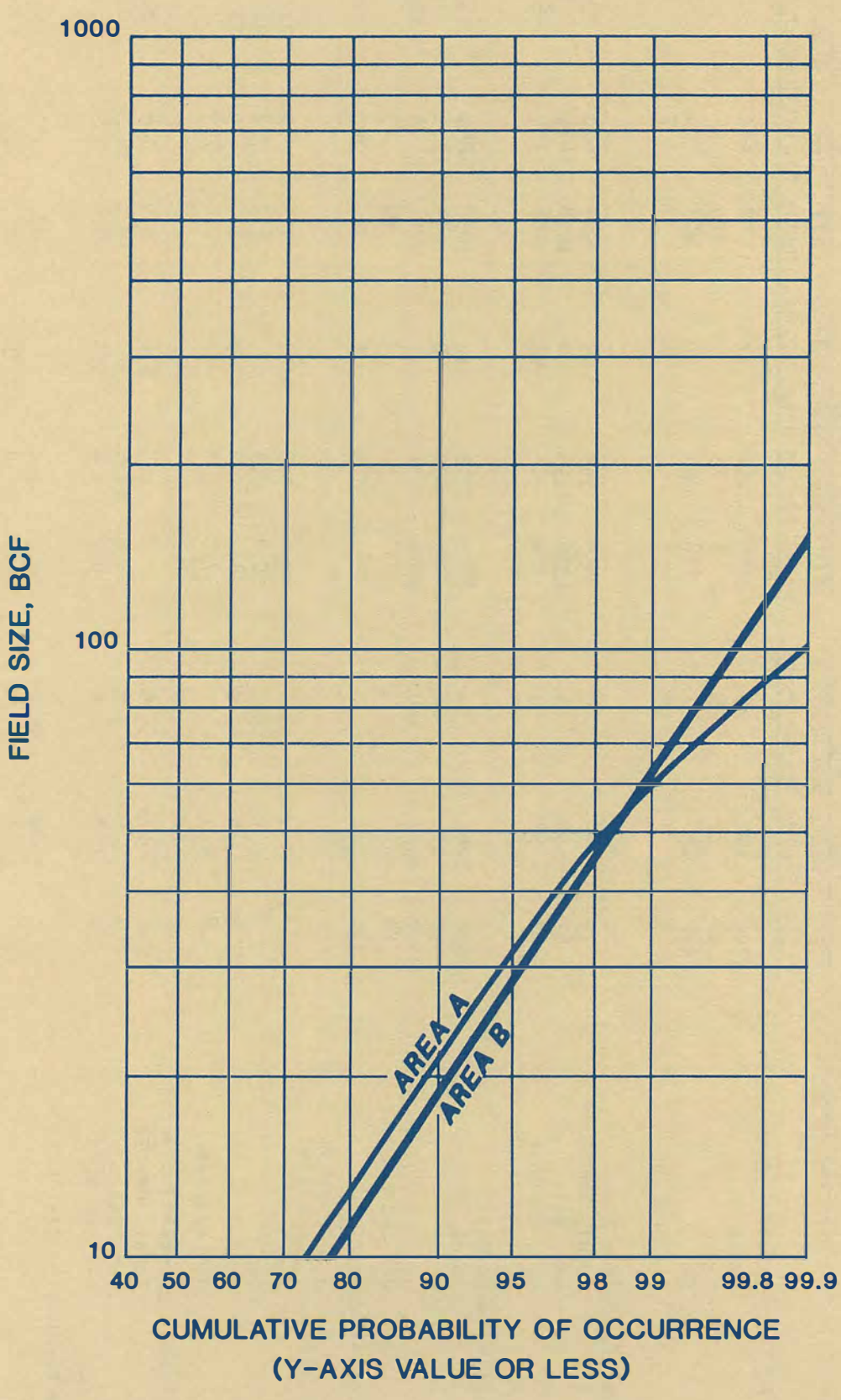
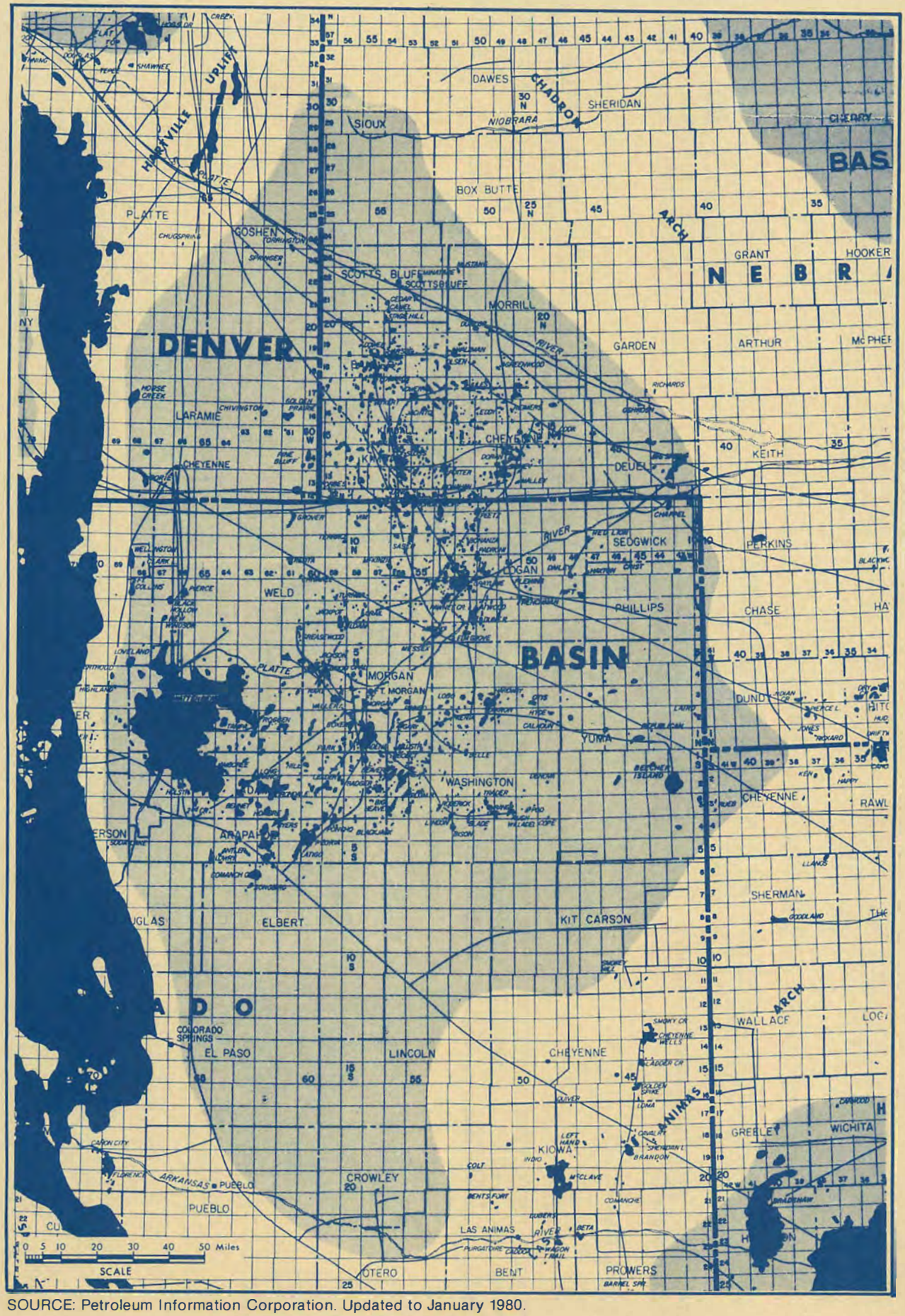


Figure 15-7. Field Size Distribution of Producible Gas, Denver Basin.



SOURCE: Petroleum Information Corporation. Updated to January 1980.

Figure 15-8. Oil and Gas Fields Map—Denver Basin.

TABLE 15-6

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 40,000
TYPE: Blanket

BASIN: Denver
SUBBASIN: Area A
FORMATION: Muddy J

DEPTH (FT.): 8000
PRESSURE (PSIA): 3000
TEMPERATURE (°F): 260

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.01	55	6.5	17	270	196	.50	.8	1.0
0.003	110	6.3	22	678	460	.60	.9	1.0
0.001	385	6.1	27	2818	1787	.80	1.0	-
0.0003	385	5.9	35	3530	2075	1.0	1.0	-
0.0001	165	5.7	45	1879	1021	1.0	1.0	-
	1100			9175	5539			

TABLE 15-7

WELL PRODUCTION SUMMARY--BASE CASE

DENVER A

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1				106	72	49	33	24		
2				62	40	27	18	13		
5				40	24	16	10	7		
10				30	19	11	7	5		
15				27	15	9	6	4		
20				24	14	9	5	3		
30				21	12	7	4	3		
30-YEAR CUMM. PROD. (MMCF)				977	592	378	243	169		

TABLE 15-8

WELL PRODUCTION SUMMARY--ADVANCED CASE

DENVER A

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1				276	233	172	124	81		
2				179	138	98	69	48		
5				118	84	58	40	29		
10				86	62	40	28	20		
15				73	50	34	23	16		
20				65	44	30	20	14		
30				54	37	25	16	11		
30-YEAR CUMM. PROD. (MMCF)				2653	1923	1320	907	638		

TABLE 15-9

PRODUCTION WELL REQUIREMENTS

BASIN: Denver
SUB-BASIN: Area A
FORMATION:

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.01	3.64	3.64	196	1.34	1.34	196
.003	7.06	4.	261	2.18	2.18	460
.001	12.28	4	582	3.52	3.52	1787
.0003	22.18	4.	374	5.94	5.94	2075
.0001	36.41	4.	112	9.68	9.68	1021
			1525			5539

Continuing with the Denver A example, the investment and operating expenses used to evaluate the Denver A are shown in Table 15-10. Fracturing costs are a function of the net pay thickness and fracture length and are presented as ranges in this table. The appropriate values for each case, however, were calculated and used in the simulator.

TABLE 15-10

INVESTMENT AND OPERATING EXPENSES

BASIN: Denver
SUB-BASIN: Area A
FORMATION:

Geology and Geophysics ($/Prospect)	45,000
Drilling Cost ($/Well)	430,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	92,500
- Advanced Case [2000/4000 Ft. Fracture]	304,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0269

The output from the simulator is shown in two tables: the economic summary for the base technology case is shown in Table 15-11; advanced technology economics are summarized in Table 15-12. Evaluations are made at discount rates of 10, 15, and 20 percent at several gas prices. Each of the 24 cases shown on each table is a complete evaluation. In other words, the entire basin is drilled and developed assuming that this gas price and discount factor prevail. In each case the table shows the rate of return and the net present value (positive only when the rate of return exceeds the discount rate). When the net present value is not positive, this simply means that none of the gas will be recoverable at this price and discount rate. In Table 15-11, this occurs at less than $7.00/MCF and at a discount rate of 10 percent, for example. As price increases, net present value become positive and some gas becomes recoverable. For example, in Case 61, at a 10 percent rate

TABLE 15-11

ECONOMICS SUMMARY

BASIN Denver A

SUB BASIN

FORMATION Muddy J

TECHNOLOGY Base

DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
20011 1	1.50	0	0	0	686	0	-392	0	0	0	0	0	0	0	0	0	0
21	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
31	3.10	2.9	1	D	862	.326	-308	"	"	"	"	2.7	"	"	"	"	"
41	3.50	"	"	"	"	"	-284	.2	"	"	"	"	"	"	"	"	"
51	5.00	7.8	2	DE	1107	.699	-66	8.2	"	"	"	7.2	"	"	"	"	"
61	7.00	35.7	3	DEF	2214	1.791	661	20.8	1039	2443	580	33.0	420	207	314	1255	2196
71	9.00	"	"	"	"	"	1206	30.5	"	"	"	"	"	"	"	"	"
81	12.00	69.0	4	DEFG	2964	2.304	2521	48.4	1413	4518	613	63.8	240	423	493	1972	3128
Discount Rate 15%																	
12	1.50	0	0	0	0	0	-393	0	0	0	0	0	0	0	0	0	0
22	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
32	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
42	3.50	2.9	1	D	862	.326	-330	.2	"	"	"	2.7	"	"	"	"	"
52	5.00	"	"	"	"	"	-264	3.5	"	"	"	"	"	"	"	"	"
62	7.00	7.8	2	DE	1107	.699	-24	14.1	"	"	"	7.2	"	"	"	"	"
72	9.00	35.7	3	DEF	2214	1.791	660	30.5	1039	2443	580	33.0	420	207	314	1255	2196
82	12.00	"	"	"	"	"	1265	45.9	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	686	0	-395	0	0	0	0	0	0	0	0	0	0
23	2.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
33	3.10	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
53	5.00	2.9	1	D	862	.326	-304	3.5	"	"	"	2.7	"	"	"	"	"
63	7.00	7.8	2	DE	1107	.699	-130	14.1	"	"	"	7.2	"	"	"	"	"
73	9.00	"	"	"	"	"	3	20.1	457	656	654	7.2	656	51	98	391	1196
83	12.00	35.7	3	DEF	2214	1.791	829	45.9	1039	2443	580	33.0	420	207	314	1255	2196

* CODE:

D	E	F	G	H
0.01	0.003	0.001	0.0003	0.0001

TABLE 15-12

ECONOMICS SUMMARY

BASIN Denver A — TECHNOLOGY Advanced

SUB BASIN — FORMATION Muddy J — DATE June 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
2001211	1.50	2.9	1	D	986	.242	-494	0	0	196	0	2.7	-	-	-	-	-
21	2.50	7.8	2	DE	1160	.633	-359	.4	0	656	0	7.2	-	-	-	-	-
31	3.10	35.7	3	DEF	2581	2.626	168	12.4	2443	2443	923	33.0	669	330	396	1583	2978
41	3.50	"	"	"	"	"	371	15.4	"	"	"	"	"	"	"	"	"
51	5.00	69.0	4	DEFG	4452	4.476	1873	29.9	4518	4518	1009	60.4	396	696	919	3675	5686
61	7.00	85.3	5	DEFGH	6074	5.475	4058	46.9	5539	5539	1012	78.8	232	863	1345	5381	7821
71	9.00	"	"	"	"	"	6101	69.5	5539	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	9105	104.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	0	0	0	915	0	-520	0	0	0	0	0	0	0	0	0	0
22	2.50	7.8	2	DE	1160	.633	-419	.4	"	656	"	7.2	"	"	"	"	"
32	3.10	"	"	"	"	"	-365	2.5	"	"	"	"	"	"	"	"	"
42	3.50	35.7	3	DEF	2581	2.646	21	15.4	2443	2443	923	33.0	669	330	396	1583	2978
52	5.00	69.0	4	DEFG	4452	4.476	1020	29.9	4518	4518	1009	60.4	396	696	919	3675	5686
62	7.00	85.3	5	DEFGH	6074	5.475	2536	46.9	5539	5539	1012	78.8	232	863	1345	5381	7821
72	9.00	"	"	"	"	"	4059	69.5	"	"	"	"	"	"	"	"	"
82	12.00	"	"	"	"	"	6344	104.7	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	0	915	0	-519	0	0	0	0	0	0	0	0	0	0
23	2.50	2.9	1	D	986	.242	-486	"	"	"	"	"	"	"	"	"	"
33	3.10	7.8	2	DE	1160	.633	-410	2.5	"	"	"	"	"	"	"	"	"
43	3.50	"	"	"	"	"	-382	3.8	"	"	"	"	"	"	"	"	"
53	5.00	35.7	3	DEF	2581	2.646	278	27.3	2443	2443	923	33.0	669	330	396	1583	2978
63	7.00	69.0	4	DEFG	4452	4.476	1517	50.9	4518	4518	1009	60.4	396	696	919	3675	5686
73	9.00	85.3	5	DEFGH	6074	5.475	2850	69.5	5539	5539	1012	78.8	232	863	1345	5381	7821
83	12.00	"	"	"	"	"	4657	104.7	"	"	"	"	"	"	"	"	"

* CODE:

D	E	F	G	H
0.01	0.003	0.001	0.0003	0.0001

of return and $7.00/MCF, present value is $661 thousand and 1,039, BCF of gas become recoverable. Note also that permeability levels to 0.001 md will be economic. All other permeability levels were tested but proved uneconomic.

The tables also show the investment required per prospect and the maximum number of prospects available in the basin at the price. The total number of wells required is also shown. Comparison of Tables 15-11 and 15-12 will show the effect of advanced technology. Similar economic summaries are shown for the other formation. An overall summary of the Denver Basin undiscovered tight gas that is potentially productive is shown in Table 15-4. These estimates for both base and advanced technology cases are calculated for gas prices of $2.50, $5.00, and $9.00/MCF at a 15 percent discount rate.

REFERENCES

Beebe, B. W., 1968, Natural Gas in Denver Basin; Amer. Assoc. Petroleum Geologists Memoir 9, vol. 1, p. 899-927.

Clayton, Jerry L. and Paul J. Swetland, 1977, Preliminary Report: Petroleum Geochemistry of the Denver Basin: Rocky Mtn. Assoc. of Geologists Symposium, p. 223-233.

Colvin, R. J., C. R. Fast, and G. B. Holman, 1976, Development of Gas Potential through MHF, Wattenberg Field, Colorado; Amer. Gas Assoc. Transmission Conf., May 3-5, Las Vegas, NV.

Lockridge, J. P. and P. A. Scholle, 1978, Niobrara Gas in Eastern Colorado and Northwestern Kansas; in Energy Resources of the Denver Basin, Rocky Mtn. Assoc. of Geologists Symposium, p. 35-49.

Martin, Charles A., 1965, Denver Basin; Amer. Assoc. Petroleum Geologists Bull., v. 49/11, p. 1908-1925.

Matuszczak, R. A., 1973, Wattenberg Field, Denver Basin; Mtn. Geologist, v. 10, no. 3, 1973, p. 99-105.

_____, 1976, Wattenberg Field: A Review; Prof. Contr. Colorado School of Mines, no. 8, November, 22:275-279.

Peterson, W. L., and S. D. Janes, 1978, A Refined Interpretation of the Depositional Environments of Wattenberg Field, Colorado; in Energy Resources of the Denver Basin, Rocky Mountain Assoc. of Geologists Symposium, p. 141-147.

Stout, John L., 1975, Assisting Project Independence - a National Program; in Methods of Estimating the Volume of Undiscovered Oil and Gas Resources, Amer. Assoc. Petroleum Geologists Studies in Geology, No. 1, p. 107-112.

Volk, Richard, W., 1970, Petroleum Potential of Eastern Colorado, Western Nebraska, Southeastern Nebraska and Northwestern New Mexico; Amer. Assoc. Petroleum Geologists Memoir 15, vol. 1, p. 673-691.

Weimer, Robert J., 1980, Recurrent Movement on Basement Faults, a Tectonic Style for Colorado and Adjacent Areas; in COLORADO GEOLOGY, Rocky Mtn. Assoc. Geologists, p. 301-313.

_____, 1978, Influence of Transcontinental Arch on Cretaceous Marine Sedimentation: A Preliminary Report; Rocky Mtn. Assoc. Geologists Symposium, p. 211-222.

TABLE 15-13

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 40,000
TYPE: Blanket

BASIN: Denver
SUBBASIN: Area B
FORMATION: Muddy J

DEPTH (FT.): 8000
PRESSURE (PSIA: 3000)
TEMPERATURE (°F): 260

NGL(BBL/MMCF): 25.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.01	20	6.5	14	80.8	59	.50	.75	1.0
0.003	35	6.3	18	176.05	120	.80	.75	1.0
0.001	125	6.1	24	812.5	515	.70	.90	1.0
0.0003	170	5.9	31	1380.4	813	.80	1.0	-
0.0001	100	5.7	40	1012.0	550	.80	1.0	-
0.00003	50	5.5	53	647.0	322	1.0	1.0	-
	500			4109.	2379			

TABLE 15-14

WELL PRODUCTION SUMMARY--BASE CASE

DENVER B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1				89	59	45	30	21	14	
2				52	33	23	16	11	8	
5				33	20	14	9	6	4	
10				24	15	10	6	4	3	
15				21	13	8	5	3	2	
20				18	11	7	5	3	2	
30				15	9	6	4	2	1	
30-YEAR CUMM. PROD. (MMCF)				765	486	339	219	152	104	

TABLE 15-15

WELL PRODUCTION SUMMARY--ADVANCED CASE

DENVER B

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1				225	188	151	105	65	34	
2				144	112	86	61	43	27	
5				92	68	51	36	25	17	
10				71	49	36	25	17	12	
15				59	40	29	20	14	10	
20				52	35	25	17	12	8	
30				45	30	21	14	10	7	
30-YEAR CUMM. PROD. (MMCF)				2156	1537	1149	795	559	371	

TABLE 15-16

PRODUCTION WELL REQUIREMENTS

BASIN: Denver
SUB-BASIN: Area B
FORMATION: Muddy J

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.01	3.8	3.8	59	1.4	1.4	59
.003	7.04	4.0	68	2.2	2.2	120
.001	12.1	4.0	170	3.6	3.6	515
.0003	21.7	4.0	150	6.0	6.0	813
.0001	36.	4.0	61	10.0	10.0	550
.00003	61.	4.0	21	17.34	12.0	223
			529			2280

TABLE 15-17

INVESTMENT AND OPERATING EXPENSES

BASIN: Denver
SUB-BASIN: Area B
FORMATION: Muddy J

Geology and Geophysics ($/Prospect)	45,000
Drilling Cost ($/Well)	430,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	92,500
- Advanced Case [2000/4000 Ft. Fracture]	304,000 - 331,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	10,000
Compressor Fuel Cost, Ratio of Cost to W.I. Gas Revenue	.0269

TABLE 15-18

ECONOMICS SUMMARY,

BASIN Denver — TECHNOLOGY Base

SUB BASIN Area-B — FORMATION — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
0 502111	1.50	0	0 -	726	-	-414	0	-	-	-	0	-	-	-	-	-
21	2.50	0	0 -	"	-	-414	0	-	-	-	0	-	-	-	-	-
31	3.10	0	0 -	"	-	-414	0	-	-	-	0	-	-	-	-	-
41	3.50	2.8	1 D	912	.261	-348	0	-	-	-	2.5	-	-	-	-	-
51	5.00	"	" "	"	"	-280	0.80	-	-	-	"	-	-	-	-	-
61	7.00	8.0	2 DE	1289	.703	38	10.8	127	179	181	7.0	191	14	36	145	387
71	9.00	25.6	3 DEF	2055	1.360	676	21.3	297	694	218	22.5	192	56	103	410	761
81	12.00	50.9	4 DEFG	2856	1.818	1626	33.2	447	1507	246	44.7	155	125	185	740	1205
Discount Rate 15%																
12	1.50	0	0 -	726	-	-415	0	-	-	-	0	-	-	-	-	-
22	2.50	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
32	3.10	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
42	3.50	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
52	5.00	2.8	1 D	912	.261	-332	0.80	-	-	-	2.5	-	-	-	-	-
62	7.00	8.0	2 DE	1289	.703	-134	10.8	-	-	-	7.0	-	-	-	-	-
72	9.00	"	" "	"	"	18	15.5	127	179	181	"	191	14	36	145	387
82	12.00	25.6	3 DEF	2055	1.360	691	31.2	297	694	218	22.5	192	56	103	410	761
Discount Rate 20%																
13	1.50	0	0 -	726	-	-415	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
33	3.10	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
43	3.50	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
53	5.00	0	0 -	"	-	-415	0	-	-	-	0	-	-	-	-	-
63	7.00	2.8	1 D	912	.261	-310	4.2	-	-	-	2.5	-	-	-	-	-
73	9.00	8.0	2 DE	1289	.703	-113	15.5	-	-	-	7.0	-	-	-	-	-
83	12.00	25.6	3 DEF	2055	1.360	367	31.2	297	694	218	22.5	192	56	103	410	761

* CODE:

D	E	F	G	H	I
0.01	0.003	0.001	0.0003	0.0001	0.00003

TABLE 15-19

ECONOMICS SUMMARY

BASIN Denver — TECHNOLOGY Advanced

SUB BASIN Area B — FORMATION — DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
050221 1	1.50	0	0	-	967	-	-551	0	-	-	-	0	-	-	-	-	-
21	2.50	8.0	2	DE	1316	.874	-336	2.2	-	-	-	7.0	-	-	-	-	-
31	3.10	25.6	3	DEF	2319	2.561	196	12.9	694	694	271	22.5	239	69	94	377	780
41	3.50	"	"	"	"	"	377	15.7	"	"	"	"	"	"	"	"	"
51	5.00	50.9	4	DEFG	4319	4.694	2012	31.4	1507	1507	321	44.7	202	163	277	1110	1752
61	7.00	67.5	5	DEFGH	6990	6.609	4760	46.2	2057	2057	311	59.3	144	210	484	1935	2773
71	9.00	"	"	"	"	"	7077	65.5	"	"	"	"	"	"	"	"	"
81	12.00	78.5	6	DEFGHI	8315	7.423	11207	89.3	2280	2280	307	68.9	108	241	579	2316	3245
Discount Rate 15%																	
12	1.50	0	0	-	967	-	-547	0	-	-	-	0	-	-	-	-	-
22	2.50	2.8	1	D	1044	.261	-497	0	-	-	-	2.5	-	-	-	-	-
32	3.10	8.0	2	DE	1316	.874	-349	4.5	-	-	-	7.0	-	-	-	-	-
42	3.50	"	"	"	"	"	-304	5.9	-	-	-	"	-	-	-	-	-
52	5.00	25.6	3	DEF	2319	2.561	530	26.0	694	694	271	22.5	239	69	94	377	780
62	7.00	50.9	4	DEFG	4319	4.694	2284	49.5	1507	1507	321	44.7	202	163	277	1110	1752
72	9.00	67.5	5	DEFGH	6990	6.609	4561	65.5	2057	2057	311	59.3	144	210	484	1935	2773
82	12.00	"	"	"	"	"	7064	93.3	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	967	-	-547	0	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	"	-	-547	0	-	-	-	0	-	-	-	-	-
33	3.10	2.8	1	D	1044	.261	-495	0	-	-	-	2.5	-	-	-	-	-
43	3.50	8.0	2	DE	1316	.874	-374	5.9	-	-	-	7.0	-	-	-	-	-
53	5.00	25.6	3	DEF	2319	2.561	225	26.0	694	694	271	22.5	239	69	94	377	780
63	7.00	50.9	4	DEFG	4319	4.694	1488	49.5	1507	1507	321	44.7	202	163	277	1110	1752
73	9.00	"	"	"	"	"	2398	66.8	"	"	"	"	"	"	"	"	"
83	12.00	67.5	5	DEFGH	6990	6.609	5014	93.3	2057	2057	311	59.3	144	210	484	1935	2773

* CODE:

D	E	F	G	H	I
0.01	0.003	0.001	0.0003	0.0001	0.00003

Chapter Sixteen

SAN JUAN BASIN

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Chapter Sixteen

SAN JUAN BASIN

GEOLOGY

The San Juan basin is a roughly circular structural depression, strongly asymmetric north to south and is located mostly in the northwestern corner of New Mexico. The lowland part of the basin embraces 12-15 thousand square miles and is underlain by 25-30 thousand cubic miles of sedimentary materials above the Precambrian basement. The Central basin within the outcrop of the major gas productive Cretaceous formations encompasses approximately 8 thousand square miles. The majority of commercial natural gas production is from the Central basin area.

The principal boundaries of the greater San Juan basin are the Zuni uplift to the south, the Defiance uplift to the west, the San Juan uplift to the north and the Nacimiento uplift to the east. Figure 16-2 shows the outline of the basin.

The sedimentary sequence in the San Juan basin ranges from Cambrian to the Recent and is up to 14 thousand feet thick in the deepest portion. There are no Ordovician or Silurian sediments. See Figure 16-3 for the correlation diagram. The major gas producing horizons are the Dakota Formation, the Mesaverde Group and the Pictured Cliffs Formation, all upper Cretaceous in age. In addition, lesser amounts of production are taken from the upper Cretaceous Graneros, Gallup, Chacra, Fruitland and Farmington sands. The Graneros sand, where present in the Basin Dakota field, is considered as being a part of the Dakota producing interval by the New Mexico Oil Conservation Commission. A cross section of the basin is shown in Figure 16-4.

General Dakota Tight Gas Formation

The Dakota Formation, due to its inherent "tight sand" characteristics in the San Juan basin, was chosen by Lewin and Associates to be included in their tight sand study. It was also recognized that the Pictured Cliffs sandstone and the Mesaverde sands possibly would qualify as "tight sands," but both Lewin and Associates and the writer felt that the greater emphasis should be concerned with the Dakota Formation since the Blanco Mesaverde field is more completely drilled up and the Pictured Cliffs sands are not so extensive.

The Dakota Formation throughout the basin ranges in thickness from 200 to 325 feet. The lithology is variable and is represented by sandstones, siltstones, shale, coal and conglomerates. The sands within the Dakota interval are present in three zones. The lower zone is at times conglomeratic and has the best reservoir characteristics, however, it is generally water bearing and is not productive of hydrocarbons within the Central basin. The middle

and upper zones and the Graneros sand, where present, are gas productive and are considered as the blanket type sands as set forth by Lewin and Associates. Within the present field limits, the Dakota producing interval averages 50 to 70 feet in thickness, has an average porosity of 8 percent and a water saturation of 30 to 50 percent.

In delineating areas of further drilling of the Dakota in the San Juan basin, an area was outlined around and outside the present Dakota field limits. The outline was restricted to certain limits which were designated by the encountering of updip water and/or the silting out of the sands (see Figure 16-1). In assigning parameters for the undeveloped tight sand areas, reservoir characteristics of a lower quality than those of the field proper were used since these undeveloped areas, in general, exhibit poor producing characteristics. Gas filled porosities ranged from 1.5% to 5%, in situ gas permeabilities ranged from .0004 to .04 md. and net thicknesses ranged from 10 to 30 feet. Average depth was 7,150 feet. A total of 1,188 sections of potential tight gas sands is estimated to exist around the Basin Dakota Field. Details of the gas potential distribution are shown in Table 16-1 indicating a maximum recoverable resource of 2.2 TCF.

The ultimate potential resources noted above are considerably less than 15 TCF in place and 12 TCF potential resources carried in the Lewin and Associates report.

Exploration History and Performance, Past and Future

Hydrocarbons were first discovered in the San Juan basin in 1911, but further development was sporadic until the early 1950's at which time a large scale gas market was initiated. To date, gas production from the three major producing formations, viz., Dakota, Mesaverde and Pictured Cliffs, totals approximately 10.5 TCF, with the Dakota having produced over 3 TCF. Approximately 10,200 wells have been drilled in these formations. Production from the remaining sands is minor in comparison. At the present time, a successful infill drilling program is nearing completion in the Blanco Mesaverde field and an infill program is beginning in the Basin Dakota field, both infill programs being instigated due to the low permeability of the reservoirs. The Dakota "tight sand" drilling program may be restricted to some extent as a result of this newly developing Dakota infill drilling.

A statistical summary of the recent exploration history and performance of the industry in the San Juan basin is shown in Table 16-9. Data are given for the 1960-1969 period and the 1970-1977 period. The number of wildcat wells, wildcat success rate, and amount of petroleum found per successful wildcat well are shown. These statistics are based on American Association of Petroleum Geologists data with some modification to eliminate low risk field extension wells. These data apply to all the formations in the basin that were being explored during this period. Our estimates are limited to the thinner lower quality portions of the Dakota Formation at the edge of the current producing area.

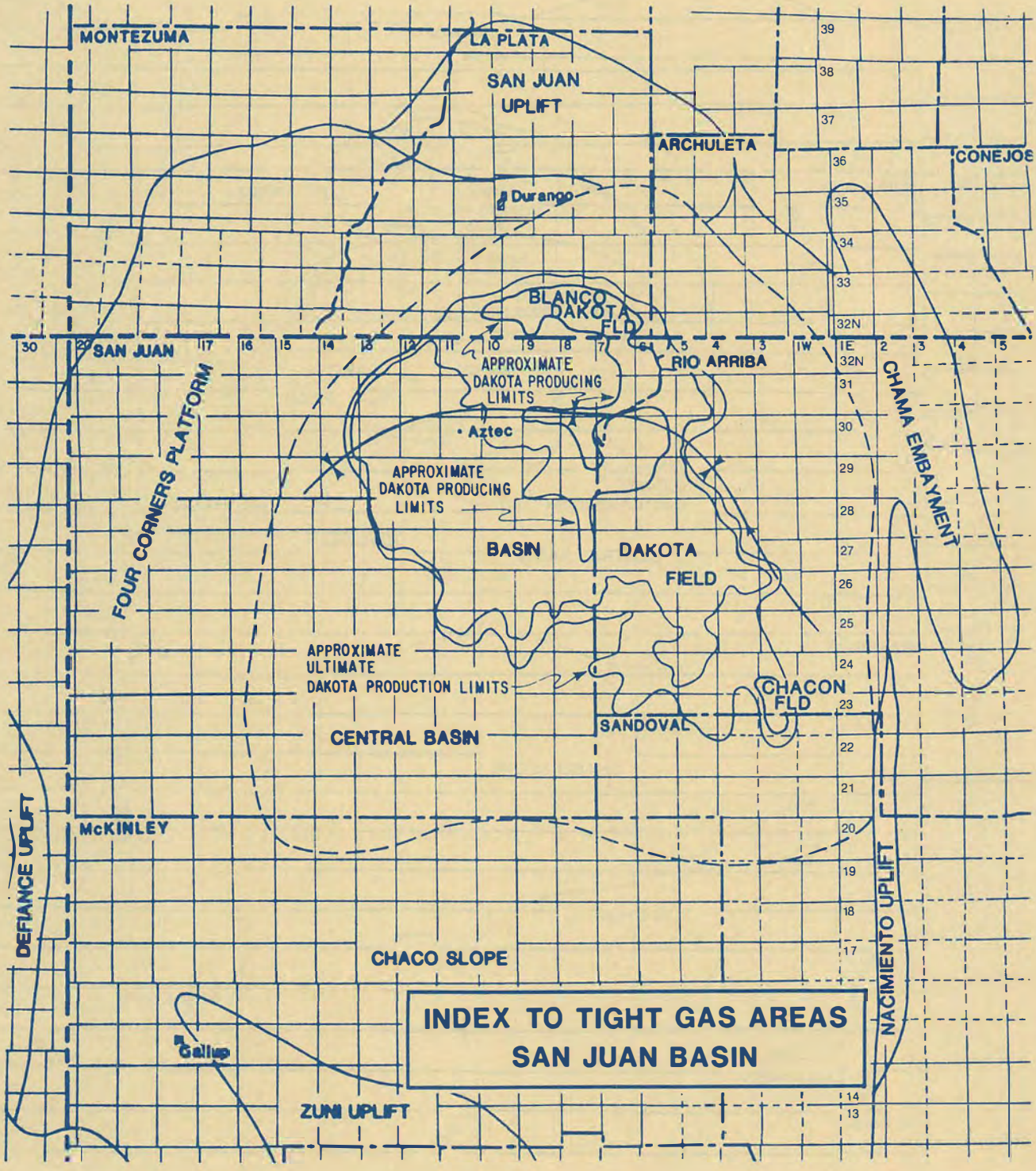


Figure 16-1. Index to Tight Gas Areas -- San Juan Basin.

