REPORT UPON

Section 36 Twp. 40 N., R. 79 W., and Oil Operating

Lease 19112 by the Midwest Oil Company as requested by

The State Land Board

March 26, 1919.

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BY

L. W. Trumbull,
State Geologist.

May 3, 1919.

CONTENTS.

In submitting this report I am not attempting to make a complete report. Such data and maps as the Land Board already has in its possession have not been incorporated herein. Nor has the general geology of the Salt Creek field been touched upon, as that is available in published reports of both the State Geologist and the United States Geological Survey.

The information herein given is only such as seems to be necessary for the Land Board to have in order that it may most intelligently handle the matter of a new lease on Section 36, and does give, I believe, all the specific information requested in the letter from the Land Board under date of March 26, 1919.

May 3 1919 L. W. Trumbull.

FIELD RECORDS.

Under the system in use the operating companies claim that it is impossible to determine the past production of any individual well. Several wells flow to a central tank, and if that tank be full or not in use, the oil is diverted to some distant tank and no record is kept whereby the oil is credited to even the particular group of wells from which it came. Personally, I do not believe that the records are as bad as represented. I think the producing companies, for some reason, do not wish to have their records examined by the State, and are making the situation appear worse than it really is. I visited the field and was told that the Salt Creek office sent all daily records to the Midwest Oil Company in Denver for filing. At Denver the Oil Company told me that the detail records were kept by the Refining Company, who were operating the lease. The Midwest Refining Company assured me that no records of individual wells could be worked out of their daily records.

The field men told me that the record of Well (No. 5 NE), producing from the second sand, was kept separate from the others. Mr. Warren of the Midwest Oil Company promised to send me the record of production of this one well. The data has, however, never reached

KEY DIAGRAM OF WELL NUMBERING.

The attached diagram is the key to the numbering of wells in a section used by the Midwest Company. Each quarter section is divided into thirty-six squares, and the squares given numbers in succession, exactly as is the numbering of sections in a township. The first well in the upper right hand square of the northwest quarter of Section 36 is then known as Well No. 1 NW 36. Any succeeding wells in the same square are given a distinguishing letter. The wells are not necessarily in the center of the square, but as the square contains only 4.44 acres, the location of the well in the section is sufficiently accurately given by its number.

The dates in some of the squares are the dates of completion of the well of that location. It will be seen that there is a total of thirty wells on the section. One only of these (No. 5 NE ) is into the second sand. It is outside the water line in the first Wall Creek sand. One of two of the wells found oil in the shale above the sand, and were never drilled into the sand.

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# SECTION 36. T. 40 N. R. 79 W.

DATES ARE THOSE OF COMPLETION OF WELL

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-12 | 2-12 | 10-15 | | | | 11-17 | 4-18 | | | | 4.44 ACRES |
| 0-12? | 3-12 | | | | | | | | | | ← 440FT → 220FT |
| 5-12 | 6-12 | 9-15 | | | | | | | | | |
| 5-15 | 5-15 | | | | | | | | | | |
| 8-11 | 6-12 | | | | | | | | | | |
| 6-15 | | | | | | | | | | | |
| 7-15 | | 9-17 | 6-17 | | | 6 | 5 | 4 | 3 | 2 | 1 |
| | | 9-17 | 7-17 | | | 7 | 8 | 9 | 10 | 11 | 12 |
| | | | 8-17 | | | 18 | 17 | 16 | 15 | 14 | 13 |
| 4-16 1-12 | 5-16 | 6-16 | | | | 19 | 20 | 21 | 22 | 23 | 24 |
| 9-16 | 8-12 | 7-16 | | | | 30 | 29 | 28 | 27 | 26 | 25 |
| 6-12 | 9-16 | | | | | 31 | 32 | 33 | 34 | 35 | 36 |

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Key to well numbers (Midwest Company System)
Each quarter section is divided into 36 square and numbers as above. The number of the square and the quarter section initials then designate the well in that square. Each square is 440 feet on a side and contains 4.44 acres

## WELLS DRILLED TO SECOND SAND.

There is but one well (No. 5 NE¼) on Section 36 drilled to the Second sand. I have been unable to obtain the record of its production. The well log shows that it came in with a flush production of 1,000 barrels per day. It probably has a settled production of from 400 to 500 barrels per day.

