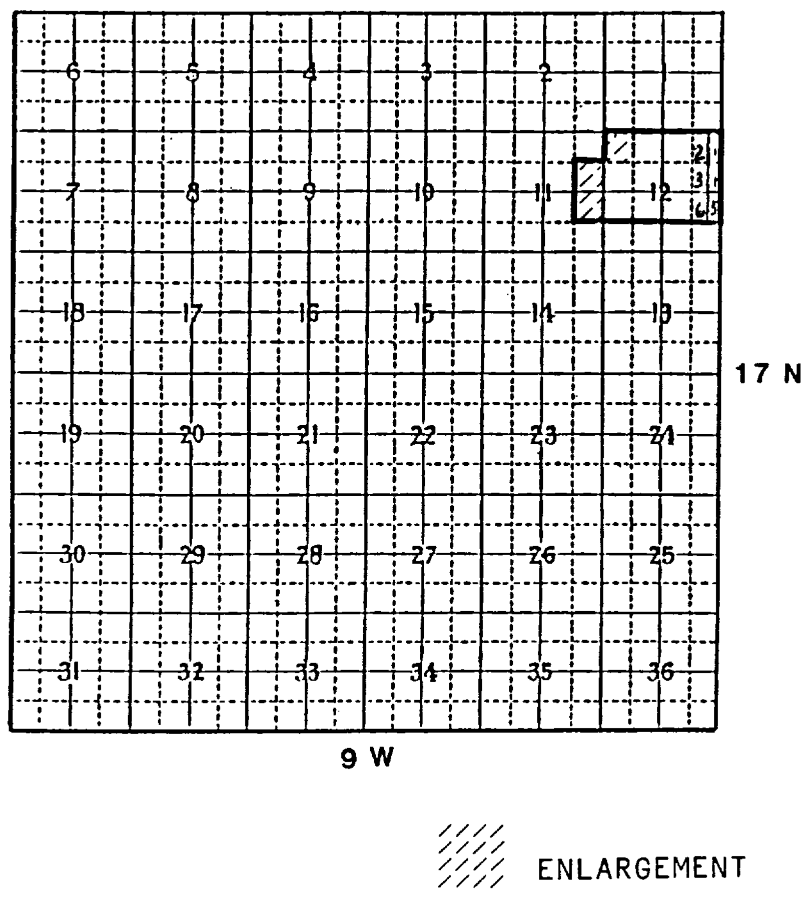
SOUTH HOSPAH

MCKINLEY COUNTY
NEW MEXICO

No. 14-08-0001-11561 EFFECTIVE 11-1-68



gulram, inc.

petroleum engineering and government regulation consultants

UNIT NAME: SOUTH HOSPAH UNIT AREA
CONTRACT NUMBER: 14-08-0001-11561
APPROVAL DATE: 10-29-68
EFFECTIVE DATE: 11-1-68
ACREAGE TOTAL: 475.90 (475.90 FED.)
TYPE: SECONDARY PRESSURE MAINTENANCE BY WATERFLOOD
UNITIZED FORMATION: UPPER HOSPAH SAND FORMATION ONLY UNITIZED FORMATION
ENLARGEMENT DATE: EFFECTIVE 7-1-70, NEW ACREAGE: 595.90 ACRES (515.90 FED.; 80.00 FEE)
AUTOMATIC ELIMINATION DATE: NONE
OPERATOR: TENNECO OIL COMPANY (DESIGNATED AGENT IS TESORO PETROLEUM CORPORATION)

PARTICIPATING AREAS

Name: HOSPAH INITIAL
Effective Date: 11-1-68
Legal Description: Lots 1-6, W/2NE/4, E/2NW/4, SW/4NW/4, N/2SW/4, NW/4SE/4 sec. 12, T.17N.,R.9W.
Acres Added: 475.90
Total Acres: 475.90 (ENTIRE UNIT AREA)

Name: 1ST REVISION
Well Name:
Location:
Effective Date: 7-1-70
Legal Description: NE/4SE/4, SE/4NE/4 sec. 11; NW/4NW/4 sec. 12, T.17N.,R.9W.
Acres added: 120.00
Total Acres: 595.90 (ENTIRE UNIT AREA)

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 4793
Order No. R-4389

APPLICATION OF TENNECO OIL COMPANY
FOR A PRESSURE MAINTENANCE PROJECT
AND UNORTHODOX LOCATIONS, McKINLEY
COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on August 9, 1972, at Santa Fe, New Mexico, before Examiner Elvis A. Utz.

NOW, on this 7th day of September, 1972, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Tenneco Oil Company, seeks authority to institute a pressure maintenance project in the South Hospah-Lower Sand Pool by the simultaneous injection of water and gas into the Lower Hospah formation through two wells located in Section 12, Township 17 North, Range 9 West, McKinley County, New Mexico.

(3) That the applicant further seeks the designation of the project area and the promulgation of special rules and regulations governing said project.

(4) That initially the project area should comprise only the following-described area:

McKINLEY COUNTY, NEW MEXICO
TOWNSHIP 17 NORTH, RANGE 9 WEST, NMPM
Section 12: NW/4 and W/2 NE/4

(5) That a pressure maintenance project, designated the Tenneco Lower Hospah Pressure Maintenance Project, comprising the above described area is in the interest of conservation and should result in greater ultimate recovery of oil, thereby preventing waste.

(6) That an administrative procedure should be established whereby said project area may be expanded for good cause shown and whereby additional wells in the project area may be converted to water injection.

(7) That special rules and regulations for the operation of the Tenneco Lower Hospah Pressure Maintenance Project should be promulgated and, for operational convenience, such rules should provide certain flexibility in authorizing the production of the project allowable from any well or wells in the project area in any proportion, provided that no well in the project area which directly or diagonally offsets a well on another lease producing from the same common source of supply should be allowed to produce in excess of top unit allowable for the South Hospah-Lower Sand Pool until such time as the well has experienced a substantial response to water injection. When such a response has occurred, the well should be permitted to produce up to two times top unit allowable for the South Hospah-Lower Sand Pool. Production of such well at a higher rate should be authorized only after notice and hearing.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby authorized to institute a pressure maintenance project in the South Hospah-Lower Sand Pool, McKinley County, New Mexico, to be designated the Tenneco Lower Hospah Pressure Maintenance Project, by the simultaneous injection of water and gas into the open-hole interval opposite the Lower Hospah formation through the following-described two wells in Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico:

Hospah Well No. 33 - 1,340 feet from the North line and
1,710 feet from the West line;

Hospah Well No. 36 - 900 feet from the North line and
2,630 feet from the East line.

(2) That the aforesaid injection wells shall be equipped with 2 7/8-inch tubing set in packers, said packers being located within 100 feet of the casing shoe. Further, that the casing tubing annulus shall be filled with an inert fluid and the annulus equipped with a pressure gauge to facilitate detection of leakage in the tubing or packer.

(3) That Special Rules and Regulations governing the operation of the Tenneco Lower Hospah Pressure Maintenance Project, McKinley County, New Mexico, are hereby promulgated as follows:

SPECIAL RULES AND REGULATIONS
FOR THE
TENNECO LOWER HOSPAH PRESSURE MAINTENANCE PROJECT

RULE 1. The project area of the Tenneco Lower Hospah Pressure Maintenance Project, hereinafter referred to as the Project, shall comprise the area described as follows:

McKINLEY COUNTY, NEW MEXICO
TOWNSHIP 17 NORTH, RANGE 9 WEST, NMPM
Section 12: NW/4 and W/2 NE/4

RULE 2. The allowables for the Project shall be the sum of the allowables of the several wells within the project area, including those wells which are shut-in, curtailed, or used as injection wells. Allowables for all wells shall be determined in a manner hereinafter prescribed.

RULE 3. Allowables for injection wells may be transferred to producing wells within the project area, as may the allowables for producing wells which, in the interest of more efficient operation of the Project, are shut-in or curtailed because of high gas-oil ratio or are shut-in for any of the following reasons: pressure regulation, control of pattern or sweep efficiencies, or to observe changes in pressures or changes in characteristics of reservoir liquids or progress of sweep.

RULE 4. The allowable assigned to any well which is shut-in or which is curtailed in accordance with the provisions of Rule 3 which allowable is to be transferred to any well or wells in the project area for production, shall in no event be greater than its ability to produce during the test prescribed by Rule 6, below, or greater than the current top unit allowable for the pool during the month of transfer, whichever is less.

RULE 5. The allowable assigned to any injection well on a 40-acre proration unit shall be top unit allowable for the South Hospah-Lower Sand Pool.

RULE 6. The allowable assigned to any well which is shut-in or curtailed in accordance with Rule 3, shall be determined by a 24-hour test at a stabilized rate of production, which shall be the final 24-hour period of a 72-hour test throughout which the well should be produced in the same manner and at a constant rate. The daily tolerance limitation set forth in Commission Rule 502 I (a) and the limiting gas-oil ratio (2,000 to 1) for the pool shall be waived during such tests. The project operator shall notify all operators offsetting the well, as well as the Commission, of the exact time such tests are to be conducted. Tests may be witnessed by representatives of the offsetting operators and the Commission, if they so desire.

RULE 7. The basic allowable assigned to each producing well in the Project shall be equal to the well's ability to produce or to top unit allowable for the pool, whichever is less. Wells capable of producing more than top unit allowable may also receive transfer allowable, provided however, that no producing well in the project area which directly or diagonally offsets a well on another lease producing from the same common source of supply shall receive an allowable or produce in excess of two times top unit allowable for the pool. Each producing well shall be subject to the limiting gas-oil ratio (2,000 to 1) for the pool.

RULE 8. Every four months the project operator shall submit to the Commission a Pressure Maintenance Project Operator's Report, on a form prescribed by the Commission, outlining thereon the data required, and requesting allowables for each of the several wells in the Project as well as the total project allowable based upon the pool's depth bracket allowable and the market demand percentage in effect. The aforesaid Pressure Maintenance Project Operator's Report shall be filed in lieu of Form C-120 for the Project.

RULE 9. The Commission shall, upon review of the report and after any adjustments deemed necessary, calculate the allowable for each well in the Project for the next two succeeding months in accordance with these rules. The sum of the allowables so calculated shall be assigned to the Project and may be produced from the wells in the Project in any proportion except that no well in the Project which directly or diagonally offsets a well on another lease producing from the same common source of supply shall produce in excess of two times top unit allowable for the pool.

RULE 10. The conversion of producing wells to injection, the drilling of additional wells for injection, and expansion of the project area shall be accomplished only after approval of the same by the Secretary-Director of the Commission. To obtain such approval, the project operator shall file proper application with the Commission, which application, if it seeks authorization to convert additional wells to injection or to drill additional injection wells shall include the following:

(1) A plat showing the location of proposed injection wells, all wells within the project area, and offset operators, locating wells which offset the project area.

(2) A schematic drawing of the proposed injection wells which fully describes the casing, tubing, perforated interval, and depth showing that the injection of gas or water will be confined to the Lower-Hospah formation.

(3) A letter stating that all offset operators to the proposed injection wells have been furnished a complete copy of the application and the date of notification.

The Secretary-Director may approve the proposed injection wells if, within 20 days after receiving the application, no objection to the proposal is received. The Secretary-Director may grant immediate approval, provided waivers of objection are received from all offset operators.

Expansion of the project area may be approved by the Secretary-Director of the Commission administratively when good cause is shown therefor.

(4) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

BRUCE KING, Chairman

ALEX J. ARMIJO, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

dr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE NO. 4793
Order No. R-4389-A

APPLICATION OF TENNECO OIL COMPANY FOR A PRESSURE MAINTENANCE PROJECT AND UNORTHODOX LOCATIONS, McKINLEY COUNTY, NEW MEXICO.

NUNC PRO TUNC ORDER

BY THE COMMISSION:

It appearing to the Commission that Order No. R-4389, dated September 7, 1972, does not correctly state the intended order of the Commission as stated below.

IT IS THEREFORE ORDERED:

(1) That Rule 8 on Page 4 of Order No. R-4389 is hereby corrected to read in its entirety as follows:

"RULE 8. Each month the project operator shall submit to the Commission a Pressure Maintenance Project Operator's Report, on a form prescribed by the Commission, outlining thereon the data required, and requesting allowables for each of the several wells in the Project as well as the total project allowable based upon the pool's depth bracket allowable and the market demand percentage factor in effect. The aforesaid Pressure Maintenance Project Operator's Report shall be filed in lieu of Form C-120 for the Project."

(2) That Rule 9 on Page 4 of Order No. R-4389 is hereby corrected to read in its entirety as follows:

"RULE 9. The Commission shall, upon review of the report and after any adjustments deemed necessary, calculate the allowable for each well in the Project for the next succeeding month in accordance with these rules. The sum of the allowables so calculated shall be assigned to the Project and may be produced from the wells in the Project in any proportion except that no well in the Project which directly or diagonally offsets a well on another lease producing from the same common source of supply shall produce in excess of two times top unit allowable for the pool."

(3) That this order shall be effective nunc pro tunc as of September 7, 1972.

DONE at Santa Fe, New Mexico, this 27th day of November, 1972.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

BRUCE KING, Chairman

ALEX J. ARMIJO, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

dr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 5246
Order No. R-4389-B

APPLICATION OF TENNECO OIL COMPANY
FOR PRESSURE MAINTENANCE EXPANSION
AND DUAL COMPLETIONS, McKINLEY
COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on May 22, 1974, at Santa Fe, New Mexico, before Examiner, Richard L. Stamets.

NOW, on this 4th day of June, 1974, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That by Order No. R-4389, the applicant, Tenneco Oil Company, was authorized to institute its Lower Hospah Pressure Maintenance Project in the South Hospah-Lower Sand Pool, McKinley County, New Mexico, by the simultaneous injection of water and gas into the Lower Hospah Sand formation through two wells located in Units B and G, respectively, of Section 12, Township 17 North, Range 9 West, NMPM.

(3) That applicant now seeks authority to dually complete two of its wells in said Section 12 to permit injection of water and gas into the lower Hospah formation as well as the injection of water into the Upper Hospah formation as is presently authorized, those two wells being described as follows:

Hospah Well No. 41, located in Unit B
Hospah Well No. 56, located in Unit A

(4) That the mechanics of the proposed dual completions are feasible and in accord with good conservation practices.

(5) That the dual completion of the subject wells to allow injection of water and gas into the lower Hospah formation as proposed by the applicant is in the interest of conservation and should result in greater ultimate recovery of oil, thereby preventing waste, will not violate correlative rights, and will afford the applicant the opportunity to produce its just and equitable share of the oil in South Hospah-Lower Sand Pool.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby authorized to dually complete its Hospah Well No. 41, located in Unit B and its Hospah Well No. 56, located in Unit A of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico, to inject water into the Upper Hospah formation and to inject water and gas into the lower Hospah formation through parallel strings of tubing.

(2) That injection in each of the subject dually completed injection wells shall take place through tubing set in packers located as near as practicable to the uppermost perforations in the respective zones to be injected, or, in the case of open-hole completions, to the casing-shoe; the annulus of each well shall be filled with an inert fluid and equipped with an approved leak-detection device.

(3) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

I. R. TRUJILLO, Chairman

ALEX J. ARMIJO, Member

A. L. PORTER, Jr., Member & Secretary

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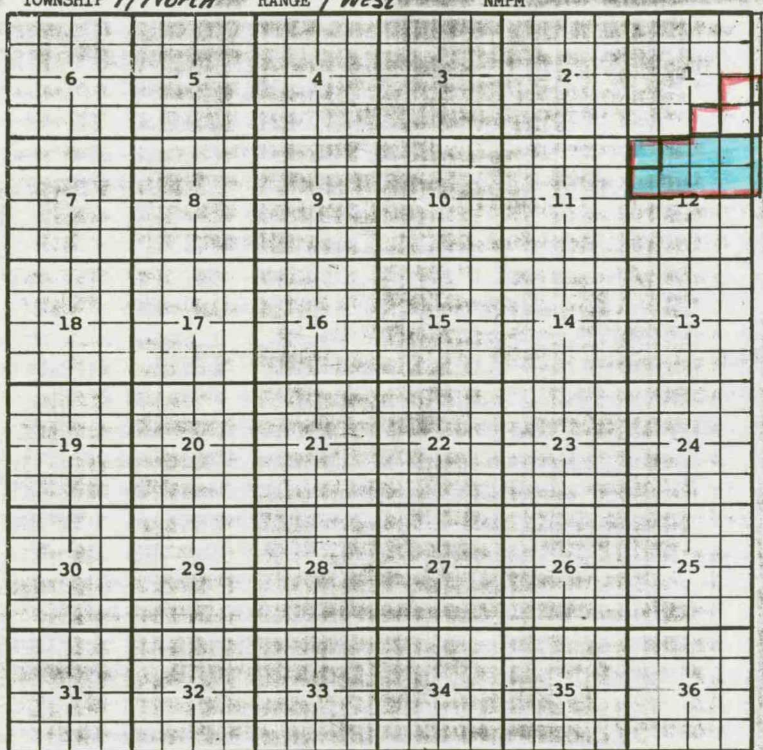
COUNTY McKinley POOL South Hospah Lower Sand Oil

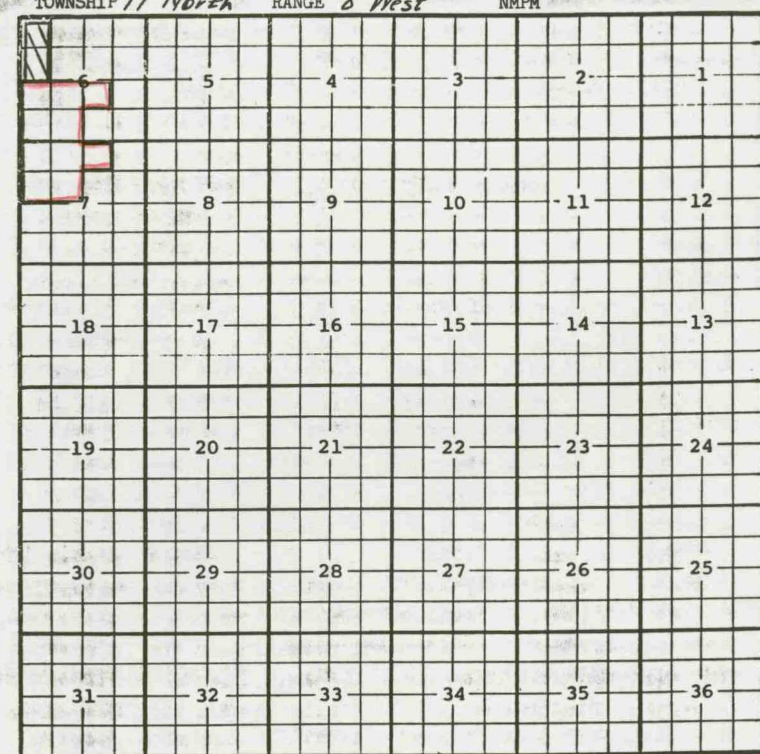
TOWNSHIP 17 North RANGE 9 West NMPM



Ext: SE/4 SE/4 & Lot 8 Sec 1 (R-3219, 5-1-67) - SW/4 SE/4 & NE/4 SE/4 Sec. 1 (R-3281, 8-1-67)
- NE/4, E/2 NW/4 & SW/4 NW/4 Sec 12 (R-3403, 5-1-68) Ext: NW/4 NW/4 Sec 12 (R-5779, 8-1-78)

COUNTY McKinley POOL South Hospah Lower Sand Oil

TOWNSHIP 17 North RANGE 8 West NMPM



Description: SW/4 Sec. 6; NW/4 Sec. 7 (R-3170, 12-28-66)
Ext: NW/4 NE/4 Sec. 7 (R-3403, 5-1-68) Ext: NW/4 SE/4 Sec 6 (R-5779, 8-1-78)
Ext: W/2 NW/4 Sec. 6 (R-7277, 5-5-83) Delete: W/2 NW/4 Sec. 6 (R-7420, 1-9-84)

APPLICATION OF TENNECO OIL COMPANY TO EXPAND ITS LOWER HOSPAH PRESSURE MAINTENANCE PROJECT IN THE SOUTH HOSPAH-LOWER SAND POOL IN MCKINLEY COUNTY, NEW MEXICO.