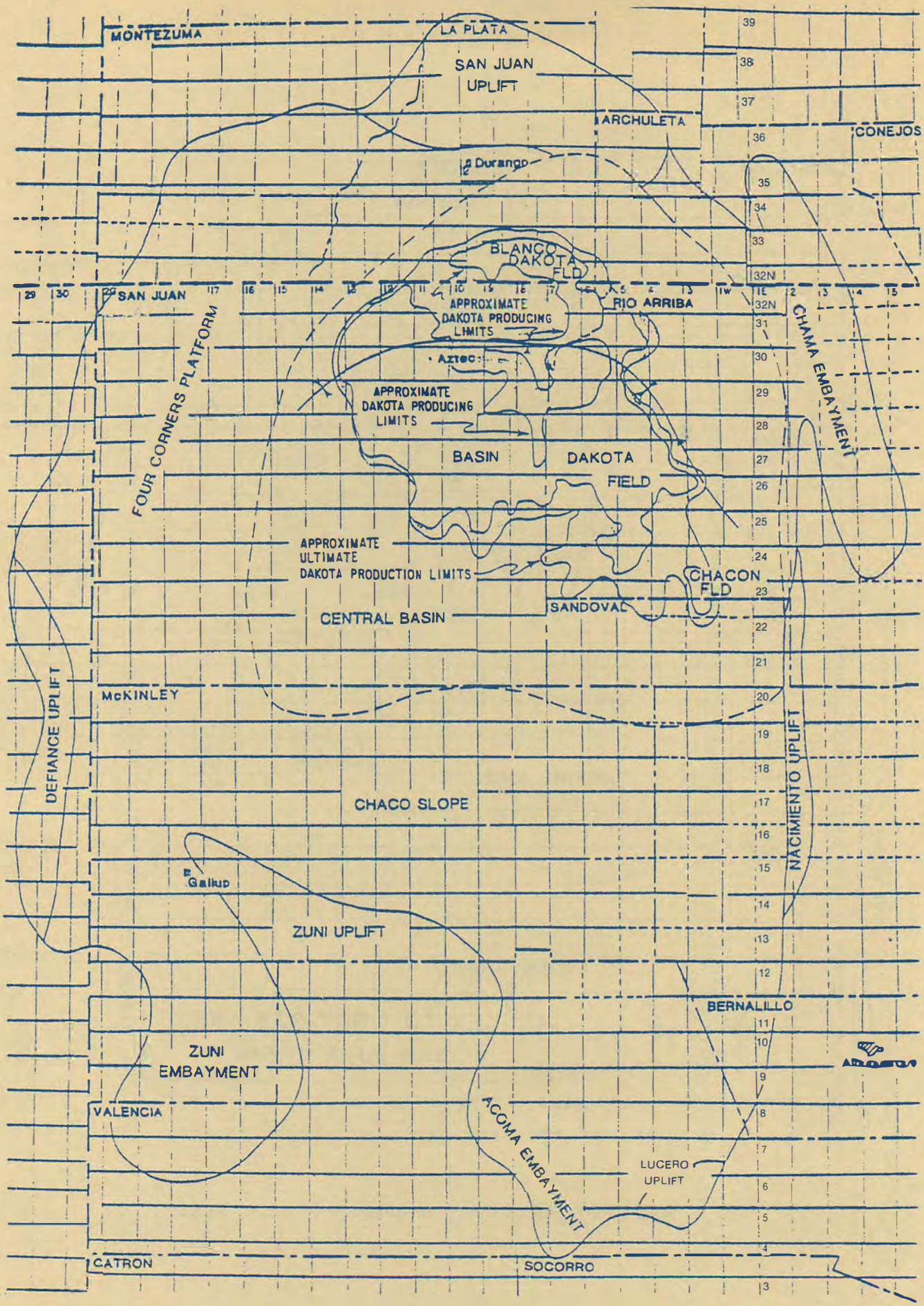


Figure 16-2. San Juan Basin Outline and Basin Axis.

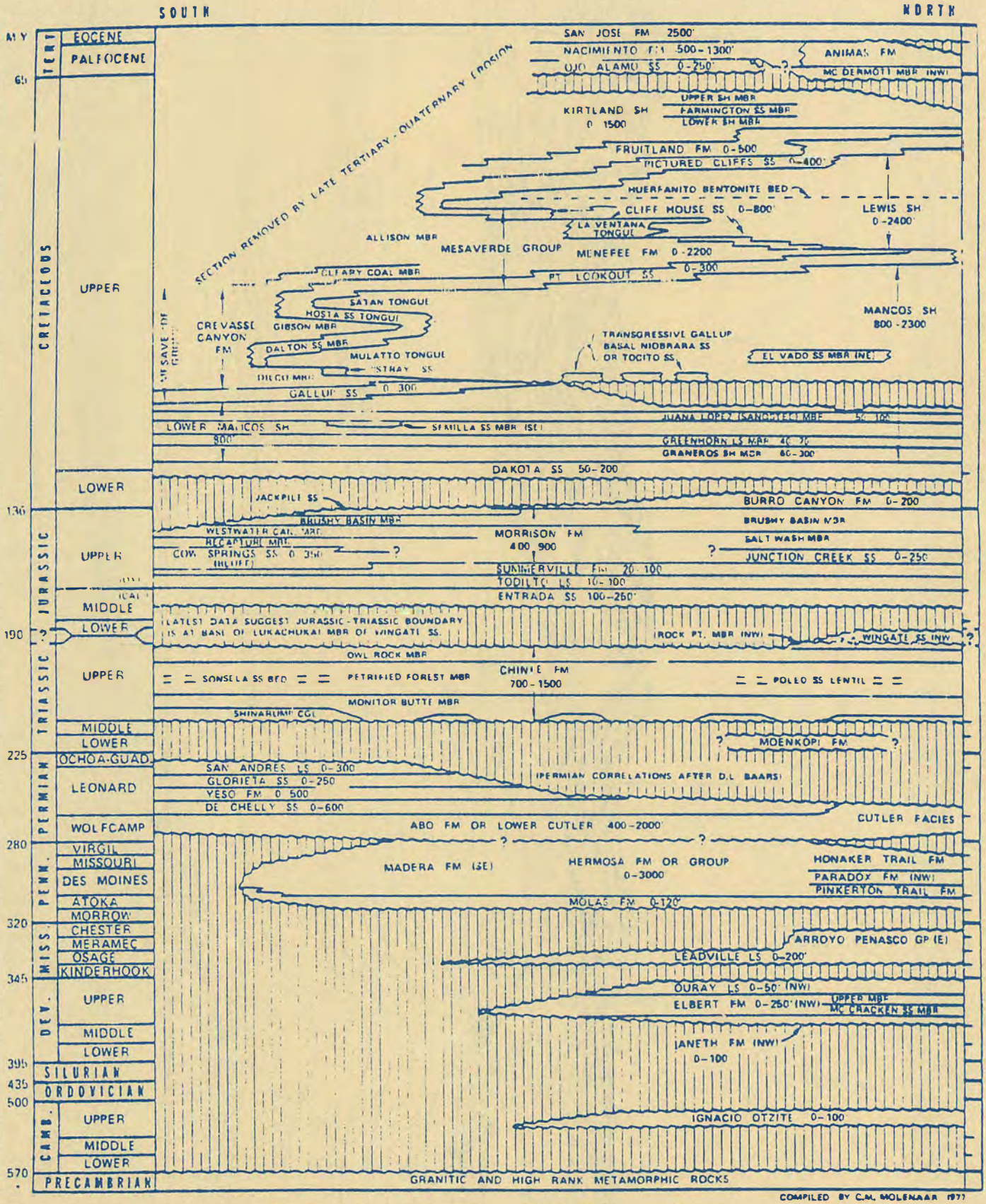


Figure 16-3. Time-Stratigraphic Nomenclature Chart (San Juan Basin).

Four Corners Geological Society

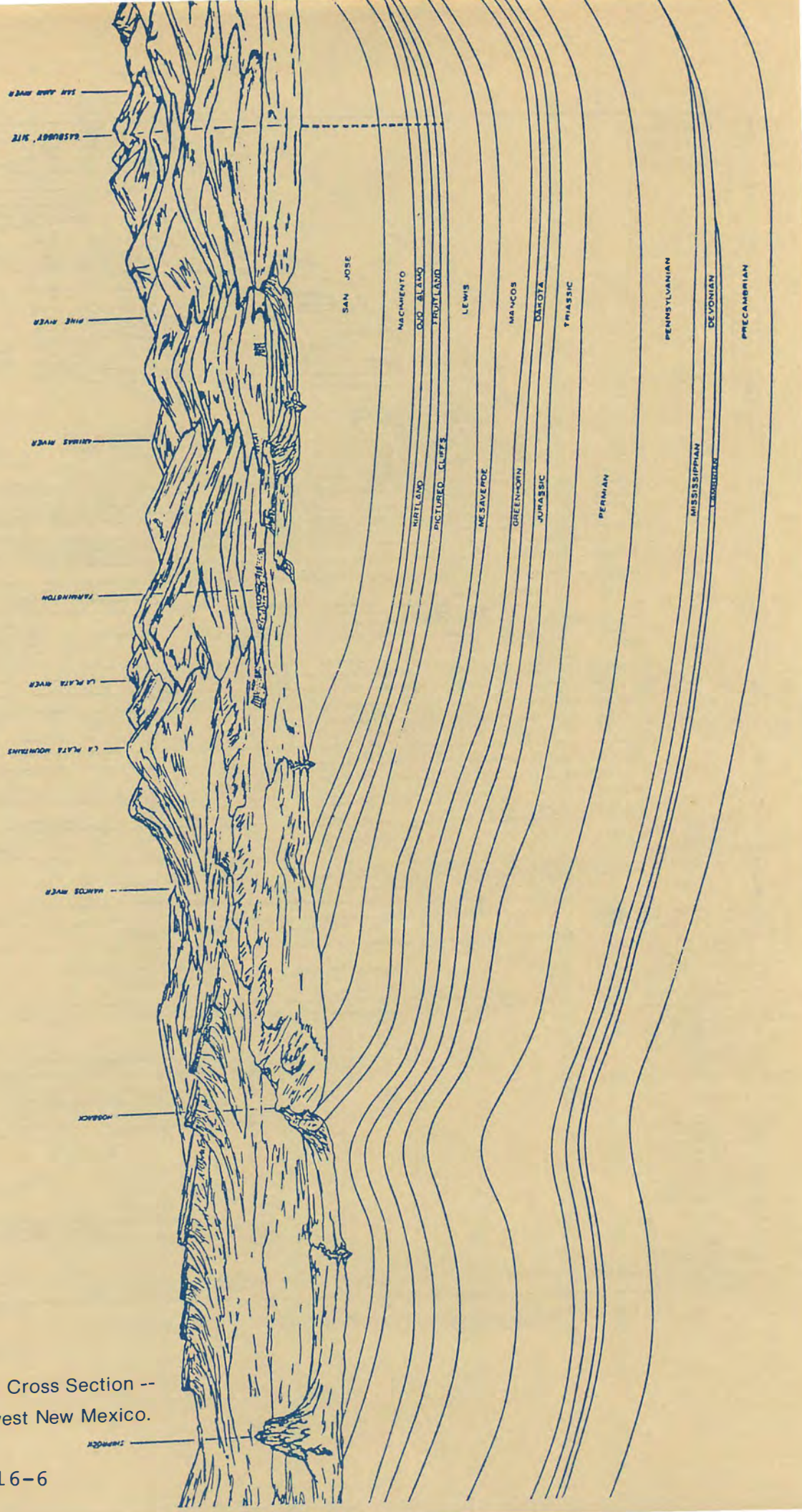


Figure 16-4. East-West Cross Section -- San Juan Basin, Northwest New Mexico.

TABLE 16-1

Geological Data Summary

Total Basin Area (Sections): 8,000
Type: Blanket

Basin: San Juan
Subbasin:
Formation: Dakota

Depth (Ft.): 7150
Pressure (PSIA): 3090
Temperature (°F): 222

NGL(BBL/MMCF): 5.

Average Perm. (MD)	Productive Area (Sections)	H/C Gas Porosity (%)	Net Pay Thickness (Ft.)	Estimated Gas in Place at Reservoir Cond. (BCF)	Max. Recoverable Gas (BCF)	For Each Drilling Location W/C: Probability That State of Nature is Productive	Probability that W/C is Productive, Given that State of Nature is Prod 1st W/C	2nd W/C
0.04	75	5.0	10	184.13	142	0.93	0.95	1.0
0.01	150	4.0	15	441.9	321	0.93	0.95	1.0
0.004	515	3.0	20	1,517.19	1,031	0.93	0.95	1.0
0.001	300	2.25	25	828.0	526	0.85	0.95	1.0
0.0004	148	1.5	30	327.08	193	0.85	0.95	1.0
	1,188			3,298.	2,213			

The 12 percent successful wildcats reported for the 1970-1977 period indicates that at the prices, 300 foot fractures, and quality of prospects available at that time, no more than 12 percent of the wells were profitable. The others were classed as dry holes and abandoned. At a price of $3.50/MCF and 1,000 feet fractures with a 15 percent DCF rate of return, our estimates indicate 15 percent of the wildcats would be profitable and successful.

The average discovery of 1.97 BCF per successful wildcat at 1970-1977 conditions compares with our projected discovery of 31 BCF per successful wildcat at $3.50/MCF and 15 percent DCF rate of return. Note that the percent successful new field wildcats increased from 3.9 percent in the 1960's to 12.5 percent in the 1970's and could rise to 15 percent in the 1980's. The decline in BCF found per successful wildcat is an indication that the better prospects were being drilled in the 1960's. This decline is projected to be reversed by higher gas prices and longer fractures as indicated above.

The number of gas exploration wells drilled over this 18 year period had declined from 30 to 15 per year. Recent approval of 160 acre spacing per well for the Dakota will delay moving into the lower quality areas for perhaps five years. Afterward the 92 wildcats required for the estimated 80 prospects could be drilled rapidly if economics improved.

Characteristics of Traps and Reservoirs

The Dakota of the San Juan basin is different from the producing areas of other basins in that production to some degree can be expected at most any location within the limits as defined by updip water and the silting out of the sands. In other words, localized structural traps are non-existent and production deviations are the result of changing reservoir characteristics and/or localized areas of natural fractures. The size of tight gas Dakota fields may be estimated from Figure 16-5.

The exploration simulator was programmed to take these basin characteristics into account. Table 16-1 is the geological data summary. It shows state of nature 93 percent productive for the first three permeaiblity levels and 85 percent for the last two levels. the first wildcat drilled in a productive area is successful 95 percent of the time; the second, if needed, always is successful. However, a successful wildcat must meet economic criteria before going on stream and initiating field development. Figure 16-5 shows a range of field sizes from 10 to 200 BCF. Tables 16-6 and 16-7 show how recoverable gas depends upon reservoir characteristics, gas selling price, and DCF rate of return. These tables also show increasing wildcat success as price increases.

PRODUCTION

One formation in the San Juan basin is considered potentially productive of tight gas. The productive area is 1,188 sections and the maximum recoverable gas is calculated to be 2,213 BCF. A full

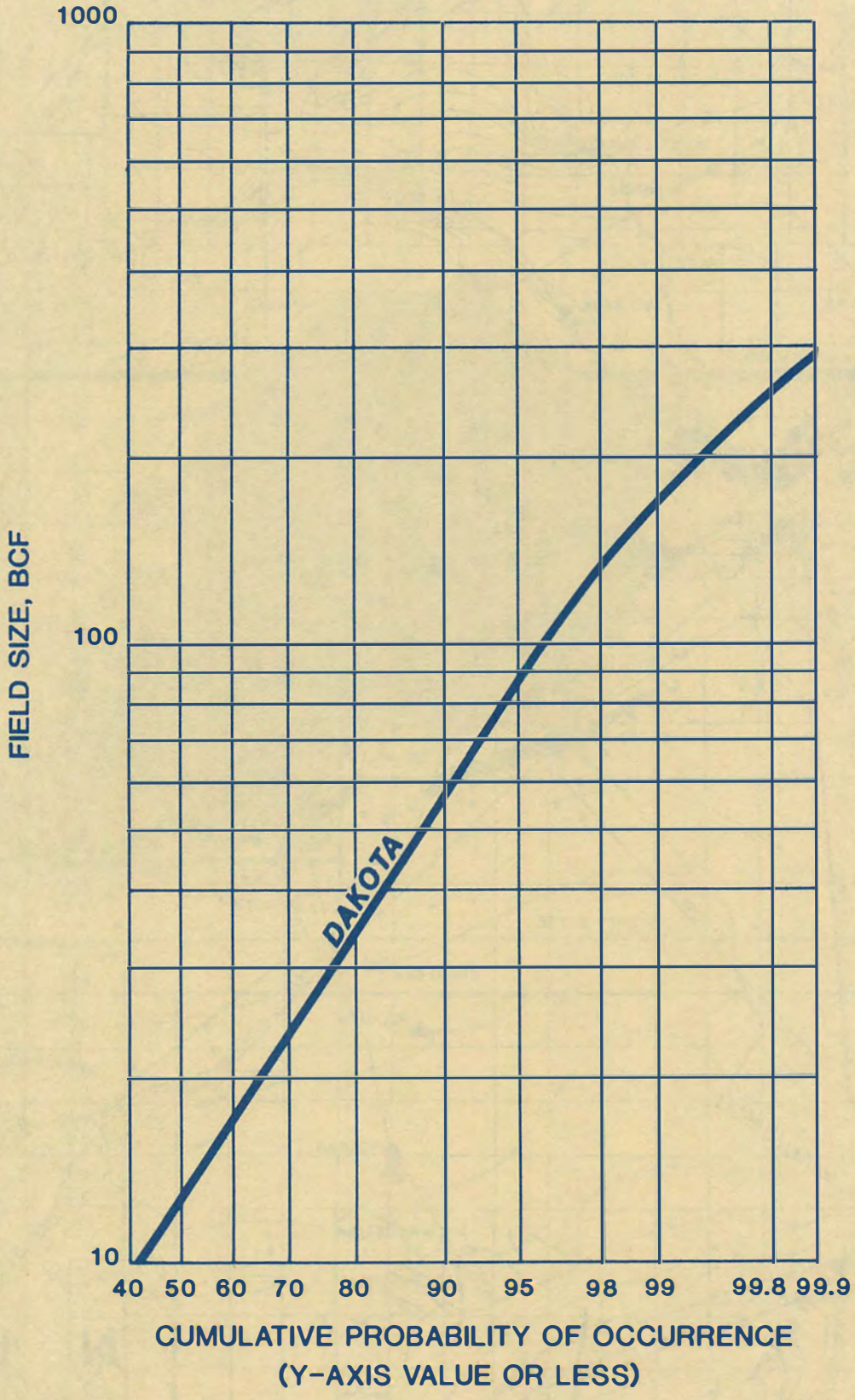
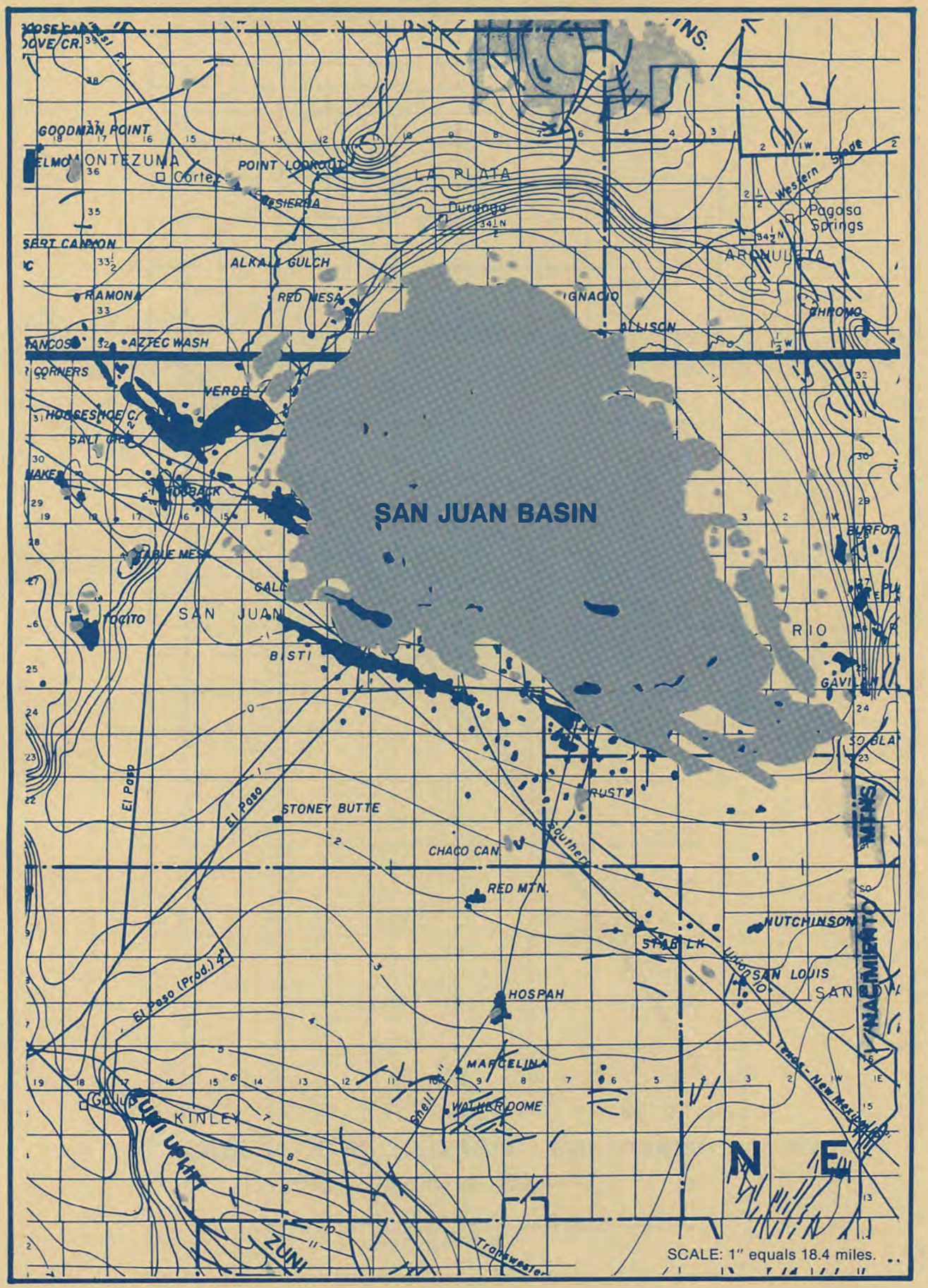


Figure 16-5. Field Size Distribution of Producible Gas, San Juan Basin.



SOURCE: Petroleum Information Corporation. Updated to September 1978.

Figure 16-6. Oil and Gas Fields Map—San Juan Basin.

set of tables is presented and the production potential and economics can be obtained by analyzing the set. The gas potential for the whole basin as a function of gas price is summarized in Table 16-8.

The geological data used in both the reservoir and exploration simulators are shown in Table 16-1. The production rates estimated with the reservoir simulator for each permeability level are shown in Table 16-2. These rates are for base case technology with a fracture half-length of 1,000 feet. Annual gas production in millions of cubic feet per year per well and the cumulative production over a 30-year period are given. The 30-year cumulatives range from 0.155 to 1.323 BCF per well for the five permeability levels studied. Table 16-3 shows the data for the advanced technology case with fracture half-lengths of up to 4,000 feet. The 30-year cumulatives for the advanced technology case are more than 100 percent higher than for the base technology case for all permeability levels.

Production rates for San Juan, Dakota wells will range from about 55 MCF/D to 360 MCF/D for the first year with base technology, depending on permeability level and net pay thickness. With longer fractures, average daily production rates in the first year will range from 200 to 800 MCF/D for the various permeability levels. Rates will decline rapidly, however, and by the fifth year even the best well with advanced technology will be producing only 370 MCF/D.

The Dakota is a blanket sand and the number of wells per section actually drilled will affect the ultimate recovery drastically. Table 16-4 shows the number of wells per section with both base and advanced technology. With base technology, the number of wells required ranges from 1.4 to 8.3 wells per section. However, with base technology and thus current well spacing restrictions, only four wells per section are permitted. The effect is to reduce recoverable gas from the maximum of 2,213 BCF, shown in Table 16-8, to only 1,905 BCF. With advanced technology, well spacing could be varied so that the actual number of wells needed could be drilled. For the Dakota, this would range from 0.66 to 2.38 wells per section. With advanced technology, the full 2,213 BCF could be recovered.

ECONOMICS

The basic geologic and production data were processed with the full cycle exploration and production simulator described in Chapter Four. The data were evaluated to determine the economics of finding and developing the gas in that particular formation. The investment and operating expenses used to evaluate the Dakota are shown in Table 16-5.

The output from the simulator is shown in two tables: the economic summary for the base technology case is shown in Table 16-6;

TABLE 16-2

WELL PRODUCTION SUMMARY--BASE CASE

SAN JUAN, DAKOTA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.4	0.1	0.04	0.01	0.004	0.001	0.0004	0.0001	0.00004	0.00001 (MD)
1			131	86	62	32	20			
2			84	53	35	17	10			
5			59	34	23	10	6			
10			46	26	17	8	5			
15			38	23	15	7	4			
20			31	21	14	6	3			
30			23	18	12	5	3			
30-YEAR CUMM. PROD. (MMCF)			1323	827	556	263	155			

TABLE 16-3

WELL PRODUCTION SUMMARY--ADVANCED CASE

SAN JUAN, DAKOTA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.4	0.1	0.04	0.01	0.004	0.001	0.0004	0.0001	0.00004	0.00001 (MD)
1			289	235	202	117	76			
2			200	148	118	65	40			
5			136	97	74	38	23			
10			99	71	53	28	17			
15			81	59	44	22	14			
20			66	51	39	19	12			
30			49	42	32	16	10			
30-YEAR CUMM. PROD. (MMCF)			2881	2171	1670	885	545			

TABLE 16-4

PRODUCTION WELL REQUIREMENTS

BASIN: San Juan
SUB-BASIN:
FORMATION: Dakota

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.04	1.4	1.4	142	.66	.66	142
.01	2.6	2.6	321	1.1	1.1	321
.004	3.6	3.6	1031	1.2	1.2	1031
.001	6.6	4.	318	1.97	1.97	526
.0004	8.3	4.	93	2.38	2.38	193
			1905			2213

TABLE 16-5

INVESTMENT AND OPERATING EXPENSES

BASIN: San Juan
SUB-BASIN:
FORMATION: Dakota

Geology and Geophysics ($/Prospect)	10,000
Drilling Cost ($/Well)	250,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	93,700
- Advanced Case [2000/4000 Ft. Fracture]	318,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	2,500
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0297

TABLE 16-6

ECONOMICS SUMMARY

BASIN San Juan

SUB BASIN

FORMATION

TECHNOLOGY Base

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																	
1601111	1.50	6.2	1	C	1357	1.889	-292	3.7	-	-	-	5.3	-	-	-	-	-
21	2.50	17.6	2	CD	3420	5.527	392	13.8	463	463	84	15.1	83	15	120	480	697
31	3.10	56.2	3	CDE	12477	16.165	1690	15.8	1494	1494	92	48.3	55	52	569	2277	2953
41	3.50	"	"	"	"	"	2602	19.1	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	6040	32.7	"	"	"	"	"	"	"	"	"
61	7.00	76.9	4	CDEF	19475	21.227	11711	40.8	1812	2020	85	66.1	33	65	839	3355	4293
71	9.00	"	"	"	"	"	17468	59.9	"	"	"	"	"	"	"	"	"
81	12.00	88.7	5	CDEFG	24132	23.224	26920	77.1	1905	2213	82	76.3	23	73	1010	4040	5145
Discount Rate 15%																	
12	1.50	0	0	-	702	-	-428	0	-	-	-	0	-	-	-	-	-
22	2.50	6.2	1	C	1357	1.889	-200	9.6	-	-	-	5.3	-	-	-	-	-
32	3.10	17.6	2	CD	3420	5.527	259	18.5	463	463	84	15.1	83	15	120	480	697
42	3.50	"	"	"	"	"	488	21.7	"	"	"	"	"	"	"	"	"
52	5.00	56.2	3	CDE	12477	16.165	3202	32.7	1494	1494	92	48.3	55	52	569	2277	2953
62	7.00	"	"	"	"	"	6400	53.0	"	"	"	"	"	"	"	"	"
72	9.00	76.9	4	CDEF	19475	21.227	10639	59.9	1812	2020	85	66.1	33	65	839	3355	4293
82	12.00	"	"	"	"	"	16670	91.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	702	-	-437	0	-	-	-	0	-	-	-	-	-
23	2.50	6.2	1	C	1357	1.889	-304	9.6	-	-	-	5.3	-	-	-	-	-
33	3.10	"	"	"	"	"	-217	12.8	-	-	-	"	-	-	-	-	-
43	3.50	17.6	2	CD	3420	5.527	96	21.7	463	463	84	15.1	83	15	120	480	697
53	5.00	56.2	3	CDE	12477	16.165	1680	32.7	1494	1494	92	48.3	55	52	569	2277	2953
63	7.00	"	"	"	"	"	4079	53.0	"	"	"	"	"	"	"	"	"
73	9.00	"	"	"	"	"	6479	74.5	"	"	"	"	"	"	"	"	"
83	12.00	76.9	4	CDEF	19475	21.227	11431	91.4	1812	2020	85	66.1	33	65	839	3355	4293

* CODE:

C	D	E	F	G
0.04	0.01	0.004	0.001	0.0004

advanced technolgy economics are summarized in Table 16-7. Evaluations are made at discount rates of 10, 15, and 20 percent at several gas prices. Each of the 24 cases shown on each table is a complete evaluation. In other words, the entire basin is drilled and developed assuming that this gas price and discount factor prevail. In each case the table shows the rate of return and the net present value (positive only when the rate of return exceeds the discount rate). When the net present value is not positive, this simply means that none of the gas will be recoverable at this price and discount rate. In Table 16-6 this occurs at the lowest price of $1.50/MCF at all discount rates, at $2.50/MCF for discount rates of 15 and 20 percent, and at $3.10/MCF for a discount rate of 20 percent. As price increases, net present value becomes positive and some gas becomes recoverable. For example, in Case 32, at a 15 percent rate of return and $3.10/MCF, present value is $259 thousand and 463 BCF of gas become recoverable. Note also that permeability levels from 0.04 to 0.01 md will be economic. All other permeability levels were tested but proved uneconomic. As price increases, both net present worth and recoverable gas increase; i.e., at $9.00/MCF, gas from permeability levels from 0.04 to 0.0001 md is recoverable. However, the base case recovery is still less than the maximum which could be recovered with advanced technology, as shown in Table 16-7.

The tables also show the investment required per prospect and the maximum number of prospects available in the basin at the price. The total number of wells required is also shown. Comparison of Tables 16-6 and 16-7 will show the effect of advanced technology. An overall summary of the San Juan basin undiscovered tight gas that is potentially productive is shown in Table 16-8. These estimates for both base and advanced technology cases are calculated for gas prices of $2.50, $5.00, and $9.00/MCF at a 15 percent discount rate.

TABLE 16-7

ECONOMICS SUMMARY,

BASIN San Juan

SUB BASIN

FORMATION

TECHNOLOGY Advanced

DATE May 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO. VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT DRY	WILDCAT PROD.	DEVELOPMENT DRY	DEVELOPMENT PROD.	TOTAL
Discount Rate 10%																
1601211	1.50	17.6	2 CD	2874	5.527	-182	7.9	-	-	-	15.1	-	-	-	-	-
21	2.50	56.2	3 CDE	7950	16.165	2360	23.1	1494	1494	92	48.3	55	52	189	757	1053
31	3.10	"	" "	"	"	3802	31.7	"	"	"	"	"	"	"	"	"
41	3.50	76.4	4 CDEF	13979	22.621	5577	30.2	2020	2020	89	66.1	35	68	343	1372	1819
51	5.00	"	" "	"	"	10682	52.3	"	"	"	"	"	"	"	"	"
61	7.00	88.7	5 CDEFG	18840	25.786	18864	72.3	2213	2213	86	76.3	24	76	456	1825	2381
71	9.00	"	" "	"	"	26700	104.0	"	"	"	"	"	"	"	"	"
81	12.00	"	" "	"	"	38455	150.8	"	"	"	"	"	"	"	"	"
Discount Rate 15%																
12	1.50	6.2	1 C	1552	1.889	-508	2.3	-	-	-	5.3	-	-	-	-	-
22	2.50	56.2	3 CDE	7950	16.165	1018	23.1	1494	1494	92	48.3	55	52	189	757	1053
32	3.10	"	" "	"	"	2039	31.7	"	"	"	"	"	"	"	"	"
42	3.50	"	" "	"	"	2720	37.5	"	"	"	"	"	"	"	"	"
52	5.00	76.9	4 CDEF	13979	22.621	6529	52.3	2020	2020	89	66.1	35	68	343	1372	1819
62	7.00	88.7	5 CDEFG	18840	25.786	12037	72.3	2213	2213	86	76.3	24	76	456	1825	2381
72	9.00	"	" "	"	"	17625	104.0	"	"	"	"	"	"	"	"	"
82	12.00	"	" "	"	"	26007	150.8	"	"	"	"	"	"	"	"	"
Discount Rate 20%																
13	1.50	0	0 -	1039	-	-620	0	-	-	-	0	-	-	-	-	-
23	2.50	17.6	2 CD	2874	5.527	-128	17.4	-	-	-	15.1	-	-	-	-	-
33	3.10	56.2	3 CDE	7950	16.165	1068	31.7	1494	1494	92	48.3	55	52	189	757	1053
43	3.50	"	" "	"	"	1582	37.5	"	"	"	"	"	"	"	"	"
53	5.00	"	" "	"	"	3517	59.7	"	"	"	"	"	"	"	"	"
63	7.00	76.9	4 CDEF	13979	22.621	7874	84.0	2020	2020	89	66.1	35	68	343	1372	1819
73	9.00	88.7	5 CDEFG	18840	25.786	12416	104.0	2213	2213	86	76.3	24	76	456	1825	2381
83	12.00	"	" "	"	"	18799	150.8	"	"	"	"	"	"	"	"	"

* CODE:

C	D	E	F	G
0.04	0.01	0.004	0.001	0.0004

TABLE 16-8

SUMMARY OF SAN JUAN BASIN GAS POTENTIAL

(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
San Juan			0	1494	1812	1494	2020	2213

TABLE 16-9

Exploration Performance - San Juan Basin

	1960 - 1969			1970 - 1977			1960-1977		
	All Wells	New Fields	New Pools and Deeper Prod.	All Wells	New Fields	New Pools and Deeper Prod.	All Wells	New Fields	New Pools and Deeper Prod.
Number of Successful Wildcat Wells									
Total	82	35	47	40	38	2	122	73	49
Gas	49	10	39	15	15	0	64	25	39
Oil	26	23	3	25	23	2	51	46	5
Oil and Gas	7	2	5	0	0	0	7	2	5
Amount of Petroleum Found									
Total (MMBOE)*	132.6	72.1	60.5	20.9	15.5	5.4	153.5	87.6	65.9
Gas (BCF)	349.0	59.0	290.0	29.6	29.6	0	378.6	88.6	290.0
Oil (MM Bbl)	31.4	31.1	0.3	15.3	9.8	5.5	46.7	40.9	5.8
Number of Wildcat Wells									
Total	507	429	78	327	320	7	834	749	85
Gas†	303	257	46	123	120	3	426	377	49
Oil†	161	136	25	204	200	4	365	336	29
Oil and Gas	43	36	7	0	0	0	43	36	7
Number of Wildcats Oil and Gas Per Year	51	43	8	41	40	1	46	42	4
Percent Wildcats Successful									
Total	16.2	8.2	60.3	12.2	11.9	28.6	14.6	9.7	57.6
Gas	16.2	3.9	84.8	12.2	12.5	0	15.0	6.6	79.6
Oil	16.1	16.9	12.0	12.3	11.5	50.0	14.0	13.7	17.2
Oil and Gas	16.3	5.5	71.4	--	--	--	16.3	5.6	71.4
Amount Found/Successful Wildcat									
Total (MMBOEE)	1.6	2.1	1.3	0.52	0.41	2.7	1.3	1.2	1.3
Gas (BCF)	7.1	5.9	7.4	1.97	1.97	--	5.9	3.5	7.4
Oil (MM Bbl)	1.2	1.4	0.1	0.61	0.43	2.8	0.9	0.9	1.2
Average Depth of Wells									
Oil (M Ft)	3.52	3.22	3.38	5.28	5.33	5.30	4.38	4.27	4.33
Gas (M Ft)	7.04	6.10	6.88	5.79	5.78	5.78	6.75	5.91	6.5

*Includes gas in solution with oil and condensate produced with gas. Converstion 5.8 MCF = 1 barrel of oil.
†Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

REFERENCES

1. Barnes, Frank C., 1950. History of Development and Production of Oil and Gas in the San Juan Basin, New Mexico Geological Society, First Field Conference, San Juan Basin, pp. 144-148.

2. Burton, Guy C., Jr., 1955. Sedimentation and Stratigraphy of the Dakota Formation in the San Juan Basin, Four Corners Geological Society Guidebook, pp. 78-88.