On the Salt Creek field as a whole, however, many wells have reached the Second sand. The first well drilled to the lower sand is on the NW¼ Sec. 27, Twp. 40 N., R. 79 W. The Hjorth wells are in the SE¼ Sec. 32, Twp. 40 N., R. 79 W. Recently the well on NW Sec. 16, Twp. 39 N., R. 78 W. found oil in the Second sand. Several wells in Section 11 and vicinity, Twp. 39 N., R. 79 W., are producing from the Second sand.

Recently Well 33-A, SE¼ Sec. 25, Twp. 40 N., R. 79 W., came in with an extraordinarily large production. This well is now pinched in to a daily production of 2,500 barrels. The very heavy production of this well is due to the presence of a fault at the point where the well cut the sands, thus permitting of an extraordinary flow from the sand to the well. While other similar wells are to be expected if properly placed with respect to the various faults known to exist, such large production per well will be the ex-

ception rather than the rule.

The number and location of the many wells in this field, which have found oil in commercial quantity in the Second sand, make it certain that every portion of Section 36 will be productive from that sand.

VALUE OF LEASE OF JANUARY 1, 1920.

The value of a five year lease is dependent upon several conditions, part of which are

1. Amount of extractable oil in the sands at beginning of term of lease.
2. Amount of oil which can be taken from the land during the term of the lease.
3. Cost of wells and pipeline to refinery.
4. Value per barrel of the oil.
5. Bonus.

## Amount of Extractable Oil in the Sands.

The oil to be taken from Section 36 may be listed as follows:

1. From the Upper Wall Creek
2. From the Second Sand.
3. From lower, as yet unprospected, sands.

These items are discussed at length in the following pages under their respective headings. The totals arrived at are as follows:

| | |
|---|---|
| In the Wall Creek ..... | 1,000,000 bbls. |
| In Second Sand ..... | 4,400,000 " |
| In unprospected ..... | unknown |
| Certain extractable crude.. | 5,400,000 bbls. |

1. The Upper Wall Creek Sand.--- In the upper sand about 160 acres may be considered as still productive. All the wells in the SW¼, except No. 6, are making water with the oil and are being pumped. Well No. 6 NE¼ is making water. All the wells in the NW¼ are free from water.

The production from the section is controlled by the field men, and only so much oil is drawn as is needed. That is, an increase of production, because of the bringing in of new wells in other parts of the field, is reflected by a lowering of production from Section 36. The following tabulation of total production during the life of the present lease is worked up from data furnished by the Land Office. In this is included Well No. 5 NE¼, which is producing from the second sand and was completed on June 21, 1918 - production 600 barrels the second day, but the monthly average per well shows no general increase after that date.

AVERAGE PRODUCTION PER WELL

ON

Sec. 36, Twp. 40 N., R. 79 W.

LEASE NO. 19112

MIDWEST OIL COMPANY.

| Month | No. of Wells. | Average per Well. |
|---|---|---|
| 1915. | | bbls. |
| Jan. | 11 | 4090.09 |
| Feb. | 11 | 3564.00 |
| March | 11 | 3926.818 |
| April | 11 | 3603.454 |
| May- | 13 | 2920.384 |
| June | 14 | 2485.071 |
| July | 15 | 2638.800 |
| Aug. | 15 | 2373.800 |
| Sept. | 16 | 2228.625 |
| Oct. | 17 | 3078.824 |
| Nov. | 17 | 2710.705 |
| Dec. | 17 | 2783.235 |
| 1916. | | |
| Jan. | 17 | 2577.176 |
| Feb. | 17 | 2143.647 |
| March | 17 | 2759.470 |
| April | 18 | 2267.720 |
| May | 19 | 2058.315 |
| June | 20 | 1849.600 |
| July | 21 | 1359.428 |
| Aug. | 21 | 1358.952 |
| Sept. | 23 | 1010.739 |
| Oct. | 23 | 2137.173 |
| Nov. | 23 | 1764.608 |
| Dec. | 23 | 1041.434 |
| 1917. | | |
| Jan. | 23 | 1417.608 |
| Feb. | 23 | 1876.173 |
| March | 23 | 2063.782 |
| April | 23 | 2017.782 |

| Month | No. of Wells | Average per Well. |
|---|---|---|
| May | 23 | 2028.086 |
| June | 24 | 1526.666 |
| July | 25 | 1830.840 |
| Aug. | 26 | 2024.423 |
| Sept. | 28 | 2018.714 |
| Oct. | 28 | 2568.821 |
| Nov. | 29 | 2376.068 |
| Dec. | 29 | 3075.895 |
| 1918. | | |
| Jan. | 29 | 2873.482 |
| Feb. | 29 | 2507.517 |
| March | 29 | 2563.310 |
| April | 29 | 2199.862 |
| May | 29 | 2138.655 |
| June | 30 | 2253.139 |
| July | 30 | 2378.472 |
| Aug. | 30 | 2258.371 |
| Sept. | 30 | 3996.228 |
| Oct. | 30 | 1551.693 |
| Nov. | 30 | 1830.794 |
| Dec. | 30 | 1908.322 |
| 1919. | | |
| Jan. | 30 | 1835.759 |
| Feb. | 30 | 1624.865 |