ADMINISTRATIVE ORDER
PMX-56-A

(Supersedes Order No. PMX-56)

ADMINISTRATIVE ORDER
OF THE OIL CONSERVATION COMMISSION

Under the provisions of Order No. R-4389 and R-4389-A, Tenneco Oil Company has made application to the Commission on February 11, 1974, for permission to expand its Lower Hospah Pressure Maintenance Project in the South Hospah-Lower Sand Pool in McKinley County, New Mexico.

NOW, on this 4th day of March, 1974, the Secretary-Director finds:

1. That application has been filed in due form.

2. That satisfactory information has been provided that all offset operators have been duly notified of the application.

3. That no objection has been received within the waiting period as prescribed by Order No. R-4389.

4. That the proposed injection wells are eligible for conversion to water injection under the terms of Order No. R-4389 and R-4389-A.

5. That the proposed expansion of the above-referenced water flood project will not cause waste nor impair correlative rights.

6. That the application should be approved.

IT IS THEREFORE ORDERED:

(1) That project area as heretofore defined is hereby expanded to include the following:

McKINLEY COUNTY, NEW MEXICO
TOWNSHIP 17 NORTH, RANGE 9 WEST, NMPM
Section 12: E/2 NE/4

(2) That the applicant, Tenneco Oil Company, be and the same is hereby authorized to inject water and gas into the Lower Hospah formation through the following described wells for purposes of secondary recovery, to wit:

Hospah Well No. 54, located 1320 feet from the North line and 5 feet from the East line,

Hospah Well No. 57, located 2290 feet from the North line and 110 feet from the West line,

Hospah Well No. 58, located 2580 feet from the North line and 1640 feet from the West line,

Hospah Well No. 59, located 2340 feet from the North line and 2500 feet from the East line,

Hospah Well No. 60, located 2210 feet from the North line and 1300 feet from the East line,

Hospah Well No. 61, located 5 feet from the North line and 1520 feet from the East line, all in Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

A. L. PORTER, JR.
Secretary-Director

S E A L

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE NO. 5995
Order No. R-5506

APPLICATION OF TENNECO OIL COMPANY
FOR DUAL COMPLETIONS AND WATERFLOOD
EXPANSIONS, McKINLEY COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on July 20, 1977, at Santa Fe, New Mexico, before Examiner Richard L. Stamets.

NOW, on this 9th day of August, 1977, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Tenneco Oil Company, seeks authority to expand its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones through parallel strings of tubing.

(3) That the applicant proposes to complete said Hospah Unit Wells Nos. 58 and 59 with parallel strings of tubing, packers set immediately above the injection intervals, and provide for testing to determine any leakage of the tubing, casing or upper packers.

(4) That the mechanics of the proposed dual completions are feasible and in accordance with good conservation practices.

(5) That before injection into either of said wells should begin, the applicant should consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata.

(6) That the operator should take all steps necessary to ensure that the injected water enters only the proposed injection interval and is not permitted to escape to other formations or onto the surface.

(7) That approval of the subject application will prevent the drilling of unnecessary wells and otherwise prevent waste and protect correlative rights.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby granted authority to expend its South Hospah-Upper Sand and South Hospah-Lower Sand Waterflood Projects by dually completing its Hospah Unit Wells Nos. 58 and 59, located in Units F and G, respectively, of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico, in such a manner as to permit water injection into each of said zones.

PROVIDED HOWEVER, that each of said wells shall be equipped with parallel strings of 2 1/16-inch tubing, packers set immediately above each injection zone, and that the casing-tubing annulus shall be filled with an inert fluid; and that a pressure gauge shall be attached to the annulus or the annulus shall be equipped with an approved leak detection device in order to determine leakage in the casing, tubing, or packer.

(2) That prior to commencing injection into either of the subject wells, the operator shall consult with the supervisor of the Commission's district office at Aztec to determine an injection pressure limitation such as to preclude fracturing of the confining strata in said projects.

(3) That the injection wells or systems shall be equipped with pop-off valves or acceptable substitutes which will limit the wellhead pressure on the injection wells to a pressure no higher than that determined pursuant to Order No. (2) above.

(4) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

PHIL R. LUCERO, Chairman

EMERY C. ARNOLD, Member

JOE D. RAMEY, Member & Secretary

S E A L
jr/

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 3695
Order No. R-3361

APPLICATION OF TENNECO OIL COMPANY
FOR SPECIAL POOL RULES, McKINLEY
COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on December 20, 1967, at Santa Fe, New Mexico, before Examiner Daniel S. Nutter.

NOW, on this 2nd day of January, 1968, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Tenneco Oil Company, seeks the promulgation of special pool rules for the South Hospah Upper Sand Oil Pool and the South Hospah Lower Sand Oil Pool, McKinley, County, New Mexico, to provide that wells drilled in said pools could be located anywhere on the 40-acre unit except that no well could be located closer than 330 feet to the outer boundary of the lease nor closer than 200 feet to another well producing from the same pool.

(3) That the applicant further proposes that any existing well not located in accordance with the above requirements be granted an exception to said requirements.

(4) That adoption of the proposed special rules and regulations will prevent waste and protect correlative rights, provided

a 40-acre proration unit in the South Hospah Upper Sand Oil Pool or the South Hospah Lower Sand Oil Pool is subject to a 40-acre unit allowable for wells in the South Hospah Upper Sand Oil Pool or South Hospah Lower Sand Oil Pool, whichever is applicable, regardless of the number of wells on the unit.

IT IS THEREFORE ORDERED:

That Special Rules and Regulations for the South Hospah Upper Sand Oil Pool and the South Hospah Lower Sand Oil Pool, McKinley County, New Mexico, are hereby promulgated as follows:

SPECIAL RULES AND REGULATIONS
FOR THE
SOUTH HOSPAH UPPER SAND OIL POOL
AND THE
SOUTH HOSPAH LOWER SAND OIL POOL

RULE 1. Each well completed or recompleted in the South Hospah Upper Sand Oil Pool or in the South Hospah Lower Sand Oil Pool or in the Gallup formation within one mile thereof, and not nearer to or within the limits of another designated Gallup oil pool, shall be spaced, drilled, operated, and produced in accordance with the Special Rules and Regulations hereinafter set forth.

RULE 2. Each well shall be located no nearer than 330 feet to the outer boundary of the lease upon which it is located nor closer than 200 feet to another well drilling to or capable of producing from the same pool nor nearer than 20 feet to the boundary of the 40-acre tract upon which it is located.

RULE 3. The Secretary-Director of the Commission shall have authority to grant exceptions to Rule 2 without notice and hearing when an application therefor has been filed in due form and the necessity for the exception is based upon topographical conditions.

All operators owning acreage within 330 feet of the proposed location shall be notified of the application by registered or certified mail, and the application shall state that such notice has been furnished. The Secretary-Director may approve the application upon receipt of written waivers from all operators owning acreage within 330 feet of the proposed location, or if no such operator has entered an objection to the unorthodox location within 20 days after the Secretary-Director has received the application.

RULE 4. A 40-acre proration unit in the South Hospah Upper Sand Oil Pool or the South Hospah Lower Sand Oil Pool shall be subject to a 40-acre unit allowable for wells in the South Hospah Upper Sand Oil Pool or the South Hospah Lower Sand Oil Pool, whichever is applicable, regardless of the number of wells on the unit.

IT IS FURTHER ORDERED:

(1) That the locations of all wells presently drilling to or completed in the South Hospah Upper Sand Oil Pool or the South Hospah Lower Sand Oil Pool or in the Gallup formation within one mile thereof are hereby approved; that the operator of any well having an unorthodox location not previously approved by order of the Commission shall notify the Aztec District Office of the Commission in writing of the name and location of the well on or before January 15, 1968.

(2) That all provisions of Order No. R-3270 and Order No. R-3325 that are in conflict with the provisions of this order are hereby superseded.

(3) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

A. L. PORTER, Jr., Member & Secretary

S E A L

esr/

SPE/DOE

Society of Petroleum Engineers U.S. Department of Energy

SPE/DOE 14917

In-Situ Combustion in the Lower Hospah Formation, McKinley County, New Mexico

by S.M. Struna, *Tenneco Oil Co.*, and F.H. Poettmann, *Colorado School of Mines*

SPE Members

This paper was prepared for presentation at the SPE/DOE Fifth Symposium on Enhanced Oil Recovery of the Society of Petroleum Engineers and the Department of Energy held in Tulsa, OK, April 20-23, 1986.

SUMMARY

In 1980-1981, Tenneco Oil Company conducted an insitu combustion pilot test on the Lower Hospah Formation of the South Hospah Field, McKinley County, New Mexico. Although the reservoir appeared to be an excellent candidate for insitu combustion, the pilot project recovered only a very small amount of incremental oil, and as a consequence was terminated.

In order to evaluate the pilot test and to determine the reasons for its performance behavior, a reservoir model of the test site was developed from the historical performance of secondary recovery operations in conjunction with available log and core data. The result was a three layer, four quadrant model of the test site. The volumetric sweep efficiency of the combustion front was estimated from two interior core holes drilled after the project was terminated. This resulted in a post combustion model of the test site depicting the vertical sweep of the combustion front.

Stoichiometric relationships were used to evaluate the combustion performance of each layer of the model. The calculated theoretical displacement agreed very well with the estimated actual oil production from the test site. The stoichiometric evaluation provided a means to quantitatively compare the post combustion reservoir model with actual test performance, thus verifying the model.

The reservoir model illustrated the factors that caused the production shortfall. The project failed because the combustion front migrated beneath the oil zone, processing an interval containing low oil saturation, and resulting in very large air-oil ratios.

References and illustrations at end of paper.

INTRODUCTION

In 1980, the Lower Hospah sandstone formation was in the declining stages of secondary recovery and was producing at very high water cuts. Combined primary and secondary recovery was about 34 percent of the original oil in place, leaving approximately 6.2 MMSTB as a tertiary recovery target.

A number of enhanced oil recovery (EOR) alternatives were studied by Tenneco engineers. It was subsequently proposed that a conventional insitu combustion process be piloted. The Lower Hospah appeared to exhibit a combination of reservoir and fluid properties amenable to the combustion process.

A small 0.592 acre inverted five-spot combustion pilot was initiated in November of 1980 and was terminated in June of 1981. Air was injected for 215 consecutive days. At the time the project was terminated, several reasons were put forth as to why the project fell short of expectations. They were as follows:

1. Waterflood interference (the pilot was surrounded by an active waterflood).

2. Combustion of the coal seam above the Lower Hospah formation.

3. Excessive heat loss to the underlying aquifer preventing efficient combustion.

As it turned out, none of these reasons were viable.

The project was never formally documented, and as a consequence, Tenneco Oil Company released the data to the authors for evaluation. The purpose of the study was to evaluate the Lower Hospah Combustion pilot and to determine why incremental recovery was low. The methodology used to evaluate the combustion pilot was to first review the historical performance of the Lower Hospah reservoir, placing particular emphasis upon the production response to various development programs and secondary recovery techniques.

Secondly, the incremental tertiary recovery was determined from pilot combustion data and the historical performance of the reservoir. Actual incremental tertiary recovery was compared to projected tertiary recovery, and the magnitude of the production shortfall was realized. The third phase of the study was a detailed evaluation of the Lower Hospah waterflood. Log and Core data were used to determine the volumetric sweep efficiency of the injected water and a pre-combustion reservoir model was developed. The fourth phase of the study was the evaluation of the combustion front sweep efficiency. This was accomplished by analyzing data obtained from two interior core holes that were drilled after the project was terminated. The end result was a post-combustion reservoir model depicting the vertical sweep of the combustion front.

The final phase of the study was a stoichiometric evaluation of the Lower Hospah combustion process. This provided a quantitative means of comparing the post-combustion reservoir model to actual incremental combustion recovery, and verified the reservoir models. These models illustrated the reasons for the production shortfall in the Lower Hospah combustion pilot.

RESERVOIR DESCRIPTION AND HISTORY

The South Hospah Field is in the Hospah Dome on the Chaco Slope of the San Juan Basin. The field is comprised of two producing sandstone reservoirs, the Upper Hospah and the Lower Hospah.

The Lower Hospah sand was deposited by a regressive Cretaceous sea sequence and is part of the massive Gallup Formation. As the sea regressed, a layer of plant sediment was deposited on the Lower Hospah sand by the swampy, back-beach environment, which followed the shore line. This organic layer was subsequently buried by continental sand deposits, and formed a thin coal seam separating the two Hospah sands.

The Lower Hospah formation is a clean, blanket sand deposit, approximately 100 feet thick. Productive limits are defined by a fault on the northwest flank and the original oil-water contact as shown on the structure map, Figure 1. The map showing the original net pay isopach of the Lower Hospah formation is shown on Figure 2. The Lower Hospah reservoir is sealed at its top by a 2-3 feet thick coal seam and bounded below by a low permeability, bioturbated sandstone.

The structure dips approximately 1° to the southeast. The thickest portion of the pay zone averages ± 40 feet along the fault and the thinnest portion, ± 20 feet, lies near the eastern edge of the field. The original pay section averages 28 feet over the areal extent of the field, and is continuous with no shale barriers. Table 1 lists reservoir and fluid properties.

The structure map and the net pay isopach map (Figures 1 and 2) represent the original reservoir conditions. The position of the oil water contact was subsequently altered due to water encroachment, or waterflood under running. A high degree of water coning also occurred.

The original aquifer below the Lower Hospah formation is active and apparently tilted approximately 0.86° to the east. Without pressure data, it is impossible to ascertain whether the tilt is a hydrodynamic condition or a result of changing capillary pressure. The tilt resulted in a vertical change in the original oil water contact of about 60 feet across the field. Other evidence indicates that the tilt is primarily due to hydrodynamics.

Oil was first produced from the South Hospah Field in September of 1965, from the Upper Hospah formation. Production from the Lower Hospah began in April of 1967. Development was completed in the Lower Hospah in 1971, following which the reservoir exhibited a steep decline, which one would expect from the crude and reservoir properties. By mid 1972, a secondary recovery study was completed for the Lower Hospah reservoir. Cyclic gas-water injection was recommended based upon economic analysis. It was believed, and confirmed by laboratory data, that the introduction of a gas phase would swell the oil and reduce viscosity.

A three well gas-water injection pilot was initiated in September of 1972. Based on favorable response to gas-water injection, a full field expansion was completed in July of 1974. Oil production peaked at 740 BOPD in November of 1974.

Following this peak the Lower Hospah field began an exponential decline in production. The injected gas caused severe operational problems and increased operation and maintenance costs. As a result, gas injection was discontinued on July 1 of 1976. Daily oil production was closely monitored and no negative production effects were observed due to the curtailment of gas injection. This was due to the fact that at this point in time the reservoir oil had probably been fully saturated with gas; and no additional improvement in oil recovery could be expected by the continued injection of gas. Water injection has continued to the present.

In 1977 the Lower Hospah formation was modeled to simulate drainage and coning radially about the wellbore. Based upon the conclusions from the study, pump capacity was increased, wherever possible, and wells were deepened and/or re-perforated to open up more of the net pay interval. As a result of these workovers, production from the reservoir increased twofold.

Starting in 1978, as the result of the rapidly declining oil cut occurring in the Lower Hospah waterflood, enhanced oil recovery (EOR) alternatives were investigated. Consequently, in 1980, it was proposed that an insitu combustion project be initiated.

PILOT DEVELOPMENT

Actual field work on the Lower Hospah combustion pilot began in August, 1980. The pilot pattern was a small inverted five-spot. It was designed to include two existing wellbores (#48 and #18) and required the drilling of three new wells (#65, #66, and #67), see Figure 3. The total pattern area was approximately six tenths of one acre.

Hospah #18 was originally an Upper Hospah producer, and was recompleted to the Lower Hospah for the pilot project. Hospah #48 was originally equipped with a REDA submersible pump, which was replaced with a rod pumping unit in an effort to prevent gas locking. The Hospah #48 was an open-hole completion in the Lower Hospah. In addition, two new producing wells were drilled and completed, #65 and #66. Wells #18, #65 and #66 were cased hole completions.