3. Deischl, Dennis G., 1973. The Characteristics, History and Development of the Basin Dakota Gas Field, San Juan Basin, New Mexico, Four Corners Geological Society Memoir Book, pp. 168-173.

4. Hoppe, W.F., 1978. Basin Dakota, Four Corners Geological Sociey, Oil and Gas Fields of The Four Corners Area, Vol. 1, pp. 204-206.

5. Kelley, Vincent C., 1950. Regional Structure of the San Juan Basin, New Mexico Geological Society, First Field Conference, San Juan Basin, pp. 101-107.

6. Annual Report of the New Mexico Oil and Gas Engineering Committee, Volume II, Northwest New Mexico, 1978.

7. Enhanced Recovery of Unconventional Gas, Vol. II, Lewin and Associates, Inc., 1978.

Chapter Seventeen

VAL VERDE BASIN, WEST TEXAS
OZONA-SONORA AREA

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Summary of Ozona Gas Potential	17-24

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- Geological Data Summary
- Well Production Summary -- Base Case
- Well Production Summary -- Advanced Case
- Production Well Requirements
- Investment and Operating Expenses
- Economics Summary -- Base Case
- Economics Summary -- Advanced Case

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Chapter Seventeen

VAL VERDE BASIN, WEST TEXAS

OZONA-SONORA AREA

PERMO-PENNSYLVANIAN CANYON SANDSTONE TRENDS

GEOLOGY

General Description

The Ozona-Sonora tight gas reservoir trends are located in southwestern Texas, primarily in the eastern two-thirds of the Val Verde Basin. The area extends eastward onto the Edwards Platform (Arch) and northward onto the Ozona Arch (Figure 17-1). Principal prospective sandstone trends are within the Late Pennsylvanian and Early Permian Canyon Series and extend across six counties: northwestern and east-central Edwards, northern Val Verde, all of Sutton but the northeast, western Schleicher, southern Crockett and northeastern Terrell (Figures 17-1 and 17-2). Val Verde and Edwards are in Railroad Commission District 1, the others in District 7C. An outline of the productive Canyon trends encompasses about 3,800 sections, with about 750 sections estimated to have proven production of gas and condensate.

The Val Verde Basin formed during Late Paleozoic time. Maximum thickness of sedimentary rocks in the Ozona-Sonora area may be about 18,000 feet; in the deepest part of the Basin, the sedimentary section attains a thickness of 28,000 feet, mainly of Pennsylvanian age. The area of the asymmetric depression is about 23,000 square miles. The Basin abuts against the Ouachita-Marathon Frontal Fold Belt on the southwest, the Reagan Uplift and south plunge of the Central Basin Platform on the northwest, and the flank of the Devils River Uplift to the southeast. Val Verde is one of three basins with major oil and gas production comprising the Permian Basin complex, the others being the Delaware to the northwest and the Midland to the north.

Surface rocks in the area of the tight gas reservoir trends are in the Cretaceous System. Sedimentary rocks of Jurassic and Triassic age are absent in the study area (Figure 17-3) and the Cretaceous System directly and unconformably overlies the Permian and Pennsylvania Systems. All pre-Pennsylvanian systems are believed to be represented in the Val Verde Basin, although the Mississippian is restricted to the southwestern third, and Siluro-Devonian rocks are present only in the western half.

Combined Ordovician Ellenburger Formation and Cambrian rocks reportedly range from less than 2,000 feet thick in the west to about 3,000 feet in the east. The younger Simpson Group thickens southwestward from a truncated edge in the eastern part of the

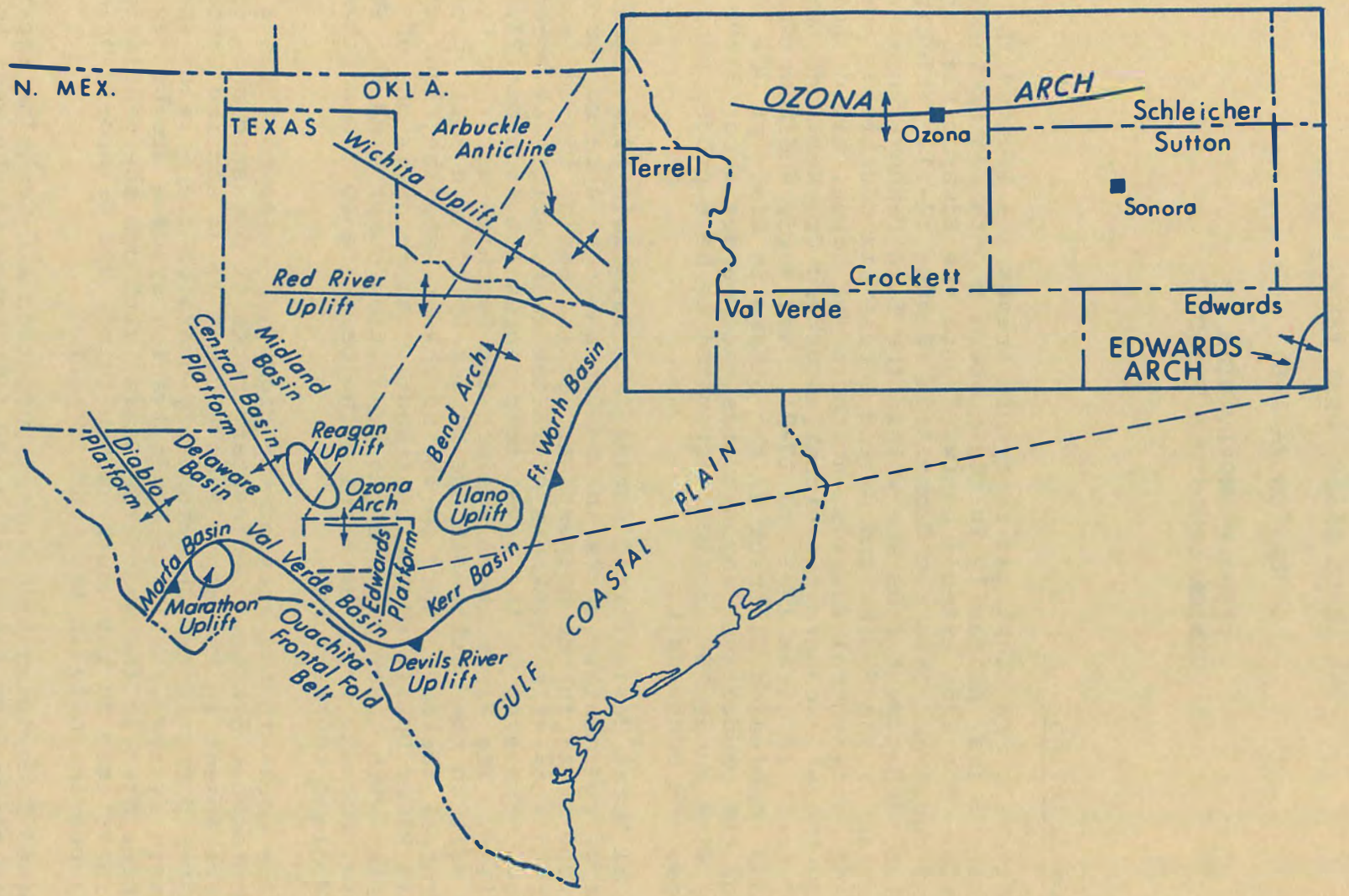


Figure 17-1. Val Verde Basin -- Ozona-Sonora Canyon Sandstone Gas Area.

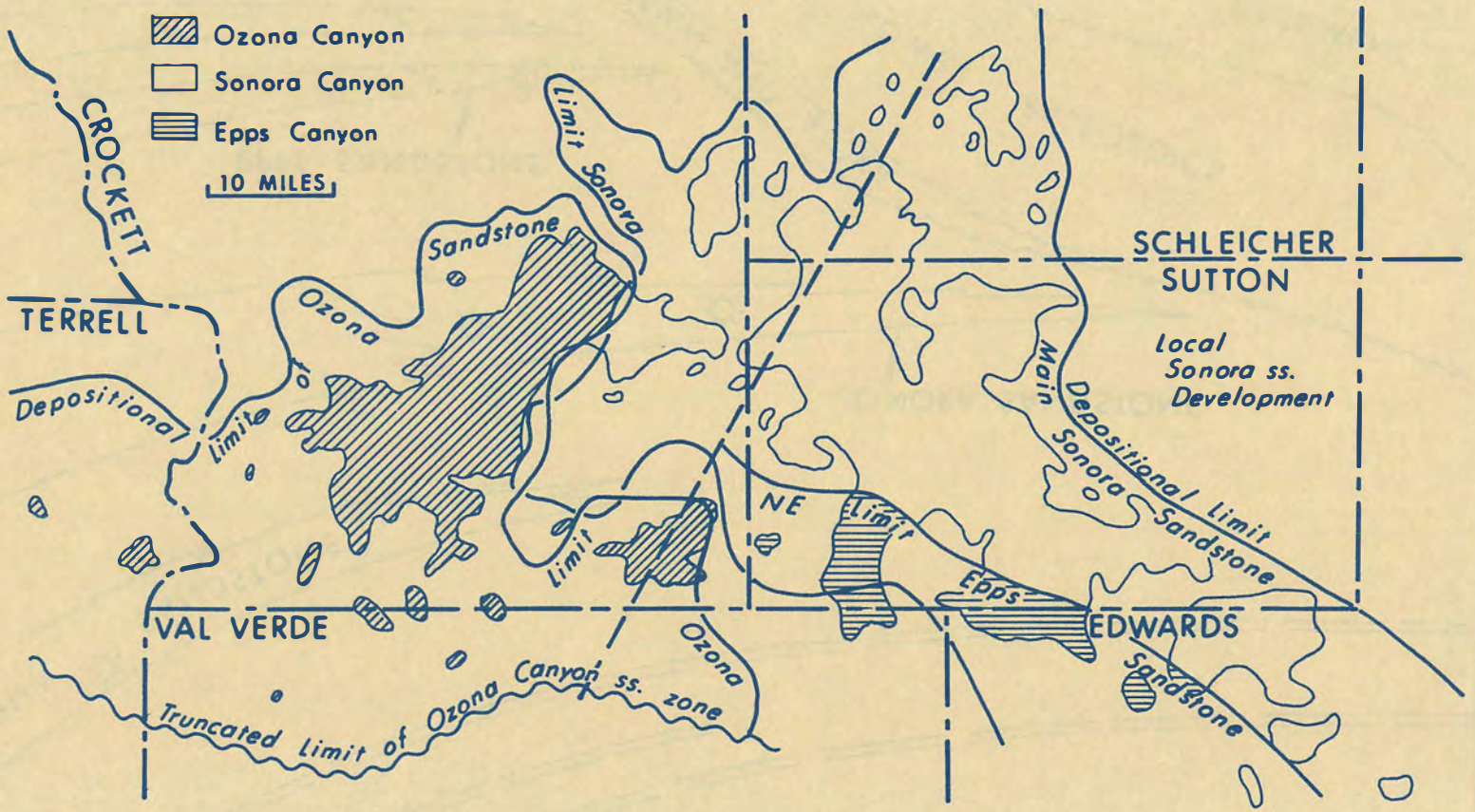


Figure 17-2. Gas Production From Canyon Sandstone -- Generalized Ozona, Sonora and Epps Reservoir Trends.

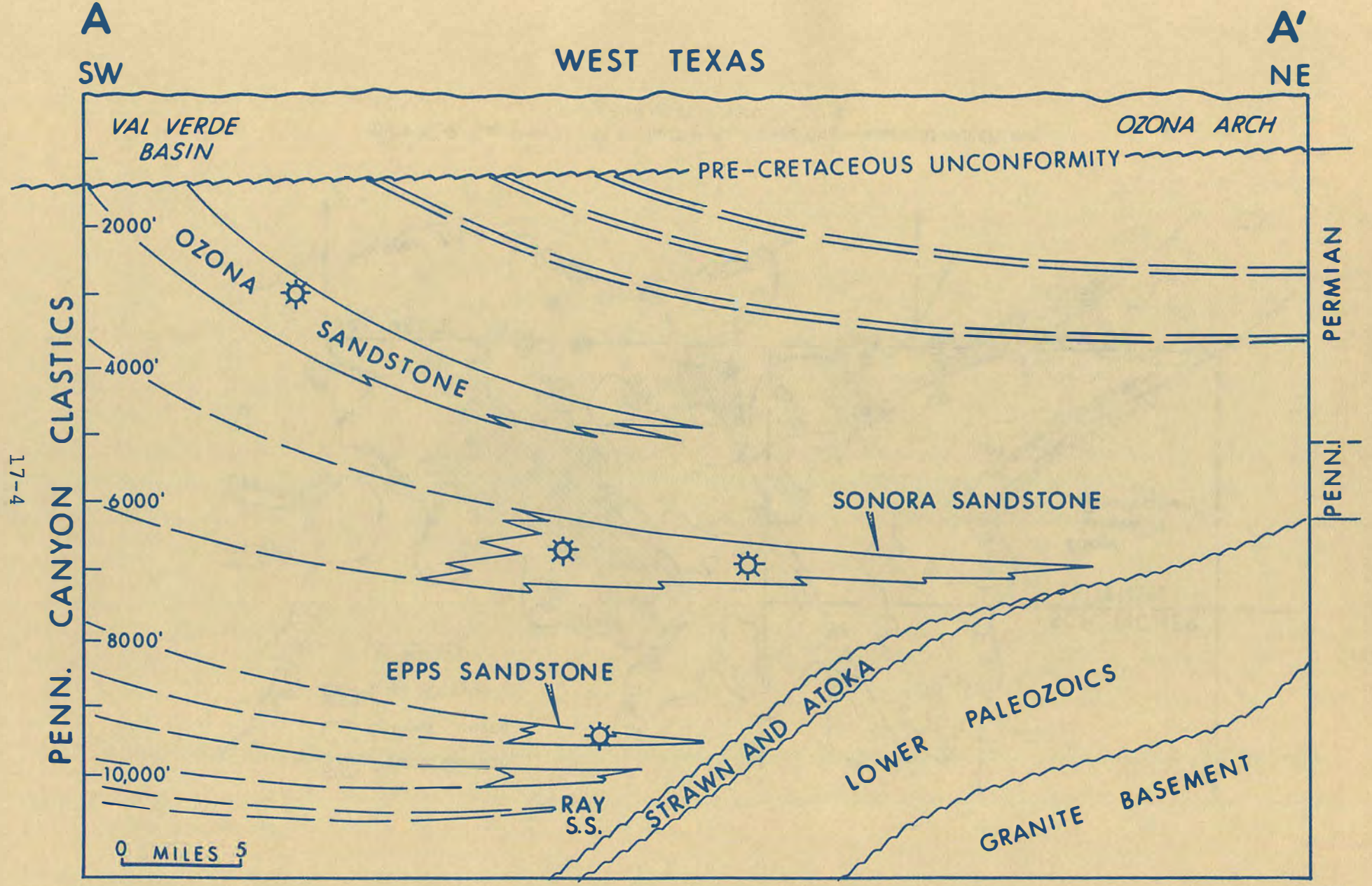


Figure 17-3. Schematic Cross Section -- Ozona-Sonora Gas Trends (West Texas).

Modified after Valder, 1977

basin to more than 2,500 feet in the west. Above the Simpson, Upper Ordovician Montoya group rocks thicken from a truncated edge in the central part of the basin to more than 500 feet in the west. Siluro-Devonian rocks are more than 500 feet thick in the central sector of the basin but are truncated eastward. Similarly, the overlying Upper Devonian Woodford Shale is truncated eastward from a maximum of about 200 feet in the basin's center. Rocks of Mississippian age are thin or absent in the Ozona-Sonora area.

The Pennsylvanian System is extremely thick in the area of interest, much of the thickness attributed to the Canyon Series. Pre-Strawn rocks of Atokan age thicken southeastward from a truncated edge in the north-central part of the basin, but generally do not exceed 500 feet in the study area. The Strawn Series of Desmoinesian age also thickens southeastward to in excess of 1,000 feet. The continental shelf edge was located near and to the southeast of the Val Verde Basin during Early and Medial Pennsylvanian time, thus accouting for the thickening of Lower and Middle Pennsylvanian rocks in that direction.

As a result of plate collision and suturing along the ancient shelf margin, a major mountain-building episode occurred during Late Pennsylvanian time along and adjacent to the south flank of the basin in the Ouachita Frontal Fold Belt (Figure 17-1). From this rapidly elevating positive, great quantities of detritus were shed into the sea occupying the subsiding basin, forming the thick suite of Canyon deposits above the Strawn. These units accumulated from the Ouachita Front northward. Thus, the oldest (Missourian) sequence is thickest in the basin depocenter, and each successive unit becomes progressively thicker in a generally northern direction onto the so-called Intermediate Shelf where the main gas trends are located.

As shown on Figure 17-4, the structure on the top of the Desmoinesian Strawn carbonate sequence dips southwest. The basinal axis at that level is along the southwestern margin, adjacent to the Ouachita Frontal Fold Belt, beyond the mapped area of Figure 17-4. However, thick lower Canyon (Missourian) shales fill this depression so that, in the Ozona Field, as an example, the Canyon sandstone reservoirs (Virgilian- Early Wolfcampian) dip gently toward the Ozona Arch to the north (Figure 17-3). A provenance to the north supplied some of the sediment that was deposited during the later stages of Canyon deposition.

Above the Canyon, Upper Wolfcamp, Leonard and Guadalupe Series of the Permian System complete the Paleozoic sequence that dominates the stratigraphic section in the Val Verde Basin. All of these units are truncated southward across the basin, as shown diagramatically on Figure 17-3.

The Ozona Canyon is truncated southward along a generally east-west arcuate line through Val Verde County (Figures 17-2 and 17-5a). This places a southern limit on the tight reservoir gas-play in that area. In addition, most of the Ozona sandstone units

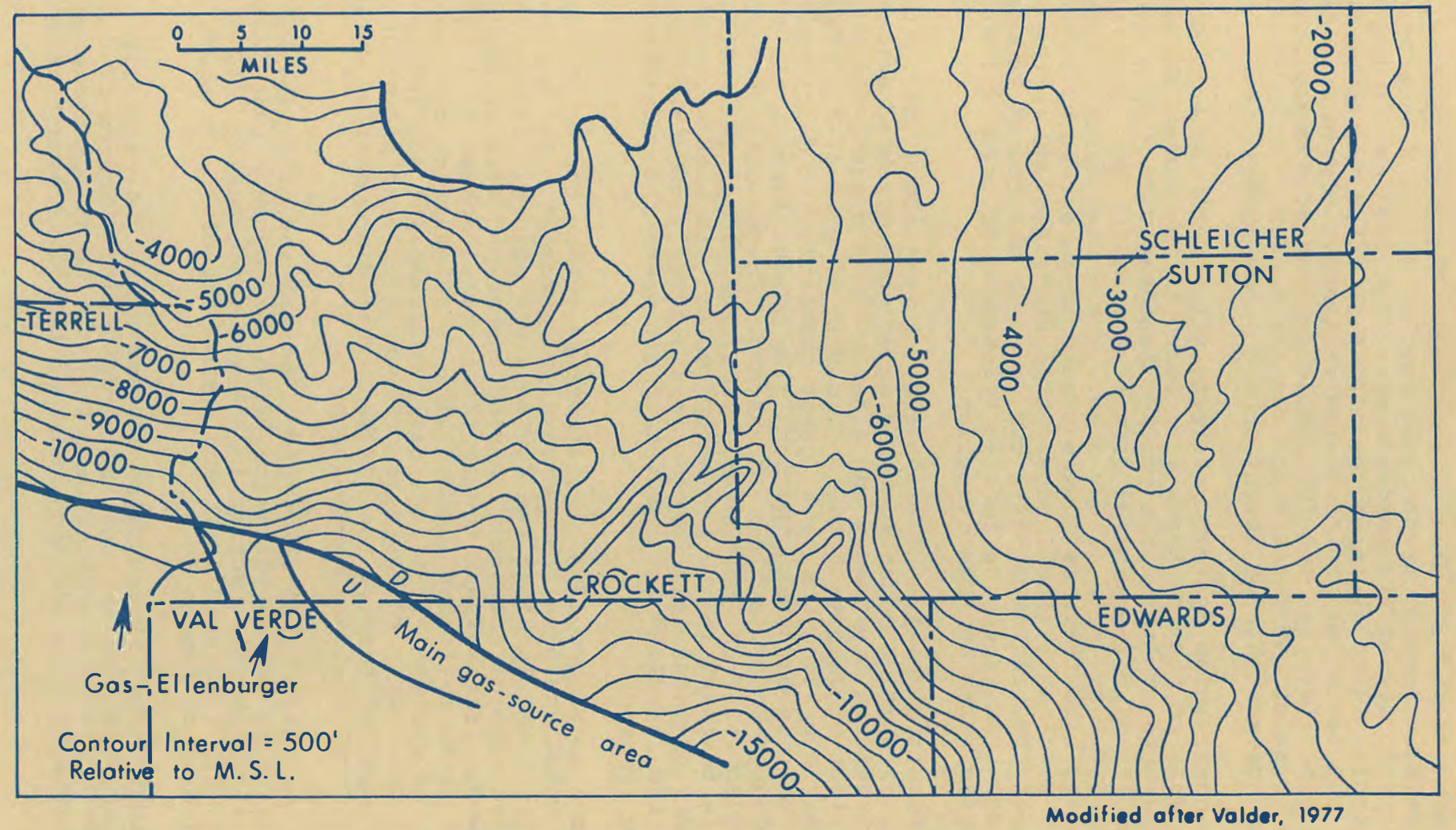


Figure 17-4. Structure Map Top Strawn Carbonate.

that are preserved near the truncation edge are essentially clay-free, but they reportedly are tight in much of that area, having been thoroughly cemented by silica.

North of the established producing trends, the sandstone reservoirs thin depositionally and by intraformational erosion at minor unconformities separating cyclic units (Figures 17-5a, 5b, and 5c). Hence, the poorer-quality clayey sandstone beds along the established trends provide the only gas reservoirs and, except locally (Figure 17-5c), they have low producibilities. They are absent over the Ozona arch except in western Schleicher County and eastern Crockett County. Therefore, the most prospective areas and reservoir sections are already well-defined.

To the southeast, the cut-off on establishing commercial production appears to be the crest of the Edwards Arch. No production of commercial importance is present on the eastern flank of the Arch or in the nearby Kerr Basin to the east.

Depositional, erosional and diagentic processes, in combination with widespread pre-Cretaceous meteoric water recharge, all placed definite limitations on entrapment and preservation of gas in the Canyon Series. As discussed under Gas Source Rocks, the relatively early (Permian Period) expulsion of gas from the deep source rocks was followed by cooling, greatly reduced pressures and consequent suspended gas generation in source rocks; all of these factors imposed additional limitations on the amount of gas in these trends.

Tight Gas Formations

The tight gas reservoirs in the Ozona-Sonora trends are primarily in clayey turbidite sandstone. Some are described as bars and channels. All are considered of Late Pennsylvanian (Virgilian and Missourian) age and Early Permian (Wolfcampian) age, and are assigned to the Canyon Series (Figures 17-2 and 17-3). Several large fields and many small fields have been discovered along these trends (Table 17-1). The major gas-productive zones are the Virgilian-Wolfcampian Ozona sandstone to the west and the older Virgilian Sonora Sandstone to the east. Minor overlap of these trends occurs in Crockett County (Figure 17-2). The Epps Sandstone (Virgilian and/or Missourian) below the Sonora is also part of the Canyon Series and is locally important as a deep producer of gas from tight reservoirs along the southern margin of the Sonora producing trend. The Epps and Sonora trends partially overlap (Figure 17-2). The deepest prospective tight gas reservoirs are in the Ray Sandstone (Figure 17-3); the Ray Sandstone zone is the thinnest of the tight gas reservoir intervals in this general area. All are considerably underpressured.

Substantial gas reserves of a more conventional nature have been developed locally in carbonates of the Middle Pennsylvanian Strawn Series which is best developed along and to the south of the Ozona-Sonora trends. Generally tight Early Permian Wolfcamp Series sandstone reservoirs are considered prospective for gas to the west of the Ozona trend but are not considered in this evaluation because of limited control.

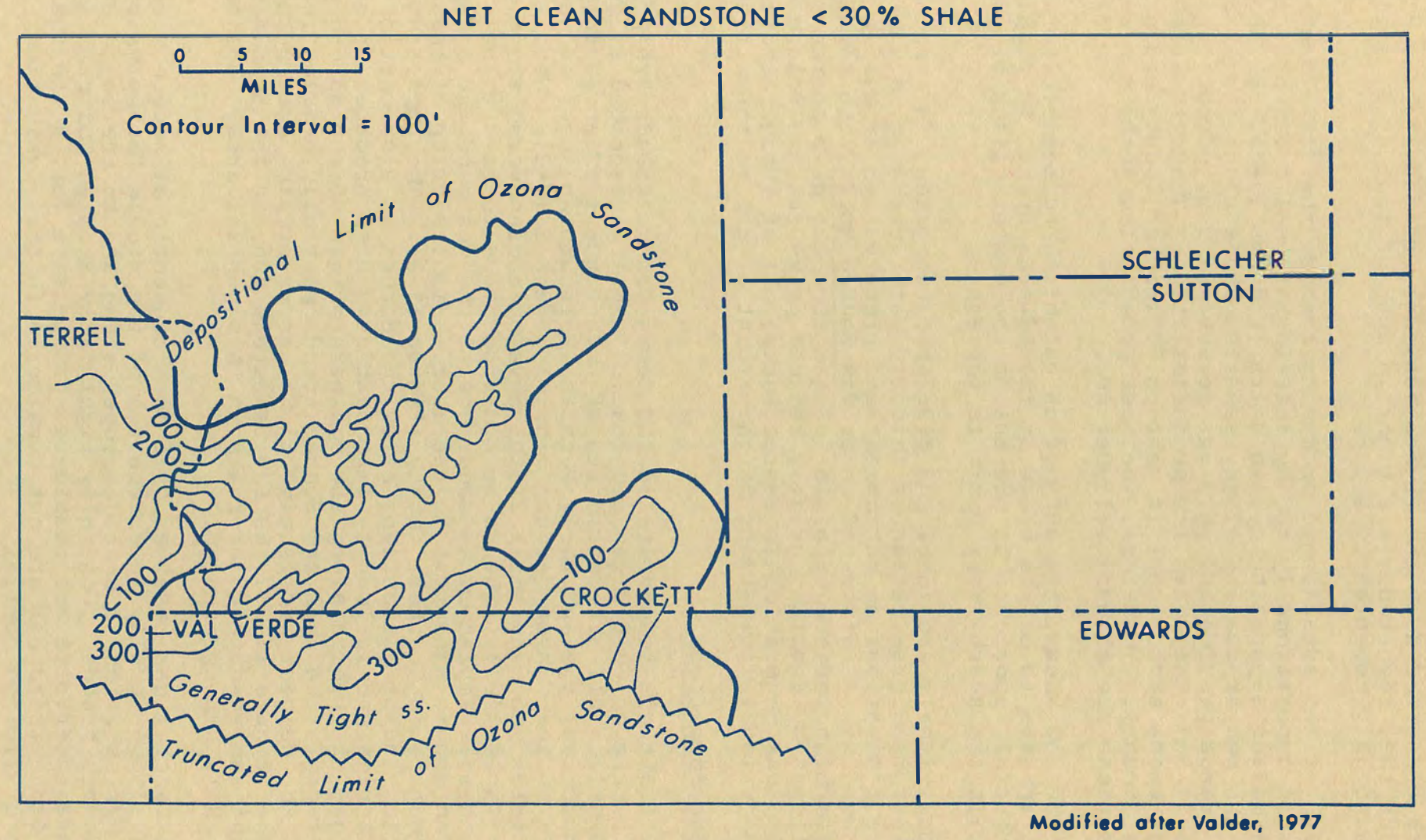


Figure 17-5a. Isopachs of Ozona Sandstone.

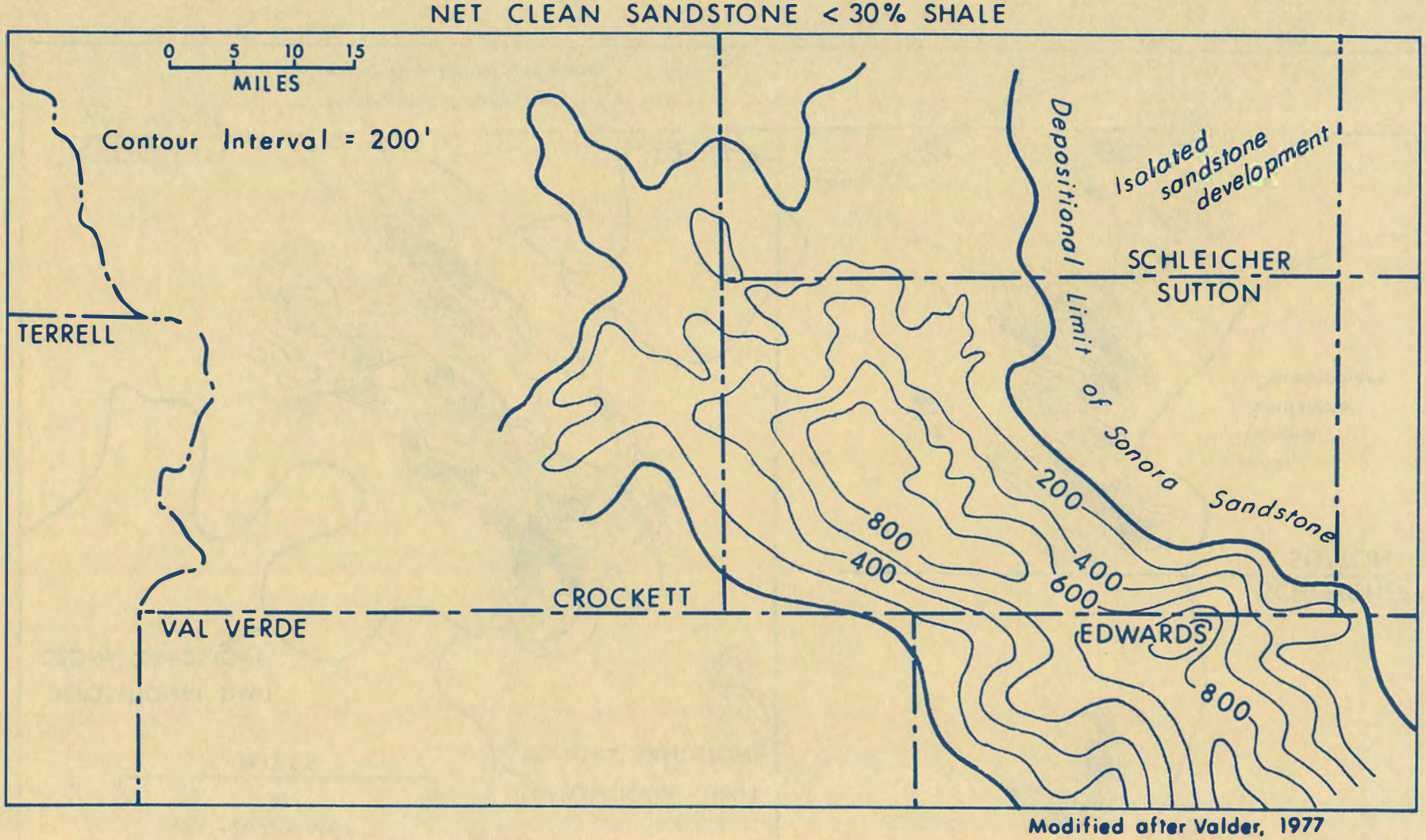


Figure 17-5b . Isopachs of Sonora Sandstone.

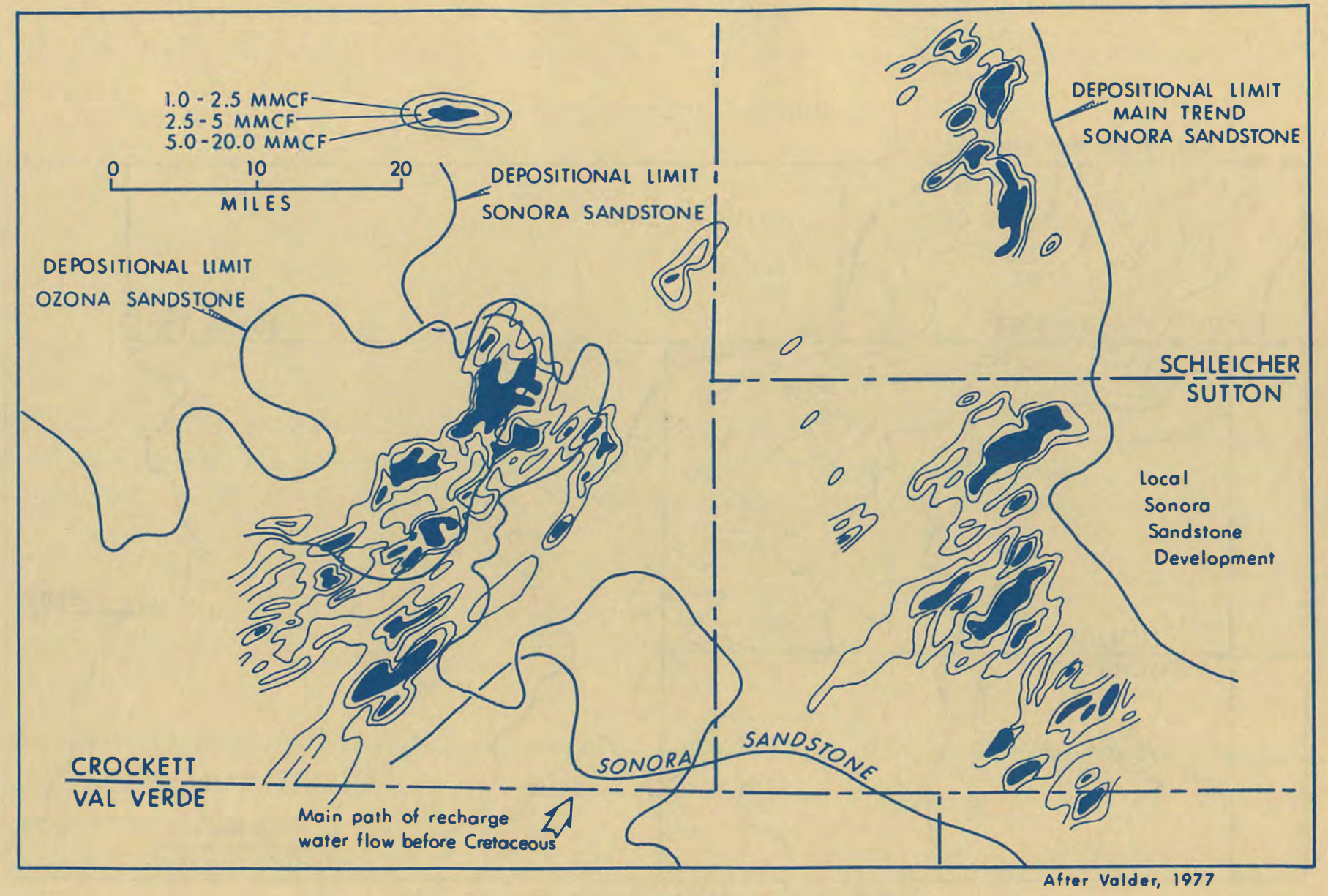


Figure 17-5c. CAOF Isopotential.

