



**U.S. Department of the Interior**
Bureau of Land Management
Wyoming State Office

Rock Springs Field Office — August 2002

# DECISION RECORD, FINDING OF NO SIGNIFICANT IMPACT, and CHANGES TO MODIFICATIONS/CORRECTIONS to the Vermillion Basin Natural Gas Exploratory and Development Environmental Assessment

MISSION STATEMENT

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

**BLM/WY/PL-02/028+1310**

WYW-040-EA00-094

# United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Rock Springs Field Office
280 Highway 191 North
Rock Springs, Wyoming 82901-3447

1792/3160 (040)

August 15, 2002

Dear Reader:

Attached you will find a new Decision Record that modifies the *Vermillion Basin Natural Gas Exploration and Development Environmental Assessment.* This document complies with the order from the Interior Board of Land Appeals (IBLA) to resolve the appeal on the environmental analysis. The Bureau of Land Management (BLM) released a notice seeking additional comment on January 11, 2002. All issues raised during the additional comment period have been considered.

BLM appreciates the public's participation in resolving the appeal. The attached document can be linked from the Rock Springs Field Office's website. The address for Rock Springs' website is http://www.wy.blm.gov/rsfo/index.htm. Copies are also available at the Rock Springs Field Office in Rock Springs. Please call Teri Deakins at 307-352-0211 to request copies. If you have questions about this action, please call Ted Murphy at 307-352-0321.

Sincerely,

Ted A. Murphy
Acting Field Manager

Attachment

# DECISION RECORD
# FINDING OF NO SIGNIFICANT IMPACT
# And
# CHANGES TO MODIFICATIONS/CORRECTIONS
# TO THE ENVIRONMENTAL ASSESSMENT
# For
# VERMILLION BASIN NATURAL GAS
# EXPLORATORY AND DEVELOPMENT PROJECT

## INTRODUCTION AND BACKGROUND

On October 30, 2000, the Bureau of Land Management (BLM), Rock Springs Field Office (RSFO) issued the *Decision Record and Finding of No Significant Impact, Vermillion Basin Natural Gas Exploration and Development Project* (DR). This decision approved the drilling of up to 56 natural gas wells and related facilities. This decision was appealed, first in the form of a State Director Review (SDR) which affirmed the original decision by the Field Manager. The SDR was then appealed to the U.S. Department of Interior, Board of Land Appeals (IBLA). IBLA ruled on the appeal. The original decision of October 30, 2000 was affirmed but set aside to the extent that the record failed to explain the facts and analysis supporting rejection of the alternatives of project-wide well densities and varying numbers of wells, and failed to provide a rational basis for failing to analyze fully the alternative of directional drilling. The case was remanded to allow BLM to further document the record.

This decision tiers to the *Decision Record and Finding of No Significant Impact, Vermillion Basin Natural Gas Exploration and Development Project* (October 2000) and is meant to supplement the information contained therein. The *Environmental Assessment for the Vermillion Basin Natural Gas Exploration and Development Project* as well as the DR can be downloaded from the Rock Springs' website at http://www.wy.blm.gov/rsfo/nepa.htm (scroll down to Vermillion Basin Project). Maps of the project area can be found in the original documents at the aforementioned website. Issuance of permits to conduct oil and gas operations has been placed on hold until the record can be further documented.

### Further Public Comment

Based on IBLA's decision, BLM released a letter, dated January 11, 2002, seeking further comment on IBLA's order. Eleven comment letters were received in response. One letter providing comment on the three alternatives also served as a cover letter to submit two wilderness proposals to BLM for consideration. Limited portions of the two wilderness proposals, known as the Citizen's Wilderness Inventories for Kinney Rim North and Kinney Rim South areas, overlap the project area. BLM has considered the proposals to the extent they overlap the Vermilion Basin Project area and has made a preliminary determination that public lands within the Vermillion Basin project area do not contain wilderness qualities due to existing human intrusions (Attachment A).

Comments raised specific to the three alternatives include the following:

- Technical feasibility of directional and/or horizontal drilling techniques including reference to the Bush Administration's policy for employing use of directional drilling techniques (technological advances) to enhance environmental protection (reduction of surface disturbance) and specific problems associated with employing such methods in the Vermillion Basin area.
- State responsibility for establishing well densities within the State of Wyoming.
- Economic effects to the State and local governments from the alternatives (loss or gain of revenues from the three alternatives).
- Economic feasibility of employing a directional or horizontal drilling program.

## DESCRIPTION OF THE ALTERNATIVES ANALYZED IN THE ENVIRONMENTAL ASSESSMENT

Two alternatives were fully analyzed in the EA and are briefly summarized below:

### Proposed Action

A complete description of the Proposed Action, including company-committed measures, can be found in the EA. The DR identifies other mitigation required for approval. To briefly summarize the Proposed Action, Wexpro Company, Questar Exploration, Marathon Oil Company, Basin Exploration and other companies (Operators) proposed to drill up to 56 natural gas wells in and around three existing, producing oil and gas units (Trail, Kinney Rim, and Canyon Creek). The wells would be completed in the Canyon Creek zone and Trail zone of the Mesaverde Formation. Three to eight wells would be exploratory but located no further than 2 miles from the existing development units. The remaining wells would be production wells. Well densities would not exceed a 40-acre spacing although spacing could range from one well per 640 acres to 40 acres per well. The State of Wyoming, via the Wyoming Oil and Gas Conservation Commission (WOGCC), establishes well spacing (density) requirements for lands in the State of Wyoming. Although BLM has the authority to require alternative well spacing, BLM seldom deviates from State requirements unless required to achieve maximum ultimate economic maximum recovery of the federal fluid mineral resource in accordance with 43 CFR 3160-0-5.

Approximately 50 percent of the wells would be drilled during a 5-year period within known producing areas (units). Drilling the balance of the wells would be dependent upon the success of exploratory wells and could be developed over a 10-20 year period.

### No Action Alternative

Under the No Action Alternative, the project would not be allowed to proceed as proposed by the Operators. The EA analyzed the impacts of not proceeding with the project and provided a benchmark for comparison with the environmental effects of the Proposed Action.

### Alternatives Considered but Eliminated From Detailed Study

Other alternatives were considered but dropped from detailed analysis in the EA in accordance with 43 CFR

1502.14(a) which requires that an agency "[r]igoursly explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detail study, briefly discuss the reasons for their having been eliminated." IBLA ordered BLM to fully explain the rationale for eliminating these alternatives from further review. Appendix B of this document modifies Appendix A, Modifications/Corrections to the Environmental Assessment, of the original decision of October 30, 2001 and further documents the record as to the facts and analysis supporting rejection of the alternatives of project-wide well densities and varying numbers of wells, and provides a rational basis for eliminating from detailed study, the alternative of directional drilling.

**DECISION**

It is my decision to reaffirm and implement the decision as stated in the *Decision Record and Finding of No Significant Impact, Vermillion Basin Natural Gas Exploration and Development Project,* dated October 30, 2000. A full description of the DR can be found at the Rock Springs Website *http://www.wy.blm.gov/rsfo/nepa.htm.* All aspects of the decision are in effect with the exception of the following two corrections:

The Decision Record (October 30, 2000), page 3, 1st bullet, should read as follows:

> "- Up to 56 natural gas wells including three to eight exploratory wells and 48 to 53 production wells at well densities not to exceed 16 locations per section (40-acre spacing) resulting in a total surface disturbance of no more than 213 acres."

The Decision Record (October 30, 2000), Appendix A, page A-1, section entitled Modifications/Corrections to the Environmental Assessment. Add to page A-4, before section 3.2.4., Threatened, Endangered, Proposed, and Candidate Species (TEP&C), the following.

**Section 2.3 Alternatives Considered but Rejected**

Delete wording in the section. Replace with Appendix B (Changes to Modifications/Corrections to the Environmental Assessment) of this decision.

**MANAGEMENT CONSIDERATION/RATIONALE FOR THE DECISION**

Appendix B to this decision provides additional information as to why certain alternatives were dropped from detailed analysis in the *Environmental Assessment for the Vermillion Basin Natural Gas Exploration and Development Project* (available at the aforementioned website) in accordance with an Order by IBLA (IBLA Docket 2001-166, dated December 6, 2001). This Order mandated BLM to explain the facts and analysis supporting rejection of project-wide well densities and varying numbers of wells, and to provide a rational basis for failing to analyze fully the alternative of directional drilling. BLM has complied with IBLA's Order.

Other Management Considerations include:

- All comment letters received in response to BLM's request for additional comment have been

considered and incorporated as appropriate. Substantive comments made that did not apply to the specific geological conditions found in the Vermillion Basin area were responded to with an explanation as to the reason/s why the comment did not warrant further action on the part of BLM in accordance with 40 CFR 1503.4(5). All letters and BLM's responses can be found in Appendix C of this document.

The rationale explained in the original decision of October 30, 2001 continues to apply.

**FINDING OF NO SIGNIFICANT IMPACT**

Based on the discussion herein, I continue to determine the Proposed Action, as described in the *Environmental Assessment for the Vermillion Basin Natural Gas Exploration and Development Project,* and as approved in the original *Decision Record and Finding of No Significant Impact, Vermillion Basin Natural Gas Exploration and Development Project* with the aforementioned corrections remains in conformance with the Green River Resource Management Plan. Implementation of the original decision will not have a significant impact on the human environment. Therefore, an environmental impact statement is not required.

**APPEAL**

Under BLM regulations, this decision is subject to administrative review in accordance with 43 CFR 3165. Any request for administrative review of this decision must include the information required under 43 CFR 3165.3(b) (State Director Review), including all supporting documentation. Such a request must be filed in writing to the State Director, Bureau of Land Management, P.O. Box 1828, Cheyenne, WY 82003, within 20 business days of the date such notice of decision was received or considered to have been received. This decision will be considered to have been received 5 days from the date of this document.

The decision of the State Director could be appealed to the Interior Board of Land Appeals in accordance with the regulations contained in 43 CFR 3165.4 and 43 CFR Part 4. Each adverse party to any such appeal must be provided with all documentation in accordance with 43 CFR 4.413(a). Adverse parties to an appeal of the decision of the State Director include:

Questar
189 East 100 South
P.O. Box 45601
Salt Lake City, Utah 84145

Wexpro
P.O. Box 458
Rock Springs, Wyoming 82902

Marathon Oil Company
Rocky Mountain Operations
1501 Stampede Avenue
Cody, Wyoming 82414

Acting Field Manager

August 15, 2002
Date

# APPENDIX A

## BLM FINDING ON CITIZEN WILDERNESS PROPOSAL
## VERMILLION BASIN PROJECT AREA

1792, 8500

July 24, 2002

Mr. Erik Molvar
Biodiversity Associates
P.O. Box 6032
Laramie, Wyoming 82073

Dear Mr. Molvar:

In February of this year our office received two reports from you. The first report is titled *A Citizen's Wilderness Inventory of Kinney Rim South* and the second report is titled *A Citizen's Wilderness Inventory of Kinney Rim North* (citizen report(s)). We have updated our inventory and added these reports to our permanent files. Because the public lands contained in your report for Kinney Rim South are under the jurisdictional control of our Rawlins Field Office (RFO), we have forwarded that citizen report to them for their review.

The public lands you included in your citizen reports for both Kinney Rim North and Kinney Rim South were reviewed in 1980 for wilderness characteristics and were considered not suitable for further wilderness study. In the years since that review took place, these public lands have been managed in accordance with the requirements and guidance contained in the applicable land use plans, most recently the Green River and Great Divide Resource Management Plans (GRRMP, 1997; GDRMP, 1990). These plans were developed using the 1980 wilderness inventories, study and review.

Our office recently performed a preliminary review of a portion of the public lands included in your citizen reports for Kinney Rim North and Kinney Rim South that overlap a portion of the Vermillion Basin Natural Gas Exploration and Development Project area (Vermillion Basin project, refer to Map 1). In April 2002 our office conducted aerial and on-the-ground reconnaissance of the Vermillion Basin project area where the project area overlaps public lands included in your citizen reports. The public lands contained in the Vermillion Basin project area were found to contain sufficient human intrusions, including producing oil and gas wells in long-established oil and gas units, maintained roads, reservoirs and pits so as to preclude wilderness characteristics.

Therefore, the public lands included in your citizen reports for Kinney Rim North and Kinney Rim South that overlap the Vermillion Basin project area have been dropped from further wilderness consideration because they do not provide outstanding opportunities for solitude and/or unconfined types of recreation (refer to Map 2.).

The GRRMP remains in effect for the Vermillion Basin project area. On-going oil and gas development, as well as other public uses, in the Vermillion Basin project area remain in conformance with the GRRMP.

The remaining public lands included in your citizen report for Kinney Rim North are under review by this office. You will be notified of our finding once the review has been completed. The remaining public lands in your citizen report for Kinney Rim South will be handled by our Rawlins Field Office. Once they have completed their review they will inform you of their finding.

If you have any questions, please contact Bernie Weynand, Assistant Field Manager for Resources at (307) 352-0246.

Sincerely,

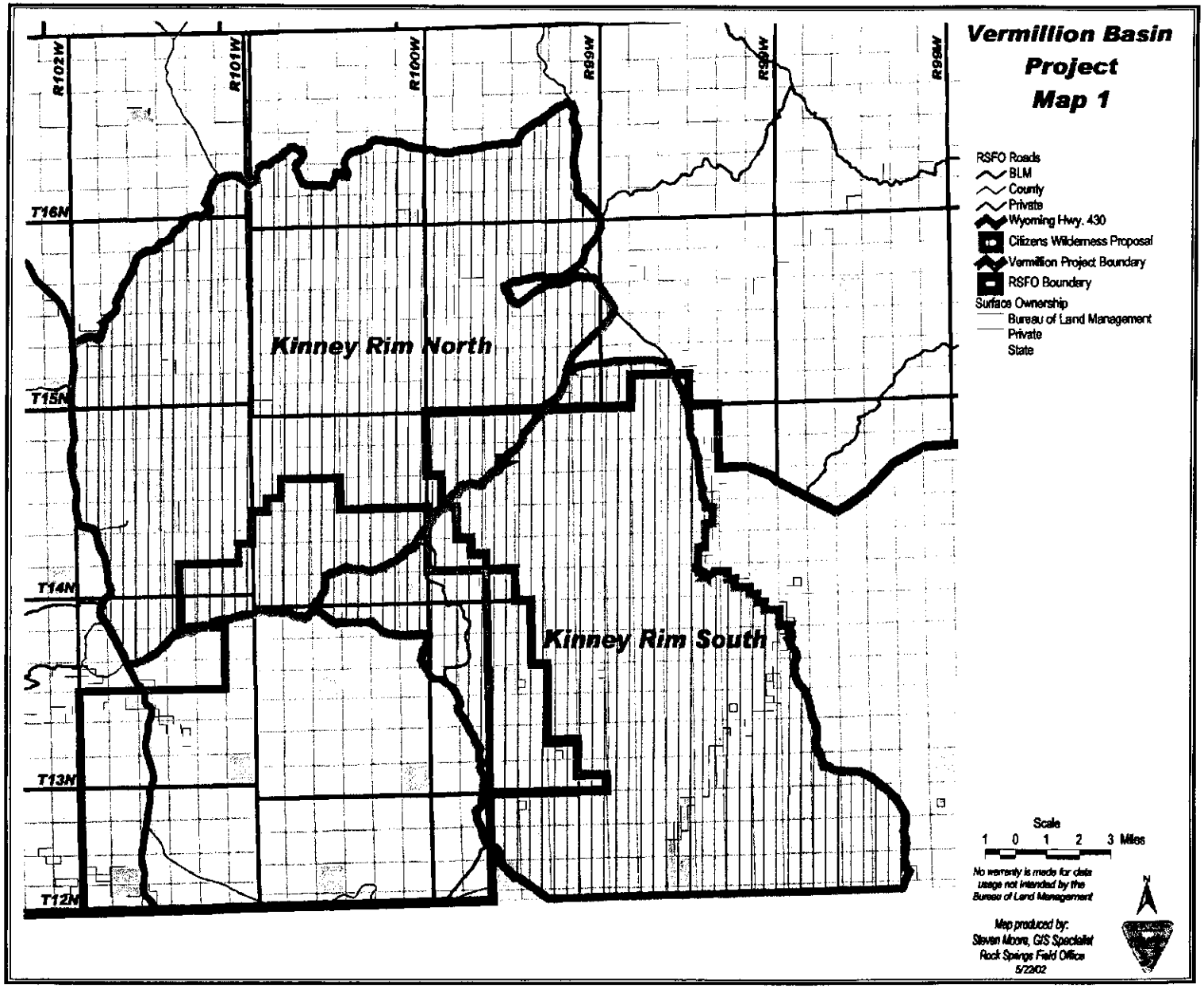
/s/ Pamela J. Lewis

Pamela J. Lewis
Acting Field Manager

2 Attachments:

1 B Map of North and South Kinney Rim Citizens= Inventory areas and Vermillion Basin Project Area
2 B Map of Vermillion Basin Project, delineating existing and proposed developments.

cc: SD, WSO (910) w/attachments
FM, RFO (030) w/attachments


Vermillion Basin
Project
Map 1
R102W
R101W
R100W
R99W
R98W
R97W
T16N
T15N
T14N
T13N
T12N
Kinney Rim North
Kinney Rim South
RSFO Roads
BLM
County
Private
Wyoming Hwy. 430
Citizens Wilderness Proposal
Vermillion Project Boundary
RSFO Boundary
Surface Ownership
Bureau of Land Management
Private
State
Scale
1 0 1 2 3 Miles
No warranty is made for data usage not intended by the Bureau of Land Management
Map produced by:
Steven Moore, GIS Specialist
Rock Springs Field Office
5/22/02
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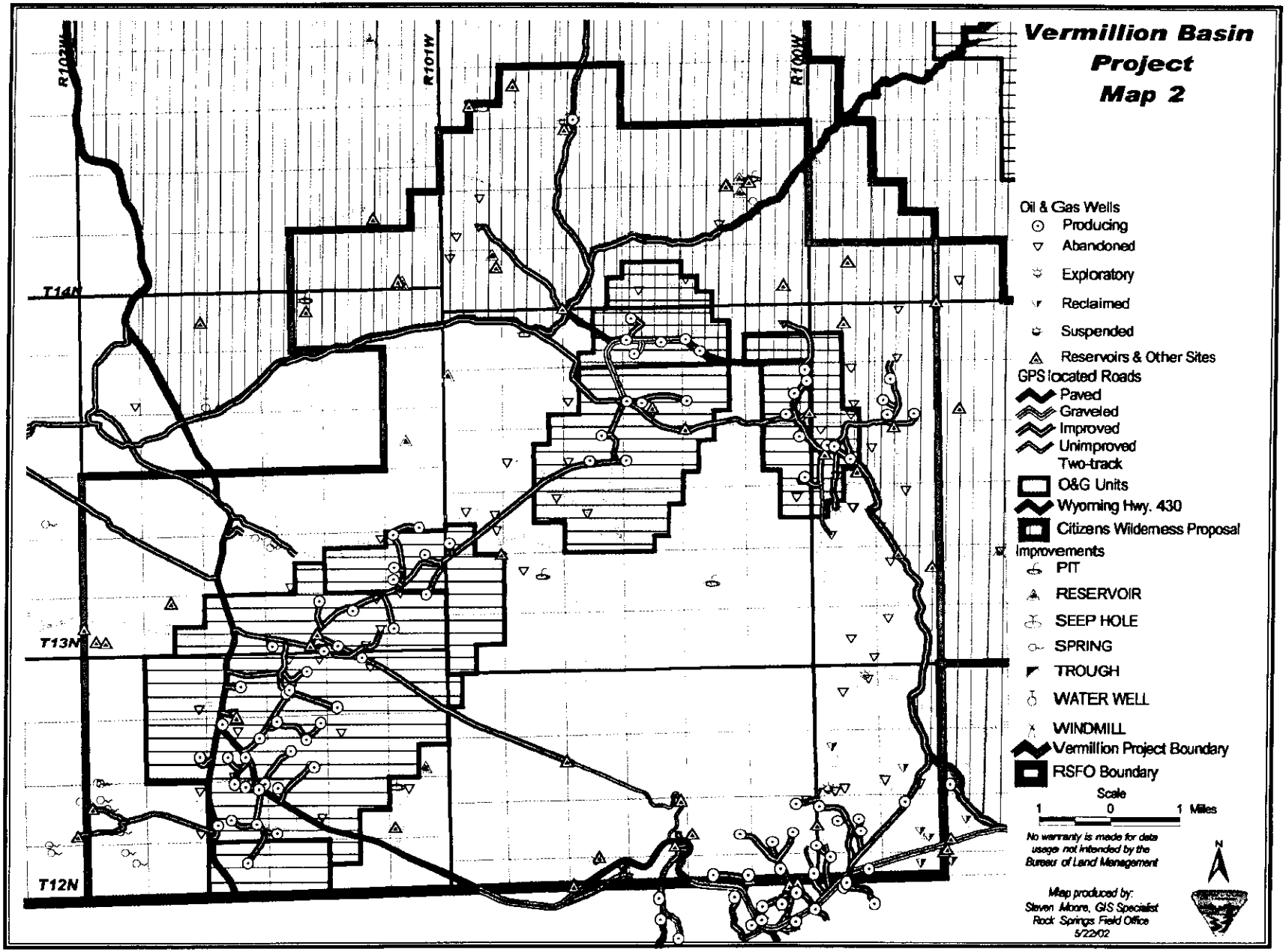
R102W
R101W
R100W
T14N
T13N
T12N
Vermillion Basin Project Map 2
Oil & Gas Wells
Producing
Abandoned
Exploratory
Reclaimed
Suspended
Reservoirs & Other Sites
GPS located Roads
Paved
Graveled
Improved
Unimproved
Two-track
O&G Units
Wyoming Hwy. 430
Citizens Wilderness Proposal
Improvements
PIT
RESERVOIR
SEEP HOLE
SPRING
TROUGH
WATER WELL
WINDMILL
Vermillion Project Boundary
RSFO Boundary
Scale
1 0 1 Miles
No warranty is made for data usage not intended by the Bureau of Land Management
Map produced by:
Steven Moore, GIS Specialist
Rock Springs Field Office
5/22/02
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# APPENDIX B

# CHANGES TO MODIFICATIONS/CORRECTIONS TO THE ENVIRONMENTAL ASSESSMENT

# APPENDIX B
# CHANGES TO MODIFICATIONS/CORRECTIONS TO THE ENVIRONMENTAL ASSESSMENT

The Decision Record (October 30, 2000), Appendix A, section entitled *Modifications/Corrections to the Environmental Assessment* is supplemented. Page A-4, before section 3.2.4. Threatened, Endangered, Proposed, and Candidate Species (TEP&C), add the following discussion.

**Section 2.3 Alternatives Considered but Rejected**

Delete wording in the section. Replace with:

Other alternatives were considered but eliminated from detailed study in the EA in accordance with 43 CFR 1502.14(a) which requires that an agency "[r]igoursly explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detail study, briefly discuss the reasons for their having been eliminated." These are the alternatives that IBLA ordered BLM to explain the facts and analysis for eliminating them from detailed study. The discussion below supplements the record.

**Alternative of Varying Numbers of Wells**

The WOGCC ruled in Chapter 3, Section 2, that in this area any gas wells drilled shall be located in the center of a one hundred-sixty (160) acre subdivision, unless brought in front of the commission and changed for cause. The project encompasses 92,490 acres, which equates to 578 potential wells with one well in each 160-acre subdivision. One hundred fifty-four wells had already been drilled, leaving 424 potential well locations available for drilling. To evaluate this number of wells exceeded the reasonably foreseeable number of wells that could be anticipated in the area. To determine and evaluate a reasonable foreseeable number of wells, the BLM sent a certified letter (dated 9/17/1999) to all the oil and gas lessees in the Vermillion Basin area asking for drilling plans over the next five years. Based on the lessees' response, BLM determined that five operators planned activity in the area and the operators' foreseeable projection of 56 wells would provide the upper limit of additional development.