A dual air injection well was drilled in the center of the pilot. Although this well was set up to inject air into both the Upper and Lower Hospah zones, it was never used as an Upper injection well.

OPERATIONAL RESULTS

The pilot was operable on November 1, 1980. Ignition of the reservoir was attained on November 26, 1980, following 10 days of continuous air injection and the injection of 14.7 MMBTUs of heat. Air was injected continuously for 215 days until project termination on June 19, 1981.

The pilot project experienced a number of operational problems during the seven months of air injection. The most severe problems included corrosion induced pump failure and emulsification of the produced oil. Both of these problems were rectified by injecting chemicals down the annulus of the producing wells. Production and injection data is summarized in Table 2.

Air injection into the Lower Hospah combustion pilot was terminated on June 29, 1981. The production response to combustion was considered to be very disappointing, and project economics were poor. Before attempting to determine the reasons for the pilot's shortcomings, it was first necessary to determine how much oil was recovered via combustion and compare that recovery to the estimated pilot recovery potential.

DETERMINATION OF INCREMENTAL TERTIARY RECOVERY

Since the combustion pilot was surrounded by an active waterflood, it is difficult to ascertain how much production was due to the waterflood and how much was attributable to the combustion process. An incremental 'kick' in oil production occurred in mid-March 1981 and lasted 84 days (until June 10, 1981). This sudden increase in oil production was a result of the combustion process. The difference between total production and the production due to the surrounding waterflood (during the 84 day period) is the incremental tertiary recovery.

Figure 4 shows average daily production from the combustion pilot with an estimated waterflood decline. The shaded region represents the incremental tertiary recovery attributable to the combustion process. This recovery was calculated to be 2692 barrels of oil.

The waterflood decline line used in Figure 4 was derived from two numerical simulation studies. In both studies, a rapid decline in waterflood production was predicted. The reason for the steep decline was the extremely close spacing of the four wells and the general producing characteristics of the waterflood. The decline line as depicted in Figure 4 is an 'average' decline from the two modeling efforts.

EXPECTED COMBUSTION RECOVERY

After the three combustion pilot wells were drilled, it was found that the average pay thickness was only 15 feet over the pattern area. The oil zone was considerably thinner than originally anticipated (28 feet), but the average oil saturation in the pay interval was 48 percent.

From log derived values (porosity = 0.248, h = 15 feet, water saturation = 0.52) and a pattern area of 0.592 acres, the oil in place in the oil zone proper was determined to be 8200 STBO.

Not all of the 8200 STBO contained in the oil zone are actually producible via the combustion process. Some of this oil will be consumed as fuel. Combustion tube tests indicated an average fuel content of 217 BBLS/acre foot. Based upon the pattern area of 0.592 acres, the 15 foot oil zone contained 1927 BO that would be consumed as fuel. Therefore, the total producible oil in the pilot area (oil zone only) is the oil in place less the oil burned as fuel, or 6273 STBO.

Table 3 summarizes actual and potential recoveries from the Lower Hospah combustion pilot.

The potential recovery as estimated above considers only the oil zone. The sweep of the combustion front was ideally to be confined to the 15 foot oil zone. The additional oil contained in the transition zone (approximately 4000 STB) was not a recovery target. When the project was finally terminated, enough air had been injected to burn 1.35 times the oil zone rock volume, but actual recovery was only 43 percent of the potential oil recovery.

The rate response to the combustion process was also low, and the incremental production response occurred nearly three months later than initially predicted. Recovery predictions were formulated using the Gates - Ramey, Brigham et al methods, (1) (2) and numerical simulations. When the incremental production response did not occur in early January, 1981, the overall success of the pilot was in question.

The combustion pilot was modeled using Intercomp's In Situ Combustion Simulator - BURNSIM. Preliminary reports from Intercomp indicated that a combustion production response would be seen in late January, 1981. Here again, the available prediction was far too optimistic concerning the time to incremental response. The simulator also predicted a cumulative combustion recovery of 3700 STBO by mid-April, 1981, which is 35 percent more than was ultimately recovered in mid-June, 1981.

In summary, the Lower Hospah combustion pilot recovered 2692 STBO, which was considerably less than volumetric potential and simulator predictions. The incremental response to combustion was observed nearly three months later than anticipated from the various prediction methods.

DEVELOPMENT OF THE POST WATERFLOOD RESEVOIR MODEL

Before the completion of the three combustion pilot wells (#'s 65, 66 and 67), it was estimated that they would encounter 28 net feet of oil pay at an average oil saturation of 39 percent. However, once these wells were drilled, the open hole logs indicated an average net pay thickness of only 15 feet at an average oil saturation of 48 percent. This discrepancy is a result of waterflood underrunning. A study of the Lower Hospah waterflood displacemnt mechanism provided valuable information for the combustion evaluation.

The saturation profiles derived from the 1980 combustion pilot wells indicate that the reservoir is divided into three layers. These layers are an oil zone that has not been influenced by the waterflood, a waterflooded 'swept region' or transition zone, and a water zone. This three layer model is described in Table 4.

This model is an average of log derived properties for the three new combustion wells (#65, #66, and #67). The 15 feet of net pay in the above table is an average of the three wells' net pay height. The permeabilities used in the model were taken from the core report from well #65 (3) and represent a geometric average over the section indicated.

This model would accurately describe the pilot reservoir characteristics in the quadrants around wells #65, #66, and #18. However, it is probably not a good description of the Lower Hospah interval in the vicinity of well #48. Well #48 had been producing from the Lower Hospah since 1971, whereas none of the other pilot wells were Lower Hospah producers prior to project start-up. It is reasonable to assume that an additional coned volume of 'swept region' exists around #48's wellbore. Therefore, the oil saturation in well #48's quadrant of the pilot would be very low, and nearly equivalent to the oil saturation in the transition zone as listed in Table 4.

The radius at the base of the coned volume (at the oil zone - transition zone interface) can be estimated on the basis that 1200 BBLS of oil were produced from this coned volume as estimated from the waterflood study. By assuming that an oil saturation change of 0.307 (the difference in So between the oil zone and the transition zone in Table 4) resulted from water sweeping through the coned volume, a coned radius of 75 feet is calculated. Figure 3 illustrates the water coning radius around well #48 and its relation to the rest of the pilot. This figure indicates that nearly one-fourth of the pilot area was comprised of reservoir rock with a substantially reduced oil content. In this quadrant, a three layer mathematical model can be described as in Table 5.

For this model, the height of the oil zone was taken as the ten feet seen in well #67. The oil saturation in the oil zone (0.313) was an average of the oil saturation in the top ten feet of well #67 and the oil saturation in the top ten feet (as estimated) in well #48.

The Lower Hospah reservoir model consists of a thin, highly saturated, pay interval above a thicker, transition zone at very low oil saturations. The low oil saturations in the transition zone were due to seven years of water injection sweeping through the layer. Lower absolute permeability in the oil zone and high saturations of viscous crude oil (55 cp), forced the injected water to preferentially avoid this upper oil zone. It is very likely that the injected air also migrated through the transition zone during combustion pilot operations.

INTERIOR CORE HOLE EVALUATION

In July of 1981, two core holes were drilled in the pattern area as depicted in Figure 3. The primary purpose of the core holes was to determine the vertical sweep efficiency of the combustion front. Core Hole #1, drilled approximately 60 feet away from the air injection well, revealed that the top ten feet of the reservoir were partially oil saturated and that the next eighteen feet of reservoir were completely burned. Core hole #2, which was drilled only thirty feet away from the air injection well showed that the top seventeen feet of the Lower Hospah sand were cleanly burned (the very top four feet were lost in the coring process) and the next twenty-three feet were partially burned.

These descriptions indicate that the oil zone close to the air injection well was burned completely. As the burn front moved away from the injection well, it migrated down into the transition zone, and propagated through this lower, less oil saturated region. The air injection well was perfortated only in the top 10' of the Lower Hospah sand, forcing the air, initially, into the oil zone. It is likely that as the steam and combustion gases migrated away from the burn front, they were channeled downward by high vertical permeability and decreasing oil saturations. Lower oil saturations result in increased relative permeability to the leading hot water bank.

It is interesting to note that in Core Hole #1, the top two feet of the reservoir was not influenced by combustion. The permeability in this streak of rock is relatively low (~ 65 MD) and evidently prevented air flux through this interval. The coal seam above the Lower Hospah sand was cut in Core Hole #1, but not recovered. It is reasonable to assume that the tight uppper two feet of Lower Hospah sandstone prevented air from contacting the coal, and therefore, the possibility of coal combustion is discounted. The fact that the coal was recovered in Core Hole #2 adds credence to the conclusion that the coal seam was not burned.

The description of both core holes indicated that the combustion process influenced the top forty feet of the Lower Hospah interval. This confirms the notion that the injected air was not confined to the fifteen foot thick oil zone. The combustion influence over this thicker interval resulted in a slowly moving combustion front.

Figure 5 is an illustration of the likely path of the burn front along a north-south cross section. Figure 6 is the same illustration along an east-west cross section. Table 6 tabulates the post combustion reservoir zones along with the average oil saturation in those zones prior to combustion.

The first column of oil saturations represents the average saturation in the respective zones prior to the combustion project in the quadrants surrounding wells #66, #18, and #65. The second column of oil saturations represents the inital conditions in #48's quadrant of the pilot.

Table 7 compares the absolute transmissibility of the three zones prior to combustion.

This table demonstrates that even on an absolute permeability basis, the upper zone contained only a small percentage of the reservoir's total transmissibility. If the high oil saturations initially present were considered, this percent of total transmissibility would be further reduced. Based upon this comparison, it is obvious that nearly all of the injected air migrated through the lower two zones (cleanly burned and lower partially burned).

The upper zone appeared to be altered by the combustion process because the heat of combustion drained some oil from this zone, i.e., thermal displacement (but not combustion). The lower zone appeared to be partially burned. Partial burning in this zone (evidenced by alternating streaks of clean rock and coke) was temperature controlled. Here, it is likely that heat loss to the aquifer prevented the attainment of sufficient combustion temperatures. Coke was deposited in the normal manner, but it was not burned as the air passed through the region.

The combustion front swept through the lower oil zone and transition zone according to the post-combustion model described in Table 7. From this model, it is evident that a good deal of rock was burned that contained low oil saturations, and therefore, combustion pilot recovery was low. Also, the lack of combustion front confinement to the thin oil zone resulted in a much slower rate of front propagation, and the response to combustion was delayed.

From the general coke combustion Equation (1) Poettmann (4) (5) derived a series of relationships that can be used to calculate the volume of air required to burn one cubic foot of reservoir, and the volume of air required to displace one barrel of oil. From these two parameters, the amount of air injected, the fuel content, and the reservoir model, the theoretical Lower Hospah oil displacement can be calculated. If theoretical oil displacement, as predicted by stoichiometry, is similar to actual recovery near the end of the project life, the model can be said to be realistic.

The data needed to perform this stoichiometric evaluation is obtained from effluent gas analysis. The analysis should be on a water-free, hydrocarbon free basis, with only O_2, N_2, CO_2, and CO present. Stoichiometric constants are calculated from the mole fractions of the constituent gases according to the following equations:

The general coke combustion reaction:

$$CH_n + \left[\frac{2m+1}{2m+2} + \frac{n}{4}\right] O_2 \longrightarrow$$

$$\left[\frac{m}{m+1}\right] CO_2 + \left[\frac{1}{m+1}\right] CO + \frac{n}{2}\ H_2O \qquad (1)$$

From effluent gas compositions:

$$m = \frac{y_{CO_2}}{y_{CO}} \qquad (2)$$

$$n = \frac{1.06 + 2\ y_{CO} - 5.06\ [y_{O_2} + y_{CO_2} + y_{CO}]}{y_{CO_2} + y_{CO}} \qquad (3)$$

$$e_{O_2} = \frac{1 - y_{CO_2} - y_{CO} - 4.76\ y_{O_2}}{y_{N_2}} \qquad (4)$$

A number of combustion process variables can be determined from the calculated values of m, n, and e_{O_2}. Those relationships used in this evaluation are as follows:

$$F_{pa} = 0.21\left[4.76 - e_{O_2} + \frac{e_{O_2}}{\frac{2m+1}{2m+2} + \frac{n}{4}}\right] \qquad (5)$$

$$a_R = \frac{379}{0.21\ e_{O_2}}\left[\frac{2m+1}{2m+2} + \frac{n}{4}\right]\left[\frac{1}{12+n}\right] F_F \qquad (6)$$

$$R_A = \frac{5.615\left[\frac{2m+1}{m+1} + \frac{n}{2}\right] F_F}{1.109 \times 10^{-3}\ (12+n)\ (\phi)\ (S_O - S_{Fr})\ e_{O_2}} \qquad (7)$$

$$S_{Fr} = \frac{F_F}{\phi\ \rho_o} \qquad (8)$$

Effluent gas compositions were measured during the combustion pilot using portable ORSAT equipment, numerous samples were also sent to the laboratory for chromatographic analysis. These analyses were performed on a daily basis for the first month of air injection. Once there was sufficient evidence that the reservoir was burning, the compositions were measured every couple of weeks. Gas analysis was discountinued on February 17, 1981. Compositions were measured at each well, then a volume weighted pilot average composition was calculated for the given test day.

It is reasonable to assume that the laboratory derived compositions would be more accurate than those done with portable field equipment. Table 8 shows two sets of average pilot compositions. Pilot average #1 is the arithmetic average of the compositions from both the ORSAT and laboratory derived analysis. Pilot average #2 is the arithmetic average of only the laboratory measured values.

The major discrepancy in the two averages compared in Table 8 is the oxygen content. An oxygen content in the vicinity of 3% is more consistent with the combustion tube effluent gas compositions.

Stoichiometric constants and air requirements were calculated for each of the average compositions listed in Table 8 and are shown in Table 9. Fuel content (F_F) was taken as 1.69 lbs/cu ft, which is an average of the fuel content values from the two combustion tube tests.

The constants as calculated from the pilot average #2 (m = 8.241, n = 1.859, e_{O_2} = .856, air requirement = 363 SCF/CF) are considered to be the most representative of the pilot combustion process. There are two primary reasons for this choice. First, this average represents compositions measured chromatographically in a laboratory, which should yield more accurate analyses. Second, this average yielded a value of n which is less than two. In theory, the H/C ratio for a complex carbon molecule will approach 2. The H/C ratio for combustion projects is typically between 1.0 and 2.0. The value of n calcualted for this composition average was 1.859, which compares well with the value from burn tube test #1, both calculated, and measured. Moreover, pilot average composition #1 yielded a H/C ratio of 2.66, which is high even when possible gas analysis error is considered. Similarly, all of the compositions measured with the portable field equipment yield an H/C ratio greater than two, and some even greater than three. In summary, the average effluent gas composition #2, as listed in Table 8, yields stoichiometric constants that agree most closely with combustion tube lab work and most accurately represent a combustion reaction.

The remainder of this evaluation is based upon the following stoichiometric constants:

m = 8.241
n = 1.859
e_{O_2} = .856
Air requirement = 363 SCF/CF
Fuel Content = 1.69 Lbs/cu ft

Table 10 summarizes pertinent data from the time of ignition (11/26/80) to the end of the incremental production response (6/10/81).

To confirm the validity of the stoichiometric coefficients, the ratio of produced gas to injected air was calculated using Equation 5. This number was compared to the actual field results obtained by dividing cumulative gas production by cumulative air injected corrected for air stored behind the combustion front. The results are as follows:

Stoichiometry	0.957	SCF Gas/SCF Air
Field Data	0.973	SCF Gas/SCF Air

Good agreement was obtained between the stoichiometric prediction and actual data.

The next step in the evaluation was to calculate the volume of air necessary to displace one barrel of oil. Since this calculation (Equation 7) is dependent upon initial oil saturation, it was performed for each air swept layer in the post-combustion reservoir model. The calculation was performed twice (since it is assumed that only the lower two zones in the post-combustion model were subjected in to air-flux) for the quadrant surrounding well #48, and twice for the remainder of the pilot.

In the vicinity of well #48, the cleanly burned zone had an initial oil saturation of 0.183. The calculated air required to displace one barrel of oil is 121,888 SCF. For the lower partially burned zone around well #48, the initial oil saturation is 0.157. Here, the air required to displace one barrel of oil is 207,539 SCF. It should be obvious that the air injected into this quadrant of the pilot reservoir yielded a very low oil recovery.

In the remainder of the reservoir, the initial oil saturation in the cleanly burned zone was 0.286, here the air/oil displacement ratio was 46,259 SCF/BBL. The lower partially burned zone was at the same initial saturation (0.157) over the entire pilot area, so here too, the air required to displace one barrel of oil is 207,539 SCF.

The stoichimetrically derived oil displacement for each layer can be obtained by dividing the amount of air consumed in each zone by the air oil ratios from above.

The air injected is either consumed at the combusion front or stored behind the combustion front. In order to estimate the amount of air actually used in the combustion process, it is necessary to calculate the stored volume and subtract that from the injected volume. Assuming that the average displaceable oil saturation over the interval influenced by combustion (the top 40 feet) is 0.159 (average So minus fuel saturation), the reservoir voidage associated with the 2692 STB is 95,066 CF (remembering that the region behind the combustion front is 100% air saturated). Assuming a bottom hole temperature of 340°F and a pressure of 350 Psi, the air stored behind the front is 1.46 MMSCF. The average temperature behind the burnfront, 340°F, was taken as a linear average between the temperature at the injection well perforations (80°F) and the temperature at the combustion front (600°F). Subtracting 1.46 MMSCF from the total air injected as listed in Table 10 yields 173.41 MMSCF air used at the burn front.

The amount of air that entered well #48's quadrant can be estimated from the amount of effluent gas produced at well #48. This well accounted for 13.95 percent of the total pilot gas production. Since the ratio of produced gas to injected air is constant, 13.95 percent of the air used at the combustion front was consumed in well #48's quadrant. The remaining 86.05 percent of the used air was consumed in the other three quadrants. Since the saturation model is the same for the reservoir surrounding well's #65, #66, and #18, it is not necessary to further divide the model. The actual volume of air consumed in well #48's quadrant was 24.20 MMSCF; 149.21 MMSCF of air was consumed elsewhere in the pilot.