TABLE 17-1

Ozona-Sonora-Epps Trends
Field Status January 1, 1977

Field	County	Discovery Year	Wells Active	(Inactive)	Cumulative Gas, BCF	+ COND., 1000 Bbls
Permian Wolfcamp Reservoirs:						
K.M.	Terrell	1974	5		5.00	109
Pennsylvanian Ozona Canyon Reservoirs:						
Brown-Bassett	Terrell	1961	1	(1)	2.40	6.5
Ozona	Crockett	1963	371	(19)	255.50	1254
Davidson Ranch	Crockett	1965	7		1.80	38.1
Morrison	Crockett/ Val Verde	1966	1		0.74	
Adams Baggett	Crockett	1970	44		1.90	1.8
Euluone	Crockett/ Val Verde	1974	3	(1)	0.32	
Miller	Crockett	1975	1		0.005	
Cox	Crockett	1976	1		0.019	
			Subtotal		262.68	1563
Pennsylvanian Sonora Canyon Reservoirs:						
Sonora	Sutton	1954	109	(51)	100.0	294
Roberts	Sutton	1960	2	(3)	1.60	2.2
Meirs	Sutton	1962	16	(2)	7.10	
Baggett	Crockett	1964	1		0.55	
Denison	Sutton	1965	1	(1)	0.04	
Lucky Lucy	Sutton	1965		(1)	0.09	
Davidson Ranch	Crockett	1966	56		55.00	43
Ozona, N.E.	Crockett/ Schleicher	1966	32	(3)	7.00	103
Rock Springs	Edwards/ Sutton	1967	3	(2)	0.50	
X-Bar	Schleicher	1967		(1)	0.06	
Sawyer	Sutton/ Schleicher	1967	632	(10)	134.3	518
Buckhorn, N.	Schleicher	1967	1	(1)	0.08	12
W.J.B.	Schleicher	1970	4		1.50	11.4
N. Branch	Sutton	1970	2		0.36	
Henry Speck	Schleicher	1971	9		0.33	2.3
Interstate	Sutton	1971	5		0.35	
Espy	Sutton	1972	11		4.00	17.2
Shurley Ranch	Sutton	1972	29		8.57	10.2
Mayer Ranch	Schleicher/ Sutton	1973	12		0.51	1.0

TABLE 17-1 (Continued)

Field	County	Discovery Year	Wells Active	(Inactive)	Cumulative Gas, BCF + COND., 1000 Bbls	
Roy Baker	Edwards	1973	11		0.79	
Companero, N.	Edwards	1973	2	(1)	0.08	
Companero	Edwards	1973	8		0.71	
Companero, E.	Edwards	1973	11		0.74	
Pan-Gil	Edwards	1975	5		0.23	
Hackberry Creek	Edwards	1975	6		0.12	2
Shanklin	Edwards	1976	1		0.02	
Sonora	Sutton	1976	1			
				Subtotal	324.65	1016.58
Pennsylvanian Epps Canyon Reservoirs:						
Holman Ranch	Sutton/ Edwards	1972	17	(4)	13.09	74.3
Francis Hill	Sutton/ Edwards	1972	34		15.84	117
Aldwell Ranch	Sutton	1973	52	(4)	25.60	17.7
Jack Mann	Edwards	1973	7		0.26	0.7
				Subtotal	54.79	200.7
				Canyon Series Total	642.12	2209.9
Pennsylvanian Strawn Reservoir:						
Vinegarone	Val Verde	1951	11	(3)	77.70	
Other (no specific data):						
Polecat Creek	Edwards	Epps Reservoir				
Karnes	Sutton	Epps				
John Rae	Schleicher	Epps				
JM	Crockett	Canyon				
Morrison, SE	Val Verde	Canyon				

Future Exploration Potential for Natural Gas

Much of the remaining potential in the Ozona-Sonora area will be realized by in-fill development drilling and by extensions. Also, deeper-pool wildcats to pre-Canyon conventional reservoir objectives in the Strawn, Devonian, Silurian Fusselman, and Ordovician Ellenburger should find substantial gas reserves mainly in structures protected from flushing. In the tight reservoirs of the Wolfcamp Series west of the Ozona trend, additional gas can be expected in sandstone pays.

Unconventional undiscovered gas-producing potential is envisioned for a maximum of about 150 additional sections in the Ozona Canyon trend, with as many as 75 sections in Crockett County, up to 65 prospective sections in northeastern Terrell County and perhaps 5 to 10 sections in northern Val Verde. Optimistically, 350 sections in the Sonora Canyon and Epps-Ray Canyon trends may become

productive with advanced technology and higher gas prices. This includes 250 sections of prospective Sonora (90 sections in Edwards, 75 in Crockett, 35 in Schleicher, and 50 in Sutton County), with about 100 sections in the deeper Epps-Ray reservoirs, mainly in Edwards, Sutton, and Crockett Counties. Of the potential Epps-Ray acreage, about 10 sections are rated as probably productive eventually, 20 sections as possibly productive and the remaining 70 sections as speculative.

The Sonora acreage is rated at about 20 sections probably productive, 50 sections possible and 180 sections with speculative potential. In view of recent developments discussed below, this potential is now considered highly speculative, regardless of gas prices and technology. The breakdown on Ozona acreage is 20 sections with probably-productive capabilities, 15 sections with less definite potential and the remaining 115 sections rated as speculative.

With advanced technology at $9.00/MCF and 15 percent discount rate (D.R.), the maximum amount of ultimately recoverable undiscovered Ozona trend gas is estimated to be about 600 BCF; with base case technology at the same price and D.R., 180 BCF. For the Sonora trend gas potential, including eventual Epps-Ray output, estimates are about 1,880 BCF for an advanced case and 690 BCF for base case technology. Assuming successful utilization of advanced case technology in the near future, then, the higher price could essentially double the volume of gas ultimately recovered from Canyon Series sandstone reservoirs throughout the six-county area. It will take gas prices in the range of $5.00 to $9.00 (1979 dollars) per MCF to achieve substantial reserve increases.

Two disparate hypotheses must be tested in parts of the Sonora trend before the ultimate potential of the Canyon can be adequately assessed. One hypothesis maintains that the Canyon encompasses multiple unconventional low-grade gas reservoirs consisting of thick sandy, silty and argillaceous intervals, all confining a great volume of combustible natural gas. Much of the gas is considered to be recoverable, and can be released by flex-spaced wells and massive fracturing technology. The second hypothesis contends that much of the Sonora Canyon consists of numerous thin, low-producibility, low-capacity conventional sandstone reservoirs, separated by relatively thicker, nonproductive, essentially impervious argillaceous intervals. As such, the reservoirs will not respond to massive fracture treatments or infill-drilling. They contain small gas resources, undergo rapid initial decline, then produce at a low rate, develop serious water-production problems, and are depleted during a few years of poor production.

Recent developments seem to support hypothesis 2 in that a water problem does indeed exist in part of the trend; decline rates on some wells have been rapid, and production rates for gas are quite low. Consequently, reservoir depletion has occurred much more quickly than anticipated, and some wells already have been plugged. Only a few wells have been treated by MHF, however.

Thus, the volume of gas contributed from the tighter intervals, and the eventual response to and success of both MHF and infill drilling remain largely unknown factors.

Available geochemical data tend to support hypothesis 2 from the standpoint of limitations on in-place gas in parts of the trends. The tighter parts of the Canyon section contain little indigenous gas, because argillaceous rocks along these trends to a depth of 10,000 feet or more evidently have not attained peak gas-generation. In fact, they were in an early gas-generation stage up to the time of flushing by recharge water before Cretaceous cover was provided, after which gas-generation was arrested as a result of cooling and degradation of organic matter. The appreciable underpressuring suggests that large quantities of gas have escaped, probably by diffusion at a slow rate through the ages. Quite likely, considerable quantities of solution gas also were swept away from meteoric water invaded the Canyon before the Cretaceous cover resealed the section. Only those parts of the trends most protected from the invasion by recharge water still contain large volumes of in-place gas; this is gas which is largely non-indigenous, having migrated from the depocenters in the deeper parts of the Val Verde Basin.

A consequence of the chemical degradation of the organic matter by oxygenated recharge water was a serious adverse effect on carbonization measurements. It is no longer possible to obtain accurate thermal carbonization levels from the organic matter in much of the Basin. Available carbonization data reflect both chemical alteration and thermal alteration and are conisderably higher than would be expected solely from the thermal history. The trends were seriously affected, for example, in southwestern Sutton and southeastern Crockett Counties. Thus, many reservoirs along the Ozona-Sonora trends contain residual thermal-gas accumulations appreciably depleted by natural processes prior to discovery. The best production is from down-dip reservoirs, often in relatively clean, more permeable sandstones comparatively isolated by rocks of much poorer reservoir quality. This partial isolation provides a higher degree of protection from the damaging effects of meteoric water invasion than was available generally.

If the evidence that the Canyon consists of thin conventional reservoirs is borne out by subsequent production results, and if these types of reservoirs are widespread, then the optimistic reserve estimates presented in this report may have to be downgraded substantially.

Published Estimates of Ozona-Sonora Gas Productivity

Speculative estimates of the gas potential in the Canyon sandstone trends, and in the older Strawn trend have been as high as 36 TCF. This high estimate was based on the highly unlikely assumption that about 60 percent of a 15,000 square mile area in nine counties (including Irion, Sterling, and Tom Green) eventually would become gas-productive, with four development wells per section averaging 1 BCF/well. Had the Canyon not been flushed, these

estimates would have been reasonable and probably conservative because, by all geochemical indications, prodigious amounts of both oil and gas were generated in this Basin.

More conservative published estimates for the six-county area in Edwards, Sutton, Schleicher, Val Verde, Crockett and Terrell counties having ranged as high as 6 TCF. Representative estimates of proved reserves range between 2.0 and 2.5 TCF. However, recent disappointing results with some Sonora Canyon wells suggest that these modest estiamtes of proved recoverable gas are too high. Furthermore, these recent developments also suggest that the estimates of remaining undiscovered resources prepared for this study may be much too optimistic, particularly with regard to the Sonora Canyon trend.

In a 1972 study, for example, average per well reserves (320 acres) for Canyon reservoirs mainly in Sutton County were estimated at 1.6 BCF. This estimate was downgraded slightly to 1.56 BCF early in 1976. Later that year, with much more well data and longer performance time, the reserve estimate was reduced to 1.25 BCF, based on 70 wells. In 1977, a study of 124 wells resulted in an estimate of 1.26 BCF per well. The latest estimate is that the best wells will ultimately produce about 3 BCF, but that many wells will only average about 0.35 BCF with an average productive life of only about 12 years for these poorer producers. It is believed that wells capable of producing at least 1.5 BCF will drain 320 acres. Poor wells may drain only 80 to 160 acres.

Table 17-1 lists cumulative gas and condensate figures for most of the fields as of January 1, 1977.

Gas Source Rocks

One of the source rock sections for gas in the Val Verde Basin is in the Ordovician Simpson Group, believed to be the main source for both the large Ellenburger gas accumulations described in the next section and the relatively minor Simpson gas accumulations. The next younger significant source, the Woodford Shale of Late Devonian-Early Mississippian age, probably expelled much of the gas found in Siluro-Devonian reservoirs.

Argillaceous rocks of Pennsylvanian age are very thick in the deep part of the Basin and constitute the important source rocks for the wet gas and condensate in the Ozona and Sonora trends, as well as for the drier gas present in the Epps-Ray intervals and in the Strawn (Figure 17-4). The effective gas source rocks generally are in northern Val Verde County and southwestern Edwards County, down-dip from, and stratigraphically below, the productive tight gas reservoir trends. Conceivably, Atoka and Strawn Series shales in the southeastern part of the Basin have expelled large volumes of gas (although the absence of production in the Kerr Basin to date suggests not) but the bulk of gas is believed to be from Missourian-age shales of the Canyon Series.

In the Ozona-Sonora trends at the present time, the Canyon is underpressured, indicating that the Basin has been cooled to depths

encompassing the productive intervals, i.e., to at least 10,000 feet or more. Geochemical evidence indicates cooling to below 14,000 feet in part of the basin. The shallower section of the Basin is therefore in an arrested stage of thermal carbonization, and thermal gas is not being generated at the present time. In the lower part of the Canyon, e.g., in much of Val Verde County, available carbonization values are high enough to preclude commercial gas accumulations. Many of these values are deceptive, however, because organic matter studies, particularly elemental analyses and extract analyses, indicate that the organic matter has been chemically degraded to at least 15,000 feet, causing a serious reduction in generating capability of the remaining organic matter.

The underpressured reservoirs are attributed to multiple causes. In addition to subsurface cooling, which terminated generation and stopped the replenishment of gas (a major cause of anomalously high pressures), the cooled section has lost large volumes of gas by diffusion and by solution in moving recharge waters. The Mesozoic recharge water invasion (Figure 17-4) breached the seals that previously had protected the gas-generating section, reducing the overpressured source and reservoir rocks to hydropressured levels. Continued loss of gas by diffusion, additional cooling and dilation of the section, plus a substantial reduction in hydrostatic head resulting from regional southward tilt beneath the resealed section (sealed by the Cretaceous cover) all contributed to the decline in pressures to about one-half of hydropressured levels. The cooling was a major factor, because it caused the generated and trapped fluids to contract, resulting in a substantial drop in fluid pressure.

Exploration History

The Val Verde Basin's successful exploration history began, for practical purposes, with the discovery of giant Puckett Field in 1952. Located west of the Ozona trend, Puckett produces gas from Ordovician Ellenburger (low Btu) and Devonian reservoirs with minor gas production from Permo-Pennsylvanian clastics. In 1957, another giant gas field, Brown-Bassett, was found in Terrell County, productive from Ellenburger (low Btu), Silurian Fusselman, Devonian, and Strawn reservoirs. Minor Canyon wet-gas production was added in 1961, and Wolfcamp production in 1969. Brown-Bassett Field is about 50 miles southeast of Puckett and near the southwest limit of Ozona Canyon trend. Puckett and Brown-Bassett clearly established the Val Verde Basin as an important gas province. Grey Ranch (1965) and JM (1965) are other large gas fields producing mainly from the Ellenburger. On Figure 17-4, Brown-Bassett (western arrow) and JM structures are indicated as gas producers from the Ellenburger.

The earliest important gas discovery in the Basin was the Vinegarone Field in northeastern Val Verde County. This 1951 find produces from the Strawn, but its ultimate recovery is estimated to be only in the 100-200 BCF range.

The Ozona Field in Crockett County yielded its first significant gas from a minor Ellenburger discovery in 1952. The first

substantial discovery of gas in the Canyon series reportedly occurred in 1954 to open the Sonora Field in Sutton County. The Mayer Field discovery followed in 1957. Activity increased in and around Sonora Field by 1959, and additional Canyon production was established in a number of strikes centering on Ozona Field in 1962 and 1963. These discoveries of wet gas stimulated interest in the potential of the Canyon Series, particularly in Crockett County; 31 gas wells were completed in the trend by early 1964 when the first wells were tied into a pipeline, and the first gas-processing plant began operating. The initial potentials of these early wells ranged from 128 MCF/D to 9,500 MCF/D, with an average of 3,300 MCF/D. Gas-to-liquid ratios were reported to range from 10,980:1 upward to 145,000:1, averaging about 50,000:1. Gas was bringing only about 16 cents per MCF at that time.

As costs escalated, interest waned somewhat until intrastate gas prices in Texas began to climb in 1971. In 1975, 525 wells were drilled in the Ozona-Sonora area as the price reached $1.80/MCF. Wells drilled in 1977 totaled 544 with the gas price at $2.04/MCF. This activity has defined discontinuous unconventional tight gas reservoir trends in an arc at least 130 miles long and up to 50 miles wide across six counties. Gross area within these irregular trends is about 3,800 square miles. Net proven productive acreage is estimated at about one-fifth of gross.

Since early 1978, exploratory and development drilling have declined, in part because of limited market outlets and locally inadequate access roads in the area. Additionally, delineations of the best producing reservoirs are sufficiently accurate to enable operators to drill fewer wells by concentrating much of their exploration efforts in parts of the trends where successful completions are more likely to be achieved. More significantly, declining activity has resulted from poorer-than-expected producibility rates and producing lifespans of some wells, owing to low reservoir fluid pressures, a serious water-production problem, limited reservoir capacity, and poor response to massive fracturing. Some of this poor response can be attributed to technical and mechanical problems, which eventually should be resolved. It is too early for a reliable assessment of the merits of MHF in these trends. Quite likely, advanced stimulation techniques will be successful in parts of the trends and parts of the stratigraphic section, and will be of limited benefit elsewhere. Ultimate gas recovery will depend, in great measure, on the volume of rock that responds to MHF and on the in-place gas volume in that rock.

Characteristics of Traps and Reservoirs

Reservoirs

In aggregate, sandstones of the Canyon Series in the Ozona-Sonora trends form a complex blanket sequence, and they comprise the most extensive gas-producing area in the entire Permian Basin region. Individual productive sandstone beds are heterogeneous, discontinuous to lenticular, typically clayey and are interspersed

with shale. Generally, even the clean sandstone layers are comparatively tight, usually owing to the presence of silica cement. Localized porosity and permeability development is common, both vertically and laterally.

An early interpretation of the Canyon quartz sandstone deposits considered them to have been deposited as alluvial fans. More recently, they have been interpreted as dominantly turbidites or deep-water fans and pelagic mud, cut by submarine channel deposits. The turbidites have characteristic graded bedding, overlain by parallel sandstone laminae, then laminae with micro-cross-bedding and parallel siltstone laminae, topped by claystone or shale. Deltaic coastal bar, and fluvial or distributary channel deposits are also considered to be present. The gross productive section ranges from 30 feet to 1,500 feet.

Distal turbidite sands deposited in relatively shallow water were cleaned and sorted locally by long-short currents and wave action. These cleaner distal sandstone reservoirs are among the best plays.

Representative Canyon Series Mineralogy:

Ozona sandstone;

79 percent quartz ss; 4 percent feldspar; 12 percent clay; 5 percent carbonate.

Sonora sandstone;

81 percent quartz ss; 3 percent feldspar; 13 percent clay; 2 percent siderite; 1 percent other.

Epps-Ray sandstone;

95 percent quartz ss; 2 percent feldspar; 2 percent clay; 1 percent dolomite.

Depth ranges and average depths, approximate:

Ozona	2,500 to 7,000 feet	6,500 feet
Sonora	2,500 to 8,500 feet	7,000 feet
Epps-Ray	5,000 to 10,000 feet	8,500 feet

Maximum thicknesses in feet:

	Total Interval	Gross Sandstone	Net Pay
Ozona	1,700	700	300
Sonora	1,600	1,260	720
Epps-Ray	2,500	420	325

Reservoir temperature range, °F:

Ozona	100° to 175°
Sonora	125° to 185°
Epps-Ray	150° to 220°

Geothermal gradient range: about 10° to 19°F/1,000 feet/60°F.

Bottom-hole shut-in pressure range, psig: 300 to 3,500. (Reservoirs are appreciably underpressured.)

Typical pressures at average depth of 7,400 feet, 1,700 to 1,850 psig. and at 3,500 feet, 750 to 1,000 psig.

Total thicknesses of "clean" sandstone (<30 percent shale content):

Ozona	0-300+ feet;	150 feet average;	net pay 15-80 feet
Sonora	0-1,000+ feet;	300 feet average;	net pay 25-130 feet
Epps-Ray	0-400±;	est. 50 feet average;	net pay 10-25 feet

	Porosity Range	Average
Ozona	1 to 12 percent	6.9 percent
Sonora	2 to 15 percent	7.4 percent
Ozona	0.001 to 0.1 est.	0.008
Sonora	0.001 to 0.4	0.020

Water saturation: 20 percent and upward in all productive sandstone intervals.

Water production reportedly is a growing problem, particularly in parts of the Sonora trend, with up to 100 barrels per 1,000 MCFG expected. Some Sonora wells are producing as little as 75 MCFG/day with 2 to 3 barrels water; they are approaching a non-economical gas-production stage. Other wells have been plugged because of low gas production combined with excessive water output.

Gas and Condensate:

	Methane (%)	gal/MCF	CO_2/N_2 (%)	Btu
Ozona	77	5.9	2.2	1,268
Sonora	83	3.5	4.5	1,099
Epps-Ray	94	0.34	2.5	1,002

As shown on Figure 17-5c, the best reservoir-quality sandstone is localized and oriented essentially north-south in the Sonora trend; this parallels structural strike (Figure 17-4) of the Strawn

carbonate sequence. In the Ozona trend, the best reservoirs cut diagonally across the deep structure. A comparison of Figures 17-5b and 17-5c reveals that much of the "clean" Sonora sandstone has low calculated absolute open flow (CAOF) potentials, even where the sandstone attains thickest development in western Sutton County. Some of the best flow rates have been achieved in relatively thin "clean-sandstone" areas, e.g., Sutton County (Sawyer Field), and in east-central Crockett County. Another area of good Sonora producers is in Edwards County on the Edwards Arch. Aldwell Ranch Field in southwestern Sutton County reportedly has some of the best Epps Sandstone production.

Evidence of regional fracture trends has been observed in the Canyon Series. In much of the area, the fractures appear to be oriented northeast-southwest and to cut across stratigraphic units. In places, fractures are believed to contribute to the productivity. The general direction of recharge water encroachment was northeastward from the Devils River Uplift, probably controlled to a great extent by open fractures. The fractures probably were induced by high fluid pressures during oil and gas generation, spreading upward and outward from the depocenters during fluid migrations, essentially at right angles to structural strike. Hydraulic fractures can be expected to assume the same orientation. Many of the natural fractures probably are cemented with inorganic minerals or sealed with devolatilized oil.

Traps

Structural traps are not required for recoverable gas accumulations in these trends. The traps are stratigraphic, resulting from up-dip reduction in pore-throat dimensions, usually accompanied by a corresponding loss of porosity and permeability, as a result of depositional, erosional and diagenetic-carbonization processes. "Clean" sandstone does not guarantee porosity and permeability. Rather, it is the cementing materials that determine reservoir storage capacity; pore-throat dimensions mainly control permeability. The former typically are calcite and dolomite, or quartz overgrowths in the Ozona. Siderite and pyrite are important cements in the Sonora; quartz overgrowths and clay in-fills reduce porosity (and permeability) in the Epps. Clay minerals also control pore-throat sizes and shapes, and thus the permeability and the trapping mechanisms in the Ozona and Sonora trends.

It is of interest that the presence of siderite seems to have a favorable effect on porosity and permeability but it increases wettable surface area by 200 to 300 percent, affecting wettability to connate water, recharge water, and to frac fluids. It also is reported to cause turbulent flow. The Sonora Canyon has the highest percentages of siderite.

PRODUCTION

The two sub-basins in the Val Verde basin considered potentially productive of tight gas are shown in Table 17-2 along with

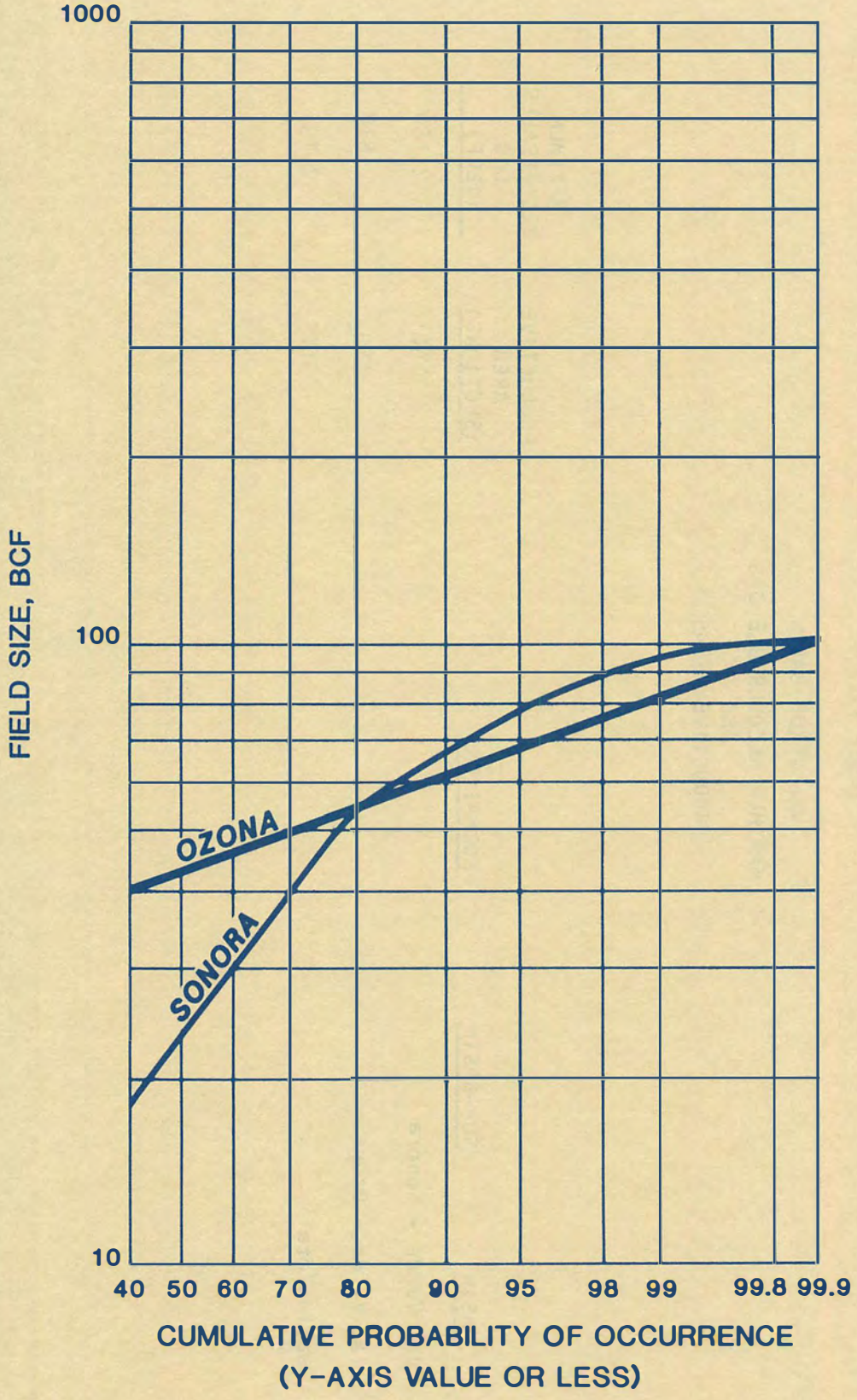


Figure 17-6. Field Size Distribution of Producible Gas, Val Verde Basin.

TABLE 17-2

VAL VERDE BASIN

MAXIMUM RECOVERABLE GAS
AND
PRODUCTIVE AREAS

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
Val Verde	- Sonora		350	2,160
Val Verde	- Ozona		150	638
Basin Total			500	2,798

areas and maximum recoverable gas for each. This study treats each of these sub-basins separately. Accordingly, a full set of tables is presented for each, and the production potential and economics of each are obtained by analyzing the appropriate data set. The gas potential for each sub-basin as function of gas price is summarized in Tables 17-3 and 17-4.

Using the Ozona sub-basin as an example, the geological data used in both the reservoir and exploration simulators are shown in Table 17-5. The production rates estimated with the reservoir simulator for each permeability level are shown in Table 17-6. These rates are for base case technology with a fracture half-length of 1,000 feet. Annual gas production in millions of cubic feet per year per well and the cumulative production over a 30-year period are given. The 30-year cumulatives range from 0.03 to 2.2 BCF per well for the ten permeability levels studied. Table 17-7 shows the data for the advanced technology case with fracture half-lengths of up to 4,000 feet.

Production rates for the Ozona wells will range from only about 10 MCF/D to 250.0 MCF/D for the first year with base technology, depending on permeability level and net pay thickness. With longer fractures, daily production rates in the best zones should exceed 500 MCF/D. Rates will decline rapidly, however, and by the fifth year even the best well with advanced technology will be producing only 260 MCF/D. The highest permeability wells, declining rapidly, will be producing at only 38 MCF/D.

Table 17-8 shows the number of wells per section with both base and advanced technology. With base technology, the number of wells required to produce the gas ranges from 1 to 50.4 wells per section. However, with base technology and thus current well spacing restrictions, only four wells per section are permitted. The effect is to reduce recoverable gas from the maximum of 638 BCF, shown in Table 17-5, to only 193 BCF. With advanced technology, well spacing can be increased. For the Ozona, this would range from 1 to 13.4 wells per section. With advanced technology it will be seen that 604 BCF can be recovered.

ECONOMICS

The basic geologic and production data for all 10 formations were processed with the full cycle exploration and production simulator described in Chapter Four. Each of the sets of data was evaluated separately to determine the economics of finding and developing the gas in that particular formation. The investment required and economics of gas production vary substantially from one formation to another.

Continuing the Val Verde-Ozona example, the investment and operating expenses used in evaluation are shown in Table 17-9. Fracturing costs are a function of the net pay thickness and fracture length and are presented as ranges in this table. The appropriate values for each case, however, were calculated and used in the simulator.

TABLE 17-3

SUMMARY OF VAL VERDE - SONORA BASIN GAS POTENTIAL
(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Val Verde - Sonora			0	633	688	1267	1613	1879

TABLE 17-4

SUMMARY OF VAL VERDE - OZONA BASIN GAS POTENTIAL
(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Val Verde - Ozona			0	106	182	370	532	604

TABLE 17-5

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 1400
TYPE: Blanket

BASIN: Val Verde
SUBBASIN: Ozona
FORMATION: Canyon

DEPTH (FT.): 6500
PRESSURE (PSIA: 1600
TEMPERATURE (°F): 150

NGL(BBL/MMCF): 1.2

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	0.3	10.	1	0.09	0.1	0.	-	-
0.1	1.2	8.5	7	2.17	1.7	0.	-	-
0.03	6.	7.5	15	20.5	15.	0.25	0.50	1.0
0.01	15.	7.0	20	64.	46.5	0.33	0.50	1.0
0.003	31.5	6.5	28	174.	119.4	0.50	0.75	1.0
0.001	36.	6.0	45	295.	188.6	0.75	0.67	1.0
0.0003	30.	5.0	60	273.	162.3	0.75	0.67	1.0
0.0001	13.5	4.0	80	131.	72.0	0.67	1.0	-
0.00003	9.	2.5	90	61.	31.1	0.50	1.0	-
0.00001	7.5	1.0	120	3.	1.4	0.	0	-
	150.			1024.	638.			

TABLE 17-6

WELL PRODUCTION SUMMARY--BASE CASE

VAL VERDE, OZONA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	18	79	90	71	52	47	31	21	9	4
2	13	53	58	41	29	25	15	11	5	2
5	10	39	38	27	17	15	9	6	3	1
10	7	31	30	19	13	10	6	4	2	1
15	6	27	26	17	11	8	5	3	1	0
20	5	23	24	15	10	7	4	3	1	0
30	3	18	21	13	8	7	4	2	1	0
30-YEAR CUMM. PROD. (MMCF)	216	902	929	626	417	345	219	145	68	32

TABLE 17-7

WELL PRODUCTION SUMMARY--ADVANCED CASE

VAL VERDE, OZONA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	26	122	197	174	161	156	109	67	28	13
2	19	84	141	115	99	91	63	41	19	9
5	14	59	98	75	61	54	37	25	11	5
10	11	45	75	58	44	38	25	17	8	4
15	9	39	64	49	37	31	21	14	6	3
20	8	34	57	43	32	27	18	12	5	2
30	6	29	47	36	26	23	14	10	4	2
30-YEAR CUMM. PROD. (MMCF)	320	1359	2234	1746	1377	1220	820	547	256	124

TABLE 17-8

PRODUCTION WELL REQUIREMENTS

BASIN: Val Verde
SUB-BASIN:
FORMATION: Ozona

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.	1.	0	1.	1.	0
.1	1.6	1.6	0	1.	1.	0
.03	2.7	2.7	15	1.1	1.1	15
.01	4.9	4.	38	1.8	1.8	46.5
.003	9.1	4.	53	2.8	2.8	119.4
.001	15.2	4.	50	4.3	4.3	188.6
.0003	24.7	4.	26	6.6	6.6	162.3
.0001	36.5	4.	8	9.7	9.7	72.0
.00003	49.7	4.	3	13.3	12.	28.0
.00001	50.4	0	0	13.4	0.	0
			193			632.

TABLE 17-9

INVESTMENT AND OPERATING EXPENSES

BASIN: Val Verde
SUB-BASIN:
FORMATION: Ozona

Geology and Geophysics ($/Prospect)	10,000
Drilling Cost ($/Well)	208,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	84,000 - 269,000
- Advanced Case [2000/4000 Ft. Fracture]	107,000 - 973,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	7,500
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0236

The output from the simulator is shown in two tables: the economic summary for the base technology case is shown in Table 17-10; advanced technology economics are summarized in Table 17-11. Evaluations are made at discount rates of 10, 15, and 20 percent at several gas prices. Each of the 24 cases shown on each table is a complete evaulation. In other words, the entire basin is drilled and developed assuming that this gas price and discount factor prevail. In each case the table shows the rate of return and the net present value (positive only when the rate of return exceeds the discount rate). When the net present value is not positive, this simply means that none of the gas will be recoverable at this price and discount rate. In Table 17-10, this occurs at less than $5.00/MCF at a 10 percent discount rate, at less than $7.00/MCF at a 15 percent discount rate, etc. As price increases, net present value becomes positve and some gas becomes recoverable. For example, in case 62, at a 15 percent rate of return and $7.00/MCF, present value is $792 thousand and 156 BCF of gas become recoverable. Note also that permeability levels through 0.001 md will be economic. All other permeability levels were tested but proved uneconomic. As price increases, through $12.00/MCF, the lowest permeability economically producible is 0.0003 md.

The tables also show the investment required per prospect and the maximum number of prospects available in the basin at the price. The total number of wells required is also shown. Comparison of Tables 17-10 and 17-11 will show the effect of advanced technology. Similar economic summaries are shown for the other basin in subsequent tables. An overall summary of the Val Verde basin undiscovered tight gas that is potentially productive is shown in Table 17-3 and 17-4. These estimates for both base and advanced technology cases are calculated for gas prices of $2.50, $5.00, and $9.00/MCF at a 15 percent discount rate.