Based on public comments, and subsequent meetings and conversations, BLM and the operators considered numerous alternatives including how the Proposed Action should be handled. It was recognized that a certain level of exploratory drilling was required (three to eight wells) to determine the number of wells actually needed to fully develop the areas of operator interest. In the absence of further exploratory drilling, it was impossible to make an exact projection of total new wells that could be drilled, but a maximum projection of no more than 56 new wells was made. Since it was not possible to project a realistic number of wells as an alternative, the Proposed Action was developed to incorporate the analysis of impacts for any number of wells within a range from one to 56 possible wells, with 56 wells representing the maximum number of wells which could be drilled under the Proposed Action. Table 1 provides the acreage or miles potentially affected and impacted and was evaluated for the range of wells between one and 56. This information comes from the footnotes found in Table 2.1, page 12, *Vermillion Basin Natural Gas Exploration and Development Project Environmental Assessment.*

**Table 1**
**Surface Disturbance by Well**

| Number Of Wells | New Surface Disturbance From Well Locations (acres) | Surface Disturbance From Well Locations After Reclamation (acres) | New Surface Disturbance From Roads (miles) | (acres) | Surface Disturbance From Roads After Reclamation (acres) | New Gathering Systems[1] (miles) | (acres) |
|---|---|---|---|---|---|---|---|
| Proposed Action (56 wells) | 213 | 56 | 28 | 187 | 109 | 28 | 85 |
| 55 | 209 | 55 | 27.5 | 183.37 | 107.25 | 27.5 | 83.6 |
| 54 | 205.2 | 54 | 27 | 180.04 | 105.3 | 27 | 82.08 |
| 53 | 201.4 | 53 | 26.5 | 176.70 | 103.35 | 26.5 | 80.56 |
| 52 | 197.6 | 52 | 26 | 173.37 | 101.4 | 26 | 79.04 |
| 51 | 193.8 | 51 | 25.5 | 170.03 | 99.45 | 25.5 | 77.52 |
| 50 | 190 | 50 | 25 | 166.70 | 97.5 | 25 | 76 |
| 49 | 186.2 | 49 | 24.5 | 163.37 | 95.55 | 24.5 | 74.48 |
| 48 | 182.4 | 48 | 24 | 160.03 | 93.6 | 24 | 72.96 |
| 47 | 178.6 | 47 | 23.5 | 156.70 | 91.65 | 23.5 | 71.44 |
| 46 | 174.8 | 46 | 23 | 153.36 | 89.7 | 23 | 69.92 |
| 45 | 171 | 45 | 22.5 | 150.03 | 87.75 | 22.5 | 68.4 |
| 44 | 167.2 | 44 | 22 | 146.70 | 85.8 | 22 | 66.88 |
| 43 | 163.4 | 43 | 21.5 | 143.36 | 83.85 | 21.5 | 65.36 |
| 42 | 159.6 | 42 | 21 | 140.03 | 81.9 | 21 | 63.84 |
| 41 | 155.8 | 41 | 20.5 | 136.69 | 79.95 | 20.5 | 62.32 |
| 40 | 152 | 40 | 20 | 133.36 | 78 | 20 | 60.8 |
| 39 | 148.2 | 39 | 19.5 | 130.03 | 76.05 | 19.5 | 59.28 |
| 38 | 144.4 | 38 | 19 | 126.69 | 74.1 | 19 | 57.76 |
| 37 | 140.6 | 37 | 18.5 | 123.36 | 72.15 | 18.5 | 56.24 |
| 36 | 136.8 | 36 | 18 | 120.02 | 70.2 | 18 | 54.72 |
| 35 | 133 | 35 | 17.5 | 116.69 | 68.25 | 17.5 | 53.2 |
| 34 | 129.2 | 34 | 17 | 113.36 | 66.3 | 17 | 51.68 |
| 33 | 125.4 | 33 | 16.5 | 110.02 | 64.35 | 16.5 | 50.16 |
| 32 | 121.6 | 32 | 16 | 106.69 | 62.4 | 16 | 48.64 |
| 31 | 117.8 | 31 | 15.5 | 103.35 | 60.45 | 15.5 | 47.12 |
| 30 | 114 | 30 | 15 | 100.02 | 58.5 | 15 | 45.6 |
| 29 | 110.2 | 29 | 14.5 | 96.69 | 56.55 | 14.5 | 44.08 |
| 28 | 106.4 | 28 | 14 | 93.35 | 54.6 | 14 | 42.56 |
| 27 | 102.6 | 27 | 13.5 | 90.02 | 52.65 | 13.5 | 41.04 |
| 26 | 98.8 | 26 | 13 | 86.68 | 50.7 | 13 | 39.52 |

| Number Of Wells | New Surface Disturbance From Well Locations | Surface Disturbance From Well Locations After Reclamation | New Surface Disturbance From Roads | | Surface Disturbance From Roads After Reclamation | New Gathering Systems[1] | |
|---|---|---|---|---|---|---|---|
| | (acres) | (acres) | (miles) | (acres) | (acres) | (miles) | (acres) |
| 25 | 95 | 25 | 12.5 | 83.35 | 48.75 | 12.5 | 38 |
| 24 | 91.2 | 24 | 12 | 80.02 | 46.8 | 12 | 36.48 |
| 23 | 87.4 | 23 | 11.5 | 76.68 | 44.85 | 11.5 | 34.96 |
| 22 | 83.6 | 22 | 11 | 73.35 | 42.9 | 11 | 33.44 |
| 21 | 79.8 | 21 | 10.5 | 70.01 | 40.95 | 10.5 | 31.92 |
| 20 | 76 | 20 | 10 | 66.68 | 39 | 10 | 30.40 |
| 19 | 72.2 | 19 | 9.5 | 63.35 | 37.05 | 9.5 | 28.88 |
| 18 | 68.4 | 18 | 9 | 60.01 | 35.1 | 9 | 27.36 |
| 17 | 64.6 | 17 | 8.5 | 56.68 | 33.15 | 8.5 | 25.84 |
| 16 | 60.8 | 16 | 8 | 53.34 | 31.2 | 8 | 24.32 |
| 15 | 57 | 15 | 7.5 | 50.01 | 29.25 | 7.5 | 22.80 |
| 14 | 53.2 | 14 | 7 | 46.68 | 27.3 | 7 | 21.28 |
| 13 | 49.4 | 13 | 6.5 | 43.34 | 25.35 | 6.5 | 19.76 |
| 12 | 45.6 | 12 | 6 | 40.01 | 23.4 | 6 | 18.24 |
| 11 | 41.8 | 11 | 5.5 | 36.67 | 21.45 | 5.5 | 16.72 |
| 10 | 38 | 10 | 5 | 33.34 | 19.5 | 5 | 15.20 |
| 9 | 34.2 | 9 | 4.5 | 30.01 | 17.55 | 4.5 | 13.68 |
| 8 | 30.4 | 8 | 4 | 26.67 | 15.6 | 4 | 12.16 |
| 7 | 26.6 | 7 | 3.5 | 23.34 | 13.65 | 3.5 | 10.64 |
| 6 | 22.8 | 6 | 3 | 20.00 | 11.7 | 3 | 9.12 |
| 5 | 19 | 5 | 2.5 | 16.67 | 9.75 | 2.5 | 7.60 |
| 4 | 15.2 | 4 | 2 | 13.34 | 7.8 | 2 | 6.08 |
| 3 | 11.4 | 3 | 1.5 | 10.00 | 5.85 | 1.5 | 4.56 |
| 2 | 7.6 | 2 | 1 | 6.67 | 3.9 | 1 | 3.04 |
| 1 | 3.8 | 1 | 0.5 | 3.33 | 1.95 | 0.5 | 1.52 |

[1]All pipeline rights-of-way would be 100% reclaimed and seeded with native species. Long-term disturbance would be 0 acres.

The Proposed Action recognized and analyzed the impacts of drilling any number of wells within the range of one to the maximum of 56 wells and determined that drilling the maximum number of wells would not have a significant impact on the human environment. Therefore, an alternative analyzing a specific well total within that range was determined to be unnecessary and unreasonable, and eliminated from detailed study in accordance with 43 CFR 1502.14(a).

**Alternative Well Densities**

The location of a well is usually determined by subsurface geology; thus, it is nearly impossible to evaluate

project-wide well densities and different well location densities without full knowledge of the subsurface geology. Such information is gained from well logs and seismic projects. Map 2.1, page 14, *Vermillion Basin Exploratory and Development Project Environmental Assessment* provides a map of the proposed well locations. Thirty-eight of the proposed wells are within established units and fall within terms and conditions of each unit. Those 38 in-fill wells will be used to efficiently drain the reservoir.

Seven wells are proposed just outside unit boundaries and are considered to be step-out wells. Step-out wells would be used to define the outer boundary of the hydrocarbon-containing reservoir. If gas is found in a step-out well, then additional wells may be drilled in the vicinity. If the step-out well is nonproductive, then additional wells are not likely to be drilled in the immediate area. The remaining wells are tentatively located in an area where minimal development has occurred and little geological information is available. Three to eight of the proposed wells are considered exploratory; the remaining wells would be in-fill development depending upon the success of exploratory drilling.

The State of Wyoming, WOGCC, establishes spacing orders for lands within the state including public lands within the Vermillion Basin project area. Well densities are established to prevent waste and to protect correlative rights and are based upon evidence of the maximum area that can be efficiently drained by one well. Currently the well density for the Vermillion Basin project area has been established by the WOGCC at one well per 160 acres. The Proposed Action identified varying well densities ranging between one well per 640-acre subdivision and one well per 40-acre subdivision depending upon current and potential future WOGCC requirements. The Proposed Action recognized that the results of proposed drilling would allow a better understanding of the hydrocarbon plays recent and possibly cause the WOGCC to change specific spacing orders. In the Vermillion Basin project area, the primary target is thin, discontinuous, stacked gas bearing sandstones in the Mesaverde Formation. If drilling density is insufficient, some gas bearing reservoirs would not be developed and gas reserves would remain unrecovered which would constitute waste. Until the results of drilling activity are known, BLM has no basis for modifying established WOGCC spacing requirements. Since the State of Wyoming is primarily responsible for establishing spacing requirements and there is no compelling evidence to modify established spacing orders, BLM eliminated from detailed study an alternative with a differing well density and continues to find such an alternative to be unreasonable.

**Directional or Horizontal Drilling Alternative**

BLM has reviewed information provided by two Operators (Wexpro/Questar and Marathon Oil, see Appendix C for letters) conducting drilling activity in the project area. These Operators have experience specific to the area and the most up-to-date information on the characteristics of subsurface geologic structures found in the project area. This information has been independently reviewed by BLM's Reservoir Management Group consisting of Petroleum Engineers and Geologists. BLM concurs with the conclusions.

To date two wells have been drilled employing directional drilling techniques in the Vermillion Basin project area, the Kinney Rim Unit 13-1 and more recently the Trail Unit 16. The Proposed Action does not precluded use of directional drilling techniques when such use is desirable and feasible. Directional drilling in the Vermillion Basin may have application where surface topography or other concerns necessitate pad drilling and is usually determined at the Application for Permit to Drill stage. Mandating a directional drilling only program would prove problematic for the reasons described below. It should also be noted that a directionally

drilled well is not necessarily drilled from an existing well pad. The Trail Unit 16 is a directionally drilled well but required construction of a new well pad and access road.

Horizontal drilling techniques are typically commercially successful in productive zones that are continuous without significant faulting and severe inclination. Horizontal drilling methods are used mainly to develop fractured reservoirs consisting of one pay zone with low matrix permeability, or to limit water encroachment from below. Sometimes wells which use horizontal completion techniques are drilled vertically to evaluate the prospective horizon, and then the well is plugged back, kicked off, and completed with one or more horizontal legs. The stacked, discontinuous sandstones of the Mesaverde Group in the Vermillion Basin project area consist of a series of low permeability gas pay zones that would not be efficiently exploited by horizontal drilling and completion techniques. A horizontal drilling requirement is not a reasonable drilling option in the Vermillion Basin project area.

Economics must be considered when drilling a directional well. Costs can prove to be substantially higher for a directional well than for a vertical well. Depending on the price of natural gas, such increased cost may effectively preclude the drilling of a commercial well. For example, the costs to drill the Trail Unit 16 directional well in the Vermillion Basin area were about $400,000 more than the costs to drill a nearby vertical well that was drilled about the same time. Wexpro (Operator) estimated that based on the costs and recoverable reserves associated with the two wells, a directional well in the Vermillion Basin would not be economic if the initial production rate of the well were at or less than 750,000 cubic feet per day and gas prices were less than $2.00 per thousand cubic feet. Although it is appropriate to require directional drilling under certain circumstances, requiring a directional drilling only program could conceivably preclude drilling entirely from an economic standpoint. Forcing a drilling method that could render development uneconomic could result in an adverse effect on the energy supply as defined in Executive Order 13211 (Sec 2 (b) (i)) and reduce revenues to the federal, state, and local governments.

## INDEPENDENT EVALUATION OF THE GEOLOGIC STRUCTURE FOUND IN VERMILLION BASIN PROJECT AREA

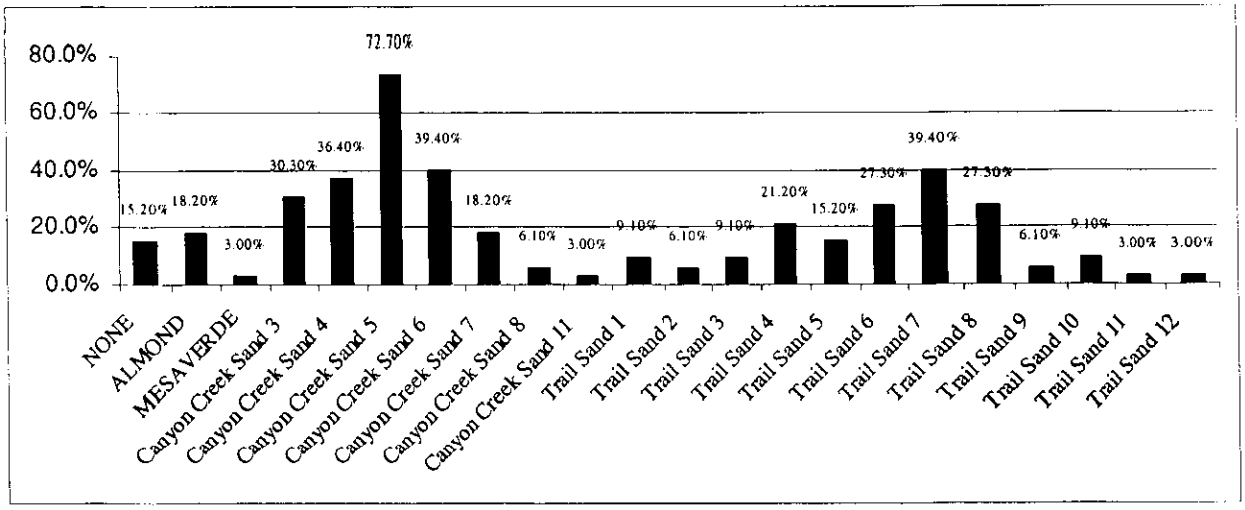
The following discussion was prepared by Daniel H. Stright Jr., P.E. (Colorado Registration PE-22313), Reservoir Management Services Inc., Lakewood, Colorado. This discussion has been reviewed by BLM's Reservoir Management Group and concurs with the discussion.

### Description of the Mesaverde Group in the Vermillion Basin

The Mesaverde Group is a major productive interval and drilling target in the Vermillion Basin. This sedimentary sequence has a variety of names and subdivisions in various basins and often within the same basin in the Western U.S. It literally has over 100 different local names. The Mesaverde Group in the Vermillion Basin includes the Almy Formation, un-named Mesaverde zones, Erickson sandstones, "Rusty" beds, Blair Formation and informally named and numbered field zones called Trail sands and Canyon Creek sands. It is a complex series of often difficult to correlate fluvial to marginal marine sandstones that in total include a gross interval of approximately 2,300 feet (at Canyon Creek Field).

These sands have produced in Trail, Kinney, Hiawatha, and Canyon Creek fields in the vicinity of the Vermillion Basin project area with varying degrees of success. Because of the complexity and because of the great thickness of the stratigraphic section involved, a true "type log" adequate to convey that complexity (just for the Mesaverde section without considering the Wasatch, Fort Union or Nugget Formations) would be difficult to construct. For more details on stratigraphy and depositional environments see GRI publication "Atlas of Major Rocky Mountain Gas Reservoirs" (1993) page 43.

**Chart 1**
**Canyon Creek Productive Sands Study**




Several operators are involved in the development of existing productive fields in the area and in the exploration for new production adjacent to existing production. Much of the existing production is from old wells with limited modern logs. An operator study completed last year on Canyon Creek field illustrates the complexity of the Mesaverde sandstones. Chart 1 shows the percentage of wells in the Canyon Creek Field completed in the 22 named sand zones. Note that there are some sand zones that are not currently named but which may prove to be productive. Also note that all potentially producible named sand zones are not completed in every well. Thus, the need for many recompletions and infill wells.

The net sand thickness for the 22 named sands in the Vermillion Basin project area ranges from 10 to 80 feet with an average of about 30 feet. The porosity ranges from 9% to 17%. The permeability ranges from less than 1 millidarcy (md) to over 20 md.

Sands in the Mesaverde exhibit normal hydrostatic pressure unless production has occurred to reduce it. Individual sand units behave as distinct reservoirs. Because of the selective completions done in the past, there are multiple stacked reservoirs remaining with some having normal pressures and some being partially depleted within active field areas. This situation complicates new infill drilling operations.

These details for the Mesaverde Group provide a good analogy for the type of geologic situation found in the Wasatch and Fort Union although they are less complex and have fewer individual sands. The geology

situation is similar for these other formations in that they are relatively thick gross intervals with multiple stacked sand reservoirs.

**Preferred Vermillion Basin Project Area Well Architecture**

The large number of thin sands distributed over a long interval impacts the selection of the well configuration. The possible well configurations for Vermillion Basin project area are show on:

**Exhibit 1: Vermillion Basin Well Options**

Four well types are shown on this diagram: vertical well, s-shaped deviated well, high angle inclined well, and horizontal well. The vertical well intersects all zones directly under the surface location. Several zones are perforated, hydraulically fractured, and produced in a single wellbore (commingled). Drilling and completion operations are based on well-established, low risk technology. Recovery of reserves is optimized by selecting zones suitable for completion based on minimum levels of reservoir properties and sufficient levels of pressure (no depletion from offset wells). If the initial completion becomes depleted then the vertical well can be recompleted in other behind pipe zones, thus increasing reserve recovery and extending the life of the well.

The horizontal well can be drilled from vertical or high angle inclined wellbores. The horizontal section is kicked off close to the depth of the target zone and can easily reach lengths of 1,500 feet to 3,000 feet from the kick off point. The main problem with this well architecture at Vermillion Basin project area is that it can produce from only one of the 22 potential target zones. If the target zone is missing, is pressure-depleted, or has poor reservoir characteristics, then the horizontal well is a failure. If the horizontal well finds a good zone, then the reserve recovery from that zone will be potentially higher than recovery from a vertical wellbore in the same zone; however, the horizontal well has no access to the other 21 potential producing zones. Furthermore, unlike the vertical well, the horizontal well does not provide any information about the remaining 21 zones for geologic interpretation. Finally, drilling experience in the area indicates that the expected success rate for horizontal wells in low permeability gas reservoirs is about 20% to 25%.

The high angle inclined well is drilled at 300 to 600 feet from vertical starting at a 1,500-foot kickoff point. This well intersects the reservoir zones at increasing distances from the surface location of the well; therefore, targeting of zones becomes more difficult than with vertical wells. There is increased cost associated with drilling time required for the longer, deviated well in addition to increased mechanical risk of directional drilling. A major problem of this type of well for Vermillion Basin project area is that, based on operator experience, the success rate for hydraulically fracturing the individual zones is about 1 in 3 due to screenout problems. During hydraulic fracturing, sand is carried into a fracture created by high-pressure fluid. If there is a restriction at the wellbore, the sand packs off, prematurely terminating the fracture treatment. Screenouts are common in wellbores inclined more than 10°.

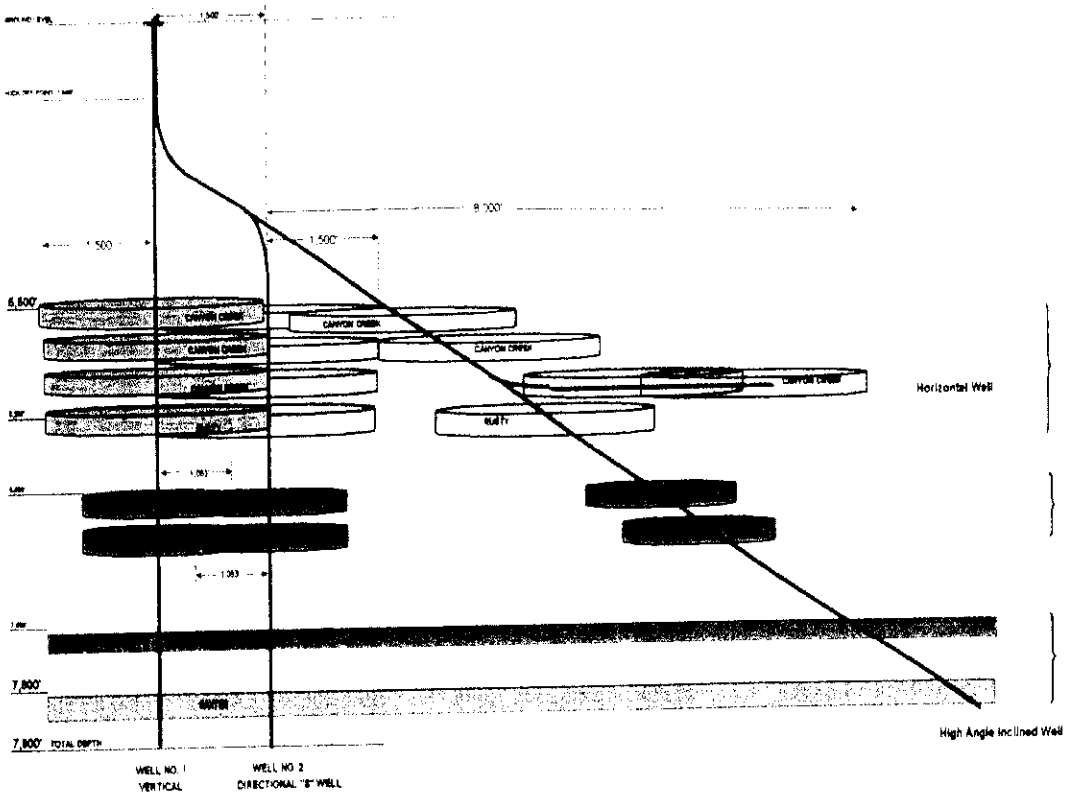
The theoretical reasons for the screen outs in inclined wells are related to fracture initiation problems caused by certain well orientations in the stress field (Hossain, et al. 1999, and Sankaran, et al. 2000). It is critical that the inclined well be correctly oriented in order to have successful hydraulic fracture treatments. However, the stress field is usually poorly defined leading to poor success rates for hydraulic fracturing in inclined wells. Zones that screenout during fracturing are generally not successfully refractured and the reserves are not produced.