It is also necessary to determine the amount of air that entered each of the two layers in the post combustion models. Table 7 shows that the cleanly burned zone contains 26,478 md ft of absolute transmissibility. The lower partially burned zone contains 14,840 md ft of absolute permeability. As was stated previously, it is assumed that all of the injected air entered these lower two layers. Normalizing the transmissibility contained in these two layers indicates that the cleanly burned zone contributed 64.08 percent of the total transmissibility, and the lower partially burned zone contributed 35.92 percent of the total transmissibility. The volume of air injected into a saturation region was fractioned into the cleanly burned zone and the lower partially burned zone according to these absolute transmissibility percentages. This method does not account for the relative permeability effects of the different oil saturations present in each layer. At such low oil saturations, it is doubtful that the relative permeabilities to air would differ. Moreover, data was not available to calculate any possible relative permeability effects.

From the above analysis it is possible to calculate the amount of air used in each layer in the two different saturation 'regions' of the pilot. From these air volumes and the calculated air/oil displacement ratios for each layer, the stoichiometrically derived displacement for that layer is determined. The results of the calculations are presented in Table 11.

The total displaced oil as calculated from stoichiometry is 2494 STB. This number is fairly close to the 2692 of actual production. Since the produced oil is greater, the difference is probably due to thermally displaced oil in the upper unburned zone, amounting to approximately eight percent of total production.

The average air/oil displacement ratio was 69,547 SCF/BBL for the entire Lower Hospah pilot project. This average was obtained by dividing the total air consumed by the total oil displaced as listed in Table 11. An air/oil displacement ratio of 69,547 SCF/BBL is extremely high. The air/oil production ratio observed in Marathon's Fry Project (6) was 17,323 SCF/BBL. This large difference in air comsumption is the primary reason the Fry project was economically successful and the Lower Hospah project was not.

The reasons that the air/oil displacement ratio was so high in the Lower Hospah combustion project were high fuel content and low oil saturation. The denominator of Equation 8 contains the difference ($S_o - S_{Fr}$), where S_{Fr} is the fuel saturation and S_o is the oil saturation (both as a fraction of pore space). This difference is the "displaceable - oil" saturation. The fuel saturation for the Lower Hospah project was 0.12 (Equation 9). In some of the burned regions, the oil saturation was as low as 0.157, yielding a difference ($S_o - S_{Fr}$) of less than 0.04. This small displaceable oil fraction resulted in very high air/oil displacement ratios, and low pilot recovery.

The models yielded very good agreement between stoichiometrically calculated displacement and actual production. It is concluded that the reservoir model described in Tables 4 and 5, and the combustion front sweep model described in Table 6 accurately described the Lower Hospah combustion pilot.

AREAL SWEEP

The position of the burn front can be estimated from the air used in each quadrant's cleanly burned zone. The area of burned rock was calculated for each quadrant and summarized below.

The radii listed in Table 12 describe the position of the burn front assuming radial propagation into each quadrant. These radii are illustrated in Figure 7. It is more likely, however, that the actual shape of the combustion front was elliptical as illustrated in Figure 8. This illustration is consistent with total area as calculated in Table 12. It is also consistent with temperature data which showed elevated production temperatures at wells #65 and #66, while production from #48 and #18 remained at reservoir temperature. The (oval) burn front being closer to #65 and #66 caused this temperature response.

Based on a total area swept of 0.413 acres, the oil contained in the upper zone was 1547 STB. According to the stoichiometric displacement/actual production comparison, 200 STB were displaced from this zone. This is equivalent to 13% recovery from the upper oil zone. Typically, thermal displacement in zones adjacent to the burn front ranges from 20 to 40 percent, as cited in the literature (1, 7). Thermal recovery in the non-air swept layer was low in the Lower Hospah combustion pilot. This was probably due to the high saturations of highly viscous crude blocking the migration of the viscosity reduced oil bank through the upper zone (liquid blocking).

The oval shape of the burn front could have resulted from directional permeability. An analysis of the waterflood and associated producing water cuts did not support the existence of directional permeability in the Lower Hospah. The best explanation is probably completion quality. Wells #65 and #66 were newly drilled and completed. Well #48 was an open hole completion drilled in 1971. Well #18 was originally drilled through the Lower Hospah in 1969, but was then completed as an UH producer. It was recompleted to the Lower Hospah for the pilot project, and may have suffered some wellbore damage over the years. The new completions were greater pressure sinks within the pattern area, and the combustion front preferentially migrated towards them.

CONCLUSIONS:

1) The Lower Hospah Pilot Project was successful in sustaining combustion and recovering incremental oil. A total of 2692 STB of tertiary oil was produced via the combustion process.

   The project was not economically successful due to the preferential path of the combustion front. High air injection costs compounded economic failure.

2) The injected air perferentialy migrated through the transition zone and upper water zone, processing reservoir rock containing low oil saturations.

3) The upper portion of the oil zone did not burn due to a lack of air-flux. The injected air was preferentially under-running this layer of the reservoir. Some oil was displaced from this upper zone as the heat from the nearby combustion front enhanced the oil mobility. The lower-most zone influenced by combustion was partially burned as evidenced by coke streaks found in the interior core holes. This partial burning resulted from heat loss to the aquifer. Temperatures were insufficient for substaining combustion.

4) Stoichiometric analsyis indicated that 2494 STBO were displaced directly by the combustion process. Actual production was 2692 STBO. The difference between actual production and the stoichiometric displacement, approximately 200 STBO, is due to thermal oil displacement from the upper, unburned layer. The Stoichiometric Equations provided a reliable means to quantitatively compare the pilot reservoir model to actual combustion performance and identify the reasons for the pilots lack of recovery.

5) The average air/oil displacement ratio was 69,547 SCF/BBL. This ratio is extremely high for combustion projects. The high air/oil displacement ratio observed in the Lower Hospah combustion project caused the economic failure. The high air/oil displacement ratios resulted from low oil saturations in the burned regions and relatively high fuel saturations. In some portions of the reservoir processed by combustion, the difference between oil saturation and fuel saturation was less than 4 percent.

NOMENCLATURE

a_R = Standard cubic feet of air necessary to burn on:cubic foot of reservoir.

E_{AS} = Areal Sweep Efficiency

e_{o_2} = Oxygen utilization efficienty, fraction

F_F = Fuel content, pounds coke per cubic foot of reservoir

F_{pa} = Moles of combustion gas produced per mole of air injected, Standard cubic feet of combustion gas produced per standard cubic foot of air injected.

m = Molar ratio of CO_2 to CO in produced gas.

n = Atomic hydrogen to carbon ratio of fuel.

ϕ = Porosity, fraction.

R_A = Standard cubic feet of air necessary to displace one barrel of oil.

ρ_o = Density of oil, pounds per cubic foot.

S_{Fr} = Equivalent saturation of fuel, fraction.

S_o = Oil saturation, fraction.

y = Mole fraction or volume fraction in combustion gases.

Acknowledgment

The authors wish to extend their appreciation to Tenneco Oil Company for releasing reservoir and production data on the Lower Hospah Formation of the South Hospah Field, McKinley County, New Mexico for the purpose of documenting and evaluating their insitu combustion pilot test in this reservoir.

This paper is a summary of a thesis submitted to the Colorado School of Mines in partial fulfillment for the requirements for the Degree of Master of Engineering in Petroleum Engineering by Stephen M. Struna. The thesis is available from the Colorado School of Mines Library.

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2. Brighham, W.E., Satman, A., and Soliman, M.Y., "Recovery Correlations for In Situ Combustion Field Projects and Application to Combustion Pilots," J. Pet. Tech. (Dec. 1980) 2132-2138.

3. "Core Analysis Report Hospah #65," Core Laboratories, Inc., Aurora, CO. (Dec. 8, 1980)

4. Benham, A.L. and Poettmann, F.H., "The Thermal Recovery Process -An Analysis of Laboratory Combustion Data," Trans., AIME. (1958) 213, 83-85. Supplemented by personal lecture notes from F.H. Poettmann.

5. Poettmann, F.H., Schilson, R.E. and Surkalo, H., "Philosophy and Technology of In Situ Combustion in Light Oil Reservoirs," The Proceedings of the Seventh World Petroleum Congress (1964), Gallard Limited, Great Yarmouth England; 487-498.

6. Howell, J.C., Peterson, M.E., "The Fry In Situ Combustion Project Performance and Economic Status," paper SPE 8381, presented at the 54th SPE Annual Fall Meeting, Las Vegas, Nevada, Sept. 23-26, 1979.

7. Nelson, T.W. and McNeil J.S., "How to Engineer an In Situ Combustion Project," Oil and Gas J. (June 5, 1961) 59, 23, 58-65.

S.I. METRIC CONVERSION FACTORS

acre	x	4.046873	E+03	= m^2
°API		141.5/(131.5 + °API)		= g/cm^3
bbl	x	1.589873	E-01	= m^3
BTU	x	1.05480	E+03	= J
cp	x	1.0* E-03	= Pa·s	
ft	x	3.048*	E-01	= m
°F		(F-32)/1.8		= °C
in	x	2.54* E+00	= cm	
lbm	x	4.535924	E-01	= kg
psi	x	6.894757	E+00	= kPa
cu ft	x	2.831685	E-02	= m^3
sq ft	x	9.290304*	E-02	= m^2

*CONVERSION FACTOR IS EXACT

TABLE 1
ORIGINAL RESERVOIR AND FLUID PROPERTIES

Average Depth	1625'
Lithology	Sandstone
Average Thickness	28 net feet
Porosity	27%
Initial Water Saturation	35%
Irreducible Water Saturation	25%
Average Horizontal Permeability	1100 md
Average Vertical Permeability	1205 md
Reservoir Temperature	80 F
Initial Reservoir Pressure	600 psi
Oil Gravity	25.8 API
Specific Gravity	.8996
GOR	0 MCF/STB
Formation Volume Factor	1.00 RB/STB
Viscosity	55 CP @ 80 F

TABLE 2
LOWER HOSPAH COMBUSTION PILOT
PRODUCTION SUMMARY
(10/31/80 - 6/29/81)

Days Air Injected	215 Days
Cumulative Air Injected	192.83 MMCF
Cumulative Oil Produced	11,814 STB
Cumulative Gas Produced	183.31 MMCF
Cumulative Water Produced	254.817 BW

Individual Well Oil and Gas Production Statistics

WELL	CUM. OIL * (STB)	CUM GAS (MCF)
#18	3134	23283
#48	678	25551
#65	5083	85851
#66	2919	48622

* Individual well production was not reported daily. Cumulative oil above was estimated from an average daily rate multiplied by total producing days. Totals were normalized to equal pilot total.

TABLE 3
ACTUAL AND POTENTIAL PROJECT RECOVERIES

Oil Zone - Oil in Place	8200 STB
Oil Zone - Fuel Content	1927 BO
Combustion Recovery Potential	6273 STB
Actual Recovery	2692 STB
% Oil in Place Recovered	32.8%
% Potential Recovery Realized	42.9%

TABLE 4
COMBUSTION PILOT POST WATERFLOOD RESERVOIR MODEL

ZONE	h [ft]	So	K_{ABS} [md]	Ø (%)	Kv/Kh	K_{eff} Water [md]
Oil	15	0.474	1253	24.8	1.01	88
Transititon	18	0.167	1416	25.2	0.80	538
Water	11*	0.146	1060	25.2	1.25	477

* Actual water zone is 65', but only the top 11' were used in the averages to make the reservoir model approximately 40 ft. thick. Forty feet was the thickness of the zone influenced by combustion.

TABLE 5
#48 QUADRANT POST WATERFLOOD RESERVOIR MODEL

ZONE	h [ft]	So	K_{ABS} [md]	Ø (%)	Kv/Kh	K_{eff} Water [md]
Oil	10	0.313	620	24.8	1.01	99
Transition	23	0.167	1397	25.2	0.93	559
Water	11*	0.146	1060	25.2	1.25	477

* Actual water zone is 65', but only the top 11' were used in the averages.

TABLE 6
POST-COMBUSTION RESERVOIR MODEL

ZONE	h [f]	Initial So (66,65,18)	Initial So (48)	Kv/Kh	K_{ABS} [md]
Upper Zone	8	0.474	0.313	0.99	596
Cleanly Burned	18	0.286	0.183	1.02	1471
Lower Partially Burned	14	0.157	0.157	1.25	1060

TABLE 7
TRANSMISSIBILITY OF POST COMBUSTION BURNED ZONES

	h [ft]	K_{ABS} [md]	Kh [md ft]	Transmissibility
Upper Zone	8	596	4768	10.35%
Cleanly Burned	18	1471	26478	57.45%
Lower Partially Burned	14	1060	14840	32.20%
			46086	

TABLE 8
AVERAGE PRODUCED GAS COMPOSITIONS

Pilot Average	$\%N_2$	$\%O_2$	$\%CO_2$	%CO
#1	85.2	1.60	11.20	2.00
#2	83.4	3.20	11.95	1.45

TABLE 9
STOICHOMETRIC CONSTANTS AND AIR REQUIREMENT COMPARISON

	CO_2/CO RATIO m	H/C RATIO n	O_2 EFFICIENCY e_{O_2}	AIR REQUIREMENT [SCF/CF]
Pilot Avg #1	5.600	2.660	0.929	356
Pilot Avg #2	8.241	1.859	0.856	363

TABLE 10
STOICHIOMETRIC ANALYSIS DATA SUMMARY (11/26/80-6/10/81)

Cumulative Tertiary Production	2692 STB
Cum Air Injected	174.87 MMCF
Cum Gas Produced (Pilot)	168.84 MMCF
Cum Gas Produced (Well #65)	81.551 MMCF
Cum Gas Produced (Well #66)	43.097 MMCF
Cum Gas Produced (Well #48)	23.555 MMCF
Cum Gas Produced (Well #18)	20.641 MMCF
Avg So over total 40 Ft zone of combustion influence	0.279

TABLE 11
STOICHIOMETRICALLY DERIVED DISPLACEMENT

AREA	LAYER	AIR CONSUMED [MMSCF]	AIR/OIL DISPLACEMENT RATIO [SCF/BBL]	OIL DISPLACED [BBL]
Quadrant #48	Cleanly burned	15.51	121888	127
	Lower Partially Burned	8.69	207539	42
Quadrants #66, #65, #18	Cleanly burned	95.62	46259	2067
	Lower Partially Burned	53.59	207539	258
Totals		173.41		2494

TABLE 12
AREA OF CLEANLY BURNED ZONE BY QUADRANT

QUADRANT	ACRE (ACRES)	RADIUS (FT)
#18	0.051	53
#48	0.058	56
#65	0.199	93
#66	0.105	68
	0.413	

E_{AS} = 0.413/.592 = 69.76%

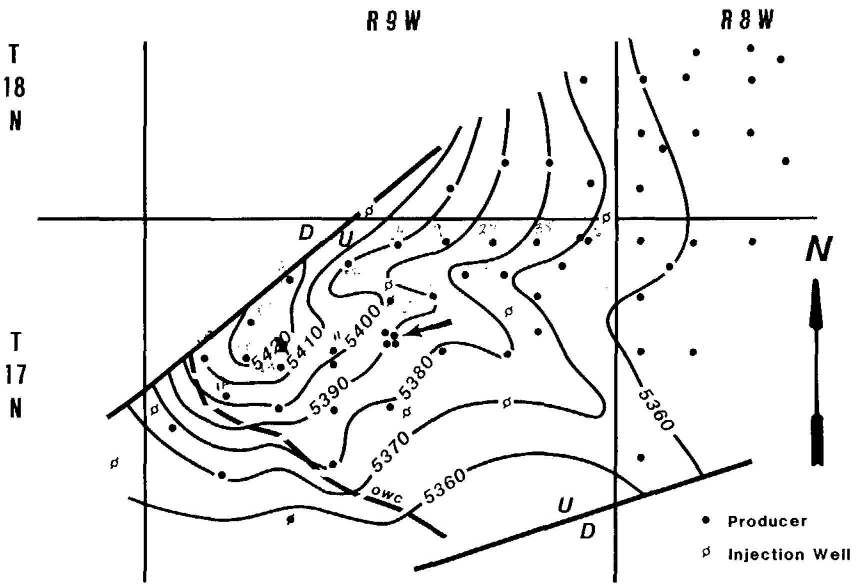


Fig. 1—Lower Hospah structure map (arrow locates pilot).

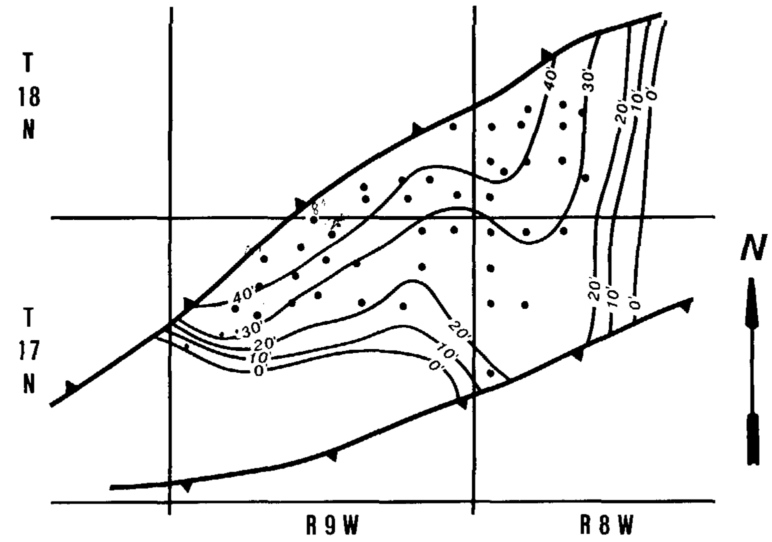


Fig. 2—Lower Hospah original (1967) net pay isopach map.

