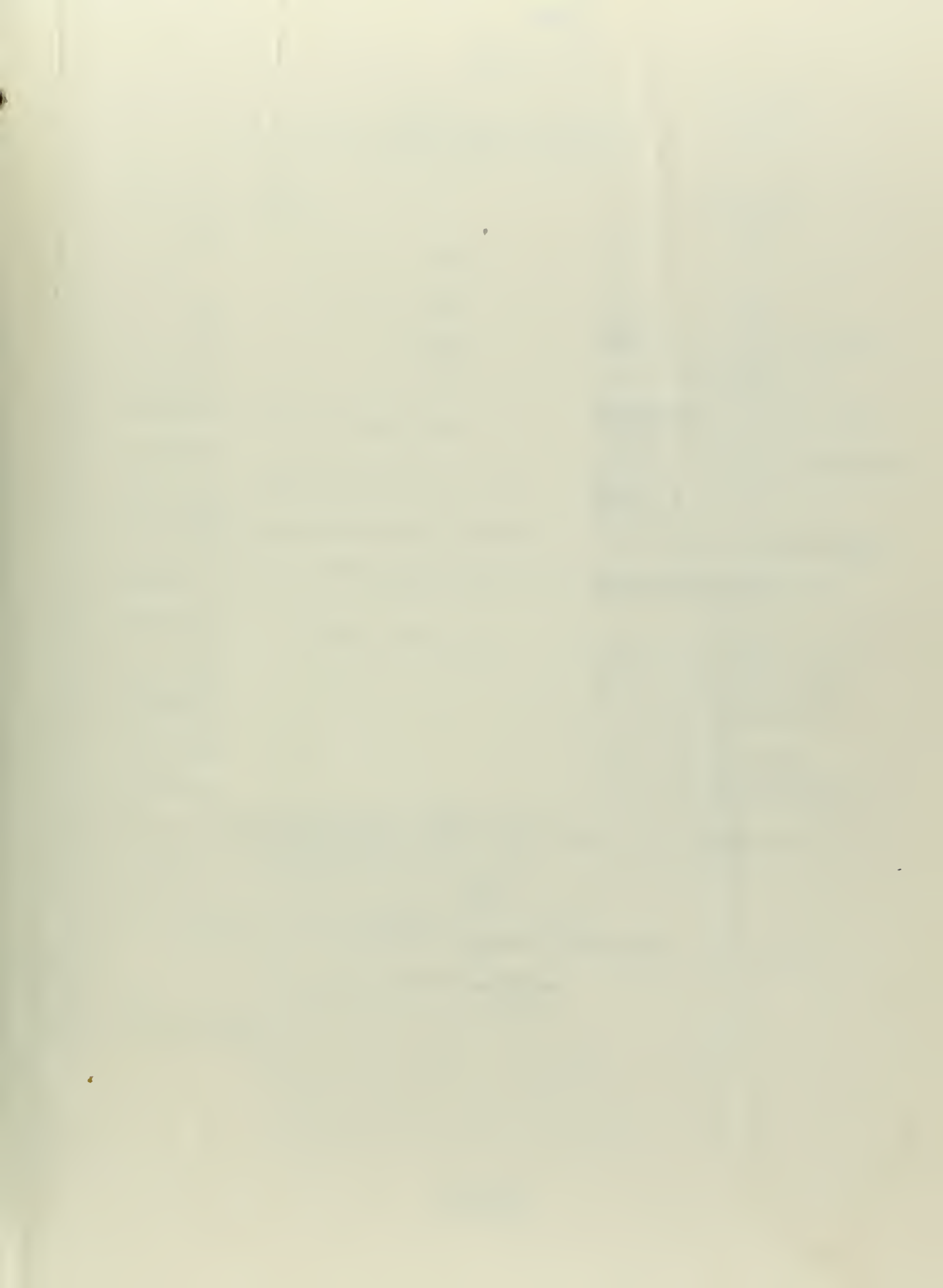


**A STUDY AND ANALYSIS OF THE
DEVELOPMENT AND UNIT OPERATION
OF NAVAL PETROLEUM RESERVE NO.1**

Will M. Adams, Jr.



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A STUDY AND ANALYSIS OF THE
DEVELOPMENT AND UNIT OPERATION

NO. 1

OF NAVAL PETROLEUM RESERVE NO. 1 val Petroleum

Will M. Adams, Jr.

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By

Lt. Will M. Adams, Jr., USN

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10 June 1954

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A STUDY OF THE

RECORDS

OF THE

NAVY

RECORDS OFFICE

with

A Critical Review of All the Naval Personnel

and

Oil Spill Records

BY

DR. WILLIAM E. ADAMS, JR.

1978

FOREWORD

This report was prepared and submitted to the Petroleum Engineering Department of the University of California at Berkeley as one of the requirements for the degree of Master of Engineering, Petroleum. It was prepared under the direction and guidance of Professor John A. Putnam.

The report was sponsored by the U. S. Naval Postgraduate School to which this officer was attached as a petroleum engineering student from 1951 to 1954.

The student wishes to acknowledge the great amount of liaison work, authorized by the Director Naval Petroleum Reserves and the Inspector Naval Petroleum Reserves in California, and accorded the student by the staff members of the above officers. This report would not have been possible without their cooperation.

W. M. Adams, Jr.

University of California, Berkeley
10 June 1954

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REPORT

This report was prepared and submitted to the President
 and the Board of Trustees of the University of California at
 Berkeley as one of the requirements for the degree of Master
 of Arts in Education. It was prepared under the direction
 and guidance of Professor John A. Larson.

The report was submitted by the U. S. Civil Service
 School in Washington, D. C. on August 15, 1964.

and includes students from 1961 to 1964.

The student's interest in knowledge and great amount of
 self-study, supported by the Director's special training
 program and the University's special training program in
 California, and encouraged the student by the staff members
 of the same center. This report would not have been
 possible without their cooperation.

John A. Larson, Jr.

University of California, Berkeley
 10 June 1964

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CHAPTER I

LOCATION, DESCRIPTION, AND BRIEF REVIEW

OF

EACH RESERVE

CHAPTER I

INTRODUCTION, SCOPE, AND AIMS

1

THE SUBJECT MATTER

CHAPTER ILOCATION, DESCRIPTION, AND BRIEF REVIEW
OF
EACH RESERVE

There are four naval petroleum reserves and three oil shale reserves. These public lands are in the possession and under the authority of the Navy. The Secretary of the Navy is responsible to Congress and the President for their administration and for the operation of petroleum reserves. The Secretary of the Navy administers the reserves through a senior naval officer appointed as the Director Naval Petroleum and Oil Shale Reserves. The administrative staff of the Director is described in Chapter VII of this report.

LOCATIONS

The general locations of the reserves within the continental United States are shown in Figure 1-1. The only reserve lying outside the boundaries of the United States is shown in Figure 1-2.

CHAPTER I

LOCATION, NUMBER, AND SIZE OF RESERVES

INTRODUCTION

GENERAL PRINCIPLES

There are four general categories of reserves and these are: (1) Strategic reserves, (2) Intermediate reserves, (3) Tactical reserves, and (4) Special reserves. These reserves are in the possession of the Government and are under the control of the Secretary of the Navy. The Secretary of the Navy is responsible to Congress and the President for their administration and for the operation of petroleum reserves. The Secretary of the Navy administers the reserves through a senior naval officer appointed as the Director Naval Petroleum and Oil Reserves. The administrative staff of the Director is described in Chapter VII of this report.

DEFINITIONS

The general locations of the reserves within the continental United States are shown in Figure 1-1. The only reserves lying outside the boundaries of the United States are shown in Figure 1-2.

NAVAL PETROLEUM AND OIL SHALE RESERVES IN CONTINENTAL UNITED STATES

LOCATION MAP

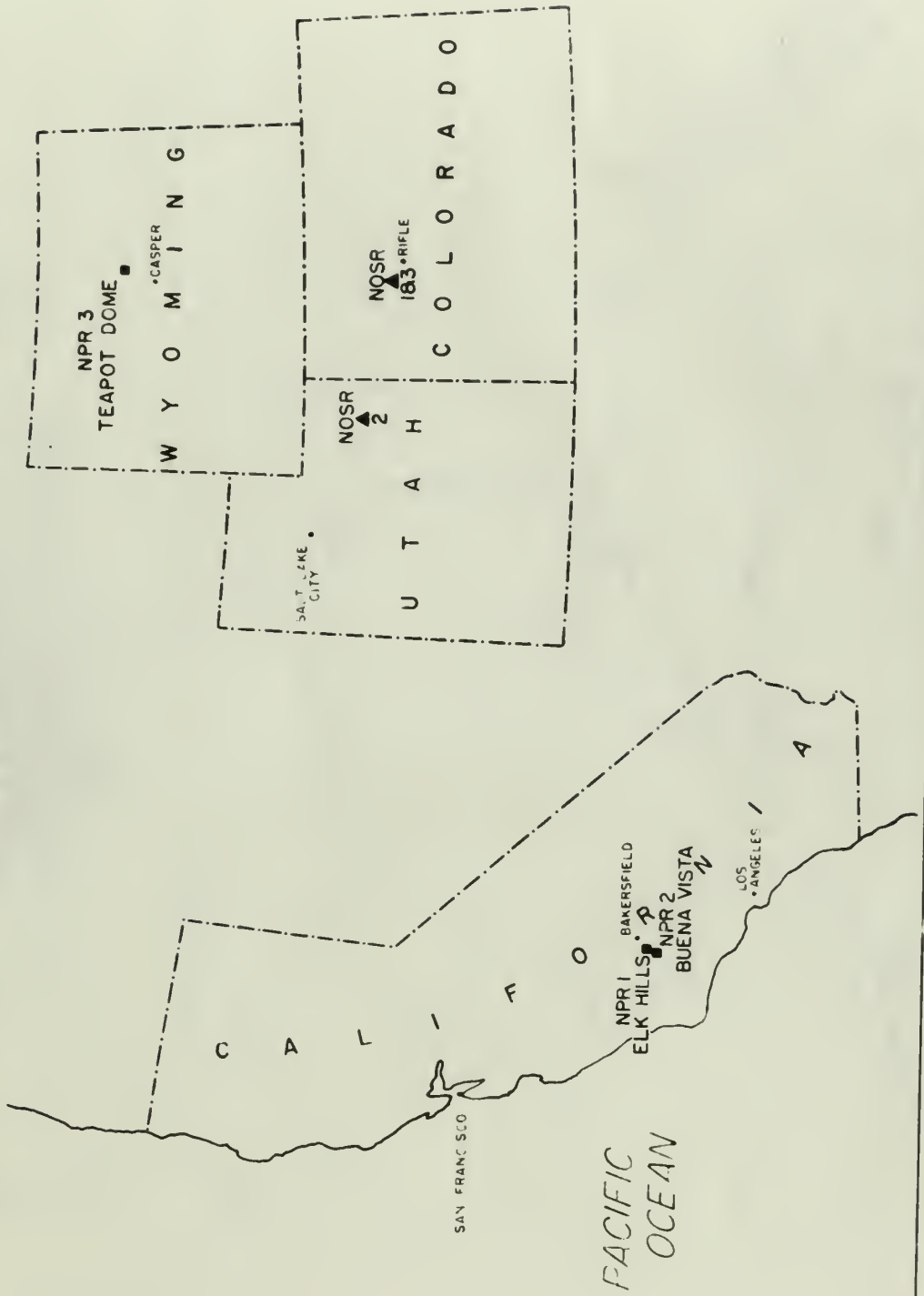


FIG. 1-1

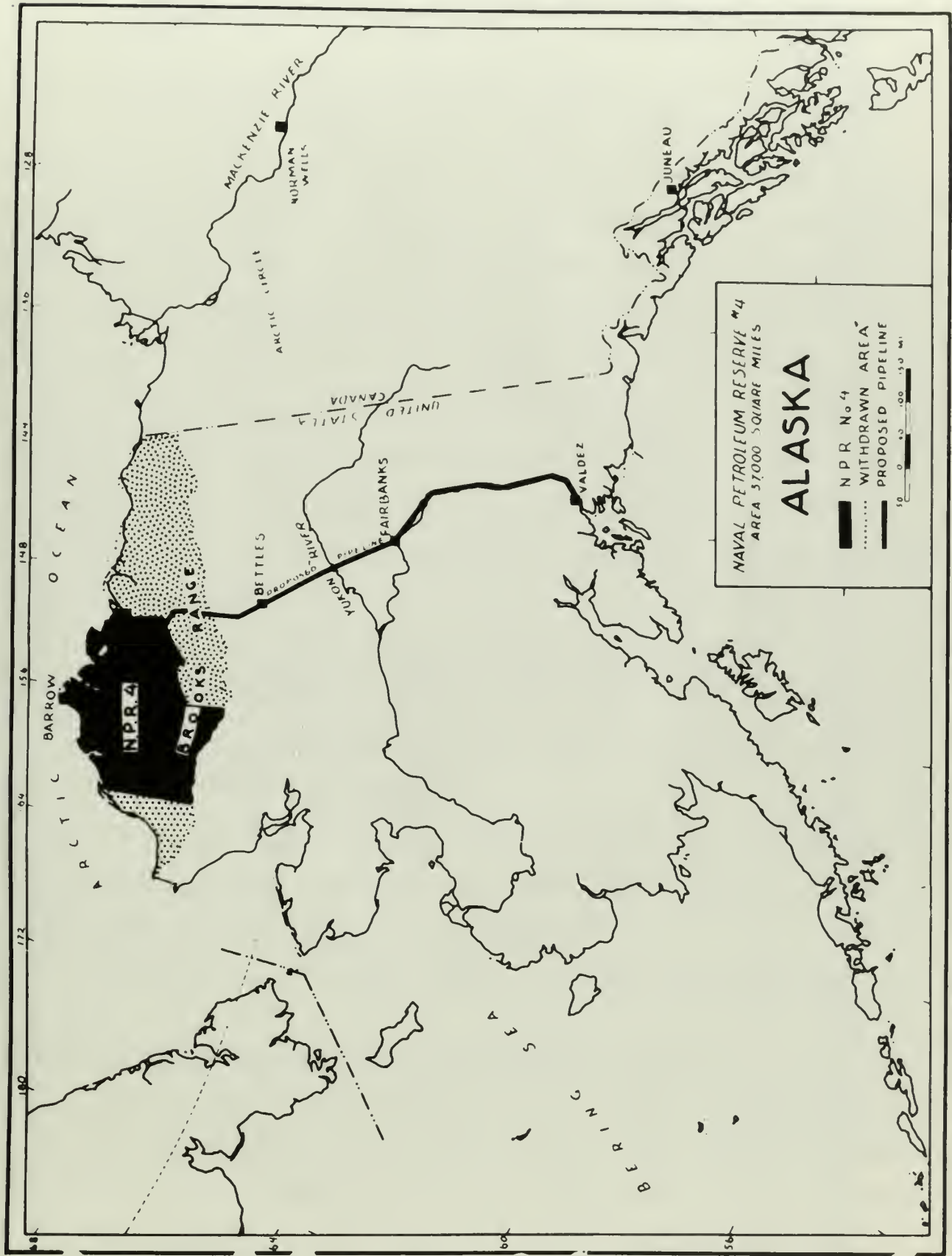


FIG. 1-2, Showing the Location of the Navy's Largest Petroleum Reserve Which Was Actively Explored from 1944 to 1952. An Enlarged Map of the Reserve is Shown on FIG. 2-11.

BRIEF DESCRIPTIONS AND RELATIVE IMPORTANCE²

Naval Petroleum Reserve No. 1 (Elk Hills).

This reserve is located near Tupman, Kern County, California. It lies approximately 20 miles west of the city of Bakersfield. The reserve covers 46,095 acres and is one of the greatest oil fields in the United States. A map of the reserve showing its boundaries at different times in the field's life is shown in Figure 1-3. As of January 1954, it was the largest oil field in California with estimated recoverable reserves exceeding 700 million barrels of oil and an estimated constant productive capacity of about 140,000 barrels per day for five years, or an initial emergency capacity of over 200,000 barrels per day.

The field is jointly owned by Navy and Standard Oil Company of California, with Navy having the majority interest. It is unitized with Standard as the Operator for Navy who has complete control of the reserve. ✓

N.P.R. No. 1 is currently the most important of all the naval petroleum and oil shale reserves. It is the only one functioning as a true petroleum reserve.

A typical view of this reserve is shown on Figure 1-4.

Naval Petroleum Reserve No. 2 (Buena Vista Hills).

This reserve lies adjacent to the southern boundary of N.P.R. No. 1 as shown on Figures 1-1 and 1-3. Sections of the city of Taft, California, lie within the reserve. The reserve comprises 30,181 acres of which only 34.6 percent belong to Navy.

NAVY PETROLEUM RESERVE NO. 1 (LAKE HILLS)

NAVY PETROLEUM RESERVE NO. 1 (LAKE HILLS)

This reserve is located near Inman, Kern County, California. It lies approximately 20 miles west of the city of Bakersfield. The reserve covers 20,181 acres and is one of the greatest oil fields in the United States. A map of the reserve showing its boundaries at different times in the field's life is shown in Figure 1-3. As of January 1954, it was the largest oil field in California with estimated recoverable reserves exceeding 700 million barrels of oil and an estimated constant productive capacity of about 140,000 barrels per day for five years, or an initial energy capacity of over 200,000 barrels per day.

The field is jointly owned by Navy and Standard Oil Company of California, with Navy having the majority interest. It is unitized with Standard as the operator for Navy and has complete control of the reserve.

N.P.R. No. 1 is currently the most important of all the naval petroleum and oil shale reserves. It is the only one functioning as a true petroleum reserve. A typical view of this reserve is shown on Figure 1-4.

NAVY PETROLEUM RESERVE NO. 2 (BUENA VISTA HILLS)

This reserve lies adjacent to the southern boundary of U.P.R. No. 1 as shown on Figures 1-1 and 1-2. Sections of the city of Taft, California, lie within the reserve. The reserve comprises 20,181 acres of which only 24.6 percent belong to



FIG. 1-4. Typical View of N.P.F. No. 1 (Elk Hills) Showing Stevens Zone Well Head in Left Foreground with Background of Shallow Zone Lerricks. Note Arid Nature of Terrain and Surface Reflection of Anticlinal Structure. (Reproduced from Art. On N.F.R. No. 1 by Cdr. V. N. Gustafson, USN, Ref. 111, Biblio.)

Because of Navy's minority interest, it was never practical for the Government to attain control from numerous private interests intent on producing oil. Consequently, the reserve has been on continuous production since its discovery in 1909 with a cumulative production of approximately 138 million barrels by 1952.

About 88 percent of the Government's land within the reserve is leased to private interests who produce the oil and pay Navy the equivalent value of the royalty oil. As of 30 June 1952, the Government had received approximately 27 million dollars from reserve in lease payments and petroleum sales. Of the estimated remaining recoverable oil of nearly 23 million barrels, the Government is due to receive only the equivalent value of about 3.6 million barrels of royalty oil.

Thus this field has never functioned as a true petroleum reserve. It is of importance only in its past and future income to the Government.

Naval Petroleum Reserve No. 3 (Teapot Dome).

This reserve, located near Casper, Wyoming, comprises 9,321 acres. All of the land is owned by the Navy. The field was partially developed by lessees for Navy; but all of the producing wells were shut-in on 31 December 1927 and have remained shut-in ever since. Prior to being shut-in, the field had produced approximately 3.5 million barrels of oil with a royalty value of about 6 million dollars accruing

because of Navy's minority interest, it was never practical for the Government to attain control from numerous private interests intent on producing oil. Consequently, the reserve has been on continuous production since its discovery in 1902 with a cumulative production of approximately 125 million barrels by 1952.

About 88 percent of the Government's land within the reserve is leased to private interests who produce the oil and pay Navy the equivalent value of the royalty oil. As of 30 June 1952, the Government had received approximately 27 million dollars from reserve in lease payments and petroleum sales. Of the estimated remaining recoverable oil of nearly 23 million barrels, the Government is due to receive only the equivalent value of about 3.6 million barrels of royalty oil.

That this field has never functioned as a true petroleum reserve. It is of importance only in the past and future income to the Government.

Naval Petroleum Reserve No. 3 (Taspo Dome).

This reserve, located near Casper, Wyoming, comprises 9,321 acres. All of the land is owned by the Navy. The field was partially developed by leases for Navy; but all of the producing wells were shut-in on 31 December 1927 and have remained shut-in ever since. Prior to being shut-in the field had produced approximately 3.5 million barrels of oil with a royalty value of about 6 million dollars accruing

to the Government.

Remaining reserves from the developed Second Wall Creek Zone are estimated at 8.4 million barrels. Several deep exploratory wells in 1952 and 1953 discovered an oil accumulation in the Tensleep Sand Zone. The results of these tests and the exact estimates of the recoverable oil in the Tensleep Horizon is not well known by this student, except the fact that the new reservoir is considered only a minor oil reserve.

Although this reserve is perhaps the best known of all the reserves as a result of the Teapot Dome scandals of the twenties, it is in no true sense of the word a naval petroleum reserve. It has been tested and found wanting in oil reserves and capacity. The only value lies in the income the Government eventually may receive from the royalty oil.

Naval Petroleum Reserve No. 4.

This huge, 37,000 square mile reserve, is located in Northern Alaska, just south of Point Barrow in the area shown on Figure 1-1. In 1944, during the last war, with the Government anticipating a possible oil shortage, Navy commenced actively exploring the reserve for possible oil deposits. This exploration program continued for nine years until it was suspended in March 1953.

Oil or gas was found in almost every one of the 45 test holes drilled---a few of which went as deep as 12,000 feet. Only one extensive oil deposit was found at Umiat in the

to the Government. Remaining reserves from the developed second half class have been estimated at 6.5 billion barrels. Several billion barrels of gas are also known and have been classified as oil accumulation in the Gwinnap and Kona. The results of these tests and the exact estimates of the recoverable oil in the Gwinnap horizon is not well known by this estimate, except for fact that the new reservoir is considered only a minor oil reserve. Although this reserve is between the two known oil fields, reserves as a result of the second known accumulations of the Gwinnap is in the true sense of the word a major petroleum reserve. It has been tested and found containing oil reserves and capacity. The only value that is known in the Gwinnap horizon is that it may receive from the royalty oil.

Naval Petroleum Reserve No. 4.

This huge, 27,000 acre oil reserve, is located in Northeast Alaska, just south of Point Barrow in the area shown on Figure 1-1. In 1944, during the last war, with the Government anticipating a possible oil shortage, Navy commenced actively exploring the reserve for possible oil deposits. This exploration program continued for nine years until it was abandoned in March 1953. Since that time the area has been explored for oil and gas and found in almost every one of the 46 test holes drilled--a fee of which cost at least \$12,000 each. Only one extensive oil deposit was found in this area.

southeastern section of the reserve. This field is estimated to contain 50 million barrels. One large gas field was also found. Some evidence of the extent and success of the drilling program to August 1952 is shown in an enlarged map of the Reserve in Figure 2-11. About 50 million dollars was spent in the exploration program.

What is the relative importance of this reserve? At the present time it is of little importance due to the small amount of oil discovered and the great difficulty involved in getting any oil out of the area. However, it is possible that in any area of 37,000 square miles great oil deposits may one day be found; and this oil will be produced and transported in spite of all difficulties and expense involved, provided the demand is great enough and the selling price is high enough. This reserve is believed to have great potential value.

The Oil Shale Reserves.

The great oil shale holdings of the Navy are divided into three reserves as shown on the location map of Figure 1-1: Shale Reserves No. 1 and No. 3 in western Colorado; and Shale Reserve No. 2 in eastern Utah. NOSR No. 1 comprises an area of 41,353 acres with an estimated shale oil reserve in rich shales of about 5 billion barrels. NOSR No. 3, bordering NOSR No. 1 on three sides, has less than 15 percent of its area as shale, but it was still necessary to establish this area as a reserve in order to provide working space and spent-shale disposal areas for future operations of NOSR No. 1.

non-bearing section of the reserve. This field is estimated to contain 30 million barrels. The lower part of the field was also found. Some evidence of the extent and success of the drilling program to August 1933 is shown in an enlarged map of the Reserve in Figure 2-11. About 30 million dollars was spent in the exploration program.

What is the relative importance of this reserve at the present time? It is of little importance due to the small amount of oil discovered and the great difficulty involved in getting any oil out of the area. However, it is possible that in any area of 30,000 square miles there are deposits of oil that are not found; and this oil will be produced and transported to other parts of the world. It is possible that reserves involved, provided the demand is great enough and the selling price is high enough. This reserve is believed to have great potential value.

The Oil Shale Reserves.

The great oil shale holdings of the Navy are divided into three reserves as shown on the location map of Figure 1-11: shale reserves No. 1 and No. 2 in western Colorado; and shale reserve No. 3 in eastern Utah. Shale No. 1 contains an area of 11,325 acres with an estimated shale oil reserve in which there is about a billion barrels. Shale No. 2, bordering shale No. 1 on the north, has less than 15 percent of the area as shale, but it was still necessary to establish this area as a reserve in order to provide working space and spent-shale disposal areas for future operations of shale No. 1.

The oil reserves from both the rich and lean shales of NOSR No. 1 and No. 3 are estimated at 36 billion barrels. NOSR No. 2 is the largest of the three with an area of approximately 92,160 acres. No estimate has been made of its great shale oil reserves.

Although Navy is responsible for the administration of the oil shale reserves, it is specifically prohibited by the Act of 30 June 1938 from developing or operating these reserves.

The oil shale reserves are of tremendous potential value. Judging by the results and reports of BuMines experimental work at the Oil Shale Demonstration Plant near Rifle, Colorado, and personal discussions with engineers in the petroleum industry, the economic production of oil shale on a competitive commercial basis with crude oil may now, or soon will be, possible. It is the considered opinion of many men, in and out of the petroleum industry, but all concerned with the needs of this nation in any future emergency, that the Government should take immediate, positive steps to finance and establish a Shale Oil Recovery Unit or Units on a commercial scale. This step could be taken with proper safeguards and guarantees to the petroleum industry as regards any possible harmful effects of such a program on the industry's economy.

But we'll probably wait until it's (almost) too late.

The oil reserves from both the 1958 and 1959 years of 1958
No. 1 and No. 2 are estimated at 50 billion barrels. No. 3
No. 4 is the largest of the three with an area of approxi-
mately 50,180 acres. No estimate has been made of the area
of oil reserves.

Although there is responsibility for the administration of
the oil shale reserves, it is specifically provided by the
Act of 30 June 1958 from developing or operating these reserves.
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oil recovery unit on a commercial scale. This step
could be taken with proper safeguards and references to the
petroleum industry as regards any possible national effects
of such a program on the industry's economy.

But we'll probably wait until it's almost too late.

POLICY

As summarized in a "History of the Naval Petroleum and Oil Shale Reserves" issued by the Director,² the Navy's policy concerning these reserves is as follows...

"Navy's policy as to the future administration of the naval petroleum reserves will be, as it has in the past, that there shall be the maximum conservation of oil consistent with the needs of the national military and naval security. The Navy has regarded itself as charged by Congress with the responsibility for maintaining its present holdings of oil lands as a reserve in the ground, insofar as that can possibly be achieved, and for restricting production to the minimum necessary to maintain the field in a state of readiness.

As to the oil shale reserves, the Navy's policy is to watch and encourage research, both Governmental and private, in synthetic liquid fuels from shale. The potential value of the shale reserves must not be underestimated."

As mentioned in a "Review of the Naval Reserve Act of 1916" (H. Rept. 100, 64th Cong., 1st Sess., 1916), the Navy's policy concerning these reserves is as follows:

"The Navy's policy is to have a reserve administration of the naval personnel reserves will be, as far as possible, to have them administered as a part of the national military and naval reserves. The Navy has regarded itself as charged with the responsibility for maintaining the present volume of all hands as a reserve in the event, insofar as that can possibly be achieved, and the corresponding production of the highest possible level in certain key fields in a state of readiness.

As to the civil service reserves, the Navy's policy is to work and encourage reserve, both Governmental and private, in synthetic fields from which the essential staff of the Navy Reserve could be recruited."

HISTORY

Aside from stating that the Naval Petroleum Reserves originally were set aside over a span of years for the purpose of providing future naval fuel-oil supplies, the history of the reserves and of the development of the present national policy concerning them will not be attempted in this report. Prior to the establishment of the first Reserve, N.P.R. No. 1, in 1912, and continuing to the present time, this history has been stormy and controversial. It would be difficult to present a clear and unbiased review of this history without writing a long and detailed report. However, excellent histories, referred to in the selected bibliography below, have been written summarizing the numerous Acts of Congress, Presidential Executive Orders, Congressional Hearings, and litigation related to the reserves. Most of these items are listed in the bibliography of this report, together with a short brief of the contents of each, which may supply the reader with enough information.

SELECTED REFERENCES IN THE BIBLIOGRAPHY

2, 3, 5, 6, 111, 124, 170, 245, 247

INDEX

Also from the fact that the Navy Department has approved of
 finally were not made over a span of years for the purpose
 of providing a more complete and logical picture, the history of
 the reserves and of the development of the present position
 policy concerning them will not be attempted in this volume.
 Prior to the establishment of the first Reserve, S. 1780, No. 1,
 in 1916, and continuing to the present time, this history has
 been slow and uneventful. It would be difficult to pre-
 sent a clear and unbiased review of this history without writing
 a long and detailed report. However, student history,
 referred to in the related bibliography below, have been written
 summarizing the numerous acts of Congress, Executive Order,
 five Orders, Congressional Resolutions, and Executive Orders
 of the Government, most of which have been listed in the biblio-
 graphy of this report, together with a brief account of the
 contents of each, which may assist the reader with enough
 information.

EXHIBIT MATERIALS IN THE APPENDICES

S. 1780, No. 1, 1916; S. 1780, No. 2, 1917

CHAPTER II

GEOLOGY

SECRET

The following information is being furnished to you for your information only. It is not to be disseminated outside your organization. This information is being furnished to you in confidence and is not to be used for any purpose other than that for which it was furnished. It is not to be used in any way to the detriment of the United States or its interests. It is not to be used in any way to the detriment of the United States or its interests.

II. SUMMARY

The following information is being furnished to you for your information only. It is not to be disseminated outside your organization. This information is being furnished to you in confidence and is not to be used for any purpose other than that for which it was furnished. It is not to be used in any way to the detriment of the United States or its interests. It is not to be used in any way to the detriment of the United States or its interests.

III. DETAILS

The following information is being furnished to you for your information only. It is not to be disseminated outside your organization. This information is being furnished to you in confidence and is not to be used for any purpose other than that for which it was furnished. It is not to be used in any way to the detriment of the United States or its interests. It is not to be used in any way to the detriment of the United States or its interests.

Approved for Release by NSA on 05-08-2014 pursuant to E.O. 13526

CHAPTER II

GEOLOGY

NAVAL PETROLEUM RESERVE NO. 1

Regional Geology.

The immediate regional geology associated with Elk Hills is best shown by the geologic section of Figure 2-1. It shows the Reserve to be a separate and distinct field except for some off-set drainage production on the southern and eastern edges of the Reserve. There are numerous nearby oil and gas fields in this lower end of the San Joaquin Valley. However, only three appear to directly affect N.P.R. No. 1, and they are:

- (1) the Buena Vista Front Field on the southern edge, from which the Reserve produces some oil to prevent drainage from Section 14-B but not drainage from the Elk Hills structure itself;
- (2) the North Coles Levee field on the eastern edge, which has a finger of oil productive Stevens Sand lensing out in the Reserve and from which the Reserve produces some oil to prevent drainage;
- (3) and the Buena Vista Field (N.P.R. No. 2), which appears to have the same aquifer as the Shallow Oil Zone on the Reserve and thereby to affect greatly the Shallow Zone reservoir.

Structural Features of Elk Hills.

The Shallow Oil Zone structure, as shown by Figures 2-2

CHAPTER 11

INDEX

INDEX OF SUBJECTS

Geological Geology

The immediate regional geology associated with the Hills is best shown by the geologic section of Figure 11-1. It shows the presence of a separate and distinct field except for some oil-field delineation produced by the structure and sequence of the reservoir. There are numerous examples of oil and gas fields in this lower end of the San Joaquin Valley. However, only those areas appear to be directly related to the structure and sequence of the reservoir.

(1) The lower San Joaquin Valley is the western edge of the basin. The geologic section 11-1 but not detailed from the Hills structure itself.

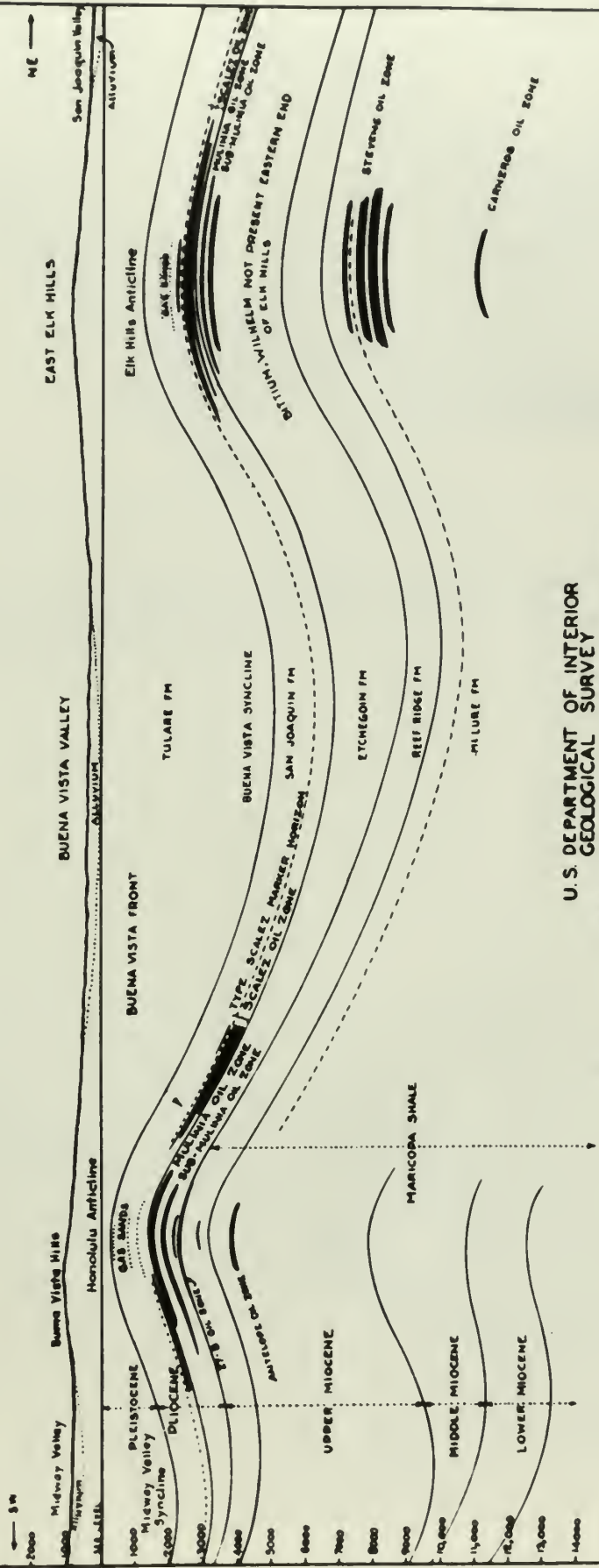
(2) The Kern County level field on the eastern edge, which has a thickness of oil equivalent between 2000 and 3000 feet in the reservoir and the whole the reservoir produces some oil to prevent drainage.

(3) and the lower San Joaquin Valley (S.J.V.) which appears to have the same structure as the shallow oil fields on the western and thereby is almost directly the shallow San Joaquin.

Structural Features of the Hills

The shallow oil field structure, as shown by Figure 11-2

18 MILES



U. S. DEPARTMENT OF INTERIOR
 GEOLOGICAL SURVEY
 CONSERVATION BRANCH - OIL AND GAS LEASING
 LOS ANGELES, CALIFORNIA

GENERALIZED GEOLOGIC SECTION
 SHOWING
 BUENA VISTA, BUENA VISTA FRONT AND
 ELK HILLS OIL FIELDS

PREPARED BY J. D. CERKEL MARCH 17, 1944
 DRAWING NO. 7087
 (MODIFIED 1952, W.M.G.)

FIG. 2-1

Generalized Geologic Section Showing the Structure and Stratigraphic Relationship Among N.P.R. No. 1, N.P.R. No. 2 and the Associated Buena Vista Front Field.

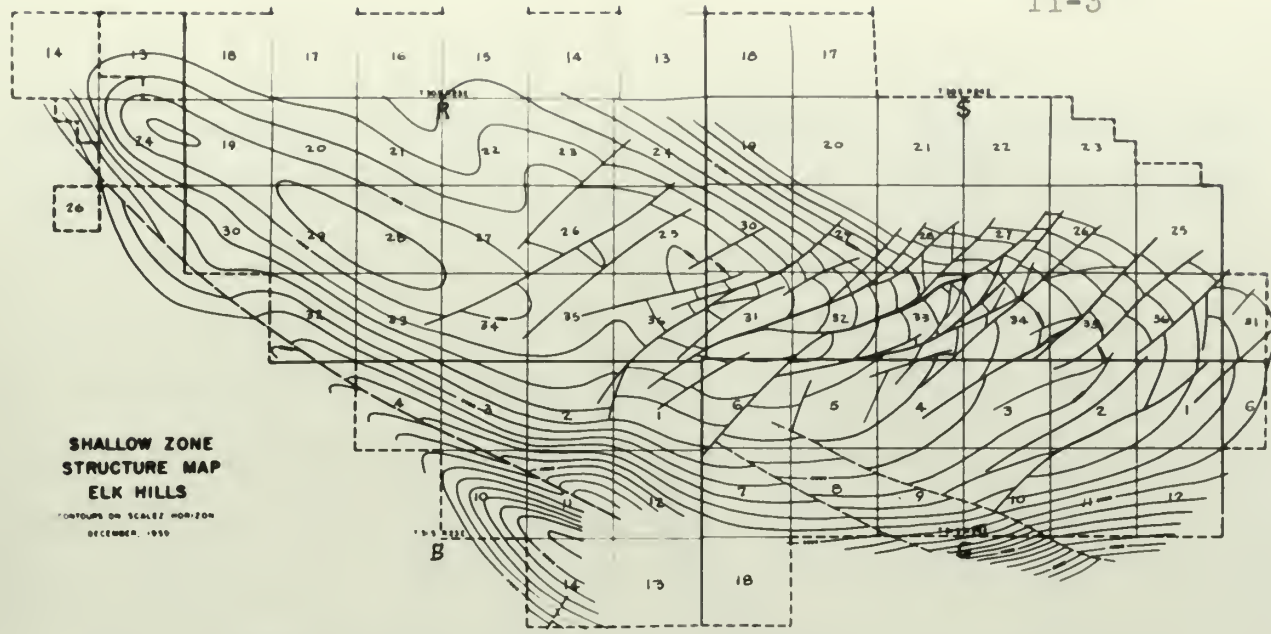


FIG. 2-2

Structure Map of the Shallow Oil Zone, N.P.R. No. 1, Showing the Intense Faulting Which Complicates the Anticlinal Structure. Contours on the Scaletz Marker.

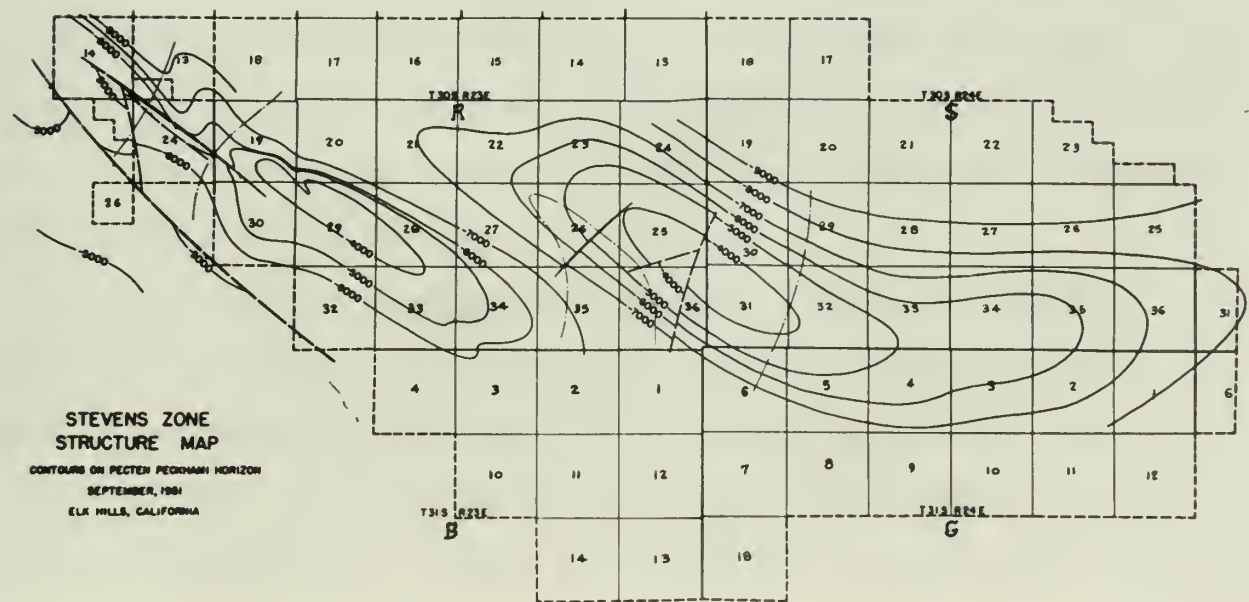


FIG. 2-3

Structure Map of the Stevens Zone, N.P.R. No. 1, Showing the Two Enechelon Folds of the Anticlinal Structure.

and 2-4, consists of a broad faulted anticline with several closed highs and is reflected by the surface structure. The anticlinal structure on the surface is 17 miles long by 6 miles wide with hills rising 1200 feet above the valley floor. As shown by the contour map of Figure 2-2, most of the faults are normal except for apparent high-angle reverse faults along the south flank. Only a few of the faults have proven to be competent fluid barriers.

The Stevens Zone structure, as indicated by the contour map of Figure 2-3 and the cross-section of Figure 2-4, consists of two enechelon folds with numerous thrust-faults.

The accumulation of oil in the Shallow Oil Zone is controlled primarily by the anticlinal structure and secondarily by faulting and stratigraphic pinch-outs.

The Dry Gas Zone lies above the Shallow Oil Zone.

The Carneros Zone underlies the Stevens Zone. The exact nature of the Carneros structure is not well known. However, it does have very steep beds dipping to the north and south as shown on Figure 2-4 and may be an anticline or a homocline open to the west with competent faults or stratigraphic barriers serving to trap the oil.

As the depth increases, the general structural trend of Elk Hills is up-dip toward the west. Any additional accumulation traps in the western end of the field, therefore, would depend on local dip reversals, faulting, pinch-outs or other permeability barriers. There are favorable possibilities for

and 7-4, consists of a broad folded anticline with several closed
 limbs and is reflected by the various structures. The additional
 structure on the surface is 17 miles long by 2 miles wide with
 hills rising 1200 feet above the level floor. It shows of
 the contour map of Figure 2-3, west of the level the central
 except for separate north-south trends along the south
 flank. Only a few of the faults were shown in the component
 fluid barriers.

The Stevens Zone structure, as indicated by the contour
 map of Figure 2-3 and the cross-section of Figure 2-4, con-
 sists of two enclaves with irregular structures.
 The accumulation of oil in the Stevens Oil Zone is con-
 trolled primarily by the structural structure and secondarily
 by faulting and stratigraphic trends.

The Tray Zone lies above the Stevens Oil Zone.

The Carnegie Zone underlies the Stevens Zone. The exact
 nature of the Carnegie structure is not well known. However,
 it does have very steep dips along to the north and south
 as shown on Figure 2-4 and may be an anticline or a nose-like
 open to the west with component faults or structural barriers
 serving to trap the oil.

As the depth increases, the general structural trend of
 Elk Hills is up-dip toward the west. A 7 mile long structure
 also traps in the western end of the field. However, traps
 depend on local dip reversals, faulting, pinch-outs or other
 permeability barriers. There are favorable possibilities for

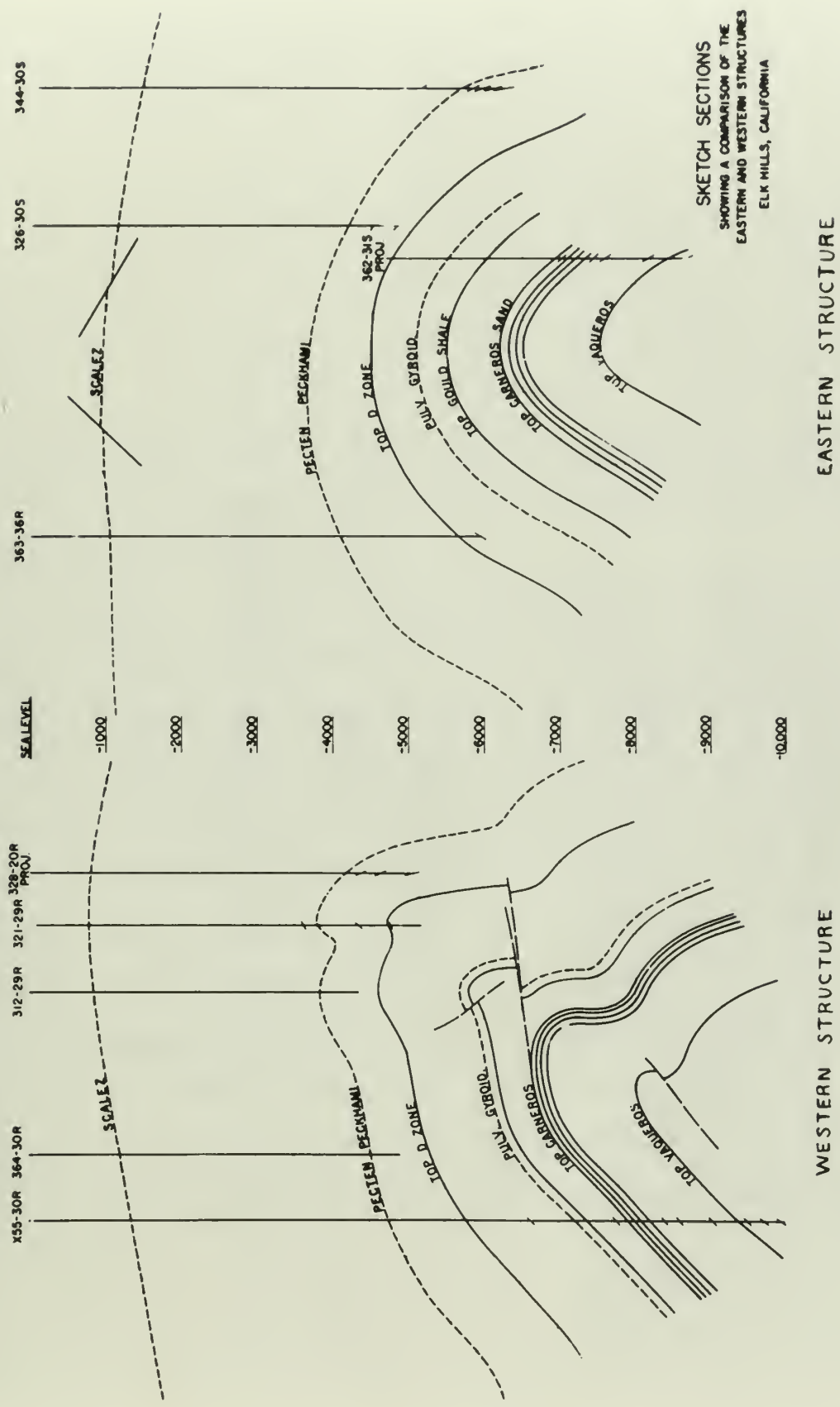


FIG. 2-4

(Reproduced from Article on N.P.R. No. 1 by
Cdr. W. M. GUSTAFSON)

Generalized Sketch Sections of the Western and Eastern Structures of N.P.R. No. 1, Elk Hills, Showing Depths Below Sea Level to the Main Productive Horizons.

future production from additional deep zones such as the Phacoides Reed Sandstone at about 11,000 feet and the Point of Rocks Sandstone at about 13,000 feet.¹²¹ As of May 1954 four deep exploratory wells had been drilled in the field to test for deep production. The deepest depth penetrated was about 12,900 feet. Two of these deep wells in the western portion of the field found commercial oil production in the Carneros Sand at about 10,000 feet and were completed there. As regards the other two deep tests, it is believed that they failed to find deep production and were plugged back and completed in the Stevens Zone.

A composite electric log alongside the stratigraphic column of Figure 2-5 indicates the various oil productive horizons in the stratigraphic column of Elk Hills.

The Dry Gas Zone comprises the several dry gas productive sand measures lying in the upper portion of the San Joaquin clay formation about 1200 to 2200 feet below the surface. Four of these sands, termed the Mya dry gas sands, have a net productive sand thickness of about 50 feet.

The Shallow Oil Zone sands are of Pliocene Age, varying in depth from 2000 to 3600 feet below the surface. For mapping structure, contours are normally based on the Lower Scalez fossil marker, Scalez Petrolia, which occurs throughout most of the field.

Labor production from horizontal sand zones such as the
 Florida New Sandstone at about 12,000 feet and the
 of Rock Sandstone at about 15,000 feet. At the end of 1934
 four deep exploratory wells had been drilled in the field to
 test for deep production. The deepest well penetrated the
 about 12,000 feet. Two of these deep wells in the western
 portion of the field found commercial oil production in the
 Carver Sand at about 10,000 feet and some oil in the
 As regards the other two deep wells, it is believed that they
 failed to find deep production and were plugged back and re-
 placed in the system zone.

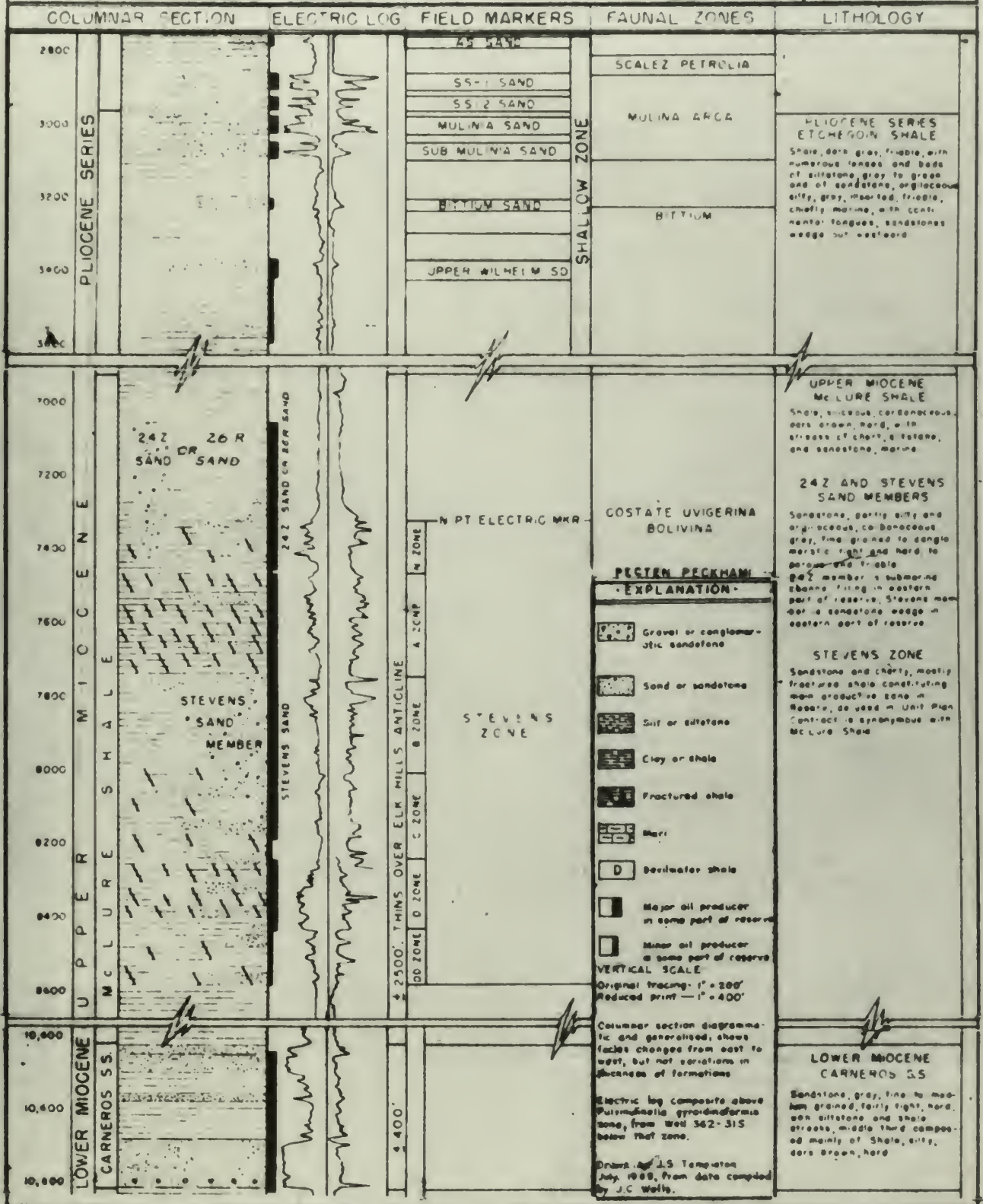
A composite section has been prepared for the field
 column of Figure 2-A indicates the various oil producing
 horizons in the stratigraphic column of the field.
 The dry gas zone comprises the interval from the productive
 sand measure lying in the upper portion of the sandstone
 clay formation about 1200 to 2000 feet below the surface.
 Four of these sands, toward the top and bottom, have a low
 productive sand thickness of about 20 feet.