*VERMILLION BASIN Well Options*

Exhibit No. 1

*VERMILLION BASIN Well Options*

Exhibit No. 1




BRICKSON:
CANYON CREEK MEMBER
RUSTY MEMBER
100 ACRE DRAINAGE
BRICKSON:
TRAIL MEMBER
80 ACRE DRAINAGE
DRAINAGE UNKNOWN

nclined Well

Orientation in the stress field is not a factor in vertical wells; consequently, success rates for hydraulic fracturing are very high.

The s-shaped well is the most common deviated well drilled for field development. A well of this type at Vermillion Basin project area would be kicked off at about 1,500 feet and straightened to vertical before entering the first pay zone at about 5,500 feet. From a completion standpoint, this well looks like the vertical well with possible problems working inside a deviated well with two doglegs (bends) in the well path. The main reservoir problem with this well type at Vermillion Basin project area is drainage area limitations due to limited reach relative to effective drainage areas of the individual zones.

**Exhibit 2: S-shaped well -Vertical cross-section**

The reach of the S-shaped well at Vermillion Basin project area is limited to 1,500 feet due to mechanical constraints imposed by having the well vertical at the top zone (5,500 feet).

While S-shaped directional wells allow multiple wells to be drilled from a single pad, thus reducing surface disturbance, the limited reach of the directional well imposed by depth of the top zone, negatively impacts reservoir drainage per well.

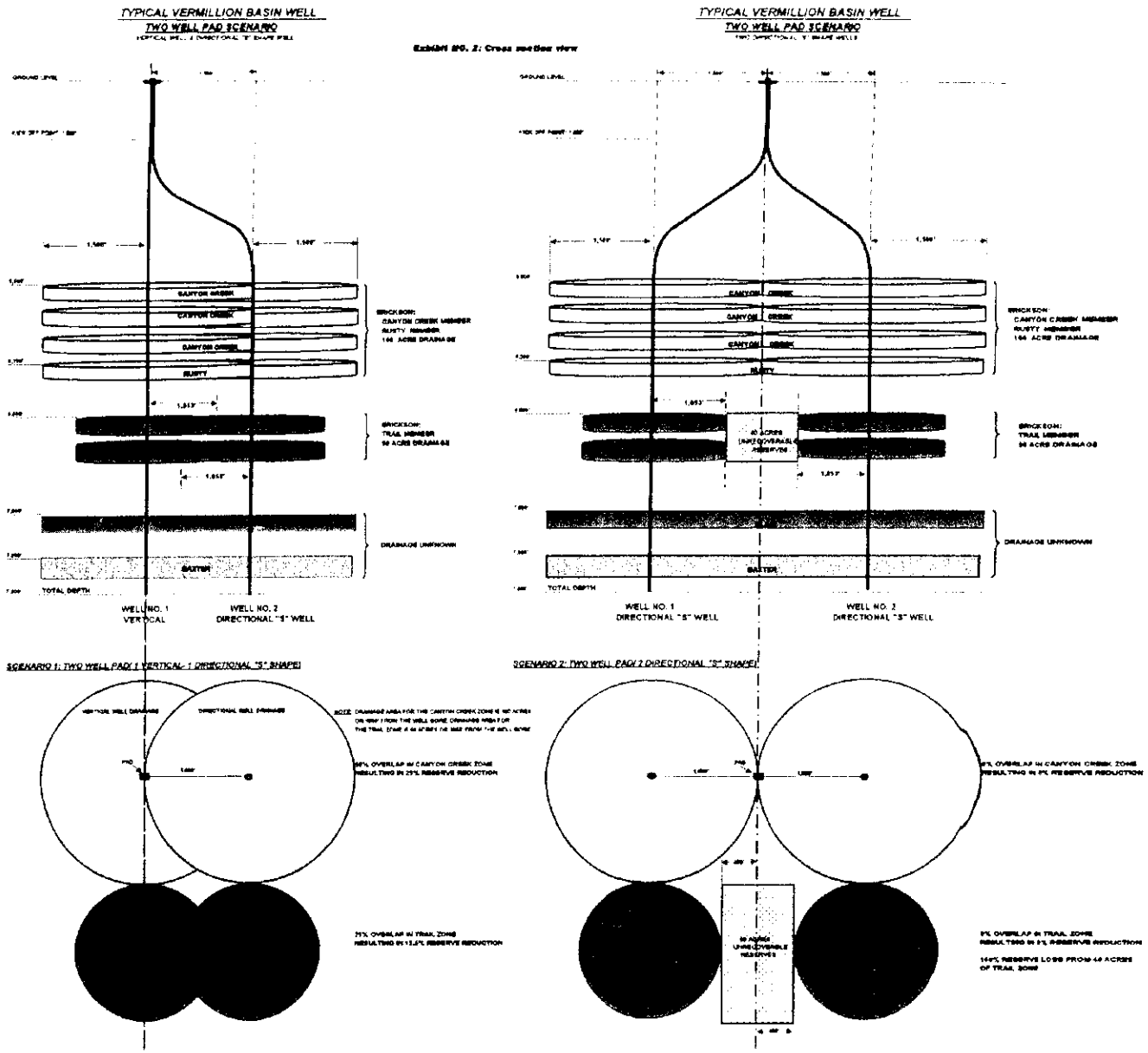
Wexpro (2002) has determined from reservoir analysis of existing Mesaverde production in the Canyon Creek and Trail fields of the Vermillion Basin, that the effective drainage area for the Canyon Creek zone is 160 acres (1,500-foot radius) and 80 acres for the Trail zone (1,050-foot radius).

For these effective drainage areas, two S-shaped wells per pad without a vertical well have the same reserves per well as two vertical wells on the same spacing but with a 25% increase in per-well cost. If the S-shaped well offsets an existing vertical well, the overlap in effective drainage area reduces the per-well reserves by 25% in the Canyon Creek and by 12.5% in the Trail. The reserve reduction combined with 25% increase in well-cost makes the two wells uneconomic.

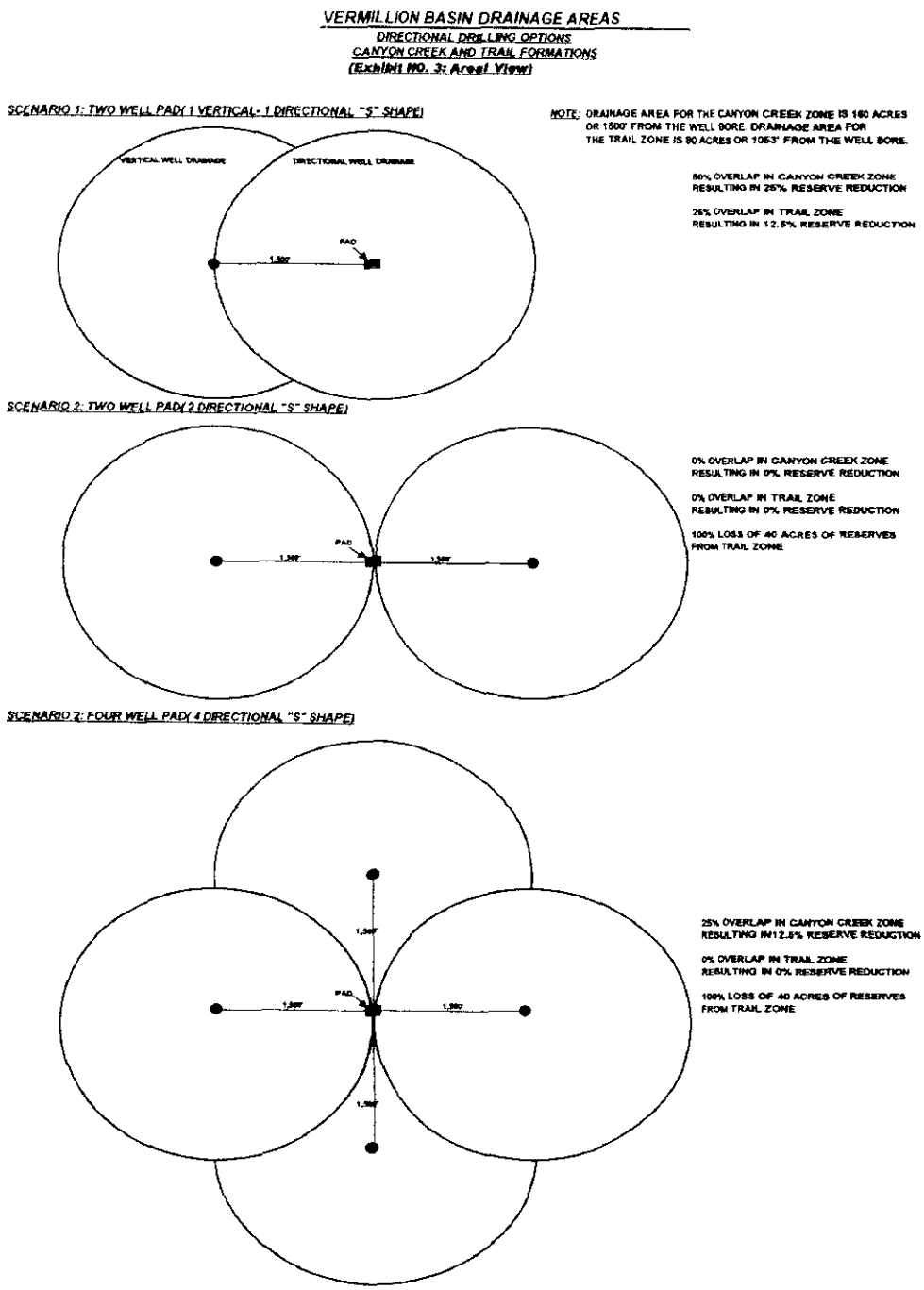
Four S-shaped wells per pad without a vertical well results in a 12.5% reduction in per-well reserves and a 25% increase in per-well cost. Adding a vertical well to the pad further reduces the per-well reserve. An aerial view of the effective drainage areas illustrates this point.

**Exhibit 3: S-shaped well - Aerial view of effective drainage areas**

In summary, vertical, hydraulically fractured, multiple zone completions are the only economically feasible well architecture for Vermillion Basin project area. It can be concluded that:


TYPICAL VERMILLION BASIN WELL
TWO WELL PAD SCENARIO
TYPICAL VERMILLION BASIN WELL
TWO WELL PAD SCENARIO
WELL NO. 1
VERTICAL
WELL NO. 2
DIRECTIONAL "S" WELL
WELL NO. 1
DIRECTIONAL "S" WELL
WELL NO. 2
DIRECTIONAL "S" WELL
SCENARIO 1: TWO WELL PAD/ 1 VERTICAL- 1 DIRECTIONAL "S" SHAPE)
SCENARIO 2: TWO WELL PAD/ 2 DIRECTIONAL "S" SHAPE)

# Exhibit 3


VERMILLION BASIN DRAINAGE AREAS
DIRECTIONAL DRILLING OPTIONS
CANYON CREEK AND TRAIL FORMATIONS
(Exhibit NO. 3; Areal View)
SCENARIO 1: TWO WELL PAD( 1 VERTICAL- 1 DIRECTIONAL "S" SHAPE)
NOTE: DRAINAGE AREA FOR THE CANYON CREEK ZONE IS 160 ACRES OR 1500' FROM THE WELL BORE. DRAINAGE AREA FOR THE TRAIL ZONE IS 80 ACRES OR 1063' FROM THE WELL BORE.
VERTICAL WELL DRAINAGE
DIRECTIONAL WELL DRAINAGE
PAD
1,500'
50% OVERLAP IN CANYON CREEK ZONE RESULTING IN 25% RESERVE REDUCTION
25% OVERLAP IN TRAIL ZONE RESULTING IN 12.5% RESERVE REDUCTION
SCENARIO 2: TWO WELL PAD( 2 DIRECTIONAL "S" SHAPE)
PAD
1,500'
1,500'
0% OVERLAP IN CANYON CREEK ZONE RESULTING IN 0% RESERVE REDUCTION
0% OVERLAP IN TRAIL ZONE RESULTING IN 0% RESERVE REDUCTION
100% LOSS OF 40 ACRES OF RESERVES FROM TRAIL ZONE
SCENARIO 3: FOUR WELL PAD( 4 DIRECTIONAL "S" SHAPE)
1,500'
PAD
1,500'
1,500'
1,500'
25% OVERLAP IN CANYON CREEK ZONE RESULTING IN12.5% RESERVE REDUCTION
0% OVERLAP IN TRAIL ZONE RESULTING IN 0% RESERVE REDUCTION
100% LOSS OF 40 ACRES OF RESERVES FROM TRAIL ZONE

Horizontal wells that target a specific sand are not feasible at Vermillion Basin project area because:

- The sands are thin and the gas reserve target for individual sands would be small and non-commercial.
- If the target sand is non-productive or pressure depleted, the horizontal section of the well must be redrilled to test other sands.
- Recompletions to another sand are not possible in the horizontal well.
- If natural fractures are not encountered, hydraulic fracturing in the horizontal well may be required to communicate vertically in the sand. This defeats the purpose of drilling the horizontal well.
- The mechanical risk of drilling and completing horizontal wells is high.

High angle wells are not feasible because:

- There is increased cost and mechanical risk associated with drilling the directional well.
- The target zones are intersected at varying (increasing) distance from the surface location and may miss some of the target zones.
- Difficulties in hydraulically fracturing in high angle wellbores results in a 1 in 3 success rate in completing the target zones leading to uneconomic wells.

S-shaped wells have some of the technical advantages of vertical wells but are not economically feasible because:

- There is increased cost and mechanical risk associated with drilling the directional well.
- The limited reach of the well (1,500 feet) relative to the effective drainage areas of the target Mesaverde zones, reduces the reserves per well if more than two wells are drilled per pad or the S-shaped well offsets an existing vertical well on a two-well pad.
- Two S-shaped wells per pad (without a vertical well) give the same reserves per well as two vertical wells on the same spacing but at a 25% increase in the per-well cost.
- With two wells per pad the cost savings in surface infrastructure do not offset the increase in well drilling and completion cost.
- Offsetting an existing vertical well with an S-shaped well will result in a decrease in the per-well reserve and an increase in the per-well cost.

Vertical wells have the following advantages:

- The risk of not finding a sufficient number of productive sands in the 22 sand section is low.
- Multiple sands can be hydraulically fractured and commingled in a single completion with low risk, proven technology.
- Vertical wells can be recompleted to other sands if production from the initial completion drops to noncommercial levels.
- The mechanical risk of drilling and completion operations is low.
- Vertical wells will maximize the recovery of gas reserves in this multi-reservoir producing section.

By estimating cost and reserve factors, it is possible to evaluate the tradeoff between increased well-cost and reduced surface infrastructure cost associated with pad directional drilling for Vermillion Basin project area. The following table compares the cost and reserve factors for vertical, S-shaped, high angle, and horizontal wells.

**Table 2**
**Vermillion Basin Natural Gas Exploration and Development Project**
**Comparison of Well Configuration Alternatives**

| | Percent of total well cost – Vertical Well | Vertical | S-Shaped Deviated | High-angle Deviated | Horizontal |
|---|---|---|---|---|---|
| Mechanical Risk | | 0.98 | 0.95 | 0.9 | 0.6 |
| Cost Factors | | | | | |
| # wells per location | | 1 | 2 | 8 | 8 |
| Location and Road | 0.7% | 1.00 | 0.800 | 0.250 | 0.250 |
| Drilling and Logging | 55.0% | 1.00 | 1.400 | 1.400 | 1.400 |
| Perforation | 1.0% | 1.00 | 1.100 | 1.200 | 0.000 |
| Hydraulic Fracturing or Stimulation | 25.0% | 1.00 | 1.100 | 1.500 | 0.250 |
| Gathering line | 2.5% | 1.00 | 0.800 | 0.250 | 0.250 |
| Surface facilities | 4.5% | 1.00 | 0.750 | 0.750 | 0.750 |
| Remediation | 5.0% | 1.00 | 0.500 | 0.125 | 0.125 |
| Risk Cost Factor | 100% | 1.00 | 1.246 | 1.468 | 1.508 |
| Reserve Factor (Vertical Well = 1.0) | | 1.00 | 1.00 | 0.31 | 0.16 |

In the above table, the total well cost for the vertical well is allocated to several categories. The cost factors are then applied for each type of deviated well to reflect their relative cost. Drilling multiple wells from a pad offers some cost savings but at the expense of increased risk and drilling cost. The risked cost of the deviated wells ranges from 1.25 (S-shaped) to 1.5 (horizontal) times the cost of a vertical well. This appears to be in line with industry experience.

The relative reserves were estimated by applying success rates based on experience for each type of well with the vertical well = 1.0.

The projected reserves per well for the S-shaped well are the same as the vertical well if a maximum of two S-shaped wells are drilled per pad (no vertical well on the pad). However, the cost of the S-shaped deviated well, including estimated savings in surface infrastructure cost, is 1.25 times the cost of the vertical well. If the number of S-shaped wells per pad is increased to three or four, or a vertical well is added to the pad, the reserves per well decrease relative to the vertical well case. The 25% increase in per well cost will likely make these wells uneconomic.

The horizontal well in the Vermillion Basin project area has an estimated cost of 1.5 times the vertical well and a projected reserve of only 16% of the vertical well. The low projected reserve is based on two factors: 1) a probability of success of 25% due to a variety of factors, including missing the target zone, not finding gas in the target zone, finding depleted pressure, not finding natural fractures, or intersecting a water bearing fractured zone, and 2) if a productive, single pay zone is found by the horizontal well, it will represent 25% of the gas in the total interval (optimistic) but will recover 2 times the gas that would be recovered by a hydraulically fractured vertical well in the same zone. Combining all of these factors gives a reserve factor of 0.16 for the horizontal well.

High angle deviated wells have an anticipated cost of 1.5 times the cost of the vertical well. The major cost components are drilling and stimulation. High angle wells can be hydraulically fractured similar to vertical wells; however, completion operations have higher risk. Fracture initiation and containment in highly deviated wellbores is a poorly understood, high-risk process (Sankaran 2000) that results in a high frequency of screenouts and contributes to higher completion cost.

The reserves for a high angle deviated well are about 1/3 those of the vertical well. This is a direct result of problems associated with hydraulically fracturing highly deviated wells. Operators' experience has shown that the success rate for fracturing in high angle wellbores will be about 1 in 3 due to screenouts. Reserves from zones where fracturing fails will be significantly reduced. Based on the foregoing, it is concluded that the only technically and economically feasible well architecture for Vermillion Basin project area is the vertical well completed in multiple pay zones.

## CONCLUSION

Reservoir analysis has determined that the Canyon Creek Zone (Mesaverde) has an effective drainage area of 160 acres which corresponds to a radial drainage radius of approximately 1,500 feet. The Trail Zone (Mesaverde) has an effective drainage area of only 80 acres which corresponds to a radial drainage radius of approximately 1,050 feet. Assuming that a vertical well has already been drilled, and that a new Canyon Creek Zone and Trail Zone well would be directionally drilled from that same well pad, a portion of the drainage areas for the two wells would overlap (see Figure 1). It is also assumed that the reach of an S-shaped directional well is only 1,500 feet. Any S-shaped directional well drilled from an existing well pad would encounter some new reserves, and some reserves that will already be recovered by existing wells on that pad. By requiring that all Canyon Creek Zone and Trail Zone wells be directionally drilled (and assuming the 1,500-foot directional distance limitation), the amount of new reserves that may be recovered by these directional wells may not be sufficient to pay out the well's drilling and completion costs (i.e., the wells would be uneconomic to drill). Potential reserves would not be recovered which would result in waste.

It simply would not be feasible to develop the Mesaverde Formation reservoirs by locating all wells in a section on one or two well pads and drilling directional wells. If a directional drilling option were selected, significant gas reserves would be left in the ground due to the limited reach of S-shaped directional wells, and the increased drilling costs associated with this type of drilling would preclude development of some gas bearing sandstones.

Based on the information provided above, BLM determines that a directional drilling only alternative remains unreasonable and was correctly dropped from detailed analysis in the EA. In addition, the other two alternatives (varying numbers of wells and alternative well density) were in essence incorporated into the Proposed Action and resulted in a finding of no significant impact even if the maximum number of wells is authorized. Consequently, it is unnecessary to analyze these alternatives in detail. Therefore, BLM concludes the analysis contained in the EA remains appropriate and that the documentation provided above meets the requirements as ordered by IBLA.

## Additional Literature Cited

GRI: "Atlas of Major Rocky Mountain Gas Reservoirs" (1993).

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# Appendix C

## Comment Letters and BLM Responses

## Appendix C
## Comment Letters and BLM Responses

BLM received 11 comment letters in response to the request seeking further comment on the three alternatives due to IBLA's Order. Comments are summarized in italics and BLM responses are in regular type.

***Biodiversity Associates/Wyoming Outdoor Council***

*These are the comments of Biodiversity Associates and Wyoming Outdoor Council on the need to evaluate new directional drilling alternatives concerning the Vermillion Basin Natural gas project. It is important to note that since the BLM's decision was set aside and remanded as pertains to the failure to adequately evaluate directional drilling and well spacing options, the DR is no longer in effect and a new decision needs to be reached via supplemental NEPA processes including at minimum a Supplemental EA evaluating fully an option to require directional drilling and thereby prevent incursions into sensitive wildlife habitats and roadless areas as delineated in the Citizens' Wilderness Inventory of the Kinney Rim South Unit and the Citizens' Wilderness inventory of the Kinney Rim North Unit. The Kinney Rim South document is included with this submission, and the Kinney Rim North Unit will be mailed to you on Monday, February 11. We incorporate these documents in full by reference. Our comments also are accompanied by a thorough review of pertinent scientific and technical literature regarding the proposed project, and we also incorporate these studies into our comments by reference.*

BLM has complied with IBLA's order. The BLM, Rock Springs Field Office, has made a preliminary determination as to the lands in Biodiversity's wilderness inventory that lie within the Vermillion Basin project area. See Appendix A.

*First, the proper remedy for a NEPA violation -in addition to all proposed and ongoing projects (including those whose NEPA is tiered to the invalid NEPA analysis) being enjoined -is a remand to the agency for supplemental NEPA. In this case, the EA was defective for failing to thoroughly analyze directional drilling that would lessen impacts to the environment. Accordingly, the proper "next step" on IBLA's remand is for the Rock Springs Field Office to initiate the EA process once again, and to prepare an entirely new or supplemental EA consistent with the deficiencies found by IBLA. See, e.g., Sierra Club v. Hodel 848 F.2d 1068, 1093, 1096 (10th Cir. 1988) rev'd in part on other grounds, Village of Los Ranchos De Albuquerque v. Marsh, 956 F.2d 970 (10th Cir. 1992) (where existing agency studies did not satisfy NEPA, BLM was required on remand to perform an new EA, which may or may not lead to a full EIS -"if the agency has not considered all relevant factors. . .the proper course. . .is to remand to the agency for additional investigation or explanation) (citations omitted); Fritiofson v. Alexander. 772 F.2d 1225, 1248 (5th Cir. 1985) rev'd in part on other grounds. Sabine River Authority v. U.S. Dept. of Interior. 951 F.2d 669 (5th Cir. 1992) (where EA is defective in cumulative impacts analysis, the proper remedy was a remand for a new EA to reconsider its FONSI).*

BLM was ordered by IBLA to further document the record as to why three alternatives were dropped from detailed study. All other issues brought forth in the appeal were affirmed.

*Second, we stress that, as before, the EA be made available for public comment and participation. In*

*addition, BLM, given the IBLA findings on directional drilling, should initiate scoping on the new EA to better frame and formulate the issues.*

The public was given the opportunity to comment further on the three alternatives.