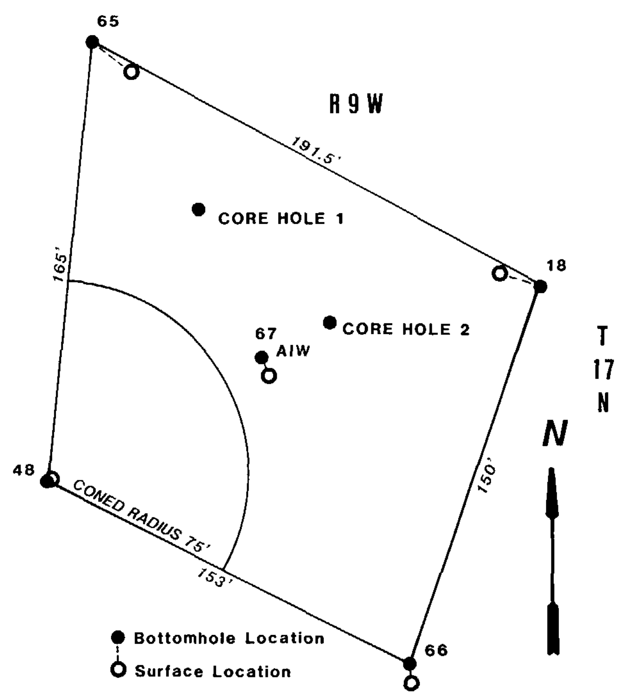


Fig. 3—Pilot pattern well location.

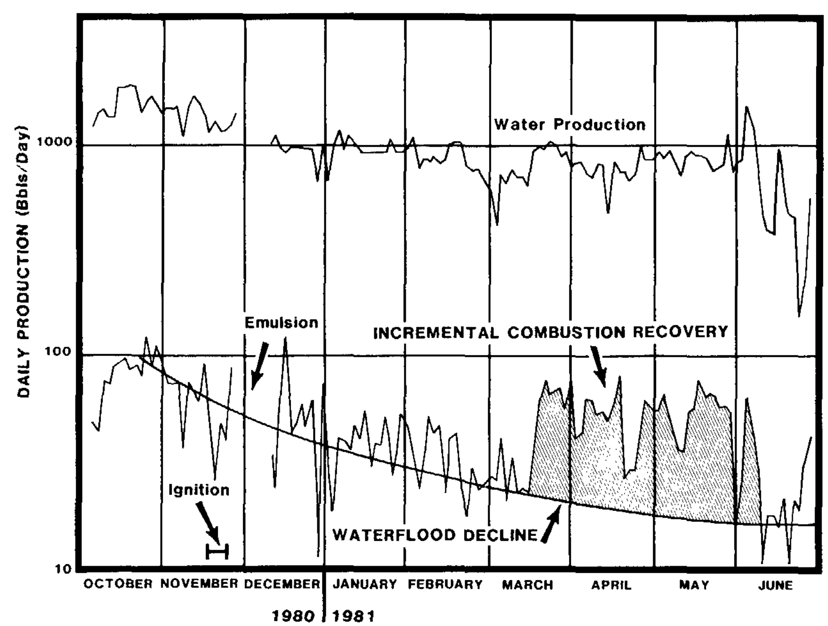


Fig. 4—Pilot production with waterflood decline.

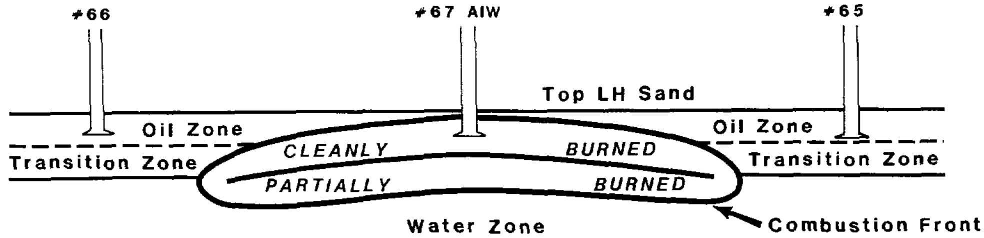


Fig. 5—Combustion front path (north-south cross section).

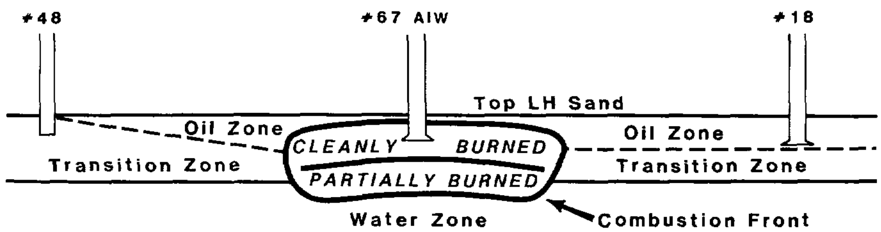


Fig. 6—Combustion front path (east-west cross section).

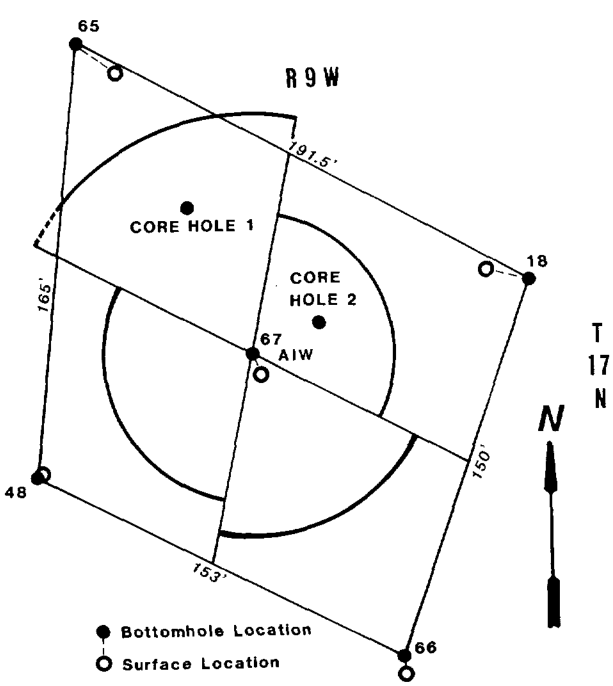


Fig. 7—Combustion front radii.

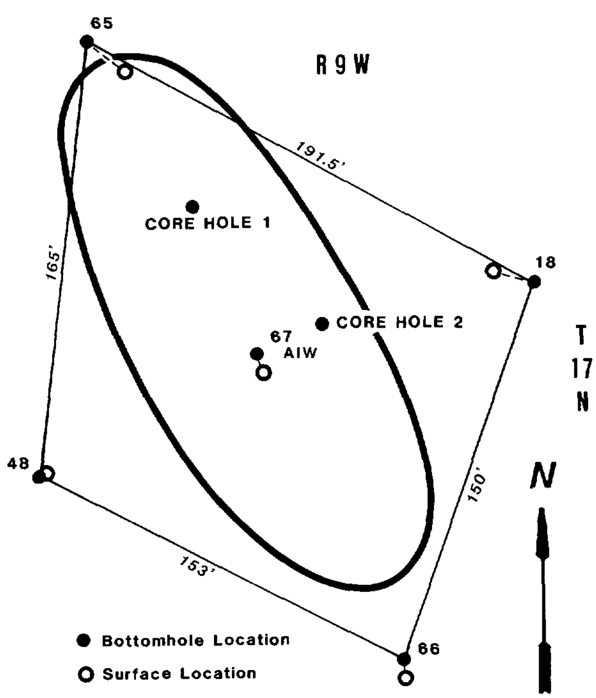


Fig. 8—Probable orientation of elliptical combustion front.

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 3660
Order No. R-3325

APPLICATION OF TENNECO OIL COMPANY
FOR A WATERFLOOD PROJECT AND FOR AN
EXCEPTION TO RULE 104 C I, McKINLEY
COUNTY, NEW MEXICO.

Also see R-3361

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on September 27, 1967, at Santa Fe, New Mexico, before Examiner Elvis A. Utz.

NOW, on this 4th day of October, 1967, the Commission, a quorum being present, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Tenneco Oil Company, seeks an exception to Rule 104 C I of the Commission Rules and Regulations to permit the drilling of more than one well per 40-acre tract, said wells being located closer than 660 feet to each other and each 40-acre tract subject to a single 40-acre allowable.

(3) That the applicant requests the above-described exception apply to both the South Hospah Upper Sand Oil Pool and the South Hospah Lower Sand Oil Pool and be applicable to Tenneco's leases comprising all of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico.

(4) That in order to allow Walker Brothers Oil Company and Tesoro Petroleum Corporation, operators in the subject pools, the

opportunity to produce their just and equitable share of the oil in the aforesaid pools without damage to the reservoir through excessive water coning, Walker Brothers Oil Company and Tesoro Petroleum Corporation were authorized by Order No. R-3270 to develop the S/2 of Section 6, the N/2 and SW/4 of Section 7, both in Township 17 North, Range 8 West, and the SE/4 of Section 1, Township 17 North, Range 9 West, NMPM, South Hospah Lower Sand Oil Pool and South Hospah Upper Sand Oil Pool, McKinley County, New Mexico, to a density of more than one well per 40-acre tract.

(5) That in order to prevent waste and protect correlative rights, the applicant, Tenneco Oil Company, an operator in the subject pools, should be allowed the opportunity to develop its leases in the subject pools to the same density as the Walker Brothers Oil Company's and Tesoro Petroleum Corporation's leases.

(6) That the applicant also seeks permission to institute a waterflood project by the injection of water into the Upper Sand of the South Hospah Upper Sand Oil Pool on its Hospah and Hospah "A" Leases through five wells located in Units A, B, F, G, and H of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico.

(7) That the wells in the project area are in an advanced state of depletion and should properly be classified as "stripper" wells.

(8) That the proposed waterflood project should result in the recovery of otherwise unrecoverable oil, thereby preventing waste.

(9) That the subject waterflood project should be approved, and that the waterflood project should be governed by the provisions of Rules 701, 702, and 703 of the Commission Rules and Regulations.

IT IS THEREFORE ORDERED:

(1) That the applicant, Tenneco Oil Company, is hereby authorized to develop its Hospah and Hospah "A" Leases comprising all of Section 12, Township 17 North, Range 9 West, NMPM, South Hospah Upper Sand Oil Pool and South Hospah Lower Sand Oil Pool, McKinley County, New Mexico, to a density of more than one well per 40-acre tract;

PROVIDED HOWEVER, that no well shall be drilled nearer than 330 feet to the outer boundary of said tract and no nearer than

200 feet to another well drilling to or capable of producing from the same pool;

PROVIDED FURTHER, that a 40-acre proration unit in the South Hospah Upper Sand Oil Pool or the South Hospah Lower Sand Oil Pool shall be subject to a 40-acre unit allowable for wells in the South Hospah Upper Sand Oil Pool or South Hospah Lower Sand Oil Pool, whichever is applicable, regardless of the number of wells on the unit.

(2) That the applicant is hereby authorized to institute a waterflood project in the South Hospah Upper Sand Oil Pool on its Hospah and Hospah "A" Leases by the injection of water into the Upper Sand through the following-described wells in Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico:

OPERATOR	LEASE	WELL NO.	LOCATION
Tenneco	Hospah	To be drilled	SW/4 NE/4 NE/4
Tenneco	Hospah	5	SW/4 NW/4 NE/4
Tenneco	Hospah	To be drilled	SW/4 SE/4 NW/4
Tenneco	Hospah	To be drilled	SW/4 SW/4 NE/4
Tenneco	Hospah	To be drilled	SW/4 SE/4 NE/4

(3) That the subject waterflood project is hereby designated the Tenneco South Upper Hospah Waterflood Project and shall be governed by the provisions of Rules 701, 702, and 703 of the Commission Rules and Regulations.

(4) That monthly progress reports of the waterflood project herein authorized shall be submitted to the Commission in accordance with Rules 704 and 1120 of the Commission Rules and Regulations.

(5) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

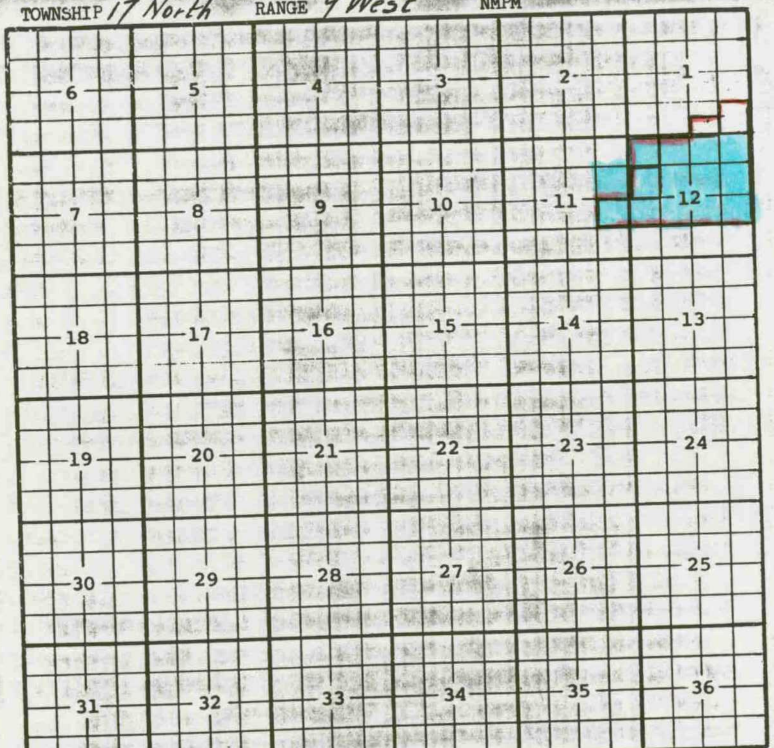
A. L. PORTER, Jr., Member & Secretary

S E A L

esr/

COUNTY McKinley POOL South Hospah Upper Sand Oil

TOWNSHIP 17 North RANGE 9 West NMPM



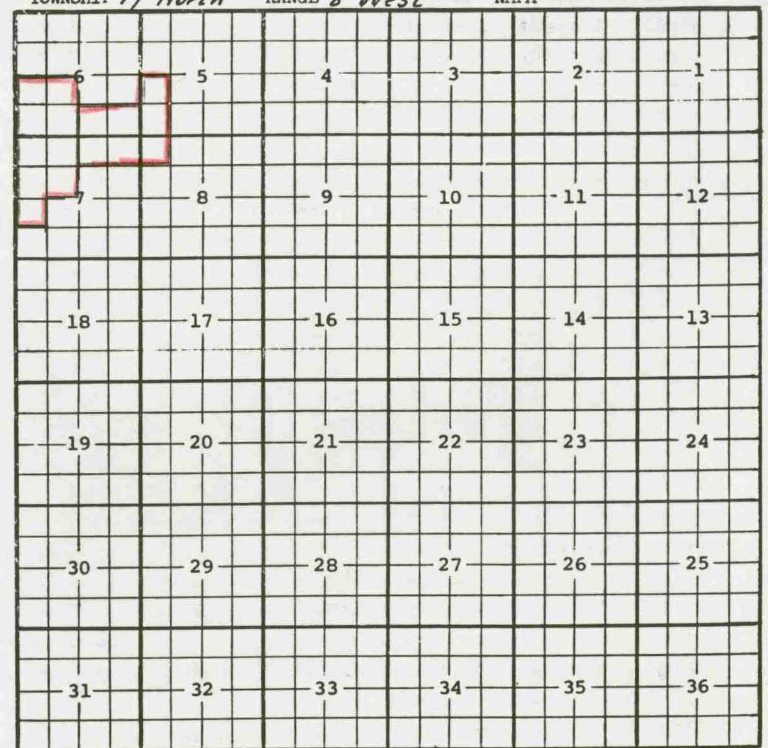
Description: SE/4 SE/4 Sec. 1; NE/4 SE/4 Sec. 11; NE/4, E/2 NW/4 & N/2 S/2 Sec. 12 (R-3170, 12-28-66)

Ext: SW/4 NW/4 Sec. 12 (R-3403, 5-1-68) - S/2 SW/4 SE/4 Sec. 1 (R-2797-A, 5-9-69)

Ext: NW/4 NW/4 Sec 12 (R-5779, 8-1-78)

COUNTY McKinley POOL South Hospah Upper Sand Oil

TOWNSHIP 17 North RANGE 8 West NMPM



Description: SW/4 Sec. 6; NW/4 & NW/4 SW/4 Sec. 7 (R-3170, 12-28-66)

Ext: W/2 SW/4 Sec 5, S/2 SE/4 Sec 6, N/2 NE/4 Sec 7, NW/4 NW/4 Sec 8 (R-5779, 8-1-78)

Rough Draft

STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION FOR THE PURPOSE OF CONSIDERING:

CASE NO. 10424
Order No. R-

APPLICATION OF CITATION OIL & GAS CORPORATION FOR DOWNHOLE COMMINGLING, MCKINLEY COUNTY, NEW MEXICO.