The Shallow Oil Zone sands are of Eocene and Oligocene
 in depth from 2000 to 2500 feet below the surface. The
 structure, contours are generally based on the lower
 fossiliferous, Eocene section, which occurs throughout most
 of the field.

STRATIGRAPHIC COLUMN

NAVAL PETROLEUM RESERVE NO 1

ELK HILLS, CALIFORNIA



Reproduced from Article on N.P.R. No. 1 by Cdr. W. M. Gustafson

FIG. 2-5

In the Shallow Oil Zone there are at least ten different oil sands, subdivisions being caused by the interbedding of shales and sands. These sands are tabulated below:^{113,136,138}

<u>Sand</u>	<u>Net Productive Sand Thickness Feet</u>	<u>Porosity % of Pore Volume</u>	<u>Water % of Pore Space</u>	<u>Average Permea- bility Md.</u>
E Laminated (EL)	-	-	-	-
Above Scalez (AS)	10	38.2	-	2000
Sub-Scalez 1 (SS-1)	46	34.0	30	2100
Sub-Scalez 2 (SS-2)	18	34.6	32.0	1600
Mulinia (M)	23	35.4	40.1	2400
Sub-Mulinia (SM)	8	33.4	43.0	700
Sub-Scalez 2 and M (SS-2-M)	20	34.4	27.2	1700
Bittium (B) Above Bittium (AB) Bittium (B)	3	36.4	-	750
Wilhelm (W) High Produc. (HPW)	7	32.1	-	200
Low Produc. (LPW)	16	31.7	-	75

The abbreviations in parentheses after each sand above will be used throughout this report in discussing the Shallow Oil Zone. The first four sands above are found in the basal portion of the San Joaquin clay formation. The other sands occur in the upper part of the Etchegoin formation.

The most prolific oil sands are the SS-1, SS-2, and M sands,

In the section (VI) from which the oil sands are derived, the oil sands, sandstones being derived from the underlying oil sands and sands. These sands are contained below 227,155,758

Section	Net Productive Sand Thickness Feet	Porosity % of Core	Permeability % of Core	Average Porosity
Unlimited (E)	-	-	-	-
Above Section (A)	10	28.2	-	2000
Sub-section 1 (22-1)	46	28.0	20	2100
Sub-section 2 (22-2)	12	28.2	22.0	1600
Wilhelm (W)	22	28.4	20.1	2400
Sub-Wilhelm (22)	8	28.4	22.0	700
Sub-section 2 and M (22-2-M)	20	28.4	21.2	1700
Bittum (B) Above Bittum (A) Bittum (B)	3	28.4	-	750
Wilhelm (W) High Product. (HP) Low Product. (LP)	7 16	28.4 21.7	- -	800 75

The approximations in percentages shown above will be used throughout this report in determining the oil flow zone. The first four sands shown are found in the oil portion of the San Joaquin clay formation. The other sands occur in the upper part of the Franciscan formation. The most prolific oil sands are the 22-1, 22-2, and M sands.

from which approximately 95 percent of the oil produced to date has come and from which 90 percent of the future production could be expected.¹¹²

The Stevens Zone consists of seven different horizons in the Upper Miocene. These oil productive zones are listed below:¹¹¹

<u>Zone</u>	<u>Remarks</u>
N	Productive at a few axial locations and in certain sand areas.
A	Fractured silicious shale and some low permeability sands; productive over most of eastern and western structure.
B*	Includes most of the permeable Stevens Sand at eastern end of Elk Hills and a fractured shale on the western structure; *most productive of all the zones.
C	Massive shale; serves as a fractured rock type reservoir in only a few locations.
D	Highly fractured silicious shales; some low permeability sand lenses; productive on both structures at crestal position.
DD	Low permeable sands and shales; marginally productive on crest of eastern structure.
PG	Sands and shales below DD zone; marginally productive on crest of eastern structure.

The above stratigraphic series of shales with sand streaks and fractured shales varies in thickness from 80 to 800 feet.¹¹³ For correlation and mapping of the Stevens Zone the fauna, Pecten Pechami, and the "N" point electric log marker generally are used. The porosity, permeability and water content of the various sands and shales in the Stevens Zone varies considerably; therefore, it is extremely difficult to assign average values

from which approximately 50 percent of the oil produced is derived
has come and has been used for the purpose of the program described
could be expected.

The Stevens zone consists of seven different horizons
in the Upper Wisconsin. These oil producing horizons are listed
below:

Horizon	Zone
Produced as a secondary horizon and is not oil bearing.	B
Produced as a secondary horizon and was low productive in the past.	A
Contains most of the gas-bearing horizons and is a source of oil and gas.	C
Produced as a secondary horizon and was low productive in the past.	D
Produced as a secondary horizon and was low productive in the past.	E
Produced as a secondary horizon and was low productive in the past.	F
Produced as a secondary horizon and was low productive in the past.	G
Produced as a secondary horizon and was low productive in the past.	H
Produced as a secondary horizon and was low productive in the past.	I
Produced as a secondary horizon and was low productive in the past.	J
Produced as a secondary horizon and was low productive in the past.	K
Produced as a secondary horizon and was low productive in the past.	L
Produced as a secondary horizon and was low productive in the past.	M
Produced as a secondary horizon and was low productive in the past.	N
Produced as a secondary horizon and was low productive in the past.	O
Produced as a secondary horizon and was low productive in the past.	P
Produced as a secondary horizon and was low productive in the past.	Q
Produced as a secondary horizon and was low productive in the past.	R
Produced as a secondary horizon and was low productive in the past.	S
Produced as a secondary horizon and was low productive in the past.	T
Produced as a secondary horizon and was low productive in the past.	U
Produced as a secondary horizon and was low productive in the past.	V
Produced as a secondary horizon and was low productive in the past.	W
Produced as a secondary horizon and was low productive in the past.	X
Produced as a secondary horizon and was low productive in the past.	Y
Produced as a secondary horizon and was low productive in the past.	Z

The above stratigraphic series of horizons which were
and fractured and varied in thickness from 50 to 100 feet.
has correlation and extent of the Stevens zone.
fractured horizons and the 100 foot thick zone.
are used. The porous, gas-bearing and gas-bearing horizons
various zones and horizons in the Stevens zone.
structure, it is extremely difficult to study system.

for these quantities as was done for the Shallow Oil Zone.

The Carneros Zone of Lower Miocene Age has been penetrated by four wells, two on the eastern structure and two on the western. The two or three oil productive sand members composing this Zone have an equivalent total sand thickness of about 200 feet. As of May 1954, two commercially productive wells had been completed in the Carneros Zone.

The above quantities are for the entire lot.

The following items are also shown and are being

by their value, and for the entire lot and for the

quantity. The two of these are included and are

being this lot have an additional amount of

about 200 lbs. at 25¢ per lb., two comparatively

well and have included in the above lot.

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GEOLOGY OF THE OTHER RESERVES

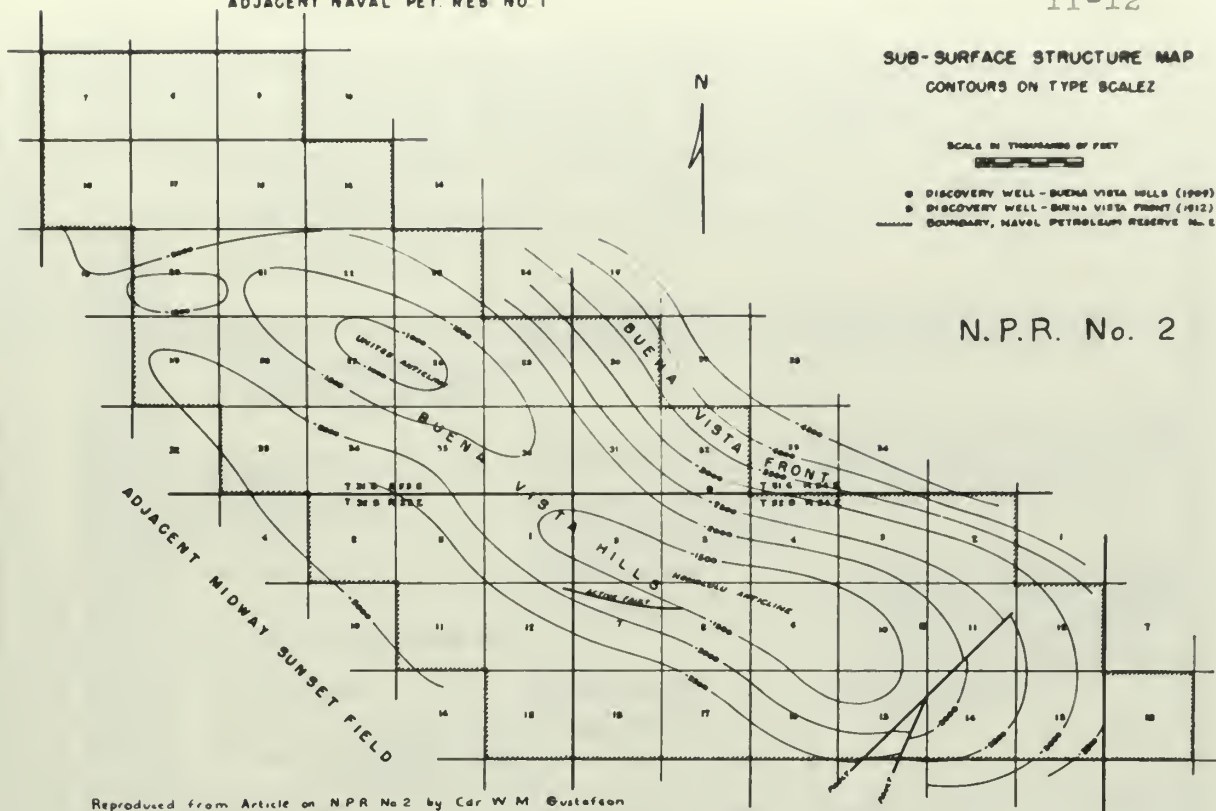
Since this report is primarily concerned with N.P.R. No. 1, no attempt will be made here to give a description of the geology of the other reserves. However, an excellent idea of the structure and the stratigraphy of the oil productive horizon of N.P.R. No. 2 (Buena Vista) may be obtained by a study of Figures 2-1, 2-6, 2-7, and 2-8 of this chapter.

Likewise, for N.P.R. No. 3 (Teapot Dome), Figures 2-9 and 2-10 will provide the reader with the essential geologic features of this field and of its productive horizons.

As regards N.P.R. No. 4 (Alaska) an enlarged geographic map of the reserved area proper indicated on Figure 1-2 is presented in Figure 2-11 of this chapter. This latter figure also shows somewhat the extent and relative success of the exploratory drilling as of August 1952.

Geological Map of the Area

Since this report is primarily concerned with the
 No. 1, an attempt will be made to give a description of
 the geology of the area covered. However, an excellent
 idea of the geology and the stratigraphy of the oil fields
 may be obtained from the geological maps of the area
 a copy of which is attached hereto as Appendix A-1, A-2, A-3
 likewise for the other fields, Appendix A-4
 and A-5 will give the geology of the respective fields
 features of this field and of the geologic structure.
 An excellent geological map of the area (Appendix A-6) is
 map of the reservoir and is attached to this report as
 presented in Figure A-7 of this report. This geological map
 also shows somewhat the extent and relative positions of the
 exploratory drilling as of August 1933.



Reproduced from Article on NPR No.2 by Car W M Gustafson

FIG. 2-6

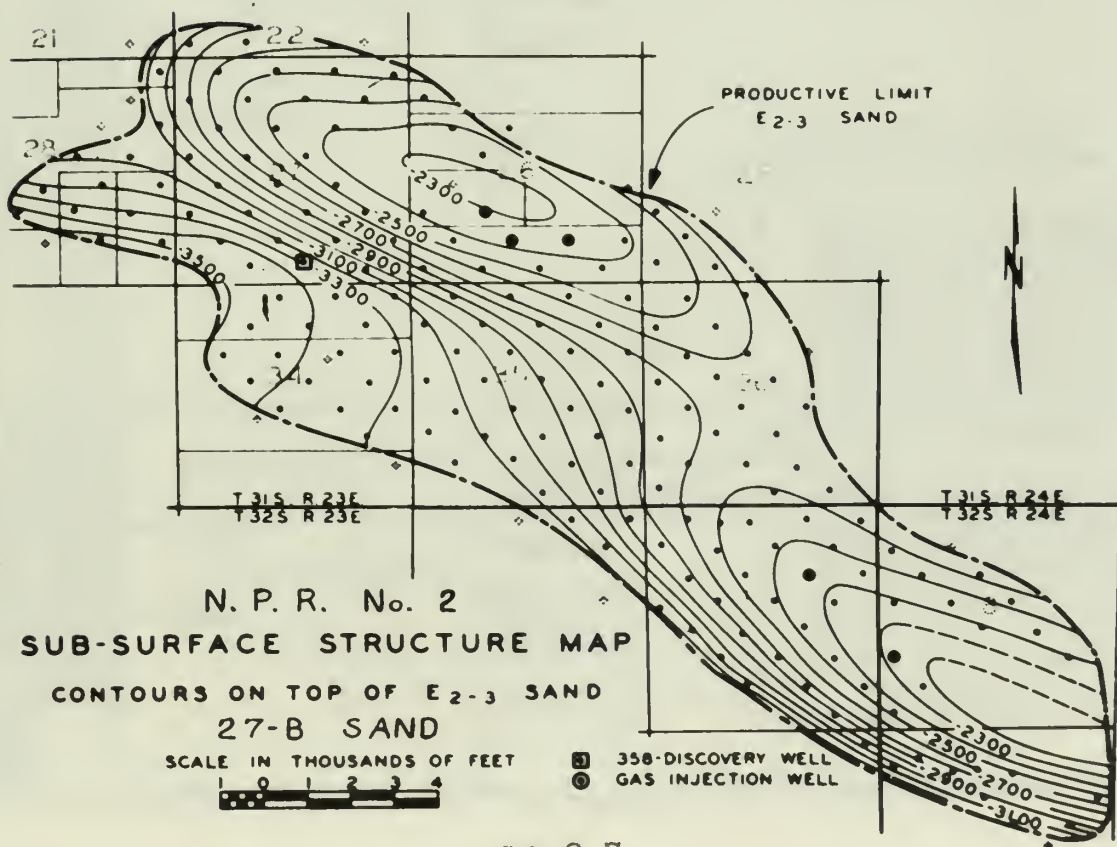
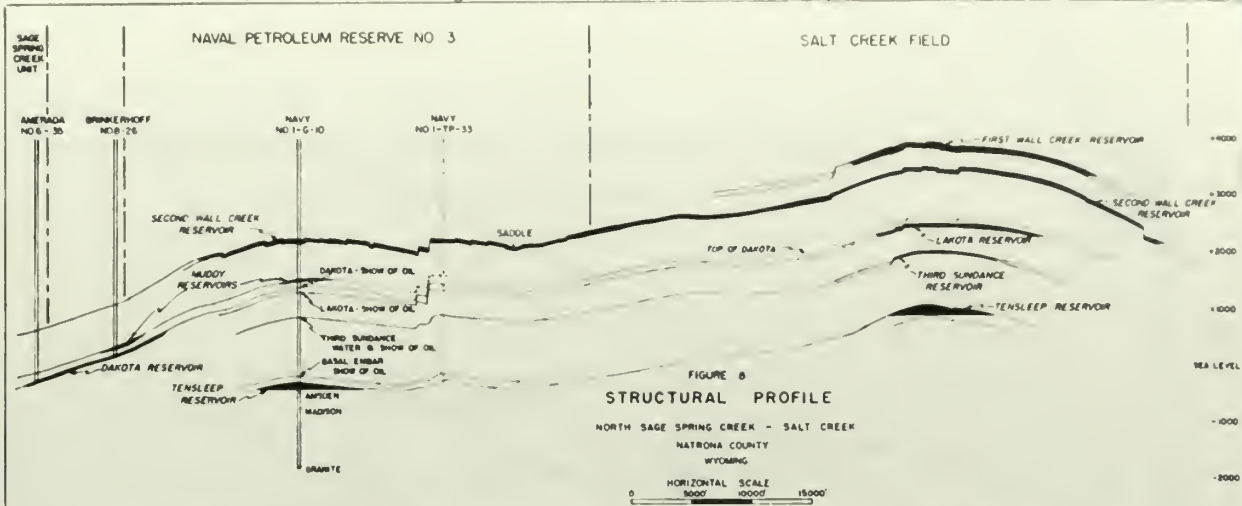


FIG. 2-7

**NAMES OF PRODUCING OIL & GAS ZONES & SANDS
OF WEST SIDE FIELDS OF SOUTHERN SAN JOAQUIN VALLEY
INCLUDING MCKITTRICK, MIDWAY-SUNSET, ELK HILLS & BUENA VISTA HILLS**

AGE		DISTINGUISHING FEATURE OR FAUNAL MARKER	PRODUCING SAND OR ZONE	REMARKS
PLIOCENE	PLIOCENE			
PLEISTOCENE	TULARE	Alternating nonmarine sands, silts & clays. Fresh water fauna. AMNICOLA	Basal Tulare Sand	Equivalent to Buttenwillow Gas Sand
	SAN JOAQUIN	OSTREA lurida <i>Predominately brackish & fresh water deposits with few marine fingers</i> "B" Zone - Green Clay & Gray Silt	"B" Zone Gas Sand	Equivalent to Semitropic Gas Sand
2 nd MYA Zone FLUMINICOLA "C" Zone - Brown Clay GONIABASIS-VALVATA Upper SCALEZ		2 nd MYA Gas Sand "C" Zone Gas Sand - 1 st Finger "C" Zone Gas Sand - 2 nd Finger	The sands of the San Joaquin fm. are broadly lenticular in character and often appearing at relatively the same stratigraphic positions are not continuous stratigraphic units. The 7 th zone and 1 st MYA zone of the south San Joaquin Clay section of Barber & Galloway* are missing in this area except in the northernmost hills. The zones "A" to "Z" refer to clay zones separating the 5 MYA zones and have no relationship to Rock's** producing zones, also alphabetically designated. * Barber & Galloway, 1976 Bull. vol. 10, no. 2 ** Elk Point, U.S.G.S., pp. 110	
3 rd MYA Zone		3 rd MYA Gas Sand		
"D" Zone - Green Clay & Gray Silt		"D" Zone Gas Sand		
4 th MYA Zone		4 th MYA Gas Sand		
"E" Zone - Thinly laminated Green clay & Gray Silt		"E" Zone Oil & Gas Sand		
PECTEN clidgeri-MYTILLUS type SCALEZ		PECTEN-MYTILLUS Sand 1 st Finger SCALEZ Oil Sand		
5 th MYA Zone AMNICOLITE		2 nd Finger SCALEZ Oil Sand		
MULINIA DISCORBIS		MULINIA Sand		
MULINIA-ARCA		Sub-MULINIA Sand		
ETCHEGOIN	SILICULA YOLSELLA BITTIUM <i>Marine Clays, Sands and Silts.</i>	Wilhelm Sub-BITTIUM of BV Hills		Has been called 2 nd sub-MULINIA
	PECTEN OWENI <i>Midwestern Shale</i>	Gusher Sand		
	PECTEN TERMINUS	Calitroleum Sand	Follans Silt of Follans area and Transport, Calivada and Lower Gusher of Maricopa	
	BULIMINELLA <i>Buliminella Silt</i>		Lower part of Etchegoin is not present on western border of basin. The Etchegoin thins out to the west and in some areas along the borders of the basin the various Etchegoin sands may rest directly on the Miocene. The BULIMINELLA Silt reach a maximum thickness in the East Elk Hills area. The Etchegoin sands vary greatly in thickness and lateral distribution, in some areas the sands predominate and in others are missing.	
		27-B SAND E ₁ E ₂ , E ₃ E ₄		
UPPER MIOCENE	MARICOPA SHALE (after Peck)	Punky Diatomaceous Shale or Massive Hard Brown Shale*	Lakeview Sand	Sometimes includes Calitroleum where it rests directly on the Lakeview, also has been called the Hallmark.
	THE HARD BROWN-MARICOPA REEF RIDGE	MULVIBERINA <i>Hard Brown Siliceous Shale</i>	Webster Sand	Lenticular sands appearing at approximately the same stratigraphic positions
		MULVIBERINA	Republic Sand Signal Sand Williams Sand	
		ANTELOPE SHALE OF B.V. HILLS	The Stevens Sand of Elk Hills and of Coles Ledge and other central valley fields occupies the approximate stratigraphic position of "The Hard Brown" sands of the Midway-Sunset Area	

FIG. 2-8



(From Art. by R. E. Sparks, Navy CEC Bull., Sept. 1952)

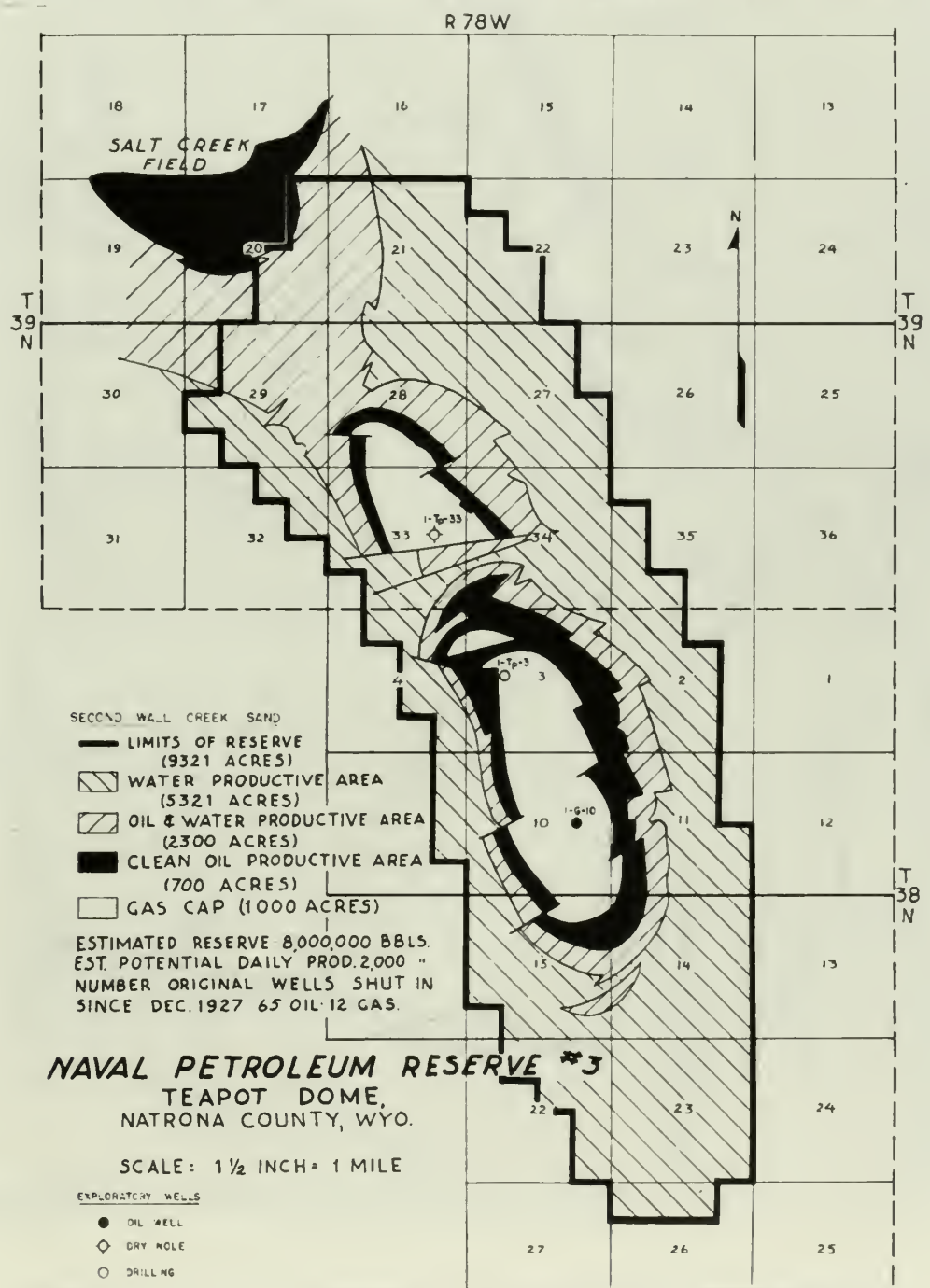


FIG. 2-10

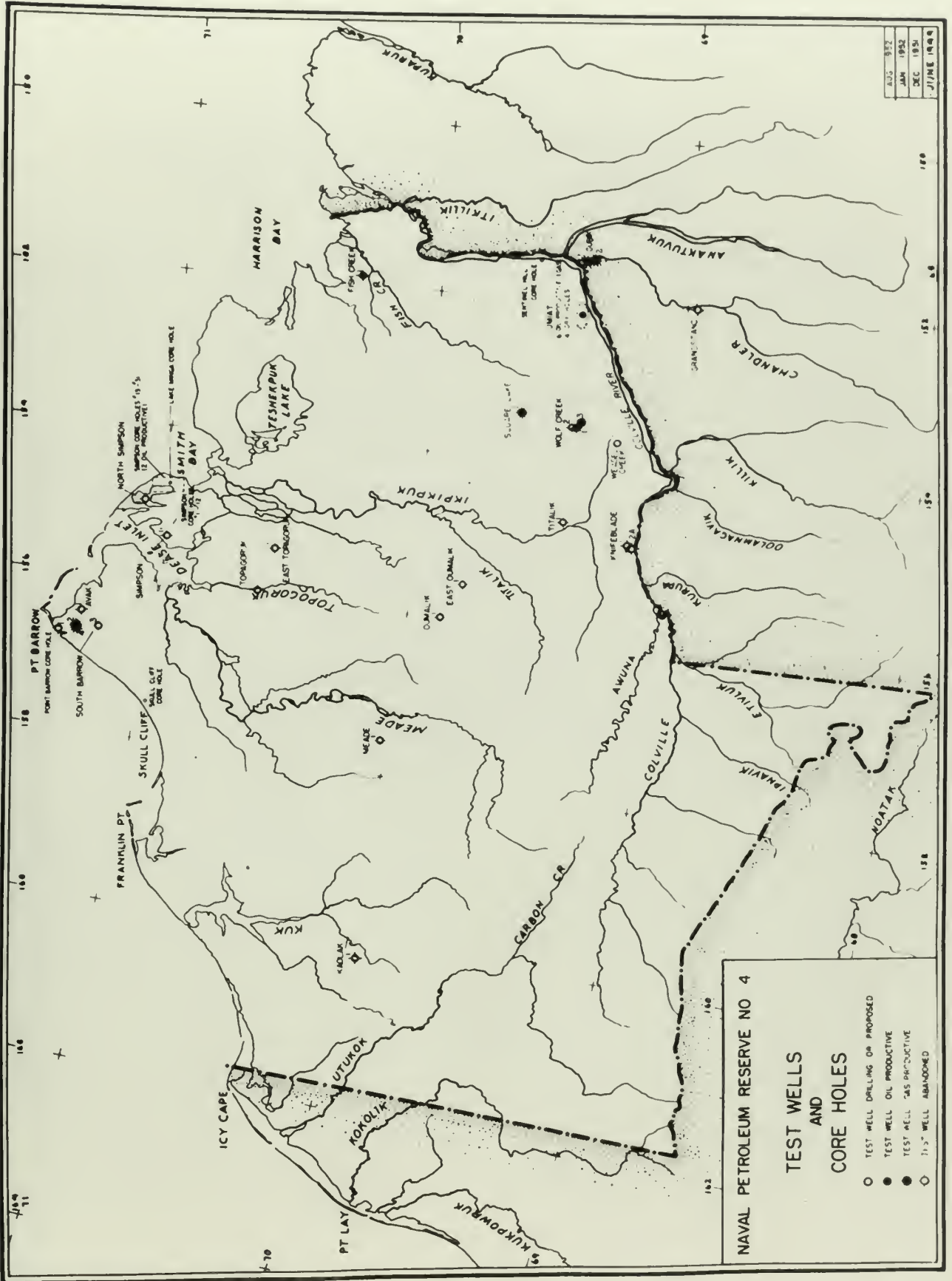


FIG. 2-11. Geographic Map of N.P.R. No. 4, Alaska, Showing the Boundaries of the Reserve and the Extent of the Exploration Drilling As of August 1952.

SELECTED REFERENCES IN THE BIBLIOGRAPHY CONTAINING
GEOLOGIC INFORMATION ON THE RESERVES

- N.F.R. No. 1: 106, 111, 113, 116, 119, 124, 128, 134, 136,
138
- No. 2: 170, 171, 178, 179
- No. 3: 188, 189, 190
- No. 4: 215, 218, 219, 223, 235
- Oil Shale
Reserves: 245, 247

CHAPTER III

DEVELOPMENT

AND

PRODUCTION HISTORY

NAVAL PETROLEUM RESERVE NO. 1

THE UNIVERSITY OF CHICAGO
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CHAPTER III

DEVELOPMENT

1982

PROSPECTIVE STUDENT

RAYAL TECHNICAL SCHOOL NO. 1

DEVELOPMENT
AND
PRODUCTION HISTORY
NAVAL PETROLEUM RESERVE NO. 1

GENERAL REVIEW

The development and production history of Naval Petroleum Reserve No. 1, may be divided into three major periods which are listed and discussed below.

- (a) 1910 to 20 November 1942 --- Discovery and competitive development and production of Elk Hills prior to unitization.
- (b) 20 November 1942 to September 1945 --- Unitization and the World War II emergency development and production of Shallow Oil Zone.
- (c) After September 1945 --- Post-War period of intensive exploration and development of all zones; and the State of Readiness Program for the Shallow Oil Zone.

1910 to 20 November 1942.

Between 1910 and 1919 some 35 unsuccessful prospect wells were drilled by private interests in search of oil in the Elk Hills area. Of these wells 33 were too shallow and 3 found oil in non-commercial quantities, probably as a result of poor completion methods.

ANNEX

III

INDUSTRIAL DEVELOPMENT

INDUSTRIAL DEVELOPMENT IN THE

INDUSTRIAL DEVELOPMENT

The development and promotion of the industrial sector is a major objective of the Government. It is to be achieved through the implementation of the industrial development strategy. The following are the main objectives of the strategy:

(a) To increase the rate of industrial growth and to diversify the industrial structure.

(b) To increase the productivity of the industrial sector.

(c) To increase the employment opportunities in the industrial sector.

(d) To increase the foreign exchange earnings of the industrial sector.

(e) To increase the contribution of the industrial sector to the national income.

(f) To increase the technological level of the industrial sector.

(g) To increase the efficiency of the industrial sector.

(h) To increase the profitability of the industrial sector.

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In January 1919 Standard brought in the first commercially successful well, Hay No. 1 in Section 36-S. It was completed in what is now called the Shallow Oil Zone. During the next year, 47 other wells were completed in this area, none of which were particularly good oil producers.

In February 1920, when Standard brought in Tupman No. 1 (Section 36-S) at an initial production rate of 5200 barrels per day, the rapid development of Elk Hills commenced in earnest. Over 200 additional wells were drilled by Standard and other operators in the Old Area within the next few years. The area and the extent of this development may be seen on Figures 5-1 and 5-2.

It soon became obvious to the Government that the Reserve would suffer serious loss of oil by drainage to wells producing on private lands within and adjacent to the Reserve. Congress then gave Navy its first authority to issue strip-leases to private companies for the purpose of drilling offset wells to prevent drainage. Some of these strip leases are shown on Figure 5-2. Navy's protective drilling program was somewhat belated and not too successful, as illustrated by Figures 5-4 and 5-5.

By 1921 yearly production, mainly from what is now called the central or Tupman part of the Old Area, reached a peak of 18 million barrels or 16 percent of the entire production of California in that year. Overproduction in California then forced a big cut-back in Elk Hills production during subsequent years.¹²⁴

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Figures 2-1 and 2-2.

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by Figures 2-3 and 2-4.

By 1961...
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subsequent years.

After the Government oil reserve scandals of 1922 and repudiation of the wholesale leasing which had occurred, the Government stiffened in its policy of conserving the oil in the Reserve. As a result of this policy and the liberal attitude of the holders of patented land within the Reserve, development prior to unitization was confined largely to the Hay-Carman and Tupman areas shown on Figure 5-1. Nevertheless, by the end of 1928 more than 400 wells had been drilled in Elk Hills.

In 1932 nearly all of the high gas-oil ratio wells in the Hay-Carman area were forced to remain shut-in as a result of litigation.

In 1941 Standard drilled some deep exploratory wells and discovered the Stevens Zone. This zone, however, was not actively developed and produced until after 1946.

Production prior to unitization amounted to about 29 percent of the total estimated recoverable oil from the Shallow Oil Zone, based on the 1949 estimate.

The effects of the development and production practices during this competitive period in the field's life are discussed in Chapter V.

20 November 1942 to September 1945.

Although the Unit Contract and Operating Agreement were not executed until 19 June 1944, the field was effectively unitized by previous agreements on 20 November 1942. This unitization has been referred to as a "shotgun marriage"

At the government oil reserves available in 1948 and the
 depletion of the national reserves has occurred.
 the government believed in the policy of conserving the oil
 in the reserve. As a result of this policy and the liberal
 attitude of the interest of national land within the reserve,
 development prior to nationalization was confined largely to the
 oil-bearing and oil-bearing areas shown on Figure 2-1. Consequently,
 by the end of 1948 more than 400 wells had been drilled in
 the fields.

In 1948 nearly all of the high potential wells in
 the oil-bearing areas were found to remain undeveloped as a
 result of depletion.

In 1941 Standard drilled some deep exploratory wells
 and discovered the Eocene Zone. This zone, however, was
 not actively developed and produced until after 1948.
 Production prior to nationalization amounted to about 20
 percent of the total estimated recoverable oil from the
 Shallow Oil Zone, based on the 1949 estimate.

The effect of the development and production practices
 during this competitive period in the field's life cycle
 caused in October 1949.

20 November 1949 to September 1948.

Although the Unit Contract and Operating agreement were
 not executed until 19 June 1949, the field was effectively
 nationalized by previous agreements on 20 November 1948. This
 nationalization has been referred to as a "de facto nationalization".

which turned out very well.¹⁶⁴ At least it came at an opportune time considering the crucial state of the nation during World War II and the critical oil shortage rapidly developing on the West Coast at that time.

Orders from Congress and the President to take the lid off N.P.R. No. 1 came in June 1944. A detachment of Navy Seabees occupied the field almost overnight to build roads and level drillsites. The goal was to increase production as rapidly as possible from 15,000 barrels per day to 65,000 barrels per day. To accomplish this goal, all drilling effort was devoted to developing the Shallow Oil Zone in lieu of the deeper Stevens Zone. About 15 drilling rigs were in continuous operation with the goal of putting a new well into the tanks every 24 hours.¹⁰⁵ By July 1945, after a development period of 13 months, the goal of 65,000 barrels per day of sustained production had been reached.¹²⁵ A maximum production of 71,000 barrels per day was possible.

The principal areas of war-time development are indicated on Figure 5-1. The effects of the high war-time production rates on the Shallow Oil Zone are discussed in Chapter V.

With the cessation of hostilities, the Secretary of the Navy in August 1945 ordered a cut-back in production from 65,000 to 15,000 barrels per day. Later the production rate was decreased still further, and the emergency production period came to an end.

which turned out very well. At least it was an opportunity
 this time considering the crucial nature of the matter. During
 World War II and the critical oil shortage resulting therefrom
 on the West Coast at that time.

Orders from Congress and the President to take the lead
 off W.P.A. No. I came in June 1944. A detachment of 200
 men occupied the field almost overnight to build roads
 and level ditches. The goal was to increase production
 as rapidly as possible from 15,000 barrels per day to 25,000
 barrels per day. To accomplish this goal, all drilling effort
 was devoted to developing the Gullion oil zone in lieu of the
 deeper Stevens zone. About 15 drilling rigs were in com-
 mune operation with the goal of reaching a new well in the
 time every 50 hours. By July 1945, after a development
 period of 13 months, the goal of 25,000 barrels per day of
 sustained production had been reached. A certain pro-
 duction of 15,000 barrels per day was possible.

The principal areas of re-tiling development are indi-
 cated on Figure 3-1. The effects of the nitrogen-tiling pro-
 duction rates of the Gullion oil zone are discussed in
 Chapter V.

With the cessation of hostilities, the Secretary of the
 Navy in August 1945 ordered a cut-back in production from
 25,000 to 15,000 barrels per day. Lower the production
 rate was deemed well justified, and the nitrogen-tiling
 period came to an end.

The total production from Elk Hills during the four years of World War II, about 31 million barrels of oil, was equivalent to only 15 percent of the total production from the Shallow Oil Zone to 1954. Thus only a relatively small percentage of oil produced from the Reserve has been used for the purpose Congress intended.

After September 1945, the Post-War Period.

This period to 1954 has consisted of the following principal development and production programs:¹⁴⁸

- (1) Intensive exploration and development of the Shallow Oil Zone and the Stevens Zone for Readiness purposes. The Stevens Zone development was completed in 1954.
- (2) Additional off-set drilling and production along the boundaries of the Reserve---Section 14-B for shallow sands and Section 25S for Stevens Zone.
- (3) Exploratory drilling by the Navy of Carneros Zone wells.
- (4) State of Readiness Program for Shallow Oil Zone described in Chapter V. The principal purposes of this Program are to maintain the Shallow Oil Zone in a full state of readiness to produce the maximum amount of oil upon short notice, and to create reservoir conditions calculated to insure maximum ultimate recovery of oil.¹²⁵
- (5) Reduced production of oil to an extent necessary to carry out necessary testing and the projects under the State of Readiness Program.

The first... of... less... 1961... for the... purpose...

After September 1961, the program...

This period in 1962 was... signal assessment and production...

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(4) Rate of... The...

(5) Rate of... The...

- (6) Construction of a 5.5 million dollar natural gas processing plant with 50 million cubic feet capacity; reconditioning of the existing 30 gas plant.
- (7) Recent drilling in various areas to protect Reserve from drainage or loss of recoverable oil.
- (8) Conservation of unused processed gas by injection into the Dry Gas Zone.

During the first eight years of the post-war period, production from the Shallow Oil Zone to 1 January 1954 had amounted to about 11.5 percent of the total cumulative production, or almost as much as the emergency production of World War II. Cumulative production from the Stevens Zone has amounted to only about one percent of its estimated recoverable reserves.

- (5) Construction of a 2.5 million dollar natural gas processing plant with 50 million cubic feet capacity; reconstruction of the existing gas plant.
- (6) Recent drilling in various areas to protect reserves from depletion or loss of recoverable oil.
- (7) Conversion of unused processed gas by injection into the gas field.

During the first eight years of the post-war period, production from the Shallow Oil Zone to 1 January 1954 had amounted to about 11.5 percent of the total available production, or almost as much as the emergency production of World War II. Unavailable production from the Shallow Zone has amounted to only about one percent of the available recoverable reserves.

The following table shows the production of natural gas from the Shallow Oil Zone from 1946 to 1954. It is seen that production has increased steadily over the period, and that the total production for the period is about 11.5 percent of the total available production. The table also shows that the production of natural gas from the Shallow Oil Zone has increased steadily over the period, and that the total production for the period is about 11.5 percent of the total available production.

DEVELOPMENT ROTHSGeneral Items of Interest.

During the Post-War Period the Unit has contracted all development work with several independent drilling companies. Rotary drilling equipment on light portable rigs is employed.

Under Unit Operations extensive coring, logging, and testing have been an integral part of the development and remedial programs. For the first wells drilled in any general area, all possible productive horizons are cored in a reduced hole. Drill-stem tests are made of each zone separately if evidence from cores, mud log, and electric log so warrant. This policy may mean coring 4000 feet of Pliocene Age formations lying above the Reef Ridge Shale at a depth of 1000 to 5000 feet from the surface. Also, drill-stem tests may be made of as many as nine different productive intervals.

The above procedure applies only to a few wells. Most are drilled without such extensive coring, logging, and testing.

Drilling costs and cost sharing are discussed in Chapter VIII.

Shallow Oil Zone.

There have been several principal periods in the development of the Shallow Zone. They are listed below:

- (1) 1919 to 1928 --- Over 400 wells were drilled by private operators and by lessee's of the Navy.

General

General

In the past, the only way to determine the extent of the development was by drilling exploratory wells. However, the use of seismic methods has made it possible to determine the extent of the development without drilling exploratory wells.

Under the present arrangement, the extent of the development is determined by drilling exploratory wells. The use of seismic methods has made it possible to determine the extent of the development without drilling exploratory wells. This policy may mean that the extent of the development is determined by drilling exploratory wells. The use of seismic methods has made it possible to determine the extent of the development without drilling exploratory wells. The above procedure applies only to a few wells. The use of seismic methods has made it possible to determine the extent of the development without drilling exploratory wells.

Drilling costs and cost accounting are discussed in Chapter VII.

Shallow Oil Wells

There have been several important changes in the development of the shallow oil wells. The use of seismic methods has made it possible to determine the extent of the development without drilling exploratory wells. The use of seismic methods has made it possible to determine the extent of the development without drilling exploratory wells.

- (2) 1942 to 1945 --- Approximately 328 wells were drilled during the war-time emergency period.
- (3) 1945 to 1947 --- An exploratory development program along mostly the south flank was continued after World War II.
- (4) 1951 --- Readiness Development Program is still in progress.
- (5) 1953 --- Protective well drilling as part of the revised State of Readiness Program was commenced to prevent drainage and loss of otherwise recoverable oil.

These wells average about 3000 feet in depth and require 7 to 14 days to drill.

In the heavily drilled Old Area the wells are generally on an 8-acre spacing. Development practice under Unit Operations has been a 20-or-40-acre well spacing for each major productive sand with the well-bore open to only one major sand body.

Stevens Zone.

Development periods in the life of the Stevens Zone are as follows:

- (1) 1941 to 20 November 1942 --- On a deep exploratory test, Standard discovered the Stevens Zone in 1941. By 20 November 1942, the date of unitization, three producing wells had been completed by Standard in this zone. Except for one or two more wells, the Stevens Zone was not developed during the emergency

(8) 1941 to 1942 -- approximately 20 wells were drilled during the period.

(3) 1941 to 1942 -- An exploratory development program was conducted, the results of which are contained in the report of 1942.

(4) 1941 -- Production development program is still in progress.

(5) 1938 -- Production well drilling is part of the revised plan of development program and is expected to produce oil and gas in 1941 or 1942.

These wells average about 2000 feet in depth and produce 7 to 10 days of oil.

In the newly drilled 20 wells are generally on an 8-acre spacing. Development drilling under this system has been a 20- or 30-acre well spacing for each major productive sand with the well-base open to only one major sand body.

Seventy Zone.

Development program in the life of the Seventy Zone was as follows:

(1) 1941 to 20 October 1942 -- a test exploratory well, Standard discovery No. 27 was drilled in 1941. By 20 November 1942, the rate of production, based on producing wells and soon completed by Standard in this zone, except for one or two test wells, was seventy zone was not developed during the test.

war-time development and production period of the Shallow Oil Zone.

(2) 1946 to 1947 --- A participating percentage (joint) exploration of the Stevens Zone was conducted.

(3) 1 July 1948 to 1 April 1954 --- An intensive Readiness Development Program for Navy was completed.

These wells average about 6500 to 7000 feet in depth and require approximately 47 days to drill.

The development program was carried out on a 40-and-80-acre well pattern.

Carneros Zone.

In 1951, Navy commenced a deep test exploratory program in the western portion of the field. Exploratory well X55-30R, completed 10 January 1952, resulted in the discovery of the Carneros Zone. The well was bottomed at 12,856 feet, plugged back to 9,385 feet and completed in an oil production finger of the Carneros Sand. Two successful wells had been completed in this zone as of May 1954. On test the wells flow at a rate of about 150 to 200 barrels per day of very high gravity crude, 54° API, and very high gas-oil ratio, 10 Mcf per barrel.

Dry Gas Zone.²

As of 1 January 1954, there were six productive wells in the Dry Gas Zone. There are 33 locations to be drilled on a 160-acre pattern. As far as is known, however, this development program has not been commenced nor is contemplated in the near future.

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80-acre well pattern.

Carnot Lake.

In July, 1951, was commenced a deep test exploratory program

in the eastern portion of the field. Exploratory well 355-328,

completed in January 1952, revealed in the vicinity of the

Carnot Lake. The well was completed at 25,000 feet, showing

well to 9,500 feet and was located in an oil production finger

of the Carnot field. The reservoir is a thin sand containing

in this case as of May 1951. On test the well was at a rate

of about 100 to 200 barrels per day at 100 psi differential

34' API, and very high gas-oil ratio, 10 to 100 barrels.

Truitt Lake.

As of January 1951, there were six productive wells

in the Truitt field. There are 25 locations to be drilled

on a 160-acre pattern. As far as is known, however, this

development program has not been completed and is contemplated

in the near future.

Section 14-B (Elena Vista Front Field).¹²⁵

As of 1 January 1954, the Unit had drilled 16 off-set wells which are on continuous production at a total daily rate of about 545 barrels per day. This Section is discussed more fully in Chapter V.

Letter 14-1 (New York, 1955) - 137-10

As of 1 January 1954, the following is a list of wells which are on continuing production at a rate of about 500 barrels per day. This figure is discussed here in Chapter 1.

The following table shows the production of the wells listed above during the period from 1 January 1954 to 31 December 1954.

The following table shows the production of the wells listed above during the period from 1 January 1955 to 31 December 1955.

The following table shows the production of the wells listed above during the period from 1 January 1956 to 31 December 1956.

The following table shows the production of the wells listed above during the period from 1 January 1957 to 31 December 1957.

The following table shows the production of the wells listed above during the period from 1 January 1958 to 31 December 1958.

The following table shows the production of the wells listed above during the period from 1 January 1959 to 31 December 1959.

The following table shows the production of the wells listed above during the period from 1 January 1960 to 31 December 1960.

The following table shows the production of the wells listed above during the period from 1 January 1961 to 31 December 1961.

The following table shows the production of the wells listed above during the period from 1 January 1962 to 31 December 1962.

The following table shows the production of the wells listed above during the period from 1 January 1963 to 31 December 1963.

PRODUCTION NOTESProduction Status of Wells, All Zones, As Of 1 January 1954.

<u>Zone</u>	<u>Total No. Of Wells</u>	<u>No. Suspended Or Standing</u>	<u>No. Producible</u>
Shallow	771	50	721
Stevens	220	1	219
Carneros*	1	0	1
Dry Gas	6	0	6
Sect. 14-B	<u>16</u>	<u>0</u>	<u>16</u>
Totals:	1014	51	963

*By May 1954 there were two producible Carneros Zone wells.

Rate of Production.

The Secretary of the Navy is required by Congress to keep production in normal times at a minimum consistent with good oil-field practice for routine testing and protection of the reservoir. Under existing law, the Secretary must find that increased production is essential for national defense and obtain permission from Congress in the form of a joint resolution before production from the Reserve can be expanded. The Navy must then dispose of its share of the petroleum produced by public sale. Also, contracts are held up while Navy confers with armed services committees of Congress.

To prevent these delays in putting N.P.R. No. 1 on full production in event of a national emergency, corrective legislation was introduced in Congress in January 1954

Production Data

Production Data of Vails, All Areas, as of 1 January 1954.

<u>Area</u>	<u>Total No. of Wells</u>	<u>No. Operating</u>	<u>No. Productive</u>
Shallow	771	50	221
Intermediate	200	1	214
Intermediate	1	0	1
Deep	6	0	6
<u>Sect. 14-B</u>	<u>12</u>	<u>0</u>	<u>12</u>
<u>Totals</u>	<u>1014</u>	<u>51</u>	<u>282</u>

*By May 1954 there were two productive wells in the area.

Rate of Production

The Secretary of the Navy is required by Congress to keep production in normal times at a minimum consistent with good oil-field practice for routine testing and protection of the reservoir. Under existing law, the Secretary must find that increased production is essential for national defense and obtain permission from Congress in the form of a joint resolution before production from the Reserve can be expanded. The Navy must then dispose of its share of the petroleum produced by public sale. Also, contracts are held up while Navy confers with various subcommittee of Congress. To prevent these delays in testing S.P. No. 1 on full production in event of a national emergency, corrective legislation was introduced in Congress in January 1954.

on the recommendation of the National Security Council. The proposed bill would give the Secretary of the Navy authority, subject to the approval of the President, to initiate production from the petroleum reserves during a national emergency or state of war declared by the Congress, and also, to negotiate sales of the products so produced. Reports would be required to the armed services committees of Congress concerning details and reasons for any expanded production and disposition of same.

The current status of this bill is not known.

Summary of Production, All Zones, From 20 November 1942 ¹⁴⁸
(Unitization) To 30 June 1953

	<u>Crude Oil</u> (Barrels)	<u>Gas</u> (MCF)	<u>Natural</u> <u>Gasoline</u> (Gallons)
Deliveries to:			
Navy	21,881,902	16,651,530	3,701,933
Standard	<u>29,690,885</u>	<u>8,939,825</u>	<u>6,332,707</u>
Total Deliveries	51,572,787	25,591,355	10,034,640
Inventory of 30 June 1953	<u>156,052</u>	-	<u>19,265</u>
Total Production	<u>51,728,839</u>	<u>25,591,355</u>	<u>10,053,905</u>

on the recommendation of the National Security Council. The proposed bill would give the Secretary of the Army authority subject to the approval of the President, to utilize production from the program received during a national emergency or state of war declared by the Congress, and also, to regulate sales of the products so produced. Reports would be required to the armed services committee of Congress concerning details and reasons for any expanded production and disposition of same. The current status of this bill is not known.

Summary of Production, All Zones, from 30 November 1954 to 30 June 1955 (Districts) To 30 June 1955

Inventory of 30 June 1955	Production	Deliveries to:	Grains Oil (Barrels)	Gas (Bbl)	Reserve (Barrels)
10,004,840	21,842,787	Standard	18,681,830	2,707,833	2,707,833
14,258	10,004,840	NAVY	2,707,833	6,222,707	6,222,707
10,004,840	21,842,787	Total Deliveries	21,389,663	8,930,540	8,930,540
10,004,840	21,842,787	Inventory of 30 June 1955	10,004,840	14,258	14,258
10,004,840	21,842,787	Total Production	10,004,840	14,258	14,258

Comparison of Current and Ultimate Allocation of Production¹⁴⁸

	<u>Crude Oil (Barrels)</u>	<u>Gas (MCF)</u>	<u>Natural Gasoline (Gallons)</u>
Navy's Participating Percentage Share of Total Production	35,056,688	19,026,053	6,907,202
Actual Deliveries to Navy	<u>21,996,695</u>	<u>16,651,530</u>	<u>3,717,138</u>
Due to Navy Under Ultimate Allocation of Production	<u>13,059,993</u>	<u>2,374,523</u>	<u>3,190,064</u>

The indicated unbalance in production receipts resulted from the extended "primary" period of the Unit Contract¹⁵⁰ As Amended¹⁴⁶ when Standard received most of the production from the Shallow Oil Zone. This extended "primary" period ended 2 August 1950. Production receipts from the Shallow Oil Zone are gradually being brought into balance with the participating percentages listed in Chapter IV, for Navy is receiving nearly eight-ninths of the Shallow Oil Zone production.¹²⁵

Shallow Oil Zone

The gravity of oil produced from the Shallow Oil Zone has varied from 17° to 44° API with an average gravity of about 25° API.

From estimated production decline curves it has been estimated that the Shallow Oil Zone currently could be produced at maximum production rates well above 100,000 barrels per day. However, such high rates could not be sustained for many months or even days as excessive sanding of wells would occur. Consequently, estimated sustained production rates

Comparison of Actual and Estimated Allocation of Production

Actual Allocation	Estimated Allocation	Percentage of Total Production
13,000,000	12,500,000	85%
51,900,000	51,500,000	91%
65,000,000	64,000,000	98%

The indicated increases in production receipts resulted from the extended "primary" period of the Well Control Act. As awarded¹⁰ when Standard received most of the production from the Shallow Oil Zone. This extended "primary" period ended August 1950. Production receipts from the Shallow Oil Zone are gradually being phased into shares with the participating percentages listed in Chapter IV. For Navy is receiving nearly all the production of the Shallow Oil Zone production, 1951.