TABLE 17-10

ECONOMICS SUMMARY

BASIN Val Verde
SUB BASIN
FORMATION Ozona
TECHNOLOGY Base Case
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE*	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
2301111	1.50	0	0	-	652	-	-399	0	-	-	-	0	-	-	-	-	-
21	2.50	5.3	2	CD	1149	1.031	-305	2.6	-	-	-	3.5	-	-	-	-	-
31	3.10	5.3	2	CD	1149	1.031	-217	4.8	-	-	-	3.5	-	-	-	-	-
41	3.50	5.3	2	CD	1149	1.031	-158	6.3	-	-	-	3.5	-	-	-	-	-
51	5.00	36.0	4	CDEF	5310	6.026	1158	19.2	156	371	26	23.9	29	9	73	292	406
61	7.00	51.1	5	CDEFG	7433	7.426	2987	29.3	182	533	25	34.0	25	13	99	396	532
71	9.00	51.1	5	CDEFG	7433	"	4947	44.0	182	533	25	34.0	25	13	"	"	"
81	12.00	58.2	6	CDEFGH	8291	7.767	8081	62.8	190	604	25	38.7	23	15	109	438	584
Discount Rate 15%																	
12	1.50	0	0	-	652	-	-403	0	-	-	-	0	-	-	-	-	-
22	2.50	1.5	1	C	745	.225	-382	0	-	-	-	1.0	-	-	-	-	-
32	3.10	5.3	2	CD	1149	1.031	-315	4.8	-	-	-	3.5	-	-	-	-	-
42	3.50	5.3	2	CD	1149	1.031	-272	6.3	-	-	-	3.5	-	-	-	-	-
52	5.00	16.6	3	CDE	2426	2.796	130	17.5	106	181	38	11.1	51	6	41	163	261
62	7.00	36.0	4	CDEF	5310	6.026	1501	33.2	156	371	26	23.9	29	9	73	292	404
72	9.00	51.1	5	CDEFG	7433	7.426	2925	44.0	182	533	25	34.0	25	13	99	396	532
82	12.00	51.1	5	CDEFG	7433	"	5019	67.0	182	533	25	34.0	25	13	"	"	"
Discount Rate 20%																	
13	1.50	0	0	-	652	-	-407	D	-	-	-	0	-	-	-	-	-
23	2.50	0	0	-	652	-	"	"	-	-	-	0	-	-	-	-	-
33	3.10	1.5	1	C	745	.225	-384	"	-	-	-	1.0	-	-	-	-	-
43	3.50	1.5	1	C	745	.225	-376	"	-	-	-	1.0	-	-	-	-	-
53	5.00	5.3	2	CD	1149	1.031	-213	11.4	-	-	-	3.5	-	-	-	-	-
63	7.00	36.0	4	CDEF	5310	6.026	820	33.2	156	371	26	23.9	29	9	73	292	404
73	9.00	36.0	4	CDEF	5310	"	1686	48.0	156	371	26	23.9	29	9	73	"	"
83	12.00	51.1	5	CDEFG	7433	7.426	3416	67.0	182	533	25	34.0	25	13	99	396	532

* CODE:

A	B	C	D	E	F	G	H	I	J
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 17-11

ECONOMICS SUMMARY

BASIN Val Verde — TECHNOLOGY Advanced Case

SUB BASIN — FORMATION Dzona — DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
23012 11	1.50	5.3	2	CD	1365	1.031	-506	0	-	-	-	3.5	-	-	-	-	-
21	2.50	36.0	4	CDEF	7720	13.666	1897	21.1	370	370	27	23.9	31	10	69	277	388
31	3.10	36.0	4	CDEF	"	13.666	3252	29.7	370	370	27	23.9	31	10	"	"	388
41	3.50	51.0	5	CDEFG	13936	20.550	5340	30.4	532	532	26	34.0	26	13	120	481	640
51	5.00	51.0	5	CDEFG	"	20.550	10448	53.7	532	532	26	34.0	26	13	120	481	640
61	7.00	58.2	6	CDEFGH	18386	22.981	18151	72.4	604	604	26	38.7	24	15	149	595	783
71	9.00	58.2	6	CDEFGH	"	22.981	25813	104.8	604	604	26	38.7	24	15	149	595	783
81	12.00	58.2	6	CDEFGH	"	22.981	37307	153.5	604	604	26	38.7	24	15	149	595	783
Discount Rate 15%																	
12	1.50	1.5	1	C	1085	.225	-581	0	-	-	-	1.0	-	-	-	-	-
22	2.50	36.0	4	CDEF	7720	13.666	737	21.1	370	370	27	23.9	31	10	69	277	388
32	3.10	36.0	4	CDEF	"	13.666	1710	29.7	370	370	27	23.9	31	10	"	"	388
42	3.50	36.0	4	CDEF	"	13.666	2359	35.6	370	370	27	23.9	31	10	"	"	388
52	5.00	51.1	5	CDEFG	13936	20.550	6473	53.7	532	532	26	34.0	26	13	120	481	640
62	7.00	51.1	5	CDEFG	"	20.550	11360	84.4	532	532	26	34.0	26	13	120	481	640
72	9.00	58.2	6	CDEFGH	18386	22.981	17200	104.8	604	604	26	38.7	24	15	149	595	783
82	12.00	58.2	6	CDEFGH	"	22.981	25466	153.5	604	604	26	38.7	24	15	149	595	783
Discount Rate 20%																	
13	1.50	0	0	-	1026	-	-596	0	-	-	-	0	-	-	-	-	-
23	2.50	5.3	2	CD	1365	1.031	-489	3.0	-	-	-	3.5	-	-	-	-	-
33	3.10	36.0	4	CDEF	7720	13.666	847	29.7	370	370	27	23.9	31	10	69	277	388
43	3.50	36.0	4	CDEF	"	13.666	1343	35.6	370	370	27	23.9	31	10	"	"	388
53	5.00	51.1	5	CDEFG	13936	20.550	4206	53.7	532	532	26	34.0	26	13	120	481	640
63	7.00	51.1	5	CDEFG	"	20.550	7936	87.4	532	532	26	34.0	26	13	120	481	640
73	9.00	51.1	5	CDEFG	"	20.550	11672	121.0	532	532	26	34.0	26	13	120	481	640
83	12.00	58.2	6	CDEFGH	18386	22.981	18505	153.5	604	604	26	38.7	24	15	149	595	783

* CODE:

A	B	C	D	E	F	G	H	I	J
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

REFERENCES

Adams, John E., 1962, Foreland Pennsylvania Rocks of Texas and Eastern New Mexico; Amer. Assoc. Petroleum Geologists Symposium, "Pennsylvanian System in the United States," p. 372-384.

Crosby, Eleanor J., and William J. Mapel, 1975, Central and West Texas; U.S. Geol. Survey pp. 853, Part I, Paleotectonic Investigations of the Pennsylvanian System in the United States, p. 197-232.

Editorial Staff, 1965, Big Ozona Grows Bigger; O&G Journal, April 12, p. 156-157.

Enright, Robert J., 1964, Permian Basin May Get Biggest Gas Play; O&G Journal, May 11, p. 202-206.

Hartmann, J. K., and Lee R. Woodward, 1971, Petroleum Resources in Post-Mississippian Strata--Texas and New Mexico; Amer. Assoc. Petroleum Geologists Memoir 15, v. 1, p. 752-800.

Hill, Charles S., 1971, Future Petroleum Resources in Pre-Pennsylvanian Rocks of North, Central, and West Texas, and Eastern New Mexico; Amer. Assoc. Petroleum Geologists Memoir 15, v. 1, p. 738-751.

Hills, John M., 1968, Gas in Delaware and Val Verde Basins, West Texas and Southeastern New Mexico; Amer. Assoc. Petroleum Geologists Memoir 9, v.2, p. 1394-1432.

Holmquest, Harold J., 1965, Deep Pays in Delaware and Val Verde Basins; Amer. Assoc. Petroleum Geologists Memoir 4, p. 257-279.

Long, M., 1976, Hot Ozona-Sorora Play Still Expanding; O&G Journal, June 14, p. 29-32.

McNeal, Robert P., 1965, Hydrodynamics of the Permian Basin; Amer. Assoc. Petroleum Geologists Memoir 4, p. 308-326.

Valder, Clayton, 1977, Gas Production from Tight Sandstones of Permo-Pennsylvanian Age, Val Verde Basin, Texas; Amer. Assoc. Petroleum Geologists presentation, SW Section Mtg., Abilene.

Ventrees, Charles, et al., 1958, Paleozoic Geology of the Delaware and Val Verde Basins; West Tex. Geol. Soc. Guidebook, Nov., p. 64-73.

TABLE 17-12

GEOLOGICAL DATA SUMMARY

BASIN: Val Verde
SUBBASIN: Sonora
FORMATION: Canyon

DEPTH (FT.): 7000
PRESSURE (PSIA): 1750
TEMPERATURE (°F): 170

TOTAL BASIN AREA (SECTIONS): 2800
TYPE: Blanket

NGL(BBL/MMCF): 1.2

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	1	12.	5	1.9	1.5	0.25	0.50	1.0
0.1	6	10.5	10	20.	15.5	0.25	0.50	1.0
0.03	25.5	9.0	20	139.	102.	0.30	0.67	1.0
0.01	52.5	8.0	25	332	242.	0.40	0.67	1.0
0.003	91.	7.0	35	704	482.	0.60	0.75	1.0
0.001	70.	6.0	50	664	424.	0.80	0.75	1.0
0.0003	42.	5.5	80	584	346.	0.75	1.0	-
0.0001	28.	5.0	110	487	266.	1.0	1.0	-
0.00003	21.	4.0	150	398	200.	1.0	1.0	-
0.00001	14.	2.0	200	177	81.	1.0	1.0	-
	350.			3507	2160.			

TABLE 17-13

WELL PRODUCTION SUMMARY--BASE CASE

VAL VERDE, SONORA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	105	132	140	102	73	56	47	34	21	11
2	79	89	90	58	40	30	23	18	12	6
5	60	64	58	38	24	17	14	10	7	3
10	46	52	46	28	18	12	10	7	3	2
15	37	44	40	24	15	10	8	6	4	1
20	31	39	37	21	13	9	7	5	3	1
30	22	31	32	19	11	8	6	4	2	1
30-YEAR CUMM. PROD. (MMCF)	1267	1509	1429	890	579	413	326	240	155	83

TABLE 17-14

WELL PRODUCTION SUMMARY--ADVANCED CASE

VAL VERDE, SONORA

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	150	203	300	247	224	187	163	108	59	29
2	112	140	216	163	138	109	94	67	41	21
5	82	98	152	107	85	65	55	40	26	13
10	65	76	116	82	61	46	38	28	18	9
15	55	65	100	69	51	37	31	23	15	8
20	48	58	88	61	44	32	27	20	13	7
30	38	48	74	52	37	28	22	16	11	5
30-YEAR CUMM. PROD. (MMCF)	1863	2269	3447	2483	1911	1402	1226	894	565	298

TABLE 17-15

PRODUCTION WELL REQUIREMENTS

BASIN: Val Verde
SUB-BASIN: Sonora
FORMATION: Canyon

	BASE CASE			ADVANCED CASE		
PERM. (MD)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.2	1.2	1.5	.8	.8	1.5
.1	1.7	1.7	15.5	1.14	1.14	15.5
.03	2.9	2.9	102.	1.2	1.2	102.
.01	5.2	4.	187.	1.86	1.86	242
.003	9.1	4.	211.	2.7	2.7	482
.001	14.7	4.	116	4.3	4.3	424
.0003	25.2	4.	55	6.7	6.7	346
.0001	39.6	4.	27	10.6	10.6	266
.00003	61.4	4.	13	16.8	12.	143
.00001	69.5	4.	5	19.30	12.	50
			733			2072

TABLE 17-16

INVESTMENT AND OPERATING EXPENSES

BASIN: Val Verde
SUB-BASIN: Sonora
FORMATION: Canyon

Geology and Geophysics ($/Prospect)	10,000
Drilling Cost ($/Well)	229,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	86,000 - 374,000
- Advanced Case (2000/4000 Ft. Fracture)	109,000 - 1,185,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	7,500
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0236

TABLE 17-17

ECONOMICS SUMMARY

BASIN Val Verde — TECHNOLOGY Base Case

SUB BASIN — FORMATION Sonora — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
18011	1.50	2.0	2	BC	972	.477	-465	0	-	-	-	1.5	-	-	-	-	-
21	2.50	8.7	4	ABCD	1829	2.843	-111	8.5	-	-	-	6.4	-	-	-	-	-
31	3.10	23.6	5	ABCDE	3360	5.693	347	12.7	517	843	91	17.5	101	21	130	520	773
41	3.50	23.6	5	ABCDE	3360	5.693	617	14.7	517	843	91	17.5	101	21	130	520	773
51	5.00	38.3	6	ABCDEF	7241	10.564	2595	21.3	633	1267	60	28.4	58	23	218	872	1170
61	7.00	46.6	7	ABCDEFG	9444	12.421	5512	28.8	688	1613	55	34.5	49	26	258	1031	1363
71	9.00	54.3	8	ABCDEFGH	11790	13.739	8650	34.1	715	1879	52	40.3	42	28	292	1167	1529
81	12.00	54.3	8	ABCDEFGH	11790	13.739	13274	43.6	715	1879	52	40.3	42	28	292	1167	1529
Discount Rate 15%																	
12	1.50	2.0	2	BC	972	.477	-503	0	-	-	-	1.5	-	-	-	-	-
22	2.50	8.7	4	ABCD	1829	2.843	-358	8.5	-	-	-	6.4	-	-	-	-	-
32	3.10	8.7	4	ABCD	1829	2.843	-218	11.2	-	-	-	6.4	-	-	-	-	-
42	3.50	23.6	5	ABCDE	3360	5.693	-25	14.7	-	-	-	17.5	-	-	-	-	-
52	5.00	38.3	6	ABCDEF	7241	10.564	986	21.3	633	1267	60	28.4	58	23	218	872	1170
62	7.00	46.6	7	ABCDEFG	9444	12.421	2728	28.8	688	1613	55	34.5	49	26	258	1031	1363
72	9.00	46.6	7	ABCDEFG	9444	12.421	4541	36.2	688	1613	55	34.5	49	26	258	1031	1363
82	12.00	54.3	8	ABCDEFGH	11790	13.739	7578	43.6	715	1879	52	40.3	42	28	292	1167	1529
Discount Rate 20%																	
13	1.50	0	0	-	835	-	-520	0	-	-	-	0	-	-	-	-	-
23	2.50	8.7	4	ABCD	1829	2.843	-491	8.5	-	-	-	6.4	-	-	-	-	-
33	3.10	8.7	4	ABCD	1829	2.843	-393	11.2	-	-	-	6.4	-	-	-	-	-
43	3.50	8.7	4	ABCD	1829	2.843	-327	12.9	-	-	-	6.4	-	-	-	-	-
53	5.00	23.6	5	ABCDE	3360	5.693	103	21.3	517	843	91	17.5	101	21	130	520	773
63	7.00	38.3	6	ABCDEF	7241	10.514	1240	29.9	633	1267	60	28.4	58	23	218	872	1170
73	9.00	46.6	7	ABCDEFG	9444	12.421	2529	36.2	688	1613	55	34.5	49	26	258	1031	1363
83	12.00	54.3	8	ABCDEFGH	11790	13.739	4533	43.6	715	1879	52	40.3	42	28	292	1167	1529

* CODE:

A	B	C	D	E	F	G	H	I	J
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 17-18

ECONOMICS SUMMARY

BASIN Val Verde — FORMATION Sonora — TECHNOLOGY Advanced Case

SUB BASIN — DATE 10/79

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
1801211	1.50	23.6	4	BCDE	3596	7.724	-334	7.4	-	-	-	17.5	-	-	-	-	-
21	2.50	38.3	6	ABCDEF	10193	21.376	2465	18.5	1267	1267	59	28.4	57	23	192	769	1041
31	3.10	38.3	6	ABCDEF	10193	21.376	4124	23.6	1267	1267	59	28.4	57	23	192	769	1041
41	3.50	46.6	7	ABCDEFG	17808	30.315	6243	24.0	1613	1613	53	34.5	47	25	268	1073	1412
51	5.00	46.6	7	ABCDEFG	17808	30.315	12027	34.8	1613	1613	53	34.5	47	25	268	1073	1412
61	7.00	54.3	8	ABCDEFGH	32160	39.367	21657	38.4	1879	1879	48	40.3	39	26	363	1454	1882
71	9.00	54.3	8	ABCDEFGH	32160	39.367	31380	48.2	1879	1879	48	40.3	39	26	363	1454	1882
81	12.00	54.3	8	ABCDEFGH	32160	39.367	45966	60.3	1879	1879	48	40.3	39	26	363	1454	1882
Discount Rate 15%																	
12	1.50	2.0	2	BC	1318	.477	-710	0	-	-	-	10.3	-	-	-	-	-
22	2.50	38.3	6	ABCDEF	10193	21.376	700	18.5	1267	1267	59	28.4	57	23	192	769	1041
32	3.10	38.3	6	ABCDEF	10193	21.376	1782	23.6	1267	1267	59	28.4	57	23	192	769	1041
42	3.50	38.3	6	ABCDEF	10193	21.376	2504	26.8	1267	1267	59	28.4	57	23	192	769	1041
52	5.00	46.6	7	ABCDEFG	17808	30.315	6444	34.8	1613	1613	53	34.5	47	25	268	1073	1412
62	7.00	46.6	7	ABCDEFG	17808	30.315	11448	46.5	1613	1613	53	34.5	47	25	268	1073	1412
72	9.00	54.3	8	ABCDEFGH	32160	39.367	18090	48.2	1879	1879	48	40.3	39	26	363	1454	1882
82	12.00	54.3	8	ABCDEFGH	32160	39.367	27517	60.3	1879	1879	48	40.3	39	26	363	1454	1882
Discount Rate 20%																	
13	1.50	2.0	2	BC	1318	.477	-730	0	-	-	-	10.3	-	-	-	-	-
23	2.50	23.6	4	BCDE	3596	7.724	-411	14.6	-	-	-	17.5	-	-	-	-	-
33	3.10	38.3	6	ABCDEF	10193	21.376	554	23.6	1267	1267	59	28.4	57	23	192	769	1041
43	3.50	38.3	6	ABCDEF	10193	21.376	1058	26.8	1267	1267	59	28.4	57	23	192	769	1041
53	5.00	46.6	7	ABCDEFG	17808	30.315	3481	34.8	1613	1613	53	34.5	47	25	268	1073	1412
63	7.00	46.6	7	ABCDEFG	17808	30.315	6963	46.5	1613	1613	53	34.5	47	25	268	1073	1412
73	9.00	46.6	7	ABCDEFG	17808	30.315	10445	56.1	1613	1613	53	34.5	47	25	268	1073	1412
83	12.00	54.3	8	ABCDEFGH	32160	39.367	17527	60.3	1879	1879	48	40.3	39	26	363	1454	1882

* CODE:

A	B	C	D	E	F	G	H	I	J
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

Chapter Eighteen

WESTERN GULF BASIN
EDWARDS REEF TREND

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In addition, each subbasin within the basin has a series of these specific tables:

- Geological Data Summary
- Well Production Summary -- Base Case
- Well Production Summary -- Advanced Case
- Production Well Requirements
- Investment and Operating Expenses
- Economics Summary -- Base Case
- Economics Summary -- Advanced Case

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Chapter Eighteen

WESTERN GULF BASIN
EDWARDS REEF TREND

GEOLOGY

The Edwards limestone of the Western Gulf Basin comprises a portion of the thick section of dominantely shallow-water carbonate deposits which characterized that area, from upper Jurassic until the earliest Upper Cretaceous (Fig. 18-1). The Stuart City trend is that part of the Edwards which is composed of reefoid facies, and it dominates the seaward edge of the carbonate platform during the Albian and earliest Cenomanian (Fig. 18-2). In what follows, Edwards and Stuart City are terms used synonymously to describe this reef trend.

The regional geology and stratigraphy of the Lower Cretaceous rocks of this area have been adequately discussed by Rose (1972), Bebout (1974), and Bebout, et al (1977). Cook (1979) has previously discussed the exploration history of this trend. The porosities and permeability of the reef rocks being what they are, coupled with the fact that these tight rocks seem to be gas saturated everywhere along the trend, make them an ideal subject for this study of "tight gas."

General Description

The Stuart City Formation was named by Winter (1961) to include those Lower Cretaceous rocks which comprise the shelf-margin reef facies of stratigraphic units commonly referred to as Edwards and Glen Rose. The formation was completely cored by Shell Oil Company at their Tomasek No. 1 test at Pawnee Field in Bee County, Texas. There the Stuart City is 1,130 feet thick. Overlain unconformably by Eagle Ford shale, it grades downward into lime mudstones of the Glen Rose. The lithology of the reef complex is shown on Figure 18-3 and has been further described by several authors, notably Bebout (1974). The rather large initial porosity in the Edwards which is estimated to have been 30-40 percent, especially in the upper 500 feet or so, has been almost completely destroyed by at least three types of post-depositional cement.

Geographic Extent

The reef marks the seaward edge of the carbonate platform in late Lower Cretaceous. Regional structural mapping (Figure 18-4) shows it to plunge from a depth of -8,000 feet at the Rio Grande to near -14,000 feet at Word Field. It continues to dip northeastward to Waller County where it crosses the axis of the East Texas embayment, and then rises again toward Louisiana.

Distribution of the Stuart City formation is easily defined. From subsurface control it is seen to terminate rather abruptly at

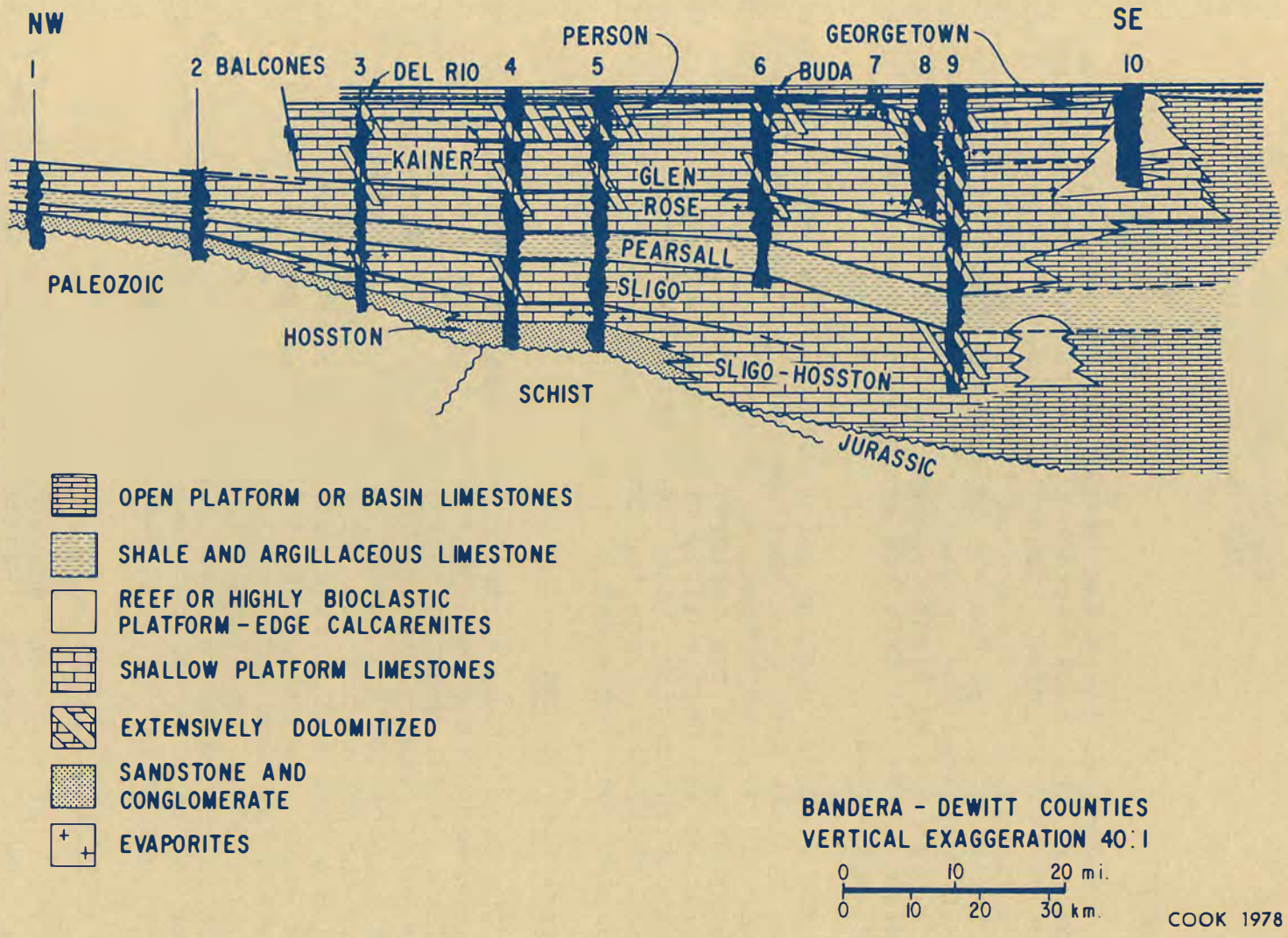


Figure 18-1. Regional Cross Section -- Lower Cretaceous.

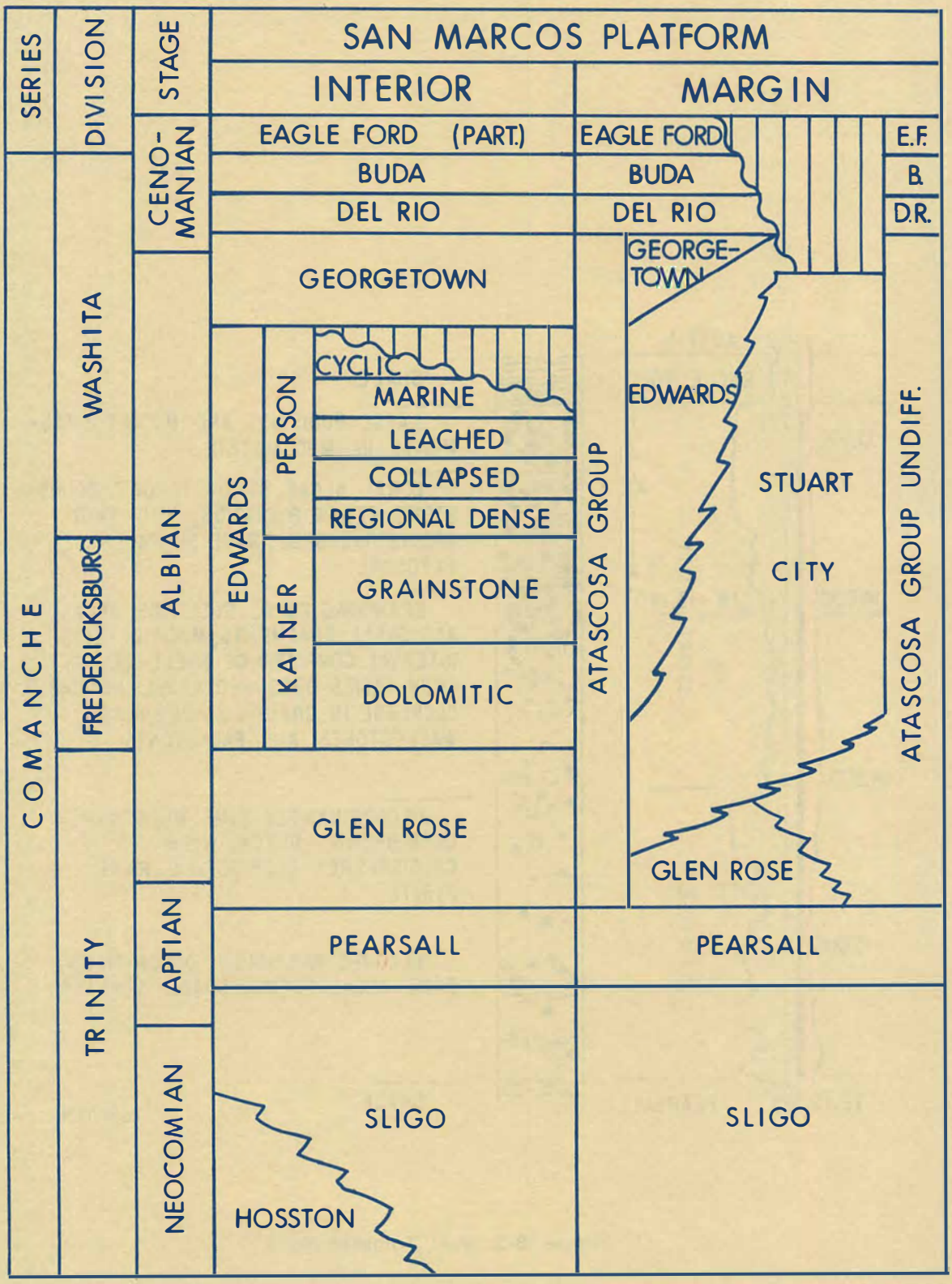


Figure 18-2. Stratigraphic Correlation Chart.

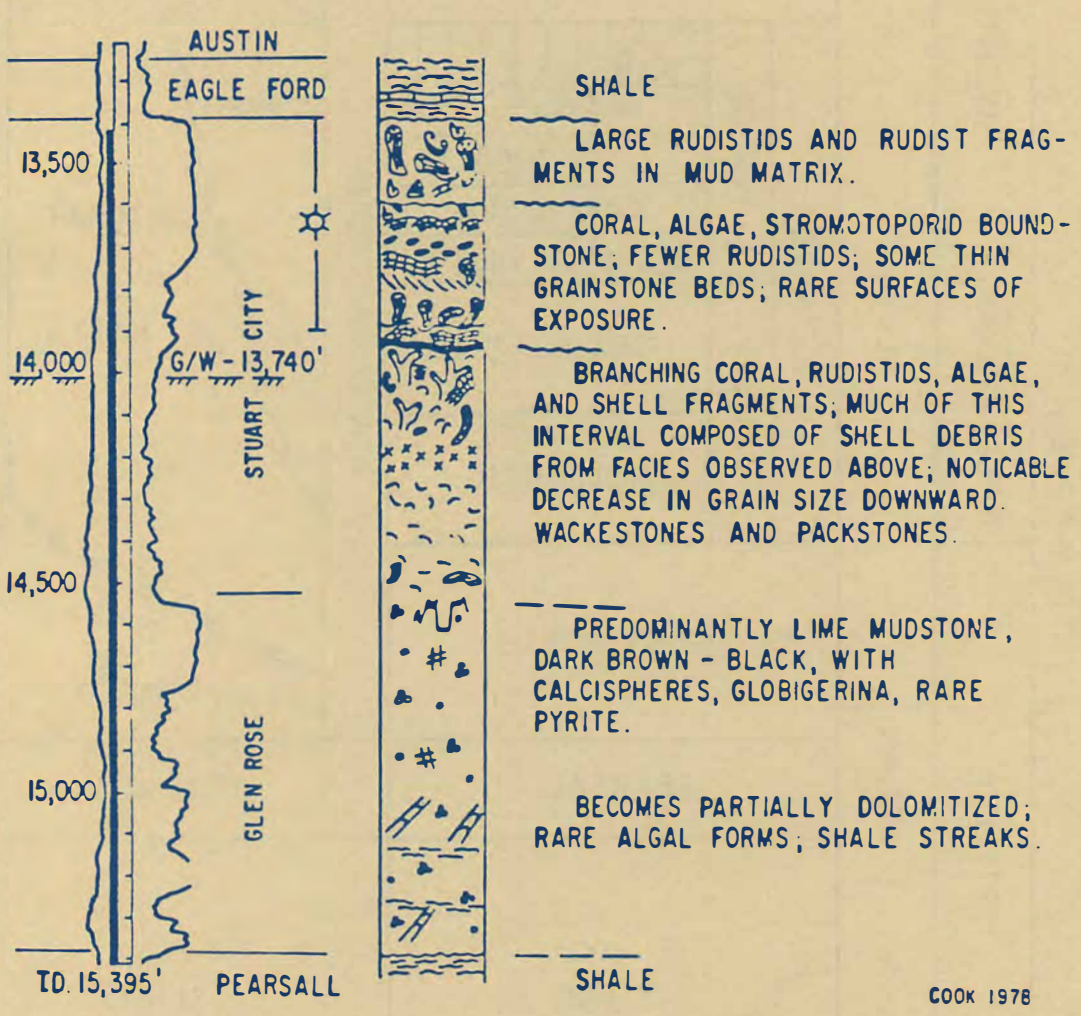


Figure 18-3. Shell, Tomasek No. 1.

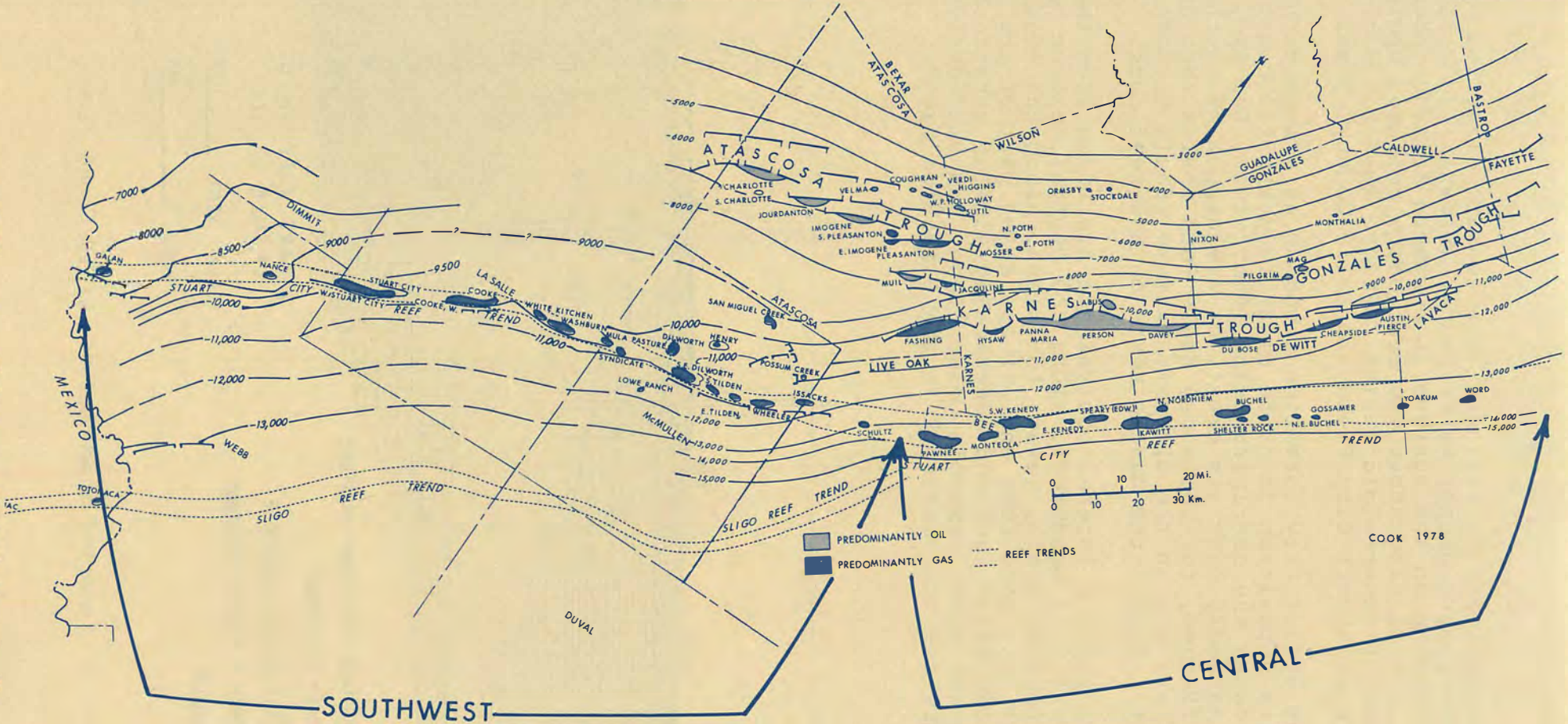


Figure 18-4. Oil and Gas Field Map -- Edwards Lime Basin.

the shelf margin, and is replaced in a seaward direction by lime mudstones carrying a deeper water fauna. Bloxsom (1972) has also mapped this change on the surface in northern Mexico. Abundant subsurface control also shows the reef being replaced updip by shallow rocks of non-reefoid facies. Figure 18-5 shows this relationship at Stuart City Field, La Salle County, Texas.

That the Stuart City formation stood up as a topographic high following its deposition is quite clear from the fact that in almost all cases the overlying units (Georgetown, Del Rio, and Buda) thin markedly over its crest, or are absent altogether. In some cases (Pawnee, for instance) Eagle Ford shales rest directly on Stuart City, and in the ultimate extreme (Shell Chapman No. 1, Waller County, Texas) the Austin rests on the reef rock.

The reef and its lateral equivalents are known from the Yucatan platform, Vera Cruz embayment, along the central Mexican platform, across the Sabinas Basin, Texas, Louisiana, along the edge of the Florida platform, into Cuba and perhaps along part of the Atlantic Coast. An age equivalent and genetically similar stratigraphic unit is present along Mexico's Golden Lane, and reef-derived calcarenites are the dominant rock in the Poza Rica trend.

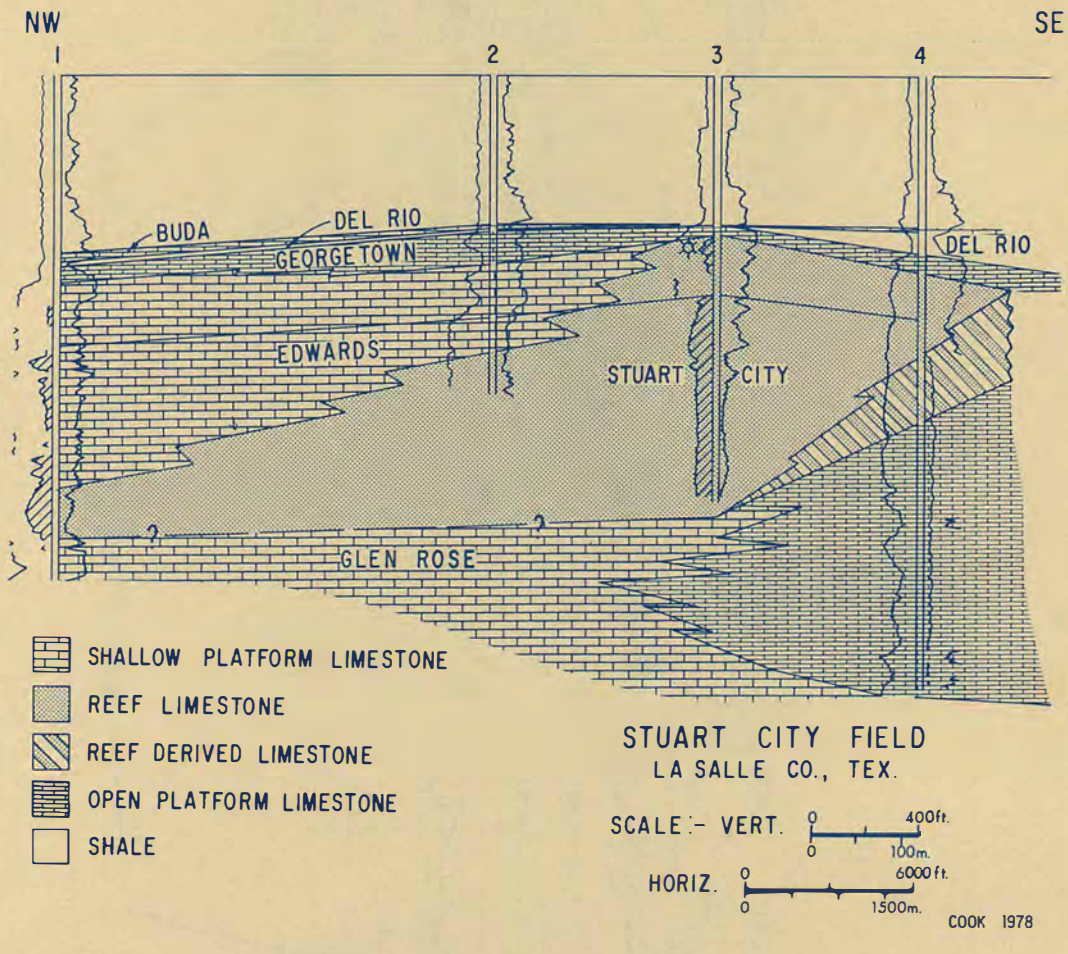


Figure 18-5. Stuart City Field -- La Salle County, Texas.