*We are concerned about the significant impacts on the human environment inherent to this project. Impacts to sage grouse, mountain plover, black-footed ferret, Wyoming pocket gopher, Preble's shrew, and raptors need to be minimized. Two-mile buffers should be established around active prairie dog towns, sage grouse leks, and raptor nest sites, and one-mile buffers should be established around mountain plover nest sites. In addition, black-footed ferrets have been released on lands in the Little Snake Black-Footed Ferret Management Area, immediately across the border from the project area.*

*We are also concerned that unnecessary road construction within roadless areas will impact BLM Sensitive Species such as sage sparrow and Brewer's sparrow through habitat fragmentation. Fragmentation of sagebrush steppe habitats is known to have deleterious effects on sagebrush obligate species such as sage sparrow, Brewer's sparrow, and sage thrasher (Kick and Rotenberry 1995). Oil and gas development has specifically been shown to negatively impact these species in Wyoming (Inglefinger 2001). BLM should take concrete steps to reduce road and well-pad construction to avoid further fragmenting the sagebrush steppe habitats used by these species.*

IBLA affirmed BLM's management of special status species in the project area.

*In the past, BLM has contested the credibility of evidence and testimonials presented to it that roadless areas exist within the Vermillion Basin project area. The Citizens' Wilderness Inventories for the Kinney Rim North and South Units present significant new information dispelling any doubt that the lands within the proposed boundaries are indeed roadless, and also demonstrates unequivocally that many wells proposed under the original Vermillion Basin EA intrudes into these roadless land, which have been proposed for wilderness.*

*The Wyoming BLM State Director's Decision affirming the original DR for this project claimed that "BLM does not have a 'roadless' designation." Decision at 3. This is incorrect-BLM does in fact have an official "roadless" designation. The BLM definition of "roadless" was published in the Wilderness Inventory and Study Procedures Handbook (H-6310-1) early in 2001 and also appeared in the Federal Register:*

> ***roadless:*** *refers to the absence of roads which have been improved and maintained by mechanical means in insure relatively regular and continuous use. A way maintained solely by the passage of vehicles does not constitute a road" (BLM Handbook H-6310-1at Glossary, p. 2).*

*In its ruling, IBLA noted that it found "no support for appellants' position in the record before us" to support claims that the Vermillion Basin project would impact roadless lands. If this case again comes under judicial review, the record will now speak loudly and unequivocally to the effect that roadless lands do exist in the area and stand to be impacted by the Vermillion Basin project. Thus, the BLM would be well advised to take seriously potential impacts to roadless lands that may inhere to this project, and take steps to safeguard the primitive qualities of these lands. We ask BLM to thoroughly evaluate a directional drilling alternative as part*

*of its supplemental NEP A, and select a directional drilling alternative that keeps surface disturbance out of roadless areas as its chosen course of action.*

See Appendix A.

*The need to employ directional drilling technologies to reduce environmental impacts of mineral development is a high priority of the Bush administration. The President's National Energy Policy contains a section titled, "21st Century Technology: The Key to Environmental Protection and New Energy Production," which states:*

> *"Producing oil and gas from geologically challenging areas while protecting the environment is important to Americans and to the future of our nation's energy security. New technology and management techniques will allow for sophisticated energy production as well as enhanced environmental protection... Smaller, lighter drilling rigs coupled with advances in directional and extended-reach drilling significantly increase protection of the environment...Modular drilling rigs, "slimhole" drilling, directional drilling, and other advances enable: [...]*
>
> - *production of oil and gas with increased protection to wetlands and other sensitive environments;*
>
> *Other examples of advanced technology include: [...]*
>
> - *Highly sophisticated directional drilling that enables wells to be drilled long horizontal distances from the drilling site [.]"*

*National Energy Policy, May 2001, "Reliable, Affordable, and Environmentally Sound Energy for America's Future: Report of the National Energy Policy Development Group, p. 5.5.*

*Likewise, the Secretary of the Interior has emphasized the need to begin utilizing directional drilling technology:*

> *We must also harness 21st Century technology to help our environment. Where we once needed scores of wells to tap underground reserves, today in some areas we can use one hole on the surface to drill for oil in a circle extending seven miles. We can use the resources below ground while we preserve the landscape and habitat above.*

*Presentation of Gale Norton, Secretary of Interior, to the National Newspaper Association (Washington, DC, March 23,2001).*

*In the case of the Vermillion Basin project, we feel strongly that directional drilling techniques must be mandated in order to prevent significant impacts to the roadless lands in the Kinney Rim North and South Units.*

*The reduced environmental impacts of directional drilling are well-documented. Cluster drilling from a single well pad (French Oil and Gas Association 1990) can reduce the footprint of oil and gas development on the*

*landscape by concentrating the activity and impacts of many wells at a few widely dispersed sites. Because fewer directional wells are required to drain a subsurface reservoir, well spacing is always greater for directional wells (Fritz et al. 1991). Indeed, Joshi (1991, p. 4) stated that "to achieve larger producible reserves, horizontal wells will have to be drilled with a larger well spacing than vertical wells." Horizontal drilling can now reach subsurface reservoirs up to 29,000 feet away from the drilling site in horizontal distance (Al-Blehed et al. 2000). Thus, by requiring cluster development (used in conjunction with horizontal or deviated directional-drilling technology), the BLM can minimize environmental damage and habitat degradation that is inherent to oilfield development.*

*Not only is directional drilling more environmentally responsible, it is also more effective at removing oil and gas from geologic formations than conventional vertical wells. Thakur (1999) reported that because horizontal drilling is a more efficient extraction method, it can increase the recoverable reserves for a given reservoir. Fritz et al. (1991) reported that directional drilling has had a higher percent success that vertical drilling in both the Austin Chalk and Williston Basin fields. Joshi (1991) asserted that for natural gas production, horizontal wells improve drainage area per well for low-permeability geologic formations, reduced near-wellbore turbulence and increased delivery efficiency for high-permeability formations. Horizontal drilling technology is so effective that it has become the benchmark for the industry: Miller and Steiger (1999) boasted that their array of vertical and directional wells had production that equaled high benchmark projections from horizontal drilling. Furthermore, directional drilling reduces "coning," the mixture of oil with gas and water that reduces production efficiency for oil and gas (Joshi 1991, Thakur 1999).*

*Directional drilling is a universally practical solution to oil and gas recovery. It is suitable for both exploration and full-field development (French Oil and Gas Association, 1990). Aguilera et al. (1991) lauded the potential of horizontal drilling in infill situations. In 1991, Fritz et al. (p. 36) noted that, "If the cost of drilling a horizontal well was equal to that of drilling a vertical well, most reservoirs would be candidates for horizontal drilling." These costs have in fact equalized in modem times. Aguilera et al. (1991, p.1) stated that, "Theoretically, all reservoirs can benefit from horizontal wells." Al-Blehed et al. (2000) asserted that horizontal drilling is superior to vertical drilling for a variety of conditions including for naturally fractured reservoirs, thin reservoirs, heterogeneous reservoirs, vertical permeability homogeneous reservoirs, reefs or isolated sand bodies, and faulted reservoirs. Horizontal drilling has proved to be a superior technology in a variety of geological settings, and we know of no examples of cases where vertical drilling offers superior results.*

*The economic feasibility of directional drilling has been well demonstrated. Cluster development of many wells on a single pad offers minimizes (sic) the capital investments of lessees (French Oil and Gas Association 1990), and reduces costs for an expensive and ecologically damaging network of improved roadways. In 1991, Joshi (p. 7) noted that costs for directional wells were 1.4 to 3 times higher than costs for vertical wells, but further noted that "In some cases, with extensive drilling experiences, the horizontal well costs are reported to be almost the same or even lower than vertical well costs." But because directional drilling requires fewer wells and yields more production per well, overall oilfield development costs may have been lower even with the older technology available in the early 1990s. Because each directional well drains a greater reservoir volume than a corresponding vertical well, fewer wells are required to drain a reservoir, reducing up-front project costs (Fritz et al. 1991). These researchers further compared the costs of older-*

*technology directional drilling with vertical drilling, and found that oil production costs per barrel were lower for directional drilling in the Austin Chalk, but higher in the Williston Basin of North Dakota. In modern times, the technology continues to improve and efficiencies rise. Al-Blehed et al. (2000) stated that their use of horizontal wells reduced drilling, flowline, and facilities costs by 20-25% over vertical drilling.*

*Directional drilling has proven to be a remarkably versatile as alternative to conventional vertical drilling in recovery. Directional drilling has been shown to increase rate of gas production and overall recoverable quantity for tight gas sands (e.g., Cassetta 1998). O'Rourke et al. (1997) found horizontal drilling of paired wells to be effective in gas production using steam injection techniques. For heavy oil recovery, Shirif (2000, p. 894) noted that, "For a given pattern, there is a horizontal well configuration [that] maximizes the total production rate." In all cases, directional drilling has resulted in superior economic yields when compared to conventional vertical drilling. Thus, directional drilling minimizes the environmental impacts associated with mineral development, is geologically and economically feasible, and produces equal and frequently superior recovery of minerals compared to vertical drilling.*

*Directional drilling is proven as an effective alternative to vertical drilling in Wyoming. The first directional well in Wyoming was completed in 1987, and as of 1994, 80 producing wells were completed out of 117 attempts (Stewart 1995). As of October 2001, Wyoming has 504 horizontal or directional wells on-line, according to State of Wyoming data. Stewart (1995) stated that "Recent developments in the gas play in the Green River Basin, particularly the Mulligan Draw, Echo Springs, and Stagecoach fields, indicate favorable exploitation by horizontal drilling" (at p. 253).*

*The target geological strata for the Vermillion Basin project also have shown themselves conducive to directional drilling. The Frontier formation has substantial and well-developed fractures through which natural gas migrates (Lorenz 1995), properties which are more conducive to horizontal drilling, which intercepts more fractures than conventional vertical drilling (Mark Kirschbaum, USGS, pers. comm.). According to Krystinik (2001), a horizontal well drilled in the Green River Basin's Frontier formation reached a depth greater than 15,000 feet in tight-gas sandstone, was drilled at a cost that was reduced to 50% of the industry average, and achieved economic production of greater than 14 mmcf/day. Dunn et al. (1995) used horizontal drilling in the Almond formation and found extensive fracturing here as well, though limited in areal extent. These researchers noted that "horizontal well completions may provide an efficient method to access the enormous natural gas resource present in Mesaverde group of the Greater Green River Basin" (at p. 268). Iverson et al. (1995) found that even without hydraulic fracturing, a horizontal well tapping into the Almond formation produced as much gas as a conventional well that used hydraulic fracturing.*

*Proof that directional drilling is feasible for the Vermillion Basin region is the fact that a producing directional well has already been drilled and completed in the Kinney Unit of the project area. According to State of Wyoming records, a Wexpro well, API #3724085 at T13N R1OOW sec. 13 NE 1/4, has been drilled directionally to a total depth of 15,131 feet (at the maximum projected depth for the Vermillion Basin unit) and is currently producing gas from the Nugget formation. The fact that directional wells are already producing natural gas within the Vermillion Basin project area demonstrates beyond a shadow of a doubt that directional drilling is appropriate for the particular geological conditions found in this area.*

*In its Decision Record for this project, BLM noted that "Directional drilling may be used if economically*

*viable" DR, App. at A-13. Now that the technical and economic viability of directional drilling has been established, BLM should require its use to protect other resource values in the Vermilion Basin project area. Failure to require directional drilling would be to accord oil and gas development an absolute priority over all other resources in the project area-a result that would be unlawful under FLMPA's multiple-use, sustained yield mandate.*

*In its original Decision Record for this project, BLM noted that "the BLM does not believe it is necessary or appropriate to mandate the use of this procedure [directional drilling] for this project." DR, App. A at A-13. This statement reveals the Rock Springs Field Office's past deference to the oil and gas industry, its misunderstanding of controlling law and policy, and its unwillingness to adopt reasonable mitigation measures which would protect the interests of the general public that owns lands managed by BLM. As a steward of public lands that belong to all Americans, BLM must exercise its discretion to condition development of public resources on respecting the greater public interest in maintaining viable wildlife populations, recreational opportunities, and open spaces for the enjoyment of generations present and future.*

*No evidence in the existing record lends support to the assertion that directional drilling would in fact be more expensive and no analysis has been performed to balance any actual increased costs with environmental and public health benefits, as well as direct savings resulting from the reduction in new roads, pipeline facilities, right-of-ways and other infrastructure associated with drilling more wells at maximum densities.*

*It is absolutely appropriate for increased production expenses to become part of the cost of doing business on public lands when these increased production costs translate into reduced harms to the public interests and the environment. Not only would it be appropriate from both a legal and ethical perspective for BLM to mandate directional drilling, but in order to reduce impacts to both developed and roadless areas within the proposed project boundary, we believe that BLM has the responsibility to mandate directional drilling in order to avoid impacts to roadless lands and sensitive species.*

See Appendix D for response to Biodiversity's letter and listing of literature cited. BLM's Wyoming Reservoir Management Group has reviewed and concurs with the response.

***Land and Water Fund of the Rockies***

*The Land and Water Fund of the Rockies (LAW Fund) has been retained by Biodiversity Associates in regard to Biodiversity's pending appeal to the Interior Board of Land Appeals (IBLA) of the Vermilion Basin Natural Gas Project and Biodiversity's participation in the ongoing NEPA analysis of the project. The LAW Fund submits these interim comments in response to BLM's January 11, 2002 notice in regard to supplementing the administrative record.*

*As the notice stated, the IBLA remanded the Vermilion Basin EA with directions that BLM comply with NEPA by carefully analyzing an alternative that considers directional drilling, project well densities, and varying numbers of wells or wellpads. The notice provided that "no new surface disturbing activities can occur until the record is updated." Additionally, ongoing surface disturbance activities which could detrimentally impact resources identified by Biodiversity should be enjoined. When an agency's NEPA analysis does not comply*

*with the law, activities related to that NEPA document and authorized by the final decision should be enjoined until the agency has complied with NEPA.*

*As stated in Biodiversity's comments dated February 8, 2002, BLM's responsibility under the IBLA remand is--at a minimum--to reopen the NEPA process with regard to the alternatives noted by IBLA. This can only be accomplished by publishing a draft" directional drilling and well density" alternative, and making it available for public comment after BLM has reviewed the initial public comments on its January 11, 2002 notice. The IBLA decision (at 9) stated that the EA "is set aside to the extent the record fails to explain the facts and analysis supporting rejection of the alternatives of project-wide well densities and varying numbers of wells, and fails to provide a rational basis for failing to analyze fully the alternative of directional drilling, and the case is remanded to allow BLM to do so." (emphasis added). Accordingly, it is incumbent on BLM to issue a new draft or supplemental draft EA for review and comment.*

BLM has complied with IBLA's order.

*After the IBLA decision was released on December 6, 2001, Biodiversity submitted to BLM (on February 8, 2002) two documents entitled Citizens' Wilderness Inventory of the Kinney Rim South Unit and Citizens' Wilderness Inventory of the Kinney Rim North Unit. These documents were submitted pursuant to the BLM Wilderness Inventory and Study Procedures, H-631 0-1. The Citizens' Wilderness Inventories fully comply with the requirements in the BLM Manual for submission of request for the public identifying public lands that have wilderness characteristics. The Citizens' Inventories establish that roadless lands with wilderness qualities overlap with the Vermillion Basin project area.*

*Because gas drilling and the associated access roads, wellpads, pipelines, etc. would disqualify Kinney Rim lands for future wilderness designation, BLM is required to "postpone the action until wilderness values can be addressed through a new land use plan or plan amendment [.]" 1610- 1.06(F). Placing mandatory "No Surface Occupancy" (NSO) stipulations on all roadless lands within the project area will protect the roadless values and wilderness characteristics of these BLM wildlands. NSO stipulations would not preclude the recovery of gas from under the roadless lands -directional drilling techniques could still be used to develop the minerals underlying the road less lands without compromising their roadless nature.*

See Appendix A.

*As stated above, the IBLA remand focused on the requirement that BLM carefully analyze the feasibility of a directional drilling alternative (among other issues), including the technical and economic feasibility of directional drilling in the Vermilion Basin. Biodiversity's February 8 comments establish that at least one directional well is already in use in the project area. This is incontrovertible evidence that directional drilling is both technically and economically feasible. Biodiversity's comments also establish that directional drilling is often a superior technique to achieve conservation of minerals by increasing the efficiency of recovery, and that the costs of directional drilling are competitive with drilling standard vertical wells.*

Two wells have been drilled to date using directional drilling techniques. See previous responses for discussion of technical and economic concerns related to directional drilling techniques in the area.

*In conjunction with BLM's future release of the newly formulated alternative(s) for public review and comment pursuant to the IBLA remand and NEPA, Biodiversity has a right to review all available seismic or geophysical data for project lands. IBLA precedent establishes that, as a party to an ongoing IBLA appeal, Biodiversity is entitled to obtain and review relevant geological and geophysical data, even if such data might otherwise be exempt from disclosure. In a 1994 decision, IBLA clarified "the applicable, procedures for limiting' disclosure of claimed confidential information when parties to proceedings before the Department request access to that information." Yates Petroleum Corp., 1994 GFS (MIN) 76(1994), 131 IBLA 230, 237. In Yates, IBLA found that 43 CFR ' 4.31 establishes a party to a proceeding to request that confidential information that it has submitted as evidence be kept confidential. However, such a request generally bars only non-parties to the proceeding. from obtaining the information. In order to prevent the disclosure of proprietary information to a party, the submitted of the information must establish that its disclosure is prohibited by law. 43 CFR 4.31(d)(1).*

*In Yates, the IBLA held that "since exemptions under FOIA are permissive and not mandatory, those exemptions do not forbid disclosure of information." Id. at 238. Because FOIA exemptions are permissive, "the fact that the claimed confidential information falls within a FOIA exemption does not suffice to establish that disclosure of the information is prohibited by law." !d. at 238. Yates cites numerous legal authorities which establish that the law on this issue is settled. Therefore, Biodiversity is entitled to obtain and review geological and geo-physical information. Biodiversity is willing to draft a confidentiality agreement that will restrict the use of such data and guarantee that potential competitors will not be allowed access to the information.*

BLM is not provided the results of data obtained through geophysical operations. Geologic information on individual wells and producing units in the area are available for review and can be obtained from the BLM (Rock Springs Field Office) or from the Wyoming Oil and Gas Conservation Commission upon request.

*As IBLA correctly held, BLM cannot defer to the project proponent's preference for conventional drilling unless BLM's decision is supported by a thorough analysis of the facts. In this case, the literature and the facts establish that directional drilling can and should be required to protect sensitive project lands. Therefore, FLPMA requires that BLM mandate directional drilling where it can be employed to protect special resources in the project area from "unnecessary or undue degradation".*

Application of directional drilling methods will be employed when necessary.

*FLPMA provides that "[i]n managing the public lands the Secretary shall, by regulation or otherwise, take any action necessary to prevent unnecessary or undue degradation of the lands."" 43 U.S.C. 1732(b). FLPMA requires that the Secretary manage the public lands under the principles of multiple use and sustained yield.. 43 U.S.C. 1732(a). The multiple use mandate requires BLM to ensure that land management activities II best meet the present and future needs of the American people." 43 U.S.C. 1702(c). It also requires "management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources" 43 U.S.C. 1702(c). Finally, FLPMA contains a provision that acknowledges "the nation's need for domestic sources of minerals[.]" 43 U.S.C. 1701(a)(12).*

*With regard to the Vermilion Basin project, BLM's analysis on remand should consider whether the initial preferred alternative would violate FLPMA by resulting in unnecessary or undue degradation of the project lands. Because alternatives are available to reduce the impacts, BLM should impose appropriate stipulations, mitigation measures and other provisions to bring this project into compliance with the Congressional mandates stated above.*

BLM imposed appropriate mitigation in the original Decision Record.

*The LAW Fund appreciates the opportunity to submit these initial comments on the remand of the Vermilion Basin EA as BLM considers public input on the scope and nature of the new alternative(s) which will be circulated for public review and comment. A summary of the points presented above is that:*

*The new alternative should impose NSO stipulations on all roadless lands identified in Biodiversity's Kinney Rim inventories and other lands with sensitive or outstanding natural values (such as the wildlife habitat identified in Biodiversity's comments).*

- *BLM is required to inventory all citizen-proposed wilderness lands within the Vermilion Basin project area before any development may proceed on these lands.*
- *Directional drilling appears to be technically and economically feasible and BLM should incorporate directional drilling requirements into its preferred alternative for this project.*
- *As a party to a pending IBLA case, Biodiversity is entitled to obtain geological and seismic data.*
- *NEPA requires that a new alternative, developed pursuant to the IBLA remand, must be made available for public review and comment.*

*Thank you for your attention to these comments and I look forward to working with BLM on addressing our environmental concerns regarding the Vermilion Basin project. By raising the bar for (i) protective stipulations such as NSO for road less lands, (ii) the employment of directional drilling and varying well densities and (iii) mitigation measures, BLM can allow gas development to proceed while complying with statutory and other requirements that BLM manage these public lands as a steward for and future generations.*

***Marathon Oil Company***

*Marathon Oil Company would like to thank you for this opportunity to submit comments in regards to the Interior Board of Land Appeals' ruling concerning the Vermillion Basin Natural Gas Project.*

*In support of the BLM intentions to supplement the record regarding its decision to drop from further analysis the alternatives of: project-wide well densities, varying number of wells, and directional drilling, Marathon submits the following.*

***Project-Wide Well Densities*** *-Presently, the project area contains the Canyon Creek Unit, the Trail Unit, and the Kinney Unit. The proposed action addresses up to 56 additional wells being drilled within the project area. It is further emphasized that none of these 56 wells will be located further than two miles from the*

*existing development (known geologic structures) that has been present since the mid 1940's. The Project Area comprises 92,490 acres, while the area of the three units plus a 2 mile buffer represents approximately 82% of the Project Area. It is highly unlikely that additional development activity will occur outside the buffered area. Because of this, Project-Wide Well Densities should be dropped from further analysis. To further support this, if in, the future, a well is proposed outside the buffered area, an individual EA will be performed at the APD Stage as addressed in the Lease Terms. With these requirements in effect, no proposed well will be permitted without an Environmental Assessment.*

BLM has explained the facts for eliminating a project-wide well density alternative.

***Varying Number of Wells*** *- The Proposed Action presently addresses* ***UP TO 56*** *new wells within the Project Area with two different alternatives, the Proposed Action and the No Action, zero wells. Granted, these two actions are the extreme ends of the possible number of wells addressed within this EA, however, any number of wells, be it one, two, twenty, or thirty, would fall within the scope of the 56 well scenario, with lesser environmental effects than the total 56 wells that were analyzed. Because of this, Varying Number of Wells should be dropped from further analysis.*

BLM has explained the facts for eliminating a varying number of wells alternative.

***Directional Drilling*** *- In agreement with the Deputy State Director, Marathon Oil Company believes that this issue was addressed properly during the public scoping period for this EA. During scoping economic, geologic, feasibility vs. distance, and other risk factors were brought to light and considered by the Interdisciplinary Team. At that point it was decided to drop this issue from further analysis. Mandating that a given number of wells, within the Project Area, be directionally drilled by this EA would not follow the original Lease Terms. Marathon feels that in certain circumstances, where the need arises to vacate the drilling of a vertical well, a directional well could be utilized for environmental preservation. These circumstances would include but not be limited to: adverse topographical features, an abundance of Cultural Material that would require in depth testing and excavation, meeting the criteria of Historical Trail visual set backs, and avoiding endangered species habitat. These circumstances would arise at the APD Stage and economic evaluation for those particular instances would be conducted at that time to determine whether or not a directional well would be utilized. Because given circumstances are not known until the APD Stage, directional drilling cannot rationally be determined, except at the APD Stage, and therefore should be dropped from further analysis at the EA Stage.*

Application of directional drilling methods will be employed when necessary at the APD stage.