Shallow Oil Zone

The gravity of oil produced from the Shallow Oil Zone has varied from 17° to 40° API with an average gravity of about 25° API. From estimated production decline curves it has been estimated that the Shallow Oil Zone currently could be produced at maximum production rates well above 100,000 barrels per day. However, such high rates could not be sustained for any length of time due to excessive sanding of wells which occur. Consequently, estimated maximum production rates

are much lower. These rates are given in Chapter IV.

Most production in the past has come from the SS-1, SS-2, and M sands, and these sands would be the source of most production in the future.

The great majority of wells require pumping. Only rod-actuated plunger-displacement pumps are used. Some wells are flowing wells as a result of the increased reservoir pressure resulting from the gas injection program.

The production history of the Shallow Oil Zone is given on the graphs of Figures 3-1 to 3-3. Figure 3-1 is a graph of monthly production rates since discovery of the field. During the post-war period, the rate of production from each of the various projects under the State of Readiness Program is given by the curves of Figure 3-2. Cumulative production curves to 1 January 1954 appear on Figure 3-3.

Stevens Zone.

The average gravity of Stevens Zone Oil is about 36° API. Combined with its natural gas and natural gasoline content, Stevens crude has nearly twice the value of Shallow Zone crude combined with its gas and gasoline.

State of depletion, estimated constant production rates, and estimates of reserves all may be found in Chapter IV.

With the reservoir pressure averaging 2400 to 3300 psi, all wells are flowing wells with the exception of a few marginal producers which are pumped.

Current production consists of (1) test production from new development wells and (2) minor off-set drainage production

and much lower. These wells are given in Section IV.
 West production in the field has been from the 48-1,
 48-2, and 48-3, and these wells should be the source of
 most production in the future.
 The great majority of wells require pumping. Only 10-10-1
 and 10-10-2 are flowing wells as a result of the increased reservoir
 pressure resulting from the gas injection program.
 The production history of the field will come to light
 on the graphs of Figures 3-1 to 3-8. Figure 3-1 is a graph
 of monthly production rates since discovery of the field.
 During the post-war period, the rate of production from each
 of the various projects under the name of Reservoir Project
 is given by the curves of Figures 3-2. Cumulative production
 curves to 1 January 1954 appear on Figure 3-3.

Stevens Zone.

The average gravity of Stevens zone oil is about 30° API.
 Combined with low natural gas and natural gasoline content,
 Stevens crude has nearly twice the value of Shell's Zone
 crude combined with its gas and gasoline.
 State of depletion, estimated current production rates,
 and estimates of reserves all can be found in Diagram IV.
 With the reservoir pressure remaining 2400 to 2500 psi,
 all wells are flowing wells with the exception of a few car-
 ginal producers which are pumped.
 Current production estimates of (1) test production from
 new development wells and (2) oil or oil-gas production

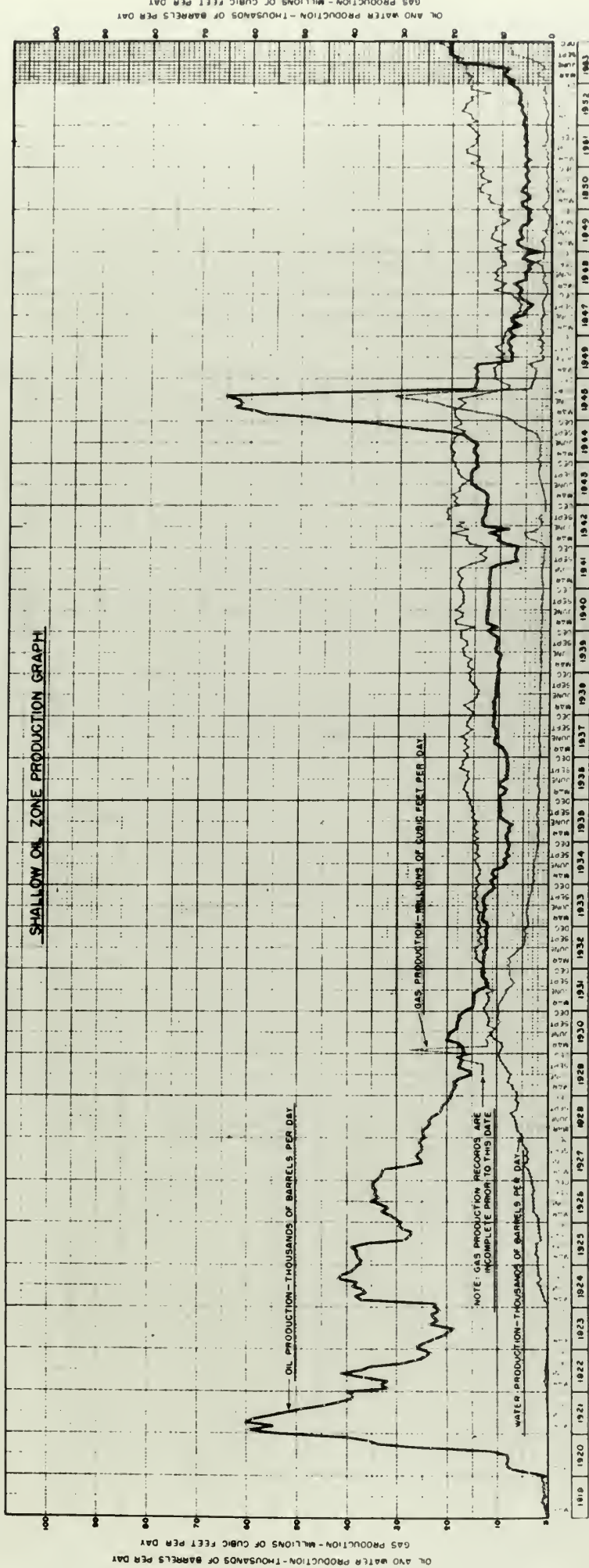


FIG. 3-1. Oil, Water, Gas Monthly Production Curves, Shallow Oil Zone, Elk Hills, Since Discovery of the Field (Reproduced from Annual Report, NPR #1, 1953)

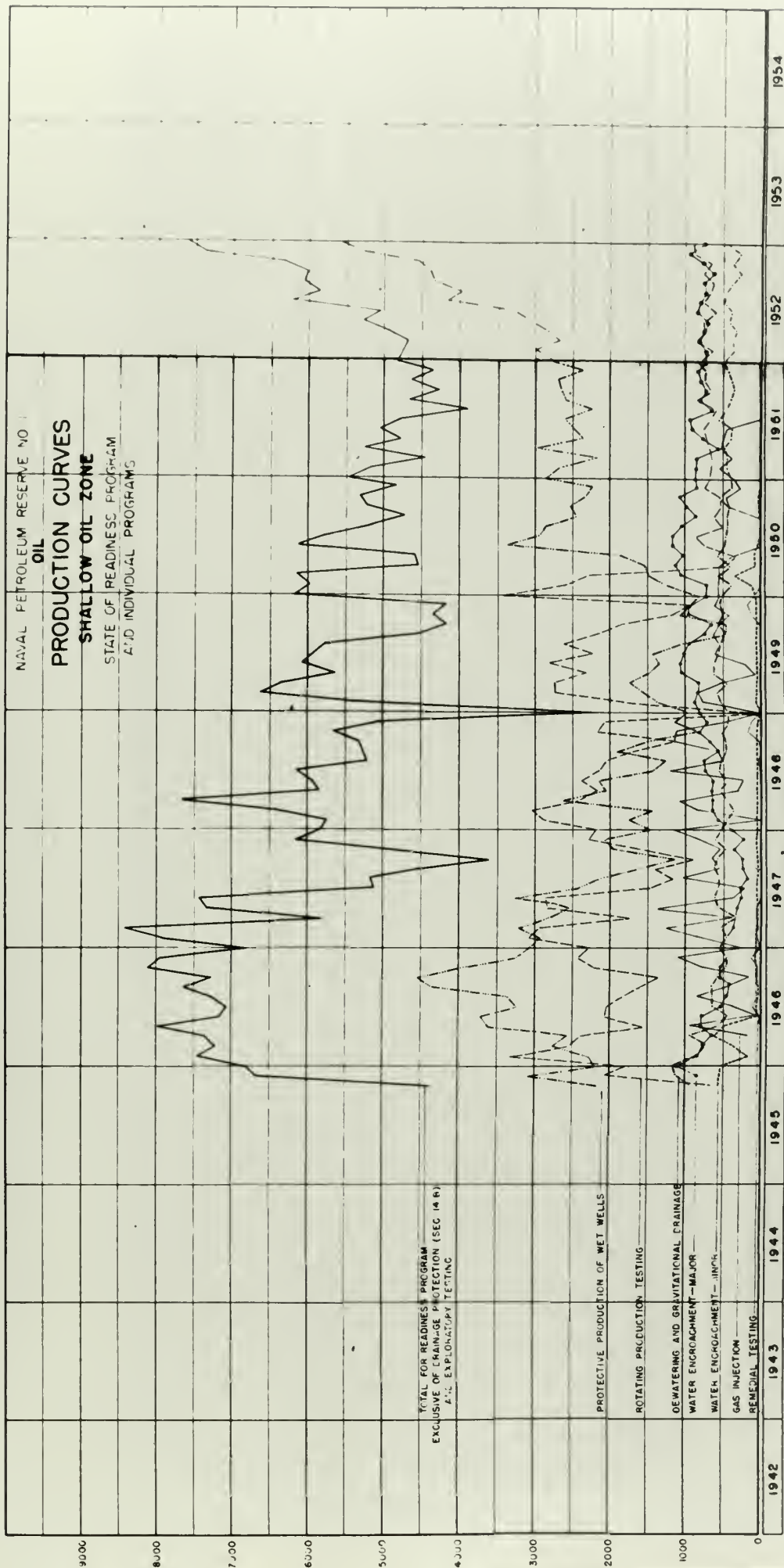


FIG. 3-2. Oil Production Curves, Shallow Oil Zone, State of Readiness and Individual Programs (Reproduced from Annual Report, NPR #1, 1952)

Graph

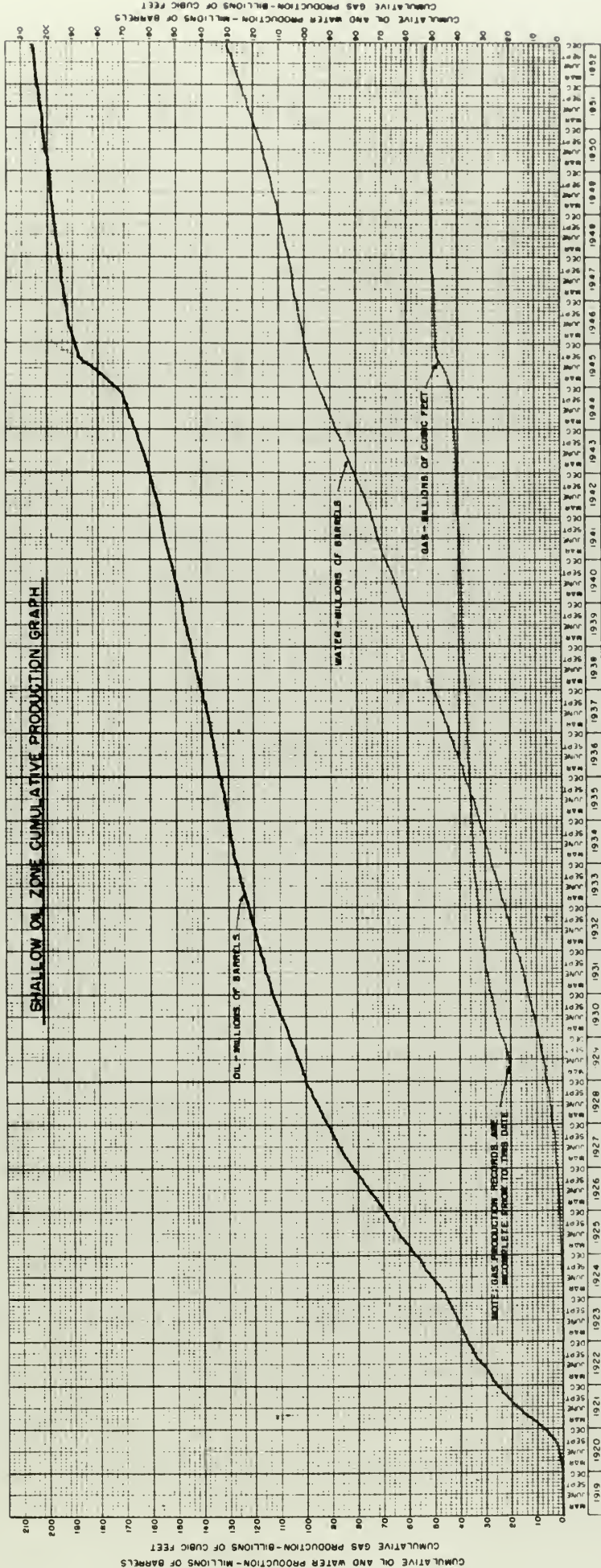


FIG. 3-3. Oil, Water, and Gas Cumulative Production Curves, Shallow Oil Zone, Elk Hills
 (Reproduced from Annual Report, NPR #1, 1952)

in Section 25-S to prevent drainage of oil from a finger of Stevens Sand reaching into the Elk Hills field from the adjacent Coles Levee field on the East.

Current and ultimate allocation of Stevens Zone production is in agreement with the latest revised participating percentages as given in Chapter IV.

The production history is graphed in Figure 3-4.

Carneros Zone.

The gravity of Carneros Zone oil is about 54° API.

As of 1 April 1954, there were only two wells---both flowing wells.

Production to date has been only minor test production. All production has been allocated to Navy since the program is still 100 percent Navy's.

Dry Gas Zone.

Until June 1952, when the gas injection program was halted, the Dry Gas Zone provided some gas for injection into the Shallow Oil Zone.

Currently, for conservation reasons, all produced gas from other zones which is not burned or sold is injected into the Dry Gas Zone.

Since the field was unitized in 1942 until 30 June 1953, approximately 16 million Mcf of gas has been produced from this Zone. Current and ultimate allocations of production agree with the participating percentages for this Zone.

Section 14-B.

As of 1 January 1954, the Unit's 16 wells on Section 14-B

in Section 14-B to prevent drainage of all the oil
Stevens sand reaching into the Six Hills field from the
adjacent Coles lower field on the east.

Current and ultimate allocation of Stevens sand produc-
tion is in agreement with the latest revised participating
percentages as given in Chapter IV.

The production history is graphed in Figure 3-4.

Garneros Zone.

The gravity of Garneros Zone oil is about 49.0 API.
As of 1 April 1954, there were only two wells--
flowing wells.

Production to date has been only minor test production.
All production has been allocated to East since the program
is still 100 percent heavy.

Dry Gas Zone.

Until June 1952, when the gas injection program was
halted, the Dry Gas Zone provided some gas for injection into
the Shallow Oil Zone.

Currently, for conservation reasons, all produced gas
from other zones which is not burned or sold is injected into
the Dry Gas Zone.

Since the field was unitized in 1948 until 30 June 1953,
approximately 16 million net of gas has been produced from
this Zone. Current and ultimate allocation of production
agree with the participating percentages for this Zone.

Section 14-B.

As of 1 January 1954, the unit's 16 wells in Section 14-B

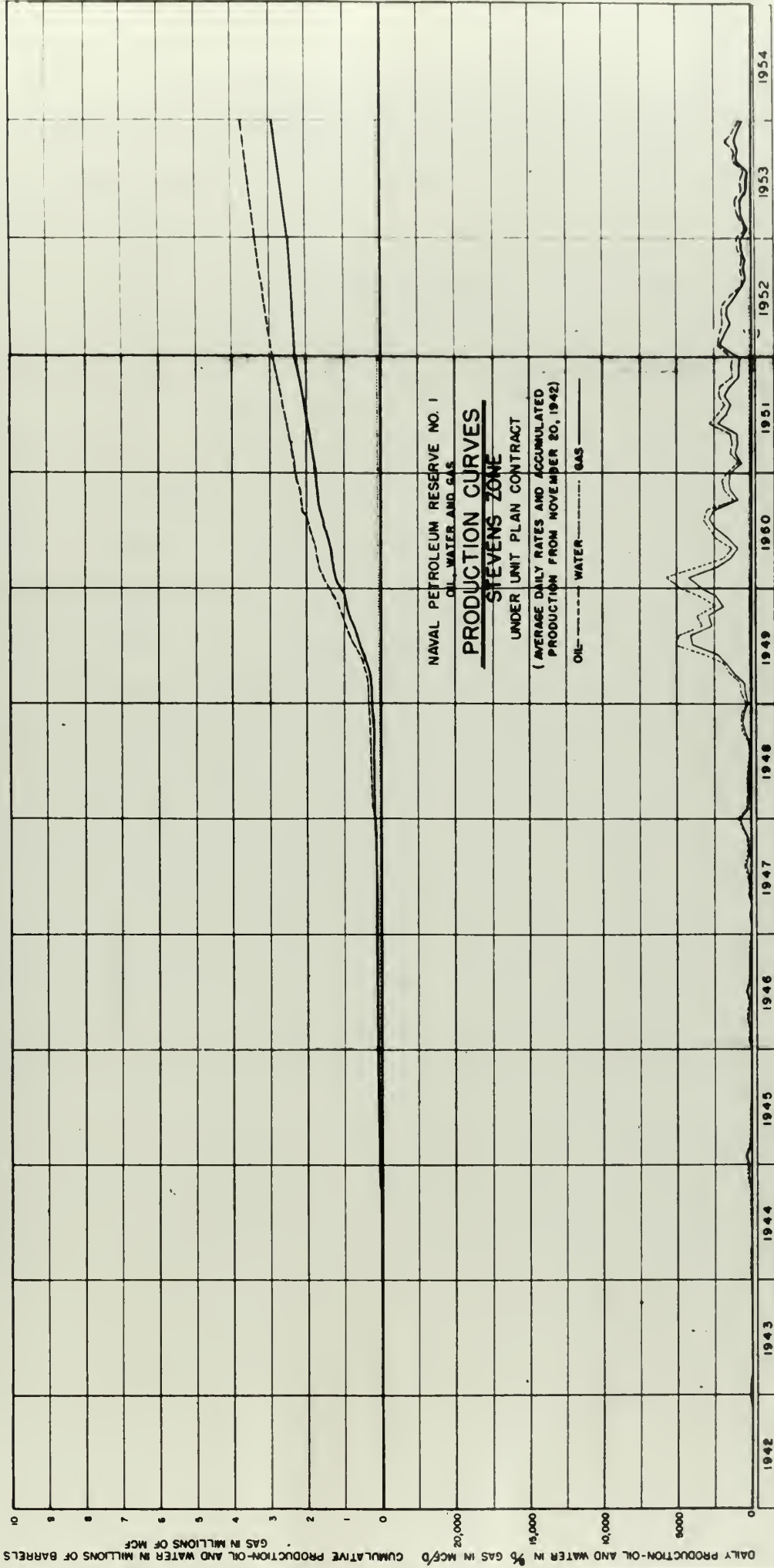


FIG. 3-4. Production History Curves, Stevens Zone, Elk Hills, from 20 November 1942.
 Note of Initial Production: 30 August 1941. (Reproduced from Annual Report,
 WPR #1, 1953)

were producing a total of 545 barrels per day from the Buena Vista Front field. The production history of this section is tabulated below:

<u>Year</u>	<u>Yearly Production (Barrels)</u>	<u>Cumulative Production (Barrels)</u>
1945	55,815	55,815
1946	180,097	235,912
1947	133,490	369,402
1948	101,292	470,694
1949	113,299	583,993
1950	126,560	710,553
1951	104,415	814,968
1952	149,036	964,004
1953	197,917	1161,921

were producing a total of 141 barrels per day from the ...
/late front field. The production history of this section is

tabulated below:

Year	Yearly Production (barrels)	Cumulative Production (barrels)
1938	127,917	127,917
1939	149,088	277,005
1940	107,816	384,821
1941	128,380	513,201
1942	112,899	626,100
1943	101,292	727,392
1944	122,450	849,842
1945	160,007	1,009,849
1946	141,616	1,151,465

PIPELINES AND REFINERIES

Eight crude oil pipe lines with high aggregate capacity are directly or indirectly connected to the Reserve.¹⁰⁵ Six of these lines can reach marine terminals. None of these lines are owned by Navy but by different oil companies, such as Standard, Union, Texas, and Norwalk. As of 1 April 1951, INPR in C estimated that the major companies could, independently of each other, ship and refine about 46,000 barrels per day of Elk Hills oil in the event the field was put on full production. Also, INPR in C pointed to indications that the whole industry, with mutual cooperation, could ship and refine 100,000 barrels per day of Elk Hills oil. A more than adequate available refining capacity, 137,000 barrels per day, exists in the nearby refineries of the Los Angeles area.¹²³ Additional refinery capacity is available in the San Francisco Bay region and Bakersfield.

With the subsequent development of both the Shallow and Stevens Zones and the discovery of the Carneros Zone, the estimated constant production rate for Elk Hills exceeds 100,000 barrels per day. Consequently, in 1954, the Navy indicated that it plans to propose the construction of a 14 inch pipe line 100 miles in length to Los Angeles to handle the increased productive capacity in case of an emergency. Costs of this project are discussed in Chapter VIII.

SELECTED REFERENCES IN BIBLIOGRAPHYFORDEVELOPMENT AND PRODUCTION

2, 105, 106, 108, 111, 124,

125

CHAPTER IV

OIL RESERVES

AND

PRODUCTIVE CAPACITY

OF

NAVAL PETROLEUM RESERVE NO. 1

CHAPTER IV

THE RESERVE

ART

PROVINCIAL CASUALTY

OR

RAVAL PROVINCE RESERVE NO. 1

CHAPTER IV
OIL RESERVES
AND
PRODUCTIVE CAPACITY
OF
NAVAL PETROLEUM RESERVE NO. 1

TOTAL OIL RESERVES

<u>Zone</u>	<u>Estimated Recoverable Oil As Of 1 January 1954 (Barrels)</u>	<u>Latest Revised Participating Percentages</u>	<u>Standard</u>	<u>Navy</u>
Shallow	337,568,562	33.0848	66.9152	
Stevens	350,000,000	20.6911	79.3089	
Carneros	<u>No Estimate</u>	-----	100	
Total	687,568,562			
Dry Gas Zone	100,000,000 M.c.f.	77.0492	22.9508	

Basis for the above values is discussed in later sections of this chapter.

STATE OF DEPLETION

<u>Zone</u>	<u>Estimated Percent Depleted As Of 1 Jan. 1954</u>
Shallow	39
Stevens	1
Carneros	0
Dry Gas	43

NAVAL PETROLEUM RESERVE NO. 1
OF
PRODUCTIVE CAPACITY
AND
OIL RESERVE
QUANTITIES

TOTAL OIL RESERVE

Zone	Estimated Recoverable Oil As of 1 January 1934 (Barrels)	Latest Revised Percentage Recoverable	Standard Day
Shallow	327,500,000	33.00%	88,000,000
Stevens	300,000,000	50.00%	150,000,000
Garnets	20,000,000	100	20,000,000
Total	647,500,000		
Dry Gas Zone	100,000,000 B.C.F.	77.00%	22,000,000

Basis for the above values is discussed in later sections of this chapter.

STATE OF ESTIMATION

Zone	Estimated Percent Depleted As of 1 Jan. 1934
Shallow	33
Stevens	1
Garnets	0
Dry Gas	62

PRODUCTIVE CAPACITY¹²⁵1952 Annual ReportEstimated Maximum Production Capacity
for Five Years, 1952-1956

<u>Year</u>	<u>Shallow</u>	<u>Stevens</u>	<u>Total</u>
1952	58,000	72,000	130,000
1953	55,000	72,000	127,000
1954	52,000	72,000	124,000
1955	51,000	70,000	121,000
1956	50,000	66,400	116,400

Revised Estimates
1953 Annual ReportEstimated Maximum Constant Producing
Rates for Five Year Period, Barrels
per Day

<u>Year</u>	<u>Shallow</u>	<u>Stevens</u>	<u>Total</u>
1953	74,000	65,950	139,950
1954	73,000	68,250	141,250
1955	72,000	-----	-----
1956	68,000	-----	-----
1957	64,000	-----	-----

COMPARATIVE STATEMENTS

1954 Annual Report

Estimated Annual Production Capacity
for Five Years, 1952-1956

Year	1952	1953	1954	1955	1956
1952	150,000	150,000	150,000	150,000	150,000
1953	150,000	150,000	150,000	150,000	150,000
1954	150,000	150,000	150,000	150,000	150,000
1955	150,000	150,000	150,000	150,000	150,000
1956	150,000	150,000	150,000	150,000	150,000

Revised Estimates
1953 Annual Report

Estimated Annual Operating Production
Costs for Five Year Period, 1952-1956

Year	1952	1953	1954	1955	1956
1952	150,000	150,000	150,000	150,000	150,000
1953	150,000	150,000	150,000	150,000	150,000
1954	150,000	150,000	150,000	150,000	150,000
1955	150,000	150,000	150,000	150,000	150,000
1956	150,000	150,000	150,000	150,000	150,000

SHALLOW OIL ZONEReserves. 125,136(Official estimate by Engineering Committee; Revision of
1 December 1949)

Proven Acreage (oil and gas production).....19,200 acres

	<u>Barrels</u>
Estimated Ultimate Recovery.....	550,184,000
Production to 20 Nov. 1942.....	<u>160,658,000</u>
Est. Reserves as of 20 Nov. 1942.....	389,526,000
Production from 11-20-42 to 1-1-54...	<u>51,957,438</u>
Est. Reserves as of 1 Jan. 1954.....	337,568,562

Discussion.

The values quoted above were from the latest Engineering Committee estimate¹³⁶ based on a combination of the decline curve and the volumetric method.

Old Area.

For the Old Area (Tupman), see Figure 5-1, the Unit engineers established average production decline curves for each of six different fault blocks within the area from the production history of each of the wells in the Area. Since many wells in this Old Area are completed in several major sands, as shown on Figure 5-3, it was necessary for the decline curves to include production from all sands penetrated. These curves were then used to obtain the estimated recoverable oil for each well in the Old Area by entering the appropriate

APPENDIX

Reserves, 1940
(Official release by Engineering Committee, October 1, 1940)

Proven Reserves (oil and gas production)..... 1,120,000 acres

Estimated Ultimate Recovery.....	600,184,000
Production to 20 Nov. 1942.....	180,638,000
Est. Reserves as of 20 Nov. 1942.....	419,546,000
Production from 11-31-42 to 7-1-54...	41,327,400
Est. Reserves as of 1 Jul. 1954.....	378,218,600

Discussion

The values quoted above were from the latest Engineering Committee estimates based on a comparison of the decline curve and the geologic methods.

Old Area

For the Old Area (Figure 2-1), the well engineers established average production decline curves for each of six different field blocks within the area from the production history of each of the wells in the Area. Since many wells in this Old Area are completed in several stages, as shown in Figure 2-3, it was necessary for the decline curves to include production from all sands penetrated. These curves were then used to obtain the estimated recoverable oil for each well in the Old Area by entering the appropriate

curve with the last representative daily production for the well and determining recoverable oil to an economic limit of 3 barrels per day. To this value was added the well's production back to the base date of 20 November 1942. Reserves from undeveloped areas scheduled for development were obtained similarly. A summation gave the estimated recoverable reserves from the Old Area.

New Area.

The remainder of the Shallow Oil Zone had been mostly developed during and after World War II. Since the production history of the wells in these areas was insufficient to establish representative decline curves, the recoverable oil was computed by the volumetric method using recovery factors based largely on analogy with the Old Area and comparison with similar nearby fields.

curves with the last representative daily production for the well and determining recoverable oil to an economic limit of 3 barrels per day. In this case the well's production back to the base date of 20 October 1942. Recoverable from undeveloped areas scheduled for development were obtained similarly. A summation gave the estimated recoverable reserves from the Old Area.

New Area.

The remainder of the Oilfield Old Zone had been mostly developed during and after World War II. Since the production history of the wells in these areas was insufficient to establish representative decline curves, the recoverable oil was computed by the volumetric method using recovery factors based largely on analysis of the Old Area and compared with similar nearby fields.

Oil Reserves

The total oil reserves of the field are estimated to be approximately 1.5 billion barrels. This estimate is based on the volumetric method and is subject to the usual uncertainties of this type of calculation. The recoverable reserves are estimated to be approximately 1.0 billion barrels. This estimate is based on the volumetric method and is subject to the usual uncertainties of this type of calculation. The remaining reserves are estimated to be approximately 0.5 billion barrels. This estimate is based on the volumetric method and is subject to the usual uncertainties of this type of calculation.

STEVENS ZONE¹²⁵Reserves (Unofficial 1948 Navy Estimate):

Proven Acreage.....8,300 acres

	<u>Barrels</u>
Estimated Ultimate Recovery.....	307,718,000
Production to 20 Nov. 1942.....	<u>107,000</u>
Reserves as of 20 Nov. 1942.....	307,611,000
Production from 11-20-42 to 1-1-54.....	<u>3,705,265</u>
Reserves as of 1 January 1954.....	303,905,735*

Discussion.

As of May 1954 no official estimate by the Engineering Committee had been made of the recoverable oil in the Stevens Zone; however, one is now in progress. Unofficial estimates have been made, such as one above by Navy field engineers in 1948 and another by consulting petroleum engineers employed by Standard. *Discovery of the 26-R sand and other extensions of the Stevens Zone since 1948 have increased the recoverable reserves to about 350 million barrels.

It may seem strange to some observers that no official estimate of recoverable reserves exists after a lapse of thirteen years since discovery of the Zone. However, there are several good reasons. Although the field was discovered in 1941, it was not until 1946 that an intensive exploratory program was commenced. The development program which followed

Summary

Reserves (Official 1948 Navy Reserve):

Proven acreage.....	3,200 acres
<u>Barrels</u>	
Estimated ultimate recovery.....	307,718,000
<u>Production to 20 Nov. 1947.....</u>	107,100
Reserves as of 20 Nov. 1947.....	307,611,000
<u>Production from 11-30-47 to 1-31-48.....</u>	3,700,000
Reserves as of 1 January 1948.....	303,911,000

Discussion

As of May 1948 no official estimate by the Engineering Committee has been made of the recoverable oil in the Reserve Zone; however, one is now in progress. Official estimates have been made, such as one made by Navy field engineers in 1948 and another by consulting petroleum engineers employed by Standard. Recovery of the 28-R and other extensions of the Stevens Zone since 1946 have increased the recoverable reserves to about 350 million barrels.

It may seem strange to some observers that no official estimate of recoverable reserves exists after a lapse of thirteen years since discovery of the Zone. However, there are several good reasons. Although the field was discovered in 1941, it was not until 1945 that an intensive exploratory program was commenced. The development program which followed

was not completed until April 1954. Late development is thus one reason. Any detailed official estimate prior to completion of the scheduled development program would have been an unnecessary expense.

Another reason is simply the difficulty involved in making an estimate of this Zone on which all parties will agree. Since the Zone has not been produced except for minor test and maintenance production, no decline curves and material balance data are available. Consequently, about the only method for estimating reserves is a calculation based on the volumetric method and comparison of this field with similar producing fields to obtain a recovery factor. No reliable secondary method is available to use as a check on the volumetric method.

Moreover, any estimate cannot be considered entirely reliable or even relatively accurate, as the Stevens Zone contains a large volume of fractured shale with great variations in porosity and permeability. Thus, most of the difficulty in making an estimate lies in deciding how to interpret, or how reliable is, the data available.

As far as this student knows, the volumetric method has been used for all estimates to date. Possible increases in recovery by secondary recovery methods were not considered in any estimate.

has not completed until April 1951. This development is due
one reason. Any detailed official studies prior to completion
of the statistical development program would have been an unwise
step.

Another reason is simply the difficulty involved in making
an estimate of this kind on which all parties will agree.
Since the time has not yet been produced except for minor part
and maintenance production, an analysis covers and material
balance data are available. Consequently, about the only
method for estimating reserves is a calculation based on the
voluntary method and comparison of this field with similar
producing fields in similar reservoirs. The reliability
of this method is evaluated as low as a check on the vol-
untary method.

However, any estimate cannot be considered entirely
reliable or even relatively accurate, as the Bureau's data
contains a large volume of irregular data and great vari-
ations in porosity and permeability. Thus, most of the diffi-
culty in making an estimate lies in deciding how to interpret
or how reliable is the data available.

As far as this subject goes, the voluntary method has
been used for all estimates to date. Possible increases in
reserves by secondary recovery methods were not considered
in any estimate.

The Bureau's data is not complete and the estimates are
based on the best available information. The estimates are
subject to change as more data becomes available.

CARNATION ZONE^{2,125}

By May 1954 only two wells had been completed in this deepest Zone. The wells have capacities of 150 to 200 barrels per day of very high gravity oil and high gas-oil ratio. No estimate of oil reserves has been attempted.

DRY GAS ZONE^{2,125}

No detailed estimates have been made of the recoverable gas in the Dry Gas Zone which lies at a depth of 1500 to 2000 feet. However, approximate estimates are as follows:

Estimated Productive Area.....6,056 acres

Rough Estimate of Gas Reserves:

Est. Ultimate Recovery.....175,000,000 M.c.f.

Approx. Gas Production to 1954.... 75,000,000 M.c.f.

Est. of Gas Reserves as of 1-1-54.100,000,000 M.c.f.

Estimated Gas Reserves

By May 1964 only two wells had been completed in this deepest zone. The wells have capacities of 150 to 200 barrels per day of very high gravity oil and high gas-oil ratios. No estimate of oil reserves has been made.

Estimated Gas Reserves

No detailed estimates have been made of the recoverable gas in the Bay Gas Zone which has a depth of 1000 to 2000 feet. However, approximate estimates are as follows:
Estimated productive area.....2,058 acres

Approximate Gas Reserves:

- Est. Volume Recoverable.....1,175,000,000 B.C.F.
- Approx. Gas Production to 1964..... 75,000,000 B.C.F.
- Est. of Gas Reserves as of 1-1-64.....1,100,000,000 B.C.F.

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2, 103, 106, 114, 117, 125, 136

REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE
ON THE PROGRESS OF THE WORK DURING THE YEAR 1881

S. 103, 106, 114, 117, 122, 130

[The following text is extremely faint and largely illegible due to the quality of the scan. It appears to be the main body of a report, containing several paragraphs of text.]

CHAPTER V

REVIEW OF

THE RESERVOIR ENGINEERING PROBLEMS

IN NAVAL PETROLEUM RESERVE NO. 1

(Elk Hills)

THE STATE OF TEXAS,
COUNTY OF DALLAS.

CLAUDE V.

DECEASED

BY HIS WILL AND TESTAMENTARY INSTRUMENTS

IN FAVOR OF HIS HEIRS AND BENEFICIARIES

(THE WILL)

CHAPTER VREVIEW OFTHE RESERVOIR ENGINEERING PROBLEMSIN NAVAL PETROLEUM RESERVE NO. 1

(Elk Hills)

INTRODUCTION

The Elk Hills oil field (Naval Petroleum Reserve No. 1), potentially the largest oil field in California if it were to be opened to maximum production, is of particular interest from an oil reservoir engineering standpoint. Nearly every problem that can be associated with a petroleum reservoir has been encountered in the development of this Reserve. This field provides the petroleum engineer with an unusual opportunity to study the interaction and interrelation of many reservoir processes in one field. It provides an opportunity to study under actual field conditions some problems previously attacked only from a theoretical basis. Its relatively shut-in condition also makes it more unusual than a producing field and provides some information on reservoir behavior not furnished by the latter.

The problems have ranged chronologically from the age-old oil field problem of drilling off-set wells to restrict drainage of oil from one's own property to the problem of probable loss of oil by migration into edgewater sands along a receding edgewater front -- an unusual condition.

CHAPTER I

REVIEW OF

THE RESERVOIR ENGINEERING PROBLEMS

IN OIL FIELD DEVELOPMENT

(Oil Field)

INTRODUCTION

The Oil Field (Naval Petroleum Reserve No. 1) is potentially the largest oil field in California. It is now to be opened to maximum production, in order to meet the demand from an oil reservoir engineering standpoint. Nearly every problem that can be associated with a petroleum reservoir has been encountered in the development of this Reserve. This field provides the petroleum engineer with an unusual opportunity to study the interaction and interpretation of many reservoir processes in one field. It provides an opportunity to study under actual field conditions some problems which are usually only treated from a theoretical basis. The relatively short-in condition also makes it more unusual than a producing field and provides some information on reservoir behavior not furnished by the latter.

The problems have ranged chronologically from the early oil field problems of drilling oil-wells to reservoir drainage of oil from one's own property to the problem of probable loss of oil by migration into adjacent strata along a receding edge-water front -- an unusual condition.

Each particular problem or project was usually accompanied by exhaustive engineering analysis and detailed reports. The new employee -- Navy or Standard, officer or civilian -- who becomes associated with the Elk Hills field in some capacity and who is interested in the oil reservoir engineering history of the Reserve, normally finds these reports too numerous and voluminous.

The purpose of this section is an attempt to alleviate to some extent the above situation. Each engineering problem of major significance or special interest in the past and current history of the Reserve is presented in chronological order in as standard and concise form as possible, stressing the most important facts in each major problem or project.

Where they are necessary for clarity and better understanding of the problem, simplified maps and graphs accompany each discussion. For the reader requiring more detailed information, a bibliography at the end of each discussion refers him to the detailed reports concerning the particular subject.

This presentation is by no means the first summary of the engineering problems and projects at Elk Hills that has been made.* It is hoped, however, that this report will be

*Early history and development through 1932 of Elk Hills field have been described in detail by Woodring, Roundly, and Farnsworth in reference 124; subsequent developments through 1947 by Eastman and Ruhlman in reference 109; and a report on the results of the postwar readiness and maintenance projects from 1945 through 1952 by the Engineering Committee in reference 138.

Each particular problem or project was usually covered by extensive engineering analysis and detailed reports. The new engineer -- now an Assistant, Officer or Engineer -- who became associated with the Six Mile field in some capacity and who is mentioned in the oil reservoir engineering history of the Reserve, usually finds these reports for questions and answers.

The purpose of this section is an attempt to elaborate in some extent the above situation. Each engineering problem of major significance or special interest in the past and present history of the Reserve is presented in chronological order in an abstract and concise form as possible, arranging the most important facts in each major problem or project. Where they are necessary for clarity and better understanding of the problem, simplified case and graphs accompany each discussion. For the reader requiring more detailed information, a bibliography at the end of each discussion refers him to the detailed reports concerning the particular subject. This presentation is by no means the first attempt at the engineering problems and projects of Six Mile field has been made. It is hoped, however, that this report will be

*Early history and development through 1945 of Six Mile field have been described in detail by Woodring, Bennett, and Pennington in reference 123; subsequent developments through 1947 by Hartman and Wilson in reference 124; and a report on the results of the postwar reevaluation and oil-bearing capacity project from 1945 through 1952 by the Reservoir Engineering Committee in reference 125.

of some value in its wide scope, its standardized presentation of each problem, and the selected references included with each discussion.

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Part ASUMMARY OF THE OIL RESERVOIR PROBLEMS FROM THE
DISCOVERY OF OIL IN ELK HILLS (JANUARY 1919)
TO UNITIZATION OF THE RESERVE IN NOVEMBER 1942

The development and production history of Elk Hills during the more than twenty years before unitization has been reviewed in Chapter III. From an oil reservoir engineering standpoint, this period is important for the manner in which the field was developed and produced. The competitive drilling and producing practices of this period resulted mainly in an overall detrimental effect to the Shallow Oil Zone, reducing its productive capacity and decreasing its ultimate recoverable reserve to an unnecessary degree. On the credit side, however, the competitive nature of the operations did serve to promote the initial discovery of oil in the field, to provide the government with high royalties from its strip-leases, and to establish Elk Hills as a major oil field and an important Reserve by 1921.

It has often been said that the Elk Hills field has everything to interest and perplex the petroleum reservoir engineer.¹⁰⁸ It was equally true in this early period of the Reserve. The problems were typical of those always encountered in the development of any single closed-structure oil pool in which there are divided interests and many different operators. Each operator is dedicated to the task of maximum economic (not necessarily efficient) recovery of oil in the

Part I

SUMMARY OF THE OIL RESERVE UTILIZATION FROM THE
DISCOVERY OF OIL IN THE MIDDLE (SOUTHWEST) AREA
TO UTILIZATION OF THE RESERVE IN NOVEMBER 1944

The development and production history of the Middle Area during the more than twenty years before utilization has been reviewed in Chapter III. From an oil reservoir engineering standpoint, this period is important for the manner in which the field was developed and produced. The competitive drilling and producing practices of this period resulted mainly in an overall detrimental effect to the Middle Area, reducing its productive capacity and decreasing the ultimate recoverable reserve to an unnecessary degree. On the credit side, however, the competitive nature of the operations did serve to promote the initial discovery of oil in the field, to provide the government with high royalties from the strip lease, and to establish the Middle Area as a major oil field and an important reserve by 1921.

It has often been said that the Middle Area was everything to interests and perplex the petroleum reservoir engineer. It was equally true in this early period of the Reserve. The problems were typical of those which encountered in the development of any single closed-structure oil pool in which there are divided interests and many different operators. Each operator is dedicated to the task of maximum economic (not necessarily efficient) recovery of oil in the

shortest time possible so as to recover his own oil and as much as possible of his neighbor's. This system has ruined most oil fields, and it nearly ruined the Shallow Oil Zone of Elk Hills.

Some of the major problems encountered during the initial development of this field, or which resulted from the early development and production practices, included the following:

(1) Uncontrolled production methods with no attempt to maintain or restore reservoir pressure caused adverse effects on the reservoir, such as the following:

(a) Depletion of reservoir energy in the Old Area in the form of free gas and solution gas produced. No gas was returned to the SS-1 from 1919 to 1942.

(b) Creation of pressure sinks and an unbalanced reservoir.

(c) Creation of secondary gas caps.

(d) Rapid decrease in productive capacity.

(e) Abnormally high percentage recovery of oil from the Old Area at the probable expense of greatly reduced ultimate recovery from the Shallow Zone.

(2) Multi-zone well completion methods -- a procedure detrimental to maintaining good control of reservoir conditions. Completion methods during this competitive period called for opening up all horizons to the well-bore, regardless of gas, oil or water productivity. Only about 40 per cent of the nearly 700 producible wells in the Shallow Zone

shortest time possible so as to recover his own oil and
even as possible to his neighbors. This system has ruined
most oil fields, and it nearly ruined the Shell Oil zone at
Six Hills.

Some of the major problems encountered during the ini-
tial development of this field, or which resulted from the
early development and production practices, included the
following:

(1) Uncontrolled production methods which are attempts
to maintain or restore reservoir pressure caused adverse
effects on the reservoir, such as the following:
(a) Depletion of reservoir energy in the Old Area in
the form of free gas and solution gas produced. No gas was
returned to the 22-1 from 1919 to 1942.

(b) Creation of pressure slots and an unbalanced
reservoir.
(c) Creation of secondary gas caps.
(d) High gas rates in productive capacity.
(e) Abnormally high percentage recovery of oil from
the Old Area at the probable expense of gas that reduced effi-
cient recovery from the Shell zone.

(2) Well-zone self-oscillation outside -- a procedure
debatable to maintaining good control of reservoir condi-
tions. Completion methods during this competitive period
called for opening up all zones to the well-bore, regard-
less of gas, oil or water productivity. Only about 40 per
cent of the nearly 700 productive wells in the Shell zone

----- BOUNDARY, 1942 to 1949.

////// OLD AREA, DEVELOPMENT PRIOR TO 1941.

ALL SECTIONS NOT MARKED ARE U. S. N.

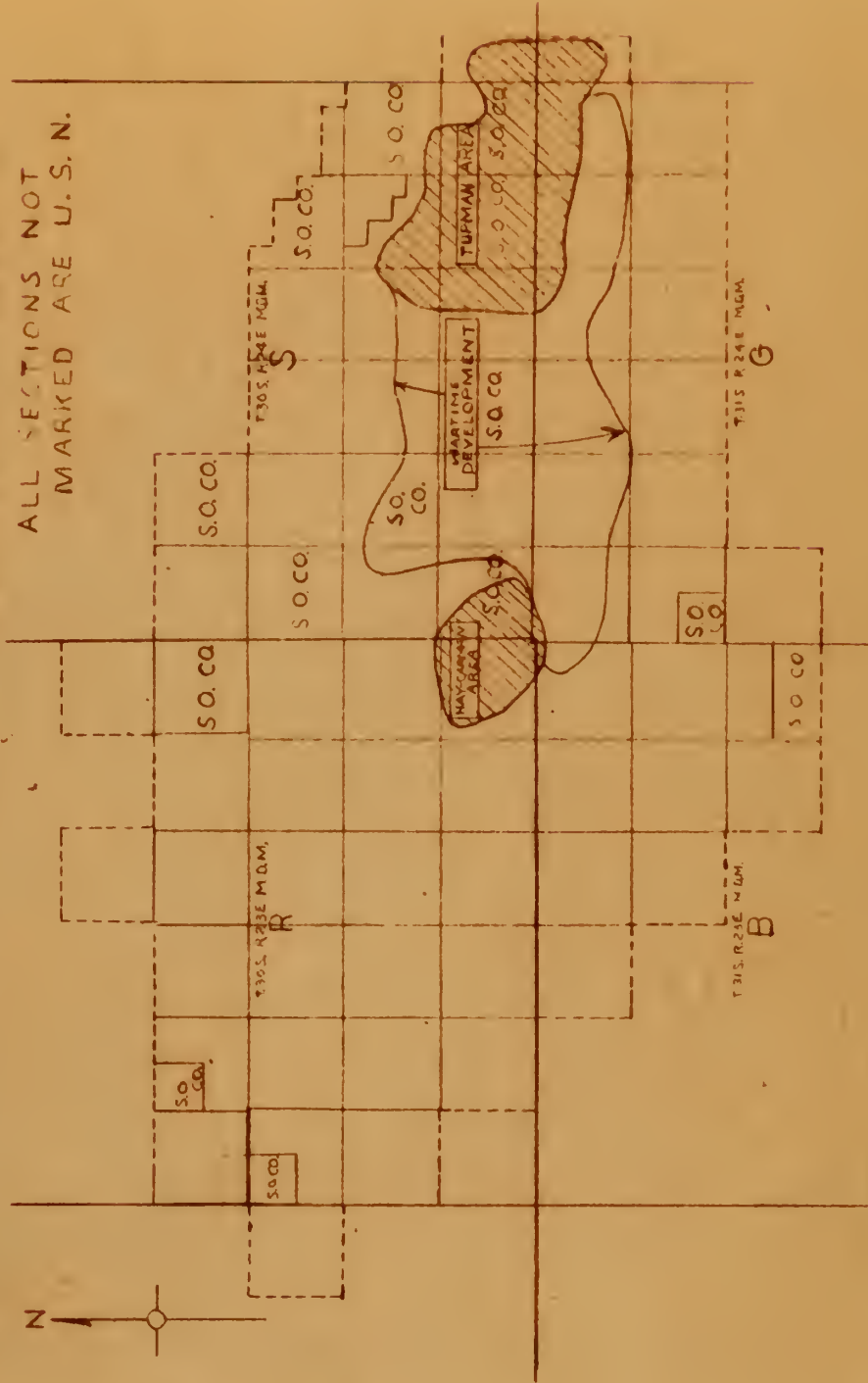


FIG. 1-DEVELOPED AREAS, ELK HILLS

FIG. 5-1, Showing the Areas of the Shallow Oil Zone Developed Prior To and During World War II

are completed in one zone only -- a fact which has prevented good control of reservoir fluids in the different zones and which has contributed to the unbalanced condition in the Shallow Zone. A sketch of three early wells is shown in Figure 5-3¹⁰⁴ to illustrate this early well-completion technique, now mainly abandoned in favor of single-zone completions.

(3) Off-set drilling and production practices. It was necessary for the Government to issue strip leases for the drilling of off-set wells to restrict drainage from the Reserve to neighboring developed lands outside of the Reserve. Some drainage occurred before the off-set wells were completed and some drainage probably continued after completion; also, the worst result was the production of great amounts of oil from a structure primarily set aside by Congress as a reserve of oil to be held in the ground for future emergency use.

(4) Production at excessively high gas/oil ratios occurred in the Hay-Carman, or central part, of the Old Area indicated on Figure 5-1.¹⁰⁹ The resulting rapid depletion of reservoir energy in the form of high-pressure gas from the original crestal gas cap of the SS-2 and other sands led to lawsuits which eventually shut in all of these wells in stages from 1925 to 1934. They remained shut in until 1944.

The Old Area of Elk Hills is indicated on the base map of Figure 5-1. It was composed of the crestal, less important central area (Hay-Carman) and the highly productive eastern

are completed in one name only -- a fact which has prevented
 good control of reservoir fluids in the different zones and
 which has contributed to the unbalanced condition in the
 shallow zone. A sketch of three early wells is shown in
 Figure 3-3¹⁰⁴ to illustrate this early well-completion prob-
 lem, now mainly abandoned in favor of single-zone comple-
 tions.

(5) Off-set drilling and production practices. It was

necessary for the Government to issue strict laws for the
 drilling of off-set wells to restrict drainage from the re-
 serve to neighboring developed lands outside of the reserve.
 Some drainage occurred before the off-set wells were completed
 and some drainage probably continued after completion; also,
 the worst result was the production of great amounts of oil
 from a structure primarily set aside by Congress as a reserve
 of oil to be held in the ground for future emergency use.

(4) Production at excessively high gas/oil ratios

occurred in the Hay-Garman, or central part, of the Oil Area
 indicated on Figure 3-1.¹⁰⁷ The resulting rapid depletion of
 reservoir energy in the form of high-pressure gas from the
 original created gas cap of the 22-2 and other sands led to
 lawless which eventually cost in all of these wells in
 stages from 1925 to 1934. They remained open in until 1944.