The upper sand is more than half exhausted according to the following:

| | |
|---|---|
| Estimated total original content ..... | 3,450,000 bbls. |
| Production previous to Jan. 1,1915 ..... | 71,694 |
| Production since Jan.1,1915, to March 1, 1919 ..... | 2,362,548 |
| Total..... | 2,434,242 " |
| Remaining on March 1, 1919..... | 1,015,738 bbls. |

The percentage of oil having been drawn from sands outside the boundary of Section 36 cannot be estimated, and will, of course, considerably affect the amount of oil which will yet be drawn from the wells in Section 36. This percentage will, of course, increase as the oil content of the sand within the boundaries is decreased. Close figures are obviously impossible.

I am of the opinion that more wells to the upper sand are not necessary to eventually obtain all the oil. The oil can be drawn from the sand more rapidly, of course, if more wells are drilled, but more completely leaving the sand cleaner of oil if the production along the water edge is not forced.

I am unable to obtain any data upon the frequency of or necessity of frequent cleaning of the

wells. There seems to be no system used. Whenever the field men think that a group of wells is slacking off too much in production, they make an investigation as to which wells of the group are in bad condition, and those are cleaned. I could get no answer as to how often this occurred.

I have no criticism to make of the field management. It is, I think, good and will result in a high percentage of total production. The State should, however, have records of the field operations, for when the offset wells are drilled the rate of production will become of prime importance. At present it is not.

2. Oil Content of Second Sand.--- The oil content of the Second Wall Creek sand is of greater value (probably about five to one) than the oil content remaining in the Upper Wall Creek sand. The lower sand is forty feet in thickness, consisting of two twenty-foot sands with a dividing shale band two feet in thickness. This sand is saturated throughout under Section 36, the water line being much farther out both to the east and to the south. A recoverable 12% oil content of the 18% porosity of the sand being assumed, the total number of barrels to be expected is

$$\frac{12 \times 5280 \times 5280 \times 40 \times 1728 \times 18}{231 \times 42 \times 100 \times 100} = 4,400,000 \text{ bbls.}$$

This does not take into consideration the oil which will be drawn from surrounding lands should the exterior wells on Section 36 be drilled and drawn upon for a period of time before the Federal government permits drilling on the surrounding lands. This flow from outside lands will continue in part after the wells on such lands are drilled if the wells on Section 36 are drilled first. That is, experience has shown that the first well in the area sets up drainage lines in the oil sands that are never entirely eliminated by the drilling of later wells.

The conclusion, then, is obvious that the exterior wells, at least, on Section 36 should be drilled and drawn upon at the earliest date possible. The nearer such wells are placed to the boundary lines, the larger percentage of oil that will be drawn from sands not within the boundaries of the section.

3. Possibilities of Sands Below Second Wall Creek.--- There is every reason to expect that the sands lying below the Second Wall Creek will prove to be oil-bearing. They have not yet been tested. The first sand is twenty-five to thirty feet thick and 150 feet below the Second Wall Creek. Below it thirty-five feet of shale and then another forty feet of sand. Again 530 feet lower (at the bottom of the Mowry) is a thin sand, and still 200 feet lower a sand which is probably the productive sand of the Lance Creek and Rock River oil fields. All these sands must be tested before the possibilities of the Salt Creek field are exhausted. As the depth to the lowest sand is not extreme, it would seem that a test well should be a required condition of a new lease upon the section.

## Amount of Oil That Can Be Taken From the Land During the Term of the Lease.

A daily production of 3,000 barrels for a total of 1500 days during the five years gives a total of 4,500,000 barrels.

To produce this amount of oil will at first require a relative small number of wells. As the production per well decreases, new wells will have to be drilled to keep the production up.

The present actual production is more than half that amount, and it seems certain that a considerably larger amount can be drawn from the present wells were it desired by the operators.

## Cost of Wells and Pipeline.

The cost of drilling wells is discussed in another place. (Page ).