***Office of Federal Land Policy***

*The Office of Federal Land Policy has reviewed the referenced scoping letter on behalf of the State of Wyoming. This Office also distributed the letter to affected State agencies for their review, in accordance with State Clearinghouse procedures. Attached are comments from the Wyoming Game & Fish Department, State Geological Survey, and the Wyoming Business Council's Minerals, Energy, and Transportation Division, based on their reviews. State agency comments are specific to their respective agency missions. While the State defers to its agencies' technical expertise in developing the State's position, the responsibility to articulate the official unified, balanced State policies and positions lies with the Governor or the Office of*

*Federal Land Policy.*

*As noted in the attached letters, there are potentially both positive and negative impacts -to the various resources and for the leaseholders -of different well densities, varying numbers of wells, and directional drilling. Please address the concerns and incorporate the information provided in the attached agency letters during the supplemental environmental impact analysis and in the supplemental Environmental Assessment.*

*Unless submitted electronically to Charlotte Engen (cengen@state. wy.us), this Office will need seven copies of future information and documents for distribution to affected State agencies for review.*

BLM has provided seven copies of the document.

***Wyoming State Geological Survey***

*These comments regarding the Vermillion Basin Natural Gas Project Additional Alternatives are specific to this agency's statutory mission within State government, which is to promote the beneficial and environmentally sound use the State's resources while helping to protect the public from geologic hazards. In that regard these comments are meant to assist in defining the State position, in association with all other agency comments. These comments defer to and are subordinate to the State position.*

*Project -wide well densities are not appropriate for determination in a NEPA document. Oilfield production practices that prevent waste and protect correlative rights are best determined on a site-specific basis, and should have flexibility to be adjusted as special circumstances arise during the course of development. A more flexible approach than dictating well densities through NEPA analysis is necessary for maximum efficiency. In areas where the BLM does not control 100% of the mineral estate, this mandated well density can result in drainage of the federal mineral estate and loss of federal and state revenue, not to mention violation of the lessee's correlative rights.*

*Field limits of reservoirs are rarely known in advance of development. Trying to control the number of wells through NEPA analysis at best futile and of little value. Once again, the best way to determine the number of wells in a project is to allow development to proceed and let economics dictate the eventual number of wells.*

*Directional drilling is a technology that may be applicable in some cases in this area, however the BLM cannot accurately predict the cost or effectiveness involved in the application of such technology. Directional drilling is known to reduce or limit the effectiveness of advanced hydraulic fracturing methods that are necessary to efficiently produce natural gas from tight reservoirs. For the BLM to dictate the application of directional drilling technology in advance presupposes that the BLM has detailed knowledge of producing characteristics of reservoirs, the precise nature and size of fracturing procedures that will be necessary to efficiently produce the gas, the appropriate well density necessary and a number of other variables that are impossible to predict in advance. Without such detailed knowledge, the BLM might well mandate use of techniques or technology that transforms an otherwise economic play into one that is non-economic, resulting in waste, decreased energy security and loss of state revenue.*

*If there are questions on our comments, please direct them to the appropriate geologist on my staff or to me. Rod De Bruin handles oil and gas issues.*

The concerns raised in this comment letter have been addressed.

### *Wyoming Game and Fish Department*

*These comments regarding the Vermillion Basin Natural Gas Exploration Development Project have been approved by the Director and are specific to this agency's statutory mission within State government which is "Conserving Wildlife, Serving People". In that regard, these comments are meant to, in association with all other agency comments, assist in defining the Official State Position. These comments defer to and are subordinate to the Official State Position.*

***Terrestrial Considerations*** *- The project is within the Bitter Creek antelope herd, the South Rock Springs deer and antelope herds, and the Petition elk herd. The project area along the Colorado border, in particular, contains winter-yearlong range for the Bitter Creek antelope herd. Total new disturbed area is estimated at 505 acres, although an existing 883 acres of disturbed vegetation from previous gas development activities will also be used in the new project (total of 1,388 acres impacted by gas development).*

*Directional drilling could reduce the size of the impacted area and could reduce habitat loss from well pads and roads, in addition to minimizing disturbance and traffic impacts to animals. This alternative should be fully analyzed in the environmental document.*

The EA/DR provides appropriate restrictions on activities occurring in crucial winter ranges.

*We suggest the BLM contact Stan Anderson or Franz Inglefinger from the University of Wyoming Cooperative Wildlife Research Unit regarding recently conducted research entitled "Songbird Response to Natural Gas Development in the Pinedale Anticline Project Area, Wyoming". This study may be of direct value in the discussions of the issues put forth by the additional alternatives.*

The EA/DR provides mitigation to protect species. Songbirds are migratory species and are protected under the Migratory Bird Act. Such species are given further consideration at the APD stage when site-specific field reviews are conducted.

*We have previously commented on this project. The only addition we have is the speckled dace has recently been found in the Vermillion drainage. This species is listed by the Department as native species status 5.*

The speckled dace is a native species status 5. Under Wyoming Game and Fish Department's Habitat Protection guidelines, status 5 species are common, widely distributed throughout its native range and population's status is stable.

### *Wyoming Business Council*

*These comments regarding the Vermillion Basin Natural Gas Exploration Development Project scoping statement for additional alternatives have been approved by the Director of the Wyoming Business Council's Minerals, Energy and Transportation Division and are specific to this agency's statutory mission within state government which is to be directly involved in state and federal policy work to assure reasonable access to public lands. In that regard these comments are meant to, in association with all other agency comments, assist in defining the Official State Position. These comments defer to and are subordinate to the Official State*

*Position.*

*In regards to directional drilling, industry tells us it is often unreliable and cost prohibitive. Success is often dependent on underground geologic formations and the position of target reservoirs in relation to such geologic restrictions. Without full and complete knowledge of the underground geology, the possible difficulties posed by this geology in relation to potential reservoirs and the economic considerations of directional drilling versus vertical drilling, any attempt to drill directionally would constitute poor business practice. If the BLM mandated such drilling without knowledge of subsurface geology, BLM would inflict additional costs and time restraints on industry, to perform an action proven to be uneconomic.*

Economic concerns of a directional drilling only program have been addressed.

*In addition, we request the BLM produce a comparison of the findings in the Environmental Assessment for the Vermillion Basin Natural Gas Exploration and Development Project, August 2000 and the alternatives that were dropped from further analysis showing the differences in revenue that would be available to the state, counties, cities and towns. A table, or graph, showing the programs Wyoming funds with these revenues would also be beneficial.*

The EA provides a discussion of the economic condition and effects of drilling up to 56 wells. The State of Wyoming would need to provide a break down of what programs are funded by royalties paid on production from public lands managed by BLM in the Vermillion Basin area.

*When discussing the proposed project-wide well densities, BLM needs to make clear their intentions. If the intention is to set the well spacing by allowing a particular number of wells to be drilled, then the BLM may be unintentionally undermining the authority of the Wyoming Oil and Gas Conservation Commission (WOGCC). The WOGCC has full authority to set well spacing. We suggest BLM consult the WOGCC to discover if this alternative may be in conflict with the WOGCC.*

BLM is complying with IBLA's order to supplement the record as to why a different well density alternative was eliminated from detailed study.

*Varying the number of wells in a staged development, if that is the intention of the BLM, is going to cause undue economic hardship to the operators who have already purchased the lease. By varying the wells, BLM will strain the ability of the operator to find drilling equipment in a timely manor, thus causing delays and incurring increasing costs. This could, in turn, slow the employment and affect the local economy due to unpredictable work schedules.*

The Proposed Action reflected a drilling program of up to 56 wells. BLM is complying with IBLA's order to further document the record why an alternative addressing a varying number of wells was eliminated from detailed study.

***Petroleum Association of Wyoming***

*The Petroleum Association of Wyoming (PAW) would like to thank BLM for the opportunity to comment on the referenced document. PAW is Wyoming's largest and oldest oil and gas trade association, the members of which account for over ninety percent of the natural gas and over seventy percent of the crude oil produced in*

*the State.*

*PAW has the following comments regarding BLM's request for information.*

*Project-wide well densities: The Wyoming Oil and Gas Conservation Commission (WOGCC) regulates well densities, which provides for 160-acre well densities for gas wells in this area. Each formation and each reservoir within each formation may vary due to porosity, permeability, thickness, fracturing, etc. Therefore, WOGCC has determined that 160-acre density will efficiently drain the mineral resource and prevent waste in this area. BLM, as well as the WOGCC, are charged with allowing for efficient recovery of the oil and gas resource without waste.*

BLM is complying with IBLA's order to further document why a different well density alternative was eliminated from detailed analysis.

*Directional drilling: The application of directional drilling is geologically and mechanically limited. In most cases of multiple gas zones, the hole must be vertical when it penetrates the zones. When more than one hole per pad is drilled, the tanks necessary to handle the volume of production must be adjusted and therefore may be larger or there may need to be more tanks on one location to satisfy the multiple wells from one pad. The dehydrator and separator size will also increase. Multiple wells per pad do not translate into a direct reduction in surface disturbance.*

*The potential loss of natural gas for the nation's energy needs is higher with directional drilling due to the rising cost impact on the reserves potentially left in the ground. As the costs accelerate, the exploration and drilling budgets get stretched. Fewer wells are drilled, less seismic work is done, and much less gas is found and produced. In some cases, the gas may not be recovered because the cost of drilling directional wells will render the project un-economic, which will in-turn render the lease un-economic. At that point, the reserves are left in the ground in violation of the mandate for BLM to recover those resources.*

See responses to the letter from Biodiversity Associates.

***Wexpro/Questar Exploration and Production Company***

*Wexpro Company and its affiliate, Questar Exploration and Production Company, (collectively referred to as "Wexpro") submit the following comments in response to the Bureau of Land Management's (BLM's) letter dated January 11,2002 regarding its intent to supplement the record it relied on in approving the above proposed project (the Vermillion Basin Project). In December, 2001, the Interior Board of Land Appeals (IBLA) set aside the BLM's Decision Record and Finding of No Significant Impact for the Vermillion Basin Project to the extent that "the record fails to explain the facts and analysis supporting rejection of the project-wide well densities and varying number of wells, and fails to provide a rational basis for failing to analyze fully the alternative of directional drilling. Wexpro supports the BLM's decision in rejecting all three of these alternatives, and provides the following additional support for finding that these alternatives, specifically directional drilling, are not reasonable alternatives.*

***Directional Drilling Alternative** -The Vermillion Basin area to date has been predominantly developed in the productive formations above 8,000 ft, with the primary objectives being in the Canyon Creek and Trail member of the Mesaverde Group that range in depth throughout the Vermillion Basin but run generally from*

*5,500 ft. to 7,600 ft. Reservoir analysis has indicated that the effective drainage for the Canyon Creek zone (from 5,500 ft. to 6,500 ft.) is 160 acres (1500 ft. radius) and for the Trail zone (from 6,500 ft. to 7,500 ft. is 80 acres (1,050 ft. radius).*

*Due to the lack of reserves and low flow rates from a single zone, the completions in the Vermillion Basin have primarily consisted of stimulating four to six zones, the production from which are commingled to provide a cumulative flow rate and reserve to render the well commercial. However, most of the productive zones are less than 20 ft. thick and cannot be linked together by a horizontal wellbore.1 Therefore, the zones targeted for completion must be stacked vertically or in the straight part of the hole. Having the zones stacked as close as possible one on top of the other in a vertical wellbore also maximizes recovery (stimulation is far more effective in a vertical wellbore than an inclined hole), promotes efficient drainage, and reduces waste. As a result, the only way that directional drilling can be successful in this area and result in a commercial well, is to drill the wellbore in an "S" shape orientation in order for the wellbore to be vertical through the Canyon Creek and Trail zones from 5,500 ft. to 7,500 ft. However, due to the limitations of bending drill pipe around two comers at this depth, the extent of the horizontal displacement, or step out, would be limited to 1,500 ft.*

*While directional drilling in the Vermillion Basin may have some application where surface topography, water sheds, etc. preclude pad construction for a vertical well, directional drilling in the Vermillion Basin is generally avoided for many reasons. First, for the reasons discussed above, directional wells are not particularly well suited for producing gas in the Vermillion Basin. A vertical well is a more efficient, cost-effective method for penetrating the various zones at the depths desired.*

*Next, directional wells in general, particularly those of the "S" orientation, are difficult to drill. They are more susceptible to problems such as stuck pipe, hole instability, fishing jobs and logging problems. They typically take longer to drill, and will result in more wear and tear on the drill string. Wexpro's recent experience with directional drilling in the Vermillion Basin is no exception. Wexpro found it necessary to drill a directional well in the last half of 200 1. It encountered problems, such as stuck drill pipe and production casing, which were more difficult to deal with and more time consuming to resolve than had the well been drilled vertically.*

*In addition, in existing fields, such as those in the Vermillion Basin that have been producing for many years, there are special problems posed by varying formation pressures. These problems are difficult for even conventional vertical wells and can be more problematic for a direction ally drilled well, causing excessively high cost and high risk of total mechanical failure of the well bore.*

*Finally, as could be expected, the cost to drill a directional well is also higher (at times substantially more so) than a vertical well. Depending on the price of gas, such increased cost may effectively preclude the drilling of a commercial well. For example, the costs to drill the recent directional well in the Vermillion Basin, as referenced above, exceeded the costs to drill a nearby vertical well drilled about the same time by approximately $400,000.00. Wexpro estimates that based on the costs and recoverable reserves associated with these two wells, a directional well in the Vermillion Basin would not be economic if the initial production rate of the well were at or less than 750 mcfd and gas prices were less than $2.00 per mcf, while a vertically drilled well would be.*

*Obviously, the main environmental benefit to be gained by directional drilling is that it allows multiple wells to be drilled from one well pad, thus reducing surface disturbance. However, given the limitation of the*

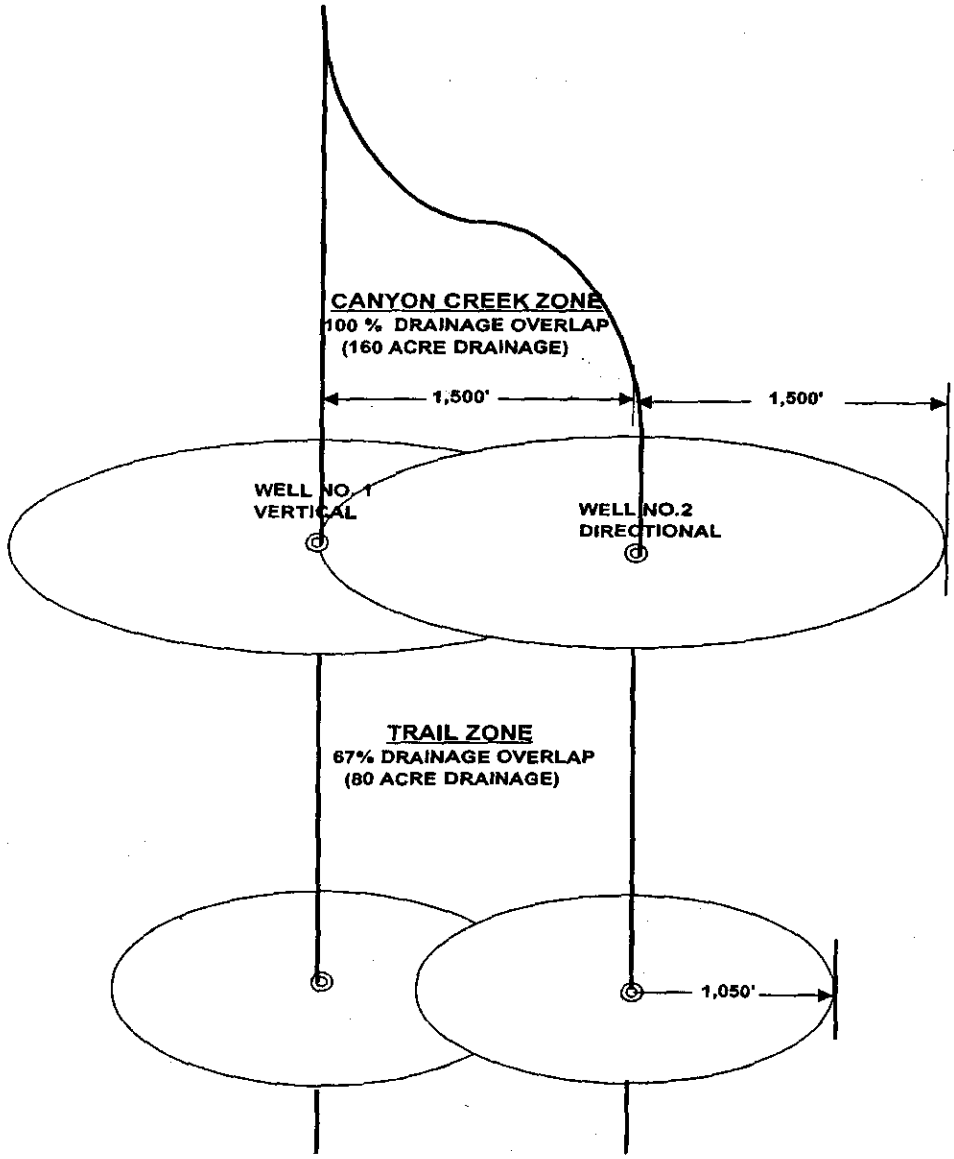
*horizontal displacement for directional drilling in the Vermillion Basin to 1,500 ft. (see discussion above), directional pad drilling in many cases would not be feasible. As mentioned above, reservoir analysis has determined the Canyon Creek zone has an effective drainage area of 160 acres, or a radial extent of nearly 1,500 ft., and the Trail zone will drain 80 acres, or 1,050 ft. Assuming that the first well drilled is vertical, or if drilling from a pre-existing vertical well location, and given that any subsequent directional well could only be drilled with a displacement of 1,500 ft., there would result a 100% drainage overlap in the Canyon Creek zones and a 67% overlap in the Trail zones (see Figure). Therefore, this would result in a reserve reduction per well of 50% in the Canyon Creek Zones and 33% reduction in the Trail Zones resulting in the wells being uneconomic. Even if the initial well has not been drilled vertically, to efficiently drain the Vermillion Basin, pad drilling would be limited to no more than two directional wells.*

*As a result of the foregoing, directional drilling, and especially pad directional drilling is not a reasonable alternative to drilling the additional developmental and few exploratory wells in the Vermillion Basin. The requirement that any future wells be directionally drilled may effectively preclude the drilling of many of the wells and reduce the amount of reserves that could be recovered, thus also reducing the amount of revenues paid to the federal government. Therefore, the BLM correctly concluded that it need not evaluate that alternative.*

***Well Spacing Already Established for the Area** - State wide spacing orders already specified by the Wyoming Oil and Gas Conservation Commission, and as applied to existing fields in the area, would continue to apply to the additional developmental and exploratory wells drilled under the proposed project until such time as it was determined that a different spacing would be appropriate. The Environmental Assessment, relied on by the BLM, provided that the proposed action would include the drilling of wells at densities of one to 16 wells per section (640- to 40-acre spacing). It concluded that "[a]s areas of the VBP A are developed and more is learned about the natural gas resources in the field, Wyoming Oil and Gas Conservation Commission (WOGCC)-specified spacing orders for the area could change." (page 13). Therefore, the BLM correctly analyzed the impact of production at the current spacing as established. Considering any other spacing at this time would not have been appropriate.*

***BLM Correctly Analyzed Maximum Number of Proposed Wells is not Reasonable** - The proposed project and the number of wells proposed represents the maximum development for the project, and assumes that exploration would validate the drilling of this number of wells. As stated in the Environmental Assessment, "approximately 50% of the proposed wells [total of 56] would be drilled during a 5-year period as production wells within the known producing areas, with the balance of the project being dependent upon the success of the exploratory wells." (p. 16). Therefore, depending on the results of the initial wells, (as well as other factors such as changing economic conditions, mineral lease ownership, and perception of geologic risk), the actual number of the wells could decrease. It is too early to know or consider reducing the number of wells*

# VERMILLION BASIN DRAINAGE AREAS
## CANYON CREEK AND TRAIL ZONES



*specified. The BLM thus appropriately evaluated the project using the maximum number of wells proposed. As a result of the foregoing, Wexpro asserts that the BLM appropriately rejected all of the above alternatives and supports the BLM's decision to supplement the record giving additional explanation and/or analysis regarding its decision. If you have any questions, please contact me at the above number. Wexpro is willing to work with the BLM in any way possible so that this issue may be resolved as expeditiously as possible so that this valuable resource can be further developed and explored.*

Your comments have been reviewed by BLM's Reservoir Management Group concurs with the conclusions reached. In addition, an independent consultant has reached the same conclusion.

***Ken Meade***

*Please accept my comment on the Vermillion Basin, Kinney Rim area. Believe the area should be protected form full-scale development. This is a special wildlife area and I have hunted mule deer on and off in the area for over 20 years. My wife and I go there on vacation (yearly) just to get away and enjoy the beauty and quite of the area. I have seen steady development in the area over the years, wells, roads, pipelines. I urge BLM to protect wildlife and scenic beauty of this basin, and protect it for future generations.*

BLM sought public comment on the three alternatives to comply with IBLA's Order. Kinney Rim is outside the project area.

***People for the USA***

*The Record of Decision concerning the gas-drilling program has been appealed and is now being reviewed with the additional consideration of directional drilling or pad drilling. The Casper Star Tribune published an article in the Sunday January 20, 2002 issue outlining the comments by the "conservation groups" and the basis for their appeal of the Record of Decision to allow the drilling activity.*

*The area has been under hydrocarbon exploration and production since 1954 with 154 wells drilled and 72 of these wells subsequently plugged and abandoned. The drilling is an attempt to add to the natural gas reserves of the area.*

Natural gas production has occurred since mid-1940s.

*The situation in the United States concerning the availability of natural gas is still critical contrary to the opinion stated by Mr. Levendosky in the same issue of the paper. The slowdown in the economy of the United States and abnormally cool summer coupled with a warmer than normal fall decreased the demand of natural gas. The product cannot be imported as easily as oil except from Canada or Mexico with out adding considerable cost to the consuming public. The baseline is simply the United States needs to develop its resources of natural gas in an economically viable manner and yet protect the other resources in the area.*

*Directional drilling is shown to be a cure for access and surface disturbance reduction, however it is not the answer for all situations.*

> *Directional drilling is expensive and can be 50% to 100% more costly (or even more) than straight hole drilling. These costs are added to the consuming public.*

*Directional drilling is a higher risk both mechanically and geologically. Drilling personnel are very good, but the risk increases with the complexity of the operation and tools needed to accomplish the job.*

*Directional drilling can also be higher risk to the environment due to the complications of directional holes in over pressured situations and the possibility of using oil based drilling fluids.*

*Directional drilling will use a larger footprint due to additional equipment required to drill the wells and additional time required to drill the wells.*

*Pad drilling will require more time on the individual wells and increased time to develop the project. Production of the gas usually requires minimal human presence and has very limited impact on wildlife. The reduced time to drill straight holes would decrease the impact on the wildlife.*

*In those rare instances where access is not possible due to topographic, archeological or palentologjcal reasons directional drilling can and should be used, however the requirement should be kept to a minimum.*

*Using directional drilling requirements to not develop the hydrocarbon resources is in fact making the area into a defacto wilderness. These areas have not been made into wilderness areas or wilderness study areas and are multiple use areas. The claim of directionally drilling wells 5 miles is not economically viable for this area or currently mechanically possible. The limited impact on an area currently developed for hydrocarbon production is necessary to efficiently recover the resource. The limited impact is verified by the claims of "protecting" an area that already has seen hydrocarbon resource development! We support the Record of Decision to allow development of the resource.*

See Appendix A. See Appendix B and Appendix D for response to Biodiversity Associates' letter that provides the evaluation of the technical and economic concerns related to directional drilling.