The Oil Area of the Hills is indicated on the base map
 of Figure 3-1. It was composed of the central, less important
 central area (Hay-Garman) and the highly productive eastern

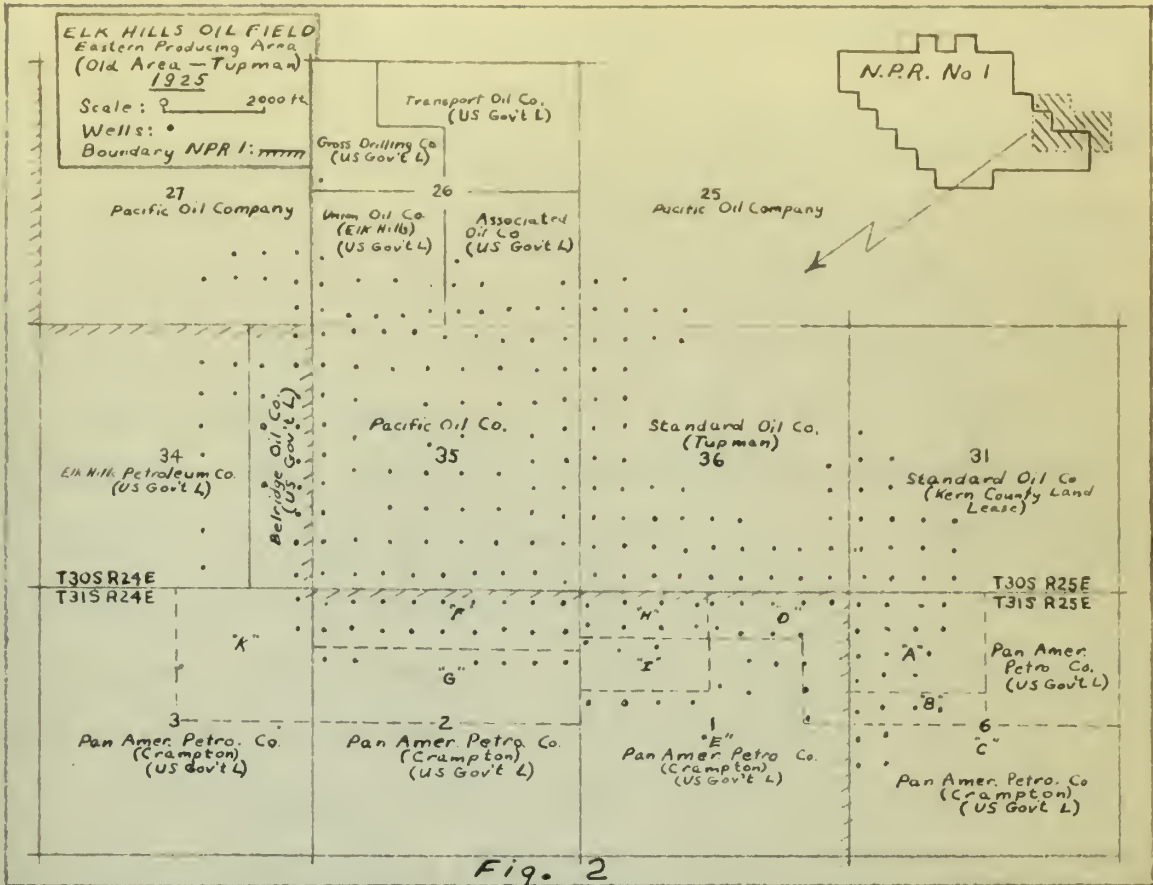


Fig. 2

FIG. 5-2, Showing the Complexity of Leases and the Off-set Drilling Practices During the Competitive Period of the Elk Hills Field

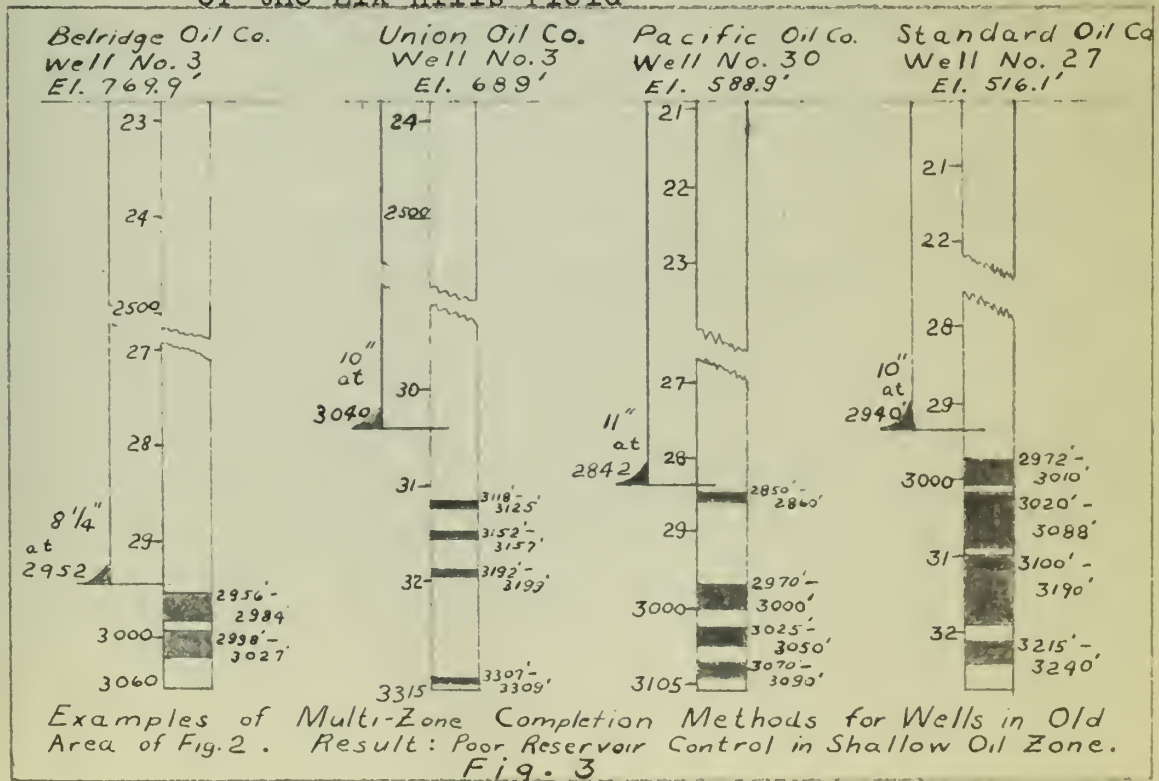


FIG. 5-3

area (Tupman). These areas represent the development occurring prior to unitization in 1942.

From Figure 5-2¹⁰⁴ may be obtained some idea of the complexity of leases and large number of operators involved in the initial development of the Shallow Zone of the Elk Hills field. The operators included those on Navy or other government leased land and those on fee owned or privately leased land. The necessity that existed for each operator to protect his lease by off-set drilling is readily apparent. The near disastrous results to the party who was late in drilling his off-set wells -- a role consistently played by Navy -- is shown by Figures 5-4 and 5-5.¹²⁰

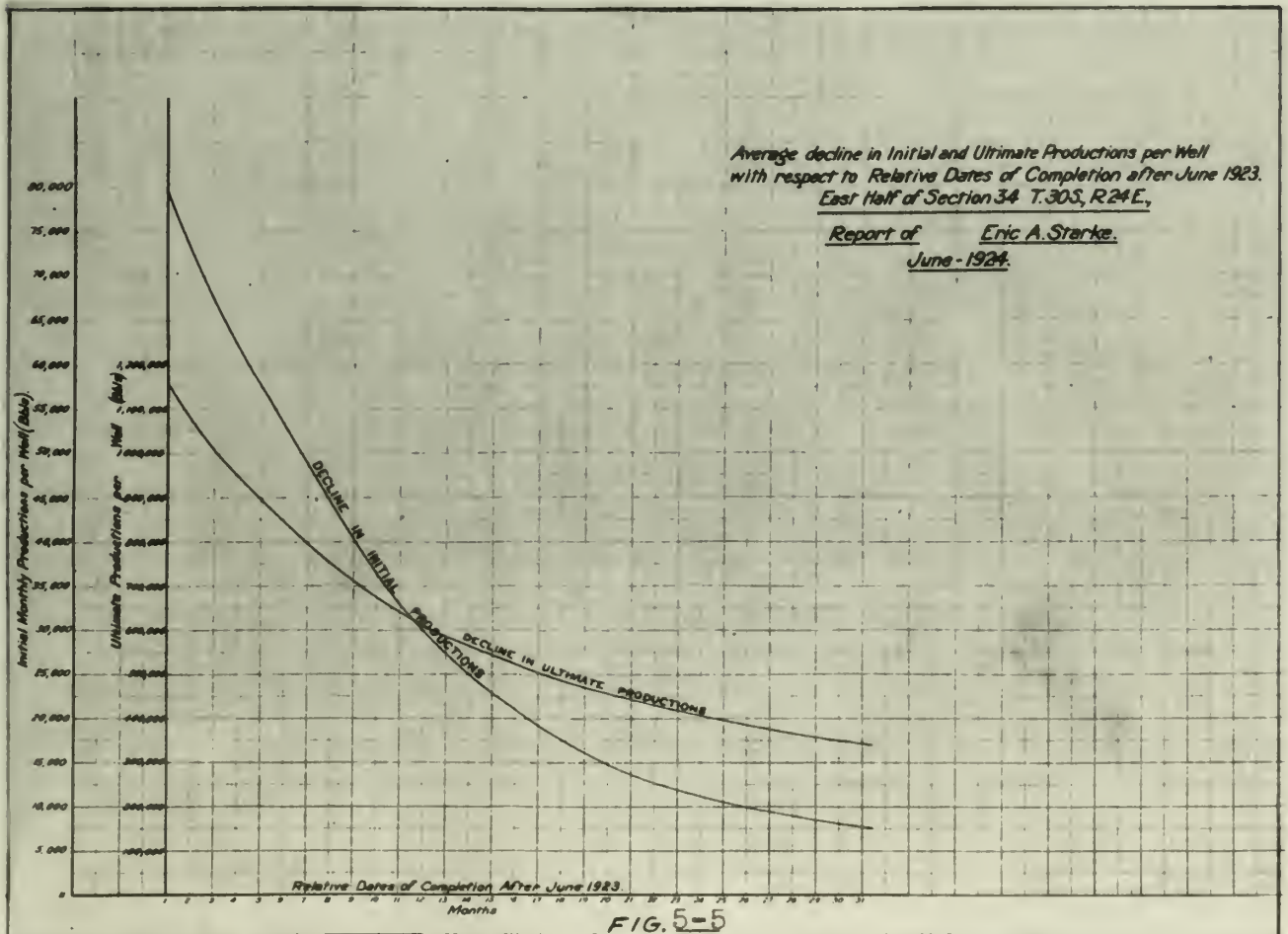
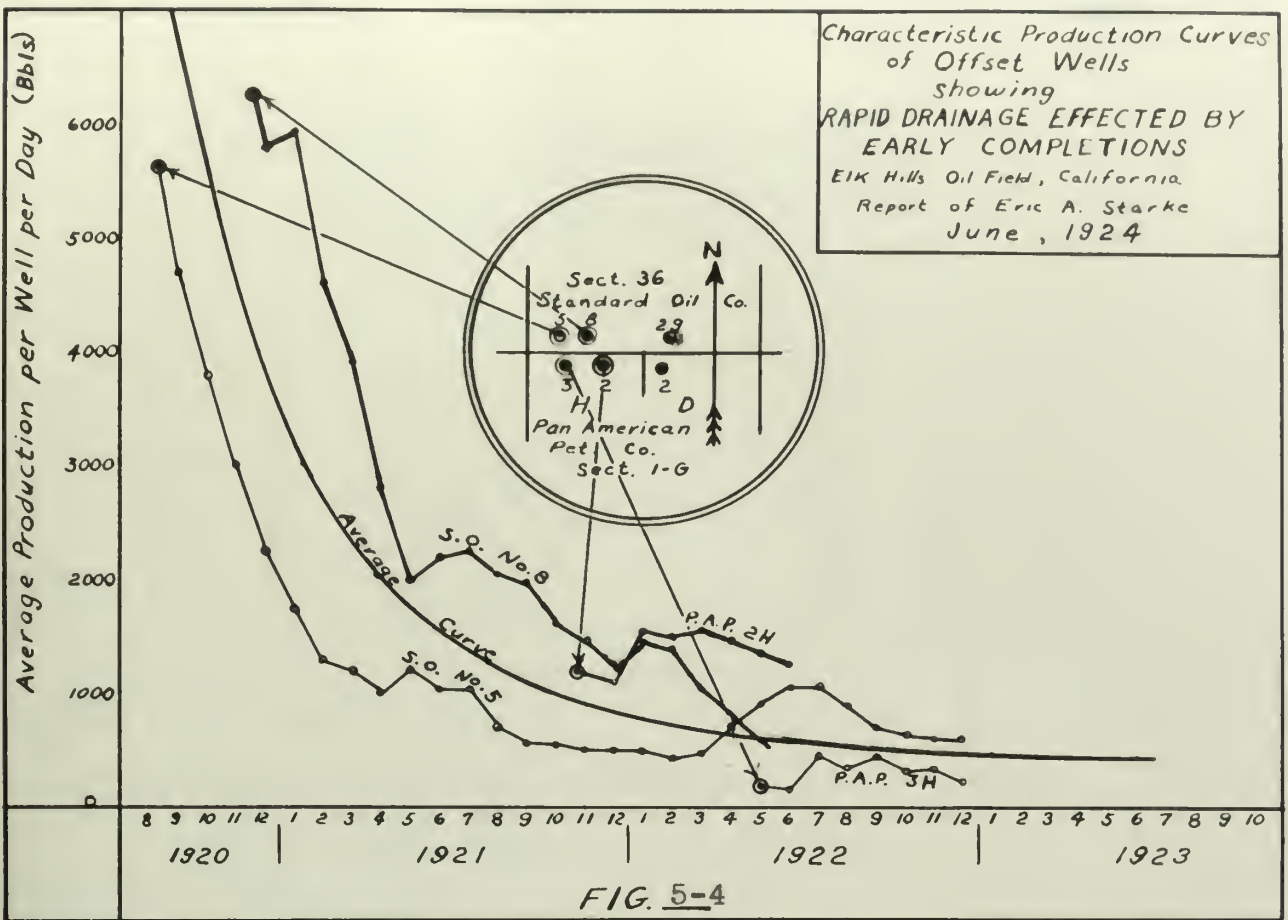
The following tabulated data given by Starke in his investigation of Navy's off-set drilling program well illustrates the great loss of oil which the Government suffered before it could put into effect its strip-lease, off-set drilling program. As Starke pointed out, "The initial productions of wells on either side of the south line of Section 36 (30-24) are shown to be closely related to the dates of completion as shown by the following data":¹²⁰

area (Township). These areas represent the development potential
prior to utilization in 1968.

From Figure 5-2¹⁰⁰ may be observed that the complexity of leases and large number of operators involved
in the initial development of the Dallas area of the Hill
Hills field. The operators included those on Navy or other
government leased land and those on the owned or privately
leased land. The necessity that existed for each operator
to protect his lease by off-set drilling is readily apparent.

The near disastrous results to the Navy was due in
drilling its off-set wells -- a role consistently played by
Navy -- is shown by Figures 5-4 and 5-5.¹⁰⁰

The following table given by States in the
investigation of Navy's off-set drilling program will illus-
trate the great loss of oil which the Government suffered
before it could put into effect the off-set, off-set
drilling program. As further related out, the initial pro-
duction of wells on either side of the south line of Section
56 (30-24) are shown as closely related to the dates of
completion as shown by the following table:¹⁰⁰



SETTLED INITIAL PRODUCTIONS IN ORDER
OF DATES OF COMPLETION

S. O. Co.	5	5700 Bbls	P.A.P.*	1 D.	300 Bbls
"	4	5550 "	"	2 D.	240 "
"	8	6274 "	"	1 H.	100 "
"	14	3834 "	"	3 D.	300 "
"	17	2777 "	"	4 D.	240 "
"	15	2618 "	"	2 H.	1209 "
"	29	1801 "	"	4 H.	795 "
"	30	289 "	"	5 D.	228 "
"	31	189 "	"	3 H.	144 "

*A Navy lessee.

Note: Wells in the two columns above are opposite one another along a section line between Standard's property and the Reserve.

Naturally, ultimate production in each case of later completion should be less, and cumulative productions to date indicate that they will be. It should be stressed that most of the commercial development described above was on privately owned lands outside of the Reserve and on the off-set strip-leases issued by Navy. Most of the fee-owned land within the original boundaries of the Reserve, except for the Hay-Carman Area, was not developed by the private owners, thereby cooperating with the Navy's policy of conserving the Reserve as a source of oil in a future emergency. However, the detrimental effects of the competitive development and production practices occurring in the Tupman area eventually led the Government to the realization that the Reserve had to be extended so as to cover the entire oil-producing structure and

SETTING INITIAL PRODUCTIONS IN OIL
OF OILS OF COMPLEXITY

200 Boles	I D.	P.A.P. *	2700 Boles	S. O. Co.	S. O.
240	3 D.	"	2550	4	"
160	1 D.	"	2214	8	"
300	3 D.	"	2824	14	"
240	4 D.	"	2777	17	"
1200	2 H.	"	2818	18	"
928	4 H.	"	1801	23	"
228	5 D.	"	289	30	"
144	3 H.	"	189	31	"

* A Navy lease.

Note: Boles in the two columns above are opposite one another along a section line between Standard's property and the Reserve.

Naturally, ultimate production in each case of later competition should be less, and cumulative production to date indicate that they will be. It should be stressed that most of the commercial development described above was on privately owned lands outside of the Reserve and on the oil-set strip-leases issued by Navy. Most of the fee-owned land within the original boundaries of the Reserve, except for the Hay-German Area, was not developed by the private owners, thereby co-operating with the Navy's policy of conserving the Reserve as a source of oil in a future emergency. However, the detrimental effects of the competitive development and production practices occurring in the Tugman area eventually led the Government to the realization that the Reserve had to be re-leaded so as to cover the entire oil-producing strata and

that the field should be operated and developed as a unit. By an Act of Congress of 30 June 1938, all leases were terminated and action was taken to insure that the field was maintained as a Reserve. Standard was the only remaining operator in the area. As a step toward securing more information for unitization, this Company drilled thirteen exploratory wells in the area in 1941. Then followed the Presidential Decree of 15 October 1942 which extended the boundaries of the Reserve to include all sections of the Old Area and all the known productive areas of the field. The reader is referred to Chapter VI for a review of the considerations that led Navy and Standard to develop and operate all the land in the Reserve as a unit, effective from November, 1942.

DISCUSSION OF SPECIFIC PROBLEMS MENTIONED ABOVE

Initial Reservoir Conditions in the Shallow Oil Zone and Results of Production Practices Prior to Unitization. The oil in the SS-1 reservoir was probably saturated with dissolved gas at approximately the original reservoir pressure (about 1150 psi). The primary motive force to remove the oil was solution gas drive. As production proceeded, more gas was produced and reservoir pressure dropped rapidly. Gas began to fill part of the void space in the reservoir and gas caps were created. When unitization of the field finally occurred, the overall average reservoir pressure in the SS-1 was very low except in areas of active edgewater encroachment; the reservoir was unbalanced; reservoir oil had shrunk and increased in viscosity upon loss of solution gas; and relative permeability to oil had been greatly reduced. None of the produced gas was returned to the SS-1 from 1919 to 1942. The principal driving force remaining was gravity drainage.

The SS-2,M zones were initially at a similar high reservoir pressure and with an overlying gas cap. Early production methods produced several billion cubic feet of gas from a probable crestal gas cap before any significant amount of oil was produced from these combined zones. To replenish the gas cap, dissolved gas came out of solution with the oil. No attempt was made during divided or unit operation prior to January 1946 toward pressure maintenance of the gas cap by gas injection. The reservoir pressure was greatly reduced, the reservoir was unbalanced, the reduced reservoir pressure had

allowed the gas cap to expand, and a secondary gas cap was created.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

2, 104, 109, 111, 112, 118, 120, 124, 131,
134, 138, 143.

allowed the gas to expand, and a secondary gas was

created.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

- 1. 104, 108, 111, 112, 113, 123, 124, 125,
- 126, 127, 128, 129.

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2. 105, 109, 110, 114, 115, 116, 120, 121, 122, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

Part BSUMMARY OF MAJOR RESERVOIR ENGINEERING PROBLEMS
FROM NOVEMBER 1942 THROUGH DECEMBER 1945 -- THE
WAR-TIME DEVELOPMENT AND PRODUCTION PERIOD

The effective unitization of the field in November 1942 and its rapid development during 1944 and 1945, and the emergency production period during which production rose from 15,000 barrels per day to a field capacity of 71,000 barrels per day,¹⁰⁹ have been traced in Chapters III and IV.

From a practical standpoint, one engineering problem dominated all others during this period: the necessity to increase the field's production as rapidly as possible to the authorized 65,000 barrels per day in order to relieve the shortage of oil on the West Coast and thus help prosecute the war. The short time (eight months) in which the 71,000 barrel per day capacity was reached is a credit to the oil industry of California and to the engineering staff at Elk Hills composed of employees of Standard Oil Co. and members of the Navy. Also, the program more clearly defined the limits of productivity of the Shallow Oil Zone.

The heavy withdrawals of oil and gas from the Shallow Oil Zone and its intensive development during the emergency period confirmed the presence of certain undesirable reservoir features and furnished evidence of new ones. Reservoir pressure had been materially reduced (250 psi drop during the emergency period) without an effective pressure maintenance

Part 2

SUMMARY OF VALUE ENGINEERING INVESTIGATION
PHONOGRAPH RECORDS THROUGH DISCORDER 1944 - 1945
VALUE ENGINEERING AND PRODUCTION CONTROL

The effective utilization of the field in November 1944 and its rapid development during 1944 and 1945, and the emergency production period during which production was from 15,000 barrels per day to a field capacity of 71,000 barrels per day, ¹⁰⁰ have been treated in Chapters III and IV.

Thus a practical standpoint, one engineering problem dominated all others during this period: the necessity to increase the field's production as rapidly as possible to the authorized 55,000 barrels per day in order to relieve the shortage of oil on the West Coast and thus help prosecute the war. The short time (eight months) in which the 71,000 barrel per day capacity was reached is a credit to the oil industry of California and to the engineering staff at the Hills composed of employees of Standard Oil Co. and members of the Navy. Also, the program was clearly defined the limits of productivity of the Ealing Oil Zone.

The heavy withdrawals of oil and gas from the Shallow Oil Zone and the intensive development during the emergency period confirmed the presence of certain unsharable reservoir features and furnished evidence of new ones. Research has been and been materially advanced (1944) but during the emergency period) without an effective pressure maintenance

or restoration program until September 1945. The pressures in all productive sands of the Shallow Zone were unbalanced in all areas. Previously unknown secondary gas caps that were probably developed during the early days of competitive production were disclosed. Shallow Oil Zone development confirmed that the eastern part of the Old Area (Tupman) was pressure depleted, that certain areas along the north and east sides were subject to active edgewater encroachment, and that Sections 31-T and 6-M were almost completely flooded with water. More and more Shallow Zone wells along the north and east flanks were being drowned out and having to be abandoned.

During the war some produced gas was reinjected into the reservoir mainly as a conservation measure since no market existed for the gas, rather than as a repressuring attempt, the net volume injected being too small to counteract the rate of pressure decline. In September, 1945, the gas injection program was intensified. The entire gas injection program and results to 1952 are covered in a following section of this chapter.

Three other items of engineering interest during the World War II period were (1) the gas processing problem created by the large emergency production, (2) the 14-B offset drilling and production program, and (3) the helium tracer studies. These items are discussed on the following pages.

or production program until January 1944. The pressure in
 all productive fields of the shallow zone were maintained in
 all cases. Pressure was usually maintained for some time after
 production had stopped during the early days of production and
 decline was delayed. Shallow oil zone development was
 limited to the eastern part of the oil area (Tyrone) and
 pressure declined, that certain water flow the north and east
 sides were subject to active seepage. In fact, and that
 Sections 21-T and 2-N were almost completely flooded with
 water. More and more shallow zone wells along the north and
 east flanks were being drilled and being to be abandoned.
 During the war some production was restricted into
 the reservoir mainly as a consequence of pressure along an interval
 existed for the gas, rather than as a production interval.
 The reservoir interval being too small to contribute the rate
 of pressure decline. In September, 1944, the gas injection
 program was initiated. The entire gas injection program
 and results to 1952 are covered in a following section of
 this report.

There were three of engineering interest during the
 World War II period were (1) the gas processing program created
 by the late company production. (2) The 14-2 offset drill-
 ing and production program, and (3) the active process studies.
 These items are discussed in the following pages.

(1) Gas Processing: The large gas production during the emergency period presented problems in the proper processing and disposal of the gas. For example, during the peak production of 31,200 MCF per day, the gas was disposed of as follows:¹¹²

Burned as fuel for field operations	20.5%
Sold	9.0%
Injected in the Reservoir	46.4%
Vented to the Atmosphere	24.1%

As was mentioned above, the initial underlying purpose of injecting the gas was the desire to reduce the percentage of gas vented to the atmosphere. Also high gas production overloaded the facilities of the small natural gasoline plant on the Reserve, requiring some gas to be reinjected without the processing necessary to recover its liquid hydrocarbons. Relatively low gasoline recoveries were obtained with an average of only 0.75 GPM whereas wet gas analysis from wells representing all individual zones indicated that the recovery could have been about 2.50 GPM (gallons recovered per thousand cubic feet of gas), if only the butanes and heavier hydrocarbons were extracted.¹¹² Principally, as a result of the discovery and later extensive development of the Stevens Zone with an expected high rate of gas production from this zone and also from the Shallow Zone in a future emergency, and partially, as a result of the relatively low natural gasoline recovery obtained by the old plant during the World War II emergency -- a modern, efficient, natural gasoline plant of 50,000 MCF

(1) Gas Recovery The image has produced during

the recovery period presented problems in the process of
ing and disposal of the gas. For example, during the peak
production of 21,000 MCF per day, the gas was disposed of as

follows:

20.0%	Flared to the atmosphere
2.0%	Flared
68.4%	Injected in the reservoir
29.6%	Flared to the atmosphere

As was mentioned above, the initial existing purpose
of injecting the gas was the desire to reduce the percentage
of gas vented to the atmosphere. Also with the production
operations the facilities of the well natural gasline plant
on the plateau, venting some gas to be vented without
the processing necessary to recover the liquid hydrocarbons.
Relatively low gasline reservoirs were obtained with an aver-
age of only 0.75 MCF per barrel wet gas analysis from wells typi-
cally all individual zones indicated that the recovery could
have been about 2.50 MCF (California recovery per thousand cubic
feet of gas). It only the process and better hydrocarbons were
extracted. ¹¹¹ Eventually, as a result of the discovery and
later extensive development of the Eastern Gas with an ex-
pected high rate of gas production from the area and also
from the Eastern Gas in a future development, and finally, as
a result of the relatively low natural gasline recovery ob-
tained by the oil field during the 1950s and 1960s --
a modern, efficient, natural gasline plant of 50,000 MCF

capacity was built in 1952 and the old plant was modernized. The new plant (35R) is mostly in "mothballs," but it can be completely activated in about three months time.¹²⁵

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

109, 111, 112, 125, 138

capacity was built in 1902 and the old plant was modernized.
The new plant (SRR) is worth in "outlets", but it can be
completely replaced in about three months time. ISI

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

109, 111, 112, 126, 128

(2) Section 14-B Production Program

Description: This program is an offset-drilling and production project in Section 14-B on the Southwest corner of N.P.R. No. 1, as shown on Figure 5-6. The productive area is part of the Buena Vista Front Field, a separate and distinct field lying between Elk Hills to the North and Buena Vista to the south.

The productive sands are the same Scalez Sands as for the Shallow Oil Zone; but as shown by the geologic cross section of Figure 2-1 the field lies on the Buena Vista structure, not the Elk Hills structure.

This program is under Unit Operation, but it has no relation to any other program pertaining to the Reserve.

Objectives: To offset producing wells to the south and west on privately-owned lands outside of the Reserve as shown on Figure 5-6.

Pertinent Dates:

October 1945: First Production. The program was commenced after oil along the Buena Vista Front was discovered by private interests on adjacent lands. Production is expected to continue until no longer profitable which is estimated to be in 1964 with a probable recovery of 1,700,000 barrels.

Action Taken: Initially five offset wells were drilled and put in continuous production in 1945. Subsequently eight more wells were added to this production by January 1953. Well sites for at least three more wells have been selected by the Unit. It is not desirable to extend the Reserve to

(2) Section 14-2 Production Program

Reservoir: This program is an attempt to produce the project in Section 14-2 on the Government corner of N.P.H. No. 1, as shown on Figure 3-2. The production area is part of the Horns Veldt West Field, a separate and distinct field lying between the hills in the north and south sides to the north.

The productive sands are the same as those shown on the the Shallow Oil Zone; but as shown by the geologic cross-section of Figure 3-1 the field lies on the Horns Veldt stratum, not the Hillia stratum.

This program is under Unit Operation, but it has no relation to any other program pertaining to the Reservoir.

Objectives: To obtain production wells to the south and east on privately-owned lands outside of the Reserve as shown on Figure 3-2.

Production Data:

October 1940: First Production. The program was commenced after all along the Horns Veldt Front was discovered by private interests on adjacent lands. Production is expected to continue until no longer profitable which is estimated to be in 1944 with a probable recovery of 1,700,000 barrels.

Action Taken: Initially five water wells were drilled and put in continuous production in 1940. Subsequently eight more wells were added to the production by January 1943. Well sites for at least three more wells have been selected by the Unit. It is not desirable to expand the Reserve to

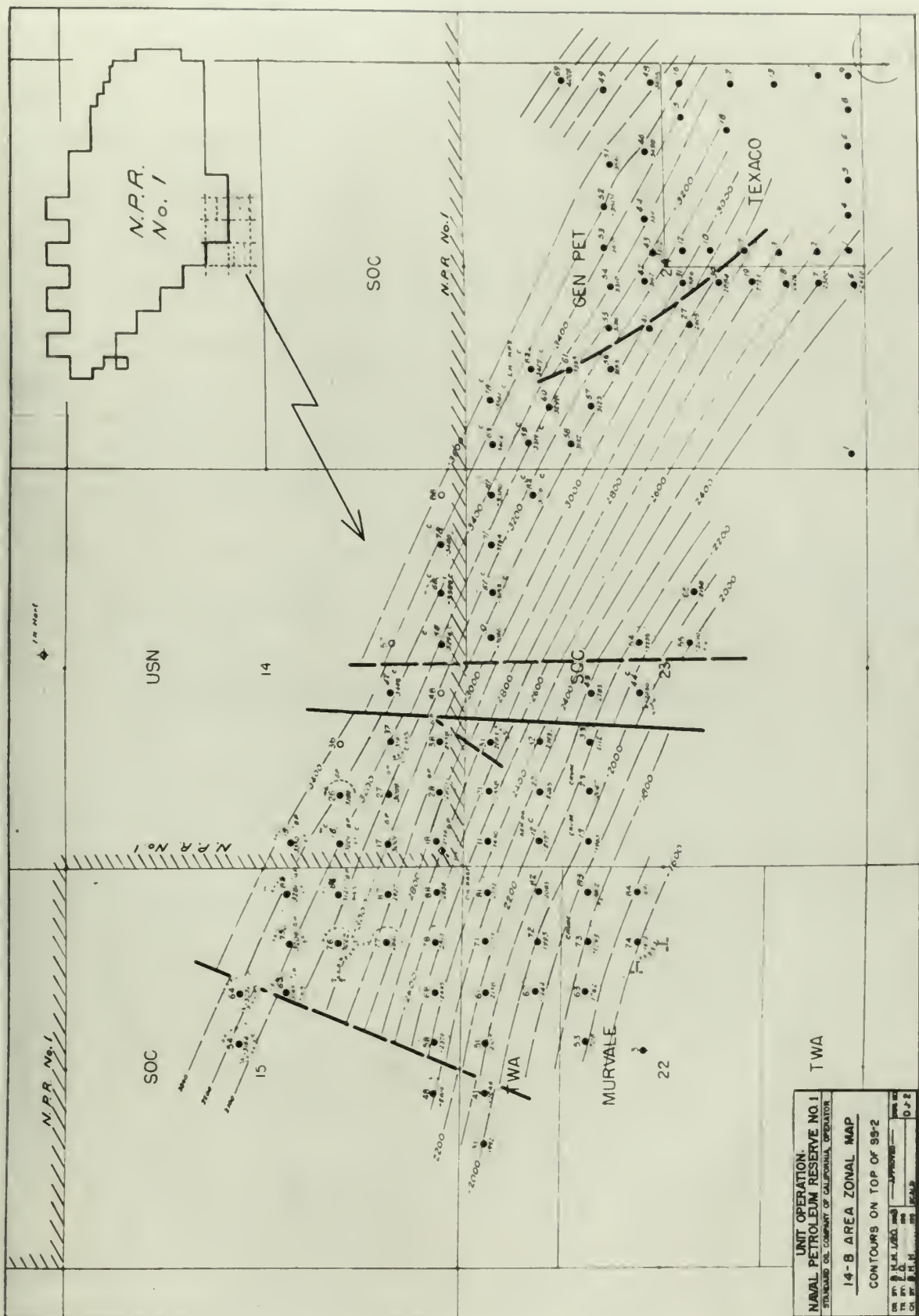


FIG. 5-6, Showing Section 14-B Production Area of N.P.R. No. 1. Production is From the Buena Vista Front Field

include all of the Buena Vista Front structure because the production and reserves from the whole area are relatively minor and Navy's share is relatively small. Being down-structure, Navy is in a relatively good position to produce its full share of oil.

Results:

1. Continuous production from Section 14-B since 1945 has given a cumulative recovery of 1,161,921 barrels by 1 January 1954.

2. Refer to Chapter III for yearly production values from 1945 through 1953.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

include all of the areas from which the
 production and reserves from the wells are relatively
 minor and they are relatively small. Being down-
 structures, they are in a relatively good position to produce
 the full share of oil.

Results:

1. Cumulative production from Section 14-8 since 1952
 has given a cumulative recovery of 1,181,921 barrels by 1
 January 1954.
2. Refer to Chapter III for yearly production values
 from 1946 through 1953.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

(3) Helium Tracer Studies in Elk Hills Field:¹¹⁰

Description: Upon request of the Navy Department for assistance in connection with a gas injection program during the emergency production from the field in 1945, the Bureau of Mines conducted helium tracer studies in a fault-block area of the Shallow Oil Zone as shown on Figure 5-7. Small percentages of helium were mixed with natural gas being pumped into Well 76-33-S, which was open to both the SS-1 and SS-2 sands. Movement of the injected gas was then traced by taking samples of produced gas from surrounding wells in an ever-increasing circle and subjecting the samples to an apparatus capable of determining minute quantities of helium at helium content percentages as low as 0.0001 per cent.

Objectives:

1. To determine the direction and extent of migration of injected gas in the fault-block area of the Shallow Oil Zone shown on Figure 5-7.
2. To determine the actual competency of faults previously judged by other methods of field analysis to be fluid barriers.

Inclusive Dates: May 25, 1945 until August 1945. The program was discontinued as a result of V-J Day, when sharp curtailment of production prevented continuing the studies effectively.

Procedure Employed: Helium was added to the injected gas in two distinct periods of 14 days and 30 days duration, separated by a period of no helium injection for 18 days.

(3) Helium Tracer Studies in the Field

Location: Upon request of the Navy Department for

assistance in connection with a gas injection program during

the emergency production from the field in 1945, the

of which conducted helium tracer studies in a fault-block

area of the Shallow Oil Lake as shown on Figure 3-7. Well

percentages of helium were mixed with natural gas being pumped

into Well 78-33-2, which was used for both the 33-1 and 33-3

and. Movement of the injected gas was then traced by taking

samples of produced gas from surrounding wells in an ever-

increasing circle and analyzing the samples to an accuracy

capable of determining minute quantities of helium at helium

content percentages as low as 0.0001 per cent.

Objectives:

1. To determine the direction and extent of migration

of injected gas in the fault-block area of the Shallow Oil

Lake shown on Figure 3-7.

2. To determine the actual competency of faults previ-

ously judged by other methods of field analysis to be fluid

barriers.

Inclusive Dates: May 25, 1945 until August 1945. The

program was discontinued as a result of V-J Day, when sharp

curtailment of production prevented continuing the studies

effectively.

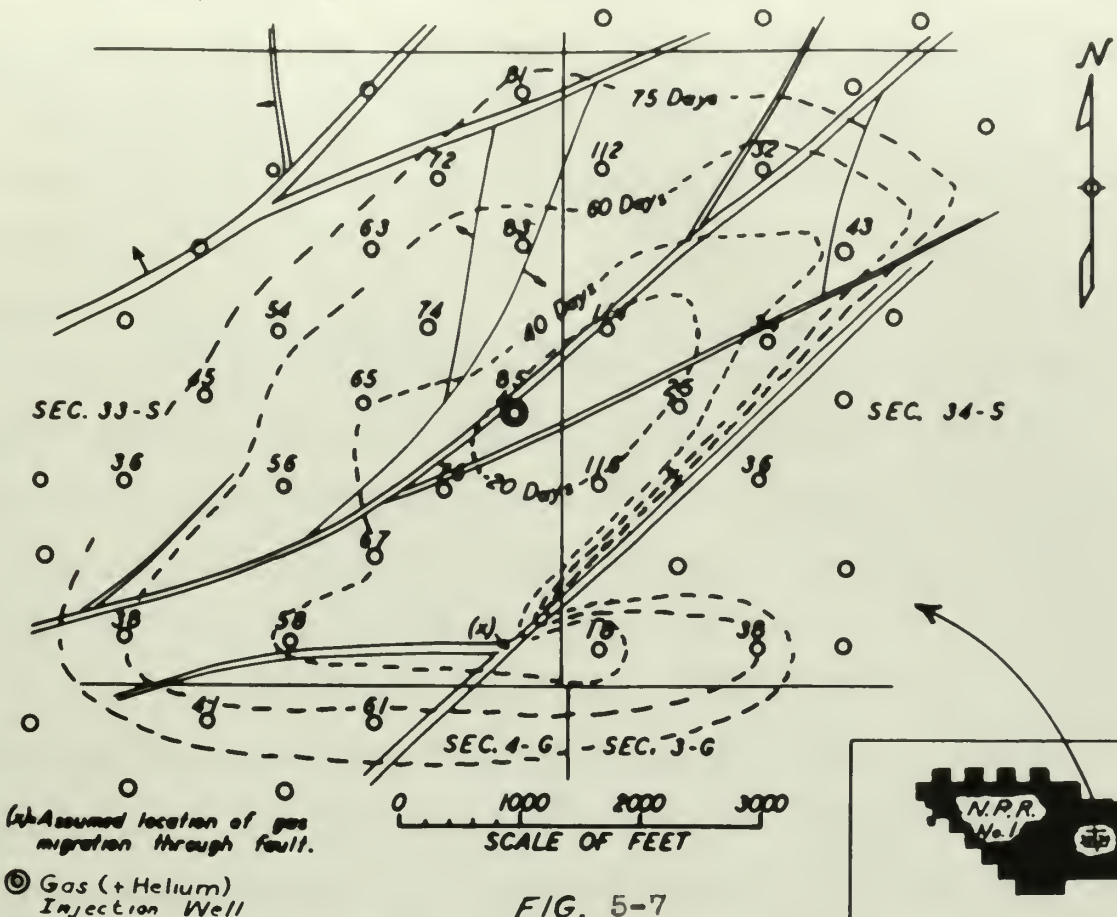
Procedure Employed: Helium was added to the injected

gas in two distinct periods of 15 days and 30 days duration,

separated by a period of no helium injection for 15 days.

HELIUM TRACER STUDIES

BuMines R.I. 3897, June 1946



Dotted Lines Above Show the Direction and Extent of Migration of Helium-Laden Injected Gas at the End of Each Period.

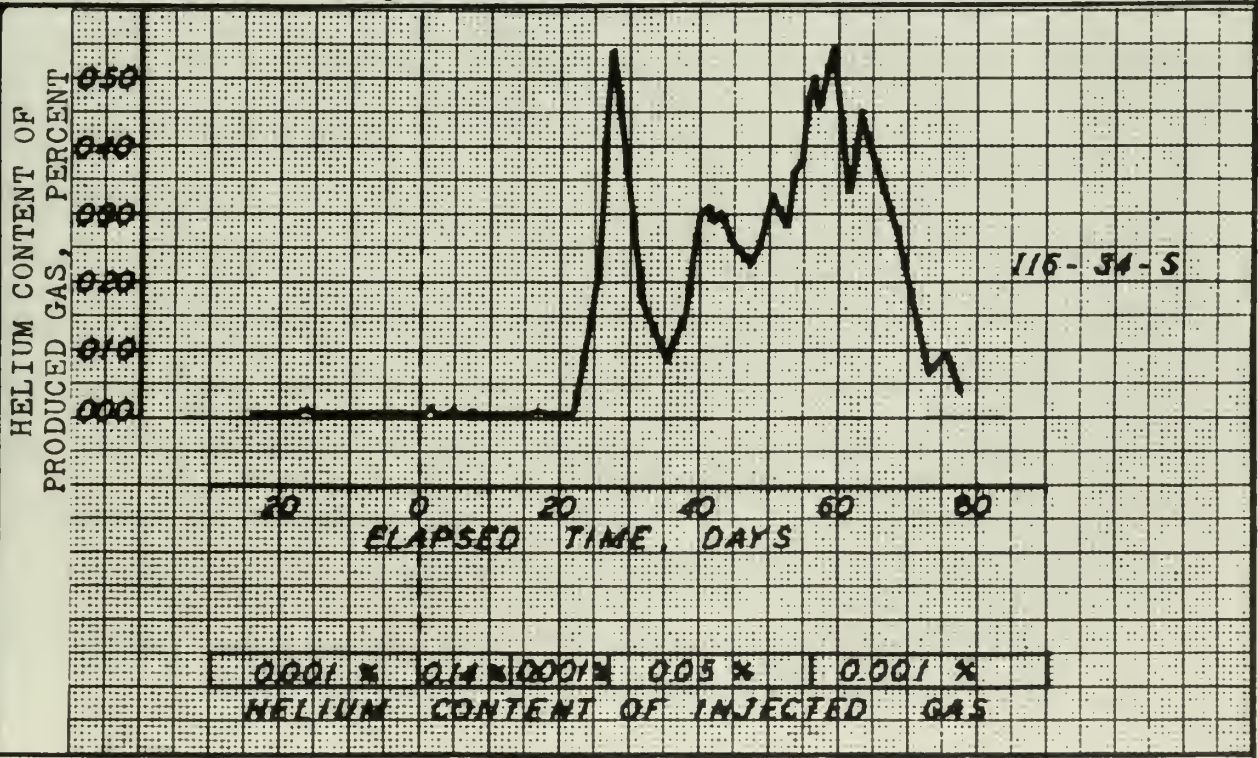


FIG. . Typical Results Obtained in Helium Tracer Study, Showing the Advance of Helium-Laden Gas Past An Observation Well. (Reprinted from BuMines Report of Investigations 3897).

Samples were collected and analyzed from nearby wells; and as the helium appeared in these wells, additional wells at a greater distance from the injection well were selected for sampling and analysis.

Results:

1. By plotting helium content in the gas of each well against elapsed time of helium injection into the reservoir, as shown on Figure 5-8, it was possible to obtain a plot showing movement of injected gas throughout a large area. This latter plot is superimposed on the map of Figure 5-7.

2. Some faults -- established by electric log correlations, drilling records, and bottom-hole pressure surveys and presumed to be competent fluid barriers -- were shown to be incompetent, especially at probable areas of extensive fracturing where faults cross. An example of a fault leak is marked (x) on Figure 5-7.

3. The information obtained enabled the field engineers to improve the gas injection pattern.

Discussion:

Not enough time elapsed between the two periods of helium injection to permit differentiation between the results obtained from the first run of gas and the results from the second run of gas. An appreciably longer time interval would be necessary in any future studies.

With the data obtained from this study, Bureau engineers are attempting to determine the characteristics of the flow

samples were collected and analyzed from nearby wells; and as the well recovered in some wells, additional wells at a greater distance from the injection well were included for sampling and analysis.

Results:

1. By plotting well content in the gas of each well against elapsed time of helium injection into the reservoir, as shown on Figure 2-5, it was possible to obtain a plot showing movement of injected gas throughout a large area. This latter plot is superimposed on the map of Figure 2-7.

2. Some wells -- established by electric log correlations, drilling records, and bottom-hole pressure surveys and presumed to be equivalent field barriers -- were shown to be independent, especially of probable areas of extensive fracturing where faults occur. An example of a fault leak is marked (A) on Figure 2-7.

3. The information obtained enabled the field engineers to improve the gas injection pattern.

Discussion:

Not enough time elapsed between the two periods of helium injection to permit differentiation between the results obtained from the first run of gas and the results from the second run of gas. An undoubtedly longer time interval would be necessary in any future studies.

With the data obtained from this study, reservoir engineers are attempting to determine the characteristics of the flow

of gases through underground reservoirs and into well bores.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

of cases through underground reservoirs and into well boxes.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

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Part CSUMMARY OF RESERVOIR ENGINEERING PROBLEMSDURING THE POST-WAR PERIOD, 1945-1953

In August 1945, following the end of World War II, the emergency development and production program at Elk Hills was halted except for an Exploratory Drilling Program on the Reserve which was continued. Upon orders of the Secretary of the Navy, production was reduced from 65,000 barrels per day to 15,000 barrels per day and later reduced to even lower rates.

The war-time necessity for rapid development and high production was succeeded by the problem of restoring the Reserve to the best reservoir conditions possible, i.e., to a state that would permit a maximum rate of production in the event of another emergency with a minimum of production in the interim. If we may consider the Reserve as a ship, it was to be placed in the best condition possible, decommissioned and placed in moth-balls, subjected to constant inspection and testing by a caretaker crew, and maintained in a state of material readiness such that upon notice it could be placed in full operation within a minimum of time.

To accomplish the above general objective for the Reserve, the Unit commenced a State of Readiness Program for the Shallow Oil Zone late in the year 1945. Insufficient reservoir information was available upon which a rigid operating policy could be based, and it was necessary for

REPORT ON RESERVE OIL PROGRAM
PERIOD FROM 1943 TO 1945

In August 1945, following the end of World War II, the emergency development and production program at Wix Hills was halted except for an Exploratory Drilling Program on the Reserve which was continued. Upon orders of the Secretary of the Navy, production was reduced from 10,000 barrels per day to 15,000 barrels per day and later reduced to even lower rates.

The war-time necessity for rapid development and high production was succeeded by the problem of restoring the Reserve to the best possible conditions possible, i.e., to a state that would permit a maximum rate of production in the event of another emergency with a minimum of production in the interim. It was considered the Reserve as a ship, it was to be placed in the best condition possible, decommissioned and placed in moth-balls, subjected to constant inspection and testing by a caretaker crew, and maintained in a state of material readiness such that upon notice it could be placed in full operation within a minimum of time.

To accomplish the above general objective for the Reserve, the War Relocation Authority of Hawaii Program for the Shallow Oil Zone late in the year 1945. Investigative research information was available upon which a rigid operating policy would be based, and it was necessary for

the Program to include experimental production projects to yield this information. This program for the Shallow Oil Zone only -- formulated by the Operating Committee and concurred in by the Engineering Committee -- consisted of eight inter-related projects:

1. Gas Injection
2. Major Water Encroachment Study
3. Minor Water Encroachment Study
4. Dewatering and Gravitational Drainage Study
5. Rotating Production Tests
6. Protective Production of Wet Wells
7. Remedial Program (started September 8, 1946)
8. Protection of Surface Equipment

The project areas for the first four projects listed above are shown on Figure 5-9.¹³⁸ These four projects, the most important and most interesting from a reservoir engineering viewpoint, are treated in some detail in succeeding sections of this chapter. The other four are described but are not discussed in any detail. An excellent graphical summary of the principal events and important dates relative to each project under this Program was presented in the Engineering Committee's Review of the Program and is reproduced here as Figure 5-10.¹³⁸

The Operating Committee served as the supervisory body for the Program. The Engineering Committee served as the advisory group, reviewing all phases of the Program at least once each quarter, and recommending changes in the Program

The program to include experimental production projects in this area. This project for the Station III Zone only -- formulated by the Operating Committee and approved in by the Engineering Committee -- consisted of eight inter-

- related projects:
1. Gas Injection
 2. Major Water Encroachment Study
 3. Minor Water Encroachment Study
 4. Dewatering and Geostatical Drainage Study
 5. Wellbore Production Tests
 6. Protective Protection of Wet Wells
 7. Remedial Program (started September 2, 1948)
 8. Protection of Surface Equipment

The project areas for the first four projects listed above are shown on Figure 8-2. ¹²⁸ These four projects, the

most important and were investigated from a reservoir engineer-
ing viewpoint, are treated in some detail in succeeding sec-
tions of this chapter. The other four are described but are
not discussed in any detail. An excellent graphical summary
of the principal events and important data relative to each
project under this program are presented in the Engineering

Committee's Review of the Program and is reproduced here as
Figure 8-10. ¹²⁸

The Operating Committee acted as the supervisory body
for the program. The Engineering Committee served as the ad-
visory group, reviewing all phases of the program at least
once each quarter, and recommending changes in the program

as deemed necessary by the Unit and concurred in by the Committee.

The Stevens Zone was never included in the State of Readiness Program described above for the Shallow Zone. There was no need; for the Stevens was still essentially a virgin reservoir, virtually unaffected by the small production from its few wells drilled prior to unitization and not subjected to any of the ills besetting the Shallow Oil Zone. The post-war program for the Stevens Zone consisted mainly of an exploratory program followed by a development program, the initial production testing of each new well for 30 days after completion and the maintenance of its wells for full production in an emergency.

Running concurrently with the State of Readiness Program for the Shallow Zone were the Exploratory and Readiness Development Programs, affecting both the Shallow and Stevens Zones and, upon discovery, the deep Carneros Zone.

In summary, the main producing zones and the different programs applicable to each during this post-war period, 1945 through 1952, are tabulated below:

Shallow Oil Zone (A Unit Operation)

1. State of Readiness Program -- Sept. 1945 to 1953.
 - a. Gas injection
 - b. Water Encroachment
 - c. Etc. See Figure 5-10.
2. Exploratory Development Program -- 5 July 1945 to October 1947. (Mostly South Flank)

as deemed necessary by the Unit and concerned in by the Committee.

The Stevens Zone was never included in the State of Readiness Program described above for the Shallow Zone. There was no need; for the Stevens was still essentially a virgin reservoir, virtually unaffected by the seal production from its few wells drilled prior to maturation and not subjected to any of the lifts besetting the Shallow Oil Zone. The post-war program for the Stevens Zone consisted mainly of an exploratory program followed by a development program, the initial production testing of each new well for 60 days after completion and the maintenance of its wells for full production in an emergency.

Running concurrently with the State of Readiness Program for the Shallow Zone were the exploratory and Readiness Development Programs, affecting both the Shallow and Stevens Zones and, upon discovery, the Deep Carnation Zone. In summary, the main producing zones and the different programs applicable to each during this post-war period, 1945 through 1952, are tabulated below:

Shallow Oil Zone (A Unit Operation)

1. State of Readiness Program -- Sept. 1945 to 1952.
 - a. Gas Injection
 - b. Water Displacement
 - c. Etc. See Figure 2-10.
2. Exploratory Development Program -- 5 July 1945 to October 1947. (Mostly South Flank)

3. Readiness Development Program -- 1951 to 1954.
4. Equipment Maintenance Program.

Stevens Zone (A Unit Operation)

1. Rotating Production Tests
2. Exploratory Program (Unit) -- 1946 to 1947.
3. Readiness Development Program (Navy) -- 1948 to April 1954.
4. Equipment Maintenance Program

Carneros Zone (Navy Only)

1. Deep Test Exploratory Drilling. Two (2) wells completed in Carneros by 1954.
2. Equipment Maintenance Program

Section 14-B -- Buena Vista Front (A Unit Operation)

1. Offset-Drilling Development Program
2. Protective Production Program
3. Equipment Maintenance Program

The individual projects or studies under the State of Readiness Program for the Shallow Oil Zone from 1945 to 1953 are discussed separately on the following pages.

3. Readiness Development Program -- 1951 to 1954.
4. Equipment Maintenance Program.

Section 1-2 (A Unit Operation)

1. Readiness Development Tests
2. Readiness Development Program (Unit) -- 1951 to 1954.

3. Readiness Development Program (Nav) -- 1951 to April 1954.

4. Equipment Maintenance Program

Section 1-3 (Nav Only)

1. Deep Test Exploratory Drilling. Two (2) wells completed in October of 1954.

2. Equipment Maintenance Program

Section 1-4 (A Unit Operation)

1. Offshore Drilling Development Program

2. Protective Production Program

3. Equipment Maintenance Program

The individual projects or studies under the steps of Readiness Program for the Shellow Oil Zone from 1943 to 1953 are discussed separately on the following pages.

Section 1-5 (A Unit Operation)

Gas Injection Project

Description:

This project consisted of the reinjection of produced gas from the Shallow Oil Zone and/or the Mya Dry Gas Zone into primary crestal and secondary gas caps of particular members of different productive sands comprising the Shallow Oil Zone.

During the emergency period of World War II, practically all of the gas injected was into the SS-1 sand; after the war, into the SS-2 and M sands.

Figure 5-11 shows the area of the primary gas cap and the various injection wells. ¹¹³

Objectives:

Primary Objective

1. To restore and maintain the pressure within certain areas and sands (mainly the SS-2 and M sands) to at least the pressures existing prior to the heavy World War II emergency withdrawals in order to
 - a. Increase the oil productive capacity of this Zone in event of another emergency.
 - b. Increase the ultimate oil recovery.
 - c. Stop water encroachment on the north flank and east nose of the SS-2 and M sands.
 - d. Stop edgewater encroachment in the SS-2 and M sands of the south flank in Sections 1-B, 4-G, 5-G, 6-G.

The prewar crestal gas-cap pressures were about 800 to 850 psi.

Gas Injection Project

Description:

This project consisted of the injection of produced gas from the Shallow Oil Zone and/or the Dry Gas Zone into primary vertical and secondary gas caps of particular members of different productive sands comprising the Shallow Oil Zone. During the emergency period of World War II, practically all of the gas injected was into the S-1 sand; after the war, into the S-2 and S sands. Figure 2-11 shows the area of the primary gas cap and the various injection wells.

Objectives:

Primary Objective

1. To restore and maintain the pressure within certain areas and sands (mainly the S-2 and S sands) to at least the pressure existing prior to the heavy World War II emergency withdrawals in order to
 - a. Increase the oil productive capacity of this zone in event of another emergency.
 - b. Increase the ultimate oil recovery.
 - c. Stop water encroachment in the north flank and east nose of the S-2 and S sands.
 - d. Stop edge-water encroachment in the S-2 and S sands of the south flank in sections 1-8, 4-8, 5-8, 6-8.

The primary vertical gas-cap pressures were about 200

Secondary Objectives

1. To conserve the gas produced under the State of Readiness Program.
2. To reduce future production costs.

Pertinent Dates:

1. January to October, 1945: initial period of gas injection to decrease the reservoir pressure decline and to conserve excess casinghead gas.
2. October 1945 to June 1952: period of intensified gas injection into the crestal SS-2, M gas caps under the State of Readiness Program; however, this pressure-restoration program was not effectively commenced until 28 January 1946.
3. September 1950 to June 1951: period of gas injection in Well 88-28S into a secondary gas cap within a fault block on the North flank. The injection well is indicated on Figure 5-11; the secondary gas cap is not shown.
4. October 1950 to February 1952: period of gas injection in well 77-2G into a secondary gas cap of the SS-2 sand near the Southeast end of the south flank.
5. June 1952: All gas injection terminated by the Engineering Committee. 138

Action Taken:

The three major divisions of the gas injection program in Elk Hills were the crestal gas cap injection and the two flank or secondary gas cap injections. These are discussed below.