The pipe line can be roughly estimated at the present time at $10,000 per mile - a half million dollars for the fifty mile line between Section 36 and some point on the railroad.

If we may accept the figure commonly mentioned as nearly true, a refinery will cost a million dollars.

A company entering the field anew must then meet the following items of expense before beginning to derive an income from the lease:

| | |
|---|---|
| Bonus | $1,000,000 |
| Pipeline | 500,000 |
| Refinery | 1,000,000 |
| Wells & field equipment | 350,000 |
| Total | $2,850,000 |

This amount is not excessive, however, when divided by the five and a half million barrels of known extractable oil.

## Value of Salt Creek Oil.

The price of Salt Creek oil is up to the present time whatever amount the Midwest Companies choose to make it. Its value is a much higher figure, but one very difficult to prove. The prices being paid for crude from the various Wyoming fields are at present as follows:

| | |
|---|---|
| Salt Creek..... | $1.50 |
| Big Muddy ..... ..... | 1.50 |
| Grass Creek.. . ..... | 1.85 |
| Elk Basin ..... | 1.85 |
| Lance Creek. ..... ..... | 1.80 |
| Pilot Butte ..... | ? |
| Rock Creek ..... | ? |
| Thermopolis (black oil). ..... | 1.00 |
| Lander " " ..... | 1.25 |

Present prices cannot be accepted as indicative of what prices will be during the life of the next lease, for two reasons.

First, competition may be confidently expected to bring the price up to an equality with the price of oil in the mid-continent fields, where there is no monopoly such as is holding down prices in this State. The mid-continent price is now $2.25.

Second, the world's supply of gasoline-making crude oils is constantly decreasing and the demand for refined oil constantly increasing, so that it seems certain that the average price of crude for the next five years will be considerable higher than at present.

A fixed price per barrel for the royalty oil would then seem inadvisable. The percentage of royalty must be fixed, but the price can be left to fluctuate with the market. The State should also have the option of taking either the oil itself at the railroad or its value at going market price.

In view of the fact that crude oil from Salt Creek is now being shipped to Whiting, Indiana, it is evident that the State can dispose of its royalty oil should it choose to take the oil itself instead of its money value.

The companies operating the fields and refining the oil insist that the value of the refined products is no indication of the value of the crude oil. Some of the following facts are, however, interesting, and I give them for whatever bearing on the question they may have.

Gasoline made from Salt Creek crude is being sold in New York State for a lower price than it is sold in Wyoming. It is sold in Denver and Omaha several cents a gallon less than in Casper.

The gas off the oil both in the field and at the refinery is being utilized. The gas compressed in

the field does not enter into the measurements of crude. The condensation plant at the refinery is yielding a profit of six hundred dollars per day. This gas was formerly lost and is a part of the three per cent allowed for losses. It would appear that as far as Salt Creek oil is concerned, the three per cent loss allowance is purely imaginary, and is in fact a present to the refiner by the producer.

Bonus.

With a certainty of five and one half millions of barrels and the probability of much more both from lower sands and from the two proven sands, it would seem that a lease based upon a one-eighth royalty (in oil or money at market price) should bring a bonus of a million dollars, if sold by competitive bid. As our State law does not permit of a cash bonus being bid by applicants for lease, the bonus must take the form of an increased percentage of royalty. Under this system the State may reasonably expect to receive a thirty-five per cent royalty for the ensuing five years, if the large competitive oil companies are given an opportunity to bid for the lease. I know that some of them are making plans and gathering information so that they will be in a position to bid for the new lease when the present lease expires.

There are several companies who will be glad to bid for the lease, and who if they obtain the lease will build their own refinery and pipeline. Such competition in the State is much to be desired and is certain to result in a higher level of crude oil prices, not only in Salt Creek, but in the other fields of the State.

It is, of course, apparent that the present lessees will derive more profit from the lease, at a

given figure, than will any competitor, due to their present ownership of wells, pipelines and refineries. This being true, it may be expected that they can afford, and will, make a higher bid than any competitor. The value to the State in true competition for, and the resulting higher prices of, the State's royalty oil in other fields as well as the Salt Creek itself, should not be lost sight of in awarding a new lease.

## CASING AND CEMENTING.

The drilling of wells through the water-bearing first sand to the second sand is attended with no danger of letting water from the first sand into the second, if ordinary care is used in cementing off at the bottom of the first sand. The attached blue print shows method of casing and cementing where oil is to be drawn from both sands, but not mixed. When the oil in the upper sand is exhausted and water takes its place, production can continue from the lower sand alone. If there is water in the upper sand at the time the well is drilled, the same method of cementing at the bottom of the upper sand will shut it off.