ORDER OF THE DIVISION

BY THE DIVISION:

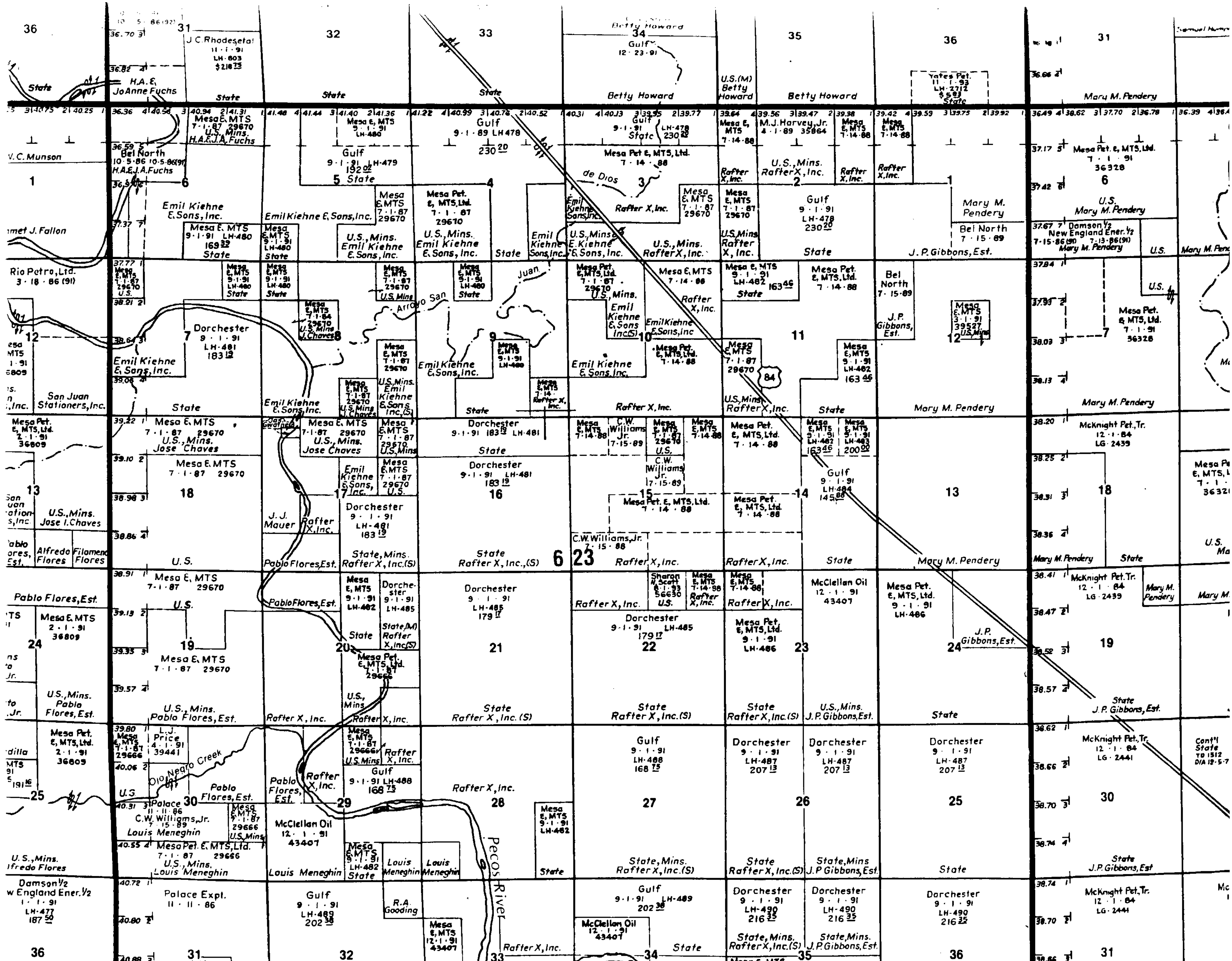
This cause came on for hearing at 8:15 AM on December 19, 1991, at Santa Fe, New Mexico, before Examiner Michael E. Stogner.

NOW, on this ____ day of ~~February~~ March, 1992, the Division Director, having considered the testimony, the record, and the recommendations of the Examiner, and being fully advised in the premises,

FINDS THAT:

(1) Due public notice having been given as required by law, the Division has jurisdiction of this cause and the subject matter thereof.

(2) That the applicant, Citation Oil & Gas Corporation ("Citation"), is the working interest owner and operator of the wells to be affected by this order.



J C Rhodes et al
H.A. & JoAnne Fuchs
V.C. Munson
Bel North
Emil Kiehne E. Sons, Inc.
Emil Kiehne E. Sons, Inc.
Gulf 9·1·91 LH·479
U.S., Mins. Emil Kiehne E. Sons, Inc.
Gulf 9·1·89 LH 478
Betty Howard
Gulf 12·23·91
U.S.(M) Betty Howard
M.J. Harvey, Jr. 4·1·89 35864
Mesa Pet. E, MTS, Ltd. 7·14·88
U.S., Mins. Rafter X, Inc.
Rafter X, Inc.
Mary M. Pendery
Bel North 7·15·89
J. P. Gibbons, Est.
Mesa Pet. E. MTS, Ltd. 7·1·91 36328
New England Ener.½
Rio Petro, Ltd. 3·18·86 (91)
San Juan Stationers, Inc.
Dorchester 9·1·91 LH·481
Arroyo San Juan
de Dios
Rafter X, Inc.
Mesa E. MTS 7·1·87 29670
U.S., Mins. Jose Chaves
U.S., Mins. Jose I. Chaves
Alfredo Flores
Filomeno Flores
J. J. Mauer
Pablo Flores, Est.
State, Mins. Rafter X, Inc.(S)
State Rafter X, Inc.,(S)
C.W. Williams, Jr. 7·15·88
Mary M. Pendery
McKnight Pet. Tr. 12·1·84 LG·2439
McClellan Oil 12·1·91 43407
Dorchester 9·1·91 LH·485
Dorchester 9·1·91 LH·486
U.S., Mins. J.P. Gibbons, Est.
U.S., Mins. Pablo Flores, Est.
Ojo Negro Creek
L.J. Price 4·1·91 39441
Palace 11·11·86
C.W. Williams, Jr. 7·15·89
Louis Meneghin
Gulf 9·1·91 LH·488
Dorchester 9·1·91 LH·487
Pecos River
U.S., Mins. Alfredo Flores
Damson½ New England Ener.½
Palace Expl. 11·11·86
Gulf 9·1·91 LH·489
R.A. Gooding
Dorchester 9·1·91 LH·490
State, Mins. Rafter X, Inc.(S)
State, Mins. J.P. Gibbons, Est.
Yates Pet. 11·1·93 LH·2712
84

( ) By Division Order No. R-4389, as amended by Order No. R-4389-A, the (Tenneco) Lower Hospah Pressure Maintenance Project was established for the purpose of injecting water and gas into the South Hospah-Lower Sand Oil Pool to recover secondary oil production from the "Hospah" ~~and Hospah "A" leases~~ Lease underlying the W/2 NE/4 and NW/4 of Section 12, Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico. By Division Administrative Order PMX-56(A), dated March 4, 1974, said Lower Hospah Project Area was expanded to include the E/2 NE/4 of said Section 12.

( ) The South Hospah Unit Area was approved by the U.S. Department of the Interior in 1968 for secondary recovery from the South Hospah Upper Sand Oil Pool underlying the N/2 and N/2 S/2 of Section 12 and the SE/4 NE/4 and NE/4 SE/4 of Section 11, both in Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico. Prior to unitization the Division by Order No. R-3325, dated October 4, 1967, authorized the (Tenneco) South Upper Hospah Waterflood Project in said Section 12 for the injection of water into the South Hospah-Upper Sand Oil Pool.

( ) The current operator of both projects ~~The applicant in this matter~~, Citation Oil & Gas Corporation, obtained 100 percent working interest ownership of said properties ~~and became operator of both projects~~ in November 1987.

( ) Currently there are 14 active oil producing wells and 8 water injection wells in the Upper Hospah, average daily oil production from said zone is 2.9 barrels of oil per day per well and approximately 41 barrels of water per day per well (41 BOPD and 3000 BWPD pool wide).

( ) The ~~2~~ Lower Hospah interval currently has 22 active oil producing wells and 9 water injection wells, average daily oil production pool wide is 132 barrels of oil per day (6 BOPD per well) and the pool wide daily water production ~~count~~ is approximately 15,000 barrels per day (682 BWPD per well).

~~( ) At this time Citation Oil & Gas Corporation seeks approval to downhole commingle oil production from both the South Hospah Upper Sand Oil Pool and the South Hospah Lower Sand Oil Pool within the wellbores of those wells located in the N/2 and N/2 S/2 of Section 12 and the SE/4 NE/4 and NE/4 SE/4 of Section 11, both in Township 17 North, Range 9 West, NMPM, McKinley County, New Mexico.~~

( ) Neither the Upper or Lower Hospah Pool produces any measurable amounts of gas.

~~( ) The applicant presented evidence showing that both projects are currently operating marginal in rapidly approaching their economic limits~~

I Michael E. Stozner, ~~and~~ in conjunction with ~~On behalf of myself~~ Linda M. Stozner, M.D. both residing at 701 Allen Street, Estancia, New Mexico 87016, ~~hereby~~ wish to be named as opponents to the application of Multi-Service for herein designated by the Environment Department as DP-840.

Further, Dr Stozner and I request a public hearing pursuant to the provisions of 3-108 of this matter for the following reasons:

We further pray the Director set said public hearing in the ~~County of~~ Torrance County Seat of Estancia so that residence of Torrance, water users within the designated water basin known as the Estancia Basin, local ~~interested~~ effected parties and all interested individuals and/or institutions may ~~be~~ appear and consider this matter, present evidence, have a reasonable chance to submit data, views or arguments orally and to question any ~~witnesses~~ of testifying witnesses. ~~which~~

~~By having said~~

~~hearing in Estancia~~ A hearing in Santa Fe, New Mexico would not provide all concerned an ampel opportunity to attend ~~the proceeding~~ this public forum which ~~would not~~ could result in ~~an~~ an incomplete ~~and~~ biased opinion with a ~~the~~ an presentation

( ) At this time Citation Oil and Gas Corporation

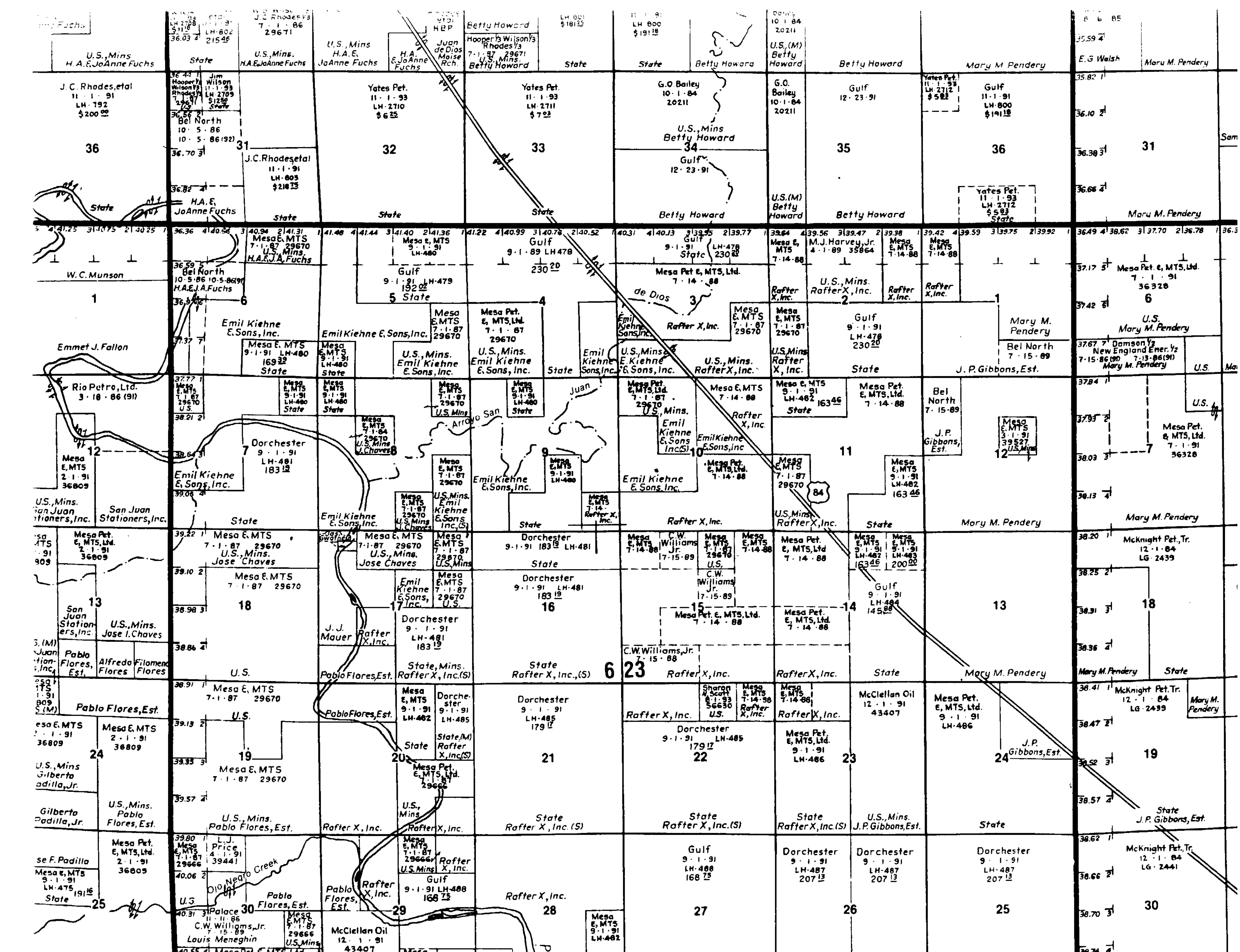
~~(3) Citation~~ seeks approval to downhole commingle oil production from the South Hospah Upper Sand Oil Pool and the South Hospah Lower Sand Oil Pool within the wellbores described on Exhibit "A" and Exhibit "B" attached and located in the N/2 of Section 12, T17N, R9W, N.M.P.M., McKinley County, New Mexico.

~~(4) Citation is 100% working interest owner of the production described in paragraph (1), above.~~

~~(5) Citation's operations in the South Hospah Upper Sand Oil Pool consists of a waterflood project of unitized federal leases while the Citation operations in the South Hospah Lower Sand Oil Pool consists of a similar waterflood project but conducted on a single federal lease.~~

~~(6) As of October, 1991, the South Hospah Upper Sand Oil Pool average total production from 14 producers was approximately 41 BOPD and 2300 BWPD and the South Hospah Lower Sand Oil Pool average total production from 22 producers was approximately 132 BOPD and 16,400 BWPD. Neither pool produces any measurable amounts of gas.~~

( ) The applicant presented evidence showing that both projects are rapidly approaching their respective economic limits and that



U.S., Mins
H.A.E. JoAnne Fuchs
J.C. Rhodes, etal
11 · 1 · 91
LH · 792
$200 00
36
Bel North
10 · 5 · 86
10 · 5 · 86 (92)
31
J.C. Rhodes etal
11 · 1 · 91
LH · 805
$218 75
H.A.E.
JoAnne Fuchs
State
Yates Pet.
11 · 1 · 93
LH · 2710
$6 25
32
Yates Pet.
11 · 1 · 93
LH · 2711
$7 03
33
Betty Howard
G.O. Bailey
10 · 1 · 84
20211
U.S., Mins
Betty Howard
34
Gulf
12 · 23 · 91
U.S. (M)
Betty Howard
35
Gulf
12 · 23 · 91
36
Gulf
11 · 1 · 91
LH · 800
$191 18
Yates Pet.
11 · 1 · 93
LH · 2712
$5 83
Mary M. Pendery
E.G. Walsh
31
W.C. Munson
1
Emmet J. Fallon
Rio Petro, Ltd.
3 · 18 · 86 (91)
Bel North
10 · 5 · 86 10 · 5 · 86 (91)
H.A.E. J.A. Fuchs
6
Mesa E. MTS
7 · 1 · 87 29670
U.S. Mins
H.A.E. J.A. Fuchs
Emil Kiehne
E. Sons, Inc.
Mesa E. MTS
9 · 1 · 91 LH · 480
169 32
State
Gulf
9 · 1 · 91 LH · 479
192 02
5 State
Emil Kiehne E. Sons, Inc.
U.S., Mins.
Emil Kiehne
E. Sons, Inc.
Mesa Pet.
E. MTS, Ltd.
7 · 1 · 87
29670
4
Gulf
9 · 1 · 89 LH 478
230 20
Mesa Pet E. MTS, Ltd.
7 · 14 · 88
de Dios
3
Rafter X, Inc.
U.S., Mins.
Rafter X, Inc.
M.J. Harvey, Jr.
4 · 1 · 89 35864
U.S., Mins.
Rafter X, Inc.
2
Gulf
9 · 1 · 91
LH · 478
230 20
State
Mary M.
Pendery
Bel North
7 · 15 · 89
J.P. Gibbons, Est.
Mesa Pet. E. MTS, Ltd.
7 · 1 · 91
36328
6
U.S.
Mary M. Pendery
Damson 1/2
New England Ener. 1/2
12
Mesa
E. MTS
2 · 1 · 91
36809
7
Dorchester
9 · 1 · 91
LH · 481
183 19
Emil Kiehne
E. Sons, Inc.
Arroyo San
Juan
8
9
Emil Kiehne
E. Sons, Inc.
10
11
Mesa Pet.
E. MTS, Ltd.
7 · 14 · 88
84
Mesa
E. MTS
9 · 1 · 91
LH · 482
163 46
Bel North
7 · 15 · 89
J.P.
Gibbons,
Est.
12
7
Mesa Pet.
E. MTS, Ltd.
7 · 1 · 91
36328
U.S., Mins.
San Juan
Stationers, Inc.
San Juan
Stationers, Inc.
State
Rafter X, Inc.
Mary M. Pendery
Mesa Pet.
E. MTS, Ltd.
2 · 1 · 91
36809
Mesa E. MTS
7 · 1 · 87 29670
U.S., Mins.
Jose Chaves
Dorchester
9 · 1 · 91 183 19 LH · 481
State
C.W.
Williams
Jr.
7 · 15 · 89
Mesa Pet.
E. MTS, Ltd
7 · 14 · 88
Gulf
9 · 1 · 91
LH · 484
145 88
McKnight Pet., Tr.
12 · 1 · 84
LG · 2439
13
Mesa E. MTS
7 · 1 · 87 29670
18
17
Dorchester
9 · 1 · 91
LH · 481
183 19
16
15
14
13
18
U.S., Mins.
Jose I. Chaves
J. J.
Mauer
Rafter
X, Inc.
C.W. Williams, Jr.
7 · 15 · 88
Pablo
Flores,
Est.
Alfredo
Flores
Filomena
Flores
U.S.
Pablo Flores, Est.
State, Mins.
Rafter X, Inc. (S)
State
Rafter X, Inc., (S)
6
23
Rafter X, Inc.
State
Mary M. Pendery
Pablo Flores, Est.
Mesa E. MTS
7 · 1 · 87 29670
U.S.
Dorchester
9 · 1 · 91
LH · 485
179 17
McClellan Oil
12 · 1 · 91
43407
Mesa Pet.
E. MTS, Ltd.
9 · 1 · 91
LH · 486
McKnight Pet. Tr.
12 · 1 · 84
LG · 2439
Mary M.
Pendery
Mesa E. MTS
2 · 1 · 91
36809
24
19
Mesa E. MTS
7 · 1 · 87 29670
20
21
Dorchester
9 · 1 · 91 LH · 485
179 17
22
23
24
J.P.
Gibbons, Est.
19
U.S., Mins
Gilberto
Padilla, Jr.
Gilberto
Padilla, Jr.
U.S., Mins.
Pablo
Flores, Est.
U.S., Mins.
Pablo Flores, Est.
Rafter X, Inc.
State
Rafter X, Inc. (S)
State
Rafter X, Inc. (S)
U.S., Mins.
J.P. Gibbons, Est.
State
J.P. Gibbons, Est.
Mesa Pet.
E. MTS, Ltd.
2 · 1 · 91
36809
L.J.
Price
4 · 1 · 91
39441
Ojo Negro Creek
Gulf
9 · 1 · 91
LH · 488
168 75
Dorchester
9 · 1 · 91
LH · 487
207 13
McKnight Pet., Tr.
12 · 1 · 84
LG · 2441
25
Pablo
Flores, Est.
30
29
28
27
26
25
30
Palace
11 · 11 · 86
C.W. Williams, Jr.
7 · 15 · 89
Louis Meneghin
McClellan Oil
12 · 1 · 91
43407
Rafter X, Inc.