Crestal Gas-Cap Injection

1. Over 1,700 M c.f. of produced gas, mostly excess

Secondary Objectives

- 1. To conserve the gas produced under the State of Readiness Program.
- 2. To reduce future production costs.

Pertinent Dates:

1. January to October, 1945: Initial period of gas injection to decrease the reservoir pressure decline and to conserve excess casinghead gas.

2. October 1945 to June 1952: period of intensified gas injection into the crestal 22-2, B gas caps under the State of Readiness Program; however, this pressure-restoration program was not effectively commenced until 23 January 1946.

3. September 1950 to June 1951: period of gas injection in Well 22-2B2 into a secondary gas cap within a fault block on the North flank. The injection well is indicated on Figure 2-11; the secondary gas cap is not shown.

4. October 1950 to February 1952: period of gas injection in well 77-2G into a secondary gas cap of the 20-2 sand near the Southeast end of the south flank.

5. June 1952: All gas injection terminated by the Engineering Committee. 138

Action Taken:

The three major divisions of the gas injection program in Elk Hills were the crestal gas cap injection and the two flank or secondary gas cap injections. These are discussed below.

Crestal Gas-Cap Injection

1. Over 1,700 M c.f. of produced gas, mostly excess

casinghead gas produced with the oil from the Shallow Oil Zone, was injected from March to September 1945 into nine crestal gas-cap wells to conserve gas and reduce the rate of reservoir pressure decline. Injection wells during this initial period were:¹¹²

SS-1 Sand	76-2G 3K-3G 17-34S 15XB-34S
SS-1 and SS-2 Sands	85-33S 36-34S
SS-2-M Sand	68-31S 37-32S

2. In January 1946 under the State of Readiness Program an intensified crestal gas injection project was commenced. At rates varying from less than 1,000 M c.f. to over 10,000 M c.f. of gas a day, as shown on Figure 5-12,¹¹³ gas was injected into the crestal gas-cap area of the SS-2,M Sand until June 1952, when all gas injection was abandoned. Injected gas was composed mostly of dry gas from the Mya sands supplemented by some gas produced with the oil from the Shallow Oil Zone. Injection wells used at various times were:

SS-1 Sand	15XB-34S (discontinued after a few months)
SS-2 M Sands	68-31S 34-32S 37-32S 32-5G 84-31S

Total gas injected into the Shallow Oil Zone from January 1945 to August 1951 was about 14,578.5 MMCF.¹¹² Most of the gas was injected directly into the SS-2 and M sands,

oil from the shallow oil zone
 was injected from March to September 1946 into five existing
 gas-cap wells to conserve gas and reduce the rate of reservoir
 pressure decline. Injection wells during this initial period
 were: 112

- 22-1 Sand
- 22-2 Sand
- 22-3-M Sand

2. In January 1946 under the State of Redness Program
 an installed special gas injection project was commenced.
 At rates varying from less than 1,000 M c.f. to over 10,000 M
 c.f. of gas a day, as shown on Figure 2-12, 112 gas was injected
 into the special gas-cap area of the 22-2, M Sand until June
 1952, when all gas injection was abandoned. Injected gas was
 composed mostly of dry gas from the dry sands supplemented by
 some gas produced with the oil from the shallow oil zone. In-
 jection wells used at various times were:

- 22-1 Sand
- 22-2 M Sand

Total gas injected into the shallow oil zone from
 January 1946 to August 1951 was about 14,378.8 MCF. 112
 of the gas was injected directly into the 22-2 and 2 sands,

but migration of the gas definitely occurred between sands.

Gas Injection on the North Flank

For nine months, commencing in September 1950, gas was injected near the top of the fault block surrounding Well 88-28S, one of the wells used for injection, in an attempt to increase the pressure in the gas and oil bands to an amount equal to the pressure of the encroaching edgewater. The area and Well 88 are shown on Figure 5-11.

Gas Injection on the South Flank

For seventeen months, commencing in October 1950, gas was injected into a fault-isolated body of the SS-2 sand through Well 77-2G on the Southeast flank of the field. The purpose was to raise the pressure in the gas and oil belts and retard the rapid and damaging movement of water upstructure.¹³⁸

The effects of these programs are discussed below under Results.

Alternate Actions Proposed:

1. Increased Gas Injection

During the period of gas injection the question often arose as to whether the rate and volume of gas injected should be greatly increased if the program were to be successful at all in retarding edgewater advancement and raising field's productive capacity. In August 1951, in answer to a request from the DNPR, Navy's member of the Operating Committee issued a report discussing the feasibility of increased gas injection to level off pressure gradients and permit reduction of large peacetime production from wet wells. Theoretically, increased

one injection of gas per day initially occurred between wells.

Gas Injection on the North Flank

For nine months, commencing in September 1950, gas was injected near the top of the fault block surrounding Well 88-202, one of the wells used for injection, in an attempt to increase the pressure in the gas and oil bands to an amount equal to the pressure of the surrounding seawater. The results and Well 88 are shown on Figure 5-11.

Gas Injection on the South Flank

For seventeen months, commencing in October 1950, gas was injected into a fault-isolated body of the 88-2 sand through Well 77-10 on the southeast flank of the field. The purpose was to raise the pressure in the gas and oil bands and retard the rapid and damaging movement of water out of the field. The effects of these programs are discussed below under

Results.

Alternative Action Proposed:

1. Increased Gas Injection

During the period of gas injection the question often arose as to whether the rate and volume of gas injected should be greatly increased if the program were to be successful at all in retarding seawater advancement and raising field's productive capacity. In August 1951, in answer to a request from the OMR, Navy's member of the Operating Committee issued a report discussing the feasibility of increased gas injection to level off pressure gradients and thereby reduction of large positive production from wet wells. Theoretically, increased

gas injection should raise the reservoir pressure to equal the edgewater pressure, and productive capacity of the field should be increased.

Basing his predictions on the results of the gas injection project up to August 1951, NMOC reached the following conclusions;¹⁰⁸

- a. Large scale gas injection was not desirable. The volume of gas required was excessive and would only tend to leak off more rapidly to lower pressure sands. Instead of reducing oil production during peacetime, increased gas injected would necessitate increased production of more observation wells in order to watch the progress of an intensified gas injection program.

Also, severe fingering of gas already was damaging the productivity of many wells. Adverse pressure gradients would be increased.

- b. Except for certain areas, it would be difficult to raise reservoir pressure sufficiently to match edgewater pressure, the reason being that few areas were competently separated from other lower pressure areas or sands by faults or other barriers. The exception was the gascap in the SS-2, M sands where productive capacity might be increased at a loss of ultimate recovery due to the aggravation of the pressure gradient promoting oil migration along the south flank downstructure into the grey sands.

gas injection would raise the reservoir pressure to equal the
advisable pressure, and production capacity of the field should
be increased.

Based on the conditions on the basis of the gas in-
jection project up to August 1951, WMOG reached the following
conclusions:¹⁰⁸
1. Large scale gas injection was not desirable. The
volume of gas required was excessive and would only
tend to leak off very rapidly to lower pressure
bands. Instead of reducing oil production during
periods, increased gas injection would necessitate
increased production of some observation wells in
order to obtain the pressure of an industrial gas
injection program.

Also, severe thinning of gas already was
damaging the productivity of many wells. Adverse
pressure gradients would be increased.
b. Except for certain areas, it would be difficult to
raise reservoir pressure sufficiently to reach edge-
water pressure, the reason being that low stress
zones were completely separated from other lower pressure
zones or areas by faults or other barriers. The
exception was the gas in the 25-2, W sands, where
the productive capacity might be increased at a loss of
ultimate recovery due to the expansion of the
pressure gradient promoting all fractures along the
south flank downgradient from the gas sands.

- c. Loss of production from wells added to or near to the gas cap due to excessive gas/oil ratios would occur.
- d. It would not be possible to repressure to the extent desired due to connection of sands through well bores and faults, insufficient retaining force on the south flank, and possible disastrous effects of high pressure on old wells with weak, lap-welded casing.

NMOC then recommended continuation of the limited gas injection project increasing reservoir pressure without conflicting with good engineering practices. He also suggested the drilling of additional edgewater wells on the north flank to increase the withdrawal rate of encroaching water, possibly concurrently with limited gas injection in adaptable areas to help balance the pressure gradient.

2. Increased Gas Injection Combined with South Flank Water-Injection

Another alternate action was to combine an increased gas injection program into the SS-2,M sands with a drilling program along the edgewater of the north flank to provide a greater production of water and a drilling program along the edgewater of the south flank to provide injection wells for injecting the high-pressure water produced on the north flank. At the same time it was proposed to carry out an extensive well-corrective program to segregate the different sands of the Shallow Zone.

Theoretically, the above idea is sound; for reservoir

... loss of production from wells added to or near to the
 gas cap to excessive gas flow would occur.
 It would not be possible to respond to the extent
 desired due to connection of sands through well
 bore and casing, insufficient retaining force on
 the south flank, and possible disastrous effects of
 high pressure on old wells with weak, lap-welded
 casing.

INCO then recommended continuation of the limited gas
 injection project increasing reservoir pressure without con-
 flicting with good engineering practices. It also suggested
 the drilling of additional edge-water wells on the north flank
 to increase the withdrawal rate of encroaching water, possibly
 concurrently with limited gas injection in suitable areas to
 help balance the pressure gradient.

S. Increased Gas Injection Combined with
South Flank Water-Injection

Another alternate action was to combine an increased gas
 injection program into the 33-S, W sands with a drilling program
 along the edge-water of the north flank to provide a greater
 production of water and a drilling program along the edge-water
 of the south flank to provide injection wells for injecting
 the high-pressure water produced on the north flank. At the
 same time it was proposed to carry out an extensive well-
 corrective program to segregate the different sands of the
 Shallow Zone.

Theoretically, the above idea is sound; for reservoir

potential energy in the form of high pressure gas and water could be retained, reservoir pressure would be increased, field's productive capacity and ultimate recovery should increase, and undesirable pressure gradients should be eliminated. Moreover, effective use of gas cap expansion and natural water-drive would be possible to raise the ultimate recovery of oil.

However, actual conditions in the reservoir and practical and economic reasons to date have prevented the application of this solution to the ills of the Shallow Oil Zone. It would be very expensive and the outcome doubtful. However, certain phases of this program are currently being accomplished, and a later engineering study may prove the entire program outlined above economically feasible.

Results of the Actual Program

1. Beneficial

- a. In the westernmost area of the SS-2,M Sand, pressure losses which occurred during heavy wartime withdrawals were restored mainly by gas injection into well 84-31S and pressure differential between north and south flanks practically equalized, thus necessitating a minimum amount of oil production from wet-wells.
- b. An over-all gain in current availability of the field had occurred, judging by the effect of the gas injection on productivity of all wells affected

potential energy in the form of high pressure gas and water could be retained, reservoir pressure would be increased, field's productive capacity and ultimate recovery would increase, and substantial pressure gradients should be eliminated. Moreover, effective use of gas cap expansion and natural water-drive would be possible to raise the ultimate recovery of oil.

However, actual conditions in the reservoir and production and economic reasons to date have prevented the application of this solution to the field at the Shell Oil Dome. It would be very expensive and the outcome doubtful. However, certain phases of this program are currently being accomplished, and a later engineering study may prove the entire program outlined above economically feasible.

Results of the Actual Program

1. Reservoir

- a. In the westernmost area of the 25-2, 25-2nd, pressure losses which occurred during heavy water injection draws were restored mainly by gas injection into well 25-212 and pressure differential between north and south flanks practically equalized, thus necessitating a minimum amount of oil production from wet-wells.
- b. An over-all gain in current productivity of the field had occurred, judging by the effect of the gas injection on productivity of all wells affected

by the gas injection.

- c. Raised the over-all reservoir pressure in the SS-2, M sands, as shown on Figure 5-12.

2. Detrimental or Unsuccessful Results

- a. Uneven gas cap expansion with extensive gas fingering through the more permeable members had occurred, with gas capturing too many clean wells.
- b. In all cases except one (Well 84-31S injection), gas injection had failed to stop the encroachment of high pressure edgewater on the north and east flanks, mainly because not enough gas was injected to raise the gas-oil pressure to match the hydrostatic pressure behind the edgewater.
- c. Aggravated the pressure-gradients tending to promote migration and possible loss of oil into the low-pressure, receding edgewater sands on the south flank, thus reducing ultimate recovery of oil.
- d. Great leakage of injected gas (approximately 3500 M.c.f. per day) occurs from the areas and sands (SS-2 and M) into which the gas is injected. This leakage occurs through incompetent faults and wellbores to lower pressure areas and sands (such as to the SS-1 Sand to the east) where additional gas and increased pressure are not necessarily desired, increasing the gas/oil ratio of many wells and lowering their productive capacity. This leakage is

of the gas injection;

4. Based on the overall reservoir pressure in the 22-1, 2

well, as shown on Figure 2-13.

2. Determination of Reservoir Pressure

3. However gas cap expansion with increasing gas finger-
ing through the more permeable members has occurred,
with gas capturing, too many cases wells.

4. In all cases except one (Well 24-313 injection),

the injection had failed to stop the encroachment
of high pressure edge water on the north and east
flanks, which became too much for the injected
to raise the gas-oil pressure to match the dynamic
reservoir pressure during the edge water.

5. Depressed the pressure gradient leading to possible

alteration and possible loss of oil into the low-
pressure, resulting edge water banks on the south
flank, thus reducing ultimate recovery of oil.

6. Great leakage of injected gas (approximately 2000
M.c.f. per day) occurs from the space and gas
(22-2 and 2) into which the gas is injected. This
leakage occurs through incompetent laminae and well-
bores to lower pressure areas and sands (such as to
the 22-1 sand to the east) where additional gas and
increased pressure are not necessarily desirable, in-
creasing the gas/oil ratio of many wells and lower-
ing their productive capacity. This leakage is

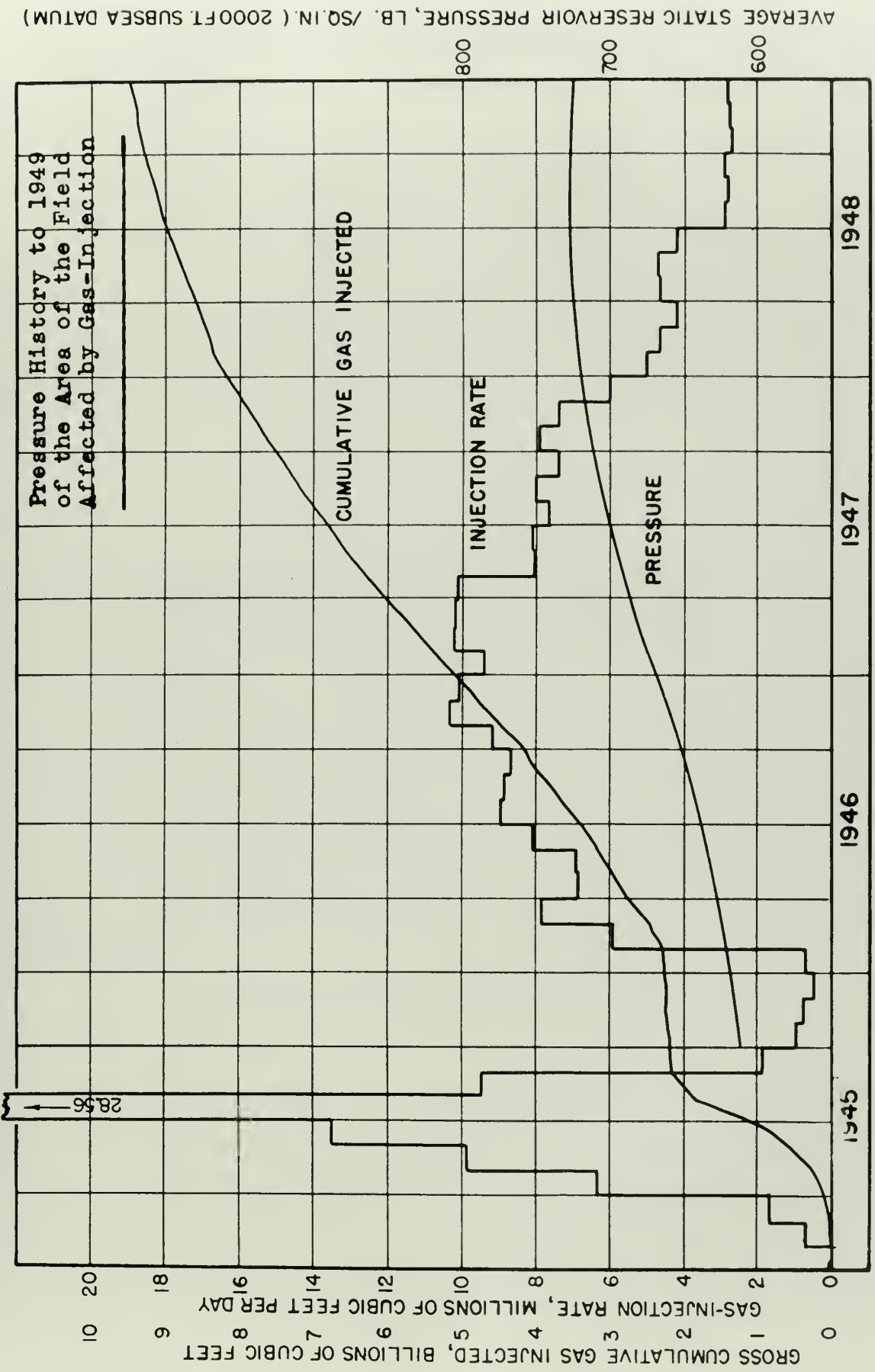


Figure 5-12. Curves showing effect of gas injection on reservoir static pressure, Shallow zone, Elk Hills field, Kern County, Calif. (Reprinted from BuMines Report of Investigations 4886).

AVERAGE STATIC RESERVOIR PRESSURE, LB./SQ. IN. (2000 FT. SUBSEA DATUM)

indicated on Figure 5-12 by the drop in reservoir pressure about June 1948 when the injection rate dropped below 3500 M.c.f. per day.

3. Cumulative Effects and Resultant Action

With the cumulative effects of the gas injection program tending to promote losses in maximum economic ultimate recovery and future availability of oil from the Shallow Oil Zone, the gas injection project was terminated in June 1952.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

108, 109, 110, 112, 113, 122, 125, 135,
138.

indicated on Figure 5-12 by the drop in reservoir pressure about June 1982 when the injection rate dropped below 3500 M.c.f. per day.

3. Cumulative Effects and Reservoir Action

With the cumulative effects of the gas injection program tending to promote losses in maximum economic ultimate recovery and future availability of oil from the Shallow Oil Zone, the gas injection project was terminated in June 1982.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

108, 109, 110, 112, 113, 122, 123, 135,

138.

MAJOR WATER ENCROACHMENT STUDYDescription:

This study formed a part of the State of Readiness Program for the Shallow Oil Zone following World War II. The study involved virtually shutting-in for a long period of 12 to 18 months most of the wells in an area relatively isolated and delineated by parallel and intersecting faults from the rest of the field. The area selected, shown on Figure 5-13,¹¹³ was one subjected to a high pressure edgewater encroaching up-structure from the North. During the shut-in period the only production consisted of reduced production from several up-structure observation wells to obtain necessary reservoir information.

Sands primarily affected by the study were the SS-1 and SS-2. However, a few new wells in the fault-block are completed in the M and SM sands.

Pertinent information on the fault-block is listed between Figures 5-13 and 5-14.

Objectives:

1. To determine if an active water drive existed in the area selected.
2. To determine the effects of natural up-structure edgewater encroachment, accompanied with minimum production and resultant pressure build-up, on the productive capacity and ultimate recovery of oil from the Shallow Oil Zone, i.e., to study the oil-producing efficiency of an active water drive.

SHALLOO OIL ZONE RECOVERY STUDY

Description:

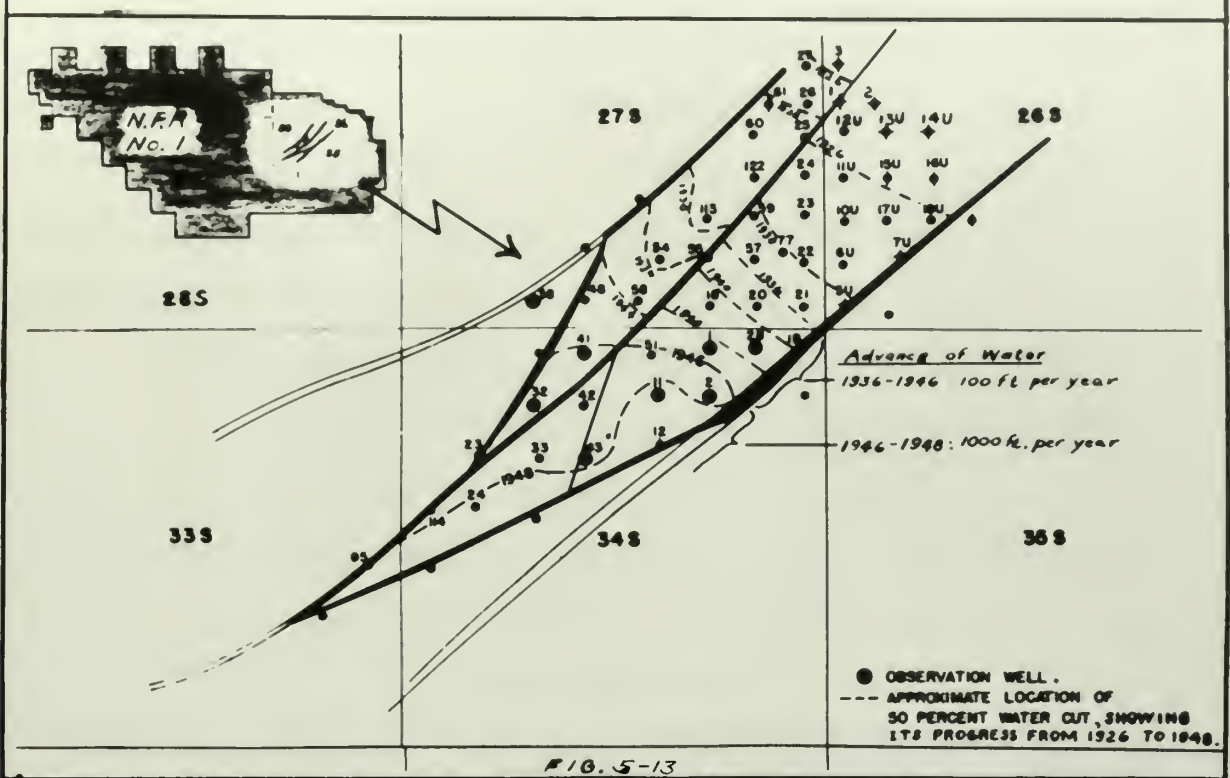
This study covers a part of the State of Nebraska program for the Shallow Oil Zone following World War II. The study involved physically shuttling in for a long period of 18 to 24 months most of the wells in an area relatively isolated and delineated by parallel and intersecting faults from the rest of the field. The area selected, shown on Figure 5-13, was one subjected to a high pressure edge-water encroaching up-structure from the North. During the shut-in period the only production consisted of reduced production from several up-structure observation wells to obtain necessary reservoir information.

Sand primarily affected by the study were the 22-1 and 22-2. However, a few new wells in the fault-block are completed in the N and NE sands. Pertinent information on the fault-block is listed between Figures 5-13 and 5-14.

Objectives:

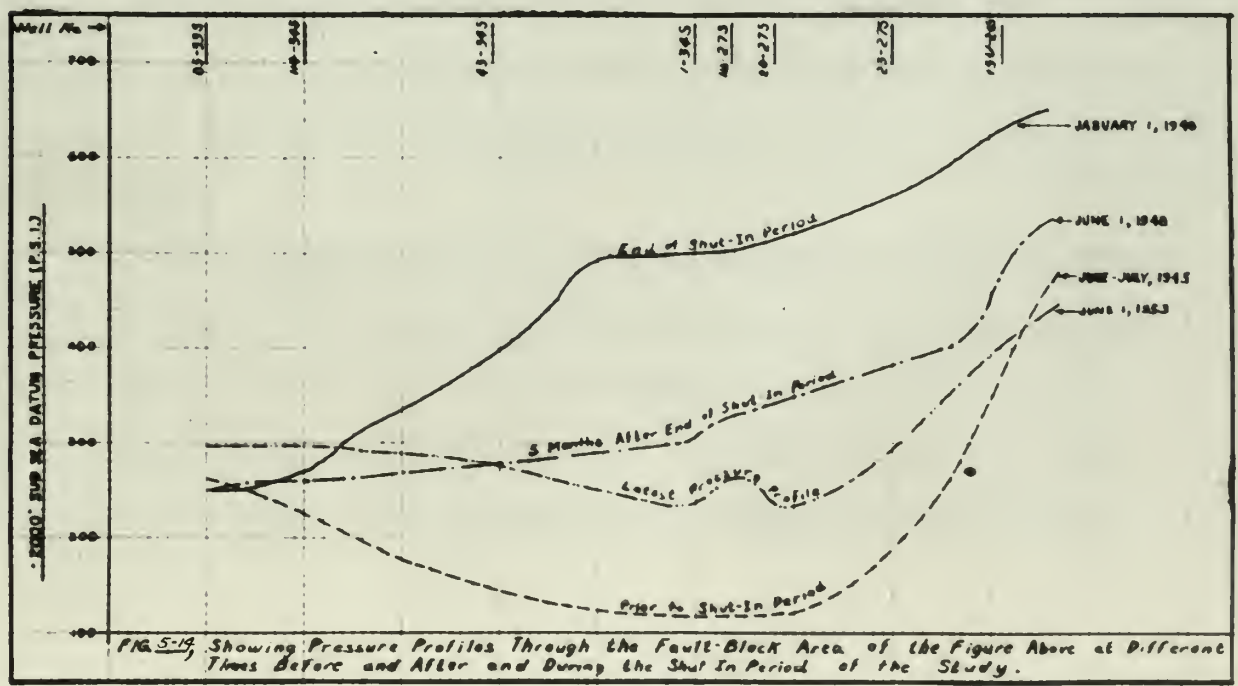
1. To determine if an active water drive existed in the area selected.
2. To determine the effects of natural up-structure edge-water encroachment, accompanied with minimum production and resultant pressure build-up, on the productive capacity and ultimate recovery of oil from the Shallow Oil Zone, i.e., to study the oil-producing efficiency of an active water drive.

MAJOR WATER-ENCROACHMENT STUDY



PERTINENT INFORMATION CONCERNING FAULT-BLOCK AREA ABOVE CHOSEN FOR THIS STUDY

<p>Sands Affected Primarily: SS-1; SS-2 Partially: M; SM Prod. Sand Vol.: 29,000 Acre-Ft. Orig. Stock Tank Oil in Place: 48.6 Ml. Bbls.</p>	<p>Orig. Press.: 1125 psia at 2000 ft Sub Sea Ave. Porosity: 34.6 % Ave. Permeability: 1 to 4 Darcys Original Water Saturation: 30 %</p>	<p>Structural Closure: 1100 ft Est. Rate of Water Influx: 1.8 Ml Bbls per Yr By 1945, prior to study, 2/3 of fault-block had been flooded to 50 % water cut.</p>
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3. To compare the results of the above study with the probable results that might be obtained if the encroachment of water had been retarded by all means available, i.e., the relative advantages of different production methods.

Pertinent Dates:

- 14 December 1945.--Area of active water drive selected. Study commenced. Production greatly reduced.
- October 1946.-----Shut-in period ended. Twenty-seven wet wells in fault block put on full production.
- January 1947-----Exploratory Well No. 77-27S completed in this fault-block area. This well provided additional information on the effects of water encroachment.
- March 1949-----Production rate increased in an attempt to dewater this area more rapidly.
- December 1949-----Production rate again increased. High rate of wet well production continues from this area.

Action Taken:

In brief, the procedure consisted in completely shutting in most of the wells in the fault block for a long period, obtaining information on water encroachment and pressure build-up from observation wells during the shut-in period, and then opening the block to full production to determine the effects

3. To compare the results of the above study with the probable results that might be obtained if the encroachment of water had been retarded by all means available, i.e., the relative advantages of different production methods.

Relevant Dates:

14 December 1945. -- Area of active water drive reduced.

Study commenced. Production greatly reduced.

October 1946. ---- Shut-in period ended. Twenty-seven

wet wells in fault block put on full production.

January 1947. ---- Exploratory well No. 77-S25 completed

in this fault-block area. This well provided additional information on the effects of water encroachment.

March 1948. ---- Production rate increased in an attempt to de-water this area more rapidly.

December 1949. ---- Production rate again increased. High rate of wet well production continues from this area.

Action Taken:

In brief, the procedure consisted in completely shutting in most of the wells in the fault block for a long period, obtaining information on water encroachment and pressure build-up from observation wells during the shut-in period, and then opening the block to full production to determine the effects

of the shut-in period on the productive capacity of each well and ultimate recovery of oil from the fault block.

There were 32 active oil wells in the area. The 24 down-structure wells, with an average water/oil ratio of 5.2, were shut-in; about 8 up-structure wells were operated as observation wells, initially at their former production rates and later at about one-half their former rate. In December 1947, the shut-in period ended and the wells began to be returned to production.

Production from most of the wells in this area has been continued to date as part of the Protective Production of Wet-well Program and in an attempt to dewater the area. When up-structure wells return to clean oil production for three consecutive months, they are then shut-in.

Exploratory Well No. 77-27S was drilled in this area to evaluate the efficiency of the active edgewater in flushing oil ahead of it, i.e., to determine the state of depletion of the different oil sands. Since its completion in January 1947, ten separate sand fingers in the SS-1, SS-2, and M zones have been selectively gun-perforated and tested. The well was finally completed in two clean oil productive sand intervals of the SS-2.

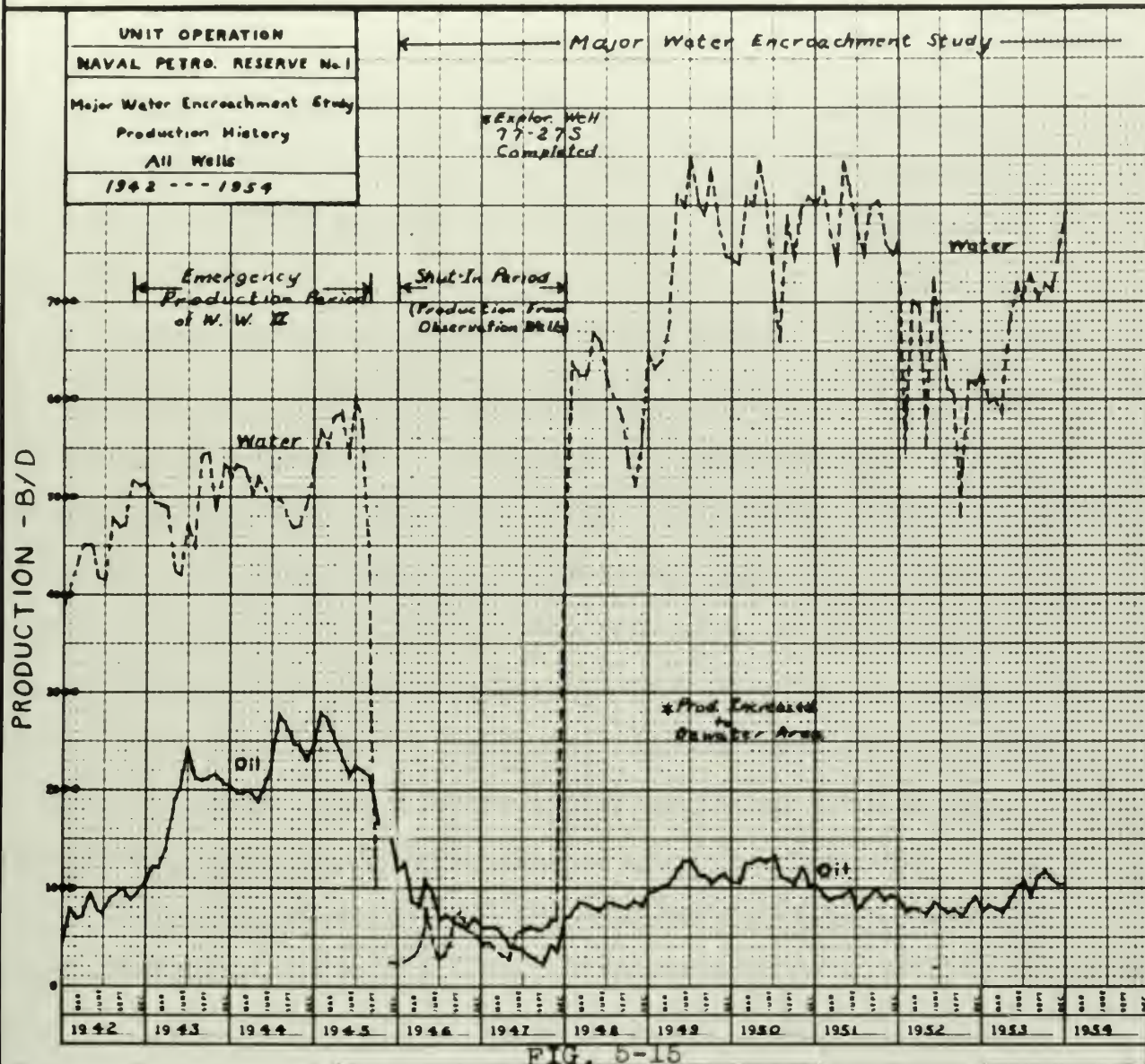
Shut-in periods, oil and water production rates, and other pertinent items are well illustrated on the graph of Figure 5-15.

Alternate Actions Proposed:

1. Remain Shut-in. Completely shut-in the fault block; allow

of the shut-in period on the production history of each well
and estimate recovery of oil from the field blocks.
There were 52 active oil wells in the area. The 52
down-structure wells, with an average water/oil ratio of 0.2,
were shut-in; about 4 up-structure wells were operated as
observation wells, initially at their former production rates
and later at about one-half their former rates. In December
1947, the shut-in period ended and the wells began to be re-
turned to production.
Production from most of the wells in this area has been
continued to date as part of the productive production of the
well program and in an attempt to determine the area. When up-
structure wells return to their former production rates, they are
active monitors, they are shut-in.
Exploratory Well No. W-275 was drilled in this area to
evaluate the efficiency of the active edge water in flushing oil
ahead of it, i.e., to determine the state of depletion of the
different oil sands. Since the completion in January 1947, ten
separate sand fingers in the 22-1, 22-2, and 22-3 have been
selectively perforated and tested. The well was initially
completed in two clean oil productive sand intervals of the
22-2.
Shut-in periods, oil and water production rates, and
other pertinent data for well W-275 are shown on the graph of
Figure 5-15.
Alternative Action Proposed:
1. Reopen W-275. Completely shut-in the lower block; allow

MAJOR WATER ENCROACHMENT STUDY



A COMPARISON OF THE PRODUCTION CHARACTERISTICS OF THE GROUP OF WET WELLS SHUT-IN FOR THE STUDY AT DIFFERENT PERIODS

	During Emerg. Prod. Period (June 1945)	Four Months After Return to Prod. (April 1948)	After Four Yrs. on Wet-Well Prod. Program (1952)
No. of Wells :	26	26	28
Oil, Bbls/Day :	1000	375	763
Water, Bbls/Day :	5500	5300	6236
Water/Oil Ratio :	5.5	14.1	8.2
Oil Prod., % of 1945 Prod. :	100	37.5	76.3
Oil Prod., % of 1948 Prod. :	267	100	203

TABLE 5-1

the pressure to continue building up as water encroaches; accept some ultimate loss of oil bypassed by water in return for an initially high rate of production when an emergency demands it.¹¹⁵

The only fallacy in this method of recovery is that the expected high rate of production failed to materialize. Theoretically, it should have increased for the area as a whole; but when the shut-in area was put on production again, the productive capacity had materially decreased.

2. Produce Wet-Wells (Revive old system). Operate continuously wet down-structure wells to decrease the up-structure edge-water encroachment -- the production method employed by operators in the Tupman Area before unitization and by the Unit during the emergency wartime production.^{113, 138}

This production method was revived in 1948 and continues to date.

3. Gravity Drainage Production by Drilling More Water-Wells and Dewatering. Re-open fault block to production; if necessary, drill additional down-structure wells in order to produce water at a rate sufficient to prevent up-structure water encroachment; employ gravity drainage for oil production; expect a much greater ultimate recovery of oil at a reduced rate over a longer period of time than in (1) or (2) above.^{115, 138}

This production method will probably supplement or succeed the present production method described in (2) above.¹³⁸

the pressure to maintain holding on an water underground
accept some ultimate loss of oil displaced by water to return
for an initially high rate of production when an emergency
demands it. 115

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expected high rate of production failed to materialize. This
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This production method was revised in 1948 and con-
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3. Gravity Drainage Production by Drilling More Water-Cells and
Dewatering. Re-open fault block to production; if necessary,
drill additional down-structure wells in order to produce water
at a rate sufficient to prevent up-structure water encroach-
ment; employ gravity drainage for oil production; expect a
much greater ultimate recovery of oil at a reduced rate over
a longer period of time than in (1) or (2) above. 115, 120
This production method will probably supplement or
succeed the present production method described in (2) above. 120

Results of the Project

1. Observation Wells. Production characteristics of the observation wells being continuously produced initially tended to improve.
2. Rate of Water Advancement. Closing the down-structure wells accelerated the edgewater advancement from a previous 100 to 125 feet per year to about 1,000 feet per year -- too rapid for effective flushing of oil from the sands. See Figure 13.
3. Type of Water Advancement. Edgewater advancement was very irregular, fingering rapidly through the more permeable members. Water encroachment occurred primarily through the SS-1 sand with only minor fingering in the SS-2 and SM sands.
4. Water Cut. By the end of the shut-in period production from all observation wells was at least 60 per cent water -- some as high as 85 per cent water. Refer to the advance of the 50 per cent water-cut on Figure 5-13.
5. Pressures. In general, the bottom-hole static pressures in the down-structure and mid-structure wells increased considerably. However, in spite of the rapid up-dip encroachment of water, the pressures in the producing observation wells up-structure decreased until the normal production rate was halved. The average pressure increase was about 200 psi. The change in pressure with time and well position is well illustrated by the pressure profile curves of Figure 5-14.
6. Production Rate. In general, as the edgewater front

Results of the Project

1. Construction Wells. Production characteristics of the construction wells being continuously produced initially tended to improve.

2. Rate of Water Advancement. Closing the down-structure wells accelerated the edge-water advancement from a previous 100 to 125 feet per year to about 1,000 feet per year -- for rapid for effective financing of oil from the sands. See Figure 13.

3. Type of Water Advancement. Edge-water advancement was very irregular, flowing rapidly through the core permeable members. Water encroachment occurred initially through the 25-1 sand with only minor flow in the 25-2 and 25 sands.

4. Water Cut. By the end of the 1962-63 period production from all observation wells was at least 50 per cent water -- some as high as 85 per cent water. Prior to the advance of the 50 per cent water-cut see Figure 2-13.

5. Pressures. In general, the bottom-hole static pressures in the down-structure and mid-structure wells increased considerably. However, in spite of the rapid oil-clip encroachment of water, the pressures in the producing observation wells up-structure decreased until the normal production rate was halved. The average pressure increase was about 200 psi. The change in pressure with time and well position is well illustrated by the pressure profile curves of Figure 2-14.

6. Production Rate. In general, as the edge-water front

approached a well, there was a sudden rise in pressure and production; but as the front passed, more water was produced and oil production declined -- as to be expected.

7. State of Depletion of Reservoir Sands. Results of extensive production testing and core analysis of ten separate sand fingers in the new Well No. 77-27S indicated that large quantities of otherwise producible oil had been left behind by the encroached edgewater; that the more permeable sands (SS-1) were only water productive; tighter sands were oil productive.¹⁴⁵
8. Productivity of Area at End of Study. After the wells were placed on sustained production again in 1948, the productive capacity of all wells in the area was only about 46 per cent of the 1945 rate prior to the shut-in period. The production characteristics of the wet wells shut-in for the study are compared as a group for the period before and after the study in Table 5-1 below Figure 5-15. A big drop occurred in oil productivity of the group.
9. Results after Return to Wet-Well Production Program. By January 1953 the productive capacity of the original 26 shut-in wells in this area had been restored to about 66 per cent of the 1945 rate and about 177 per cent of the 1948 rate.¹²⁵

Conclusions and Corrective Action

1. Water Drive. Active edgewater drive definitely exists in this particular fault block. However, other studies have shown that in several areas of the Shallow Zone no active

approached a well, there was a sudden rise in pressure and production; but as the front passed, some water was produced and oil production declined -- as to be expected.

7. State of Depletion of Reservoir Sands. Results of extensive

production testing and core analysis of various sands in the new well No. 77-275 indicated that large quantities of otherwise producible oil had been left behind by the encroached edge water; that the more permeable sands (22-1) were only water productive; tighter sands were oil productive. 145

8. Productivity of Area at End of Study. After the wells were

placed on sustained production basis in 1945, the productive capacity of all wells in the area was only about 48 per cent of the 1945 rate prior to the shut-in period. The production characteristics of the well shut-in for the study are compared as a group for the period before and after the study in Table 8-1 below Figure 8-15. A big drop occurred in oil productivity of the group. 146

9. Results After Return to Well Production Program. By

January 1953 the productive capacity of the original 20 shut-in wells in this area had been restored to about 65 per cent of the 1945 rate and about 177 per cent of the 1948 rate. 147

Conclusions and Corrective Action

1. Water Drive. Active edge water drive definitely exists in this particular field block. However, other studies have shown that in several areas of the Shallow zone no active

water drive exists, and in other areas a receding edgewater exists.

2. Inefficient. In this area of Shallow Oil Zone, oil production efficiency by natural water drive appears impaired due to severe fingering of encroaching edgewater through the highly permeable members. The water tends to bypass and surround an excessive amount of residual oil. This method of production does not appear applicable to the Shallow Oil Zone.
3. Losses. As a result of the Major Water Encroachment Study which permitted a too-rapid rate of edgewater advance, appreciable quantities of otherwise producible oil in the affected area were apparently bypassed, and the overall productive capacity of the area was abnormally reduced.
4. Corrective Action. The wet wells were returned to the Wet-Well Protective Production Program and the area partially dewatered in order to reduce edgewater level and perhaps restore availability of wet wells -- the production program still being used with some success in restoring productive capacity.

Discussion:

Natural water drive existed in the SS-1 sand as early as 1923 with water invasion occurring on the North and East flanks. A study in May, 1947, by California Research Corporation estimated that the net rate of water entry into the fault block is about 1.8 million barrels per year, or about 5,000

water drive exists, and in other areas a residual edge-water
exists.

3. Inefficient. In this area of Shallow Oil Zone, oil pro-
duction efficiency by natural water drive appears lowered
due to severe fingering of encroaching edge-water through
the highly permeable sandstone. The water tends to bypass
oil and surround an excessive amount of residual oil. This
method of production does not appear applicable to the
Shallow Oil Zone.

3. Losses. As a result of the water meter monitoring study
which provided a two-year record of edge-water volumes,
appreciable quantities of edge-water production are in the
area and were apparently bypassed, and the overall
productive capacity of the area was apparently reduced.

4. Corrective Action. The well was returned to the 1961
Well Protective Production Program and the area partially
bypassed in order to reduce edge-water level and perhaps
restore availability of wet wells -- the production program
still being used with some success in restoring productive
capacity.

Discussion:

Natural water drive existed in the B-1 well as early
as 1961 with water level recorded on the North and East
flanks. A study in May, 1964, by California Research Corpora-
tion estimated that the net rate of water entry into the field
block is about 1.8 million barrels per year, or about 5,000

barrels per day.¹¹⁵

Down-structure two-thirds of the fault block area is in the Old Area (Tupman). This area was damaged early in the field's life by rapid depletion of reservoir energy through excessively high production rates, by high gas/oil ratios, and by unbalancing due to multi-zone completions. Some fault block energy has apparently been maintained by naturally encroaching high pressure water on the North flank. If permeabilities and permeability variations in the Shallow Oil Zone sands were not such as to promote formation of water stringers, this natural water drive could be employed as a very efficient oil-producing mechanism.

As part of this program, as already mentioned in the review of the gas injection program, some gas was injected up-structure into the apex of the fault block in an attempt to prevent the rapid encroachment and severe fingering of the high pressure water up-structure by correcting the great pressure differential existing between the aquifer and the oil and gas zones. The gas injection program was unsuccessful because the faults proved incompetent near the apex and the gas bled off to areas and zones of lower pressure.

Some objection has been raised to the procedure employed in this study of keeping the 8 up-structure wells on continuous production.¹¹² It was felt that the rapid water fingering through the more permeable sand members was aggravated by this production; and, if these wells had not been produced,

details per day. 111

Downstream two-thirds of one hour down stream is in

the Old Area (Tanner). This area was developed early in the

1950's due to rapid depletion of reservoir energy through

excessively high production rates, by high gas/oil ratios, and

by increasing use to multi-zone completions. Some wells close

energy has apparently been maintained by naturally eroding

high pressure water on the North flank. If permeabilities and

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such as to promote formation of water fingers, this natural

water drive could be employed as a very efficient oil-producing

mechanism.

As part of this program, an already mentioned in the

review of the gas injection program, some gas was injected up-

structure into the apex of the fault block in an attempt to

prevent the rapid encroachment and severe fingering of the

high pressure water up-structure by connecting the great pres-

sure differential existing between the aquifer and the oil and

gas zones. The gas injection program was unsuccessful because

the faults proved incompetent near the west end and the gas did

not to spread and areas of lower pressure.

Some collection has been related to the procedure employed

in this study of mapping the up-structure wells on continuous

production. 112 It was felt that the rapid water flowing

through the more permeable sand members was aggravated by

early production; and, if these wells had not been produced,

less severe fingering and a more even encroachment and better flushing might have resulted. Desirable reservoir data could have been taken at periodic intervals by intermittent production from different wells.

Also, theoretically, some objection may be raised to the present rapid production of high pressure water, representing a definite loss in vital reservoir energy. Rapid production of high pressure gas and resultant depletion of reservoir energy for production of oil is no longer approved or generally practiced; likewise, water at high pressure is recognized more and more as being just as vital a source of oil-producing energy as gas. Nevertheless, the practical aspects and results of this study, as have been explained, indicated this field to be no textbook example; rather, it was the exception to the rule. The presence of wide variation in the permeabilities of the sand members and the great pressure differentials existing over short distances were the main reasons the water drive failed.

It is still possible that in other areas of the Shallow Oil Zone, effective use of the active water drive may be made in recovering more oil during the later life of the field, profiting by the information and knowledge obtained from the Major Water Encroachment Study of 1945-1948.

Reservoir energy may be preserved and reservoir pressure gradients from North to South removed by producing high pressure edgewater along the North flank and injecting it into the

less severe filtering and a more even distribution and better
 flushing might have resulted. Detailed reservoir data could
 have been taken at periodic intervals by instrumented wells
 from different wells.

Also, theoretically, some objection may be raised to the
 present rapid production of high pressure water, representing
 a definite loss in vital reservoir energy. Rapid production
 of high pressure gas and resultant depletion of reservoir
 energy for production of oil is no longer approved or generally
 practiced; likewise, water at high pressure is produced more
 and more as being just as vital a source of oil-producing
 energy as gas. Nevertheless, the practical aspects and re-
 sults of this study, as have been explained, indicated this
 field to be an excellent example, whether it was the exception
 to the rule. The presence of wide variation in the perme-
 abilities of the sand members and the great pressure differ-
 ences existing over short distances were the main reasons the
 water drive failed.

It is still possible that in other areas of the shallow
 Oil Zone, effective use of the active water drive may be made
 in recovering more oil during the later life of the field,
 profiting by the information and knowledge obtained from the
 Water Drive Experiment Study of 1945-1948.

Reservoir energy may be conserved and reservoir pressure
 gradients from water to sands covered by producing oil pres-
 sure equivalent along the early tank and injection is into the

receding or static aquifer on the South flank, combined with a gas injection program into any low pressure gas or oil zones. To date this has not been done due to very high costs necessitated and questionable results of such a program.¹³⁸

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

109, 112-115, 122, 125, 135, 138, 145.

feeding on waste matter on the water table, combined with
a gas injection program into the low pressure gas or oil zones.
To date this has not been done but very high costs would
be incurred and questionable results of such a program. 1961

SELECTED REFERENCES IN THE LITERATURE:

109, 112-116, 122, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

MINOR WATER ENCROACHMENT STUDYDescription:

This study, similar to the Major Water Encroachment Study previously described, involved shutting-in four down-structure wells which were heavy water producers and producing thirteen upstructure wells as observation wells. The fault-block area on the northeast flank chosen for the study is shown in Figure 5-16. Only the Shallow Oil Zone was involved in the study. Sand primarily affected was the SS-1.

Objectives:

The primary objective was to determine the extent and effects of encroaching water in Section 25-S on the productivity characteristics of upstructure wells.

Pertinent Dates:

April 1945-----The study was commenced. The four down-structure wells shown in Figure 5-16 were shut-in.

December 1949--The study was abandoned.

May 1950-----The shut-in wells were returned to production under the Protective Production of Wet Well Program.

Results:

1. No apparent effect of high pressure edgewater in Section 25-S on upstructure observation wells was observed. This fact is best illustrated by the pressure profile curves of Figure 5-17.

WATER RESOURCES RESEARCH

Description:

This study, similar to the Water Resources Research Study previously described, involved studying in four down-structure wells which were heavy water producers and producing thirteen observation wells as observation wells. The study block area on the northeast flank chosen for the study is shown in Figure 5-16. Only the Shallow Oil Zone was involved in the study. Sand primarily affected was the 22-1.

Objectives:

The primary objective was to determine the extent and effects of encroaching water in Section 22-2 on the productivity characteristics of observation wells.

Relevant Dates:

April 1945-----The study was commenced. The four down-structure wells shown in Figure 5-16 were shut-in.
December 1949--The study was abandoned.
May 1950-----The shut-in wells were returned to production under the Protective Production of Wet Well Program.

Results:

1. No apparent effect of high pressure seawater in Section 22-2 on observation well production was observed. This fact is best illustrated by the pressure profile curves of Figure 5-17.

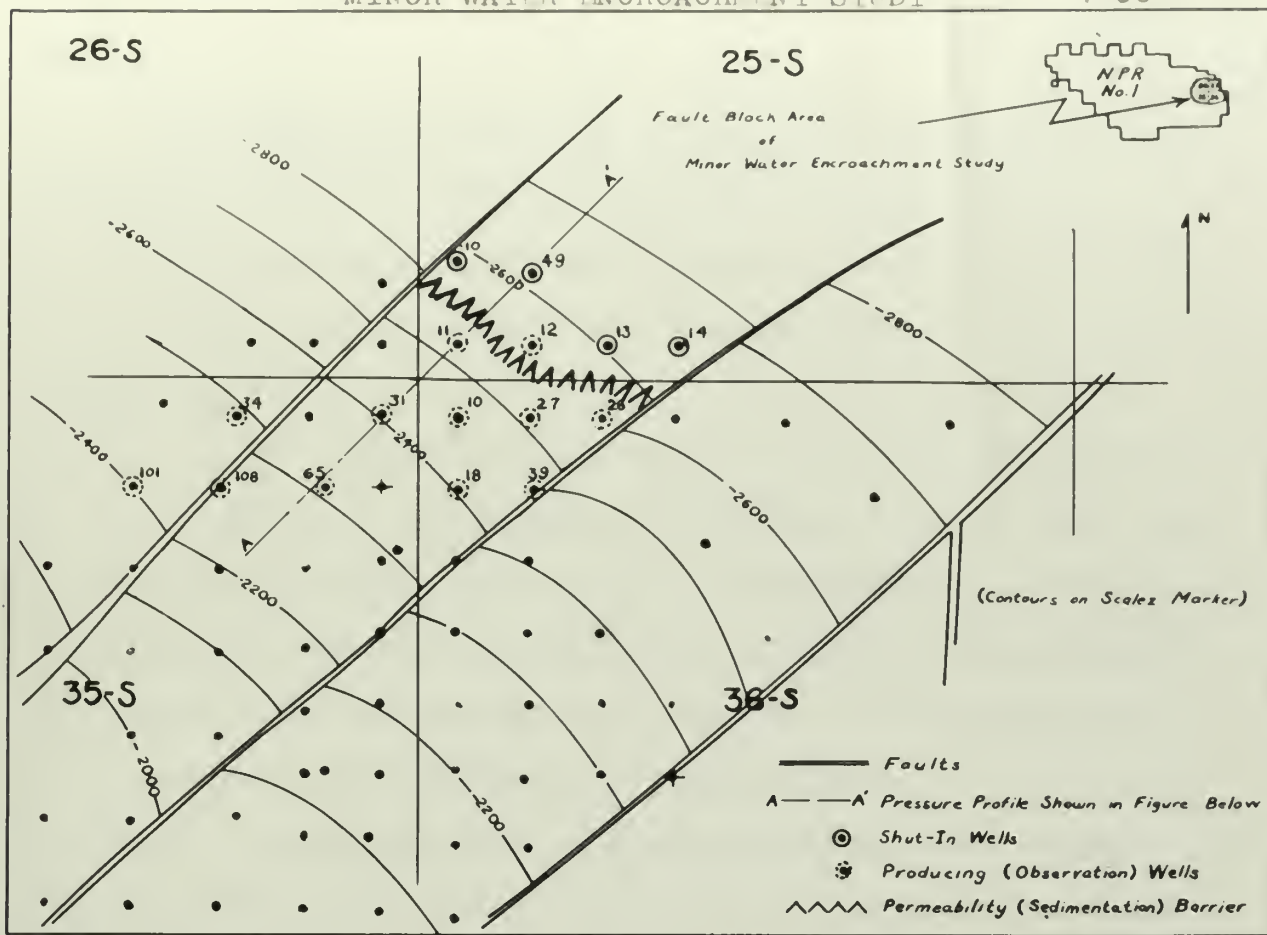


FIG. 5-16. Contour Map of Fault Block Area for Minor Water Encroachment Study Showing Apparent Location of Permeability (Sedimentation) Barrier.