Hydrocarbon Potential

In Texas the reef is productive of dry gas from 26 accumulations from Galan Field in Webb County eastward to Word Field in Lavaca County (Figure 18-4). In all cases the reservoir is one of extremely low porosity and permeability. Along the Golden Lane and the adjacent Pora Rica trend in Mexico post-depositional leaching has been significant in improving the reservoir quality.

Pawnee Field, Bee County, Texas (Figure 18-6) is one of the larger structures producing from the Stuart City. Structural closure of some 300 feet and covering 9,000 acres was mapped by seismic. The hydrocarbon column encountered was more than 600 feet indicating a large amount of stratigraphic closure. This is the case in most of the accumulations. Reef width from near the Pawnee Field eastward was taken to average 4.7 miles for this study.

A more typical reef trend structure is Stuart City Field, La Salle County, Texas (Figure 18-7). Here the structural closure mapped on top Lower Cretaceous is very small and the hydrocarbon column of 400 feet again requires stratigraphic closure. The field is 9 miles in length. The productive area for the fields along the trend in this area was taken to average 3.3 miles in width for this study.

Edwards (Stuart City) reef reservoirs at one time held some liquid hydrocarbons as evidenced by residual oil seen in cores. However, today the only hydrocarbon encountered is dry gas. Source rocks for the Stuart City hydrocarbons could be the younger Eagle

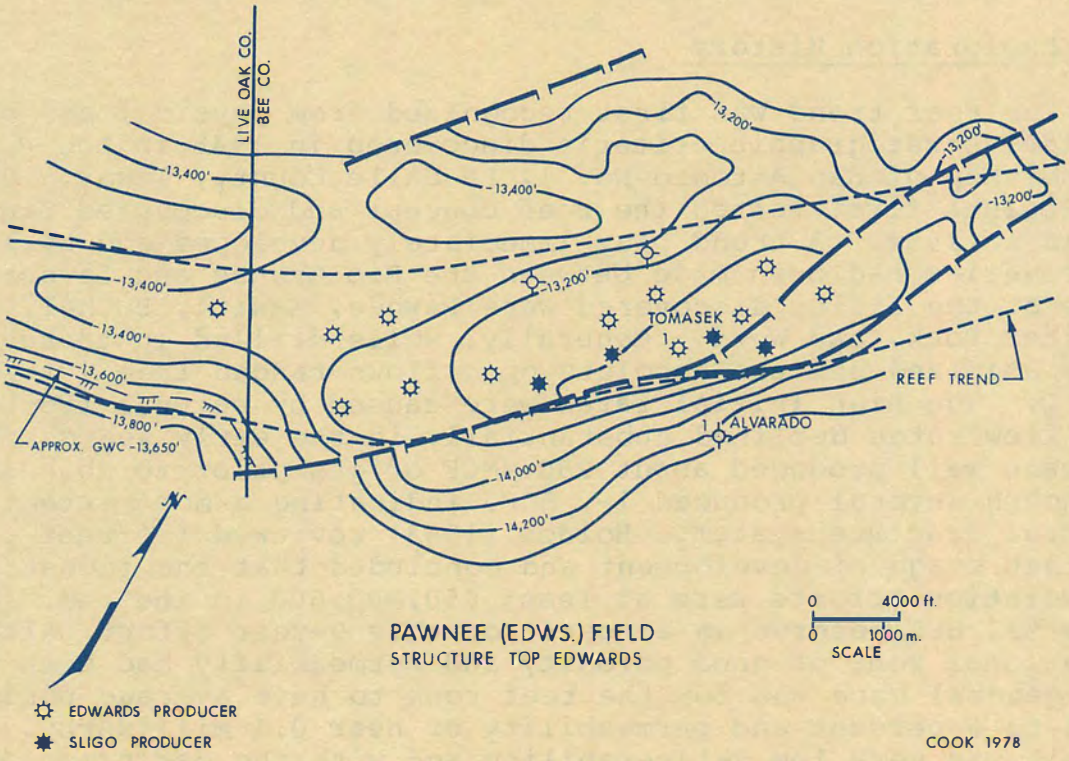


Figure 18-6. Live Oak and Bee Counties, Texas.

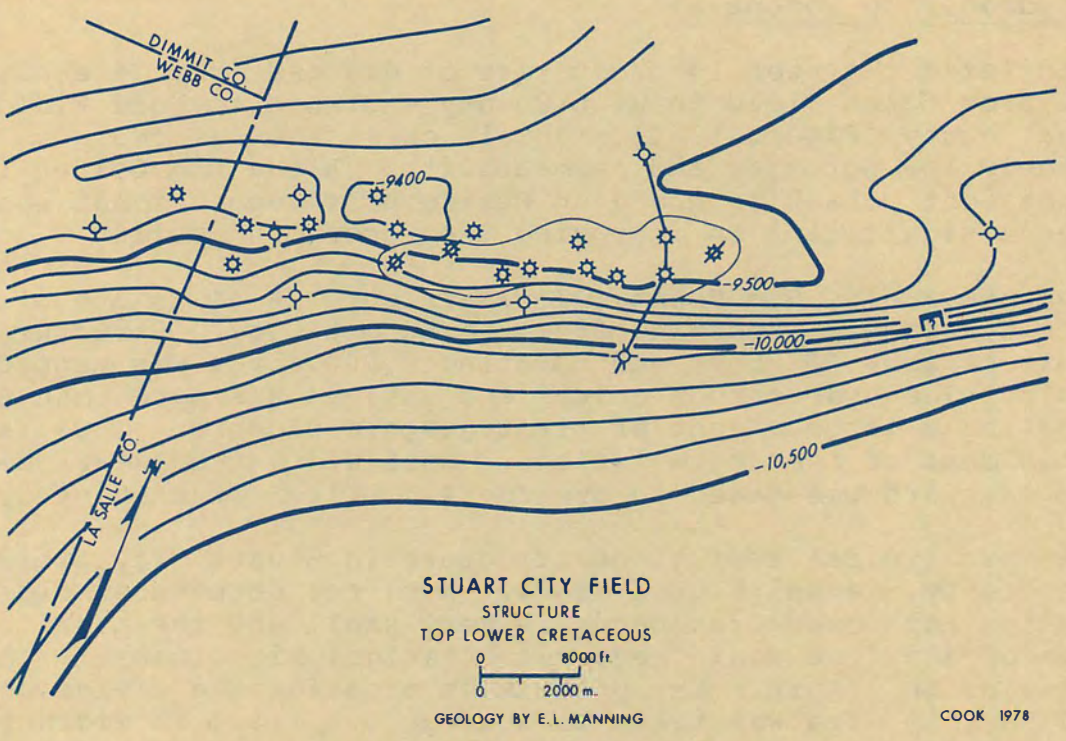


Figure 18-7. La Salle County, Texas.

Ford shales which are often juxtaposed to the reef due to the overlying unconformity, the age-equivalent shaley-lime mudstones which lie immediately basinward, or the older Pearsall shale which over large parts of South Texas is known to be organic rich.

Exploration History

The reef trend was first recognized from physical and biological stratigraphic criteria discovered in 1948 in the Plymouth Archbishop of San Antonio No. 1, La Salle County, Texas. Stanolind geologists first tested the reef concept and discovered Stuart City Field in 1954. A trend play immediately developed and by 1963 15 discoveries had been made between the Rio Grande and Lavaca County. Some of the fields discovered were Pawnee, Kawitt, Buchel, Roehl, Shelter Rock, and Word. Generally, wells drilled in these fields were acidized and the absolute open flows ranged from 1 to 15 MMCFD. The high initial rates were caused by natural fractures and gas flow rates declined substantially in the early years. An average well produced about 250 MMCF of gas prior to abandonment, although several produced 1-2 BCF, indicating a more extensive natural fracture system. Holden (1963) reviewed the reef potential at that stage of development and concluded that the industry's exploration efforts were at least $50,000,000 in the red. He saw some 531 BCF reserve as a result of this 9-year effort. Although an occasional zone of good porosity and permeability had been found the general case was for the reef rock to have average porosities of 4 to 6 percent and permeability of near 0.1 millidarcy. The result was very low deliverability and with the gas price of the day most wells failed to pay out.

Activity subsided until the early seventies when Shell began a modest development program at Pawnee, and in 1974 their Gordon No. 1 was completed as the best Stuart City producer. The well was fracture treated using water based polymer and several thousand pounds of 20-40 mesh sand. Initial production was 4,650 MCFD at 4,100 psi flowing tubing pressure, and the well produced 2.25 BCF in the first 22 months.

This success rekindled reef trend activity and during the middle seventies an additional 11 discoveries were made and several significant extentions to older fields were completed (i.e., Cooke and Stuart City). Better fracturing technology and a better gas price have kept this activity moving at a moderate pace, but even now the tight reservoirs and bottom water inhibit fracture stimulation and thus keep the play from flourishing.

Some formations above the Edwards have been observed to prevent the hydraulic fracture from growing in the upward direction. However, there is usually no barrier to fracture growth in the downward direction. Therefore, a fracture of 1,000+ feet in length could also be 1,000+ feet high. As suggested above, fracturing into the wet portion of the reef may result in the production of excess formation water.

It is obvious that substantial advances in technology will be required to fully develop the Reef Trend. Because of the above problems, exploration in the trend has subsided during the past few years. However, some improvements in technology have already been field tested. Density controlled fracture treatments have been used with moderate success. The purpose of such treatments is to keep the propping agent in the upper, gas bearing portion of the reef and allow only pad to penetrate the lower portion of the reef.

Future advances in fracturing technology and increased gas prices will allow the Edwards Reef Trend to be more fully developed.

Characteristics of Traps and Reservoirs

A typical Edwards Reef Field is an anticlinal structure formed either by deep seated tectonic movement or a result of natural reef development. Overlying, dense formations serve as a reservoir seal. Therefore, exploration activity in the Reef Trend can be coordinated with seismic interpretations, thereby minimizing the number of rank wildcats which will be required to delineate productive acreage. This characteristic sets the Edwards apart from most of the formations and basins which are being considered by the NPC Tight Gas Reservoirs Task Group. However, due to the depth of the Reef, the fact that the formation permeability is quite low and the special problems involved with stimulating the massive reef formation, future exploration and development will be both risky and extremely expensive.

PRODUCTION

Formations and Sub-Basins to be Produced

For the purposes of this study, the Edwards Reef Trend has been divided into three areas - Southwest, Central and Northeast. The Northeast area has never been found productive; therefore, it was not considered in this study. The Southwest (SW) and Central (C) portions (identified on Figure 18-4) have been analyzed in this study. Deleting the northeast (and further) areas makes the following projections conservative. The following table summarizes the acreage considered in the study.

	SW Area	C Area
Reef width, mi.	3.3	4.7
Reef length, mi.	110	105
Productive area, %	52.4	52.4
Productive area, $mi.^2$	189	261

Table 18-1 is a summary of maximum recoverable gas and productive areas.

TABLE 18-1

Edwards Lime Basin
Maximum Recoverable Gas and Productive Areas

Basin	Subbasin	Formation	Productive Area (Sections)	Maximum Recoverable Gas (BCF)
Edwards Lime		Southwest	189	3,171
		Central	261	5,477
Basin Total			450	8,648

Well Drilling and Geological Data and Performance Forecasts

Specific data used to characterize the Edwards Reef will now be discussed. This will be followed by a summary of some results obtained from analysis of the characteristic data using the Exploration and Production simulator described in Chapter 4. Because of the similarity of the data and method of analysis, the following discussion will follow the data for the Edwards Lime, Central Region, base case, principally; the advanced case as well as the results from the Southwest Region may be similarly interpreted from the example.

Table 18-10 is a geological data summary for the Central Region in the Edwards Lime Trend. The productive area considered is 261 sections out of the 450-section region. The Central Edwards is divided into eight average permeability zones with area, porosity, and net pay as shown for each. Reservoir pressure is 7,600 psia and temperature is 360°F. Gas in place can be estimated from these data. Maximum recoverable gas is defined using recovery factors which recognize less than full recovery.

Data for each drilling location include probability distributions for state-of-nature, first wildcat, and second wildcat. For the 0.06 md zone, the state-of-nature is 0.25 productive (thus 0.75 dry). This means that statistically seven and one half out of ten wildcats drilled in 0.06 MD locations will be dry. The probability of the first wildcat drilled in a productive area being productive is 0.95. If a second wildcat is drilled, the probability of success is 1.0. As net pay increases, the probability that the state-of-nature will be productive increases.

Table 18-13 lists production well requirements for both base and advanced cases. Well productivity data are tabulated in Tables 18-11 for the base case and 18-12 for the advanced case. Note that the 0.02 MD well has the best initial production rate (year 1) of all permeabilities as well as the best 30-year cumulative production. This is principally due to the relative values of the permeability thickness product of the wells. A similar statement may be made for the 0.02 md advanced case well. Ultimate production per well from Tables 18-11 and 18-12 were used to compute the number of wells per section required to produce all gas in Table 18-13.

Recoverable gas from actual wells, Table 18-13, for both base and advanced cases should be compared to the Maximum Recoverable Gas column in Table 18-10. The current practice of drilling no more than four wells per section (base case) reduces recoverable gas from 5,477 BCF to 4,393 BCF. However, the advanced case allows full recovery of the 5,477 BCF available.

ECONOMICS

Exploration and Production Model

The geological, drilling, and performance data described above along with further economic data form the input to a full cycle exploration and production model to evaluate performance of the subbasins. Results of this performance evaluation are summarized in Table 18-2 and described in the following.

Investment and Operating Expense

Table 18-14 presents investment and operating expenses. The reason for the range of fracture costs is that net pay thickness increases as permeability decreases, requiring greater volumes of frac fluid and proppant. The reason advanced case fractures cost

more than base case is that fracture length is greater for the advanced case.

Economics Summary for Edwards Central

We can now discuss the Edwards Central economics summary, Tables 18-15 and 18-16. After the customary identification entries, we find rows of entries beginning with "Case Number" and continuing across the page. There are three sets of data corresponding to discount rates of 10%, 15%, and 20%. Each set has gas selling price from $1.50/MCF to $12.00/MCF. Case Number 702111, Table 18-15, is a base case at $1.50/MCF price and 10% discount rate. Remember that the entire productive area is drilled in order to evaluate this $1.50 price. Only 12.4 percent of the prospects were profitable. Permeability levels 0.06 md and 0.02 md, coded B and C, came on stream. All other permeabilities were tested but were unprofitable. The investment averaged $5.171 million and the net present value at 10% discount rate was -$1.867 million. DCF rate of return was zero. No gas is recoverable in this formation at $1.50/MCF if 10% rate of return is required.

The question may be asked why the highest permeability Zone A (0.2 md) was not on stream. A review of its performance on Table 18-11 shows that it is inferior to zones at 0.06 and 0.02 md and, therefore, it doesn't pay out.

For Case Number 702121 the gas price is $2.50. Zones A (0.2 md) and D (0.006 md) permeability levels are added but production is still uneconomical. The higher price does bring the DCF rate of return to 9.4%. The net present value is -$132 thousand at 10% discount rate. For the purposes of this study, no gas is available at $2.50.

Continuing with Case Number 702131 at $3.10, we find 38.3 percent of the prospects drilled to be profitable, and that Zone E (0.002 md) has joined A, B, C, and D as profitable. This increases the gas per prospect to 14.299 BCF for an average investment of $9.627 million. Rate of return is 15.0 percent, and the net present value is $1.477 million. From Table 18-10 it is learned that maximum recoverable gas for these zones is 4,056 BCF. From Table 18-13, base case, the recoverable gas from actual wells in these three zones is 3,820 BCF. These values are shown on Table 18-15. There are 267 prospects available in the productive area of the basin at the $3.10 price level. This number is obtained by dividing 3,820 BCF available by 14.299 BCF per prospect. The program lists the well requirements as 280 dry wildcats, 102 productive wildcats, 87 dry development wells, and 348 producers. This is a total of 817 wells.

The 15% discount rate is similar to the 10% rate. However, $3.10 will not bring Zone E on stream at 15% as it did at 10% discount rate; $5.00 is required. At 20% rate, $5.00/MCF is required to turn a profit in the Net Present Value column.

The DCF rate of return at $12.00/MCF is 80.9 percent at the 10 and 15% discount rates. This brings on all the gas available in the base case except the 0.00006 md zone. At the 20% discount rate, neither the 0.00006 md or the 0.0002 md gas is economically producible at $12.00/MCF.

The advanced case, Table 18-16, is interpreted in the same manner. One should contrast the amount of gas recoverable in the advanced case at each price with the amount of gas recoverable in the base case. The E and P investment for the advanced case is actually less than the base case. This is largely because the advanced case fractures are so much more efficient than the base case (see Tables 18-11 and 18-12) that much fewer total wells are required which offsets the higher costs of the advanced case fractures. Rates of return for the advanced cases are much better than for the base cases.

Tables 18-3 through 18-9 show data for the Edwards Southwest Region as discussed above for the Edwards Central Region and may be similarly reviewed. It is of interest to note that even though the wells in the Edwards Southwest are not as good as in the Central Region (see Table 18-4 vs. 18-11), the E&P investment is less and the rate of return is better for the Southwest for both the base and advanced case. The principal reason for this is that the 14,500 foot depth of the Central Region causes a notable increase in costs over the Southwest Region at 11,000 feet.

REFERENCES

Bebout, D. G. (1974), Stuart City Trend Lower Cretaceous, South Texas: Texas Univ. Bur. Econ. Geology Rept. Inv. 78.

_____, Schatzinger, R. A. and Loucks, R. G. (1977), Porosity Distribution in the Stuart City Trend, Lower Cretaceous, South Texas in Cretaceous Carbonates of Texas and Mexico, Applications to Subsurface Exploration: Texas Univ. Bur. Econ. Geology Rept. Inv. 89, p. 234-256.

Bloxsom, W. E. (1972), A Lower Cretaceous (Comanchean) Prograding Shelf and Associated Environments of Deposition, Northern Coahuila, Mexico: Master's Thesis, Univ. Texas, Austin, 207 pgs.

Cook, T. D. (1979), Exploration History of South Texas Lower Cretaceous Carbonate Platform: AAPG Bull., Vol. 63, p. 32.

Holden, R. N. (1963), A Review of the Discovery and Development of the Lower Cretaceous Reef in South Texas in Geology of Peregrina Canyon and Sierra de El Abra, Mexico: Corpus Christi Geol. Soc. Field Trip Guidebook, p. 65-71.

Rose, P. R. (1972), Edwards Group, Surface and Subsurface, Central Texas: Texas Univ. Bur. Econ. Geology Rept. Inv. 74, 198 pgs.

Winter, J. A. (1961), The Atascosa Group of the Lower Cretaceous of South Texas: South Texas Texas Geol. Soc. Bull., v. 1, no. 11, p. 15-21.

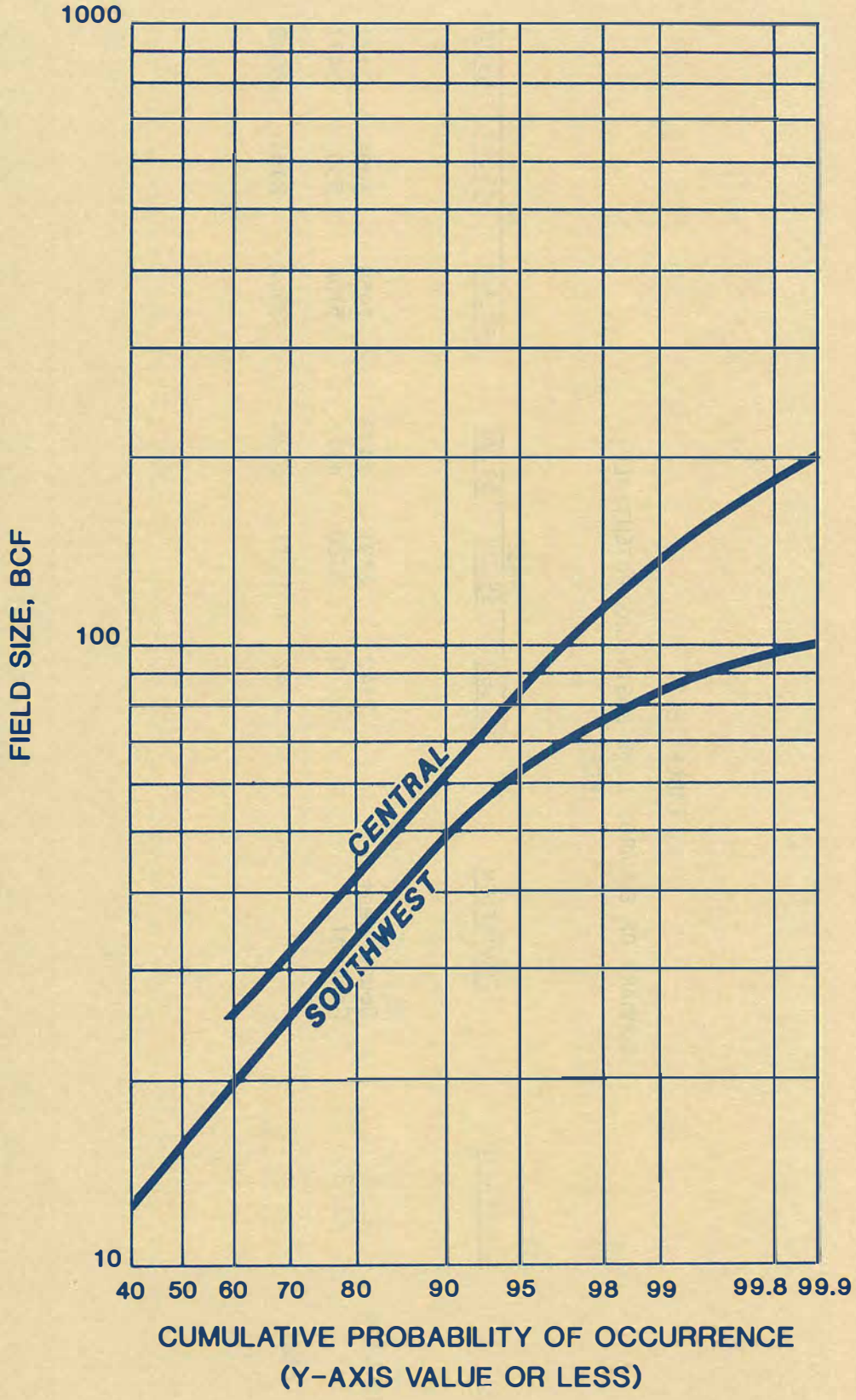


Figure 18-8. Field Size Distribution of Producible Gas, Edwards Lime Basin.

TABLE 18-2

SUMMARY OF EDWARDS LIME BASIN GAS POTENTIAL
(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Edwards Lime	EL 1	South West	2142	2391	2423	2958	3098	3171
	EL 2	Central	0	3820	4311	5104	5353	5477
Basin Total			2142	6211	6734	8062	8451	8648

TABLE 18-3

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

NGL(BBL/MMCF): 2.

BASIN: Edwards Lime
SUBBASIN: Southwest
FORMATION:

DEPTH (FT.): 11,000
PRESSURE (PSIA): 5800
TEMPERATURE (°F): 265

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.2	4	7.0	6	12.26	9	0.05	0.95	1.0
0.06	24	6.5	25	284.7	219	0.25	0.95	1.0
0.02	32	5.7	60	798.91	573	0.50	0.95	1.0
0.006	45	5.5	68	1228.59	842	0.50	0.95	1.0
0.002	38	5.2	78	1125.13	711	0.75	1.0	-
0.0006	34	5.0	90	1116.9	604	0.75	1.0	-
0.0002	8	4.8	100	280.32	140	1.0	1.0	-
0.00006	4	4.7	115	157.82	73	1.0	1.0	-
	189			5005.	3171			

TABLE 18-4
WELL PRODUCTION SUMMARY--BASE CASE

EDWARDS LIME, SOUTHWEST

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.2	0.06	0.02	0.006	0.002	0.0006	0.0002	0.00006	0.00003	0.00001 (MD)
1	401	881	1094	633	391	236	144	89		
2	286	598	682	385	218	128	78	44		
5	161	413	480	245	143	76	45	27		
10	88	281	373	191	105	57	32	19		
15	54	208	309	168	89	49	27	15		
20	39	162	267	152	81	43	23	13		
30	20	108	202	131	71	36	21	11		
30-YEAR CUMM. PROD. (MMCF)	2629	7793	10747	5956	3328	1835	1054	623		

TABLE 18-5

WELL PRODUCTION SUMMARY--ADVANCED CASE

EDWARDS LIME, SOUTHWEST

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.2	0.06	0.02	0.006	0.002	0.0006	0.0002	0.00006	0.00003	0.00001 (MD)
1	578	1820	2822	1945	1362	883	543	306		
2	313	1272	1972	1280	813	499	295	168		
5	147	801	1294	830	527	311	172	97		
10	126	504	876	593	380	217	122	68		
15	104	348	641	473	312	184	103	55		
20	89	267	507	399	274	159	88	48		
30	74	161	333	290	220	132	72	41		
30-YEAR CUMM. PROD. (MMCF)	4532	15764	25283	16596	10660	6407	3882	2334		

TABLE 18-6

PRODUCTION WELL REQUIREMENTS

BASIN: Edwards Lime
SUB-BASIN:
FORMATION: Southwest

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.2	.921	.921	9	.534	.534	9
.06	1.151	1.151	219	.569	.569	219
.02	1.672	1.672	573	.711	.711	573
.006	3.141	3.141	842	1.127	1.127	842
.002	5.694	4.	499	1.778	1.778	711
.0006	9.700	4.	249	2.778	2.778	604
.0002	17.725	4.	32	4.817	4.817	140
.00006	30.979	4.	9	8.266	8.266	73
			2432			3171

TABLE 18-7

INVESTMENT AND OPERATING EXPENSES

BASIN: Edwards Lime
SUB-BASIN:
FORMATION: Southwest

Geology and Geophysics ($/Prospect)	65,000
Drilling Cost ($/Well)	1,021,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	101,000 - 300,000
- Advanced Case [2000/4000 Ft. Fracture]	128,000 - 1,084,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	7,500
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0236

TABLE 18-8

ECONOMICS SUMMARY

BASIN Edwards Lime Southwest
SUB BASIN
FORMATION
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2201111	1.50	23.7	3	BCD	2776	6.686	61	10.6	1634	1634	244	16.5	294	60	36	142	530
21	2.50	37.6	5	ABCDE	3800	10.220	1666	23.9	2142	2354	210	26.1	223	79	65	261	628
31	3.10	52.6	6	ABCDEF	4719	11.966	2779	30.6	2391	2958	200	36.5	182	105	91	364	742
41	3.50	"	"	"	"	"	3446	35.8	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	5946	55.3	"	"	"	"	"	"	"	"	"
61	7.00	57.3	7	ABCDEFG	5125	12.377	9459	79.2	2423	3098	196	39.8	170	112	101	405	788
71	9.00	"	"	"	"	"	12899	103.5	"	"	"	"	"	"	"	"	"
81	12.00	59.3	8	ABCDEFGH	5363	12.507	18154	136.1	2432	3171	194	41.2	165	115	107	429	817
Discount Rate 15%																	
12	1.50	23.7	3	BCD	2776	6.686	-310	10.6	-	-	-	-	-	-	-	-	-
22	2.50	37.6	5	ABCDE	3800	10.220	771	23.9	2142	2354	210	26.1	223	79	65	261	628
32	3.10	"	"	"	"	"	1402	31.3	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	1823	36.3	"	"	"	"	"	"	"	"	"
52	5.00	52.6	6	ABCDEF	4719	11.966	3800	55.3	2391	2958	200	36.5	182	105	91	364	742
62	7.00	57.3	7	ABCDEFG	5125	12.377	6315	79.2	2423	3098	196	39.8	170	112	101	405	788
72	9.00	"	"	"	"	"	8810	103.5	"	"	"	"	"	"	"	"	"
82	12.00	59.3	8	ABCDEFGH	5363	12.507	12602	136.1	2432	3171	194	41.2	165	115	107	429	817
Discount Rate 20%																	
13	1.50	23.7	3	BCD	2776	6.686	-522	10.6	-	-	-	16.5	-	-	-	-	-
23	2.50	23.8	4	ABCD	2778	6.691	73	21.3	1643	1643	246	16.5	295	58	36	143	532
33	3.10	37.6	5	ABCDE	3800	10.220	755	51.3	2142	2354	210	26.1	223	79	65	261	628
43	3.50	"	"	"	"	"	1080	56.3	"	"	"	"	"	"	"	"	"
53	5.00	52.6	6	ABCDEF	4719	11.966	2566	55.3	2391	2958	200	36.5	182	105	91	364	742
63	7.00	"	"	"	"	"	4441	80.5	"	"	"	"	"	"	"	"	"
73	9.00	57.3	7	ABCDEFG	5125	12.377	6433	103.5	2423	3098	196	39.8	170	112	101	405	788
83	12.00	"	"	"	"	"	9338	137.3	"	"	"	"	"	"	"	"	"

*CODE:

A	B	C	D	E	F	G	H
0.2	.06	0.02	0.006	0.00^2	0.0006	0.0002	0.00006

TABLE 18-9

ECONOMICS SUMMARY

BASIN Edwards Lime Southwest — TECHNOLOGY Advanced Case

SUB BASIN — FORMATION — DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
22012 11	1.50	52.6	6	ABCDEF	4288	14.587	1672	24.6	2958	2958	203	36.5	185	107	42	170	504
21	2.50	57.3	7	ABCDEFG	5137	16.103	4553	47.8	3098	3098	192	39.8	167	110	57	227	561
31	3.10	57.3	7	ABCDEFG	5137	"	6282	63.1	3098	3098	"	39.8	"	"	"	"	"
41	3.50	57.3	7	ABCDEFG	5137	"	7435	73.2	3098	3098	"	39.8	"	"	"	"	"
51	5.00	59.3	8	ABCDEFGH	5995	16.904	12029	106.4	3171	3171	188	41.2	159	111	71	282	624
61	7.00	59.3	8	ABCDEFGH	5995	"	18056	152.5	3171	3171	188	41.2	159	111	71	282	624
71	9.00	59.3	8	ABCDEFGH	5995	"	24083	194.3	3171	3171	188	41.2	159	111	71	282	624
81	12.00	59.3	8	ABCDEFGH	5995	"	33124	249.9	3171	3171	188	41.2	159	111	71	282	624
Discount Rate 15%																	
12	1.50	37.6	5	ABCDE	3310	11.017	543	22.3	2354	2354	213	26.1	227	80	22	88	416
22	2.50	52.6	6	ABCDEF	4288	14.587	2831	49.2	2958	2958	203	36.5	185	107	42	170	504
32	3.10	57.3	7	ABCDEFG	5137	16.103	4274	63.1	3098	3098	192	39.8	167	110	57	227	561
42	3.50	57.3	7	ABCDEFG	5137	"	5150	73.2	3098	3098	"	39.8	"	"	"	"	"
52	5.00	57.3	7	ABCDEFG	5137	"	8437	110.0	3098	3098	"	39.8	"	"	"	"	"
62	7.00	59.3	8	ABCDEFGH	5995	16.904	13150	152.5	3171	3171	188	41.2	159	111	71	282	624
72	9.00	59.3	8	ABCDEFGH	5995	"	17727	194.3	3171	3171	"	41.2	159	111	71	282	624
82	12.00	59.3	8	ABCDEFGH	5995	"	24592	249.9	3171	3171	"	41.2	159	111	71	282	624
Discount Rate 20%																	
13	1.50	37.5	4	BCDE	3310	11.012	138	22.3	2345	2345	213	26.1	227	80	22	88	416
23	2.50	52.6	6	ABCDEF	4288	14.587	1928	49.2	2958	2958	203	36.5	185	107	42	170	504
33	3.10	52.6	6	ABCDEF	4288	"	2893	64.1	2958	2958	203	36.5	185	107	42	170	504
43	3.50	57.3	7	ABCDEFG	5137	16.103	3744	73.2	3098	3098	192	39.8	167	110	57	227	561
53	5.00	57.3	7	ABCDEFG	5137	"	6379	110.0	3098	3098	"	39.8	"	"	"	"	"
63	7.00	59.3	8	ABCDEFGH	5995	16.904	10108	152.5	3171	3171	188	41.2	159	111	71	282	624
73	9.00	59.3	8	ABCDEFGH	5995	"	13774	194.3	3171	3171	188	41.2	159	111	71	282	624
83	12.00	59.3	8	ABCDEFGH	5995	"	19273	249.9	3171	3171	188	41.2	159	111	71	282	624

* CODE:

A	B	C	D	E	F	G	H
0.2	.06	0.02	0.006	0.002	0.0006	0.0002	0.00006

TABLE 18-10

GEOLOGICAL DATA SUMMARY

BASIN: Edwards Lime
SUBBASIN:
FORMATION: Central

TOTAL BASIN AREA (SECTIONS):
TYPE: Blanket

DEPTH (FT.): 14,500
PRESSURE (PSIA): 7600
TEMPERATURE (°F): 360

NGL(BBL/MMCF): 2.