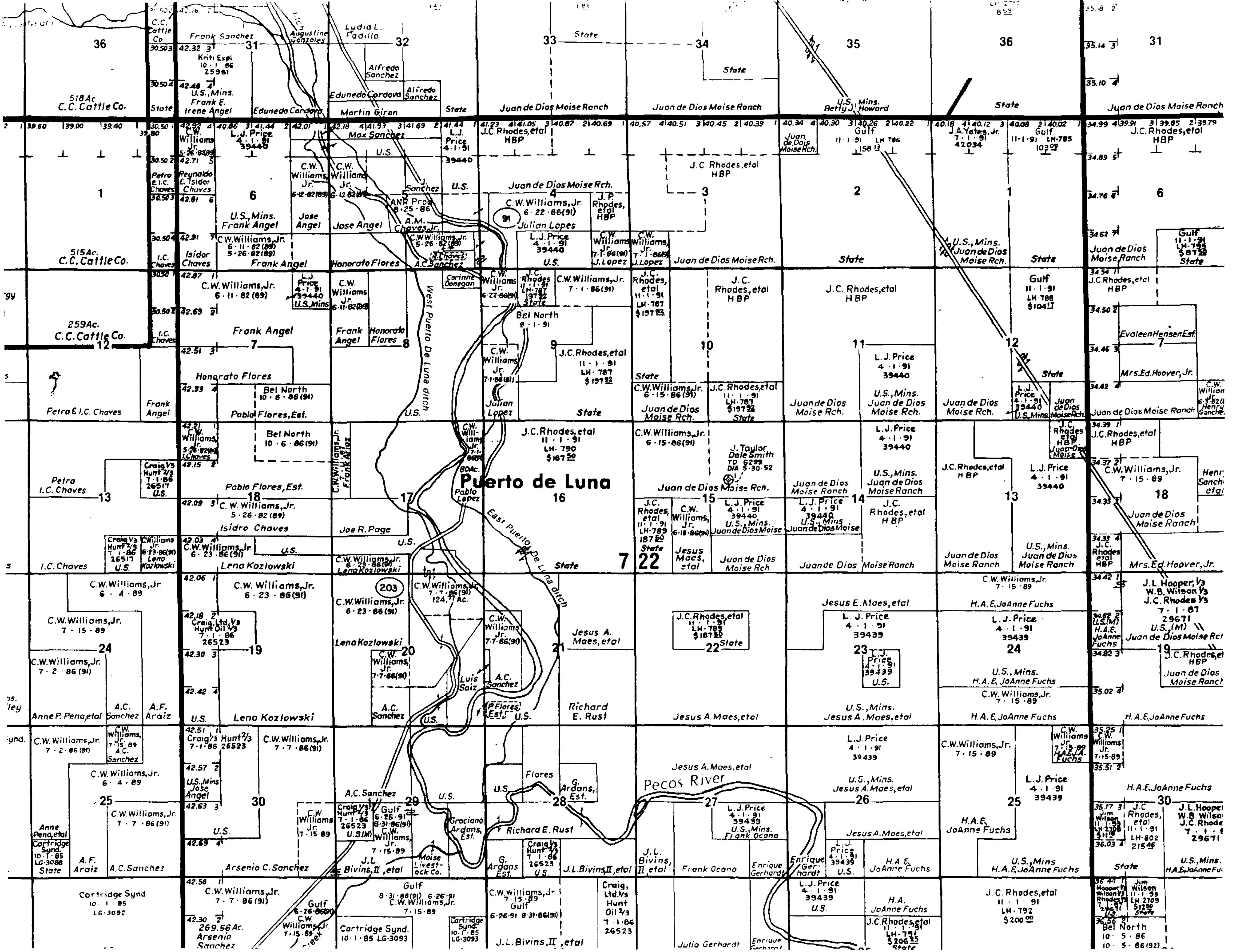
~~(7) The subject wells are capable of only relatively low rates of production.~~

~~(8) Authorization of~~ downhole commingling ~~will~~ would extend the economic life of the combined project~~s~~ an estimated three additional years and will allow for the recovery of an additional 128,200 barrels of oil that may otherwise be abandoned thereby preventing waste of recoverable hydrocarbons.

(9) Although the royalty ownership is not identical between the two pools, ~~Citation~~ the applicant has proposed an allocation formula for the equitable distribution of commingled production so that the correlative rights of all royalty owners ~~will be protected.~~ could best be served and protected.

(10) Citation recommended allocating production on a monthly basis using a ratio of remaining recoverable reserves which results in 79.9% of the total estimated remaining reserves being attributed to the Lower Hospah and 20.1% to the Upper Hospah.

(11) The reservoir characteristics of each of the two pools are such that underground waste would not be cause by the proposed commingling of production.



Puerto de Luna
Pecos River
West Puerto De Luna ditch
East Puerto De Luna ditch
518Ac. C.C. Cattle Co.
515Ac. C.C. Cattle Co.
259Ac. C.C. Cattle Co.
Juan de Dios Moise Ranch
J.C. Rhodes, etal HBP
U.S., Mins. Betty J. Howard
Frank Sanchez
Lydia L. Padilla
Augustine Gonzales
Alfredo Sanchez
Edunedo Cordova
Martin Giron
Max Sanchez
Irene Angel
Petra & I.C. Chaves
Petra I.C. Chaves
I.C. Chaves
Isidor Chaves
Reynaldo & Isidor Chaves
U.S., Mins. Frank Angel
Frank Angel
Jose Angel
Honorato Flores
Pablo Flores, Est.
Bel North
Isidro Chaves
Joe R. Page
Lena Kozlowski
C.W. Williams, Jr.
L.J. Price
Julian Lopes
Julian Lopez
Pablo Lopez
Corinne Donegan
A.C. Sanchez
A.M. Chaves, Jr.
Luis Saiz
Jesus A. Maes, etal
Jesus E. Maes, etal
Richard E. Rust
G. Ardans, Est.
Graciano Ardans, Est.
Moise Livestock Co.
J.L. Bivins, II, etal
Frank Ocano
Enrique Gerhardt
Julio Gerhardt
H.A.E. JoAnne Fuchs
U.S., Mins. H.A.E. JoAnne Fuchs
Mrs. Ed. Hoover, Jr.
Evaleen Hensen Est.
J.L. Hooper 1/3 W.B. Wilson 1/3 J.C. Rhodes 1/3
J. Taylor Dale Smith
Anne P. Pena, etal
A.F. Araiz
Arsenio C. Sanchez
269.56 Ac. Arsenio Sanchez
Cartridge Synd.
Craig 1/3 Hunt 2/3
Craig, Ltd. 1/3 Hunt Oil 2/3
Gulf
State
U.S.

(12) In addition, at the time of the hearing, the applicant presented adequate testimony and evidence to show:

(a) there will be no crossflow between the two commingled pools;

(b) neither commingled zone exposes the other to damage by produced liquids;

(c) the fluids from each zone are compatible with the other;

(d) the bottom-hole pressure of the lower pressure zone is not less than 50 percent of the bottom hole pressure of the higher pressure zone adjusted to a common datum; and

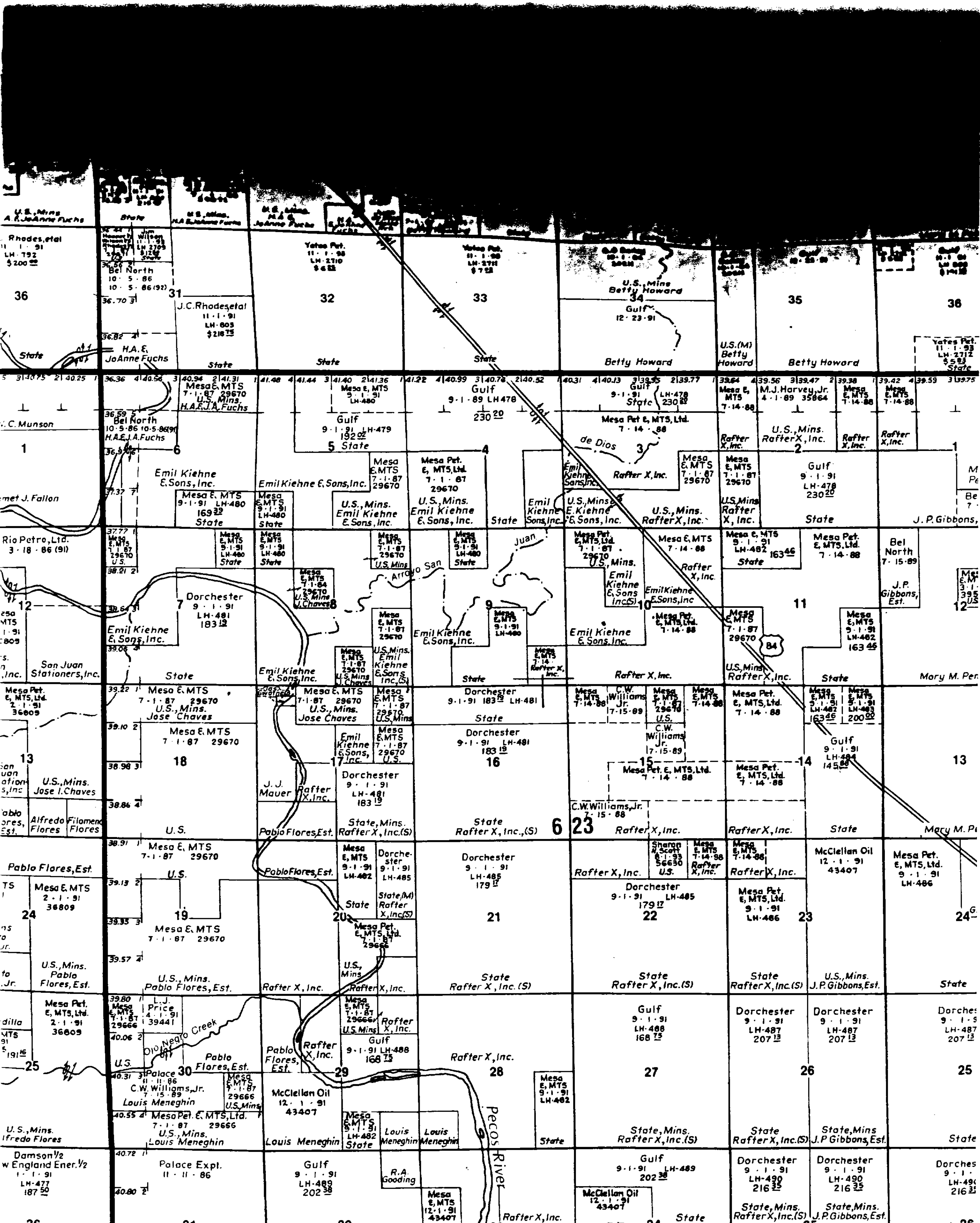
(e) the value of the commingled production is not less than the sum of the values of the individual production.

(13) Proper notice was provided to all parties affected by this case and no party appeared in opposition to this application.

(14) The operator should be responsible for reporting ~~the~~ any monthly gas production from the subject wells by utilizing the proposed allocation formula.

( ) For reporting purposes the operator should also ~~utilize a similar~~ allocation ~~figures for~~ water production based on the current water production in ~~[illegible]~~ both intervals.

83% - Lower Hospah
17% - [illegible]



Rhodes, etal
Bel North
J.C.Rhodes etal
H.A. & JoAnne Fuchs
Yates Pet.
U.S., Mins. Betty Howard
Gulf 12·23·91
Betty Howard
U.S.(M) Betty Howard
State
Bel North 10·5·86
H.A.&J.A.Fuchs
Gulf 9·1·91 LH-479
Gulf 9·1·89 LH 478
Mesa Pet & MTS, Ltd. 7·14·88
M.J.Harvey, Jr. 4·1·89 35664
U.S., Mins. Rafter X, Inc.
Rafter X, Inc.
de Dios
Emil Kiehne & Sons, Inc.
Emet J. Fallon
Mesa & MTS 9·1·91 LH-480
Mesa Pet. & MTS, Ltd. 7·1·87 29670
U.S., Mins. Emil Kiehne & Sons, Inc.
U.S., Mins. Rafter X, Inc.
Gulf 9·1·91 LH-478
J. P. Gibbons,
Rio Petro, Ltd. 3·18·86 (91)
Arroyo San Juan
Bel North 7·15·89
J.P. Gibbons, Est.
Dorchester 9·1·91 LH-481
San Juan Stationers, Inc.
Emil Kiehne & Sons, Inc.
U.S., Mins. Jose Chaves
Mary M. Pe
Mesa & MTS 7·1·87 29670
Dorchester 9·1·91 183 LH-481
C.W. Williams Jr. 7·15·89
Gulf 9·1·91 LH-484
Mesa Pet. & MTS, Ltd. 7·14·88
U.S., Mins. Jose I. Chaves
J. J. Mauer
Alfredo Flores
Filomeno Flores
State, Mins. Rafter X, Inc.(S)
State Rafter X, Inc., (S)
C.W.Williams, Jr. 7·15·88
Pablo Flores, Est.
McClellan Oil 12·1·91 43407
Dorchester 9·1·91 LH-485
Mesa Pet. & MTS, Ltd. 9·1·91 LH-486
Mesa & MTS 2·1·91 36809
U.S., Mins. Pablo Flores, Est.
Rafter X, Inc.
State Rafter X, Inc. (S)
U.S., Mins. J.P. Gibbons, Est.
L.J. Price 4·1·91 39441
Rio Negro Creek
Gulf 9·1·91 LH-488
Dorchester 9·1·91 LH-487
Palace 11·11·86
C.W. Williams, Jr. 7·15·89
Louis Meneghin
Pecos River
U.S., Mins. Alfredo Flores
State, Mins. Rafter X, Inc.(S)
State, Mins J.P Gibbons, Est.
Damson 1/2 New England Ener. 1/2
Palace Expl. 11·11·86
Gulf 9·1·91 LH-489
R.A. Gooding
Dorchester 9·1·91 LH-490
84

Water flow into ~~both~~ both projects through all ( ) Water injection wells must remain segregated.

~~whereby no ... water will be permitted to mix~~

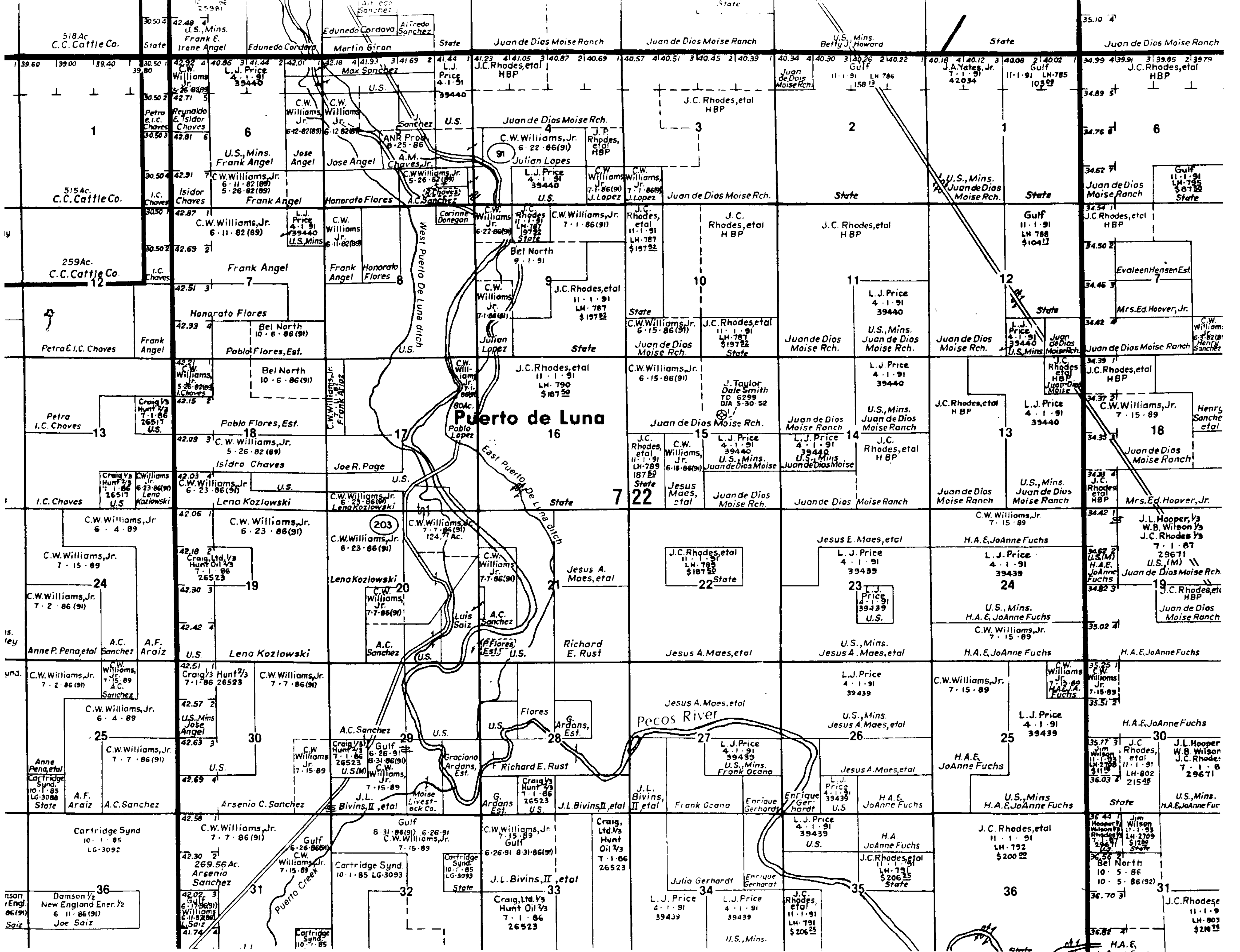
(15) An annual report should be submitted by the operator to both the Aztec District Office of the Division and to the Santa Fe Office showing the complete computation for each month.