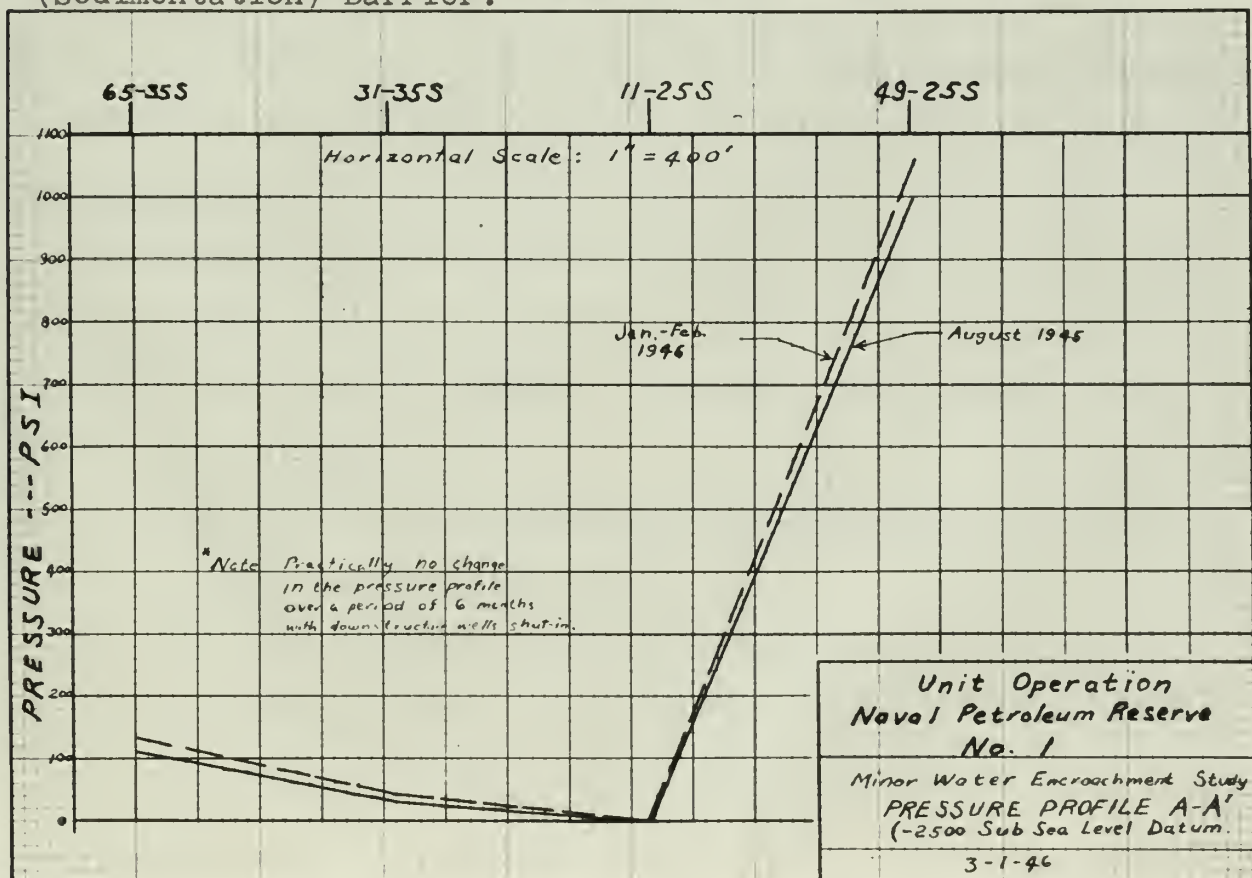


FIG. 5-17. Pressure Profiles Through Area Indicated In Fig. 5-16 and Supporting Existence of a Downstructure Barrier.

2. No apparent movement of edgewater upstructure was observed.

3. Pressures in the area increased only from 50 to 200 psi between January 1946 and January 1950.

Conclusions:

1. The failure of the edgewater to move upstructure, despite a pressure differential of 1000 psi between the shut-in wells and the observation wells, indicated the presence of a permeability barrier between the two groups. Pressure profiles like those of Figure 5-17 supported the theory of a permeability barrier indicated on Figure 5-16.

2. Again, as in the Major Water Encroachment Study, the conclusion was reached that a natural water drive along the North flank of the Shallow Oil Zone was not an effective production method but for diametrically opposite reasons to the Major Study. No active water drive could function through a localized area of very low permeabilities.

Discussion:

Since the pressure in this area is nearly depleted and natural water drive has not proved feasible, remaining methods of obtaining greater productive capacity and ultimate yield from this area are:

- (1) Localized gas injection into the secondary gas cap of this fault-block.
- (2) Water flood by injecting high pressure water from nearby downstructure wells into wells upstructure of the apparent permeability barrier.

2. No apparent movement of edgewater was observed.

3. Pressures in the area increased only from 80 to 200 psi between January 1946 and January 1950.

Conclusions:

1. The failure of the edgewater to move upward, despite a pressure differential of 1000 psi between the strata in wells and the observation wells, indicated the presence of a permeability barrier between the two groups. Pressure profiles like those of Figure 5-14 supported the theory of a permeability barrier indicated on Figure 5-15.

2. Again, as in the Major Water Encroachment Study, the conclusion was reached that a natural water drive along the North flank of the Spallan Oil Zone was not an effective production method but for diametrically opposite reasons to the Major Study. No active water drive could function through a localized area of very low permeabilities.

Discussion:

Since the pressure in this area is nearly depleted and natural water drive has not proved feasible, remaining methods of obtaining greater productive capacity and ultimate yield

from this area are:

- (1) Localized gas injection into the secondary gas cap of this fault-block.
- (2) Water flood by injecting high pressure water from nearby downstructure wells into wells upstream of the apparent permeability barrier.

(3) Gravity drainage.

The success of localized gas injection would depend upon the fluid competency of the faults shown on Figure 5-16, which as shown on the map apparently form a closure for this area. Pressure gradients, however, indicate the eastern fault and the upstructure southern fault are not pressure barriers, and adverse pressure gradients might be developed toward the south flank, contributing to the migration of oil into wet sands.

Natural water drive having failed, an artificial water flood farther upstructure probably would not be attempted except as a secondary recovery method much later in the life of the field, provided economic considerations would warrant it.

Gravity drainage, therefore, remains as the most probable means of obtaining the most production economically from this area. Downstructure wells which are upstructure of the apparent permeability barrier would be produced. This production should reduce the pressures in the lower area and thus create a potential gradient inducing the drainage of oil downstructure into the producing wells.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

112, 122, 125, 138.

The amount of localized gas injection would depend upon the fluid conductivity of the fault block as shown in Figure 2-18, which is shown on the map apparently, with a legend for this area. Pressure gradients, however, indicate the eastern fault and the upstructure southern faults are not pressure barriers, and adverse pressure gradients might be developed toward the south flank, contributing to the migration of oil into wet sands. Natural water drive having failed, an artificial water flood further upstructure probably would not be warranted except as a secondary recovery method much later in the life of the field, provided economic considerations would warrant it. Gravity drainage, therefore, remains as the most probable means of obtaining the best production economically from this area. Downstructure wells which are upstructure of the apparent permeability barrier would be produced. This production should reduce the pressure in the lower area and thus create a potential gradient inducing the drainage of oil

downstructure into the producing wells. It would be desirable to have a secondary recovery program in the lower area. An artificial water drive would be desirable in the lower area. This would be a secondary recovery program.

SELECTED REFERENCES IN THE FIELD

1. ... 1952, 1953, 1954, 1955

2. ... 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025

PROTECTIVE DEWATERING AND GRAVITATIONAL DRAINAGE STUDY

Description:

As part of the Gravitational Drainage Study, about 25 water wells and high water/oil ratio wells along the east flank of the Shallow Oil Zone in the area shown on Figure 15-18 were produced at maximum capacity; and the effect of this production on 7 upstructure observation wells was studied. The Program was later changed to the Protective Dewatering Project.

The SS-1 Sand was primarily affected. The program covered areas in Sections 1-G, 6M, 36S, and 31T.

Objectives:

Initially --

1. To create a drainage gradient along the east flank by dewatering and then to determine the possibility of obtaining maximum economic ultimate oil recovery by gravity drainage mechanism in the Shallow Oil Zone.

Finally --

1. To prevent damage to upstructure wells by encroaching edgewater.

Pertinent Dates:

1 November 1945--Study commenced.

May 1947-----Larger pumps installed.

April 1950-----Gravity drainage aspect of the study abandoned; shifted to a Protective Dewatering Project.

PROTECTIVE DRAINAGE AND GRAVITY DRAINAGE STUDY

Description:

As part of the Gravitational Drainage Study, about 25 water wells and high water table wells along the east flank of the Shallow Oil Zone in the area shown on Figure 15-18 were produced to maximum capacity; and the effect of this production on V structure observation wells was studied. The program was later changed to the Protective Drainage Project.

The 66-1 sand was primarily affected. The program covered areas in sections 1-9, 24, 32S, and 31S.

Objectives:

Initially --

1. To create a hydraulic gradient along the east flank by dewatering and then to determine the possibility of obtaining maximum economic ultimate oil recovery by gravity drainage mechanism in the Shallow Oil Zone.

Finally --

1. To prevent damage to hydrocarbon wells by producing and dewatering.

Pertinent Dates:

November 1948--Study commenced.
May 1949--Larger pumps installed.
April 1950--Gravity drainage aspect of the study abandoned; shifted to a protective dewatering project.

Action Taken:

From 25 to 29 water wells and high water/oil ratio wells shown in Figure 5-18 were produced at their maximum fluid capacity. Later larger pumps were installed and additional wells were added in efforts to increase the water withdrawal rate.

Three to four clean upstructure wells were produced to observe the results of the heavy downstructure production on their productivity characteristics.

Results:

1. The gravity drainage aspect of the program was unsuccessful. Even though larger pumps were installed and additional wells were produced, still the rate of fluid withdrawal from the wells in this area was never great enough to dewater the area and produce the necessary gradients for promoting gravity drainage downstructure. As shown by the pressure profiles of Figure 5-19, three years of dewatering production failed to produce the gradient necessary for gravity drainage.

2. However, the program did serve to reduce encroachment of high pressure edgewater into low pressure, clean oil sands on the southeast flank.

Discussion:

The low fluid withdrawal rate is attributed to the age and condition of the wells -- all old ones completed in the 1920's, and to the sand trouble attendant with high production rates. Some wells were in poor mechanical condition and the drainage channels around the well bores and liners were badly

Action taken:

From 1935 to 1938 water wells and high water wells
 shown in Figure 3-1a were produced at nearly constant field con-
 ditions. Later larger pumps were installed and additional wells
 were added in efforts to increase the water withdrawal rate.
 Three to four linear aquifer-type wells were produced to
 observe the results of the heavy downstructure production on
 their productivity characteristics.

Results:

1. The gravity drainage aspect of the program was un-
 successful. Even though larger pumps were installed and addi-
 tional wells were produced, still the rate of fluid withdrawal
 from the wells in this area was never great enough to develop
 the area and produce the necessary gradient for producing
 gravity drainage downstructure. As shown by the pressure pro-
 files of Figure 3-1b, three years of downstructure production
 failed to produce the gradient necessary for gravity drainage.
2. However, the program did serve to reduce the amount
 of high pressure water being taken into the reservoir, clear of
 sands on the southeast flank.

Discussion:

The low fluid withdrawal rate is attributed to the age
 and condition of the wells -- all are completed in the
 1930's, and to the sand production attendant with high production
 rates. Some wells were in poor mechanical condition and the
 drainage channels around the well bore and liners were badly

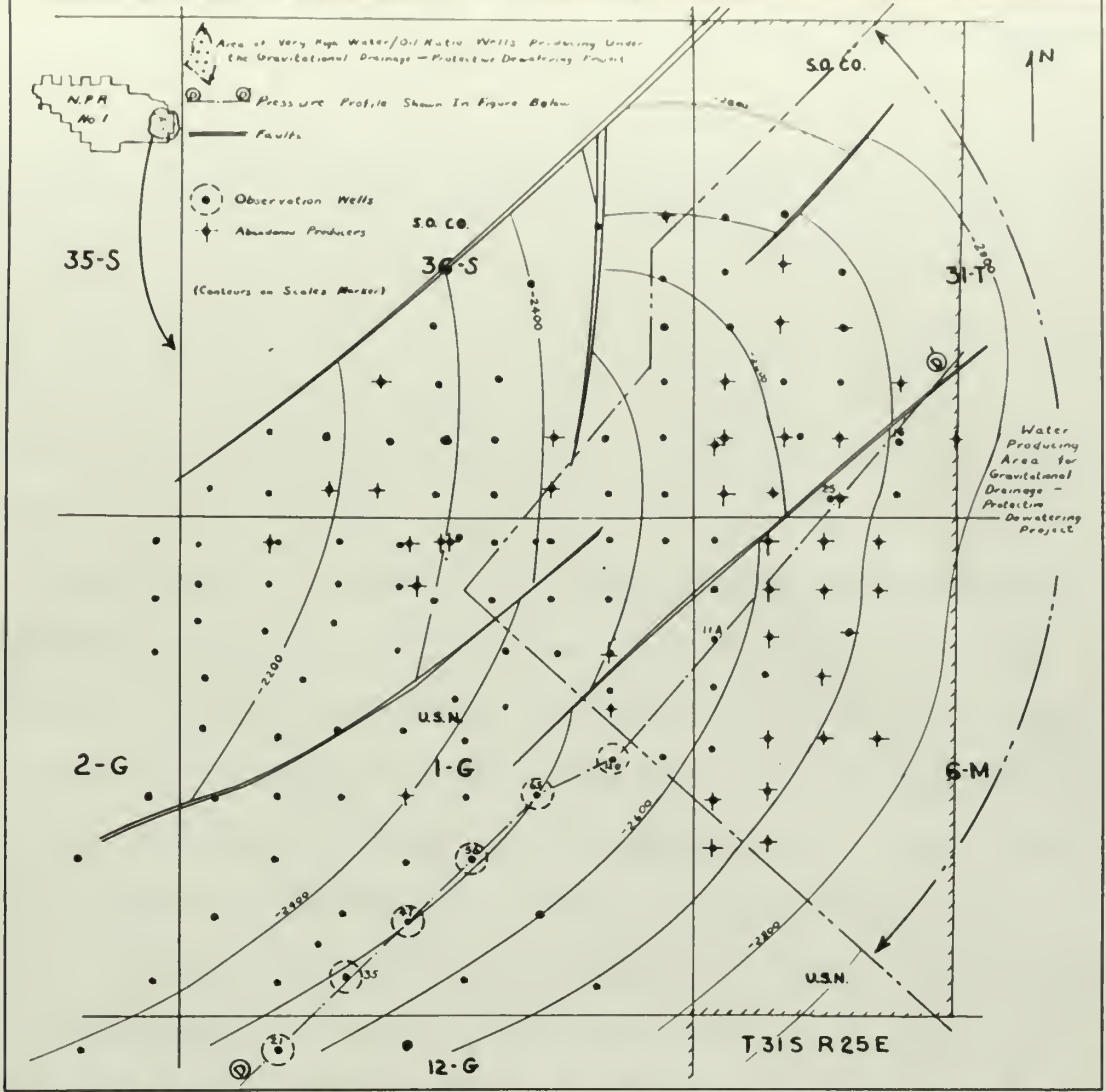
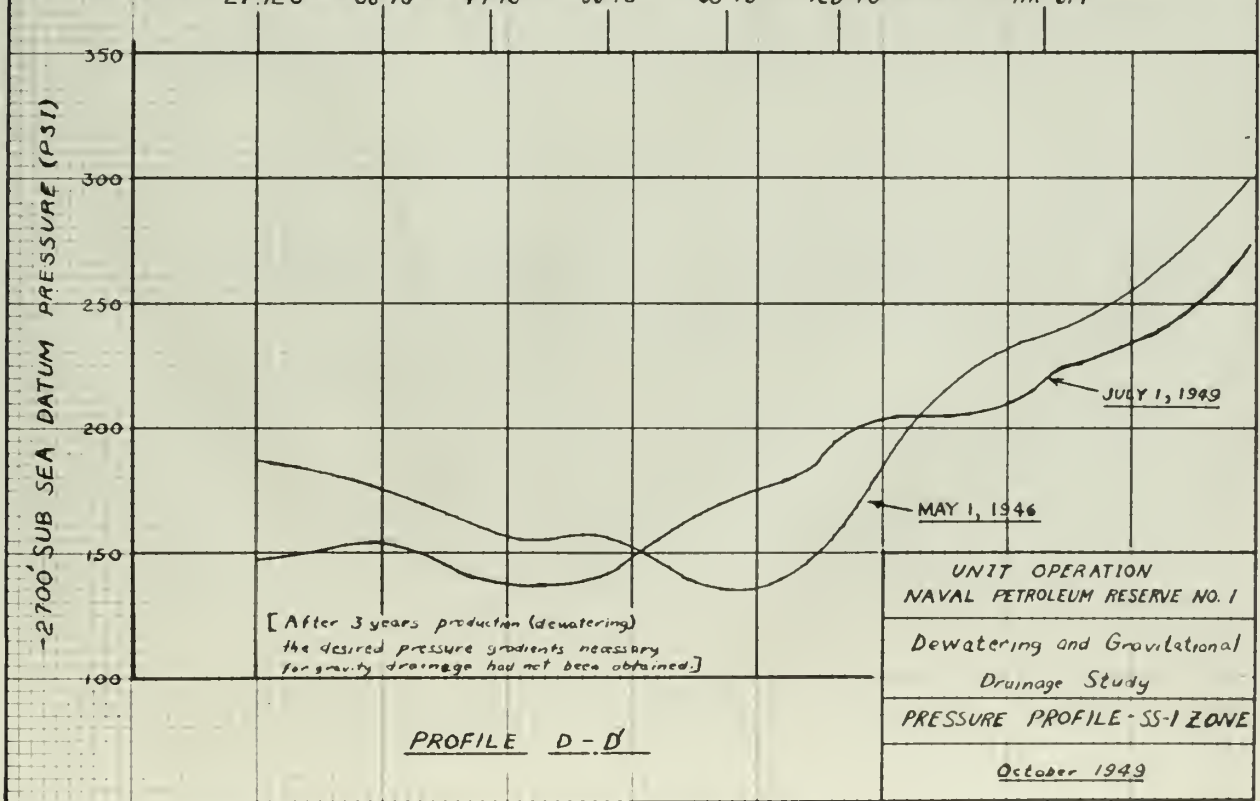


FIG. 5-18. Area of the Dewatering-Gravitational Drainage Study Showing Water Producing Area and Upstructure Observation Wells.

FIG. 5-19. Press. Profiles Through Area of Fig. 5-18 Illustrating Inability To Establish Gradients for Gravity Drainage.



clogged and sanded. The high cost of reworking these wells to secure better drainage and less sanding and the doubtful results of a complete well reconditioning program sufficiently increasing the fluid withdrawal rate to dewater the area, necessitated shifting the program to a protective dewatering project.

Even if the area had been successfully dewatered and gradients promoting gravity drainage had been created, the rate of drainage and resultant production rate may well have been too low for economic production of oil due to the relatively low structural relief of this area and the high viscosity of the gas denuded oil. The high permeabilities, however, in this area would tend to offset these disadvantages.

Other areas of higher structural relief, equally good permeabilities, and lower rates of water encroachment might provide a more effective gravity drainage study, such as the fault-block area used for the Minor Water Encroachment Study previously described.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

112, 122, 125, 138.

closed and sealed. The high cost of reworking these wells to
 secure better drainage and less seepage and the resulting re-
 suits of a complete well reconditioning program satisfactorily
 increasing the fluid withdrawal rate to double the original
 necessitated shifting the program to a protective dewatering
 project.

Even if the area had been successfully dewatered and
 gradients promoting gravity drainage had been created, the
 rate of drainage and resultant production rate may well have
 been too low for economic production of oil due to the rela-
 tively low structural relief of this area and the high vis-
 cosity of the gas denuded oil. The high permeabilities,
 however, in this area would tend to offset these disadvantages.
 Other areas of higher structural relief, equally good
 permeabilities, and lower rates of water encroachment might
 provide a more effective gravity drainage study, such as the
 fault-block area used for the Minor Water Encroachment Study
 previously described.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

118, 122, 123, 124

ROTATING PRODUCTION TEST PROJECTDescription:

This project consists of the periodic production testing of all wells in the Shallow Oil Zone which have producing facilities and are not produced under one of the other projects of the Readiness Program. Most of the wells under this project are clean wells. As many as 423 wells have been included under this program at one time or another.

Objectives:

1. To determine the mechanical condition of each well and its productivity characteristics.
2. To provide information for a continuing estimate of the productive capacity of the field.

Pertinent Dates:

22 October 1945---Project initiated.

20 April 1950-----Testing methods changed and production under this project curtailed on advice of the Engineering Committee.

Procedure:

Initially, each well not being produced under another program was placed on maximum rate of production for a minimum period of 10 to 11 days each year while mechanical and production information was obtained.

Following a review of data the testing procedure was altered to reduce production under this program. The wells are now divided into two groups, each tested differently:

ROTARY PRODUCTION TEST PROJECT

Description:

This project consists of the periodic production testing of all wells in the Shallow Oil Zone which have produced for a period of 10 to 15 days each year with mechanical and production records maintained. As many as 423 wells have been included under this program at one time or another.

Objectives:

1. To determine the mechanical condition of each well and its productivity characteristics.
2. To provide information for a continuing estimate of the productive capacity of the field.

Pertinent Dates:

Project initiated October 1945. Testing methods changed and production records maintained under this project curtailed on April 1950. The Engineering Committee.

Procedure:

Initially, each well not being produced under another program was placed on maximum rate of production for a minimum period of 10 to 15 days each year with mechanical and production information obtained. Following a review of data the testing procedure was altered to reduce production under this program. The wells are now divided into two groups, each tested differently.

Group I includes clean wells with little or no water production. These wells are produced every 2 years for 5 days at good operating rates as determined by the Operating Committee, with the restriction that wells of capacities exceeding 300 barrels per day are not to be produced above 300 barrels per day.

Group II includes wells increasing in water production and clean wells near wet wells or in areas of active water encroachment. These wells are produced each year for 8 days at good operating rates as determined by the Operating Committee from the production history of each individual well.

About 270 wells were produced under this project in 1952.

Results:

1. The project has been successful in providing adequate information concerning the mechanical operating condition of the wells and in supplying desirable reservoir engineering information on the Shallow Oil Zone.

2. Production under this project was quite high under the original ten-day test procedure, reaching as high as 2900 barrels per day. Under the present system of two groups of wells and test procedures, the production has been reduced to an average of about 700 barrels per day, a rate considered a minimum to provide adequate operating and production information.

Group I includes clean wells with little or no water production. These wells are produced every 5 years for 1 day at good operating rates as determined by the Operating Committee, with the restriction that wells of capacities exceeding 300 barrels per day are not to be produced above 200 barrels per day.

Group II includes wells increasing in water production and clean wells near wet wells or in areas of active water encroachment. These wells are produced each year for 2 days at good operating rates as determined by the Operating Committee from the production history of each individual well.

About 270 wells were produced under this project in

1952.

Results:

1. The project has been successful in providing adequate information concerning the mechanical operating condition of the wells and in applying desirable reservoir engineering information on the Shallow Oil Zone.
2. Production under this project was quite high under the original run-in test procedure, reaching as high as 2500 barrels per day. Under the present system of two groups of wells and test procedures, the production has been reduced to an average of about 700 barrels per day, a rate considered a minimum to provide adequate operating and production information.

Discussion:

Controversial aspects of this project have centered around its primary objective. Is the objective to test the mechanical operating condition of the wells or to provide production and reservoir information?

Between 1945 and 1950 emphasis seemed to be on the latter with long production periods and high production rates.

In 1950, a Navy Board convened by the Director concluded that sufficient production history had been obtained, that production should be curtailed, and that clean oil wells could be tested by bore-hole measurements without production.

Based on a Navy directive production programs were curtailed. Emphasis was shifted to obtaining operating information rather than production information, resulting in a steep decline in production under this project. Determining the condition of clean oil wells by running suitable instruments in the hole, as recommended by the Navy Board Review, has not as yet been adopted.

However, in approving the new testing methods, Standard's representatives did so with the reservation that an eight-day test period in one case and a rate restriction of 300 barrels per day in another test method would not yield adequate reservoir information and thus reduce the effectiveness of the program in protecting the Reserve and insuring maximum ultimate recovery.

Since adoption of the revised testing methods, the

Controlled aspects of this project have centered around the primary objective. In the subject to test the mechanical operating condition of the wells or to provide production and reservoir information.

Between 1948 and 1950 emphasis seems to be on the latter

with long production periods and high production rates.

In 1950, a Navy Board convened by the Director concluded that efficient production history had been obtained, that production should be curtailed, and that clean oil wells could be tested by core-hole measurement method production. Based on a Navy directive production programs were out-

lined. Emphasis was shifted to obtaining operating information rather than production information, resulting in a series

of production under this project. Determining the condition of clean oil wells by running suitable instruments in the hole, as recommended by the Navy Board Review, has not as yet been adopted.

However, in approving the new testing methods, Standard's representatives did so with the reservation that an eight-day test period in one case and a rate restriction of 300 barrels per day in another case would not yield adequate reservoir information and thus reduce the effectiveness of the program in protecting the Reserve and insuring maximum oil recovery. Since adoption of the revised testing methods, the

program has been followed with only slight variation.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

109, 112, 122, 125, 138.

PROTECTIVE PRODUCTION OF WET WELLSDescription:

Wells of high water/oil ratios not being produced under other phases of the Readiness Program are produced under this project.

About 200 wells have been produced from time to time under this project.

Objectives:

1. To prevent losses in availability and ultimate recovery by protecting upstructure clean oil sands of the reservoir against damage by encroaching water surrounding and bypassing oil, rendering it unrecoverable.

2. To prevent water from high pressure, wet sands flooding lower pressure, clean sands through the well bore of multi-completed wells which are wet.

Pertinent Dates:

September 1945: Project initiated.

Procedure:

1. If a well on the Rotating Production Test Program appears wet, it is produced for a period of 30 to 60 days.

2. If the well remains wet at a substantially high water cut, it is placed on continuous production under the Wet Well Protective Production Program. Some wells clean up after the test production period or after continuous production. Others may be repaired and the encroaching water excluded. In these cases, the wells are then returned to the

PROTECTIVE PRODUCTION OF OIL WELLS

Description:

Wells of high water/oil ratios not being produced under other phases of the Reservoir Protection Program are produced under this project.

About 200 wells have been produced from time to time

under this project.

Objectives:

1. To prevent losses in availability and ultimate recovery by protecting reservoir clean oil sands of the reservoir against damage by encroaching water surrounding and bypassing oil, rendering it unrecoverable.
2. To prevent water from high pressure, wet sands flooding lower pressure, clean sands through the well bore of multi-completed wells when the well.

Pertinent Dates:

September 1948: Project initiated.

Procedure:

1. If a well on the Rotating Production Test Program appears wet, it is produced for a period of 30 to 60 days.
2. If the well remains wet at a substantially high water cut, it is placed on continuous production under the Wet Well Protection Production Program. Some wells clean up after the test production period or after continuous production. Others may be repaired and the encroaching water excluded. In those cases, the wells are then returned to the

Rotating Production Test Program.

Results:

General --

This Program may be considered relatively successful in its objective of retarding the invasion of clean oil sands by encroaching water through the well bore of wet wells and in retarding upstructure migration of water.

Specific -- (Results as of 1953)

Total number of wells produced on this project: 200.

Number of wells initially on this project: 58.

Number of wells which cleaned up (i.e., water/oil ratio reduced) sufficiently after continuous production to be removed from this project: 54.

Number of wells repaired (water excluded) and removed from this project: 61.

Number of wells currently producing on this project: 85.

Rate of production and cumulative production under this program may be found in Chapter III.

Discussion:

Judging by the number of initial wells on the program and the number produced under it currently or at one time, the project appears to have a snow-balling tendency. This effect is not necessarily the fault of the project itself; for it is essentially corrective in its nature, not preventative. If other programs fail to correct potential gradients and prevent water encroachment, some upstructure wells become wet and they are added to the Wet Well Protective Production Program. Thus

Protective Production Test Program.

Results:

General --

This Program may be considered relatively successful in its objective of reducing the invasion of clean oil areas by encroaching water through the well bore of wet wells and in reducing water saturation of water.

Specific -- (Results as of 1953)

Total number of wells produced on this project: 200.

Number of wells initially on this project: 68.

Number of wells which showed an (i.e., water/oil ratio

reduced) sufficiently after conditions production to

be removed from this project: 64.

Number of wells repaired (water excluded) and removed

from this project: 61.

Number of wells currently producing on this project: 35.

Rate of production and cumulative production under this

program may be found in Chapter III.

Discussion:

Justified by the number of initial wells on the program and the number produced under it currently or at one time, the project appears to have a snow-balling tendency. This effect is not necessarily the fault of the project itself; for it is essentially corrective in its nature, not preventative. If other projects fail to correct potential fractures and prevent water encroachment, some water-carrying wells become wet and they are added to the Wet Well Protective Production Program. Thus

the damage has already been done by the time a well is put on this program. By the singular nature of its corrective action, there is little reason for the return of any well to sustained clean production without extensive water shut-off repairs, which have proved expensive and not too successful -- often resulting in all production being shut-off.

When is a well wet enough to be placed on this Program? Only an arbitrary answer can be used. The selection method has been that any well showing a 10 per cent water cut or producing 10 barrels of water on production tests is added to this program if not already on another continuous production program. However, this testing method is not conclusive evidence that water flooding is occurring. Also, it might serve unnecessarily to aggravate the unbalanced condition inducing the fingering of water into the well, causing more water encroachment rather than less.

At what rate should the wet well be produced? Very high production usually means rapid rate of oil withdrawal as well as water withdrawal; for conservation reasons this is not desirable. If the production rate is low, water may be bypassing the well, moving upstructure or into low pressure clean sands connected in the well bore. The general policy on production rate for wet wells has varied considerably during the life of this program. The initial practice of automatically producing a wet well at maximum fluid withdrawal was abandoned in favor of analyzing each case to determine the

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 It is felt that a well not enough to be placed on this program
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 producing 10 barrels of water in production rate is added to
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best rate of production to protect the well and the reservoir. without excessive oil production. However, recent programs to be discussed have returned to the "maximum production" theory for wet wells.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

112, 123, 125, 138.

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to be discussed have returned to the "maximum production"
theory for wet wells.

SELECTED REFERENCES IN THE BIBLIOGRAPHY:

119, 122, 125, 128,

REPAIR AND REMEDIAL PROJECTDescription:

This Project consists of the repair or abandonment of Shallow Zone wells.

Objectives:

1. To maintain wells in the best possible condition for prompt availability of production.
2. To repair or abandon wells which constitute a hazard or which might damage the reservoir.

Pertinent Dates:

Sept. 1946 to March 1949: Period of intensive repair and remedial work.

March 1949 to----- Occasional repair work only.

Action Taken:

1. One hundred and eight (108) wells were repaired primarily to exclude water from the well bore.
2. Ten (10) wells in the Hay-Carman area of high pressure gas were repaired and now serve as observation wells.
3. Thirty-eight (38) wells, about 25 years old, in Hay-Carman area were abandoned due to their hazardous mechanical condition.

Results:

1. Repair of the 108 wells resulted in successful water exclusion, but also, all too often, partial or complete oil exclusion occurred. The net result was an overall marked decrease in availability.

REPAIR AND REPAIRS PROGRAM

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This project consists of the repair or abandonment of
Shallow Zone wells.

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Performance Dates:

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2. Ten (10) wells in the Hag-German area of high pressure were repaired and now serve as observation wells.
3. Thirty-eight (38) wells, about 25 years old, in Hag-German area were abandoned due to their hazardous mechanical condition.

Results:

1. Repair of the 108 wells resulted in successful water exclusion, but also, all too often, partial or complete oil exclusion occurred. The net result was an overall marked decrease in availability.

2. As a result of unsuccessful repair work some wells had to be abandoned.

3. Water encroachment in the area around the repaired wells continued.

4. The migration of fluids between sands was stopped only in the well bores of the few repaired wells.

Conclusions and Current Actions:

As far as guarding against hazardous conditions in wells of bad mechanical condition, the program may be termed successful.

As regards the repair of wells to prevent water encroachment without damaging oil productivity and to prevent the migration of fluids between sands -- these phases of the Program were unsuccessful and in effect have been abandoned.

Lack of current repair work, for which there is much justification or hope of success, has retarded other phases of this program.

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109, 122, 138.

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SELECTED REFERENCES IN THE BIBLIOGRAPHY:

109, 102, 108.

Part DRECENT ADDITIONAL RESERVOIR ENGINEERING PROBLEMSNOW IN PROGRESS OR PROPOSED AS OF 1952

In 1952 the Operating Committee and the Engineering Committee concluded that drastic changes and additions were necessary to the State of Readiness Program for the Shallow Oil Zone. The Program with modifications had been in effect for seven years, and sufficient production and reservoir data were available to permit a complete reevaluation. Also, considerable additional reservoir information had become available as a result of the extensive post-war exploratory and development drilling program in the Shallow Zone, especially along the South Flank and in the western portions of the Reserve. This information also indicated the urgent need for changes in the current Program.

Consequently, in 1952 and 1953, the Engineering Committee made a comprehensive review of the State of Readiness Program. This study culminated in the preparation by the Unit of a comprehensive report entitled, "Review of State of Readiness Program, Shallow Oil Zone, 1945-1952; Recommended Programs for Future Operation with Particular Reference to Present Losses of Availability and Ultimate Recovery."¹³⁸ This report, dated 27 February 1953, was submitted by the Engineering Committee to the Secretary of the Navy and to the Standard Oil Company of California.

In brief the conclusions of the Engineering Committee were that "...losses in maximum economic ultimate recovery

APPENDIX

RECENT ADDITIONAL RESERVOIR ENGINEERING PROGRAMS

HOW IN PROGRAMS OR PROPOSED AS OF 1955

In 1955 the Operating Committee and the Engineering Committee concluded that drastic changes and additions were necessary to the State of Readiness Program for the Shallow Oil Zone. The Program with modifications had been in effect for seven years, and sufficient production and reservoir data were available to permit a complete reevaluation. Also, considerable additional reservoir information had become available as a result of the extensive post-war exploratory and development drilling program in the Shallow Zone, especially along the coast plain and in the western portion of the Reserve. This information also indicated the urgent need for changes in the current Program.

Consequently, in 1953 and 1955, the Engineering Committee made a comprehensive review of the State of Readiness Program. This study culminated in the preparation by the Unit of a comprehensive report entitled, "Review of State of Readiness Program, Shallow Oil Zone, 1945-1955; Recommendations for Future Operation with Particular Reference to Present Losses of Availability and Ultimate Recovery." This report, dated 27 February 1955, was submitted by the Engineering Committee to the Secretary of the Navy and to the Standard Oil Company of California.

In order the coordination of the Engineering Committee were that "... losses in maximum economic ultimate recovery

and availability of production have been and are taking place in the Shallow Oil Zone." The present Program had not and could not prevent the losses, which would continue under the existing reservoir conditions.

Recommendations of the Committee consisted of four programs designed to correct undesirable conditions. These programs as recommended and as approved will be covered briefly in the following pages. Since these programs constituted a two to three-fold increase in oil production, they were thoroughly reviewed and explained by Navy and Standard to the Congressional Committee on Naval Affairs. With a "green light" from Congress, the programs with some restrictive modifications were finally approved by the Secretary of the Navy in the spring of 1953. In addition to the new programs, the following projects under the original State of Readiness Program were continued: Rotating Production Test, Repair and Remedial Work, Protection of Surface Equipment and to a minor extent the Protective Production of Wet Wells. The latter project and other original projects under the Old Program were mostly absorbed or abandoned under the four new programs now in progress.

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Protection of Surface Equipment and to a minor extent the Pro-
tective Production of Wet Wells. The latter project and other
original projects under the Old Program were mostly absorbed
or abandoned under the four new programs now in progress.

The following table shows the results of the four new programs
under the State of Readiness Program for the period from
January 1, 1933, to December 31, 1933. The total production
of the four new programs was 1,000,000 barrels of oil,
which is a two-fold increase over the production of the
four old programs for the same period. The total production
of the State of Readiness Program for the period from
January 1, 1933, to December 31, 1933, was 1,500,000
barrels of oil, which is a three-fold increase over the
production of the State of Readiness Program for the same
period under the Old Program.

SS-2 AND M SOUTH FLANK REMEDIAL PROGRAMObjectives:

This program was designed to eliminate an adverse pressure gradient on the south flank of the SS-2,M sand, which indicated that oil was being lost by migration downdip into water sands. Calculations indicated that the migration was occurring at a rate of approximately 2 million barrels per year of which 50 per cent would probably be unrecoverable unless additional wells were drilled. However, additional drilling would not be economical.

Action:

Commencing in June 1953 a remedial production program was initiated consisting of continuously producing rows of high pressure upstructure wells, both in the gas cap and in the oil zone, in order to reduce upstructure pressure and thereby correct the North to South pressure gradient.

Results:

Commencing about December 1953 the pressure gradient already had been corrected in certain areas along the South Flank. As the gradient was corrected in each area the continuous producing wells except for some observation wells were removed from production. All of the area is approaching a balanced pressure condition. The program currently is being made more flexible to maintain the area in as near a static condition as possible.

22-2 AND 2 SOUTH MAIN FIELD PROGRAM

Objectives:

This program was designed to eliminate an adverse pressure gradient on the south flank of the 22-2, N field, which indicated that oil was being lost by migration down the water sands. Calculations indicated that the migration was occurring at a rate of approximately 2 million barrels per year of which 10 per cent would probably be unrecoverable unless additional wells were drilled. However, additional drilling would not be economical.

Action:

Commencing in June 1953 a remedial production program was initiated consisting of continuously producing from oil high pressure structure wells, both in the gas cap and in the oil zone, in order to reduce upstructure pressure and thereby correct the North to South pressure gradient.

Results:

Commencing about December 1953 the pressure gradient already had been corrected in certain areas along the South flank. As the gradient was corrected in each area the corresponding producing wells except for some observation wells were removed from production. All of the area is approaching a balanced pressure condition. The program currently is being made more flexible to maintain the area in as near a static condition as possible.

SS-1 SOUTH FLANK REMEDIAL PROGRAMDescription:

In essence this program is similar to the one described above for the SS-2, M South Flank. An adverse pressure gradient from North to South exists, coupled with an apparently receding and diminishing aquifer to the South. Extensive migration of oil (about 1.5 million barrels per year) downdip into the water sands is believed to be occurring as a result of the pressure gradient and as indicated by development well and production evidence.

Action:

To minimize this loss, an increased production program was initiated along the south flank as the only practical solution currently available. In addition, high gas-oil wells upstructure are being produced to correct the pressure gradient.

Commencing in 1953, an electric-analogy study of the regional aquifer affecting the SS-1 sand, particularly along the south flank, was in progress by California Research Corporation.

Status:

The current status of the above program and study as of May 1954 is not known by the author.

22-1 SOUTH FLANK REPAIR PROGRAM

Description:

In essence this program is similar to the one described above for the 22-2, a South Flank. An adverse pressure gradient from North to South exists, coupled with an apparently rising and diminishing aquifer to the South. Extensive migration of oil (about 1.5 million barrels per year) down the flank the water sands is believed to be occurring as a result of the pressure gradient and as indicated by development well and production evidence.

Action:

To minimize this loss, an increased production program was initiated along the South Flank as the only practical solution currently available. In addition, large gas-oil wells structures are being proposed to correct the pressure gradient. Commencing in 1953, an electric-analogy study of the regional aquifer affecting the 22-1 sand, particularly along the South Flank, was in progress by California Research Corporation.

Status:

The current status of the above program and study as of May 1954 is not known by the author.

NORTH FLANK AND EAST NOSE REMEDIAL PROGRAMDescription:

Results of the various water encroachment studies under the original State of Readiness Program convinced the Engineering Committee that the encroachment of high pressure edgewater was damaging to the Shallow Oil Zone. Efforts to utilize this natural water drive as an effective producing force and sweeping mechanism had shown it to be inefficient for the Shallow Oil Zone sand with its great variation in permeability.

Recommendations:

With the above in mind and with heavy water encroachment still occurring along the North flank and East Nose, the Engineering Committee recommended an increased production program in these areas and the drilling of 36 new wells. The production was to be mainly from wet wells of high water-oil ratios and from all water wells. The new wells were to be drilled in high water-oil ratio areas, and placed on continuous production. The desired result was a water production rate to match the rate of water encroachment and thus prevent upstructure migration of high pressure edgewater.

Status:

The exact status of this program as of May 1954 is not well known by the author. However, it is known that many additional North flank and East nose wells have been placed on continuous production. Also, a reduced drilling program was approved by the Secretary of the Navy.

WORTH PLANT AND EAST MOOR SPECIAL PROGRAM

Description:

Results of the various water encroachment studies under the original State of Reserves Program convinced the Engineering Committee that the encroachment of high pressure edge-water was damaging to the Shallow Oil Zone. Efforts to utilize this natural water drive as an effective producing force and sweep-out mechanism had shown it to be inefficient for the Shallow Oil Zone and with its great variation in permeability.

Recommendations:

With the above in mind and with heavy water encroachment still occurring along the North flank and East nose, the Engineering Committee recommended an increased production program in these areas and the drilling of 36 new wells. The production was to be mainly from out wells of high water-oil ratios and from all water wells. The new wells were to be drilled in high water-oil ratio areas, and placed on continuous production. The desired result was a water production rate to match the rate of water encroachment and thus prevent structure alteration of high pressure edge-water.

Status:

The exact status of this program as of May 1954 is not well known by the author. However, it is known that many additional North flank and East nose wells have been placed on continuous production. Also, a reduced drilling program was approved by the Secretary of the Navy.

77-2G AREA (SS-2 SAND) REMEDIAL PROGRAMDescription:

This program is a small version of the previous program described for the North flank and East nose. To the southeast of the competent fault just north of well 77-2G the SS-2 acts as a separate and individual reservoir. Water encroachment upstructure is occurring, and efforts in 1950-1952 to stop it by gas injection in the secondary gas cap through well 77-2G were not successful.

Recommendations:

The program as recommended by the Engineering Committee consisted of drilling and producing three SS-2 downstructure wells to retard water encroachment, putting all SS-2 wells in the area on production, and producing wells in the gas cap to a limited extent.

Status:

The program is in progress but its present status is not known by the author.

77-20 AREA (22-2 647) REGIONAL PROGRAM

Description:

This program is a small version of the previous program described for the North flank and East nose. To the west of the competent fault just north of well 77-20 the 22-2 acts as a separate and individual reservoir. Water encroachment upstructure is occurring, and efforts in 1950-1952 to stop it by gas injection in the secondary gas cap through well 77-20 were not successful.

Recommendations:

The program as recommended by the Engineering Committee consisted of drilling and producing three 22-2 downstructure wells to retard water encroachment, control the 22-2 wells in the area on production, and producing wells in the gas cap to a limited extent.

Status:

The program is in progress but its present status is not known by the author.

CHAPTER VI
UNITIZATION
AND
UNIT OPERATION
OF
NAVAL PETROLEUM RESERVE NO. 1

1950

The following is a list of the members of the
Committee on the History of the University of Chicago
for the year 1950. The members are listed in
alphabetical order of their last names.

CHAPTER VI

UNIVERSITY

ART

DEPARTMENT

OF

WALLACE THURGOOD BULLOCK NO. 1

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Committee on the History of the University of Chicago
for the year 1950. The members are listed in
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CHAPTER VI
UNITIZATION
AND
UNIT OPERATION
OF
NAVAL PETROLEUM RESERVE NO.1

BRIEF REVIEW OF EVENTS
LEADING TO UNITIZATION^{5,6}

For nearly twenty years after the discovery of oil in Elk Hills, Navy had not experienced much success in carrying out the settled policy of the Government of maintaining a great naval petroleum reserve in the ground. As evidenced by the production history of the Shallow Oil Zone, Figures 3-1 and 3-3, production from the Elk Hills field was continuous and heavy; for production from privately owned lands adjacent to and within N.P.R. No. 1 had compelled the issuance by Navy of off-set leases and continuous production from them to restrict drainage from the Reserve.

Finally, in 1938, Navy obtained legislation from Congress which enabled it to deal positively and constructively toward making Elk Hills a petroleum reserve in reality. This legislation was the Congressional Act of June 30, 1938.¹⁶² It authorized the Secretary of the Navy in effect either (1) to make satisfactory agreements with private owners on the Elk Hills field for the conservation of petroleum from the field;

CHAPTER VI

LEGISLATION

AND

UNIT OPERATIONS

OF

NAVAL PETROLEUM RESERVE NO. 1

SELECT REVIEW OF EVENTS
LEADING TO ESTABLISHMENT

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 authorized the Secretary of the Navy in effect either (1) to
 make satisfactory agreements with private owners on the Elk
 Hills field for the conservation of petroleum from the field;

or (2) in the event satisfactory agreements could not be reached, then he was authorized to proceed with the purchase or condemnation of all such privately owned lands or leases in N.P.R. No. 1.⁵

With this Act as a backdrop, negotiations with Standard--- who was the only remaining owner and operator of any significance at the field---finally culminated in a contract of 20 November 1942 which effectively unitized N.P.R. No. 1 and gave the Secretary of the Navy complete and final authority over the Reserve.

In anticipation of the successful conclusion of the above contract, Navy obtained Executive Order No. 9257 from the President.⁵ This order, dated 15 October 1942, extended the boundaries of N.P.R. No. 1 to include an additional 1720 acres of public land and approximately 4000 acres of privately owned land, mainly Standard's fee owned and leased land on the Elk Hills structure. This enlargement effectively included the balance of the known geologic structure of the Shallow Oil Zone. This boundary and others during the life of the field are shown on Figure 1-3.

Although this contract was never finally approved by Congress for legal reasons and was superceded by temporary agreements until the approval of the present Unit Contract on 19 June 1944,¹⁵⁰ the date of 20 November 1942 marks the effective unification of the Government and privately owned lands on N.P.R. No. 1.

or (2) in the event satisfactory agreements could not be reached, then he was authorized to proceed with the purchase or redemption of all such privately owned lands or leases in H. P. No. 1.

With this Act as a backdrop, negotiations with Standard Oil who was the only remaining owner and operator of any significant acreage in the field--finally culminated in a contract of 30 November 1942 which effectively unified H. P. No. 1 and gave the Secretary of the Navy complete and final authority over the Reserve.

In anticipation of the successful conclusion of the above contract, Navy obtained Executive Order No. 9857 from the President. This order, dated 18 October 1942, expanded the boundaries of H. P. No. 1 to include an additional 1780 acres of public land and approximately 6000 acres of privately owned land, mainly Standard's fee owned and leased land on the Elk Hills structure. This enlargement effectively included the balance of the known geologic structure of the Shallow Oil Zone. This boundary and others during the life of the field are shown on Figure 1-3.

Although this contract was never finally approved by Congress for legal reasons and was superseded by temporary agreements until the approval of the present Unit Contract on 12 June 1944, the date of 30 November 1942 marks the effective unification of the government and privately owned lands on H. P. No. 1.

UNIT OPERATION OF N.P.R. NO. 1

The Unit Operation of N.P.R. No. 1 is carried out under four interrelated contracts entered into by Navy and Standard.^{147,148} These contracts are discussed below.

Unit Plan Contract, NOD 4219.¹⁵⁰

On 19 June 1944 the Unit Plan Contract between the Navy Department and Standard Oil Company of California was approved. This Contract, retroactive to 20 November 1942, rescinded all previous temporary agreements and is the basic contract for the Unit development and operation of the entire N.P.R. No. 1 (Elk Hills field). Navy and Standard are the only participants in the Unit Operation.

In many ways it is similar to any contract completely unitizing an oil field. It eliminated all competitive features of past operations by substituting cooperative unit development and production methods. Procedures were established for determining relative participating percentages of each party in production receipts and costs. Methods of allocating and disposing of production were agreed to. And the other usual items---such as determination of disputes, accounting procedures, term of the contract, etc.---are all provided for in the Unit Contract. Advisory and operating committees established for the Unit Operation of the Reserve are discussed later in this chapter.

The Unit Contract, however, is unlike any contract unitizing a commercial oil field among private interests only. This fact

UNIT OPERATION OF A. S. N. No. 1

The Unit Operation of A. S. N. No. 1 is carried out under four interrelated contracts entered into by Navy and Standard. These contracts are discussed below.

Unit Plan Contract, A. S. N. No. 1

On 19 June 1944 the Unit Plan Contract between the Navy Department and Standard Oil Company of California was approved. This Contract, retroactive to 30 November 1942, provided all previous temporary agreements and is the basic contract for the Unit development and operation of the entire A. S. N. No. 1 (Eik Wills Field). Navy and Standard are the only participants in the Unit Operation.

In many ways it is similar to any contract completely unitizing an oil field. It eliminated all competitive features of past operations by establishing cooperative unit development and production methods. Procedures were established for determining relative participating percentages of each party in production receipts and costs, methods of allocating and disposing of production were agreed to. And the other usual items--such as determination of disputes, accounting procedures, form of the contract, etc.--are all provided for in the Unit Contract. Advisory and operating committees established for the Unit Operation of the Reserve are discussed later in this chapter.

The Unit Contract, however, is unlike any contract unitizing a commercial oil field among private interests only. This case

will be illustrated by some of the important and interesting features quoted from the Contract and/or discussed in succeeding paragraphs.

Reasons for unitization and basic provisions of the Contract are given in the following excerpts from the Recitals in the Unit Contract...¹⁵⁰

"(6) The following considerations have led Navy and Standard to conclude that the most desirable and effective means of protecting the Reserve and of assuring the maximum ultimate recovery of oil, gas, natural gasoline and associated hydrocarbons from the Reserve is to develop and operate all lands in the Reserve as a unit:

- (a) The Reserve is a part of a single geologic structure; and the practice of offset drilling has not proved to be an effective means of assuring to Navy its proper share of oil produced from the Reserve and does not conserve Navy's oil in the ground.
- (b) The independent development and operation of privately-owned lands in the Reserve, from which oil may be freely produced without control or restraint by Navy, would constitute a grave threat to the security of the Reserve and would impair Navy's power to conserve oil in the ground.
- (c) Navy deems it inadvisable to shut in the wells on Navy's lands forthwith in view of possible permanent damage to the wells or to the national interest in the ultimate economical production of oil therefrom, and in view of the probable drainage of oil from Navy's lands in the event lands not controlled by Navy are developed and operated without simultaneous protective development and operation of Navy's lands.
- (d) The unit plan of development and operation as set out herein will:
 - (i) Afford Navy a means of acquiring complete control over the development of the entire Reserve and the production of oil therefrom in order that Navy may protect the Reserve and conserve in the ground all of Navy's share of the oil in the Reserve as well as a substantial portion of Standard's share of oil in the Reserve.

will be illustrated by some of the important and interesting features noted from the Contract and/or discussed in preceding paragraphs.

Reasons for limitation and basic provisions of the Contract are given in the following excerpts from the Reserves in the Unit Contract... 150

"(e) The following considerations have led Navy and Standard to conclude that the most desirable and effective means of protecting the Reserve and of assuring the maximum ultimate recovery of oil, gas, natural gasoline and associated hydrocarbons from the Reserve is to develop and operate all lands in the Reserve as a unit:

(a) The Reserve is a part of a single geologic structure; and the practice of offset drilling has not proved to be an effective means of securing to Navy its proper share of oil produced from the Reserve and does not conserve Navy's oil in the ground.