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.2	5	7.0	10	26.55	22	0.05	0.95	1.0
0.06	33	6.5	33	536.58	393	0.25	0.95	1.0
0.02	43	5.7	75	1393.63	973	0.50	0.95	1.0
0.006	60	5.5	86	2151.00	1450	0.50	0.95	1.0
0.002	50	5.2	98	1931.50	1218	0.75	1.0	-
0.0006	45	5.0	115	1962.00	1048	0.75	1.0	-
0.0002	10	4.8	130	473.00	249	1.00	1.0	-
0.00006	15	4.7	145	774.9	124	1.00	1.0	-
	261			9249.	5477			

TABLE 18-11

WELL PRODUCTION SUMMARY--BASE CASE

EDWARDS LIME, CENTRAL

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.2	0.06	0.02	0.006	0.002	0.0006	0.0002	0.00006	0.00003	0.00001 (MD)
1	801	1379	1601	933	566	346	214	129		
2	557	941	1009	566	316	188	116	64		
5	291	627	713	364	209	114	68	40		
10	148	409	544	287	155	88	48	28		
15	87	290	438	252	132	73	40	23		
20	61	224	371	227	122	64	35	20		
30	37	140	271	193	106	55	32	16		
30-YEAR CUMM. PROD. (MMCF)	4699	11386	15418	8862	4908	2727	1594	902		

TABLE 18-12

WELL PRODUCTION SUMMARY--ADVANCED CASE

EDWARDS LIME, CENTRAL

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.2	0.06	0.02	0.006	0.002	0.0006	0.0002	0.00006	0.00003	0.00001 (MD)
1	1150	2869	4186	2870	1982	1301	813	451		
2	795	1986	2712	1716	1112	702	444	259		
5	478	1263	1751	1093	695	409	259	153		
10	283	817	1229	793	489	299	180	106		
15	188	577	954	650	406	247	146	87		
20	140	447	788	562	356	211	127	74		
30	80	277	552	450	297	174	109	61		
30-YEAR CUMM. PROD. (MMCF)	8230	23004	35763	24190	15473	9411	5811	3381		

TABLE 18-13

PRODUCTION WELL REQUIREMENTS

BASIN: Edwards Lime
SUB-BASIN:
FORMATION: Central

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.2	.881	.881	22	.503	.503	22
.06	1.063	1.063	393	.526	.526	393
.02	1.491	1.491	973	.643	.643	973
.006	2.727	2.727	1450	.999	.999	1450
.002	4.960	4.	982	1.574	1.574	1218
.0006	8.537	4.	491	2.474	2.474	1048
.0002	15.580	4.	64	4.277	4.277	249
.00006	27.542	4	18	7.358	7.358	124
			4393			5477

TABLE 18-14

INVESTMENT AND OPERATING EXPENSES

BASIN: Edwards Lime
SUB-BASIN:
FORMATION: Central

Geology and Geophysics ($/Prospect)	65,000
Drilling Cost ($/Well)	2,821,000
Fracture Cost ($/Well)	
- Base Case [1000 Ft. Fracture]	107,000 - 444,000
- Advanced Case [2000/4000 Ft. Fracture]	136,000 - 1,471,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	7,500
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.0236

TABLE 18-15

ECONOMICS SUMMARY

BASIN Edwards Lime Central
SUB BASIN
FORMATION
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT Dry	WELLS: WILDCAT Prod.	WELLS: DEVELOPMENT Dry	WELLS: DEVELOPMENT Prod.	WELLS: Total
Discount Rate 10%																	
2202111	1.50	12.4	2	BC	5171	3.900	-1867	0	-	-	-	8.7	-	-	-	-	-
21	2.50	23.7	4	ABCD	7012	9.050	-132	9.4	-	-	-	16.6	-	-	-	-	-
31	3.10	38.3	5	ABCDE	9627	14.299	1477	15.0	3820	4056	267	26.8	280	102	87	348	817
41	3.50	"	"	"	"	"	2277	17.7	"	"	"	"	"	"	"	"	"
51	5.00	"	"	"	"	"	5276	28.4	"	"	"	"	"	"	"	"	"
61	7.00	51.2	6	ABCDEF	12226	17.085	10490	42.8	4311	5104	252	35.8	232	129	123	493	977
71	9.00	56.0	7	ABCDEFG	12598	17.890	15447	56.8	4375	5353	245	39.2	213	137	140	561	1051
81	12.00	"	"	"	"	"	22733	80.9	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	12.4	2	BC	5171	3.900	-2067	0.0	-	-	-	8.7	-	-	-	-	-
22	2.50	23.6	3	BCD	6998	9.024	-948	9.4	-	-	-	16.5	-	-	-	-	-
32	3.10	23.7	4	ABCD	7012	9.050	-341	12.9	-	-	-	16.6	-	-	-	-	-
42	3.50	"	"	"	"	"	61	15.3	2838	2838	313	"	374	74	50	198	696
52	5.00	38.3	5	ABCDE	9627	14.299	2734	28.4	3820	4056	267	26.8	280	102	87	348	817
62	7.00	51.2	6	ABCDEF	12226	17.085	6281	42.8	4311	5104	252	35.8	232	129	123	493	977
72	9.00	"	"	"	"	"	9627	58.6	"	"	"	"	"	"	"	"	"
82	12.00	56.0	7	ABCDEFG	13598	17.890	14971	80.9	4375	5353	245	39.2	213	137	140	561	1051
Discount Rate 20%																	
13	1.50	9.2	1	C	4977	2.993	-2255	0	-	-	-	6.4	-	-	-	-	-
23	2.50	12.4	2	BC	5177	3.900	-1782	2.9	-	-	-	8.7	-	-	-	-	-
33	3.10	23.7	4	ABCD	7012	9.050	-926	12.9	-	-	-	16.6	-	-	-	-	-
43	3.50	"	"	"	"	"	-615	15.3	-	-	-	"	-	-	-	-	-
53	5.00	38.3	5	ABCDE	9627	14.299	1310	28.4	3820	4056	267	26.8	280	102	87	348	817
63	7.00	"	"	"	"	"	3528	42.9	"	"	"	"	"	"	"	"	"
73	9.00	51.2	6	ABCDEF	12226	17.085	6495	58.6	4311	5104	252	35.8	232	129	123	493	977
83	12.00	"	"	"	"	"	10363	82.4	"	"	"	"	"	"	"	"	"

*CODE: A 0.2, B .06, C 0.02, D 0.006, E 0.002, F 0.00002, G 0.000006

TABLE 18-16

ECONOMICS SUMMARY

BASIN Edwards Lime Central
SUB BASIN
FORMATION

TECHNOLOGY Advanced
DATE September 1980

					AVERAGE PER PROSPECT				BASIN TOTALS			WELLS					
CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	VALUE *	E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	GAS RECOVER. AT PRICE,BCF	MAX RECOV. GIP,BCF	MAX. NO. PROSP. AT PRICE	WILDCAT SUCCESS %	WILDCAT Dry	WILDCAT Prod.	DEVELOPMENT Dry	DEVELOPMENT Prod.	Total
Discount Rate 10%																	
2202211	1.50	38.3	5	ABCDE	6840	14.381	75	10.3	4056	4056	282	26.8	295	108	21	84	509
21	2.50	51.2	6	ABCDEF	8902	19.202	3772	26.4	5104	5104	266	35.8	244	136	47	188	615
31	3.10	"	"	"	"	"	5782	35.8	"	"	"	"	"	"	"	"	"
41	3.50	56.0	7	ABCDEFG	11063	21.843	7674	40.9	5353	5353	245	39.1	213	137	68	273	691
51	5.00	"	"	"	"	"	13320	66.3	"	"	"	"	"	"	"	"	"
61	7.00	58.2	8	ABCDEFGH	11795	22.388	21146	99.2	5477	5477	"	40.7	207	142	76	305	731
71	9.00	"	"	"	"	"	28851	132.7	"	"	"	"	"	"	"	"	"
81	12.00	"	"	"	"	"	40409	180.4	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	38.2	4	BCDE	6832	14.358	-719	10.3	-	-	-	26.7	-	-	-	-	-
22	2.50	51.2	6	ABCDEF	8902	19.202	1955	26.4	5104	5104	266	35.8	244	136	47	188	615
32	3.10	"	"	"	"	"	3484	35.8	"	"	"	"	"	"	"	"	"
42	3.50	"	"	"	"	"	4504	42.2	"	"	"	"	"	"	"	"	"
52	5.00	56.0	7	ABCDEFG	11063	21.843	9036	66.3	5353	5353	245	39.1	213	137	68	273	691
62	7.00	"	"	"	"	"	14733	100.4	"	"	"	"	"	"	"	"	"
72	9.00	58.2	8	ABCDEFGH	11795	22.388	20728	132.7	5477	5477	"	40.7	207	142	76	305	731
82	12.00	"	"	"	"	"	29470	180.4	"	"	"	"	"	"	"	"	"
Discount Rate 20%																	
13	1.50	23.6	3	BCD	5966	8.999	-1614	5.6	-	-	-	16.5	-	-	-	-	-
23	2.50	38.3	5	ABCDE	6840	14.381	385	23.2	4056	4056	282	26.8	295	108	21	84	509
33	3.10	51.2	6	ABCDEF	8902	19.202	2097	35.8	5104	5104	266	35.8	244	136	47	188	615
43	3.50	"	"	"	"	"	2917	42.2	"	"	"	"	"	"	"	"	"
53	5.00	56.0	7	ABCDEFG	11063	21.843	6441	66.3	5353	5353	245	39.1	213	137	68	273	691
63	7.00	"	"	"	"	"	11000	100.4	"	"	"	"	"	"	"	"	"
73	9.00	58.2	8	ABCDEFGH	11795	22.388	15756	132.7	5477	5477	"	40.7	207	142	76	305	731
83	12.00	"	"	"	"	"	22750	180.4	"	"	"	"	"	"	"	"	"

*CODE: A 0.3, B 0.1, C 0.03, D 0.01, E 0.003, F 0.001, G 0.0003, H 0.0006

Chapter Nineteen

COTTON VALLEY BASIN

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Chapter Nineteen

COTTON VALLEY BASIN

GEOLOGY

General Description

The Cotton Valley trend is in the three corners area of Texas, Louisiana, and Arkansas (Figure 19-1). It includes about 20,600 square miles, of which some 13,140 square miles is producing or has tight gas potential. An additional 7,460 square miles has speculative potential, but is not evaluated in this report. Structurally, the area is bounded on the northeast by the Monroe Uplift, on the north by the South Arkansas Fault Zone, and on the west by the Mexia-Talco Fault Zone. In addition to structural control, production is limited by a downdip (south) stratigraphic change to basinal shale. Stratigraphy also plays a part in limiting the production to the north by changing to a continental facies.

The surface rocks over most of the area are Eocene in age. The maximum sedimentary thickness from the base of the Paleozoic through Eocene is more than 40,000 feet. The post Louann salt Jurassic thickness is about 4,000 feet.

The traps presently producing from this trend are both structural and stratigraphic. Present "tight" gas exploration is directed primarily toward finding the stratigraphic trap. Subsurface geology is the most effective tool used where well control exists. Seismic is used in structural areas away from well control to map faults in relation to producing trends. General producing depths are in the 8,000 to 14,000 foot range, but depths in excess of 20,000 feet may be necessary in the future to develop the tight gas sands.

It is generally agreed that the Cotton Valley formation represents a regressive series of sediments with regional unconformities occurring both above and below it. The sandstones were deposited in a general east-west direction subparallel to the shoreline in offshore bars, delta fronts, and lagoonal environments.

Figure 19-2 is a sectional detail showing the Cotton Valley.

Exploration History

In 1937 the Ohio Oil Company (Marathon Oil Company) drilled the first well in what later became the Cotton Valley Trend. Gas was first found in the 1940's in Louisiana in updip pinchouts subparallel to structural strike. Large scale drilling activity occurred in the early 1950's. During this period the seismograph was used to map structural attitudes of the prolific fields found in Arkansas, and in the 1960's the activity moved to Texas. In the 1970's, when gas prices increased and massive hydraulic fracturing

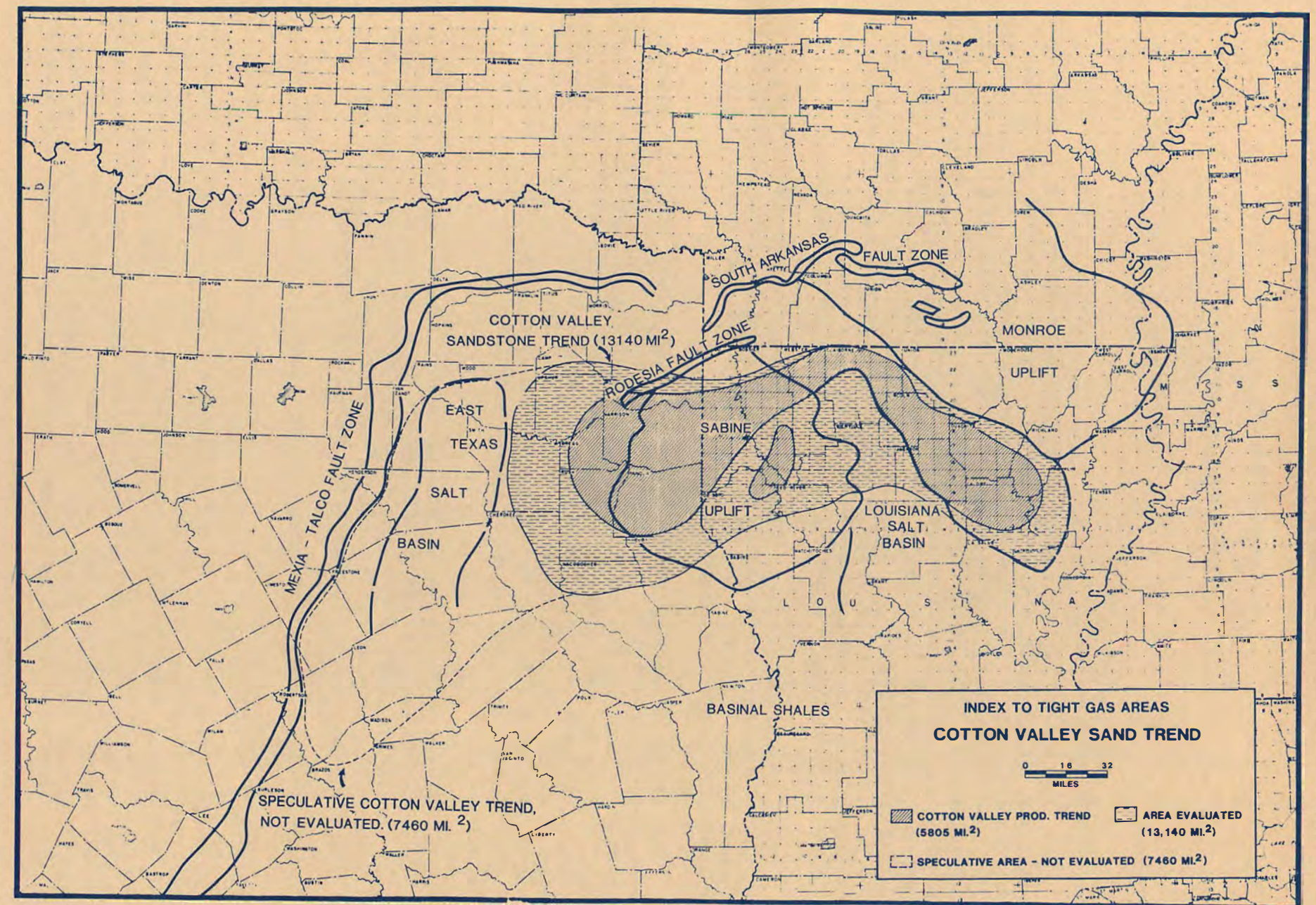
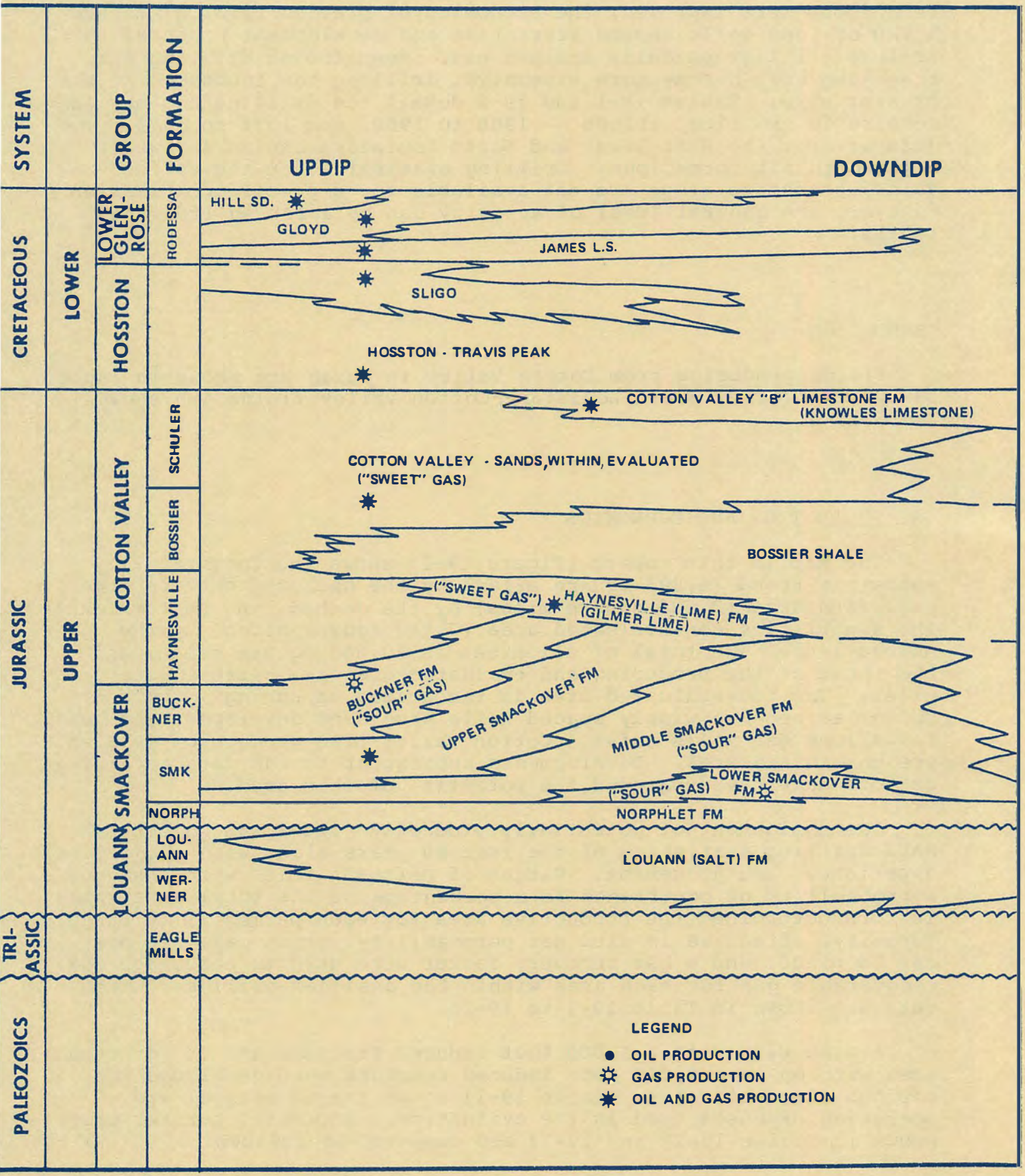


Figure 19-1. Index to Tight Gas Areas—Cotton Valley Sand Trend.



ADAPTED FROM LEWIN, AND COLLINS, WORLD OIL, MAY 1968

Figure 19-2. Detail Type Section.

techniques were improved, the economics of previously marginal 500 MCFPD or less wells became attractive and development expanded to include stratigraphically trapped gas. Even though drilling and frac jobs have become more expensive, drilling has increased to the present time. Tables 19-1 and 19-2 detail the drilling history and results in two time periods -- 1960 to 1969, and 1970 to 1979. The data are for the East Texas and North Louisiana basins for wells drilled to all formations. Drilling statistics for the Cotton Valley sandstone alone are not available for a precise compilation. However, the general level of activity can be inferred from the tables.

PRODUCTION

Fields producing from Cotton Valley in Texas are shown in Table 19-3. Similarly, north Louisiana Cotton Valley fields are shown in Table 19-4.

GAS PRODUCTION AND ECONOMICS

The map in this report (Figure 19-1) shows the Cotton Valley sandstone trend (5,805 square miles) by the hachured pattern, the evaluated area (7,335 square miles) by the dashed line pattern, and the speculative non-evaluated area (7,460 square miles) by the dashed line. The total of all areas is 20,600 square miles, and the total of the producing and evaluated area is 13,140 square miles. The non-evaluated area is recognized as having speculative potential because widely spaced wells have sand developed, and some low volume gas wells exist. Cotton Valley Lime production is also present in the area. Developments subsequent to the data gathering cut-off date have upgraded the potential of this area.

The assignment of potentially productive areas was guided by AAPG drilling statistics of the last 20 years along with subjective experience, and judgement. Ranges of permeabilities were assigned a probability of occurrence in a percentage of the total area which in turn determined the productive area for each permeability range. Porosity, effective in situ gas permeability, gross pay, net pay, gas in place, and a gas recovery factor were used to calculate the recoverable gas for each area within the assigned outline. These data are shown in Table 19-7 to 19-10.

A base case with a 1,000 foot induced fracture and an advanced case with up to a 4,000 foot induced fracture were developed for various discount rates. Table 19-11 shows the investment and operating expenses used in the evaluation. Economics for two cases shown in Tables 19-12 and 19-13 are compared as follows.

	Base Case (1,000 foot frac.)	Advanced Case (4,000 foot frac.)
Gas price	$5.00	$5.00
Discount rate	15%	15%
Number of perm. levels productive	7	8
	Base Case (1,000 foot frac.)	Advanced Case (4,000 foot frac.)
Number of wells needed, prod.	2,468 (70% Succ.)	1,848 (70% Succ.)
Number of wells needed, dry	1,042	807
Prospects drilled	596	569
Recoverable gas for area	8.4 TCF	9.8 TCF (12% more)
Total investment for area	*3,056.3 MM$	**4,281.7 MM$ (40% more)
DCF ROR per prospect	30.6%	38%
Net present value per prospect	2.6 MM$	5.4 MM$
Profit per investment, $/$		

* 596 prospects times 5,128 M$/prospect
** 569 prospects times 7,525 $/prospect

In this comparison the advanced case would recover 1.4 TCF more gas than the base case, but an additional expenditure of 1,224.5MM$ or $0.87/MCF would be needed. Complete economic summaries for base and advance cases are presented in Tables 18-15 and 18-16. The explorer can select the case best suited to his investment needs.

REFERENCES

East Texas Gas Field Gets First Massive Frac
Noran D
World Oil V 180, No 6, PP 98-100, May 1975
1975

Slim-Hole Tubing Was One Key to the Successful Production of Natural Gas From a Low-Permeability, Low-Porosity Reservoir
Bronte R F
SPE of AIME Europe Spring Mtg Prepring No SPE-4926, 14 PP, 1974
1974

East Texas Gas Field Gets First Massive Frac
World Oil V 180, No 6, PP 98-100, May 1975
1975

A Successful Approach to the Commercial Production of Gas From Cotton Valley and Hosston Lenticular Sandstones in the Upper Gulf Coast
Forgotson J M Jr; Forgotson J M
AAPG Sept Annu Mtg Abstr V-1, P 35, April 1974
1974

Stratigraphy and Selected Gas-Field Studies of North Louisiana
Amer Assoc Petrol Geol Mem No 9, V 1, PT 11, PP 1099-1175, 1968
1968

Formation Evaluation with Logs in Ark-La-Tex Cotton Valley Formation
(ABSTR)
Frank, R. W.
Am. Assoc. Pet. Geol., Bull. (USA) (AAPGBS), Vol. 62, No. 9, p. 1757, 1978 (Gulf Coast Association of Geological Societies and Gulf Coast Section Sepm, 28th Annual Meeting, New Orleans, La., Oct. 11-13, 1978)

Hosston Sand Porosity Critical in Mississippi, Louisiana
Weaver, O. D.,; Smitherman, J., III
Oil Gas J. (USA) (OIGJAV), Vol. 76, No. 10, P. 108-110, 1978, Illus., Sketch Maps

Interpretation of Cotton Valley Depositional Environment from Core Study, Frierson Field, Louisiana
Weaver, O. D.; Smitherman, J., III
Gulf Coast Assoc. Geol. Soc., Trans. (USA) (TGCGA9), No. 26, P. 320-325
1976, 11 Ref., Illus., Sketch Map

Biggest Frac Job's Results 'Encouraging'
Frederick R O
Drilling V 40, No 3, PP 42, 44, 47-49, Jan 1979 (ISSN 00126241)

Successful Stimulation in the Cotton Valley Sandstone--A Low-Permeability Reservoir
Jennings A R Jr; Sprawls B T
J Petrol Technol V 29, PP 1267-1276, Oct 1977 SRBA# 212,479
1978

The Evolution of a Fracturing Technique for the Cotton Valley
Hufft H F
52nd Annu Spe of AIME Fall Tech Conf Preprint No SPE-6868, 11 PP, 1977

Successful Stimulation in the Cotton Valley Sandstone--A Low Permeability Reservoir
Jennings A R Jr; Sprawls B T
50th Annu Spe of AIME Fall Mtg Preprint No SPE-5627, 12 PP, 1975
1975

Recovery Improvement Study of the Gray Sand Reservoir
Chen T K; Kennedy J H; McElhiney J E
48th Annu SPE of AIME Fall Mtg Preprint No SPE-4596, 12 PP, 1973
1973

Possible Future Petroleum Potential of Jurassic, Western Gulf Basin
Newkirk R F
Amer Ass Petrol Geol Mem No 15, PP 927-953, 1971 (V 2)
1971

Possible Future Petroleum Provinces of the Gulf Coast--Jurassic
Amoruso J J
20th Annu Gulf Coast Assoc. Geol Soc Mtg Trans V 20, P 159, 1970
1971

Possible Future Petroleum Provinces of Gulf Coast--Jurassic
Amoruso J J
20th Annu AAPG Gulf Coast Sect + Sepm Gulf Coast Sect Conv Pap 1970
1970

Upper Jurassic Stratigraphy of Some Adjacent Parts of Texas, Louisiana and Arkansas
Dickinson K A
US Geol Surv Prof PAP No 594-E, 26 PP, 1 PL, 1968
1968

Carthage Field, Panola County, Texas
Rogers R E
Amer Assoc Petrol Geol Mem No 9, V 1, PT II, PP 1020-1059, 1968
1968

Stratigraphy and Selected Gas-Field Studies of North Louisiana
Amer Ass Petrol Geol Mem No 9, V 1, PT II, PP 1099-1175, 1968
1968

Smackover, Cotton Valley Pays Place Top in East Texas Play
Burke R G
Oil Gas J V 65, No 46, PP 176-180, 11/13/67
1967

Jurassic Sediments of Mississippi and Alabama
Minihan E D; Oxley M L; Ridgway J M
17th Ann GCAGS-Sepm Gulf Coast Sect-AAPG Reg Joint Mtg 10/25-27/67
Paper
1967

Resume of Jurassic to Recent Sedimentation History of Gulf of Mexico Basin
Rainwater E H
17th Ann GCAGS-Sepm Gulf Coast Sect-AAPG Reg Joint Mtg 10/15-27/67
Paper
Tenneco Oil Co
1967

High Pressure Reservoir Successfully Produced
Petrol Eng V 39, No 7, PP 44, 46, 48, 53-55, July 1967
1967

Stratigraphic-Trap Possibilities in Upper Jurassic Rocks, San Marcos Arch, Texas
Halbouty M T
Bull Amer Assoc Petrol Geol V 50, No 1, PP 3-24, Jan 1966
1966

Late Jurassic Depositional Environment, Louisiana and Arkansas
Thoma W A; Mann C J
Bull Amer Assoc Petrol Geol V 50, No 1, PP 178-182, Jan 1966
1966

Formation Evaluation With Logs In Ark-La-Tex Cotton Valley Formation

Frank, R. W.
Am. Assoc. Pet. Geol., Bull. (USA) (AAPGBS), Vol. 62, No. 9, P. 1757, 1978 (Gulf Coast Association of Geological Societies and Gulf Coast Section Sepm, 28th Annual Meeting, New Orleans, La., Oct. 11-3, 1978)

Hosston Sand Porosity Critical in Mississippi, Louisiana
Weaver, O. D.; Smitherman, J., III
Oil Gas J. (USA) (OIGJAV), Vol. 76, No. 10, P. 108-110, 1978, Illus., Sketch Maps

Depositional Environments of the Schuler Formation (late Jurassic) in Upshur County, Texas (ABSTR) Programs (USA) (GAAPBC), Vol. 9, No. 1, P. 29, 1977 (The Geological Society of America, South-Central Section; 11th Annual Meeting, El Paso, Tex., March 17-18, 1977)

Interpretation of Cotton Valley Depositional Environment from Core Study, Frierson Field, Louisiana
Sonnenberg, S. A.
Gulf Coast Assoc. Geol. Soc., Trans. (USA) (TGCGA9), No. 26, P. 320-325
1976, 11 Ref., Illus., Sketch Maps

Late Jurassic Depositional Environments, Louisiana and Arkansas
Thomas, Wiliam A.; Mann, C. John
in Jurassic of the Gulf Coast II; Local Stratigraphy and Deposition., Am. Assoc. Pet. Geol., Repr. Ser., (APGRAI), No. 13, P. 105-109, Illus. (Incl. Sketch Maps), 1974, (Reprint from AAPG Bulletin Vol. 50, No. 1, 1966)

Stratigraphy of Cotton Valley Beds of Northern Gulf Coastal Plain
Swain, Frederick M.
in Jurassic of the Gulf Coast I; Regional Stratigraphy., Am. Assoc. Pet. Geol., Repr. Serv., (APGRAI), No. 12, P. 131-169, Illus. (Incl. Sketch Maps), 1974, (Reprint from AAPG Bulletin Vol. 28, No. 5, 1944)

Evaluation of Hosston and Cotton Valley Fine Grained Sandstones
Forgotson, James M., Jr.: Forgotson, James M.
Soc. Prof. Well Log Anal. Annu. Logging Symp., Trans., (LGSTA6), No. 15, P. Z1-Z15, Illus., 1974

Late Jurassic Depositional Environments, Louisiana and Arkansas
Thomas, William A.; Mann, C. John
Am. Assoc. Petroleum Geologists Bull., V. 50, No. 1, P. 178-182, Illus., 1966

A Successful Approach to the Commercial Production of Gas from Cotton Valley and Hosston Lenticular Sandstones in the Upper Gulf Coast
Forgotson, James M., Jr.; Forgotson, James M.
Am. Assoc. Pet. Geol., Soc. Econ. Paleonton. Mineral., Annu. Mtg. Abstr., (APGAB2), Vol. 1, P. 35, 1974

Stratigraphic Exploration Finds Gas in Fine-Grained East Texas Sands
Forgotson, James M., Jr.
Oil Gas J., (OIGJAV), Vol, 72 No. 44, P. 94-97, Illus. (Incl. Sketch Map), 1974

Significant North Louisiana Cotton Valley Stratigraphic Traps
Pate, Barney F.
Gulf Coast Assoc. Geol. Socs. Trans., V. 13, P. 177-183, 1963

Correlation Chart of Upper Cotton Valley Sands, in Report on Selected North Louisiana and South Arkansas Oil and Gas Fields-Reference Volume 5
Thomas, William A.; Mann, C. John.
Shreveport, La., Shreveport Geol. Soc., P. 9-17, 1963

TABLE 19-1

EXPLORATION PERFORMANCE - East Texas Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	266	184	82	140	110	30	406	294	112
Gas	117	74	43	94	77	17	211	151	60
Oil	133	95	38	43	32	11	176	127	49
Oil and Gas	16	15	1	3	1	2	19	16	3
Amount of Petroleum Found									
Total, MMBOE **	1058.2	900.3	157.9	505.2	391.4	113.8	1563.4	1291.7	271.7
Gas, BCF	2541.7	1866.3	675.4	1657.4	1263.1	394.3	4199.1	3129.4	1069.7
Oil, MM Bbls.	309.9	284.2	25.7	63.7	55.3	8.4	373.6	339.5	34.1
Number of Wildcat Wells									
Total	2195	2026	169	1040	966	74	3235	2992	243
Gas *	965	891	74	699	649	50	1664	1540	124
Oil *	1098	1013	85	319	297	22	1417	1310	107
Oil and Gas	132	122	10	22	20	2	154	142	12
Number of Wildcats, O & G/year	220	203	17	130	121	9	180	166	14
Percent Wildcats Successful									
Total	12.1	9.1	48.5	13.5	11.4	40.5	12.6	9.8	46.1
Gas	12.1	8.3	58.1	13.4	11.9	34.0	12.7	9.8	48.4
Oil	12.1	9.4	44.7	13.5	10.8	50.0	12.4	9.7	45.8
Oil and Gas	12.1	12.3	10.0	13.6	5.0	100.0	12.3	11.3	25.0
Amount Found/Successful Wildcat									
Total, MMBOEE	4.0	4.9	1.9	3.6	3.6	3.8	3.9	4.4	2.4
Gas, BCF	21.7	25.2	15.7	17.6	16.4	23.2	19.9	20.7	17.8
Oil, MM Bbls	2.3	3.0	0.7	1.5	1.7	0.8	2.1	2.7	0.7
Average Depth of Wells, M ft.									
Oil	7.02	6.71	7.80	8.46	8.76	7.59	7.37	7.23	7.76
Gas	9.38	9.38	9.39	10.12	10.05	10.47	9.71	9.72	9.68

* Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

TABLE 19-2

EXPLORATION PERFORMANCE - North Louisiana Basin

	1960 - 1969			1970 - 1977			1960 - 1977		
	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.	All Wells	New Fields	New Pools & Deeper Prod.
Number of Successful Wildcat Wells									
Total	196	90	106	158	127	31	354	217	137
Gas	89	44	45	95	77	18	184	121	63
Oil	100	44	56	61	49	12	161	93	68
Oil and Gas	7	2	5	2	1	1	9	3	6
Amount of Petroleum Found									
Total, MMBOE **	351.1	279.7	71.4	160.1	114.0	46.1	511.2	393.7	117.5
Gas, BCF	945.6	830.6	115.0	365.8	262.0	103.8	1311.4	1092.6	218.8
Oil, MM Bbls.	29.6	12.4	42.0	50.2	45.6	4.6	79.8	58.0	46.6
Number of Wildcat Wells									
Total	1873	1554	319	1342	1254	88	3215	2808	407
Gas *	851	705	146	807	754	53	1658	1459	199
Oil *	955	793	162	518	484	34	1473	1277	196
Oil and Gas	67	56	11	17	16	1	84	72	12
Number of Wildcats, O & G/year	187	155	32	168	157	11	179	156	23
Percent Wildcats Successful									
Total	10.5	5.8	33.2	11.8	10.1	35.2	11.0	7.7	33.7
Gas	10.5	6.2	30.8	11.8	10.2	34.0	11.1	8.3	31.7
Oil	10.5	5.5	34.6	11.8	10.1	35.3	10.9	7.3	34.7
Oil and Gas	10.4	3.6	45.5	11.8	6.3	100.0	10.7	4.2	50.0
Amount Found/Successful Wildcat									
Total, MMBOEE	1.8	3.1	0.7	1.0	0.9	1.5	1.4	1.8	0.9
Gas, BCF	10.6	18.9	2.6	3.9	3.4	5.8	7.1	9.0	3.5
Oil, MM Bbls	0.3	0.3	0.8	0.8	0.9	0.4	0.5	0.6	0.7
Average Depth of Wells, M ft.									
Oil	4.32	3.91	4.64	6.99	6.97	7.08	5.33	5.52	5.08
Gas	6.41	6.21	6.60	7.31	6.54	10.61	6.83	6.42	7.62

* Estimated by multiplying the number wildcats by the same percentage distribution as the successful wildcats.

** Includes gas in solution with oil and condensate produced with gas. Conversion 5.8 MCF = 1 bbl oil.

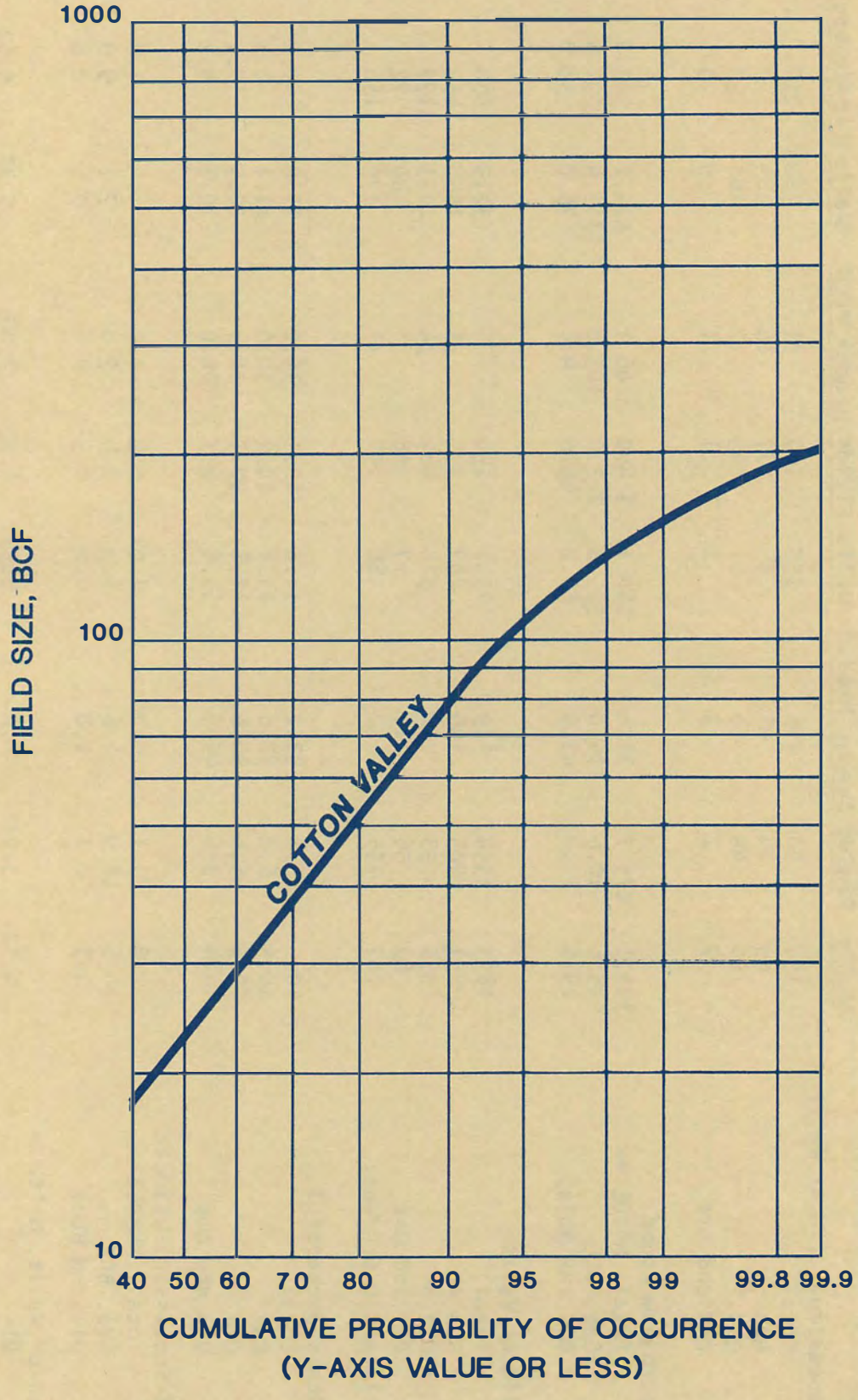


Figure 19-3. Field Size Distribution of Producible Gas, Cotton Valley Trend.