## Appendix D

## Report Prepared by Reservoir Management Services

**RESERVOIR MANAGEMENT SERVICES, INC.**
Integrated Consulting Services for the Petroleum Industry

May 10, 2002

Ms. Teri Deakins, Project Manager
Bureau of Land Management
280 Highway 191 North
Rock Springs, WY. 82901- 3447

Re: Vermillion Basin Natural Gas Project - IBLA Decision 2001-166
Discussion of Biodiversity Associates' letter dated February 8, 2002 and Analysis of the Alternative of Directional Drilling

Dear Ms. Deakins:

Wexpro Company retained Reservoir Management Services, Inc. to comment on Biodiversity Associates' letter to the BLM dated February 8, 2002 and to analyze the alternative of directional drilling for the Vermillion Basin Natural Gas Project (VBPA).

In the following discussion, the direct quotes from Biodiversity Associates' letter to the BLM dated February 8, 2002 are shown in italics and numbered. It appears that Biodiversity took quotes from technical references out of context, misinterpreted the data, and omitted major conclusions presented by some of the authors. Each numbered quote is discussed in detail based primarily on the references cited in their letter and recent production data from the public record. The objective is to show how the technical literature relating to directional drilling applies to the VBPA.

Finally, well architecture alternatives are analyzed and compared based on relative cost and reserve factors.

The final conclusion is that vertical wells are currently the only reasonable alternative for development of the VBPA.

## Discussion of Biodiversity Associates' Letter Dated February 8, 2002

When reading the following critique of Biodiversity's letter, it would be helpful to keep in mind the general characteristics of the gas reservoirs in VBPA. The primary target of exploratory and development drilling is 22 potentially productive, low permeability gas pay zones of the

Mesaverde Group. These zones average 30 ft in thickness and are distributed over 2300 ft of gross interval starting at about 5500 ft from surface. If potential targets in the Wasatch, Fort Union, Frontier and Nugget are included, the interval is significantly larger. Previous completions in the Vermillion Basin consist of commingling of four to six hydraulically fractured zones in a vertical wellbore. Single pay zones are generally not commercial.

1. Biodiversity states (February 8, 2002, p.3):

*The need to employ directional drilling technologies to reduce environmental impacts of mineral development is a high priority of the Bush administration. The President's National Energy Policy contains a section titled, "21st Century Technology: The Key to Environmental Protection and New Energy Production," which states:*

> *"Producing oil and gas from geologically challenging areas whiled protecting the environment is important to Americans and to the future of our nation's energy security. New technology and management techniques will allow for sophisticated energy production as well as enhanced envimmental (sic) protection...Smaller, lighter drilling rigs coupled with advances in directional and extended-reach drilling significantly increase protection of the environment...Modular drilling rigs, "slimhole" drilling, directional drilling, and other advances enable: [...]*
>
> - *Production of oil and gas with increased potection (sic) to wetlands and other sensitive environments;*
>
> *Other examples of advanced technology include: [...]*
>
> - *Highly sophisticated directional drilling that enables wells to be drilled long horizontal distances from the drilling site [.]"*

The focus of the National Energy Policy - 2001 relating to oil and gas exploration and development is primarily directed at Alaska and OCS (Outer Continental Shelf) areas.

In "Chapter Five – Energy for a New Century: Increasing Domestic Energy Supplies", the only recommendation relating to lower 48 oil and gas exploration and development stated:

> "The NEPD Group recommends that the President direct the Secretary of the Interior to examine land status and lease stipulation impediments to federal oil and gas leasing, and review and modify those where opportunities exist (consistent with the law, good environmental practice, and balanced use of other resources).
>
> - Expedite the ongoing Energy Policy and Conservation Act study of impediments to federal oil and gas exploration and development.
> - Review public lands withdrawals and lease stipulations, with full public consultation, especially with the people of the region, to consider modifications where appropriate."

The NEP suggests that there must be a balance of the various land use interests in order to provide adequate supplies of energy at reasonable prices. The NEP also stated:

> "The most significant long-term challenge relating to natural gas is whether adequate supplies can be provided to meet sharply projected increased demand at reasonable prices." (p. 1-8).

The Vermillion Basin Natural Gas Exploration and Development Project application contains 22 pages of Operator-Committed Measures and Additional BLM-Required Mitigation designed to protect the environment in the proposed project area.

*2. Directional Drilling is Technically Feasible for the Vermillion Basin Project*

*The reduced environmental impacts of directional drilling are well-documented. Cluster drilling from a single well pad (French Oil and Gas Association 1990) can reduce the footprint of oil and gas development on the landscape by concentrating the activity and impact of many wells at a few widely dispersed sites.*

French Oil and Gas Association 1990 is primarily a manual for design of deviated offshore wells. It is stated on page 7 of the reference that:

"Although well bores are generally vertical in exploration, local difficulties may require the planning of directional wells. By contrast, the general rule governing development wells drilled from offshore platforms is to drill deflected holes"

Cluster drilling from a single pad is not new technology. Development drilling from pads on the North Slope of Alaska, drilling from platforms offshore, and development of oil fields under cities in the Los Angeles Basin are examples of this technology that has developed over the past 50 years. In these examples there are clear economic reasons for clustering development wells.

It is important to note that exploration wells are generally vertical in both onshore and offshore areas. In order to plan deviated wells that may be required for development, information from vertical exploratory wells and/or 3D seismic is generally required.

*3. Because fewer directional wells are required to drain a subsurface reservoir, well spacing is always greater for directional wells (Fritz et al. 1991).*

This statement is true for horizontal wells in a single pay zone but not for high-angle wells (45° to 60° deviation) or s-shaped deviated wells (vertical through the reservoir). Fritz, p. 36 also states

"...a general definition of an HD-type[horizontal drilling-type] reservoir is one in which horizontal drilling can improve production significantly and economically over a vertical well".

The number and cost of each type of well required to efficiently drain a reservoir certainly enters into the economic calculation.

*4. Indeed, Joshi (1991, p. 4) stated that "to achieve larger producible reserves, horizontal wells will have to be drilled with a larger well spacing than vertical wells."*

This direct quote does not exist on p.4 of Joshi's book. The well spacing issue is much more complex than stated by Biodiversity. Joshi (p. 4) points out that:

"The major disadvantage is that only one pay zone can be drained per horizontal well."

For a single pay zone, Joshi states( p.56):

".... in a low permeability reservoir, horizontal wells can be used to enhance drainage volume per well in a given period of time."

Given sufficient time, vertical and horizontal wells may recover the same reserves from a single pay zone but horizontal wells generally accelerate the production in time.

Joshi's book deals almost exclusively with comparison of vertical, slanted, and horizontal wells drilled in single pay zone reservoirs, a situation quite different to the proposed VBPA where the objective reservoirs are multiple pay zones distributed over 2300 vertical feet. The reservoirs at VBPA must be hydraulically fractured and commingled in a vertical well completion to efficiently recover the gas reserves.

For the VBPA reservoirs, the claim that deviated wells will recover the gas reserves more efficiently than vertical wells is simply untrue.

> *5. Horizontal drilling can now reach subsurface reservoirs up to 29,000 feet away from the drilling site in horizontal distance (Al-Blehed et al. 2000).*

Drilling of long horizontal well sections is well documented in the literature. This paper is irrelevant to the VBPA discussion because it describes horizontal well applications, mainly to reduce coning in prolific oil producing Saudi Arabian sandstone and carbonate reservoirs.

> *6. Thus, by requiring cluster development (used in conjunction with horizontal or deviated directional-drilling technology), the BLM can minimize environmental damage and habitat degradation that is inherent to oilfield development.*

The Operator-committed mitigation measures and additional BLM-required mitigation measures proposed as part of the October 2000 Vermillion Basin Natural Gas Exploration and Development project were designed to minimize impacts to the environment and at the same time economically recover the maximum possible gas reserves. This objective is best accomplished in VBPA by the use of hydraulically fractured vertical wells with multiple commingled pay zones.

> *7. Not only is directional drilling more environmentally responsible, it is also more effective at removing oil and gas from geologic formations than conventional vertical wells. Thakur (1999) reported that because horizontal drilling is a more efficient extraction method, it can increase the recoverable reserves for a given reservoir.*

In some cases, horizontal drilling can increase recoverable reserves. Thakur (1999) states that:

"The use of horizontal wells in water and gas coning situations have proved to be extremely profitable for Chevron."

Thakur reported that of 44 horizontal wells drilled in coning situations 95% have been successful. However, for fractured reservoirs the success rate has been 29% and for low permeability reservoirs 60%. Thakur also summarizes the results of 80 horizontal wells drilled by Elf Aquitaine between 1987 and 1999. This operator reports good success for most wells

except for those drilled in thermal recovery and low permeability reservoirs. For the Elf Aquitaine wells, the average cost ratio of horizontal to vertical wells for the 80 wells was 1.5.

For the type of reservoirs present at VBPA, Thakur reports success rates of less than 60%.

> *8. Fritz et al. (1991) reported that directional drilling has had a higher percent success than vertical drilling in both the Austin Chalk and Williston Basin fields.*

Fritz reports that the percent success for the Bakken Formation, a fractured shale source rock in the Williston Basin, is 94% for vertical wells and 97% for horizontal. For the Austin Chalk, a fractured, faulted, compartmentalized oil reservoir, the percent success is 85% for vertical wells and 98% for horizontal wells. In fact, Swindell (1996) stated that:

"Poor overall economics have slowed the use of horizontal drilling in the Bakken Shale of North Dakota."

The conclusions derived from this information have no bearing on the development of gas reservoirs at VBPA. The discussion below will document that the percent success for horizontal wells drilled in low permeability gas reservoirs near VBPA is 20% to 25%.

> *9. Joshi (1991) asserted that for the natural gas production, horizontal wells improve drainage area per well for low-permeability geologic formations, reduced near-wellbore turbulence and increased delivery efficiency for high-permeability formations.*

Joshi's statement has no relevance to the VBPA reservoirs, which are multiple, thin pay zones spread over a large interval and are not amenable to development by horizontal wells.

> *10. Horizontal drilling technology is so effective that it has become the benchmark for the industry: Miller and Steiger (1999) boasted that their array of vertical and directional wells had production that equaled high benchmark projections from horizontal drilling.*

This reference is not documented in the Literature Cited in Biodiversity's letter.

> *11. Furthermore, directional drilling reduces "coning," the mixture of oil with gas and water that reduces production efficiency for oil and gas (Joshi 1991, Thakur 1999).*

As there are no coning issues associated with the VBPA reservoirs this statement is not relevant to the current discussion.

> *12. Directional drilling is a universally practical solution to oil and gas recovery. It is suitable for both exploration and full-field development (French Oil and Gas Association 1990).*

There is no such statement or claim made in the cited reference. The reference simply lists different situations where directional drilling has been used to develop oil and gas fields.

> *13. Aguilera et al. (1991) lauded the potential of horizontal drilling in infill situations.*

Aguilera et al. (1991, p.2) stated:

"Horizontal wells can be considered as an alternative to infill drilling [vertical wells] and fracturing, with the objective in all cases to increase the economic recovery of oil and gas."

The VBPA contains thin multi-pay reservoirs not suitable for development by horizontal drilling.

> *14. In 1991, Fritz et al. (p. 36) noted that, "If the cost of drilling a horizontal well was equal to that of drilling a vertical well, most reservoirs would be candidates for horizontal drilling." These costs have in fact equalized in modern times.*

There is no substantiation for the claim that costs have equalized in modern times. In fact, Thakur presents modern data that show that the ratio of horizontal to vertical well costs is 1.4 to 1.5. Joshi p.5, Fig 1-3a, shows that even after 4 years of drilling horizontal wells at Prudhoe Bay and flattening of the learning curve, the ratio of H/V is still 1.5. Joshi's data also shows considerable scatter in the cost of the horizontals (some later-drilled horizontal wells cost 80% of the initial horizontal well cost), indicating that after 4 years of experience there is considerable risk in the drilling horizontal wells.

> *15. Aguilera et al. (1991, p. 1) stated that, "Theoretically, all reservoirs can benefit from horizontal wells."*

Aguilera et al. (1991, p. ix) also stated in the Preface:

"It must be stressed that horizontal wells are not suitable for all types of reservoirs."

> *16. Al-Blehed et al. (2000) asserted that horizontal drilling is superior to vertical drilling for a variety of conditions including for naturally fractured reservoirs, thin reservoirs, heterogeneous reservoirs, vertical permeability homogeneous reservoirs, reefs or isolated sand bodies, and faulted reservoirs. Horizontal drilling has proved to be superior technology in a variety of geological settings, and we know of no examples cases where vertical drilling offers superior results.*

Al-Blehed et al. (2000) discusses horizontal drilling in Saudi Arabia, which currently produces about 8.8 MMBO/D from 50 fields from a total of 1000 wells for an average per well rate of 8,800 BOPD. The 6 fields discussed in detail by Al-Blehed all had horizontal wells drilled to produce thin oil zones. The increased oil rates in all of these cases are related to reduced water coning and increased waterflood efficiency in high permeability oil reservoirs. The facts reported in this reference do not provide any support for horizontal drilling at VBPA.

> *17. The economic feasibility of directional drilling has been well demonstrated. Cluster development of many wells on a single pad offers minimizes (sic) the capital investments of lessees (French Oil and Gas Association 1990), and reduces costs for an expensive and ecologically damaging network of improved roadways.*

Directional drilling has been used for over 50 years in the petroleum industry. The economic feasibility has been demonstrated, especially in offshore applications. The fact that certain capital investments related to surface drilling and production operations can be reduced through cluster drilling does not automatically equate to an economic project that maximizes the recovery of oil and gas reserves.

*18. In 1991, Joshi (p. 7) noted that costs for directional wells were 1.4 to 3 times higher than costs for vertical wells, but further noted that "In some cases, with extensive drilling experiences, the horizontal well costs are reported to be almost the same or even lower than vertical well costs."*

The first part of this statement: "that costs for directional wells were 1.4 to 3 times higher than costs for vertical wells" is correct and is actually quoted directly from p.4 and supported by industry experience.

The quote relating to reported horizontal well costs being the same or even lower than vertical well costs is taken from Gust (1989). There is an error in the Joshi text. Gust actually shows on Fig. 2 of his paper that the ratio of horizontal versus directional well drilling, $/meter (cost per meter drilled) is less than one. Gust stated (p.51):

"Based on these observations, we expect that horizontal wells drilled in development programs will compete with directional wells at the same cost per meter, providing the casing and drilling fluids programs are similar. The total well cost will be higher than vertical or directional wells due to their increased measured depth; however, this cost should be offset by their increased amount of reservoir exposure".

Horizontal wells in the multi-zone VBPA actually have less reserve exposure than vertical wells.

*19. But because directional drilling requires fewer wells and yields more production per well, overall oilfield development costs may have been lower even with the older technology available in the early 1990s. Because each directional well drains a greater reservoir volume than a corresponding vertical well, fewer wells are required to drain a reservoir, reducing up-front project costs (Fritz et al. 1991). These researchers further compared the costs of older-technology directional drilling with vertical drilling, and found that oil production costs per barrel were lower for directional drilling in the Austin Chalk, but higher in the Williston Basin of North Dakota.*

This discussion relates to horizontal drilling in the Austin Chalk and Bakken formations, which are single zone, fractured reservoirs. The conclusions derived from this reference have no bearing on the VBPA.

*20. In modern times, the technology continues to improve and efficiencies rise. Al-Blehed et al. (2000) stated that their use of horizontal wells reduced drilling, flowline and facilities costs by 20 - 25% over vertical drilling.*

As discussed above, the findings in this reference have no relevance to VBPA.

*21. Directional drilling has proven to be a remarkably versatile as alternative (sic) to conventional vertical drilling in recovery. Directional drilling has been shown to increase rate of gas production and overall recoverable quantity for tight gas sands (e.g., Cassetta 1998).*

Cassetta's reference is an AAPG abstract that has been misinterpreted by Biodiversity. Cassetta attributes the increased rate of gas production and overall recoverable quantity from geopressured Upper to Middle Wilcox tight sands solely to 3D seismic results. Directional drilling was required in this field because the field is partially submerged below a surface water reservoir.

*22. O'Rourke et al. (1997) found horizontal drilling of paired wells to be effective in gas production using steam injection techniques.*

This reference refers to the SAGD (Steam Assisted Gravity Drainage) project in the oil sands of Fort McMurray. The SAGD process uses closely spaced horizontal wells to recover steam-heated bitumen from shallow unconsolidated sands by gravity drainage and is not relevant to gas production from the VBPA.

*23. For heavy oil recovery, Shirif (2000, p. 894) noted that, "For a given pattern, there is a horizontal well configuration [that] maximizes the total production rate." In all cases, directional drilling has resulted in superior economic yields when compared to conventional vertical drilling. Thus, directional drilling minimizes the environmental impacts associated with mineral development, is geologically and economically feasible, and produces equal frequently superior recovery of minerals compared to vertical drilling.*

This is another reference discussing thermal heavy oil projects in Alberta where well spacing can be on the order of 2 ½ acres per well. This information is not pertinent to the VBPA.

*24. Directional drilling is proven as an effective alternative to vertical drilling in Wyoming. The first directional well in Wyoming was completed in 1987, and as of 1994, 80 producing wells were completed out of 117 attempts (Stewart 1995). As of October 2001, Wyoming has 504 horizontal or directional wells on-line, according to State of Wyoming data. Stewart (1995) stated that "Recent developments in the gas play in the Green River Basin, particularly the Mulligan Draw, Echo Springs, and Stagecoach fields, indicate favorable exploitation by horizontal drilling" (at p. 283).*

A total of 8 horizontal wells have been drilled in Mulligan Draw, Echo Springs, and Stagecoach fields out of a total of 133 total wells drilled. Three of the horizontals are suspended with zero cumulative gas production. In Echo Springs and Mulligan Draw, the horizontal wells have produced less gas than the average well in the field. Only one horizontal well in Stagecoach field has produced more than the average well in the field (2 times the average). Given the horizontal/vertical cost ratio of 1.4 to 1.5 times, these results can hardly be classified as favorable for horizontal drilling.

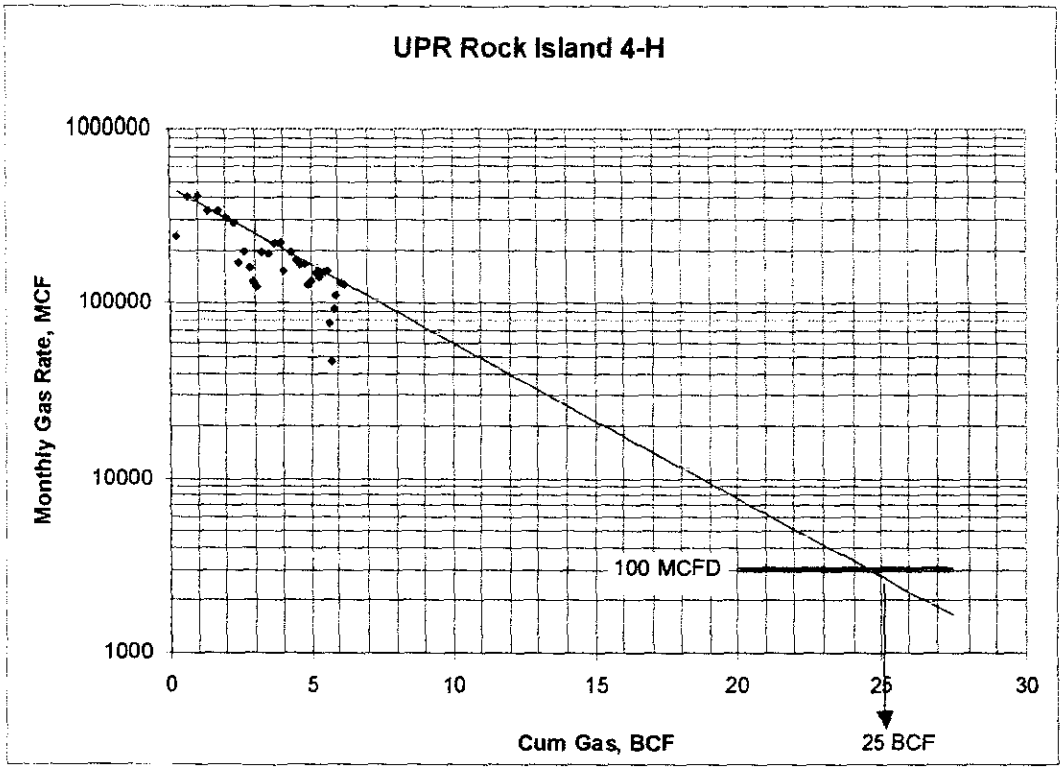
*25. The target geological strata for the Vermillion Basin project also have shown themselves conducive to directional drilling. The Frontier formation has substantial and well-developed fractures through which natural gas migrates (Lorenz 1995), properties which are more conducive to horizontal drilling, which intercepts more fractures than conventional vertical drilling (Mark Kirschbaum, USGS pers. comm.).*

There are numerous references in the literature documenting the presence of natural fractures in low permeability gas sands. For successful development of low permeability gas sands with horizontal wells, the first challenge is to locate areas of high fracture intensity, either by vertical drilling or by multi-component 3D seismic in order to optimally orient the horizontal well (Kuuskraa et al. 1999). The second challenge is to intersect open fractures filled with gas and not water.

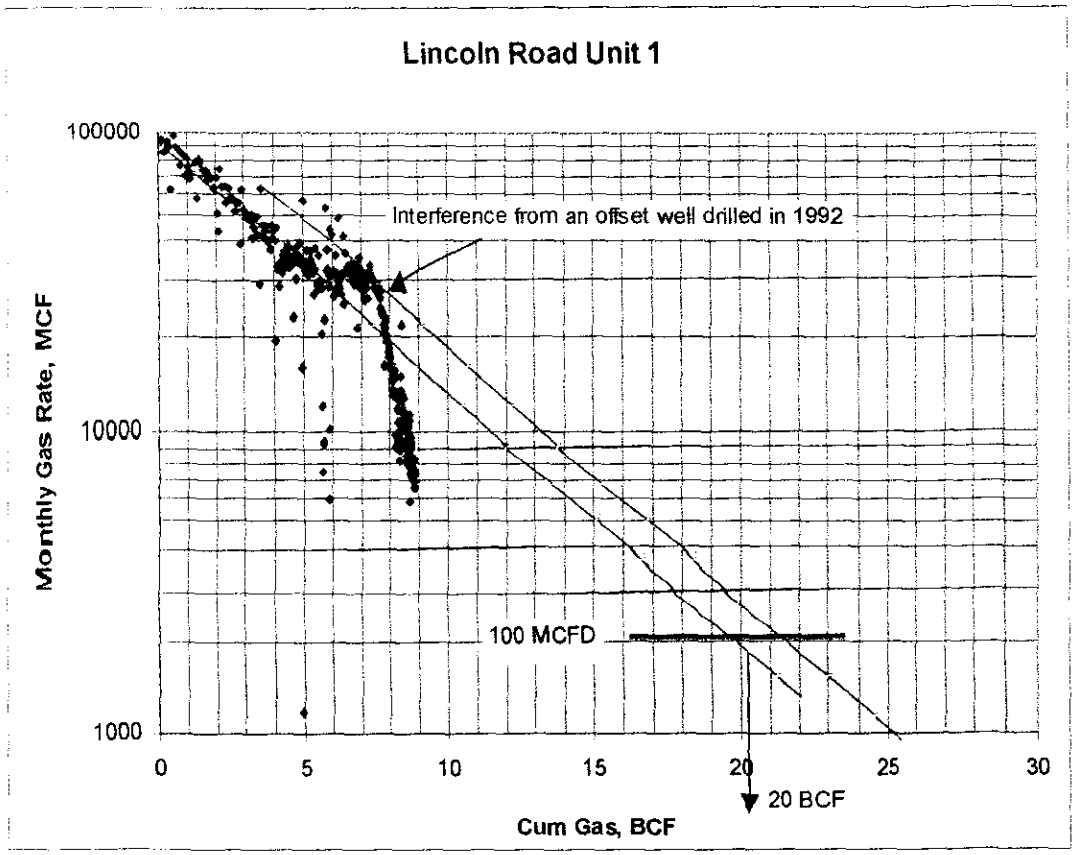
*26. According to Krystinik (2001), a horizontal well drilled in the Green River Basin's Frontier formation reached a depth greater than 15,000 feet in tight-gas sandstone, was*

*drilled at a cost that was reduced to 50% of the industry average, and achieved economic production of greater than14 mmcf/day.*

The well referred to by Krystinik is the UPR Rock Island 4-H, completed in the Frontier. It is certainly a successful horizontal well and is probably the best horizontal well drilled to date in a low permeability gas reservoir. As shown on the following plot, this well could produce 25 BCF of gas if it is not offset by other wells.