(b) The independent development and operation of privately-owned lands in the Reserve, from which oil may be freely produced without control or restraint by Navy, would constitute a grave threat to the security of the Reserve and would impair Navy's power to conserve oil in the ground.

(c) Navy deems it inadvisable to shut in the wells on Navy's lands forthwith in view of possible permanent damage to the wells or to the national interest in the ultimate economical production of oil therefrom, and in view of the probable drainage of oil from Navy's lands in the event lands not controlled by Navy are developed and operated without simultaneous protective development and operation of Navy's lands.

(d) The unit plan of development and operation as set out herein will:

(1) Afford Navy a means of acquiring complete control over the development of the entire Reserve and the production of oil therefrom in order that Navy may protect the Reserve and conserve in the ground all of Navy's share of the oil in the Reserve as well as a substantial portion of Standard's share of oil in the Reserve.

- (ii) Make available to Standard a limited quantity of oil from one of its most important sources at a time when it is needed by Standard to meet its war requirements for refined petroleum products in the West Coast area.
- (iii) Place the Reserve in a condition of readiness whereby it will be able promptly to produce oil in substantial quantities whenever the strategic situation of the United States in the future may so require.
- (iv) Result in the eventual receipt by Navy and Standard, respectively, from the various commercially productive zones underlying the Reserve of the quantities of recoverable oil, gas, natural gasoline and associated hydrocarbons underlying their respective lands as of November 20, 1942.
- (v) Provide for the economical and efficient development and operation of the Reserve.
- (vi) Result in securing the maximum ultimate recovery of oil, gas, natural gasoline and associated hydrocarbons from the Reserve."

Thus, under terms of the Contract, Navy acquired complete control and was finally in a position to operate the field as a true naval petroleum reserve. As a special consideration to Standard, a "primary period" was established and later extended during which Standard effectively received all of the Shallow Oil Zone production from after the war until 2 August 1950. This production amounted to about 30 million barrels and was charged against Standard's ultimate share in the total production from the Shallow Oil Zone.

The unusual but necessary provisions for the current and ultimate sharing of all costs are extensively discussed in Chapter VIII.^{147,152}

The Contract gives the Secretary of the Navy the final decision in all disputes arising in connection with the Unit

(ii) have available to Standard a limited quantity of all types of its most important products at a time when it is needed by Standard to meet its war requirements for related petroleum products in the West Coast area.

(iii) Place the Reserve in a condition of readiness whereby it will be able promptly to produce all its additional quantities whenever the strategic situation of the United States in the future may so require.

(iv) Place in the Standard Reserve by Navy and Standard, respectively, from the various commercially productive zones underlying the Reserve of the quantities of recoverable oil, gas, natural gasoline and associated hydrocarbons underlying their respective lands as of November 30, 1942.

(v) Provide for the economical and efficient development and operation of the Reserve.

(vi) Permit in operating the Reserve a flexible recovery of oil, gas, natural gasoline and associated hydrocarbons from the Reserve.

Thus, under terms of the Standard, Navy assigned complete control and was finally in a position to operate the field as a true naval petroleum reserve. As a special consideration to Standard, a "primary period" was established and later extended during which Standard effectively received all of the Shallow Oil Zone production from after the war until Standard 1950. This production amounted to about 50 million barrels and was charged against Standard's liability there in the total production from the Shallow Oil Zone.

The unusual but necessary provisions for the current and future sharing of all costs were alternatively discussed in Chapter VII, 147, 152.

The Contract gives the Secretary of the Navy the final decision in all disputes arising in connection with the Unit

Operation of the Reserve. Moreover, he is the only party to the Contract with authority to terminate it.

Unit Operating Agreement NOD 4220 of 19 June 1944.¹⁴⁹

Contingent with the signing of the Unit Plan Contract, Navy selected Standard as the Operator for the Unit Operation of N.P.R. No. 1, and the two parties entered into an operating agreement, Contract NOD 4220. This contract spells out the duties and responsibilities of the Operator and his relationships with Navy. It more clearly defines the duties of the Operating Committee; states the records and reports required; and outlines a specific accounting procedure to be followed.

Whereas only Navy can cancel the Unit Plan Contract, either Standard or Navy may terminate the Unit Operating Agreement. In such an event, Navy would have the right to select another Operator.

The Amendatory and Supplemental Agreement to the Unit Plan Contract, NOD 8477.¹⁴⁶

On 22 December 1948, the Unit Plan Contract was amended and supplemented by additional agreements. The boundaries of the Reserve had been extended to include some land previously outside of the Reserve but later found to be on the same geologic structure of Elk Hills. The agreement extended the Unit Operation to these additional lands. Some of the other important terms of this Agreement are listed below:

- (1) The primary period was extended.
- (2) The Engineering Committee was given advisory functions to the Operating Committee.

Department of the Navy, as the only party to the contract with authority to terminate it.

Unit Operating Agreement, 000 4330 of 11, Jan 1914.

Consistent with the signing of the Unit Plan Contract, Navy selected Standard as the Operator for the Unit Operation of R.F.A. No. 1, and the two parties entered into an operating agreement, Contract 000 4330. This contract spells out the duties and responsibilities of the Operator and his relation-ships with Navy. It more clearly defines the duties of the Operating Committee; states the reports and reports required; and outlines a specific accounting procedure to be followed.

Whereas only Navy can cancel the Unit Plan Contract, either Standard or Navy may terminate the Unit Operating Agreement. In such an event, Navy would have the right to select another Operator.

The Amendment and Supplemental Agreement to the Unit Plan Contract, 000 8477, 148

On 23 December 1943, the Unit Plan Contract was amended and supplemented by additional agreements. The boundaries of the Navy's had been expanded to include more land previously outside of the Navy's but later found to be on the same geographic structure of Elk Hill. The agreement extended the Unit Operation to these additional lands. Some of the other important terms of this Agreement are listed below:

- (1) The primary period was extended.
- (2) The Engineering Committee was given advisory functions to the Operating Committee.

- (3) Maintenance readiness costs were to be paid currently by Navy and Standard in accordance with their percentage receipt of current production.

Supplemental and Exploratory Agreement, NOd 7166.148,152

This relatively less important of all the Contracts provided for the drilling of a well in Section 31-T on the east end of the Reserve. It was necessary to determine if oil sands in this region bordering on the North Coles Levee field were the same sands as in the Stevens Zone and thus if it would be necessary to extend the boundaries of the Reserve to include perhaps the North Coles Levee field.

After drilling this well, it was decided that, although the oil productive sand was a Stevens Sand, a stratigraphic or other barrier apparently separated the two fields; thus no action was taken to extend the boundaries of the Reserve farther east.

(3) Rainwater recharge basins were to be paid currently
by levy and standard in accordance with their par-
centage receipt of water production.

Supplemental and Exploratory Agreement, 1954-1955

This relatively less important of all the contracts pro-
vided for the drilling of a well in Section 31-T on the east
end of the Reserve. It was necessary to determine if oil
sands in this region bordering on the North Colas level field
were the same sands as in the Stevens Zone and thus if it would
be necessary to extend the boundaries of the Reserve to include
perhaps the North Colas level field.

After drilling this well, it was decided that, although
the oil productive sand was a Stevens sand, a stratigraphic
or other barrier separated the two fields; thus
no action was taken to extend the boundaries of the Reserve
further east.

The following text is extremely faint and largely illegible, appearing to be a continuation of the report or a list of items.

OPERATING COMMITTEE

The Unit Plan Contract created an Operating Committee to supervise and direct all exploration, prospecting, development, and producing operations on the Reserve.¹⁵⁰

Membership.

The committee consists of two petroleum engineers, one from each of the two participants. Each member of the committee must have at least ten years' experience as a petroleum engineer, or be a graduate engineer with at least five years such experience.

Duties.^{146,149,150}

In brief, it is the responsibility of the Operating Committee to formulate and execute..."plans and methods for developing and maintaining Naval Petroleum Reserve No. 1 in state of readiness that will make available, when the strategic demands of the country require, maximum production compatible with good engineering practice."¹¹³

Navy's member of the Operating Committee is referred to by the abbreviated title NMOC. Currently, Standard's member of the committee is also the Field Superintendent. This committee meets daily, and minutes are recorded of decisions and plans made at each meeting. Disagreements are settled by the Secretary of the Navy. The relationships of this committee in the Unit Operation are shown on the organization diagrams of Figures 7-3 and 7-4.

OPERATING COMMITTEE

The Unit has created an Operating Committee to supervise and direct all exploration, development, production and marketing operations in the Basin.

The committee consists of two petroleum engineers, one from each of the two participating independent companies, and one must have at least ten years general experience as a petroleum engineer, or be a graduate engineer with at least five years general experience.

Include, 10, 14, 15

In order, it is the responsibility of the Operating Committee to formulate and execute... plans and policies for developing and maintaining... in... state of readiness that will meet... when the strategic demands of the country require, maximum production capabilities with good engineering practices.

NAVY's member of the Operating Committee is referred to by the approved title WOOD. Currently, Standard's member of the committee is also the Vice Superintendent. This committee meets daily, and minutes are recorded of decisions and plans made at each meeting. Decisions are reached by the Secretary of the Navy. The relationship of this committee in the Unit Operation and the organization

diagram of Figures 7-3 and 7-4.

ENGINEERING COMMITTEE

The Unit Plan Contract established a committee entitled the Engineering Committee to carry out certain specific functions under the Contract and Operating Agreement.¹⁵⁰

Membership.

The committee consists of six members, three each for Navy and Standard. Two of the members must be same members as for Operating Committee. The other four members must be petroleum engineers or geologists, with the same qualifications as for those for members of the Operating Committee.

Duties.^{146,150}

Specific duties are enumerated in Contracts NOd 4219 and NOd 8477. In brief, the Engineering Committee is responsible for the review and approval of certain plans and methods and other engineering matters as may be referred to it by the Operating Committee or Standard and Navy. One of its most important functions is the fixing of the participating percentages of Navy and Standard in each zone.

The Committee now meets quarterly or more often as necessary. Formal but not detailed minutes are recorded of each meeting.

OPERATING COMMITTEE

The first plan proposed established a committee entitled the Engineering Committee to carry out certain specific functions under the Contract and Operating Agreement, 1919.

The committee consists of six members, three each from Navy and Standard. Two of the members must be non-members of the Operating Committee. The other four members must be petroleum engineers or geologists, with the same qualifications as for those for members of the Operating Committee.

Article 1.18, 1.20

Specific duties are enumerated in Contract 1919-1920 and 800 2477. In brief, the Engineering Committee is responsible for the review and approval of certain plans and methods and other engineering matters as may be referred to it by the Operating Committee of Standard and Navy. One of its most important functions is the fixing of the participating percentages of Navy and Standard in each zone.

The Committee now meets quarterly or more often as necessary. Formal but not detailed minutes are recorded of each meeting.

SELECTED REFERENCES IN THE BIBLIOGRAPHY REFERRING
TO UNITIZATION AND UNIT OPERATION OF R.P.H. NO. 1

2, 5, 6, 60-69, 146-150, 156, 162, 258-261

SELECTED REPORTS OF THE DISTRICT ATTORNEY GENERAL
IN CONNECTION WITH THE OPERATION OF W. A. H. NO. 1

2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

The following reports were received from the various sources mentioned in the foregoing list, and are being published in this volume for the information of the public. The reports are arranged in the order in which they were received, and are not necessarily in chronological order. The reports are published as they are received, and are not necessarily in chronological order. The reports are published as they are received, and are not necessarily in chronological order.

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CHAPTER VII

ADMINISTRATION

NAVAL PETROLEUM AND OIL SHALE RESERVES

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CHAPTER VII

STATISTICS

STATISTICS AND THE SCIENCE OF THE FUTURE

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CHAPTER VIIADMINISTRATIONNAVAL PETROLEUM AND OIL SHALE RESERVESORGANIZATION

Congress -- by an Act of 1920¹⁴ as amended¹⁶² -- and the President -- by an Executive Order of 17 March 1927⁹ -- placed the administration of the naval petroleum and oil shale reserves under the authority of the Navy, and gave the Secretary of the Navy authority for the exploration, development and operation of the naval petroleum reserves only, subject to many Congressional limitations.

In October, 1927, the Secretary of the Navy established the Office of Naval Petroleum and Oil Shale Reserves. The Director of this office is an officer of the Navy, appointed by the Secretary of the Navy. Different grades of officers have held this post; however, the billet is normally assigned to a Captain. The Director serves as a representative of the Secretary in executing the responsibilities of administration and control of the naval reserves as authorized by Congress and delegated by the President.⁷ His functions are somewhat similar to those of a bureau chief.

General Field Organization. The general field organization of the Office of Naval Petroleum and Oil Shale Reserves

CHAPTER VII

ADMINISTRATION

NAVAL RESERVE AND OIL SHALE RESERVE

ORGANIZATION

Government -- by an Act of 1933¹⁴ as amended¹⁵ and the President -- by an Executive Order of 14 March 1937 -- placed the administration of the naval petroleum and oil shale reserves under the authority of the Navy, and gave the Secretary of the Navy authority for the expansion, development and operation of the naval petroleum reserves only, subject to many Congressional limitations.

In October, 1937, the Secretary of the Navy established the Office of Naval Petroleum and Oil Shale Reserves. The Director of this office is an officer of the Navy, appointed by the Secretary of the Navy. Different grades of officers have held this post; however, the billet is normally assigned to a Captain. The Director serves as a representative of the Secretary in exercising the responsibilities of administration and control of the naval reserves as authorized by Congress and delegated by the President.¹⁶ His functions are somewhat similar to those of a general officer.

General Field Organization. The general field organization of the Office of Naval Petroleum and Oil Shale Reserves

varies considerably, depending upon the location and extent of exploration and development work in progress in each Reserve from year to year.

In Figure 7-1 a recent Field Organizational Chart for the Naval Petroleum and Oil Shale Reserves is shown. The chart illustrates the extent which the field organization may assume during years of extensive exploration and development work in the various Reserves, such as 1944 through 1952, as provided for by Congressional appropriations. By 1954, however, most of the exploration and development work had been suspended except in Elk Hills (N.P.R. #1); and most of the field offices were on caretaker status or closed, as indicated by the asterisks on the Chart of Figure 7-1. The chart also indicates the rank of the officer in some of the billets at the date of the chart.

Office of the Director Naval Petroleum Reserves,⁷ The organization and staff of the Director's Office is varied by the Director to meet current requirements. The type of organization and the number of civilian employees and officers on the staff may vary widely as the exploration and development program in each of the reserves changes.

The organization of this office as of January 1953 is shown in Figure 7-2. Even at the time exploration was in progress in Reserves No. 3 and No. 4 (Teapot Dome and Alaska), the staff was relatively small considering the work being done and the large funds involved. With the suspension of exploration in Teapot Dome and Alaska, the staff was reduced in 1953.

various countries, depending upon the location and extent of existing and development work in progress in each country. Two years to four.

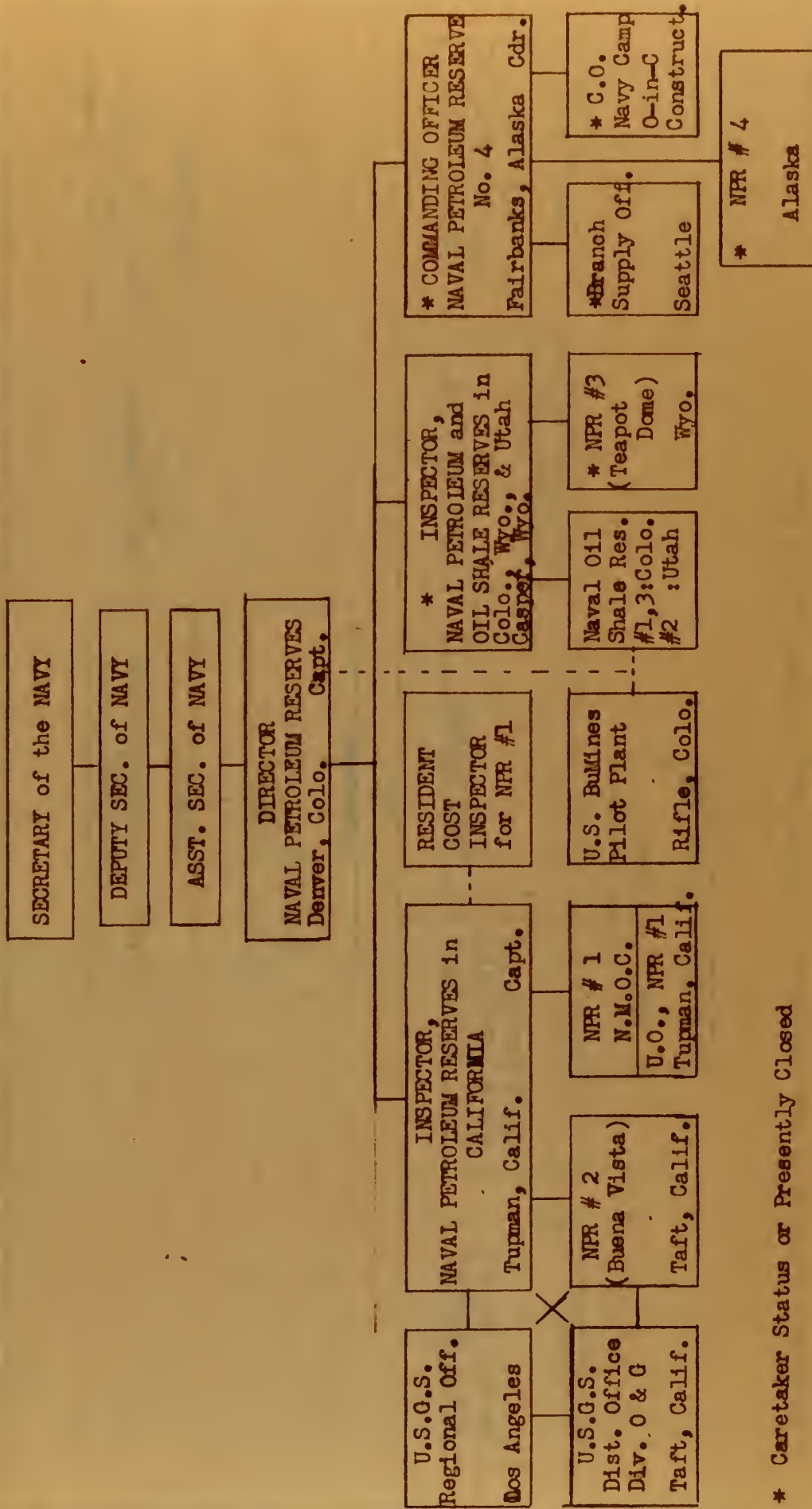
In Figure 7-1 a general field organizational chart for the Naval Petroleum and Oil Shale Research is shown. The chart illustrates the extent which the field organization has assumed during years of extensive exploration and development work in the various reserves, such as 1944 through 1952, as provided for by Congressional appropriations. By 1954, however, most of the exploration and development work had been suspended except in the field offices in the Gulf of Mexico and west of the field offices were no longer active or closed, as indicated by the asterisks on the chart in Figure 7-1. The chart also indicates the rank of the officer in each of the offices as well as the name of the officer.

Office of the Director Naval Petroleum Research

Organization and staff of the Director's Office is varied by the Director to meet current requirements. The type of organization and the number of civilian employees and officers in the staff may vary widely as the exploration and development program in each of the reserves changes.

The organization of this office as of January 1954 is shown in Figure 7-2. Even at the time exploration was in progress in Reserves No. 2 and No. 4 (Yacop Dome and Island), the staff was relatively small considering the work being done and the large funds involved. With the suspension of exploration in Yacop Dome and Island, the staff was reduced in 1953.

FIELD ORGANIZATION, NAVAL PETROLEUM RESERVES



* Caretaker Status or Presently Closed

FIG. 7-1

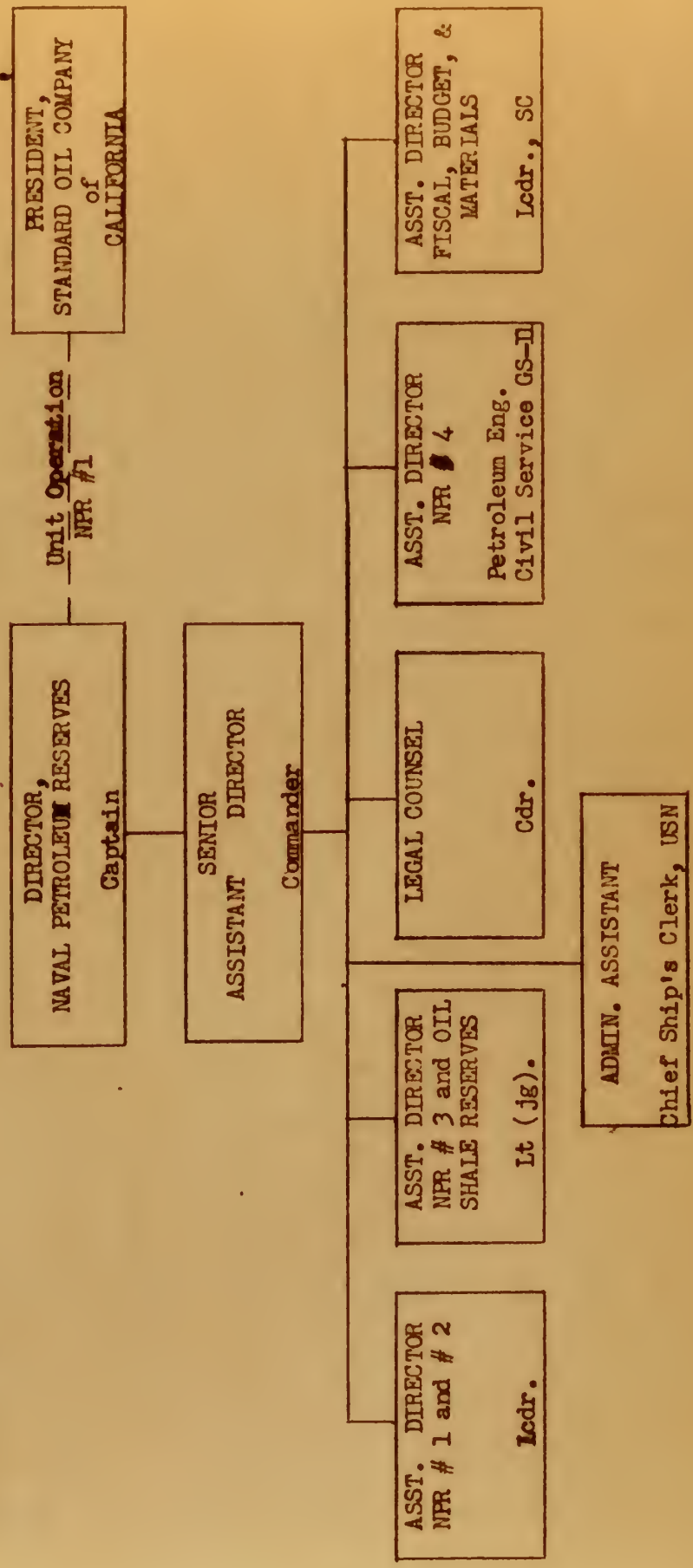
1950

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MOITASIMADPO QJAITA
 ZAVRAGEB MUDJORTJA JAVVAM

ORGANIZATION CHART OFFICE OF THE DIRECTOR, N.P.R.s.



(Organization Varied at the Discretion of the Director to Meet Current Needs)

FIG. 7-2

15 January 1953

TRAHD MOLT A SIMA QRO
 2P 2 M 9AOT 3ERID 3HT 3O 3D LTA 3O



Page 1 of 1

1954

1. General Investigative Division (GID) is the primary unit for all laboratory and field work.

The Senior Assistant Director also serves as the Legal Counsel. At present there are two other Assistant Directors: a civil service petroleum engineer serving as technical advisor and an officer of the supply corps as fiscal, budget and material officer. The members of the Director's staff have advisory functions only in connection with the operation of the Reserves. Supervisory and executive control is administered by the Director for the Secretary of the Navy through the Inspector or Commanding Officer at each Reserve. The duties, relationships, and authority of each member of the Director's Office and of the Inspectors of the Reserves are covered in the ORGANIZATION MANUAL for this Office.⁷

During the years of considerable exploration and development activity in the petroleum reserves, the Office was in Denver, Colorado -- a relatively central location with respect to the field activities and to the Navy Department. In 1954, the Office was returned to Washington, D. C.

Organization of the Naval Petroleum Reserves in California. The field office of the Inspector, Naval Petroleum Reserves in California, is located on N.P.R. No. 1 at Tupman, California. The official representatives of the Secretary of the Navy in this office are the Inspector and Navy's Member of the Operating Committee. Through these representatives, the Director, Naval Petroleum Reserves, exercises control of N.P.R. No. 1 (Elk Hills) and maintains administrative control of Navy's leased lands in N.P.R. No. 2.

The general Organization Chart for the Naval Petroleum

The Senior Assistant Director also serves as the local Council at present there are two other Assistant Directors, a civil service position continues serving as technical advisor and an officer of the supply corps as fiscal, budget and material officer. The members of the Director's staff have advisory functions only in connection with the operation of the Bureau. Supervisory and executive control is administered by the Director for the Secretary of the Navy through the Inspector or Consulting Officer of each Bureau. The duties, responsibilities, and authority of each member of the Director's Office and of the Inspectors of the Bureaus are covered in the ORGANIZATION MANUAL for this Office.

During the years of construction expansion and development activity in the petroleum business, the Office was in Denver, Colorado -- a relatively central location with respect to the field activities and to the Navy Department. In 1964, the Office was returned to Washington, D. C.

Organization of the Naval Petroleum Reserves in California

The field office of the Inspector, Naval Petroleum Reserves in California, is located on S.F.P. No. 1 at Torrance, California. The official representatives of the Secretary of the Navy in this office are the Inspector and Navy's Member of the Operating Committee. Through these representatives, the Director, Naval Petroleum Reserves, exercises control of Navy's leased lands in S.F.P. No. 1 (MEX Hill) and maintains administrative control of Navy's leased lands in S.F.P. No. 2. The general Organization Chart for the Naval Petroleum

Reserves in California is shown in Figure 7-3. The inter-relationship indicated on this chart between the Inspector and Standard Oil Company of California as the unit operator for N.P.R. No. 1 has been discussed in Chapter VI. The independent status and duties of the Navy Cost Inspector and his relationship to N.P.R. No. 1 will be explained in Chapter VIII.

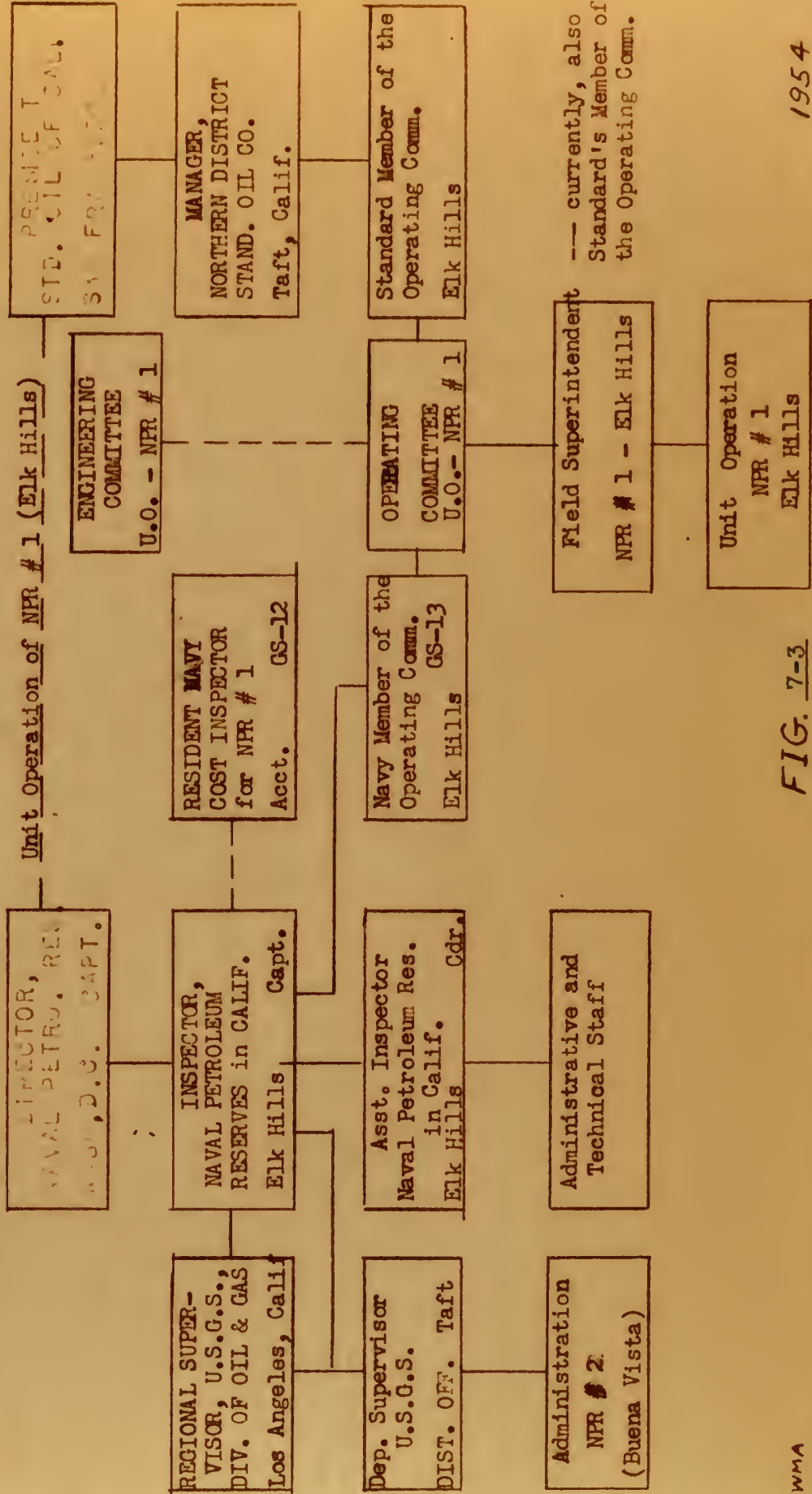
The unit operation of N.P.R. No. 1 -- with Navy and Standard as partners and Standard serving as the operator -- has been discussed in Chapter VI. Final resolution of all disagreements between Standard and the Navy rests with the Secretary of the Navy.

As has been shown in previous chapters, Navy has a minority interest in N.P.R. No. 2, controlling about 35 per cent of the total land and only about 25 per cent of the productive acreage; and its control over this Reserve is not as direct or complete as over N.P.R. No. 1.^{125,170} The Inspector serves as the representative of the Secretary of the Navy in administering the leased lands under Operating Regulations promulgated jointly by the Interior and Navy Departments. Under these regulations, the U.S. Geological Survey performs certain supervisory and accounting services for the Navy for which payment is made by transfer of funds. The Supervisor of the U.S.G.S. District Office, Division of Oil and Gas, in Taft, California, is responsible for the gauging of produced oil and gas from Navy leases and for determining that good oil field practices are followed by the lessees.^{176, 177} No restrictions other than the latter are placed on rate of production.

... in California is shown in Figure 7-2. The latter
 relationship indicated in this chart between the inspector and
 Standard Oil Company of California as the main operator for
 S.F.R. No. 1 has been discussed in Chapter VI. The Inspector
 states and desires of the Navy Dept Inspector and the relation-
 ship to S.F.R. No. 1 will be explained in Chapter VIII.
 The main operation of S.F.R. No. 1 -- also Navy and
 Standard as partners and Standard acting as the operator --
 has been discussed in Chapter VI. Other portions of all dis-
 agreements between Standard and the Navy Dept with the excep-
 tion of the Navy.

As has been shown in previous chapters, Navy Dept a
 directly interested in S.F.R. No. 1, controlling about 25 per
 cent of the total and about 25 per cent of the pro-
 ductive capacity; and its control over this resource is not re-
 stricted or controlled as over S.F.R. No. 1. The Inspector
 believes in the responsibility of the Secretary of the Navy in
 administering the latter under existing regulations pro-
 vided jointly by the Interior and Navy Departments. Under
 these regulations, the U.S. Geological Survey retains certain
 supervisory and accounting functions for the Navy for which
 payment is made by Secretary of War. The Secretary of the
 U.S.G.S. Interior Office, Division of Oil and Gas, in turn,
 California, is responsible for the carrying of produced oil and
 gas from Navy leases and the distribution of such oil and
 gas. The latter was followed by the Interior, 1907. No restrictions
 other than the latter are placed on sale of production.

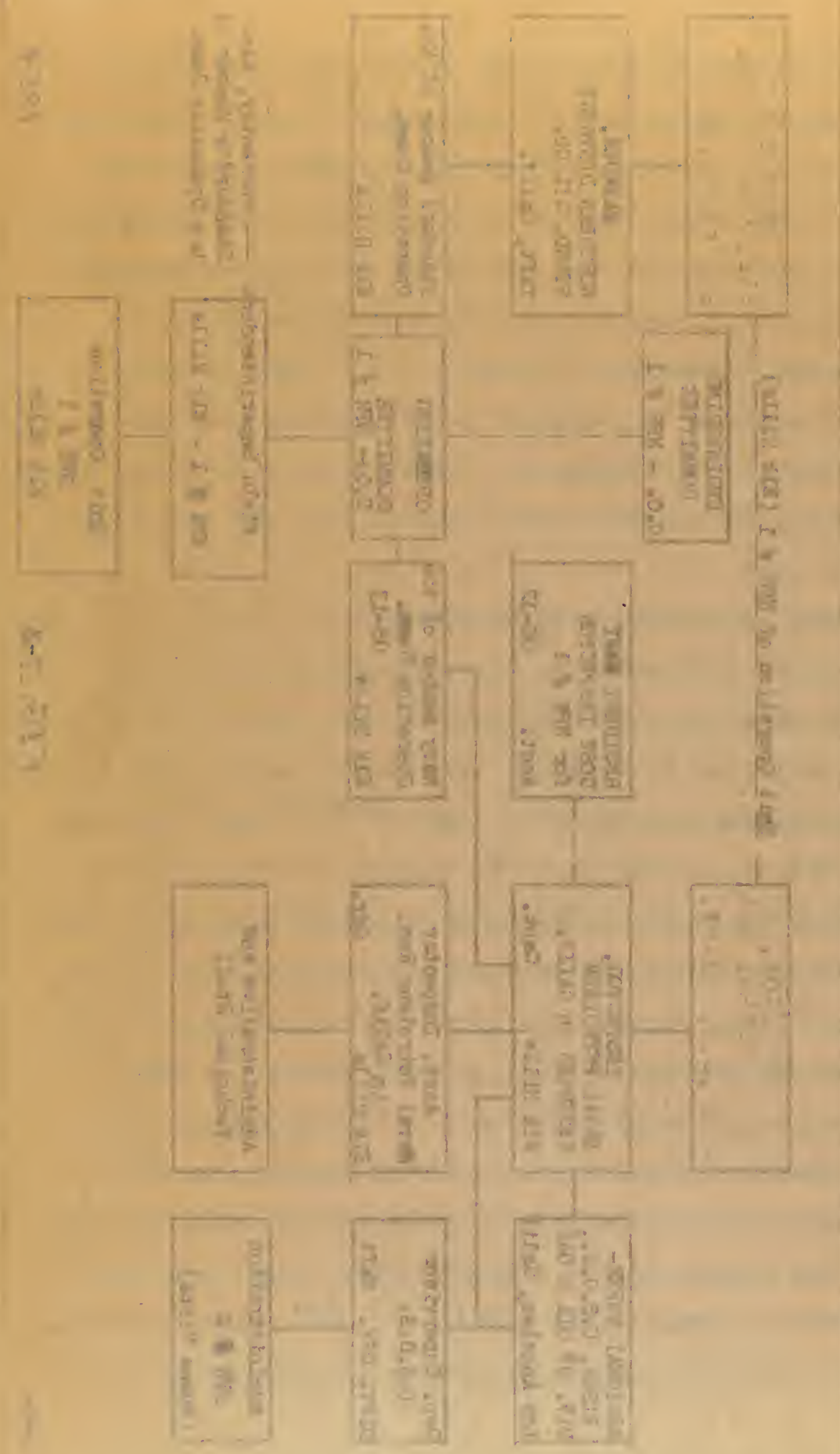
ORGANIZATION CHART NAVAL PETROLEUM RESERVES IN CALIFORNIA



--- currently, also Standard's Member of the Operating Comm.

FIG. 7-3

TRANO MOITASILMADRO ALMADOLJAD MI ZAVRABEZA MUDJORTER JAVYAM



Accounting services for royalty payments to the Navy from the lessees are performed by the U.S.G.S. Regional Office in Los Angeles.

The INPR in C is under the military command of the Commandant, Eleventh Naval District.

Office of the Inspector, Naval Petroleum Reserves in California. The composition of the administrative and technical staff of the Office of the Inspector is shown in Figure 7-4. The rank of the officer in each officer billet and the service rating and title of each civil service employee is given as they existed about January 1954.

Standard's Field Organization at Elk Hills. Pursuant to the Unit Plan Contract of 1944,¹⁵⁰ Standard was selected as the operator for the unit operation of Naval Petroleum Reserve No. 1. Navy and Standard then entered into an Operating Agreement dated 19 June 1944,¹⁴⁹ retroactive to 20 November 1942 -- the date the Unit Operation was effectively commenced. In order to carry out its obligations under the above Contract and Agreement, Standard established a unit operation staff, the base of which was its own original operating force at the field prior to formation of the unit operation. During the emergency development and production period of World War II, the unit operation required the assistance of Naval Construction Battalions to accomplish essential survey work and road construction¹¹¹ and several Naval Officers qualified as petroleum engineers. In 1946 Standard again assumed all duties as operator.

Accounting services for monthly payments to the Navy from the
losses are performed by the U.S.C.S. Regional Office in Los
Angeles.

The IWR in C is under the military command of the
Commandant, Eleventh Naval District.

Office of the Inspector, Naval Petroleum Reserves in

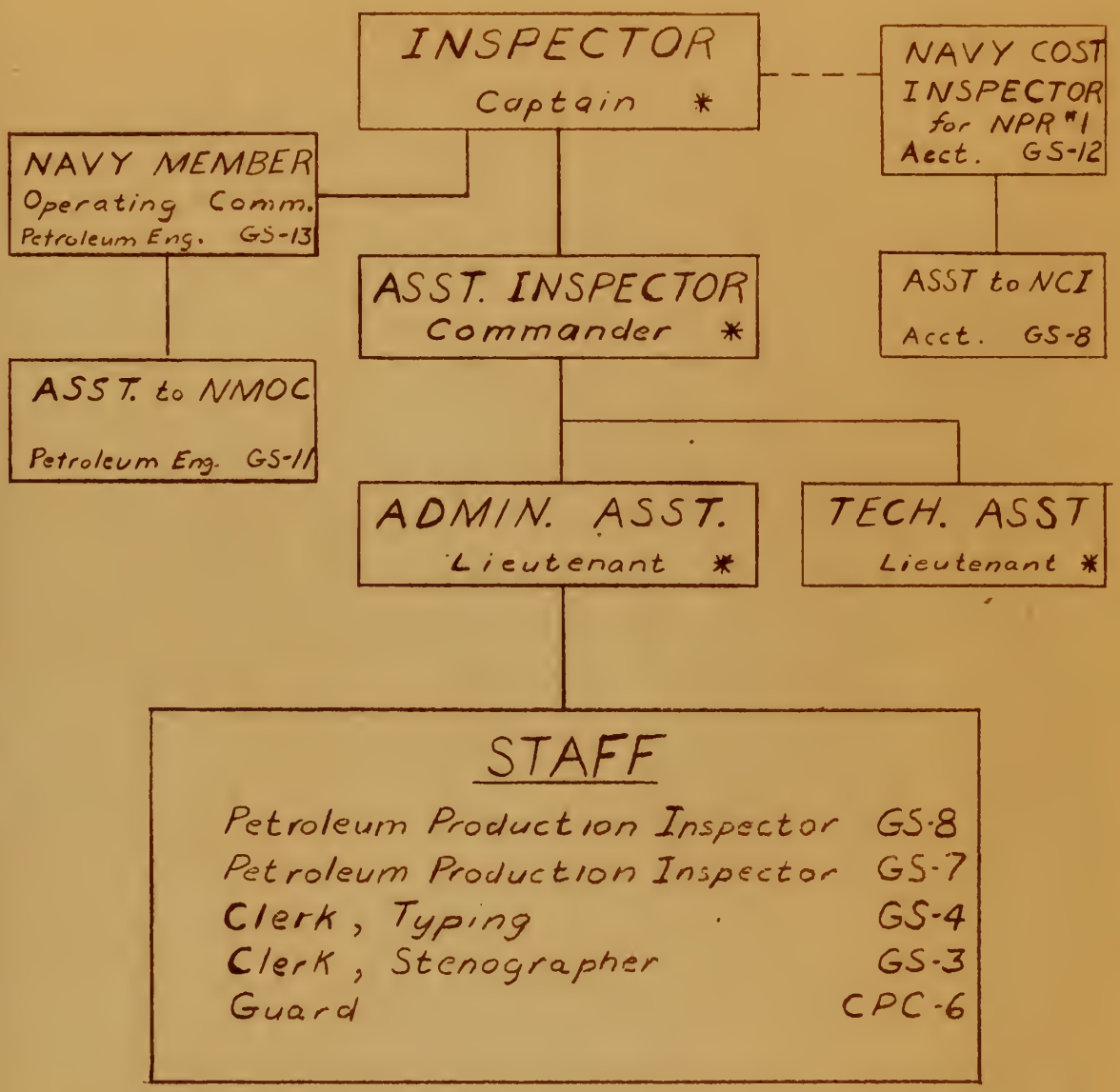
California. The composition of the Administrative and Control
and Staff of the Office of the Inspector is shown in Figure
7-4. The rank of the officer in each officer billet and the
services setting and title of each civil service employee is
given as they existed about January 1954.

Standard's Field Organization at the Office.

to the Unit Plan Contract of 1944, 1950 Standard was selected
as the operator for the unit operation of Naval Petroleum Re-
serve No. 1. Navy and Standard then entered into an operating
Agreement dated 15 June 1944, 1950 effective 20 November
1944 -- the date the Unit Operation was effectively commenced.
In order to carry out its obligations under the above Contract
and Agreement, Standard established a unit operation staff,
the size of which was its own original operating force at the
time prior to formation of the unit operation. During the
emergency development and production period of World War II,
the unit operation required the assistance of Naval Petroleum
Reserve Station to accomplish essential survey work and road
construction and several Naval Officers qualified as petro-
leum engineers. In 1948 Standard again assumed all duties as
operator.

ORGANIZATION CHART

Office of the Inspector, Naval Petroleum Reserves in Calif.



* Officers are C.E.C., E.D.O., or LINE contingent on petroleum engineering experience and training.

ORGANIZATION CHART

Office of the Inspector

Naval Petroleum Reserve - Calif.



* OFFICES are CEC, EOC, and the central petroleum production section are located at the Naval Petroleum Reserve - Calif.

Standard's field organization at Elk Hills as of June 1953 is shown in Figure 7-5. The relationship of this organization with Standard's Northern District management is also shown. Navy and Standard share the expense of the unit operation staff on a participating percentage basis.¹⁵⁰ The chart shows two or three numbers after each group of employees -- Standard's accounting system for employees. The first column, P, indicates the number of employees on the payroll. The second column, B, indicates the equivalent number of full-time employees on the "basic" organization authorized by Standard's main office in San Francisco. The third column, circled B, lists the number of employees "authorized over the basic" number by Standard's Northern District Manager. If the actual organization is consistently running over or under "basic" on some employees, the basic organization is altered to reflect this condition. Standard's member of the Operating Committee, who is currently also the field superintendent, is charged with the responsibility of keeping the field force as small as possible and still adequate. If Navy feels that the field organization of the operator is inadequate or otherwise, desired changes may be requested by Navy's member of the Operating Committee through this Committee.

The number of employees varies with the field activity. Since all of the drilling and major construction work are accomplished by independent contractors, the actual work force at Elk Hills at any time may be considerably greater than the total of Navy's and Standard's employees.

Standard's Field Organization as of June 1955 is shown in Figure 7-5. The relationship of this organization with Standard's Corporate Staffing Management is also shown. Key and Standard show the response of the unit organization staff on a participating management basis. The staff shows two or three members after each group of employees -- Standard's accounting system for employees. The first column, V, indicates the number of employees on the payroll. The second column, B, indicates the equivalent number of full-time employees on the "basic" organization established by Standard's main office in New York. The third column, C, lists the number of employees transferred from the "basic" number of Standard's Corporate Staffing Management. It is assumed organization is consistently working over or under "basic" on some employees, the basic organization is allowed to reflect this position. Standard's number of the operating Committee, who is currently also the Field Organization, is compared with the responsibility of working the field force as well as possible and will advance. It has been that the Field Organization of the operator is developed as otherwise desired changes may be requested by Key's member of the Operating Committee through the Committee.

The number of employees varies with the field activity. Since all of the details and other considerations were not maintained of independent contractors, the actual work force at the field at any time may be considerably greater than the total of Key's and Standard's employees.

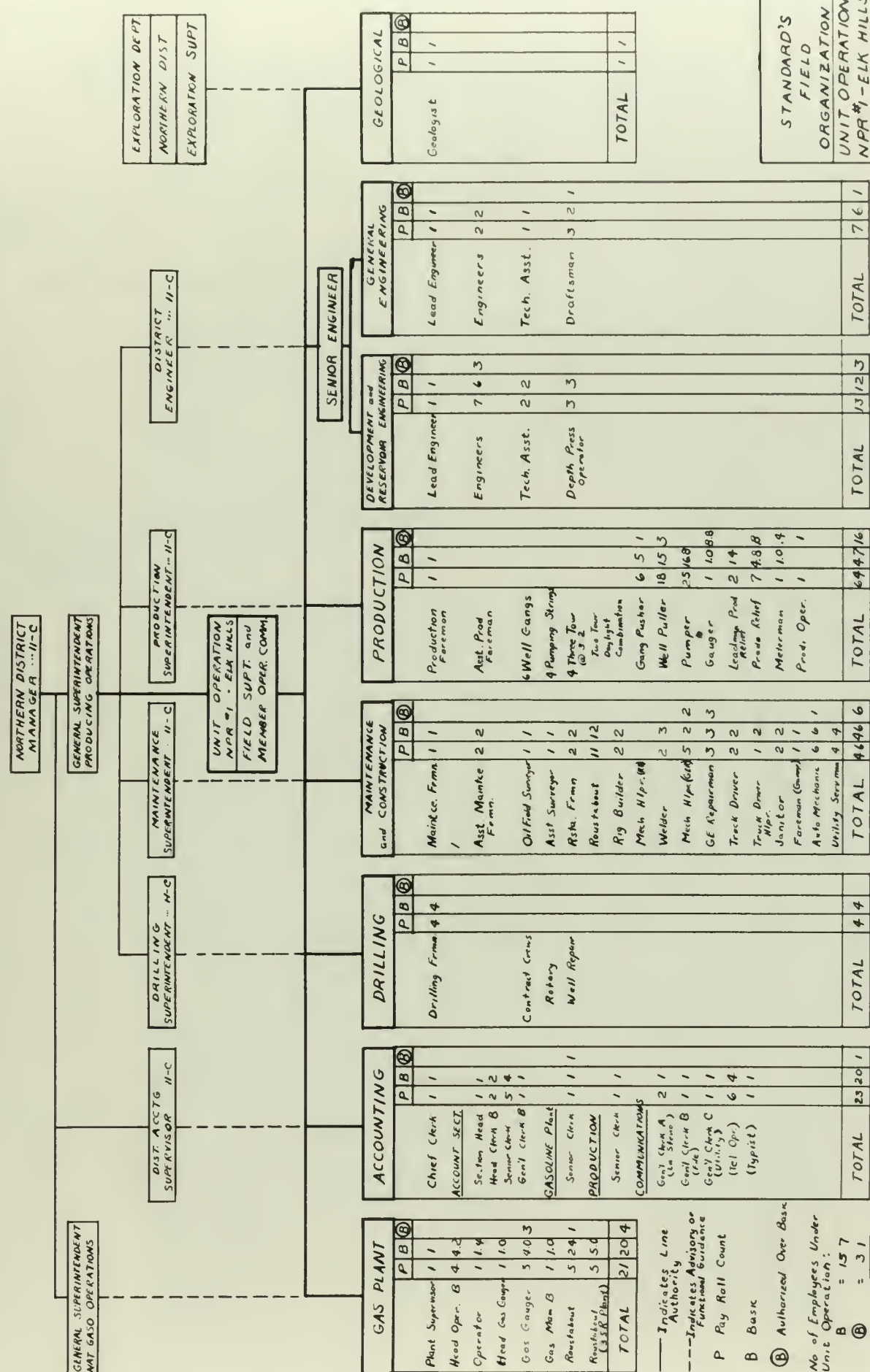


FIG. 7-5

— Indicates Line Authority
 -- Indicates Advisory or Functional Guidance
 P Pay Roll Count
 B Basic
 (B) Authorized Over Basic
 No. of Employees Under Unit Operation:
 B = 157
 (B) = 31
 TOTAL = 188

JOB CLASSIFICATIONS OF PRINCIPAL NAVY EMPLOYEESAT NAVAL PETROLEUM RESERVE NO. 1Inspector, Naval Petroleum Reserves in California
(INPR in C);⁷**Qualifications:**

1. Officer of the Navy, usually a Commander or Captain; or civil service employee of the Navy with GS-14 rating.
2. Petroleum background necessary; petroleum engineering degree is desirable.

Primary Duties:

1. Take custody and charge of the Petroleum Reserves in California on behalf of the Director.
2. Insure the proper execution of contracts between Navy and Standard.
3. Execute plans and programs to carry out the functions of the Petroleum Reserves as approved by the Director Naval Petroleum Reserves (DNPR).
4. Administer generally all operations on Reserves No. 1 and No. 2 under existing leases, cooperating under a working agreement with U.S. Geological Survey in the administration of N.P.R. No. 2.
5. Formulate general plans for the protection, conservation, development and use of the Reserves for the production of petroleum therefrom and make recommendations to the Director with reference thereto.

JOB CLASSIFICATIONS OF PETROLEUM RESERVE NO. 1

AT NAVAL PETROLEUM RESERVE NO. 1

Inspector, Naval Petroleum Reserves in California
(TYPE IN C) V

Qualifications:

1. Officer of the Navy, usually a Commander or Captain; or civil service employee of the Navy with GS-14 rating.
2. Petroleum background necessary; petroleum engineering degree is desirable.

Primary Duties:

1. Take custody and charge of the Petroleum Reserves in California on behalf of the Director.
2. Insure the proper execution of contracts between Navy and Reserves.
3. Execute plans and programs to carry out the functions of the Petroleum Reserves as approved by the Director Naval Petroleum Reserves (DNPR).
4. Administer generally all operations on Reserves No. 1 and No. 2 under existing leases, cooperating under a working agreement with U.S. Geological Survey in the administration of U.S. No. 1.
5. Formulate general plans for the protection, acquisition, development and use of the Reserves for the production of petroleum products and make recommendations to the Director with reference thereto.

6. Consult and correspond with Navy activities up to and including District level and other government activities of comparable authority.
7. Communicate as desired with Engineering Committee and Operating Committee. The Navy Member of the Operating Committee corresponds through the Inspector unless otherwise directed.
8. Serve as Navy's representative between Navy and the California oil industry.

Navy Member of the Operating Committee (NMOG):^{149, 150}

Qualifications:

1. Officer or civil service employee of the Navy; currently civil service employee, GS-13.
2. Ten (10) years experience as a petroleum engineer, or a graduate engineer with at least five (5) years experience as a petroleum engineer.

Primary Duties:

1. Represent Navy on the Operating Committee and Engineering Committee.
2. Carry out duties of the Operating Committee as specified in the Unit Plan Contract, NOD 4219,¹⁵⁰ and in the Unit Operating Agreement, NOD 4220.¹⁴⁹ These duties have been discussed under "Functions of the Operating Committee" in Chapter VI on Unit Operation of N.P.R. No. 1.
3. Confer with and carry out orders and instructions

- 6. Council and correspond with Navy activities up to and including Chief level and other Government activities of appropriate authority.
- 7. Committee as desired with Engineering Committee and Operating Committee. The Navy member of the Operating Committee correspond through the Inspector whose activities directed.
- 8. Serve as Navy's representative between Navy and the California oil industry.

Navy Member of the Operating Committee (NOC), 1st, 2nd

Qualifications:

- 1. Officer or civil service employee of the Navy; currently civil service employee, 12-11.
- 2. Ten (10) years experience as a petroleum engineer or a graduate engineer with at least five (5) years experience as a petroleum engineer.