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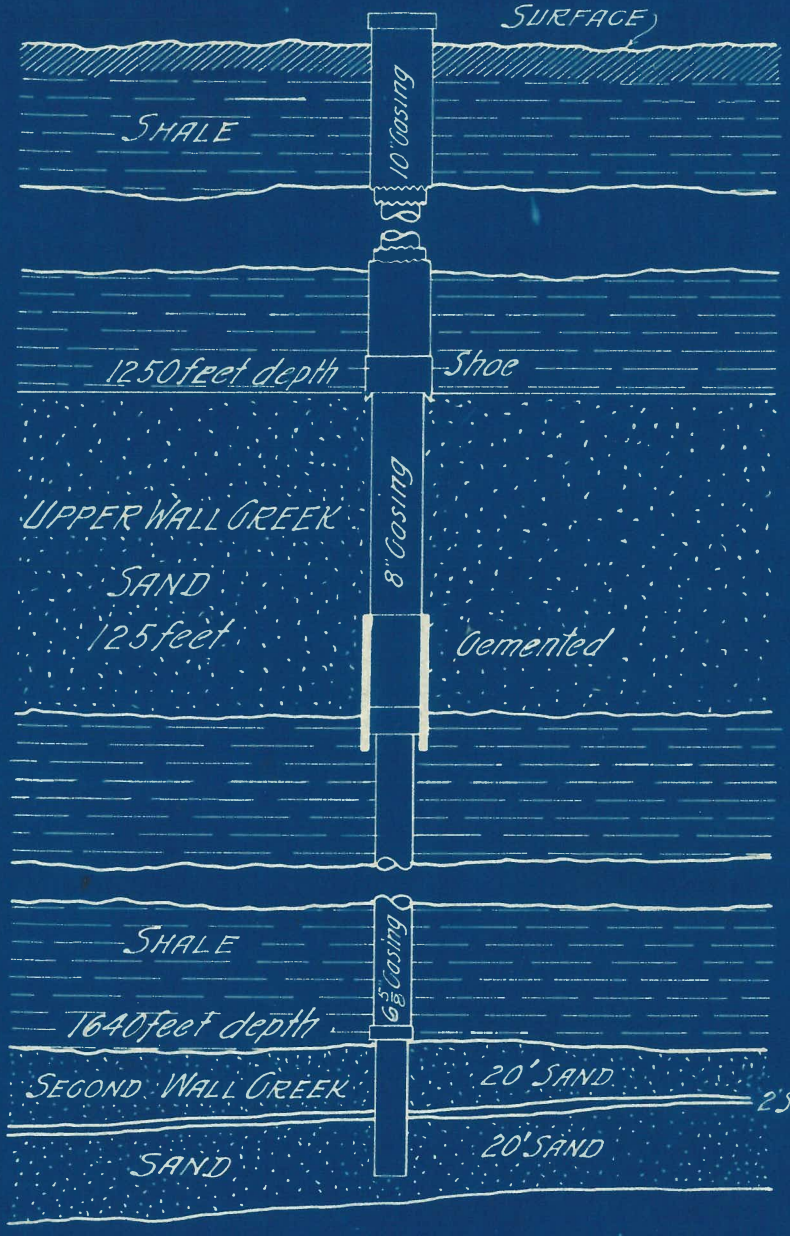



WELL CASE TO DRAW OIL FROM BOTH THE FIRST AND SECOND SANDS.

## DEEPENING WELLS TO LOWER SAND.

Where the old wells now drawing oil from the upper sand are of sufficient diameter, they may be deepened to the second sand by setting a string of casing in cement at the bottom of the upper sand and going down with a smaller bore to the lower sand. This is only advisable where the old well is straight and in good condition.

The comparatively low cost of drilling in the Salt Creek field makes it of doubtful economy to deepen old wells.

## COST OF DRILLING.

At the present time, the labor contract for drilling to the upper sand is $1.50 per foot; to the lower sand $2.50 per foot. Under this contract the company furnishes everything but the labor. A thousand-foot well to the first sand costs $1500 for labor and a well to the lower sand at the same point costs $3480 for labor. The other costs are not much different whether the lower sand be reached through the first well, or a separate hole made.