This is a basin-centered gas well in the overpressured Frontier producing below 15,000'; therefore, it is difficult to compare this well to the performance of other Frontier vertical wells. However, there are good vertical wells producing from shallower, normally pressured Frontier reservoirs. An example is the Lincoln Road Unit #1 located on the Moxa Arch about 80 miles northwest of the RI 4H:




The Lincoln Road Unit 1 produced from the Frontier several years with no decline at 1000 MCFD and would probably have ultimately produced 20 to 25 BCF if the offset well had not been drilled in 1992.

What Biodiversity failed to mention is that the four horizontal wells following the UPR Rock Island 4-H were failures:

1. The Sidewinder 1-H well encountered nearly 2000 open fractures and produced high volumes of water and no commercial gas.
2. The Sidewinder 2-H encountered lower than expected reservoir pressure and produced no water and small quantities of gas.
3. The Table Rock Unit 115-H encountered lower than expected reservoir pressures and has produced 179 MMSCF. The current rate is 160 MCFD.
4. The Sage Flat 7-H had no released production data at the time Krystinik published his results. The well was completed in April 2000 but has no reported production to date.

In this series of five horizontal wells, located within about a 10-mile radius of the center of T20N R97W (UPR Rock Island 4-H), the success rate is only 20%. Not very encouraging given the cost of these deep deviated wells.

*27. Dunn et al. (1995) used horizontal drilling in the Almond formation and found extensive fracturing here as well, though limited in areal extent. These researchers noted "horizontal well completions may provide an efficient method to access the enormous natural gas resource present in Mesaverde group of the Greater Green River Basin" (at p. 268).*

Fluid flow equations predict that the inherently high permeability of natural fractures will yield high initial gas flow rates. The extent of the natural fracture system will determine the long-term contribution that the fractures will make to production. Dunn (p.267) points out that:

"First, the areal extent of the fractures is unknown, and may be small. A few of the fractures terminate within the diameter of the whole core as they traverse it at an oblique angle, suggesting that those open fractures are of limited extent. Limited areal extent would reduce the open fracture contribution to production flow rate."

Iverson et al. (1995, p.279) also suggest that the numerous sandstone layers of the Almond are not connected by natural fractures and that hydraulic fracturing is required to connect all of the reservoir sands for production.

In discussing the results of a horizontal well in Sidewinder, Krystinik et al (2001) pointed out an additional risk of drilling horizontal wells:

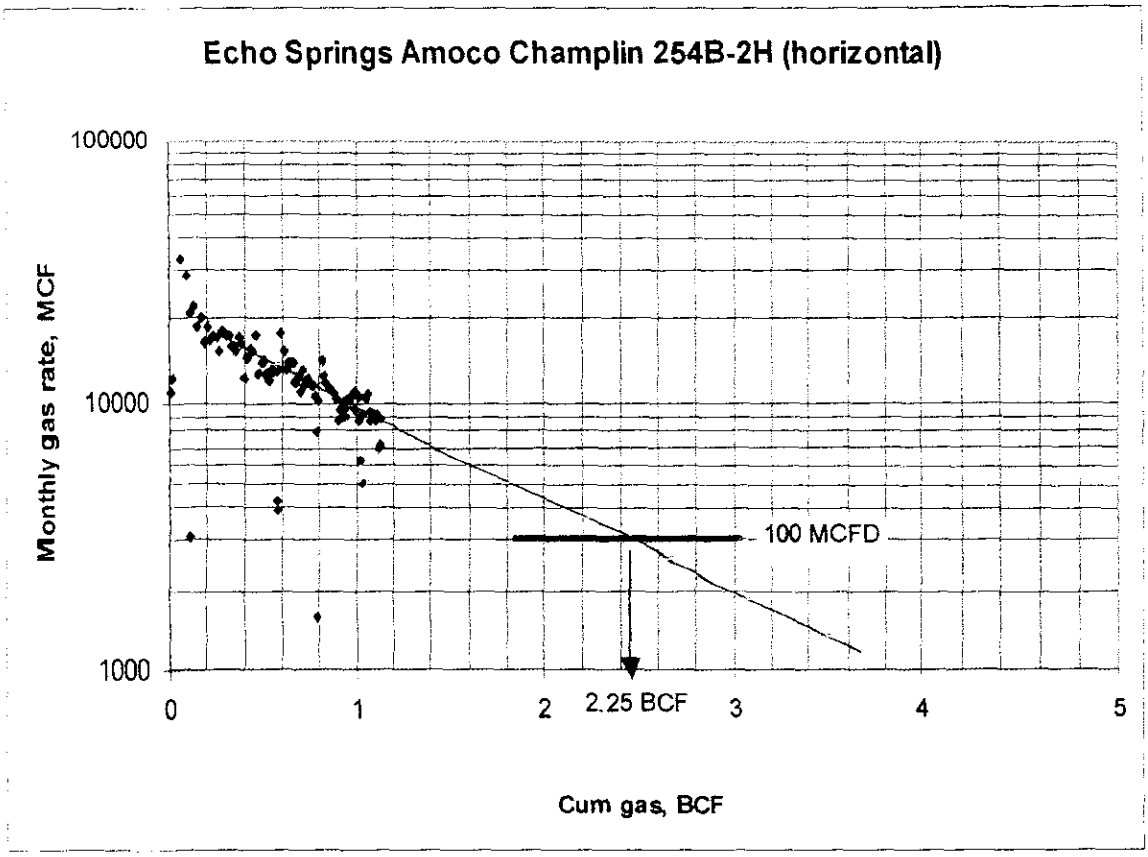
"The SW 1-H was drilled on the upthrown side of the fault, in an area predicted to be heavily fractured. This well encountered nearly 2000 open fractures and had very high flow rates of water, but had sub-economic rates of gas."

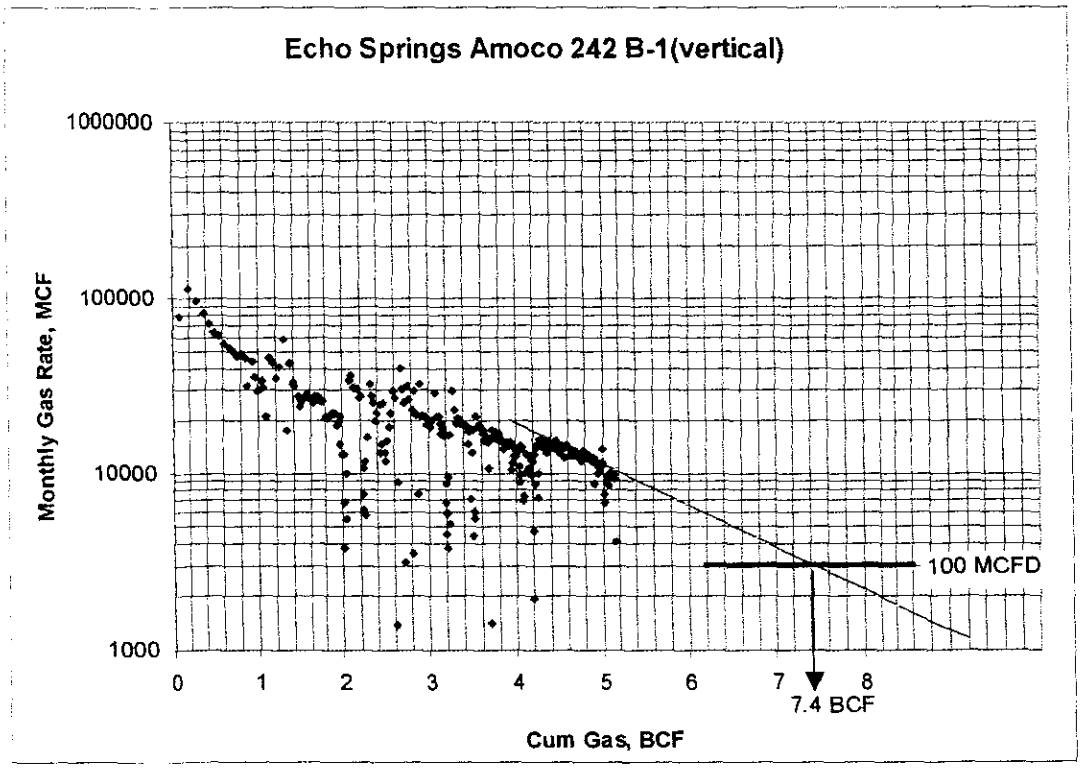
*28. Iverson et al. (1995) found that even without hydraulic fracturing, a horizontal well tapping into the Almond formation produced as much gas as a conventional well that used hydraulic fracturing.*

Iverson discussed two wells at Echo Springs: Amoco B-1 (vertical) and Amoco Champlin 245B-2H (horizontal) located about 2 two miles apart in T20N R93W. At the time of Iverson's publication, very little production data was available for the horizontal well. After 8 years of production it is now possible compare performance of the vertical and horizontal well. Iverson speculated in 1995, based on initial testing of the horizontal well that:

"Considering the additional cost of horizontal drilling, the economics likely favor vertical or slant hole completions. The horizontal well probably will recover gas more efficiently from a single Almond Formation sand bar. But without hydraulic fracturing, the sands beneath are not tapped, and the well cannot be a spectacular producer."

Inspection of the production histories of these two wells through December 2001 shows that Iverson's prediction was correct. As shown on the two plots following, the projected ultimate gas recovery, to a limiting rate of 100 MCFD, will be 7.5 BCF for the vertical well and 2.25 BCF for the horizontal well.




The projected recovery from the vertical well is over 3 times the projected recovery from the horizontal well. As suggested by Iverson, horizontal wells can efficiently recover gas from single

pay zones, but for draining numerous stacked sandstones hydraulically fractured vertical wellbores may be the best choice. Iverson goes on to say:

"Natural fractures certainly help to achieve high flow rates from any one sand, yet hydraulic fractures are needed in order to tie Almond Formation reservoir sand bodies together."

This analysis supports a conclusion exactly opposite to the conclusions reached by Biodiversity using the same data.

> *29. Proof that directional drilling is feasible for the Vermillion Basin region is the fact that a producing directional well has already been drilled and completed in the Kinney Unit of the project area. According to State of Wyoming records, a Wexpro well, API #3724085 at T13N R100W sec. 13 NE ¼, has been drilled directionally to a total depth of 15, 131 feet (at the maximum projected depth for the Vermillion Basin unit) and is currently producing gas from the Nugget formation. The fact that directional wells are **already** producing natural gas within the Vermillion Basin project area demonstrates beyond a shadow of a doubt that directional drilling is appropriate for the particular geological conditions found in this area.*

The Wexpro well, API #3724085 has produced about 1.33 BCF from the Nugget. The current rate is about 500 MCFD. This well will produce less than the volume of gas produced from the average vertical well in the Kinney Field. Given the 40% incremental cost of drilling a horizontal well at over 15000 ft, it cannot be concluded that *"directional drilling is appropriate for the particular conditions found in this area"*. In fact, this well was deemed a non-paying well for purposes of unit expansion by the BLM.

> *30. In its Decision Record for this project, BLM noted that "Directional drilling may be used if economically viable" DR, App A at A-13. Now that the technical and economic viability of directional drilling has been established, BLM should require its use to protect other resource values in the Vermillion Basin project area. Failure to require directional drilling would be to accord oil and gas development an absolute priority over all other resources in the project area –a result that would be unlawful under FLMPA's multiple-use, sustained yield mandate.*

The body of evidence presented by Biodiversity regarding horizontal drilling, as corrected by the discussion above, points to a conclusion exactly opposite of the one reached in their letter of February 8, 2002. The professionals employed by the BLM and Operators are all very familiar with the results discussed above and are responsible for preparing development plans that protect the environment, maximize the recovery of natural gas, and at the same time provide an economic return. They understand the issues relating to horizontal drilling in low permeability gas reservoirs. If the results and economics were as positive as portrayed by Biodiversity Associates, then a very high percentage of wells drilled today in Wyoming's low permeability gas reservoirs would be horizontal wells.

***31. Implementing Directional Drilling Requirements is an Appropriate Method to Protect Roadless Lands and Sensitive Species in the Vermillion Basin Project Area.***

*In its original Decision Record for this project, BLM noted that "the BLM does not believe it is necessary or appropriate to mandate the use of this procedure [directional drilling] for this project." DR, App. A at A-13. This statement reveals that the Rock Springs Field Office's past deference to the oil and gas industry, its misunderstanding of controlling law and policy, and its unwillingness to adopt reasonable mitigation measures which would protect the interests of the general public that owns lands managed by BLM. As a steward of public lands that belong to all Americans, BLM must exercise its discretion to condition development of public resources on respecting the greater public interest in maintaining viable wildlife populations, recreational opportunities, and open spaces for the enjoyment of generations present and future.*

*No evidence in the existing record lends support to the assertion that directional drilling would in fact be more expensive and no analysis has been performed to balance any actual increased costs with environmental and public health benefits, as well as direct savings resulting from the reduction in new roads, pipeline facilities, right-of-ways and other infrastructure associated with drilling more wells at maximum densities.*

*It is absolutely appropriate for increased production expenses to become part of the cost of doing business on public lands when these increased production costs translated to reduced harms to the public interests and the environment. Not only would it be appropriate from both a legal and ethical perspective for BLM to mandate directional drilling, but in order to reduce impacts to both developed and roadless areas within the proposed project boundary, we believe that BLM has the* ***responsibility*** *to mandate directional drilling in order to avoid impacts to roadless lands and sensitive species.*

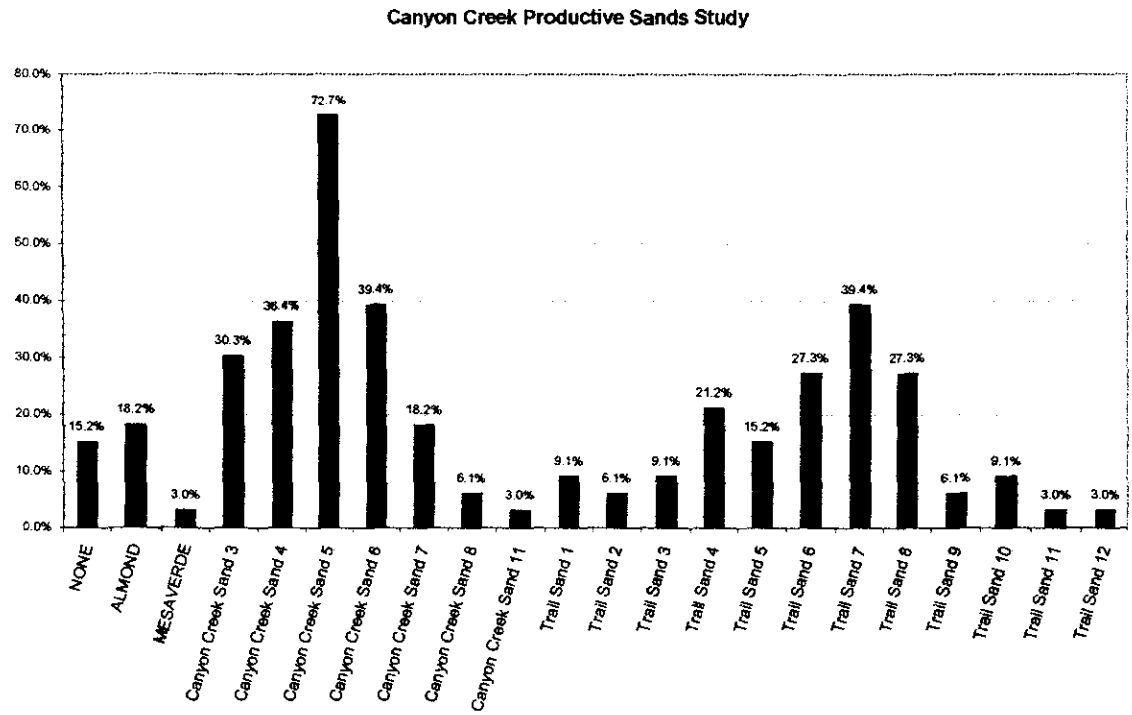
The facts indicate otherwise as will be summarized in the following discussion.

**Description of the Mesaverde Group in the Vermillion Basin**

The Mesaverde Group is a major productive interval and drilling target in the Vermillion Basin. This sedimentary sequence has a variety of names and subdivisions in various basins and often within the same basin in the western US. It literally has over 100 different local names. The Mesaverde Group in the VB includes the Almy Formation, un-named Mesaverde zones, Erickson sandstones, "Rusty" beds, Blair Formation and informally named and numbered field zones called Trail sands and Canyon Creek sands. It is a complex series of often difficult to correlate fluvial to marginal marine sandstones that in total include a gross interval of approximately 2300' (at Canyon Creek Field).

These sands have produced in Trail, Kinney, Hiawatha, and Canyon Creek fields in the vicinity of the VBPA with varying degrees of success. Because of the complexity and because of the great thickness of the stratigraphic section involved, a true "type log" adequate to convey that complexity (just for the Mesaverde section without considering the Wasatch, Fort Union or Nugget formations) would be difficult to construct. For more details on stratigraphy and depositional environments see GRI publication "Atlas of Major Rocky Mountain Gas Reservoirs" (1993) page 43.

Several operators are involved in the development of existing productive fields in the area and in the exploration for new production adjacent to existing production. Much of the existing production is from old wells with limited modern logs. An operator study completed last year on Canyon Creek field illustrates the complexity of the Mesaverde sandstones. The chart below shows for Canyon Creek Field the percentage of wells in the field completed in the 22 named sand zones. Note that there are some sand zones that are not currently named but which may prove to be productive. Also note that all potentially producible named sand zones are not completed in every well. Thus, the need for many recompletions and infill wells.




The net sand thickness for the 22 named sands in the VBPA ranges from 10 to 80 ft with an average of about 30 ft. The porosity ranges from 9% to 17%. The permeability ranges from less than 1 md to over 20 md.

Sands in the Mesaverde exhibit normal hydrostatic pressure unless production has occurred to reduce it. Individual sand units behave as distinct reservoirs. Because of the selective completions done in the past, there are multiple stacked reservoirs remaining with some having normal pressures and some being partially depleted within active field areas. This situation complicates new infill drilling operations.

These details for the Mesaverde Group provide a good analogy for the type of geologic situation found in the Wasatch and Fort Union although they are less complex and have fewer individual sands. The geology situation is similar for these other formations in that they are relatively thick gross intervals with multiple stacked sand reservoirs.

**Preferred VBPA Well Architecture**

The large number of thin sands distributed over a long interval impacts the selection of the well configuration. The possible well configurations for VBPA are show on:

**Exhibit 1: Vermillion Basin Well Options**

Four well types are shown on this diagram: vertical well, s-shaped deviated well, high angle inclined well, and horizontal well.

The vertical well intersects all zones directly under the surface location. Several zones are perforated, hydraulically fractured, and produced in a single wellbore (commingled). Drilling and completion operations are based on well-established, low risk technology. Recovery of reserves is optimized by selecting zones suitable for completion based on minimum levels of reservoir properties and sufficient levels of pressure (no depletion from offset wells). If the initial completion becomes depleted then the vertical well can be recompleted in other behind pipe zones, thus increasing reserve recovery and extending the life of the well.

The horizontal well can be drilled from vertical or high angle inclined wellbores. The horizontal section is kicked off close to the depth of the target zone and can easily reach lengths of 1500' to 3000' from the kick off point. The main problem with this well architecture at VBPA is that it can produce from only one of the 22 potential target zones. If the target zone is missing, pressure-depleted or has poor reservoir characteristics, then the horizontal well is a failure. If the horizontal well finds a good zone, then the reserve recovery from that zone will be potentially higher than recovery from a vertical wellbore in the same zone; however, the horizontal well has no access to the other 21 potential producing zones. Furthermore, unlike the vertical well, the horizontal well does not provide any information about the remaining 21 zones for geologic interpretation. Finally, drilling experience in the area indicates that the expected success rate for horizontal wells in low permeability gas reservoirs is about 20% to 25%.

The high angle inclined well is drilled at 30° to 60° from vertical starting at a 1500 ft kickoff point. This well intersects the reservoir zones at increasing distances from the surface location of the well; therefore, targeting of zones becomes more difficult than with vertical wells. There is increased cost associated with drilling time required for the longer, deviated well in addition to increased mechanical risk of directional drilling. A major problem of this type of well for VBPA is that, based on operator experience, the success rate for hydraulically fracturing the individual zones is about 1 in 3 due to screenout problems. During hydraulic fracturing, sand is carried into a fracture created by high-pressure fluid. If there is a restriction at the wellbore, the sand packs off, prematurely terminating the fracture treatment. Screenouts are common in wellbores inclined more than 10°.

The theoretical reasons for the screenouts in inclined wells are related to fracture initiation problems caused by certain well orientations in the stress field (Hossain et. al., 1999, and Sankaran et. al., 2000). It is critical that the inclined well be correctly oriented in order to have successful hydraulic fracture treatments. However, the stress field is usually poorly defined leading to poor success rates for hydraulic fracturing in inclined wells. Zones that screenout during fracturing are generally not successfully refractured and the reserves are not produced.

Orientation in the stress field is not a factor in vertical wells; consequently success rates for hydraulic fracturing are very high.

The s-shaped well is the most common deviated well drilled for field development. A well of this type at VBPA would be kicked off at about 1500' and straightened to vertical before entering the first pay zone at about 5500'. From a completion standpoint, this well looks like the vertical well with possible problems working inside a deviated well with two doglegs (bends) in the well path. The main reservoir problem with this well type at VBPA is drainage area limitations due to limited reach relative to effective drainage areas of the individual zones. A cross section of the s-shaped well is shown on:

**Exhibit 2: S-shaped well – Vertical cross-section**

The reach of the s-shaped well at VBPA is limited to 1500' due to mechanical constraints imposed by having the well vertical at the top zone (5500').

While s-shaped directional wells allow multiple wells to be drilled from a single pad, thus reducing surface disturbance, the limited reach of the directional well imposed by depth of the top zone, negatively impacts reservoir drainage per well.