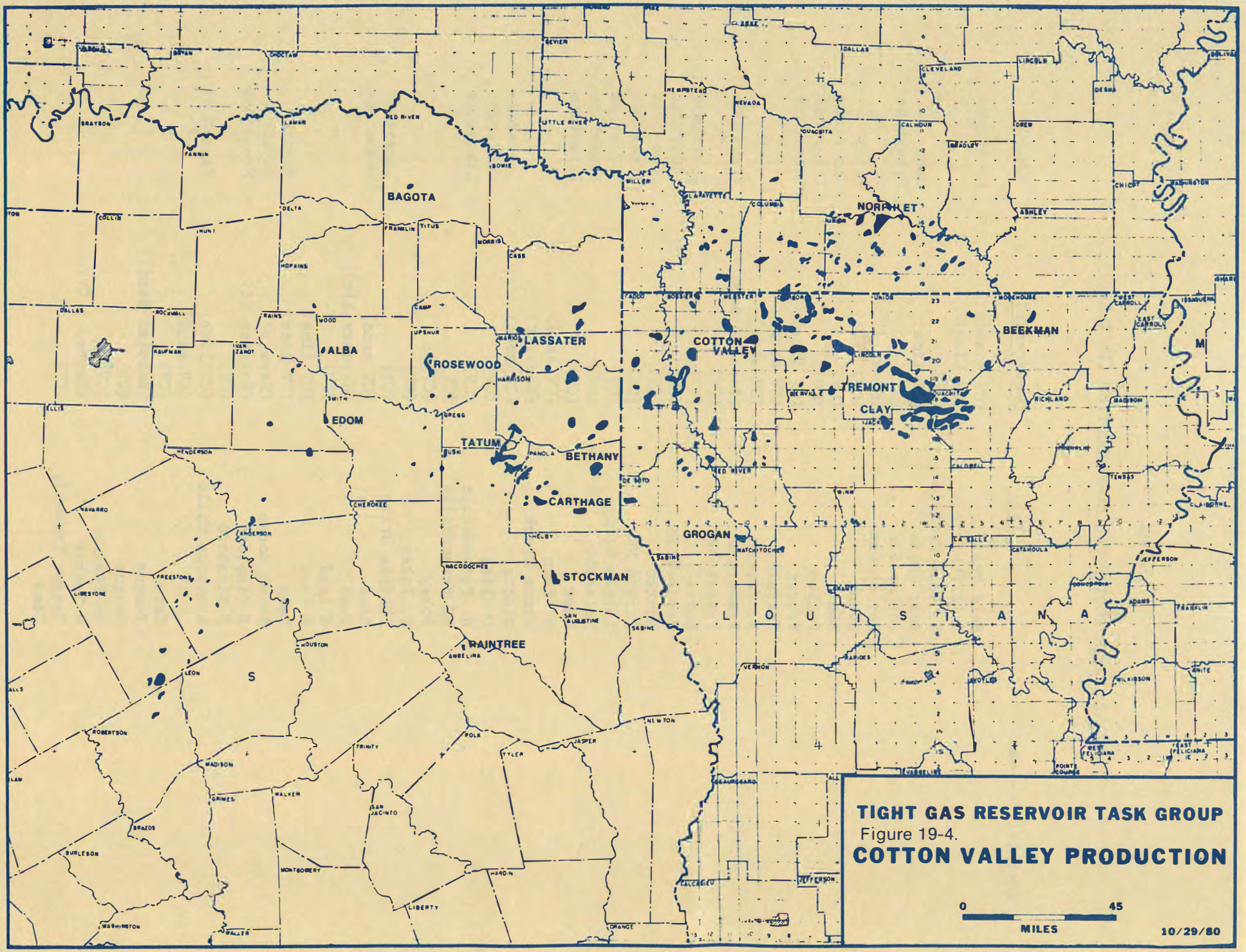

BAGOTA
LASSATER
ALBA
ROSEWOOD
EDOM
TATUM
BETHANY
CARTHAGE
STOCKMAN
RAINTREE
NORPHLET
COTTON VALLEY
REMONT
CLAY
GROGAN
BEEKMAN
L O U I S I A N A
S
TIGHT GAS RESERVOIR TASK GROUP
Figure 19-4.
COTTON VALLEY PRODUCTION
0
45
MILES
10/29/80

TABLE 19-3

FIELDS WITH COTTON VALLEY PRODUCTION (IN TEXAS)

District 5 - Gas	Field	(Reservoir)	County
	Bald Prairie	(CV Bossier)	Robertson
	Bald Prairie	(CV Lime)	"
	N. Bald Prairie	(CV)	"
	Bear Grass	(CV lime)	Leon
	Cotton Gin	(CV)	Freestone
	Cotton Gin	(CV-sand)	"
	Denny	(CV)	Falls
	Edom	(CV)	Van Zandt
	Fallon	(CV)	Limestone
	Farrar	(CV lime)	Limestone
	Farrar	(CV sand)	"
	N. Farrar	(CV sand)	"
	Freestone	(Bossier sand)	Freestone
	Freestone	(CV)	"
	Hayes	(CV)	Robertson
	Headsville	(CV)	Limestone
	Hunter	(CV)	Freestone
	Kirvin NE	(CV)	Freestone
	Little Buddy	(CV)	Limestone
	Malakoff	(CV)	Henderson
	Mann	(CV)	Freestone
	N. Mann	(CV sand)	"
	Mimms Creek	(Bossier)	"
	Oletha	(CV sand)	Limestone
	Opelika	(CV)	Henderson
	N. Personville	(CV)	Limestone
	NE Personville	(CV)	"
	Pokey	(CV)	"
	E. Pokey	(CV)	"
	Prairie Grove	(CV)	Limestone
	Reed	(CV sand)	Freestone
	Reed	(Haynesville)	"
	N Reed	(CV)	"
	N Reed	(CV lime)	"
	Reka	(CV lime)	Navarro
	Round House	(Haynes)	Navarro
	N Simsboro	(Bossier Sd)	Freestone
	N Simsboro	(CV)	"
	Stewards Mills	(CV lime)	Freestone
	"	(CV sand)	"
	Tate	(CV)	"
	Teague	(Bossier Sand)	"
	Teague	(CV)	"
	SW Teague	(CV)	"
	W Teague	(Haynes & CV)	"
	Teague Township	(CV)	"
	Teas		"

TABLE 19-3 (Continued)

District 6 - Gas	Field	(Reservoir)	County
	Beckville	(CV)	Panola
	N Beckville	(CV)	"
	W Beckville	(CV)	"
	Belle Bower		"
	Bethany	(CV)	Harrison
	E. Bethany	(CV)	Panola
	Blocker	(CV)	Harrison
	Carthage	(CV)	Panola
	S. Carthage	(CV)	"
	SE Carthage	(CV)	"
	Cayuga	(CV)	Anderson
	Cedar Springs	(CV sand)	Upshur
	Cedar Springs	(Haynes)	"
	Centennial		Panola
	Chapman	(CV)	Rusk
	Cherokee Trace	(CV)	Upshur
	Cyril	(CV)	Rusk
	Dirgin	(CV)	Rusk
	Fairplay	(CV)	Panola
	Gilmer	(CV)	Upshur
	S Gilmer	(CV)	"
	S Gilmer	(CV, up)	"
	S Hallsville	(Hoss-CV)	Harrison
	Henderson	(CV)	Rusk
	Kildare	(CV)	Cass
	Lake Farrell	(CV)	Marion
	Lassater	(CV)	"
	Oak Hill	(CV)	Rusk
	Overton	(CV sand)	Smith
	Overton	(Haynes)	"
	NE Overton	(Haynes)	Rusk
	Pod	(CV)	Rusk
	Rosewood	(Hoss-CV)	Upshur
	Rufus	(CV)	Rusk
	Runnion	(CV)	Smith
	Sabine	(CV)	Harrison
	Stockman	(CV)	Shelby
	SW Tatum	(Hoss-CV)	Rusk
	Tenaha	(CV mass LS)	Shelby
	Trawick	(CV)	Nacogdoches
	Waskom	(CV	Harrison
	Waskom	(CV,LO.)	"
	Waskom	(CV 8100)	"
	Willow Springs	(CV)	Gregg
	Willow Springs	(CV)	"
	Woodlawn	(CV)	Harrison
	NE Woodlawn	(CV)	"
	SW Woodlawn	(CV)	"

TABLE 19-4

NORTH LOUISIANA COTTON VALLEY FIELDS

PARISH

BOSSIER

- Arkana
- Bentoni
- Lake Bistineau
- Plain Dealing
- Rocky Mount
- Sarepta
- Scottsville
- Sentell
- Sligo

CADDO

- Pine Island
- Ouachita
- Caspiana
- Dixie
- Greenwood, E
- Longwood
- Waskom

CALDWELL

- Caldwell
- Vixen

CLAIBORNE

- Anticoch
- Athens
- Colquit,NW
- Dykesville,E
- Haynesville
- Homer
- Sugar Cr
- Summerfield

DESOTO

- Grogan

LINCOLN

- Choudrant
- Clay
- Rico
- Ruston
- Terryville
- Unionville

OUCHITA

- Fremont

UNION

- Bernice
- Downsville
- Marion
- Monroe

WEBSTER

- Ada
- Cotton V.
- Ivan
- Lincoln
- Minden
- Shongaloo

TABLE 19-5

COTTON VALLEY BASIN

MAXIMUM RECOVERABLE GAS
AND
PRODUCTIVE AREAS

BASIN	SUB-BASIN	FORMATION	PRODUCTIVE AREA (SECTIONS)	MAXIMUM RECOVERABLE GAS (BCF)
Cotton Valley			1,027	12,816

TABLE 19-6

SUMMARY OF COTTON VALLEY BASIN GAS POTENTIAL
(BCF)

BASIN	SUB-BASIN	FORMATION	BASE			ADVANCED		
			$2.50	$5.00	$9.00	$2.50	$5.00	$9.00
Cotton Valley			5387	6976	7292	8352	9795	12735

TABLE 19-7

GEOLOGICAL DATA SUMMARY

TOTAL BASIN AREA (SECTIONS): 13140
TYPE: Blanket

NGL(BBL/MMCF): 9.

BASIN: Cotton Valley
SUBBASIN:
FORMATION:

DEPTH (FT.): 9000
PRESSURE (PSIA): 5500
TEMPERATURE (°F): 250

AVERAGE PERM. (MD)	PRODUCTIVE AREA (SECTIONS)	H/C GAS POROSITY (%)	NET PAY THICKNESS (FT.)	ESTIMATED GAS IN PLACE AT RESERVOIR COND. (BCF)	MAX. RECOVERABLE GAS (BCF)	FOR EACH DRILLING LOCATION W/C: PROBABILITY THAT STATE OF NATURE IS PRODUCTIVE	PROBABILITY THAT W/C IS PRODUCTIVE, GIVEN THAT STATE OF NATURE IS PROD 1st W/C	2nd W/C
0.3	2	11.0	5.5	8.8	7.	.10	.80	1.0
0.1	8	7.9	14.0	64.4	52.	.20	.80	1.0
0.03	41	5.0	29.0	432.5	328.	.20	.80	1.0
0.01	154	4.0	48.0	2151.38	1538.	.30	.80	1.0
0.003	308	3.3	70.0	5177.48	3462.	.40	1.0	-
0.001	154	2.9	85.0	2761.2	1723.	.60	1.0	-
0.0003	103	2.6	110.0	2143.4	1242.	.80	1.0	-
0.0001	103	2.4	150.0	2697.6	1443.	.95	1.0	-
0.00003	103	2.2	210.0	3461.8	1697.	.95	1.0	-
0.00001	51	2.0	400.0	2968.2	1324.	.95	1.0	-
	1027			21867.	12816.			

TABLE 19-8

WELL PRODUCTION SUMMARY--BASE CASE

COTTON VALLEY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	490	669	611	512	347	220	143	105	77	78
2	363	469	395	310	205	121	77	57	38	42
5	218	315	280	211	131	80	46	33	23	20
10	121	203	206	166	101	58	33	23	16	17
15	77	149	162	142	88	49	30	19	13	14
20	56	105	134	124	80	44	26	17	11	12
30	31	73	94	101	70	39	22	15	9	10
30-YEAR CUMM. PROD. (MMCF)	3621	5719	5770	4949	3182	1838	1107	768	536	545

TABLE 19-9

WELL PRODUCTION SUMMARY--ADVANCED CASE

COTTON VALLEY

GAS PRODUCTION (MMCF/YEAR/WELL)

YEAR	K = 0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001 (MD)
1	687	1039	1497	1423	1181	798	547	396	264	241
2	499	700	992	902	681	437	294	217	154	153
5	331	468	644	572	416	269	171	126	91	91
10	213	327	449	412	301	187	119	88	64	64
15	152	257	341	333	250	158	102	72	51	54
20	118	198	278	282	217	137	89	62	45	46
30	73	146	189	221	176	114	72	52	36	38
30-YEAR CUMM. PROD. (MMCF)	6075	9358	12831	12336	9406	6013	3908	2834	2013	2030

TABLE 19-10

PRODUCTION WELL REQUIREMENTS

BASIN: Cotton Valley
SUB-BASIN:
FORMATION:

PERM. (MD)	BASE CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	BASE CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=4]	BASE CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)	ADVANCED CASE: NUMBER OF WELLS/SECTION REQD. TO PRODUCE ALL GAS	ADVANCED CASE: NUMBER OF WELLS/SECTION ACTUALLY USED [MAX=12]	ADVANCED CASE: RECOVERABLE GAS FROM ACTUAL WELLS (BCF)
.3	1.	1	7	1.	1.	7
.1	1.	1	52	1.	1.	52
.03	1.	1	328	1.	1.	328
.01	2.	2	1538	1.	1.	1538
.003	3.5	3.5	3462	1.2	1.2	3462
.001	6.08	4	1133	1.9	1.9	1723
.0003	10.88	4	456	3.1	3.1	1242
.0001	18.24	4	316	4.9	4.9	1443
.00003	30.6	4	221	8.2	8.2	1697
.00001	47.6	4	111	12.8	12.0	1243
			7624			12735

TABLE 19-11

INVESTMENT AND OPERATING EXPENSES

BASIN: Cotton Valley
SUB-BASIN:
FORMATION:

Geology and Geophysics ($/Prospect)	175,000
Drilling Cost ($/Well)	597,000
Fracture Cost ($/Well)	
- Base Case (1000 Ft. Fracture)	95,000 - 412,000
- Advanced Case (2000/4000 Ft. Fracture)	121,000 - 1,307,000
Surface Equipment ($/Well)	45,000
Annual Operating Expense ($/Well)	14,400
Compressor Fuel Cost, Ratio of Cost to	
W.I. Gas Revenue	.023

TABLE 19-12

ECONOMICS SUMMARY

BASIN Cotton Valley
SUB BASIN
FORMATION
TECHNOLOGY Base
DATE September 1980

CASE NO.	GAS PRICE $/MCF	PROFIT PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	GAS PROD. BCF	NET PRES. VALUE $M	DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	MAX RECOV. GIP, BCF	MAX. NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WILDCAT Dry	WILDCAT Prod.	DEVELOPMENT Dry	DEVELOPMENT Prod.	Total
Discount Rate 10%																	
2101111	1.50	18.1	5	ABCDE	3151	7.647	156	11.5	5387	5387	704	15.9	675	238	341	1362	2506
21	2.50	26.1	6	ABCDEF	4398	10.755	1739	23.1	6520	7110	606	22.9	533	158	478	1917	3080
31	3.10	"	"	"	"	"	2686	30.0	"	"	"	"	"	"	"	"	"
41	3.50	"	"	"	"	"	3317	34.4	"	"	"	"	"	"	"	"	"
51	5.00	34.1	7	ABCDEFG	5128	11.797	6030	49.8	6976	8352	591	29.9	472	202	562	2247	3483
61	7.00	42.7	8	ABCDEFGH	6281	12.748	9823	67.9	7292	9795	572	37.4	408	244	669	2676	3998
71	9.00	58.6	10	A-J	7631	13.565	13911	82.9	7624	12816	562	51.4	311	329	802	3207	4650
81	12.00	"	"	"	"	"	19774	107.7	"	"	"	"	"	"	"	"	"
Discount Rate 15%																	
12	1.50	6.1	1	D	1667	2.363	-529	4.1	-	-	-	5.4	-	-	-	-	-
22	2.50	18.1	5	ABCDE	3151	7.647	572	22.3	5387	5387	704	15.9	675	128	341	1362	2506
32	3.10	26.1	6	ABCDEF	4398	10.755	1411	30.0	6520	7110	606	22.9	533	158	478	1911	3080
42	3.50	"	"	"	"	"	1849	34.4	"	"	"	"	"	"	"	"	"
52	5.00	34.1	7	ABCDEFG	5128	11.797	3685	49.8	6976	8352	591	29.9	472	202	562	2247	3483
62	7.00	"	"	"	"	"	6067	69.3	"	"	"	"	"	"	"	"	"
72	9.00	42.7	8	ABCDEFGH	6281	12.748	8802	85.9	7292	9795	572	37.4	308	244	669	2676	3998
82	12.00	58.6	10	A-J	7631	13.565	1309	107.7	7624	12816	562	51.4	311	329	802	3207	4650
Discount Rate 20%																	
13	1.50	6.1	1	D	1667	2.363	-616	4.1	-	-	-	5.4	-	-	-	-	-
23	2.50	18.1	5	ABCDE	3151	7.647	139	22.3	5387	5387	704	15.9	675	128	341	1362	2506
33	3.10	"	"	"	"	"	512	28.3	"	"	"	"	"	"	"	"	"
43	3.50	26.1	6	ABCDEF	4398	10.755	1039	34.4	6520	7110	606	22.9	533	158	478	1911	3080
53	5.00	"	"	"	"	"	2266	50.1	"	"	"	"	"	"	"	"	"
63	7.00	34.1	7	ABCDEFG	5128	11.797	4167	69.3	6976	8352	591	29.9	472	202	562	2247	3483
73	9.00	"	"	"	"	"	5951	86.5	"	"	"	"	"	"	"	"	"
83	12.00	42.7	8	ABCDEFGH	6281	12.748	9039	109.3	7292	9795	572	37.4	408	244	669	2676	3998

*CODE:

A	B	C	D	E	F	G	H	I	J
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

TABLE 19-13

ECONOMICS SUMMARY

BASIN Cotton Valley — TECHNOLOGY Advanced Case

SUB BASIN — FORMATION — DATE

CASE NO.	GAS PRICE $/MCF	PROFIT. PROSP. %	K-LEVELS ON STREAM NO.	K-LEVELS ON STREAM VALUE *	AVERAGE PER PROSPECT: E & P INVEST. $M	AVERAGE PER PROSPECT: GAS PROD. BCF	AVERAGE PER PROSPECT: NET PRES. VALUE $M	AVERAGE PER PROSPECT: DCF RATE OF RETURN %	BASIN TOTALS: GAS RECOVER. AT PRICE, BCF	BASIN TOTALS: MAX RECOV. GIP, BCF	BASIN TOTALS: MAX NO. PROSP. AT PRICE	WELLS: WILDCAT SUCCESS %	WELLS: WILDCAT DRY	WELLS: WILDCAT PROD.	WELLS: DEVELOPMENT DRY	WELLS: DEVELOPMENT PROD.	WELLS: TOTAL
Discount Rate 10%																	
2101211	1.50	26.1	6	ABCDEF	3570	11.347	1081	19.4	7110	7110	627	22.9	551	164	173	691	1579
21	2.50	34.1	7	ABCDEFG	4622	13.632	3612	37.2	8352	8352	613	29.9	490	209	249	997	1945
31	3.10	34.1	7	ABCDEFG	4622	13.632	5032	47.3	8352	8352	613	29.9	490	209	249	997	1945
41	3.50	42.7	8	ABCDEFGH	7525	17.207	6916	51.7	9795	9795	569	37.4	406	243	401	1605	2655
51	5.00	58.6	10	A-J	14268	23.318	13636	66.0	12735	12816	546	51.4	302	320	764	3056	4442
61	7.00	58.6	10	A-J	14268	23.318	21643	99.8	12735	12816	546	51.4	302	320	764	3056	4442
71	9.00	58.6	10	A-J	14268	23.318	29649	129.9	12735	12816	546	51.4	302	320	764	3056	4442
81	12.00	58.6	10	A-J	14268	23.318	41659	168.3	12735	12816	546	51.4	302	320	764	3056	4442
Discount Rate 15%																	
12	1.50	26.1	6	ABCDEF	3570	11.347	372	19.4	7110	7110	627	22.9	551	164	173	691	1579
22	2.50	34.1	7	ABCDEFG	4622	13.632	2134	37.2	8352	8352	613	29.9	490	209	249	997	1945
32	3.10	34.1	7	ABCDEFG	4622	13.632	3158	47.3	8352	8352	613	29.9	490	209	249	997	1945
42	3.50	34.1	7	ABCDEFG	4622	13.632	3841	53.8	8352	8352	613	29.9	490	209	249	997	1945
52	5.00	42.7	8	ABCDEFGH	7525	17.207	7538	76.8	9795	9795	569	37.4	406	243	401	1605	2655
62	7.00	58.6	10	A-J	14268	23.318	14466	99.8	12735	12816	546	51.4	302	320	764	3056	4442
72	9.00	58.6	10	A-J	14268	23.318	20206	129.9	12735	12816	546	51.4	302	320	764	3056	4442
82	12.00	58.6	10	A-J	14268	23.318	28816	168.3	12735	12816	546	51.4	302	320	764	3056	4442
Discount Rate 20%																	
13	1.50	18.1	4	BCDE	2667	7.642	-246	15.6	-	-	-	15.9	-	-	-	-	-
23	2.50	26.1	6	ABCDEF	3570	11.347	1042	35.4	7110	7110	627	22.9	551	164	173	691	1579
33	3.10	34.1	7	ABCDEFG	4622	13.632	2067	47.3	8352	8352	613	29.9	490	209	249	997	1945
43	3.50	34.1	7	ABCDEFG	4622	13.632	2592	53.8	8352	8352	613	29.9	490	209	249	997	1945
53	5.00	42.7	8	ABCDEFGH	7525	17.207	5315	76.8	9795	9795	569	37.4	406	243	401	1605	2655
63	7.00	58.6	10	A-J	14268	23.318	10319	99.8	12735	12816	546	51.4	302	320	764	3056	4442
73	9.00	58.6	10	A-J	14268	23.318	14713	129.9	12735	12816	546	51.4	302	320	764	3056	4442
83	12.00	58.6	10	A-J	14268	23.318	21304	168.3	12735	12816	546	51.4	302	320	764	3056	4442

* CODE:

A	B	C	D	E	F	G	H	I	J
0.3	0.1	0.03	0.01	0.003	0.001	0.0003	0.0001	0.00003	0.00001

APPENDIX

APPENDIX

The following is an alternative estimate of economically recoverable biogenic gas in the Northern Great Plains/Williston basin presented by a member of the study group.

NORTHERN GREAT PLAINS/WILLISTON BASIN--ALTERNATIVE ESTIMATE OF ECONOMICALLY RECOVERABLE BIOGENIC GAS

Available estimates of recoverable gas in Cretaceous reservoirs of the northern Great Plains differ considerably, ranging from more than 100 TCF to only about one-tenth that amount. The high estimate is based on a study by the USGS. All estimates are qualified to the extent that actual recoveries will be determined by technology and economics. The great differences in the estimates result from fundamental differences in theories concerning origin of the gas.

At least four theories are in vogue as the origin of hydrocarbon gas consisting predominantly of methane with high negative carbon isotope values. The gas is usually found at shallow depths in underpressured accumulations. The northern Great Plains has been described as a particularly favorable habitat for these kinds of gas accumulations.

Thermal Theory

A theory held by some European geochemists is that gas with these characteristics has had dual thermal origins. They believe that some of these gas accumulations were generated at an early stage of carbonization, and thus are thermally immature and isotopically light. Also, they attribute some to generation at higher stages of carbonization, followed by isotopic fractionation and molecular segregation along migration paths, thereby permitting nearly pure methane enriched in C^{12} to be concentrated in shallow accumulations. Although serious questions have been raised regarding large isotope fractionations during gas migration, these scientists have a number of cogent arguments to support their position. Undoubtedly, some so-called biogenic gas is of one or both of these derivations, perhaps even including accumulations in the northern Great Plains.

Depositional Biogenic Gas Theory

Another theory strongly advocated by the U.S. Geological Survey maintains that commercial accumulations of biogenic gas formed as a result of anaerobic (methanogenic) bacterial generation from organic matter and CO_2 during deposition and early burial. Accordingly, the northern Great Plains accumulations would be about 75 million to more than 100 million years old. Critics of this theory question whether methane, with its mobility and high escape rate, could survive in commercial accumulations under relatively

ineffective argillaceous rock seals for that length of time. The methane molecule can diffuse rather freely through the subcapillary pore system of argillaceous rocks, even when these pores contain multiple layers of adsorbed water. Fractures and other common migration pathways greatly expedite the rate of escape of methane. This point is countered to a certain extent by the fact that these accumulations usually attain a low-pressure equilibrium with their surroundings, thus minimizing further loss, if fluid-pressure seals remain intact and effective.

Post-Depositional Biogenic Gas Theory

A third theory regarding biogenic gas origin is that the progeny of anaerobic bacteria buried with the sediment survive through the millenia after lithification of the sediment, while generating gas over a long span of geological time. Thus, some gas could have been generated comparatively recently and that gas would comprise the accumulations being found in, for example, the northern Great Plains. Perhaps the strongest argument against this theory is that changing conditions through a long time span militate against survival of the anaerobes. Nutrients for the bacteria may not be sufficient, objectors believe, to sustain bacterial activity for millions of years, nor would other essential environmental conditions remain favorable (temperature; disposal of toxic waste, etc.) in many parts of such a huge area. However, this argument must be tempered by the fact that bacteria are remarkably adaptable, and not much is known about their ability to survive as viable organisms for prolonged periods in the slowly changing physical and chemical environment of buried semimentary rocks.

Biogenic Gas Generated After Recent Entry Into Subsurface

According to the fourth theory regarding the origin of shallow methane-rich gases highly enriched in carbon-12, the gas is geologically youthful. It results from current or recent anaerobic bacterial encroachment into the subsurface, the methanogenic bacteria mainly utilizing CO_2 and degradation products from aerobic bacterial consumption of crude oil to generate biogenic gas. By "recent" in the above context is meant bacterial generation during the Quaternary and perhaps during the Pliocene.

Opposition to this theory is based on the contentions that (1) anaerobic bacteria cannot penetrate the subsurface because of the oxygenated condition of the recharge waters and (2) anaerobes are not present at the surface in the northern Great Plains and similar areas. Thus, they could not enter the subsurface even if geological conditions permitted entry. However, they were present in Cretaceous inland seas.

Because of the difficulties in isolating viable methanogenic bacteria, their enzymes, or their remains from sedimentary rocks, and because they are not spore-formers, no direct evidence is available to establish their presence. Only circumstantial evidence has been accumulated to suggest their presence or former presence. One line of evidence is occurrences of presumed biogenic gas. If the gas is indeed thermal, this "evidence" is meaningless.

But when the gas is in a recharge area (percolating meteoric water that entered the subsurface from subaerial or subaqueous surface settings) as determined by salinity, water composition, temperature and pressure data, and directly downdip from areas of proven aerobic bacterial activity, the circumstantial evidence for anaerobic bacterial activity is regarded as convincing by some authorities. This is the habitat of much of the gas regarded as biogenic. Furthermore, this common association with active or recently active recharge waters near outcrops, fracture sets, or faults, and in proximity to active aerobic bacteria, is considered indicative of fairly recent entry, geologically speaking, into the subsurface by anaerobes.

Anaerobic bacteria obtain their oxygen, required for metabolism, from chemical compounds, either inorganic (such as CO_2) or organic. To counter the criticism that anaerobes cannot survive oxygenated recharge waters (trace quantities of free or dissolved oxygen quickly kill or inactivate anaerobes), it is suggested that the downdip front of the recharge area is depleted of oxygen as it advances through permeable rocks comprised of unoxidized minerals. Updip waters retain their dissolved oxygen because the oxidized minerals are unable to remove it from the water. This enables aerobes to follow behind anaerobes. Then the aerobes remove dissolved oxygen, while releasing degradation products to the deoxygenated water. This water migrates downdip to supply the anaerobes with nutrients in the form of aerobic degradation products. The anaerobes use these products to generate methane enriched in C^{12}, along with a minor amount of ethane. They also use organic matter diretly as carbon and hydrogen sources during methane generation. An excellent example is the presence of biogenic methane in glacial till in the Illinois Basin.

As to the surface source of anaerobes, any stagnant (anoxic) body of water, ranging from lakes to bogs, could provide an ample source. Or an anoxic sediment layer beneath an oxic water environment could be a source. In the northern Great Plains, these types of water bodies were prevalent during the periods when glacial melt water was widespread.

It is particularly noteworthy that gas presumed to be biogenic in the northern Great Plains is concentrated in the area of former glacial cover and also in proximity to that cover where permafrost and gashydrates should have been present. The farther south the search is extended for possible biogenic gas accumulations in the Rocky Mountains or Great Plains, the less seems to be found. The reasons for this are believed to be two-fold. First, the glaciers provided the conditions for the anaerobic bacterial presence at and near the surface. Second, they provided the permafrost-gas hydrate seals to help preserve the biogenic gas, once generated, from rapid escape. With the latest glacial episode terminating only about 11,000 years ago, excellent protection against escape was provided for the products of Quaternary anaerobic bacterial generation. The same seals would have inhibited escape of any thermal gas in the region. The situation just described is analogous to that in the Western Siberian Basin of the USSR except that the Soviet gas accumulations, believed to be partly thermal and partly biogenic, are much larger.

This latter theory, then, suggests that the gas is quite young and that its distibution is limited to those areas where methanogenic bacteria were present on the surface, where they could penetrate the subsurface and survive, and where the generated gas could have been preserved under effective seals. Consequently, the theory requires predictions of localized occurrences of gas where the "plumbing" was suitable to permit access by bacteria and then prevent the escape of generated gas.

Limitations on Gas Preservation

Because of the extensive flushing by recharge water in the northern Great Plains, large areas are not conducive to gas preservation. Not only are the porous and permeable reservoir-quality rocks being flushed but the argillaceous rocks as well. This is supported by a recent study, "Geochemical Exploration in the Powder River Basin, Northeastern Wyoming and Southeastern Montana," by J. A. Momper and J. A. Williams, submitted to the American Association of Petroleum Geologists for publication.

The preservation of biogenic gas possibly is further limited because aerobic methane-consuming bacteria may be present in the region. Little is known about occurrences of these organisms in the subsurface of the northern Great Plains, or any other geological province, but their activities could be widespread.

Limitation on Gas Generation

A limitation on generation of biogenic gas probably should be expected, owing to extensive distribution of sulfate waters. Sulfate ions inhibit methane production by anaerobes, as pointed out by Claypool in 1974. For example, U.S. Bureau of Mines analyses revealed the presence of sulfate waters in many Cretaceous reservoirs wherever sampled in the Powder River Basin. Significantly, no biogenic gas has been reported present in quantity in these reservoirs. However, this argument could be countered by those who maintain that bacterial gas is quite old and therefore, it could have been generated before the appearance of sulfate waters. What needs to be explained is the apparent lack of significant recoveries, or even shows, of biogenic gas from many wells drilled in the northern Great Plains. Is this entirely due to inadequate testing, or to a lack of sizeable accumulations in many areas?

Possible Association of Gas with Oil-Migration Paths

In addition to the previously described affinity for areas of glacial activity, another noteworthy feature of many known occurrences of presumed biogenic gas in the northern Great Plains deserves consideration. To date, the principal reserves of gas have been established in ares of previous oil migration and entrapment; more specifically, gas occurs in the parts of the stratigraphic section influenced by these migrations, and by the products of aerobic bacterial degradation of oils. Examples are the Sweetgrass Arch, the Bearpaw Mountains and the intervening migration path; Cedar Creek Anticline; the Hardin Terrace; the northern

Powder River Basin; and the vast updip area in the Alberta Basin. A possible exception is gas-productive Bowdoin Dome, not known to have been an oil-migration path. It seems significant that structural features such as the Porcupine Dome, Miles City Arch, Bull Mountain Basin, Hogeland Basin (except for the Rapdan Trend), and Blood Creek Syncline, all essentially isolated from effective source rocks and migration paths, have not yielded significant finds of biogenic gas. Nor has the Williston Basin, aside from the peripheral Cedar Creek Anticline. In the Willison Basin, the Cretaceous and Tertiary source rocks are immature and, in most of the Basin, Cretaceous and Tertiary reservoirs are effetively isolated from deeper oil by extensive evaporite seals. This paucity of biogenic gas discoveries may be explained, in part, as the result of inadequate exploration, but it may be caused also by the lack of aerobic bacterial degradation products because of the lack of crude oil and of CO_2 at shallow depths.

Degradation products and CO_2 are considered by some authorities to be the main source materials for the generation of methane and for an oxygen supply for the methanogenic anaerobic bacteria. Of course, CO_2 alone is not suitable; an ample supply of hydrogen is needed also. The only known sources of hydrogen are organic matter and oil-degradation products. The common association between oil migration paths and occurrences of so-called biogenic gas is one argument used by those favoring Theory 1 that the gas is thermal rather than bacterial.

To make accurate resource estimations, it is crucial to know which of these theories is, or are, correct. All but Theory 2, which considers the gas as ancient and therefore almost ubiquitous, place definite limitations on the areal extent of these sought-after shallow gas accumulations. I believe that the weight of evidence supports Theory 4 (that the gas is young and dominantly formed near or beneath glacial cover along oil-migration paths) as the most realistic in explaining the origin of much of this gas. Theory 1, the thermal theory, may account for a substantial quantity in certain areas. If so, a conservative resource estimate is in order. Even basing estimates on Theory 2, a more conservative approch seems desirable than to use the best of the Canadian fields as an analog when estimating likely resources in the northern Great Plains of the United States.

From the foregoing considerations, my optimum estimate of the resource of biogenic gas in the four-state northern Great Plains region of the United States is about 10 trillion cubic feet of technically and economically recoverable gas. A completely independent estimate by one of the operators, based on entirely different considerations, is a maximum of 15 trillion feet. These estimates are almost one order of magnitude lower than the USGS figures, and predict less than one year's additional domestic supply at present production-consumption rates. I can only hope that the USGS forecast is more nearly correct.