(16) That this application should be approved and an allocation adopted as proposed by the applicant.

IT IS THEREFORE ORDERED THAT:

(1) The applicant, Citation Oil & Gas Corporation, is hereby authorized to commingle South Hospah Upper Sand Oil Pool production with South Hospah Lower Sand Oil Pool production for each producing well listed on Exhibit "A" and Exhibit "B" attached hereto all being located within the N/2 ~~and N/2S/2~~ of Section 12, T17N, R9W, NMPM, McKinley County, New Mexico.

(2) The allocation of production from both pools shall be subject to the monthly allocation formula hereby adopted for these wells so that 79.9% of the oil and gas production is allocated to the South Hospah Lower Sand Oil Pool and 20.1% of the oil and gas production is allocated to the South Hospah Upper Sand Oil Pool. Water production for each well shall be allocated such that ~~the ...~~ 83% is appropriated to the South Hospah Lower Sand Oil Pool and 17% is appropriated to the South Hospah Upper Sand Oil Pool.



Puerto de Luna
Pecos River
West Puerto De Luna ditch
East Puerto De Luna ditch
Puerto Creek
Juan de Dios Moise Ranch
J.C. Rhodes, etal HBP
518 Ac. C.C. Cattle Co.
515 Ac. C.C. Cattle Co.
259 Ac. C.C. Cattle Co.
C.W. Williams, Jr.
L.J. Price 4-1-91 39440
U.S., Mins.
State
Gulf
Jesus A. Maes, etal
Jesus E. Maes, etal
H.A.E. JoAnne Fuchs
Mrs. Ed Hoover, Jr.
Evaleen Hensen Est.
Julia Gerhardt
Enrique Gerhardt
Frank Ocano
J.L. Bivins, II, etal
Richard E. Rust
G. Ardans, Est.
Graciano Ardans, Est.
Craig, Ltd. 1/3 Hunt Oil 2/3 7-1-86 26523
Cartridge Synd. 10-1-85 LG-3093
Lena Kozlowski
A.C. Sanchez
Arsenio C. Sanchez
Joe R. Page
Frank Angel
Honorato Flores
Pablo Flores, Est.
Isidro Chaves
I.C. Chaves
Petra E. I.C. Chaves
Bel North
Julian Lopes
Julian Lopez
Max Sanchez
Martin Giron
Edunedo Cordova
Jose Angel
Moise Livestock Co.
Luis Saiz
Joe Saiz
A.F. Araiz
Anne P. Pena, etal
Damson 1/2 New England Ener. 1/2
J. Taylor Dale Smith

(3) The operator is responsible for reporting the monthly production from the subject wells to the Division by utilizing the allocation formulas herein adopted. An annual report shall be submitted by the operator to both the Aztec District Office and the Santa Fe Office of the Division showing the complete computation for the previous twelve month period. Said annual report must be submitted no later than April 1, 1993 and annually thereafter.

(5) (4) That jurisdiction of this cause is retained for the entry of such further orders as the Division may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

WILLIAM J. LEMAY
Director

Seal

ordt204.358

(4) ~~All~~ Water flow into injection wells shall remain segregated between pools.

Adequate water for stock can be expected anywhere in this area. Reported chemical analysis of water samples taken from 9 wells in Township 5 North, Range 10 East and Township 6 North, Range 9 and 10 East, NMPM, Torrance County, New Mexico range from 1160 to 6170 mg/l TDS, which falls well below the 10,000 mg/l TDS standard set forth in 3-101 of the Water Quality Control Commission (WQCC) Regulations for waters to be protected under Part 3 of said Regulations (Smith, R.E., 1957, Geology and Ground-Water Resources of Torrance County, New Mexico: New Mexico Bureau of Mines and Mineral Resources and Mineral Resources Ground-Water Report No. 5);

b) The introduction by the leaching process of such metals commonly found in large-municipal sludge residue such as, but not limited to, zinc, copper, nickel, chromium, lead and selenium and other contaminants such as organics, nitrates and other trace elements could cause the existing ground water to be rendered unacceptable for continued agricultural and domestic needs;

c) Localized drainage of ground water underlying the selected sites are toward the numerous playa lakes in the area, the largest being Laguna del Perro. Another primary feature is Laguna Salina. Both are located in Townships 5 and 6 North, Range 9 and 10 East, NMPM, Torrance County, New Mexico. Historically, the playas have provided significant nesting, roosting, feeding and loafing areas for migratory shore birds and migratory wading birds and hunting areas for migratory raptors. For centuries, the playa lakes have been a commercial source of halite (sodium chloride, common salt) and in the days Spanish Rule the salt was transported to silver mines in Chihuahua, Mexico (Northrup, S.A., 1941, Minerals of New Mexico, New Mexico University Bulletin 379, geological survey, Vol. 6, No. 1, pg. 168). In modern times, salt deposits in Laguna Salina were gathered and sold commercially starting in 1915 and continuing into the late 1930s (Talmage, S.B. and Weotton, T.P., 1937, The Nonmetallic Mineral Resources of New Mexico and Their Economic Features [Exclusive of Fuels], New Mexico School of Mines, State Bureau of Mines and Mineral Resources Bulletin 12, pg. 146). Due to such uses, the degradation or destruction of Laguna del Perro and/or Laguna Salina could affect interstate commerce and should therefore be classified as "waters of the United States" as defined in 40 CFR Part 122.2, and as such could be governed under the provisions of Section 308 of the Clean Waters Act (CWA), 33 U.S.C. 1251;

Case No. 10424
Order No. R-______

SOUTH HOSPAH UNIT (Upper Sand)
SOUTH HOSPAH UPPER SAND POOL
McKINLEY COUNTY, NEW MEXICO

Section 12, Township 17 North, Range 9 West, NMPM

WELL SUMMARY

Well No.	STATUS	TYPE	WELL LOCATION	
1X	Act	Oil	1980 FNL 2062 FEL	S12, T17N, R9W
2	Act	Oil	2310 FNL 2310 FWL	S12, T17N, R9W
4	Act	Oil	990 FNL 2310 FWL	S12, T17N, R9W
~~5~~	~~Act~~	~~WIW~~	~~990 FNL 2712 FEL~~	~~S12, T17N, R9W~~
~~13~~	~~Act~~	~~WIW~~	~~2280 FNL 1620 FWL~~	~~S12, T17N, R9W~~
15	Act	Oil	2500 FNL 330 FWL	S12, T17N, R9W
16	Act	Oil	1755 FNL 2330 FWL	S12, T17N, R9W
~~17~~	~~Act~~	~~WIW~~	~~2250 FNL 3000 FWL~~	~~S12, T17N, R9W~~
~~18~~	~~Act~~	~~WIW~~	~~1475 FNL 3055 FWL~~	~~S12, T17N, R9W~~
19	Act	Oil	2310 FSL 2712 FEL	S12, T17N, R9W
21	Act	Oil	2310 FSL 2310 FWL	S12, T17N, R9W
22	Act	Oil	2210 FSL 990 FWL	S12, T17N, R9W
26	Act	Oil	330 FNL 380 FEL	S12, T17N, R9W
27	T/A	Oil	1570 FNL 330 FEL	S12, T17N, R9W
28	Act	Oil	933 FNL 1485 FEL	S12, T17N, R9W
29	Act	Oil	410 FNL 1870 FEL	S12, T17N, R9W
30	Act	Oil	950 FNL 1980 FEL	S12, T17N, R9W
31	Act	Oil	330 FNL 2800 FEL	S12, T17N, R9W
34	T/A	Oil	1820 FNL 1700 FWL	S12, T17N, R9W
37X	T/A	Oil	1280 FNL 1280 FWL	S12, T17N, R9W
40	T/A	Oil	2420 FNL 1650 FEL	S12, T17N, R9W
48	Act	Oil	1485 FNL 2817 FEL	S12, T17N, R9W
~~51~~	~~Act~~	~~WIW~~	~~1775 FNL 620 FWL~~	~~S12, T17N, R9W~~
~~52~~	~~Act~~	~~WIW~~	~~720 FNL 1850 FWL~~	~~S12, T17N, R9W~~
55	T/A	Oil	1750 FNL 1550 FEL	S12, T17N, R9W
~~58~~	~~Act~~	~~WIW~~	~~2580 FNL 1640 FWL~~	~~S12, T17N, R9W~~
~~59~~	~~Act~~	~~WIW~~	~~2340 FNL 2500 FEL~~	~~S12, T17N, R9W~~
65	T/A	Oil	1418 FNL 2769 FEL	S12, T17N, R9W
66	T/A	Oil	1646 FNL 2667 FEL	S12, T17N, R9W

EXHIBIT "A"

d) The subject facility could directly and indirectly have an adverse impact on state trust and acquired lands and federal public lands within the prescribed area; and

e) The application included lands in Section 36, Township 6 North, Range 9 East, NMPM, and in Sections 11, 12, and 13, Township 5 North, Range 9 East, NMPM, Torrance County, New Mexico, which lands extend beyond the advertised area.

It is my understanding that this matter is to be considered under the provisions of Part 3-104 of the WQCC Regulations requiring a "discharge plan" from the New Mexico Environment Department in that the affidavit is seeking authorization to discharge effluent onto the surface which would then be allowed to move directly and indirectly into ground water supplies. To that end I am confident that the Department acting under authority of the Water Quality Control Commission will exercise its full responsibility to protect said water resource against immediate contamination or the possible contamination of any such water source of reasonably foreseeable beneficial use.

Thank you in advance for your consideration in this matter.

Very truly yours,

Michael E. Stogner

cc:
Board of County
Commissioners
Torrance County
Estancia, NM 87016

U.S. Environmental
Protection Agency
Region VI
1445 Ross Avenue
Suite 1200
Dallas, TX 75202-2733
Attn: Buck Winn, Regional
Administrator

Jim Baca
NM State Land
Commissioner
310 Old Santa Fe Trail
Santa Fe, NM 87501

Multi-Service Company
Burrell Markum
Drawer G
Valley Mills, TX 76689

NM Water Quality Control
Commission
1190 St. Francis Drive
Santa Fe, NM 87503

Al Abee
US Bureau of Land
Management
Rio Puerco Resources Area
435 Montaño Road, N.E.
Albuquerque, NM 87107

State Engineer's Office
P.O. Box 25102
Santa Fe, NM 87504-5102
Attention: Eluid Martinez

Case No. 10424
Order No. R-________

EXHIBIT "B"

HOSPAH LEASE (Lower Sand)
SOUTH HOSPAH LOWER SAND POOL
McKINLEY COUNTY, NEW MEXICO
Section 12, Township 17 North, Range 9 West, NMPM

WELL SUMMARY

WELL NO.	STATUS	TYPE	WELL LOCATION	
3	Act	Oil	1650 FNL 1392 FEL	S12, T17N, R9W
6	Act	Oil	330 FNL 330 FEL	S12, T17N, R9W
7	Act	Oil	1650 FNL 330 FEL	S12, T17N, R9W
8	Act	Oil	1650 FNL 2051 FEL	S12, T17N, R9W
9	Act	Oil	330 FNL 2051 FEL	S12, T17N, R9W
10	Act	Oil	990 FNL 2300 FWL	S12, T17N, R9W
11	Act	Oil	1650 FNL 2310 FWL	S12, T17N, R9W
12	Act	Oil	2160 FNL 990 FWL	S12, T17N, R9W
14	Act	Oil	1700 FNL 1300 FWL	S12, T17N, R9W
24	Act	Oil	330 FNL 2650 FEL	S12, T17N, R9W
25	Act	Oil	330 FNL 1505 FEL	S12, T17N, R9W
32	Act	Oil	550 FNL 2370 FWL	S12, T17N, R9W
~~33~~	[redacted]	~~WIW~~	~~1340 FNL 1710 FWL~~	~~S12, T17N, R9W~~
34	T/A	Oil	1820 FNL 1700 FWL	S12, T17N, R9W
35	Act	Oil	330 FNL 850 FEL	S12, T17N, R9W
~~36~~	[redacted]	~~WIW~~	~~900 FNL 2630 FEL~~	~~S12, T17N, R9W~~
37X	Act	Oil	1280 FNL 1280 FWL	S12, T17N, R9W
38	Act	Oil	660 FNL 660 FEL	S12, T17N, R9W
~~39~~	[redacted]	~~WIW~~	~~2180 FNL 660 FEL~~	~~S12, T17N, R9W~~
46	Act	Oil	1700 FNL 700 FWL	S12, T17N, R9W
47	Act	Oil	785 FNL 1775 FWL	S12, T17N, R9W
49	Act	Oil	885 FNL 2117 FEL	S12, T17N, R9W
50	Act	Oil	950 FNL 900 FEL	S12, T17N, R9W
53	T/A	Oil	950 FNL 330 FEL	S12, T17N, R9W
~~54~~	[redacted]	~~WIW~~	~~1319 FNL 5 FEL~~	~~S12, T17N, R9W~~
~~57~~	[redacted]	~~WIW~~	~~2290 FNL 110 FWL~~	~~S12, T17N, R9W~~
~~58~~	[redacted]	~~WIW~~	~~2580 FNL 1640 FWL~~	~~S12, T17N, R9W~~
~~59~~	[redacted]	~~WIW~~	~~2340 FNL 2500 FEL~~	~~S12, T17N, R9W~~
~~60~~	[redacted]	~~WIW~~	~~2210 FNL 1300 FEL~~	~~S12, T17N, R9W~~
61	Act	Oil	1120 FNL 2510 FEL	S12, T17N, R9W
62	Act	Oil	650 FNL 1770 FEL	S12, T17N, R9W
~~63~~	[redacted]	~~WIW~~	~~710 FNL 1325 FEL~~	~~S12, T17N, R9W~~
64	Act	Oil	1360 FNL 900 FEL	S12, T17N, R9W

EXHIBIT "B"

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION

P. O. BOX 2088
SANTA FE, NEW MEXICO 87501

Form C-132
Revised 5-10-81

APPLICATION FOR WELLHEAD PRICE CEILING CATEGORY DETERMINATION

1. FOR DIVISION USE ONLY:

DATE COMPLETE APPLICATION FILED ____________

DATE DETERMINATION MADE ____________

WAS APPLICATION CONTESTED? YES ______ NO ______

NAME(S) OF INTERVENOR(S), IF ANY:

5A. Indicate Type of Lease STATE ☐ FEE ☐

5. State Oil & Gas Lease No.

7. Unit Agreement Name

8. Farm or Lease Name

2. Name of Operator

9. Well No.

3. Address of Operator

10. Field and Pool, or Wildcat

4. Location of Well UNIT LETTER ________ LOCATED ________ FEET FROM THE ________ LINE AND ________ FEET FROM THE ________ LINE OF SEC. ________ TWP. ________ RGE. ________ NMPM

12. County

11. Name and Address of Purchaser(s)

WELL CATEGORY INFORMATION

Check appropriate box for category sought and information submitted.

1. Category(ies) Sought (By NGPA Section No.) ____________

2. All Applications must contain:

☐ a. C-101 APPLICATION FOR PERMIT TO DRILL, DEEPEN OR PLUG BACK

☐ b. C-105 WELL COMPLETION OR RECOMPLETION REPORT

☐ c. DIRECTIONAL DRILLING SURVEY, IF REQUIRED UNDER RULE 111

☐ d. AFFIDAVITS OF MAILING OR DELIVERY

3. In addition to the above, all applications must contain the items required by the applicable rule of the Division's "Special Rules for Applications For Wellhead Price Ceiling Category Determinations" as follows:

A. NEW NATURAL GAS UNDER SEC. 102(c)(1)(B) (using 2.5 Mile or 1000 Feet Deeper Test)

☐ All items required by Rule 14(1) and/or Rule 14(2)

B. NEW NATURAL GAS UNDER SEC. 102(c)(1)(C) (new onshore reservoir)

☐ All items required by Rule 15

C. NEW ONSHORE PRODUCTION WELL

☐ All items required by Rule 16A or Rule 16B

D. DEEP, HIGH-COST NATURAL GAS, TIGHT FORMATION NATURAL GAS, AND PRODUCTION ENHANCEMENT NATURAL GAS

☐ All items required by Rule 17(1), Rule 17(2) or Rule 17(3), or Rule 17(4)

E. STRIPPER WELL NATURAL GAS

☐ All items required by Rule 18

I HEREBY CERTIFY THAT THE INFORMATION CONTAINED HEREIN IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

____
NAME OF APPLICANT (Type or Print)

____
SIGNATURE OF APPLICANT

Title ____________

Date ____________

FOR DIVISION USE ONLY

☐ Approved

☐ Disapproved

The information contained herein includes all of the information required to be filed by the applicant under Subpart B of Part 274 of the FERC regulations.

____
EXAMINER