Wexpro (2002) has determined from reservoir analysis of existing Mesaverde production in the Canyon Creek and Trail fields of the Vermillion Basin, that the effective drainage area for the Canyon Creek zone is 160 acres (1500 ft radius) and 80 acres for the Trail zone (1050 ft).

For these effective drainage areas, two s-shaped wells per pad without a vertical well have the same reserves per well as two vertical wells on the same spacing but with a 25% increase in per-well cost. If the s-shaped well offsets an existing vertical well, the overlap in effective drainage area reduces the per-well reserves by 25% in the Canyon Creek and by 12.5% in the Trail. The reserve reduction combined with 25% increase in well-cost makes the two wells uneconomic.

Four s-shaped wells per pad without a vertical well results in a 12.5% reduction in per-well reserves and a 25% increase in per-well cost. Adding a vertical well to the pad further reduces the per-well reserve.

An areal view of the effective drainage areas illustrates this point.

**Exhibit 3: S-shaped well – areal view of effective drainage areas**

In summary, vertical, hydraulically fractured, multiple zone completions are the only economically feasible well architecture for VBPA. It can be concluded that:

Horizontal wells that target a specific sand, are not feasible at VBPA because:

1. The sands are thin and the gas reserve target for individual sands will be small and non-commercial.
2. If the target sand is non-productive or pressure depleted, the horizontal section of the well must be redrilled to test other sands.

3. Recompletions to another sand are not possible in the horizontal well.
4. If natural fractures are not encountered, hydraulic fracturing in the horizontal well may be required to communicate vertically in the sand. This defeats the purpose of drilling the horizontal well.
5. The mechanical risk of drilling and completing horizontal wells is high.

High angle wells are not feasible because:

1. There is increased cost and mechanical risk associated with drilling the directional well.
2. The target zones are intersected at varying (increasing) distance from the surface location and may miss some of the target zones.
3. Difficulties in hydraulically fracturing in high angle wellbores results in a 1 in 3 success rate in completing the target zones leading to uneconomic wells.

S-shaped wells have some of the technical advantages of vertical wells but are not economically feasible because:

1. There is increased cost and mechanical risk associated with drilling the directional well.
2. The limited reach of the well (1500 ft) relative to the effective drainage areas of the target Mesaverde zones, reduces the reserves per well if more than two wells are drilled per pad or the s-shaped well offsets an existing vertical well on a two-well pad.
3. Two s-shapes wells per pad (without a vertical well) give the same reserves per well as two vertical wells on the same spacing but at a 25% increase in the per-well cost.
4. With two wells per pad the cost savings in surface infrastructure do not offset the increase in well drilling and completion cost.
5. Offsetting an existing vertical well with an s-shaped well will result in a decrease in the per-well reserve and an increase in the per-well cost.

Vertical wells have the following advantages:

1. The risk of not finding a sufficient number of productive sands in the 22 sand section is low.
2. Multiple sands can be hydraulically fractured and commingled in a single completion with low risk, proven technology.
3. Vertical wells can be recompleted to other sands if production from the initial completion drops to noncommercial levels.
4. The mechanical risk of drilling and completion operations is low.
5. Vertical wells will maximize the recovery of gas reserves in this multi-reservoir producing section.

By estimating cost and reserve factors, it is possible to evaluate the tradeoff between increased well-cost and reduced surface infrastructure cost associated with pad directional drilling for VBPA. The following table compares the cost and reserve factors for vertical, s-shaped, high angle, and horizontal wells.

## Vermillion Basin Natural Gas Exploration and Development Project
## Comparison of Well Configuration Alternatives

| | % of total well cost vertical well | Vertical | S-shaped Deviated | High-angle Deviated | Horizontal |
|---|---|---|---|---|---|
| **Mechanical risk** | | **0.98** | **0.95** | **0.9** | **0.6** |
| **Cost Factors** | | | | | |
| # wells per location | | 1 | 2 | 8 | 8 |
| Location and road | 7.0% | 1.00 | 0.800 | 0.250 | 0.250 |
| Drilling and logging | 55.0% | 1.00 | 1.400 | 1.400 | 1.400 |
| Perforation | 1.0% | 1.00 | 1.100 | 1.200 | 0.000 |
| Hydraulic Fracturing or Stimulation | 25.0% | 1.00 | 1.100 | 1.500 | 0.250 |
| Gathering line | 2.5% | 1.00 | 0.800 | 0.250 | 0.250 |
| Surface facilities | 4.5% | 1.00 | 0.750 | 0.750 | 0.750 |
| Remediation | 5.0% | 1.00 | 0.500 | 0.125 | 0.125 |
| **Risked Cost Factor** | **100%** | **1.00** | **1.246** | **1.468** | **1.508** |
| **Reserve Factor (Vertical Well=1.0)** | | **1.00** | **1.00** | **0.31** | **0.16** |

In the above table, the total well cost for the vertical well is allocated to several categories. The cost factors are then applied for each type of deviated well to reflect their relative cost. Drilling multiple wells from a pad offers some cost savings but at the expense of increased risk and drilling cost. The risked cost of the deviated wells ranges from 1.25 (s-shaped) to 1.5 (horizontal) times the cost of a vertical well. This appears to be in line with industry experience.

The relative reserves were estimated by applying success rates based on experience for each type of well with the vertical well = 1.0.

The projected reserves per well for the s-shaped well are the same as the vertical well if a maximum of two s-shaped wells are drilled per pad (no vertical well on the pad). However, the cost of the s-shaped deviated well, including estimated savings in surface infrastructure cost, is 1.25 times the cost of the vertical well. If the number of s-shaped wells per pad is increased to three or four, or a vertical well is added to the pad, the reserves per well decrease relative to the vertical well case. The 25% increase in per well-cost will likely make these wells uneconomic.

The horizontal well in the VBPA has an estimated cost of 1.5 times the vertical well and a projected reserve of only 16% of the vertical well. The low projected reserve is based on two factors: 1) a probability of success of 25% due to a variety of factors, including missing the target zone, not finding gas in the target zone, finding depleted pressure, not finding natural fractures, or intersecting a water bearing fractured zone, and 2) if a productive, single pay zone is found by the horizontal well, it will represent 25% of the gas in the total interval (optimistic) but will recover 2 times the gas that would be recovered by a hydraulically fractured vertical well in the same zone. Combining all of these factors gives a reserve factor of 0.16 for the horizontal well.

High angle deviated wells have an anticipated cost of 1.5 times the cost of the vertical well. The major cost components are drilling and stimulation. High angle wells can be hydraulically fractured similar to vertical wells; however, completion operations have higher risk. Fracture initiation and containment in highly deviated wellbores is a poorly understood, high-risk process (Sankaran 2000) that results in a high frequency of screenouts and contributes to higher completion cost.

The reserves for a high angle deviated well are about 1/3 those of the vertical well. This is a direct result of problems associated with hydraulically fracturing highly deviated wells. Operators' experience has shown that the success rate for fracturing in high angle wellbores will be about 1 in 3 due to screenouts. Reserves from zones where fracturing fails will be significantly reduced.

Based on the foregoing, it is concluded that the only technically and economically feasible well architecture for VBPA is the vertical well completed in multiple pay zones.

It is hoped that this analysis will help resolve the selection of an appropriate well architecture for the VBPA. If you have any questions, please contact the undersigned.

Sincerely,

Reservoir Management Services, Inc.

Daniel H. Stright, Jr., P.E.
Colorado Registration: PE-22313

Cc: James R. Livsey
Wexpro Company

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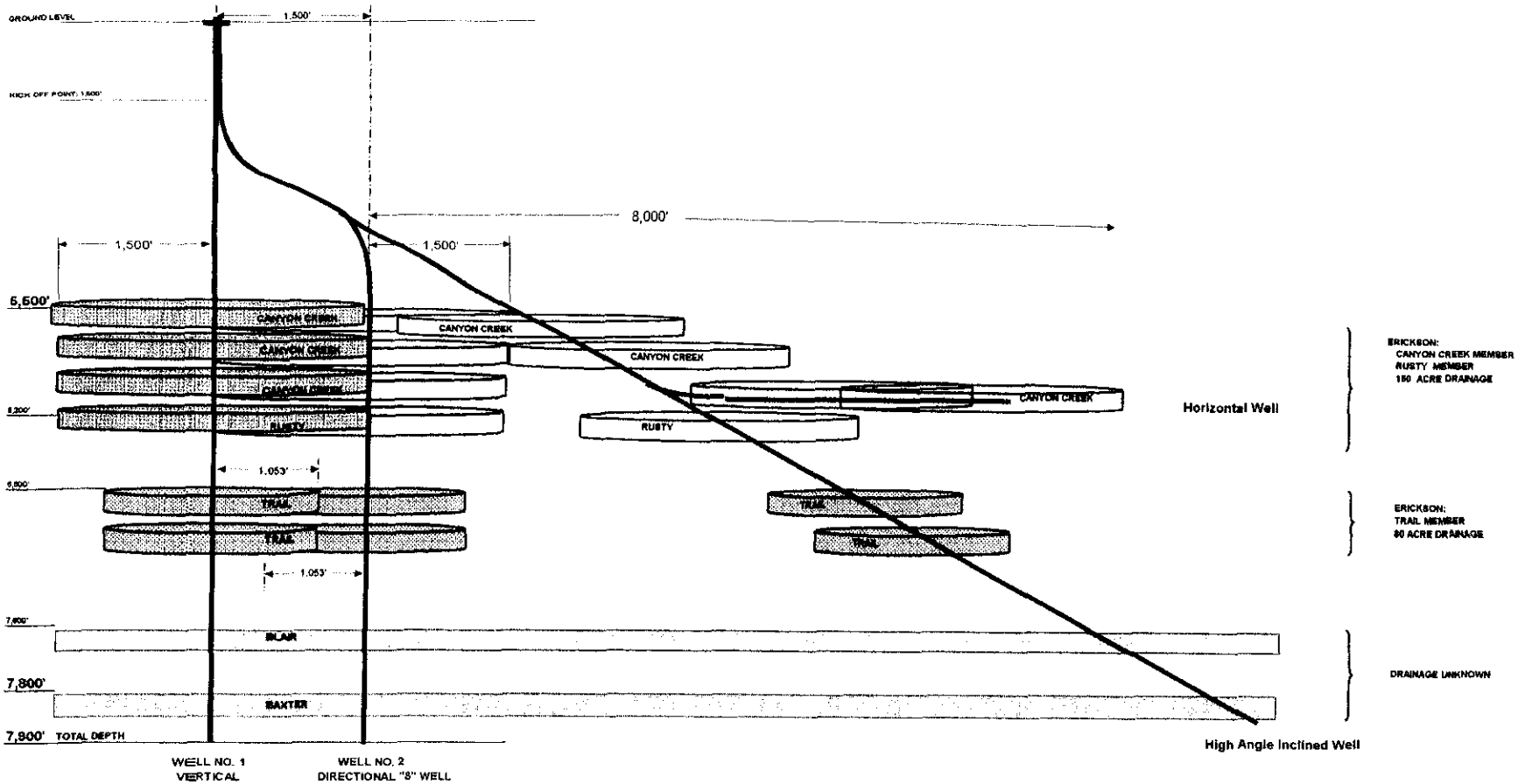
*VERMILLION BASIN Well Options*

**Exhibit No. 1**

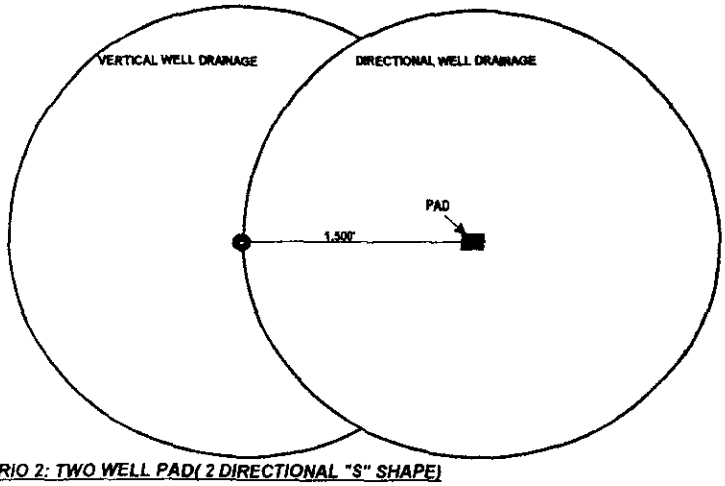


# VERMILLION BASIN DRAINAGE AREAS

## DIRECTIONAL DRILLING OPTIONS
## CANYON CREEK AND TRAIL FORMATIONS
## (Exhibit NO. 3: Areal View)

*SCENARIO 1: TWO WELL PAD( 1 VERTICAL- 1 DIRECTIONAL "S" SHAPE)*

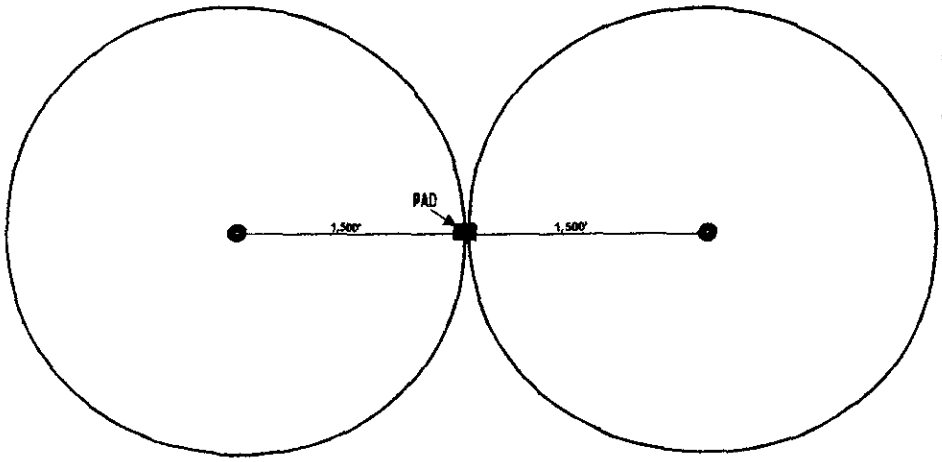
*NOTE:* DRAINAGE AREA FOR THE CANYON CREEK ZONE IS 160 ACRES OR 1500' FROM THE WELL BORE. DRAINAGE AREA FOR THE TRAIL ZONE IS 80 ACRES OR 1053' FROM THE WELL BORE.




50% OVERLAP IN CANYON CREEK ZONE
RESULTING IN 25% RESERVE REDUCTION

25% OVERLAP IN TRAIL ZONE
RESULTING IN 12.5% RESERVE REDUCTION

*SCENARIO 2: TWO WELL PAD( 2 DIRECTIONAL "S" SHAPE)*

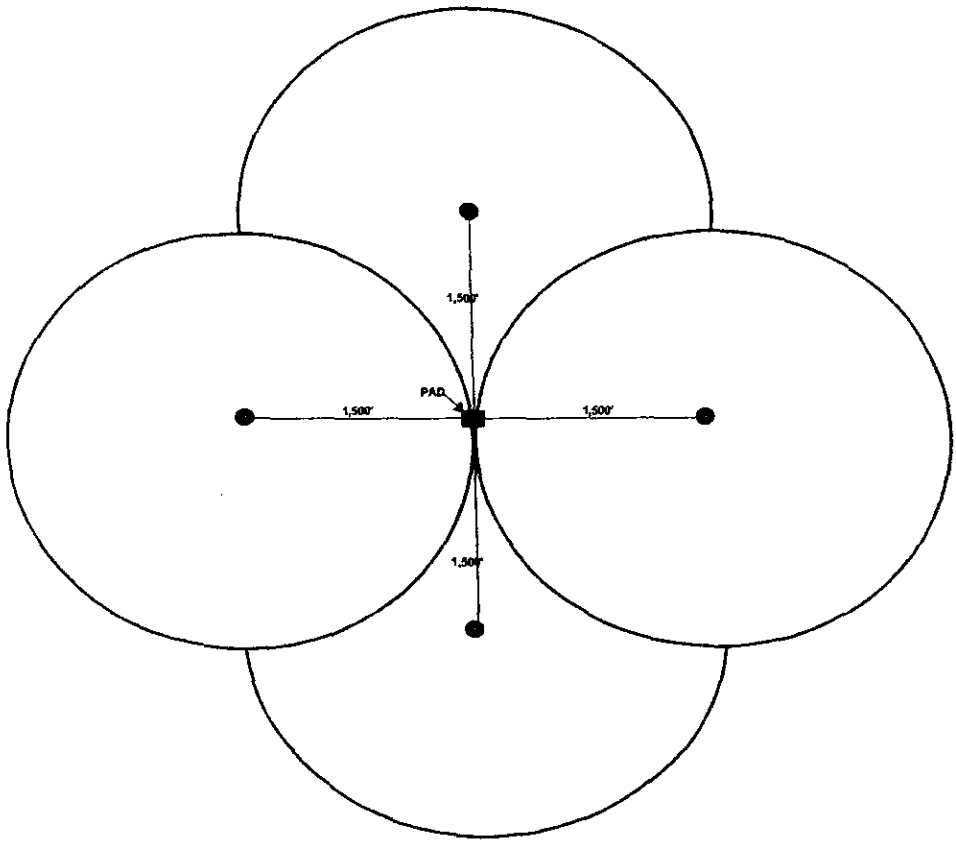



0% OVERLAP IN CANYON CREEK ZONE
RESULTING IN 0% RESERVE REDUCTION

0% OVERLAP IN TRAIL ZONE
RESULTING IN 0% RESERVE REDUCTION

100% LOSS OF 40 ACRES OF RESERVES
FROM TRAIL ZONE

*SCENARIO 2: FOUR WELL PAD( 4 DIRECTIONAL "S" SHAPE)*



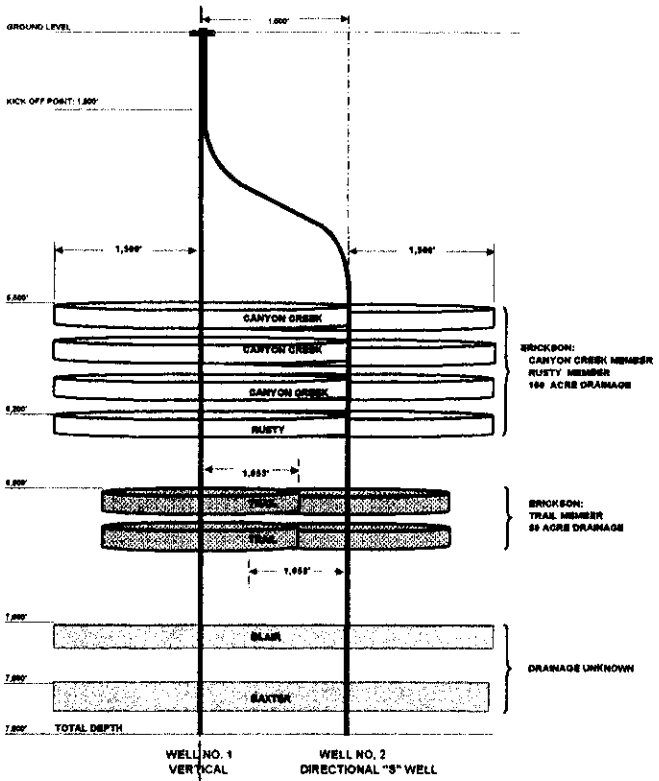

25% OVERLAP IN CANYON CREEK ZONE
RESULTING IN12.5% RESERVE REDUCTION

0% OVERLAP IN TRAIL ZONE
RESULTING IN 0% RESERVE REDUCTION

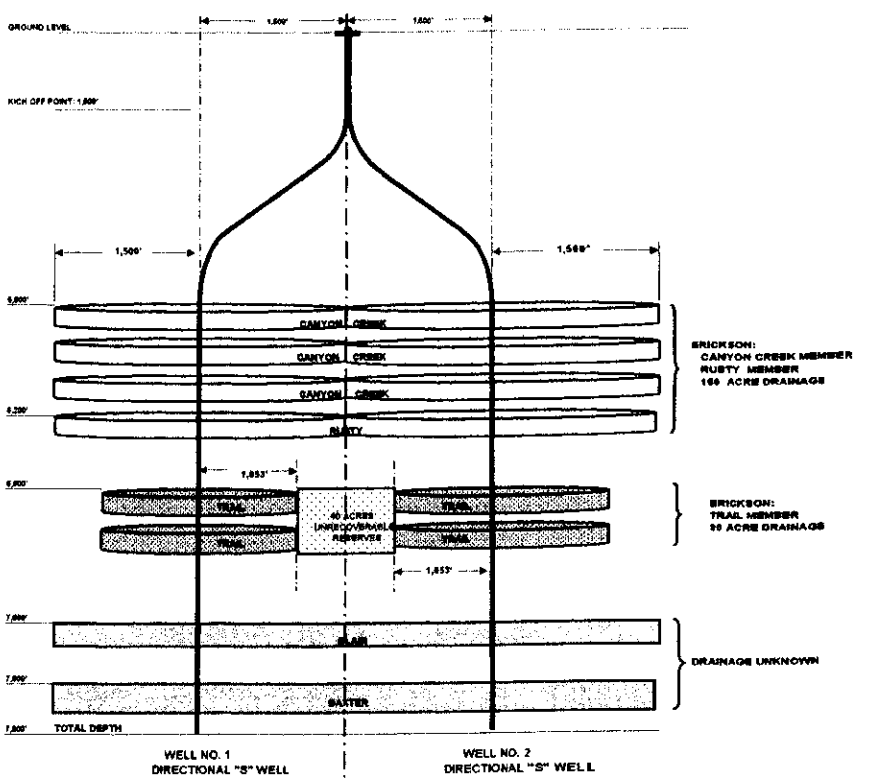
100% LOSS OF 40 ACRES OF RESERVES
FROM TRAIL ZONE

**Exhibit NO. 3: Cross section view**

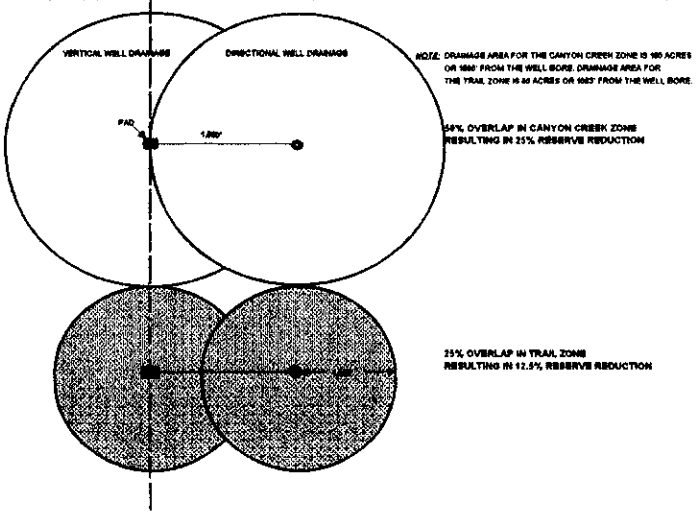
## TYPICAL VERMILLION BASIN WELL
### TWO WELL PAD SCENARIO
VERTICAL WELL & DIRECTIONAL "S" SHAPE WELL




## TYPICAL VERMILLION BASIN WELL
### TWO WELL PAD SCENARIO
TWO DIRECTIONAL "S" SHAPE WELLS




### SCENARIO 1: TWO WELL PAD( 1 VERTICAL- 1 DIRECTIONAL "S" SHAPE)




### SCENARIO 2: TWO WELL PAD( 2 DIRECTIONAL "S" SHAPE)