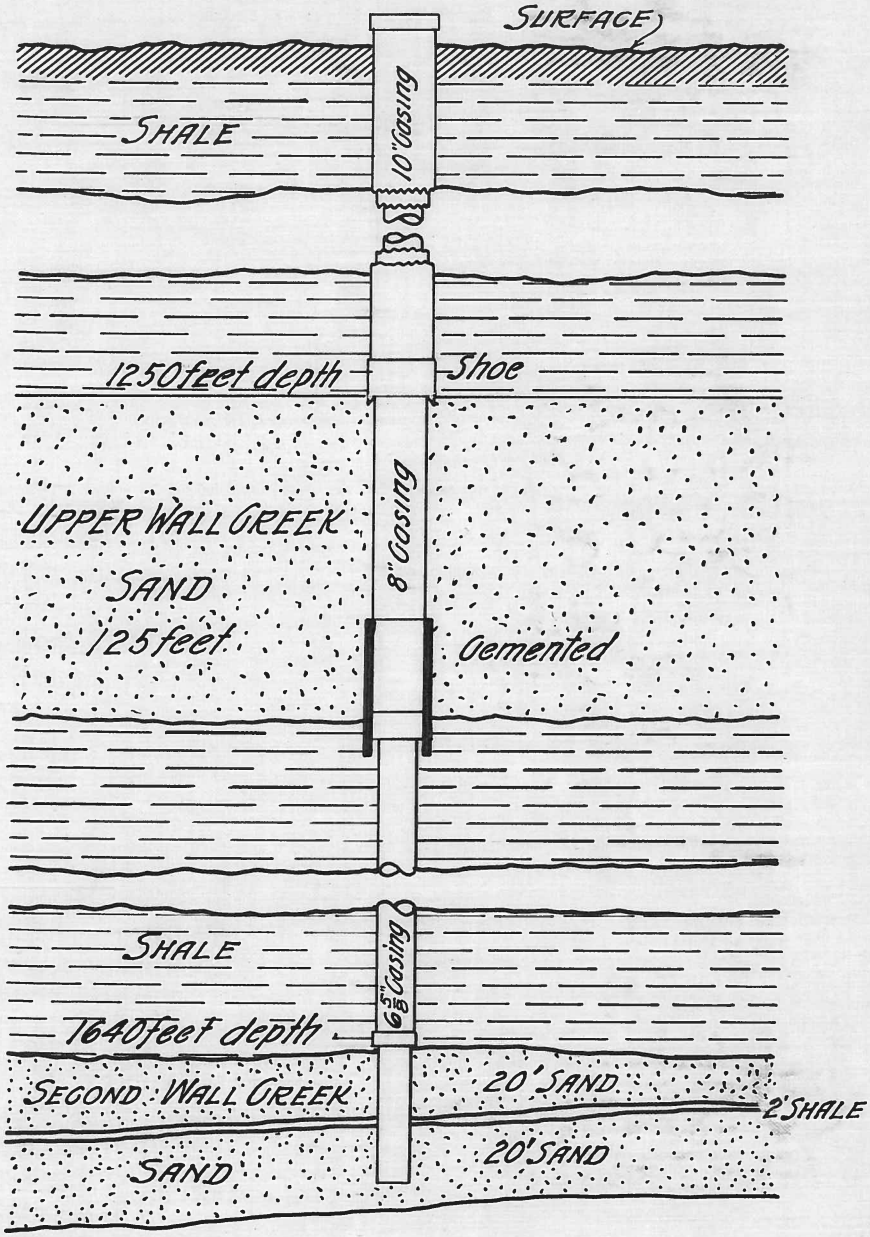
DRILLING REQUIREMENTS UNDER THE 1920 LEASE.

Assuming that a requirement of 3,000 barrels minimum per day from the Second sand is part of the new lease. Also, that the first wells drilled shall be exterior wells, i.e., along the boundaries of the section. Under the system of squares used by the Midwest Company there are forty-four squares - or wells 440 feet distant from each other. As half this number of wells may be expected to yield the amount of 3,000 barrels per day, it would seem best to require the drilling of alternate exterior wells first.

A test well should be drilled to the Muddy sand (Cloverly or Dakota).

Production records, as well as well logs, kept and furnished to the State monthly. Also, dates of cleaning of wells, and all field data of whatever nature.

Wells drilled to the Second sand shall be cased and cemented at the bottom of the Upper sand, so that no water from the Upper sand may enter.




WELL CASE TO DRAW OIL FROM BOTH THE FIRST AND SECOND SANDS.

# SECTION 36. T. 40 N. R. 79 W.

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