Primary Duties:

- 1. Represent Navy on the Operating Committee and Engineering Committee.
- 2. Carry out duties of the Operating Committee as specified in the Unit Plan Contract, 400 4212, 1st and in the Unit Operating Agreement, 400 4220, 1st. These duties have been discussed under "Functions of the Operating Committee" in Chapter VI on Unit Operation of S.V.R. No. 1.
- 3. Officer also carry out orders and instructions

of DNPR and INPR in C as regards unit operation of Elk Hills, such as consulting INPR in C before putting any well on production, if not previously scheduled.

4. Serve as Petroleum Engineer on staff of INPR in C; make budget recommendations.
5. Make various reports to the California Conservation Committee, such as on the MER or optimum production rate of the different oil zones.

Assistant Inspector:

Qualifications:

1. Officer of the Navy
2. Petroleum Engineer

Duties:

1. Act as chief technical adviser to the Inspector.
2. Serve as correlation engineer for N.P.R. No. 1.
3. Assign and coordinate the work of the various officers on the staff serving as petroleum engineers or administrative assistants. This staff usually consists of one officer who is a qualified petroleum engineer and an officer who serves as administrative assistant.

Administrative Assistant to the Inspector:

Qualifications:

1. Officer of the Navy

Duties:

1. Expedites or initiates correspondence and reports

of 1974 and 1975 in a report with caption of
RIS 7112, and as amended RIS 7113 in 1976
having any well on production, it was previously
submitted.

- 4. Serve as Technical Engineer on staff of RIS in 1974
and submit recommendations.
- 5. Make various reports to the California Conservation
Committee, such as on the RIA or optimum production
rate of the different oil zones.

Assistant Inspector:

Qualifications:

- 1. Officer of the Navy
- 2. Petroleum Engineer

Duties:

- 1. Act as chief technical adviser to the Inspector.
- 2. Serve as correlation engineer for R.I.S. No. 1.
- 3. Assign and supervise the work of the various
offices on the staff serving as petroleum engi-
neers or administrative assistants. This staff
usually consists of one officer who is a qualified
petroleum engineer and an officer who serves as
administrative assistant.

Administrative Assistant to the Inspector:

Qualifications:

- 1. Officer of the Navy

Duties:

- 1. Expedite or initiate correspondence and reports

as necessary to carry out the functions of the Office.

2. Serves as custodian of funds allocated for administrative and technical expenses of the Office; maintains a balance ledger in this respect.
3. Responsible for all matters pertaining to office management and for supervision of all clerical personnel.
4. Advises Inspector on status and policies concerning civil service employees.
5. Assists in the administration of all leases pertaining to N.P.R. No. 1.
6. Assists in the initiation of requests for bids or the negotiations of contracts for sale of gas, gasoline, oil, and materials.
7. Other miscellaneous duties include public relations, transportation, security, custody of all classified and non-classified publications, preparation of the annual report, and matters pertaining to permits and right-of-ways on N.P.R. No. 1.

an agreement to carry out the provisions of the
1954 Act.

2. There is a number of funds allocated for main-
tenance and technical expenses of the Office and
these are included in the budget.
3. Responsibility for all matters pertaining to office
management and the supervision of all students
personnel.

4. Salary increases on basis and policies concerning
civil service employees.
5. Matters in the administration of all issues per-
taining to the Act.

6. Matters in the field of research for the
the acquisition of contracts for sale of gas,
coal, oil, and minerals.

7. Other miscellaneous matters which require attention,
investigation, research, study or all classified
and non-classified questions, preparation of the
annual report, and matters pertaining to general
and right-of-way to the Act.

8. Matters in the field of research for the
the acquisition of contracts for sale of gas,
coal, oil, and minerals.
9. Other miscellaneous matters which require attention,
investigation, research, study or all classified
and non-classified questions, preparation of the
annual report, and matters pertaining to general
and right-of-way to the Act.

SELECTION OF NAVY EMPLOYEESN.P.R. NO. 1

The Inspector is responsible for the hiring and firing of civilian employees on the Navy staff at N.P.R. No. 1, subject to civil service ceilings and examinations. As regards the NMOC, he is hired as a petroleum engineer by the Inspector. He then may be appointed by the Secretary of the Navy to the position of NMOC.

DNPR negotiates for the services of petroleum consulting firms, subject to the approval of the Secretary of the Navy. Often members of such firms are appointed by DNPR to serve as Navy's members or alternate members on the Engineering Advisory Committee for the Unit Operation of N.P.R. No. 1, subject to the approval of the Secretary of the Navy.

SECTION OF NAVY REGULATIONS

U.S.N. NO. 1

The Inspector is responsible for the hiring and firing of civilian employees on the Navy staff at U.S.N. No. 1, subject to civil service ratings and examinations. As regards the WMO, he is listed as a petroleum engineer by the Inspector. He then may be appointed by the Secretary of the Navy to the position of WMO.

DNB regulates for the services of petroleum companies in time, subject to the approval of the Secretary of the Navy. Other members of each firm are appointed by DNB as per the Navy's orders or alternate members on the Engineer-Advisory Committee for the Oil Operation of U.S.N. No. 1, subject to the approval of the Secretary of the Navy.

These regulations are subject to the approval of the Secretary of the Navy. The regulations are subject to the approval of the Secretary of the Navy. The regulations are subject to the approval of the Secretary of the Navy.

REPORTS AND RECORDS, OFFICE OF THE INSPECTORNAVAL PETROLEUM RESERVES IN CALIFORNIA

On the supposition that the reports issued and received by any activity often serve as an effective guide to its functions, responsibilities, and relationships -- a skeleton list of most incoming and outgoing reports from this office is given in Table I. Attention is invited to the large number of different addresses, a fact illustrating the complex relationships of the petroleum reserves within the Navy. Specific information on each report, as to its preparation or action required upon its receipt, is maintained on a card index system by the clerical staff at the Reserve. "Reports Issued" are grouped according to routine reports required by most Navy shore activities and to reports unique to its functions as a Petroleum Reserve.

TABLE I

REPORTS ISSUED BY INPR in CA. Routine Navy Reports

<u>Type</u>	<u>Title</u>	<u>To</u>
Annual	1. Officer Data Card	Chief of Nav Pers
	2. Qualification Questionnaire - Active Duty Officers	Chief of Nav Pers
	3. Biography of Officers	Chief of Nav Pers
	4. Report on Salary and Wage Distribution of Civilian Employees	Chief of Industrial Relations, Navy Dept.
	5. Position Description Review	Personnel Officer, 11th N.D.
	6. Automotive Costs and Inventory	Transp. and Equip. Off., 11th N.D.

REPORTS AND MEMORANDA, OFFICE OF THE INSPECTOR

NAVY VESSELING SERVICE IN CALIFORNIA

On the assumption that the reports listed and received by my auditing office cover an effective guide to the status, responsibilities, and relationships -- a complete list of such findings and pending reports from this office is given in Table I. Attention is directed to the large number of different addresses, a fact illustrating the complex relationship of the business services within the Navy. Specific information on each report, as to the preparation or revision required upon the receipt, is maintained on a card index system by the clerical staff at the Reserve. "Reports Issued" are grouped according to service reports required by each Navy shore activities and are reported copies to the Inspector as a

Lester H. Hoover

TABLE I

REPORTS ISSUED BY THIS OFFICE

A. Routine Navy Reports

<u>To</u>	<u>Title</u>	<u>Time</u>
Chief of Nav Force	1. Officer Data Card	Annual
Chief of Nav Force	2. Qualification Questionnaire - Active Duty Officers	
Chief of Nav Force	3. Biography of Officers	
Chief of Industrial Relations, Navy Dept.	4. Report on Salary and Wage Distribution of Civilian Employees	
Personnel Officer, U.S. Navy	5. Position Description Review	
Transport and Supply Officer, U.S. Navy	6. Automotive Costs and Inventory	

(Table I, continued)

<u>Type</u>	<u>Title</u>	<u>To</u>
Semi-Annual	1. Report on Fitness of Officers	BuPers
	2. Navy Awards and Incentives	Chief, O.I.R., Navy Dept.
	3. Plant Account Cards, Class Two	NSD, San Pedro, Calif.
Quarterly	1. Shore Duty Survey Report	Com. 11th N.D.
	2. Report of Agency Hiring	U.S. Civil Service
	3. Overtime Work Performed by Civilian Employees and Cost Thereof	DNPR
	4. Employee Development Program	Chief, O.I.R., Navy Dept.
	5. Agency Actions Under Executive Order 10450	Chief, O.I.R., Navy Dept.
Bi-Monthly	1. Mileage Report	11th N.D.
Monthly	1. Roster of Officers	BuPers
	2. Personnel Diary	PAMI, 11th N.D.
	3. Report of Personnel	O.I.R., Navy Dept.
	4. Expenditures Incurred on Travel Orders for Civilian and Military Personnel	D.N.P.R.
	5. Blanket Certificate of Assignment of Quarters	Navy Accts. Disb. Off., Long Beach
	6. Civilian Employment by Appropriations	Chief, O.I.R., Navy Dept.
	7. Personnel Housing Facilities under Cognizance of the Navy	Com. 11th N.D.
	8. Reservations for Quarterly Allotment	Naval Supply Depot, San Pedro
	9. Accident Data Report	Asst. Sec. Navy. Safety Div.
	10. Employees Savings Bonds Participation Data	Long Beach Naval Shipyard
	11. Government Transportation Requests	Regional Accounts Office, Wash. D. C.
Semi-Monthly	1. Officers' Regular Pay Day Payments	Naval Accts. Disb. Off., Long Beach
Weekly	1. Personnel Diary	PAMI, 11th N.D., San Diego

(Table I, continued)

<u>Type</u>	<u>Title</u>	<u>To</u>
As Changes Occur	1. Personnel Diary	PAMI, San Diego
	2. Military and Civilian Personnel	DNPR
	3. Biography of Officers	Chief Nav. Pers.
<u>B. Reports Pertaining to Petroleum, Issued by INPR in C</u>		
Quarterly	1. Inspector's Quarterly Reports on N.P.R. No. 1 and No. 2	DNPR
	2. Production Sales and Royalties N.P.R. No. 1 and No. 2	DNPR
Monthly	1. Liquid Fuel Report	Fuel Supply Office, Navy Dept.
	Billing for Crude Oil from the.....	Naval Supply Depot, San Pedro
	2. Shallow Zone	
	3. Stevens Zone	
	4. Carneros Zone	
	5. Billing for Natural Gas to Commercial Companies, N.P.R. No. 1	Naval Supply Depot, San Pedro
	6. Production Under the State of Readiness Program, N.P.R. No. 1	DNPR
	7. Status of Funds Report, N.P.R. No. 1	DNPR
	8. Verification of Unit's Monthly Statement of Production for N.P.R. No. 1	Resident N.C.I.
	9. Lessee's Monthly Report of Operation, N.P.R. No. 2	DNPR
	10. Report to Property Accounting Office for N.P.R. No. 2	DNPR
11. Automotive Rental, and Pay and Allowances Invoices	U. O. - N.P.R. No. 1	
When Occurring	1. Payment of Consulting Firms (Navy Members of Engineering Committee)	DNPR

Line	Description	Amount
1	Personnel Salary	1,000.00
2	Military and Civilian Personnel	500.00
3	Contract of others	500.00

2. Reserve Personnel to Legislative Branch by Year is:

Year	Description	Amount
1979	1. Inspector's Quarterly Report on A.P.R. No. 1 and No. 2	1,000.00
1978	2. Production Rates and Report on A.P.R. No. 1 and No. 2	1,000.00
1977	3. Report on A.P.R. No. 1 and No. 2	1,000.00
1976	4. Report on A.P.R. No. 1 and No. 2	1,000.00
1975	5. Report on A.P.R. No. 1 and No. 2	1,000.00
1974	6. Report on A.P.R. No. 1 and No. 2	1,000.00
1973	7. Report on A.P.R. No. 1 and No. 2	1,000.00
1972	8. Report on A.P.R. No. 1 and No. 2	1,000.00
1971	9. Report on A.P.R. No. 1 and No. 2	1,000.00
1970	10. Report on A.P.R. No. 1 and No. 2	1,000.00
1969	11. Report on A.P.R. No. 1 and No. 2	1,000.00
1968	12. Report on A.P.R. No. 1 and No. 2	1,000.00
1967	13. Report on A.P.R. No. 1 and No. 2	1,000.00
1966	14. Report on A.P.R. No. 1 and No. 2	1,000.00
1965	15. Report on A.P.R. No. 1 and No. 2	1,000.00
1964	16. Report on A.P.R. No. 1 and No. 2	1,000.00
1963	17. Report on A.P.R. No. 1 and No. 2	1,000.00
1962	18. Report on A.P.R. No. 1 and No. 2	1,000.00
1961	19. Report on A.P.R. No. 1 and No. 2	1,000.00
1960	20. Report on A.P.R. No. 1 and No. 2	1,000.00
1959	21. Report on A.P.R. No. 1 and No. 2	1,000.00
1958	22. Report on A.P.R. No. 1 and No. 2	1,000.00
1957	23. Report on A.P.R. No. 1 and No. 2	1,000.00
1956	24. Report on A.P.R. No. 1 and No. 2	1,000.00
1955	25. Report on A.P.R. No. 1 and No. 2	1,000.00
1954	26. Report on A.P.R. No. 1 and No. 2	1,000.00
1953	27. Report on A.P.R. No. 1 and No. 2	1,000.00
1952	28. Report on A.P.R. No. 1 and No. 2	1,000.00
1951	29. Report on A.P.R. No. 1 and No. 2	1,000.00
1950	30. Report on A.P.R. No. 1 and No. 2	1,000.00

TABLE II

REPORTS RECEIVED BY INPR in C

<u>Type</u>	<u>Title</u>	<u>From</u>
Annual	Annual Report, U.S. Geological Survey	U.S.G.S.
Quarterly	Rotating Production Test Program	U. O. - NPR #1
	Rotating Production Test Schedule	U. O. - NPR #1
	Shallow Oil & Dry Gas Zone Summary of Depth Pressure and Temp. Measurements - Elk Hills	U. O. - NPR #1
	Depth Pressure Summary for Stevens Zone Wells - Elk Hills	U. O. - NPR #1
	California Field and Pool, Max. Efficient Crude Prod. Rate - Scheduled Pools	Conservation Committee of Calif. Oil Producers
	California Anticipated Production Performance - Unscheduled Pools	Conservation Committee of Calif. Oil Producers
	Recommended Monthly Schedule of Production Elk Hills Field - Buena Vista Field	Conservation Committee of Calif. Oil Producers
	Monthly Engineering Report, U.S. Geological Survey, California Region	U.S.G.S.
	Summary of California Oilfield Operations	American Petroleum Institute
	Productive Capacity Estimates for Stevens Zone Wells	U. O. - NPR #1
Monthly	Monthly Well Production Report PRO-420 Elk Hills	U. O. - NPR #1
	Resume of Operations, 27-B Pool Unit	27-B Pool Operating Committee
	27-B Pool Statement of Production	Operator - 27-B Pool Unit
	Monthly Well Production Report - Pro 420 (27-B Pool)	Std. Oil Co., San Francisco
	Monthly Report, Buena Vista Hills 27-B Pool Operations	27-B Pool Administrative Group
	Mineral Industry Surveys, Monthly Petroleum Statement	U.S. Dept. of the Interior, Bureau of Mines
	District 5 Petroleum Statement No. 244-B, Statistical and Economic Surveys	U.S. Dept. of the Interior, BuMines Petroleum Statistics Branch
	Buena Vista Field, Summary of Production (Total Barrels)	California Conservation Committee

YEAR II

EXHIBIT CONTAINING LIST OF

<u>From</u>	<u>Title</u>	<u>Type</u>
V.S. 0-4	Annual Report, U.S. Geological Survey	Annual
U. S. - W.R. 41 U. S. - W.R. 41 U. S. - W.R. 41	Rotating Production Test Program Rotating Production Test Schedule Shallow Oil & Gas Test Sum- mary of Depth Pressure and Temp. Measurements - Elm Hills Depth Pressure Summary for Seventy Seven Wells - Elm Hills California Field and Pool, Mex. Lithologic Correlation Notes - Schedada Pool California Anticline Production Performance - Unsaturated Pools	Quarterly
Conservation Com- mission of Calif. Oil Producers Conservation Com- mission of Calif. Oil Producers Conservation Com- mission of Calif. Oil Producers	Recommended Monthly Schedule of Production Elm Hills Field - Utama Vista Field Monthly Engineering Report, U.S. Geological Survey, California Region Summary of California Oilfield Operations Productive Capacity Estimates for Seventy Seven Wells Monthly Well Production Report PAC-450 Elm Hills Review of Operations, 27-B Pool Unit 27-B Pool Estimate of Produc- tion Monthly Well Production Report - Pool (27-B Pool) Monthly Report, Utama Vista Field 27-B Pool Operations Mineral Industry Survey Monthly Petroleum Statement District 2 Petroleum Statement No. 244-B Statistical and Economic Survey Utama Vista Field, Summary of Production (Total Survey)	Monthly
U.S. 0-4	Monthly Engineering Report, U.S. Geological Survey, California Region	Monthly
American Petroleum Institute U. S. - W.R. 41 U. S. - W.R. 41	Summary of California Oilfield Operations Productive Capacity Estimates for Seventy Seven Wells Monthly Well Production Report PAC-450 Elm Hills Review of Operations, 27-B Pool Unit 27-B Pool Estimate of Produc- tion Monthly Well Production Report - Pool (27-B Pool) Monthly Report, Utama Vista Field 27-B Pool Operations Mineral Industry Survey Monthly Petroleum Statement District 2 Petroleum Statement No. 244-B Statistical and Economic Survey Utama Vista Field, Summary of Production (Total Survey)	Monthly
U.S. Dept. of the Interior, Bureau of Mines U.S. Dept. of the Interior, Bureau of Mines California Conserva- tion Commission	Recommended Monthly Schedule of Production Elm Hills Field - Utama Vista Field Monthly Engineering Report, U.S. Geological Survey, California Region Summary of California Oilfield Operations Productive Capacity Estimates for Seventy Seven Wells Monthly Well Production Report PAC-450 Elm Hills Review of Operations, 27-B Pool Unit 27-B Pool Estimate of Produc- tion Monthly Well Production Report - Pool (27-B Pool) Monthly Report, Utama Vista Field 27-B Pool Operations Mineral Industry Survey Monthly Petroleum Statement District 2 Petroleum Statement No. 244-B Statistical and Economic Survey Utama Vista Field, Summary of Production (Total Survey)	Monthly

(Table II continued)

<u>Type</u>	<u>Title</u>	<u>From</u>
Monthly (cont.)	Monthly Summary of Production, Elk Hills (Total Barrels) Preliminary Daily Average, California Crude Oil Production Actual Production and Disposition of Oil Well Gas by Fields	California Conser- vation Committee California Conser- vation Committee California Conser- vation Committee
As Requested	Fractional Analysis, Field and Analysis Data - U. O. - NPR #1	California Research Corporation
As Group Meets	27-B Pool Unit Meeting of Admin- istrative Group Representatives #15	27-B Pool Adminis- trative Group

The lists of reports required also may serve to illustrate the large number of routine Navy reports required not only by this Naval activity but all Naval activities. Moreover, issuing these reports requires the constant services of an officer and a clerical staff. In spite of the efforts in recent years to reduce the great volume of routine reports, one cannot help but wonder -- after reading these lists and perhaps recalling personal experience elsewhere in the Navy -- whether "the axe to cut reports" more than scratched the surface. The only panacea would seem to be a greater delegation of authority to lower echelons of command and a less frequent collection of statistical information, which may be desirable but seldom urgent.

(Table II continued)

From	Title	Type
California Council on Education	Monthly Review of Education	Monthly (cont.)
California Council on Education	California Daily Coverage	
California Council on Education	California Trade Oil Production	
California Council on Education	Actual Production and Distribution of Oil and Gas by State	
California Council on Education	Production Analysis, Field and Corporation	As Requested
California Council on Education	1974-1975 Yearly Review	As Group
California Council on Education	California Council on Education	As Group

The title of reports required also may vary to list the title number of volume they report required not only by this level activity but all level activities. However, during these reports reviews the constant reviews of an office and a special staff. In spite of the efforts in recent years to reduce the great volume of routine reports, the amount has not been reduced -- often leading to more time and money to be spent on routine activities. However, in the past -- whether "the use of the reports" were then revealed the results. The only manner would seem to be a greater delegation of authority to lower officials of technical and a less frequent collection of statistical information, which may be necessary for some

pages

AWARDING OF CONTRACTS FOR THE SALE OF PETROLEUM
ACCRUING TO NAVY FROM ITS PARTICIPATION IN THE
UNIT OPERATION OF N.P.R. NO. 1^{101, 102}

At the present time, Navy receives the major percentage of all petroleum produced from the Reserve. The petroleum is in the form of gas, natural gasoline, and crude oil which are being produced constantly, even in times of no emergency, as part of the development, readiness and maintenance, and conservation program in the Reserve. Consequently, Navy must have a means of disposing of its petroleum share. This is done under contracts with civilian concerns.

The Inspector at Elk Hills initiates negotiations for the sale of all products. He supplies information on products for sale such as quantity, storage, availability, specifications, transportation facilities, period of sale and deliveries -- to DNPR, who in turn makes arrangements with Navy's Bureau of Supplies and Accounts (BuSanda) for preparing a contract.¹⁰¹ BuSanda provides a sample contract for revision by the Director or the Inspector. When the final form of the contract is approved by the Director, BuSanda issues a notice of sale to all interested parties -- i.e., to all oil companies in the vicinity on a mailing list maintained by the Inspector. Also, the notice of sale is advertised and posted at several post offices. The notice of sale, invitation to bid, contract form, bid form, corporate authority form, bond form, and other necessary forms are mailed as a packaged unit

AGREEMENT OF CONTRACTS FOR THE SALE OF PETROLEUM
AGREEMENT TO BUY FROM THE PARTITION IN THE
JOINT OWNERSHIP OF A. J. C. CO., INC., 1901

At the present time, they receive the major percentage of all petroleum products from the market. The petroleum is in the form of gas, natural gasoline, and other oil which are being produced constantly, even in times of no emergency, on part of the development, production and maintenance and conservation program in the market. Consequently, they have a means of disposing of the petroleum above. This is done under agreement with various companies.

The Inspector at his office indicates negotiations for the sale of all products. He supplies information on products for sale such as quantity, nature, availability, specification, transportation facilities, period of sale and delivery. See -- to G.M.P., and in some cases correspondence with Ray's Bureau of Supplies and Services (Bureau) for preparing a contract. Bureau provides a sample contract for review by the Director of the Inspector. When the final form of the contract is approved by the Director, Bureau issues a notice of sale to all interested parties -- i.e., to all companies in the vicinity on a mailing list maintained by the Inspector. Also, the notice of sale is published and posted at several post offices. The notice of sale, invitation to bid, contract form, bid form, contracts authority form, and other necessary forms are mailed as a separate unit.

by BuSanda and/or the Inspector's office to all oil companies on the Inspector's mailing list and to additional companies who indicate interest in the sale.

The notice of sale specifies the time and place for submitting bids. At a prearranged date and location, Navy representatives of BuSanda open all sealed bids in the presence of all bidders. All bids are announced. Representatives of the bidders may then bid higher or may even submit reasons tending to give their bid priority over all except higher bids. In other words, a public auction is held.

These bids -- original sealed bids and additional ones made at the auction -- are analyzed by a representative of BuSanda. He normally awards the contract to the highest bidder. In cases of equivalent bids, one bidder may receive the contract due to certain supporting reasons -- such as an emergency request for an additional crude oil source to keep a refinery in operation.

In some cases BuSanda may request assistance or an opinion from the Inspector in determining to whom the contract should be awarded. Also, a representative of DNPR and INPR-in-C is normally present at the bid opening (auction) to provide additional information as requested by prospective bidders and representatives of BuSanda.

The Secretary of the Navy has the right to reject any or all bids.

In 1952, Navy's petroleum share from N.P.R. No. 1 was disposed of as follows: ¹²⁵

by the Inspector's office to all of companies
on the Inspector's mailing list and to additional companies
who indicate interest in the sale.

The notice of sale specifies the time and place for
submitting bids. As a prescribed date and location, Navy
representatives of Submarine open all sealed bids in the pres-
ence of all bidders. All bids are announced. Representatives
of the bidders may then bid in any way even should reasons
be given to give their bid priority over all other bids.
In other words, a public auction is held.

These bids -- original sealed bids and additional ones
made at the auction -- are analyzed by a representative of
Submarine. He normally awards the contract to the highest
bidder. In case of equivalent bids, the higher bid priority
the contract goes to certain supporting reasons -- such as an
emergency request for an additional award all bidders in such
a situation in operation.

In some cases Submarine may request assistance or an
opinion from the Inspector in determining to whom the contract
should be awarded. Also, a representative of NPTC and INR-12-
0 is normally present at the bid opening (auction) to provide
additional information as requested by prospective bidders
and representatives of Submarine.

The Secretary of the Navy has the right to reject any
or all bids.

In 1953, Navy's petroleum sales from J.F.R. No. 1 was
disposed of as follows: 128

- a. Oil from the Shallow and Stevens Zones sold to Wilshire Oil Co.
- b. Oil from the Carneros Zone sold to Caminol Co. of Hanford, California.
- c. Gas sold to the Southern California Gas Co.
- d. Natural gasoline sold to Sunland Refining Corp.

Money received from the sale of these petroleum products is handled by a naval supply activity and is credited to the Federal Government under Miscellaneous Receipts of the Treasury.

ISSUANCE OF OUT-LEASES, REVOCABLE PERMITS,
AND RIGHT-OF-WAYS BY INPR-IN-C^{101, 102}

OUT-LEASES. Another administrative function of the Inspector is the issuance of out-leases permitting the use of Navy land on the Reserves for various purposes not associated with mineral leases -- such as for grazing and farming.

The procedure followed in issuing one of these out-leases is given below:

- a. The Inspector may originate a notice of the availability of certain land for various purposes; or an application for an out-lease may be received by the Inspector from an individual or party.
- b. The application is analyzed by the Inspector's staff. It is submitted with recommendations and necessary illustrations, such as a sketch of the area, to DNPR who in turn forwards it with additional recommendations to the Navy Department, Bureau of Docks (BuDocks).
- c. BuDocks prepares the legal contract form for the lease, the final form being approved by the Inspector and DNPR.
- d. BuDocks conducts the bidding by public notice of availability and receives all bids.
- e. BuDocks selects the bidder to whom the lease is issued. The Contract is signed by representatives of BuDocks and the applicant.

INSTRUCTIONS TO THE BOARD OF INVESTIGATION
AND THE BOARD OF APPEALS
1917, 1918

OUT-LETTERS. Another administrative function of the Inspector is the issuance of out-letters certifying the use of Navy land on the premises for various purposes not associated with military issues -- such as for grazing and farming.

The procedure followed in issuing out-letters is given below:

- a. The Inspector may originate a notice of the availability of certain land for various purposes or an application for an out-letter may be received by the Inspector from an individual or party.
- b. The application is analyzed by the Inspector's staff. It is submitted with recommendations and necessary illustrations, such as a sketch of the area, to the Board and is then forwarded to the Board of Investigation for the Navy Department's review and approval (out-letters).
- c. The Board prepares the final contract form for the issue, the final form being approved by the Inspector and the Board.
- d. The Board certifies the bidding by public notice of availability and receives all bids.
- e. The Board selects the bidder to whom the land is issued. The contract is signed by representatives of the Board and the applicant.

f. Duration: 5 years or less at which time the lease is re-negotiated. The lease may be renewed with the previous lessee only on a year to year basis, complying with certain specified conditions.

Two of these leases were issued in 1951 and 1952, amounting to a receipt of \$6,157.60 by the Federal Government. In 1953 renewal of a grazing lease on N.P.R. No. 1 came to \$6,157.60; a farming lease on N.P.R. No. 2, \$815.

OIL AND GAS LEASES. There were no outstanding oil and gas leases on Navy property in N.P.R. No. 1 by the end of 1952.

REVOCABLE PERMITS AND RIGHT-OF-WAYS. These items are also administered by the Inspector. They include right-of-ways across the Reserve for country roads and pipe-lines of commercial companies. Permits may be issued for such items as the establishment of churches and schools on the Reserve, construction of an automatic radio repeater station within the Reserve, and location of oil field facilities of commercial companies on the Reserve. No charge is made for these privileges if they are of mutual interest and/or benefit.

The procedure for issuing these permits and right-of-ways is as follows.

- a. Application is made by the interested party to the Inspector.
- b. The Inspector analyzes the request, makes appropriate recommendations, and forwards it to Navy's Bureau of Yards and Docks (BuDocks) via DNPR.
- c. If BuDocks approves the request, it will prepare

1. RENTAL: 5 years or less at what time the lease is re-computed. The lease may be renewed with the previous lease only on a year to year basis, unless stipulated otherwise.

Two of these leases were issued in 1951 and 1952, amounting to a total of \$2,129.00 by the Federal Government. In 1953 amount of a leasing lease on N.Y.N. No. 1 was \$2,129.00; a leasing lease on N.Y.N. No. 2, \$212.90.

OIL AND GAS LEASING. There were no outstanding oil and gas leases on Navy property in N.Y.N. No. 1 by the end of 1952.

REVENUE RIGHTS AND RIGHT-OF-WAY. These items are also administered by the Inspector. They include right-of-way across the Reserve for country roads and pipelines of commercial character. Permits may be issued for such items as the establishment of churches and schools on the Reserve, construction of an airstrip and other projects within the Reserve, and location of all other facilities of commercial character on the Reserve. No charge is made for these permits unless it may be of mutual interest and/or benefit.

The procedure for issuing these permits and right-of-way is as follows:

1. Application is made by the interested party to the Inspector.
2. The Inspector analyzes the request, makes appropriate recommendations, and forwards it to Navy's Bureau of Land and Tides (Budget) via NAVS.
3. If Bureau approves the request, it will prepare

the legal form and return it to the applicant via the Director and the Inspector, either of whom may return the form to BuDecks with supporting reasons before it reaches the applicant.

- d. The applicant signs the legal form, keeping the original. Copies are returned to the Inspector, the Director, and BuDecks.
- e. These permits are revocable at will by the Navy within a specified time after notice is given the permit holder. Moreover, Navy cannot be held liable for any accidents or other legal action arising out of issuance of the permit. Consequently, the permit holder is required to be heavily bonded.

The paper for the report is to be prepared by the Director and the Inspector, either of whom may return the form to the office with supporting material before it reaches the recipient.

d. The applicant signs the paper form, having the original. Copies are retained by the Inspector, the Director, and the Board.

e. These records are reviewed as will by the Navy within a specified time after notice is given the

parent holder. However, Navy cannot be held liable for any negligence or other legal action arising out of failure of the parent. Consequently, the parent holder is required to be carefully checked.

The parent holder is required to be carefully checked. The parent holder is required to be carefully checked.

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DISPOSAL OF USED EQUIPMENT

Under the Unit Operating Agreement, Section 6(d), Standard as Operator has the right and responsibility for disposing of all scrap, salvageable material, and other equipment belonging to the Unit Operation and determined by the Operating Committee not to be needed and desired to be disposed of. Standard sells or transfers this material, subject to the approval of the Operating Committee.

Payments received by Standard are retained by Standard. Proper adjustment is made on the accounts of the Unit Operation so as to give Navy its share of credit from the sale or transfer.

INSPECTIONS MADE OF THE RESERVES IN CALIFORNIA

GENERAL INSPECTIONS OF THE RESERVES. Routine Inspections of the Reserves in California are made by the Petroleum Committee of the Federal Munitions Board and the District Civil Engineer of the Eleventh Naval District.

INDUSTRIAL PROCEDURES AND RELATIONS AND ACCOUNTING METHODS. A periodic inspection is made of the Reserves by the Navy's Industrial Survey Board.

PERSONNEL REQUIREMENTS. Personnel requirement surveys of Navy's staff at Elk Hills is made annually by the District Supply Officer of the Eleventh Naval District.

AUTOMOTIVE. Representatives of the Commandant, Eleventh Naval District, make routine inspections of all

REGULATION OF THE SERVICE

Under the Unit Operating Agreement, Section 2(d),
 Standard as Operator has the right and responsibility for the
 making of all orders, assignments essential, and other operations
 pertaining to the Unit Operation and determined by the Com-
 manding Officer not to be needed and desired to be assigned to
 Standard with or without this material, subject to the
 approval of the Operating Committee.
 Reports received by Standard are retained by Standard.
 Proper adjustment is made on the accounts of the Unit Oper-
 ation so as to give the share of credit from the sale of
 Standard.

INVESTIGATIONS MADE BY THE RESERVE IN CALIFORNIA

GENERAL INVESTIGATION BY THE RESERVE. Routine investi-
 gation of the Reserve in California was made by the Personnel
 Committee of the Federal Maritime Board and the District
 Civil Engineer of the Eleventh Naval District.

INDUSTRIAL ENGINEERS AND MECHANICS AND ELECTRICIANS

REPORTS. A periodic inspection is made of the Reserve by the
 Navy's Industrial Survey Board.

INDUSTRIAL REQUIREMENTS. Technical requirements

of Navy's staff of the Reserve is made annually by the District
 Supply Officer of the Eleventh Naval District.

ANTICIPATION. Requirements of the Commanding

Eleventh Naval District, with periodic inspections of all

automotive equipment under cognizance of the Navy at Elk Hills. This equipment belongs to the Eleventh Naval District and is assigned to the Inspector.

TRAINING

An important activity at the Inspector's office is the training of various groups of naval personnel in petroleum production and oil field development practices. These groups include naval reserve officers on annual training duty, members of volunteer petroleum units, and naval postgraduate students in petroleum engineering.

SELECTED REFERENCES IN THE BIBLIOGRAPHY

2, 7, 9, 14, 101, 102, 111, 125, 146,
149, 150, 170, 173, 176, 177.

reflexive equipment under cognizance of the Navy at this time. This equipment belongs to the Research Naval District and is assigned to the Inspector.

TRAINING

An important activity at the Inspector's office is the training of various groups of naval personnel in petroleum production and oil field development practices. These groups include naval reserve officers on annual training duty, members of volunteer petroleum units, and naval petroleum systems in petroleum engineering.

SELECTED REFERENCES IN THE BIBLIOGRAPHY

- 1. V. S. 14, 101, 102, 111, 125, 146,
- 148, 150, 170, 178, 177.

CHAPTER VIII

ECONOMIC REVIEW

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IRVING BERLIN

WILSON JIM RICE

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CHAPTER VIIIECONOMIC REVIEWGeneral Review of the Economic Factors of the Naval
Petroleum and Oil Shale Reserves Program

In the administration and operation of Naval Petroleum Reserve No. 1, Navy is charged by Congress with the responsibility for normally conserving the oil in the ground, producing as little as possible during normal times, and maintaining the Reserve in a state of readiness for maximum production "whenever the strategic situation of the United States in the future may so require."¹⁵⁰ Navy's share of N.P.R. No. 2 (Buena Vista) is being produced under leases with royalties to Navy. N.P.R. No. 3 has a relatively small amount of recoverable oil and in no way qualifies as a petroleum reserve. It is more of a liability than an asset. If it were not such a political football, the Government probably would dispose of it. As regards N.P.R. No. 4 (Alaska), it is still commercially unproductive after 50 million dollars for exploration. Only experimental work has been done in relationship to the Oil Shale Reserves.

With the status of each reserve so different and under the policy demanded by Congress for N.P.R. No. 1 as described above, an economic appraisal and evaluation of this Program, as if it were a commercial venture, is not strictly plausible; for, from a strictly financial viewpoint, the Program cannot

QUALITY
ECONOMIC REVIEW

General Review of the Economic Factors of the Naval
Reserve and Oil Shale Reserves Program

In the administration and operation of Naval Reserve No. 1, Navy is charged by Congress with the responsibility for normally conserving the oil in the ground, producing as little as possible during normal times, and maintaining the Reserve in a state of readiness for maximum production whenever the strategic situation of the United States in the future may so require. Navy's course of N.R. No. 2 (Brown Vase) is being produced under leases with royalties to Navy. N.R. No. 2 has a relatively small amount of recoverable oil and in no way qualifies as a petroleum reserve. It is more of a liability than an asset. It is not worth a political football, the Government probably would dispose of it. As regards N.R. No. 4 (Alaska), it is still comparatively unproductive after 50 million dollars for exploration. Only experimental work has been done in relationship to the Oil Shale Reserves.

With the reserve of sea reserves so different and under the policy handed by Congress for N.R. No. 1 as described above, an economic appraisal and evaluation of this program as it is a commercial venture, is not strictly possible; for, from a strictly financial viewpoint, the program should

be justified. Millions of dollars in revenue are deferred annually by not producing N.P.R. No. 1. Also, some actual loss of assets may be occurring by the migration of oil from N.P.R. No. 1, which a current program is attempting to correct. The Naval Reserve Program is in many respects comparable to maintaining a combatant ship in the line: it is expensive to build, maintain, and operate, of little or no commercial value normally, and yet it must be maintained constantly in a state of readiness to meet the emergencies of war. The principal facts to determine, then, are how efficiently is the Program administered, what have been the total costs and receipts, what has been accomplished, and what is the potential value in oil and money.

Expenditures and Receipts. Over a period of 36 years -- fiscal year 1916 through fiscal year 1952 -- a net profit of \$2,300,000 had been made by the Naval Petroleum Reserve Program. This profit represented the difference between the total income, principally from the sale of Navy's share of oil from N.P.R. No. 1 and royalties from N.P.R. No. 2, and the total capital and non-capital expenditures resulting from the operation of the Reserve Program -- including the exploration and development of N.P.R. No. 1 to its present potential capacity of approximately 125,000 barrels per day and 700 million barrels of recoverable oil, the extensive exploration and exploratory drilling program in N.P.R. No. 4 in Alaska, the exploration and partial development of N.P.R. No. 3, and the administration of all of the reserves.

be justified. Millions of dollars in revenues are delayed annually by not producing W.P.R. No. 1. Also, some annual loss of assets may be occurring by the migration of oil from W.P.R. No. 1, which a current program is attempting to correct. The Naval Reserve Program is in many respects comparable to maintaining a combatant ship in the line: it is expensive to build, maintain, and operate, of little or no commercial value normally, and yet it must be retained essentially in a state of readiness to meet the emergencies of war. The principal factors to determine, then, are how efficiently is the program administered, what have been the total costs and receipts, what has been accomplished, and what is the potential value in oil and money.

Expenses and Receipts. Over a period of 25 years

-- fiscal year 1918 through fiscal year 1942 -- a net profit of \$2,300,000 had been made by the Naval Petroleum Reserve Program. This profit represented the difference between the total income, principally from the sale of Navy's share of oil from W.P.R. No. 1 and royalties from W.P.R. No. 2, and the total capital and non-capital expenditures resulting from the operation of the Reserve Program -- including the exploration and development of W.P.R. No. 1 to the present potential capacity of approximately 125,000 barrels per day and 700 million barrels of recoverable oil, the extensive exploration and exploratory drilling program in W.P.R. No. 4 in Alaska, the exploration and partial development of W.P.R. No. 3, and the administration of all of the reserves.

Figures for the total appropriations, expenditures and income from 1916 through 1952 are tabulated below:

Total Appropriations Capital and Non-capital	\$103,924,008
Total Expenditures	\$ 95,544,939
Total Receipts	\$ 97,855,228
Net Income to the Government	\$ 2,310,289

How Efficient? This question is difficult to answer.

The main criticism of the Program from an economic standpoint usually stems from a criticism of its objectives and purposes, such as the extensive exploration and drilling program conducted at great expense in Alaska. On the credit side for efficiency are such items as the relatively small staffs which the Navy has employed to administer the Program, the unit operation and development of N.P.R. No. 1 to its present huge capacity and reserve using the best oil field practices, and the cooperation with the U.S. Geological Survey in the administration of N.P.R. No. 2.

Potential Value. If N.P.R. No. 1 should be put on full production at 100,000 barrels per day, the Navy's share would be about 84,000 barrels daily with an income to the Navy from the oil alone of almost \$202,000 daily at 1952 prices. The revenue from the oil, natural gasoline, and other hydrocarbons would give the Navy a gross income annually approximating \$75,000,000. Over a five year period, the gross income annually should remain at approximately the above value or

figures for the total appropriations, expenditures and income from 1952 through 1955 are tabulated below:

Total Appropriations Capital and Non-capital	\$103,984,000
Total Expenditures	\$ 82,744,000
Total Receipts	\$ 97,083,000
Net Income to the Government	\$ 14,339,000

Are Efficient? This question is difficult to answer.

The main criticism of the program from an economic standpoint usually stems from a criticism of its objectives and purposes, such as the extensive exploration and drilling program conducted at great expense in Alaska. On the other hand, it is pointed out that the program has achieved a relatively small amount of oil production and that the program, the way operation and development of P.R. No. 1 to its present stage, and the best oil field practices, and the cooperation with the U.S. Geological Survey in the administration of P.R. No. 2.

Potential Values. If P.R. No. 1 should be put on full

production at 100,000 barrels per day, the Navy's share would be about \$4,000 barrels daily with an income to the Navy from the oil alone of about \$200,000 daily at 1955 prices. The revenues from the oil, natural gas, and other hydrocarbons would give the Navy a gross income annually approximating \$75,000,000. Over a five year period, the gross income annually should result at approximately the above value of

higher, depending on the price of oil and the possibility of increased development and production of oil from the deepest zone, the Carneros Zone -- oil of high gravity and high value.

The income from N.P.R. No. 2 in the form of royalties on all hydrocarbon products produced from government leases aggregated approximately \$862,000 in 1951 and \$805,000 in 1952 or nearly a million dollars each year. Income from N.P.R. No. 2 should continue for many years, perhaps a score or more, declining steadily each year as indicated by the values above. The possibility of production from as yet undiscovered deeper zones under Navy leases would keep the royalty income high from N.P.R. No. 2.

The potential value of the oil shale reserves controlled by the Navy is extremely great with the reserve of oil in several billions of barrels. The production of oil from shale is becoming more and more economically feasible with each passing year as oil prices and demand continue to rise.

The potential values of N.P.R. No. 2 and No. 3 are small, and that of N.P.R. No. 4 in Alaska may be great but still unproved. The present economic or actual value of N.P.R. No. 2 to the Navy is only the present-day value of about 3,652,000 barrels of oil, or only 3.5 per cent of the total recoverable reserves in N.P.R. No. 2. The value of N.P.R. No. 3 is that of approximately 8.4 million barrels from the Second Wall Creek zone plus the value of an undetermined, but not major, accumulation of oil in the deeper Tensleep sandstone.²

...depending on the price of oil and the possibility of
 increased development and production of oil from the Alaska
 zone, the Garter zone -- oil of high gravity and high value.
 The income from A.P.R. No. 2 in the form of royalties
 on all hydrocarbon products produced from Government leases
 aggregated approximately \$682,000 in 1961 and \$808,000 in 1962
 or nearly a million dollars each year. Income from A.P.R. No.
 2 should continue for many years, perhaps a score or more, de-
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 each passing year as oil prices and demand continue to rise.
 The potential value of A.P.R. No. 2 and No. 3 are
 small, and that of A.P.R. No. 4 in Alaska may be great but
 still unproven. The present economic or actual value of A.P.R.
 No. 2 to the Navy is only the present-day value of about
 2,882,000 barrels of oil, or only 2.5 per cent of the total
 recoverable reserves in A.P.R. No. 2. The value of A.P.R. No.
 3 is that of approximately 8.4 billion barrels from the Garter
 zone plus the value of an additional, but not

major, accumulation of oil in the deeper Tertiary sediments.

Appropriations, Expenditures, etc.

Breakdown of Appropriation, Expenditures, and Income
 Figures where Available for Each Petroleum Reserve
 from 1916 through 30 June 1952

	Naval Petroleum Reserve			
	#1 ^{111,125}	#2 ^{170,173}	#3	#4
	_____	_____	_____	_____
A. Appropriations..	\$53,491,327			\$45,265,000
B. Expenditures:				
1. Administra-				
tive.....		\$1,877,719	\$333,562	
2. Develop.,				
Oper., etc..				
3. Total				
Expend.....	\$50,968,730	_____	_____	_____
C. Gross Income....	\$64,375,098	\$27,379,289	\$6100,841	
D. Net Income.....	\$13,406,368	\$25,501,570		None

(Note: All values were not available to the author.)

Appropriations, Expenditures, etc.

Statement of Appropriation, Expenditure, and Income
Figures were Available for each Federal Reserve
From 1916 through 30 June 1953

Naval Petroleum Reserve

	#1	#2	#3	#4
A. Appropriations	103,481,337	111,185	140,143	49,855,000
B. Expenditures:				
1. Administration			1,577,715	223,552
2. Development				
3. Other, etc.				
Total				
Excess	103,481,337	111,185	140,143	49,855,000
C. Gross Income	104,775,000	275,300	210,000	100,000
D. Net Income	113,405,325	286,485	210,000	None

(Note: All values were not available to the author.)

Items of Economic Interest under the Unit Operation
of Naval Petroleum Reserve No. 1

COSTS

Plant Costs. Upon inception of the Unit Contract the respective value of Navy's share and Standard's share of the plant on the Reserve was credited to each on the accounting records of the Unit.

The inventory value of the plant as of 20 November 1942, subdivided into tangible costs (physical property such as derricks, buildings) and intangible costs (labor, fuel, power, etc.), is tabulated below:

	<u>Tangible</u>	<u>Intangible</u>	<u>Totals</u>
Navy	\$ 826,805	\$ 907,514	\$1,734,319
Standard	<u>\$1,501,708</u>	<u>\$1,582,049</u>	<u>\$3,083,757</u>
	\$2,328,513	\$2,489,563	\$4,818,076

The total plant cost of nearly 5 million dollars in 1942 had increased to over 60 million dollars by 1954 -- approximately 42 per cent to tangible costs and 58 per cent to intangibles. This twelve-fold gain in plant costs over a twelve year period, representing only a third of the field's life to date, is ample evidence of the intense development which the field has experienced under the Unit Operation.

An actual present-day or market value of the plant has not been determined.

Items of Property Acquired Under the Unit Operation
of Great Northern Railway No. 1

NOTE

First Class. Upon acquisition of the Unit Operation the respective value of Navy's share and Standard's share of the plant on the Reserve was credited to each in the accounting records of the Unit.

The inventory value of the plant as of 30 November 1945, subdivided into tangible costs (physical property such as structures, buildings) and intangible costs (patents, fuel, power, etc.), is tabulated below:

<u>Tangible</u>	<u>Intangible</u>	<u>Total</u>
\$ 222,208	\$ 227,212	\$ 449,420
\$ 1,201,708	\$ 1,282,046	\$ 2,483,754
\$ 1,423,916	\$ 1,509,258	\$ 2,933,174

The total plant cost of nearly 3 million dollars in 1945 had increased to over 30 million dollars by 1954 -- approximately 42 per cent for tangible costs and 34 per cent for intangible. This twenty-fold gain in plant value over a twenty year period, representing only a third of the Unit's life so far, is ample evidence of the intense development which the Unit has experienced under the Unit Operation.

An actual present-day or market value of the plant has not been determined.

Summary of Major Cost Divisions and Subdivisions.

Shallow Oil Zone Costs. Costs in this Zone are segregated under the following major subdivisions:

- (1) Operating and Development
- (2) Exploratory
- (3) Readiness Maintenance
- (4) Development Readiness

Stevens Zone Costs. Major cost subdivisions are:

- (1) Operating
- (2) Exploratory
- (3) Exploratory, Extended Area (Contract NOd 8477)
- (4) Development

Carneros Zone Costs. To date all costs have been charged to Navy. Standard has not entered into the Unit Operation of this Zone as yet.

Dry Gas Zone. Relatively little or no expenditures have been made on this zone in recent years.

Wet Gas Handling Facilities. No definite allocation of costs of Wet Gas Handling Facilities between zones has been made to date by the Operating Committee.

Drilling (Development) Costs. All drilling at the Reserve is accomplished by private drilling contractors who are hired by the Unit on a competitive bid basis. They use their own rotary drilling equipment -- usually light portable rigs -- and hire their own employees.

With three different oil zones at Elk Hills under active development, a fair comparison of the relative drilling and

Summary of Major Cost Divisions and Subdivisions.
Stevens Zone Costs. Costs in this zone are

represented under the following major subdivisions:

- (1) Operating and Development
- (2) Exploratory
- (3) Handing Waterman
- (4) Development Handing

Stevens Zone Costs. Major cost subdivisions are:

- (1) Operating
- (2) Exploratory
- (3) Exploratory, Extended Area (Contract WOB 8477)
- (4) Development

Contract Zone Costs. To date all costs have been

charged to Navy. Standard has not entered into the Unit
Operation of this zone as yet.

Gas Zone. Relatively little or no expenditure

has been made on this zone in recent years.

Gas Handling Facilities. No definite allocation

of costs of Gas Handling Facilities between zones has been
made to date by the Operating Committee.

Drilling (Development) Costs. All drilling at the

Reserve is accomplished by private drilling contractors who
are hired by the Unit on a competitive bid basis. They use
their own rotary drilling equipment -- usually light portable
 rigs -- and hire their own equipment.

With three different oil zones at El Paso under active

development, a fair comparison of the relative drilling and

equipment costs at different depths and for different years may be obtained. Total drilling and equipment cost data as available for each zone is tabulated and discussed below. 109, 111, 125, 148

<u>Period</u>	<u>No. of Wells Drilled</u>	<u>Av. Cost per Well</u>	<u>Average Footage</u>	<u>Av. Cost per Foot</u>	<u>Av. Cost per Day</u>
<u>(Shallow Oil Zone)</u>					
1946- 1947	-----	\$48,000	-----	\$12.00	\$1400
1952	39	\$34,086	3048	\$11.18	-----
<u>(Stevens Zone)</u>					
1946- 1947	-----	\$280,000	-----	\$35.00	\$1300
1948- 1951	99	\$123,463	6504	\$18.98	-----
1952	33	\$132,655	6743	\$19.67	-----
<u>(Carneros Zone)</u>					
1952	1	\$798,874	12,856 (Plugged at 9,385)	\$62.00	

The unusually high cost of \$280,000 for a Stevens Zone well in the 1946-1947 period was the result of extensive logging, coring, testing, and prolonged fishing jobs in certain wells. Actually, many wells were drilled for less than \$250,000 per well; and thus the \$35.00 per foot is not a particularly good representative figure.

equipment costs in different depths and for different years may be obtained. Total drilled and equipped cost data as available for each year is tabulated and discussed below, 1946, 1947, 1948, 1949.

Period	No. of Wells Drilled	Average Cost per Well	Average Footage	Average Cost per Foot	Total Cost
(Shallow Oil Zone)					
1946	---	\$27,000	---	\$12.00	\$1400
1947	22	\$24,000	2048	\$11.70	---
1948	22	\$127,400	6204	\$19.90	---
1949	22	\$132,850	6743	\$19.67	---
(Stevens Zone)					
1946	---	\$20,000	---	\$38.00	\$1800
1947	---	---	---	---	---
1948	22	\$127,400	6204	\$19.90	---
1949	22	\$132,850	6743	\$19.67	---
(General Zone)					
1946	---	\$120,000	10,000	\$12.00	---

The normally high cost of \$200,000 for a Stevens Zone well in the 1948-1949 period was the result of extensive log-
ging, boring, testing, and proposed casing jobs in certain wells. Actually, many wells were drilled for less than \$200,000 per well; and thus the \$38.00 per foot is not a particularly good representative figure.

In analyzing the costs above it is of interest that during the 1946-1947 period the average cost per foot for a Stevens Zone well was nearly three times that for a Shallow Zone well while the average cost per day for the deeper well was actually less.¹⁰⁹

Comparing cost per foot figures for each zone in 1952 a rapid increase in costs with depth may be noted and should be expected. However, the \$62.00 per foot for a Carneros Zone well is excessively high due to the extensive logging, coring, and testing attendant with the drilling of this deep exploratory well.

Ordinary Production and Readiness Maintenance Costs.

With all the different programs simultaneously in progress in the Shallow Oil Zone, ordinary production cost values are difficult to obtain for this zone. An estimate of the production cost for each month is obtained by applying a weighted cost index factor to a cost per barrel value for the base year. The full year prior to unitization was considered a normal year, and as such, the base year.

The Readiness Maintenance costs are then obtained by subtracting the production costs calculated by the formula described above from the total Shallow Zone Operating costs.¹⁴⁷

Since no Readiness Maintenance program exists for the Stevens Zone, production costs may be obtained directly. Some available production cost figures are tabulated below:

In analyzing the costs above it is of interest that during the 1946-1947 period the average cost per foot for a Stevens Zone well was nearly three times that for a Shallow Zone well while the average cost per day for the deeper well was actually less. 100

Operating cost per foot differs for each zone in 1946 a rapid increase in costs with depth may be noted and should be expected. However, the \$2.00 per foot for a Shallow Zone well is excessively high due to the extensive logging, coring, and testing attendant with the drilling of this deep exploratory well.

Ordinary Production and Residual Maintenance Costs

With all the different programs simultaneously in progress in the Shallow Oil Zone, ordinary production cost values are difficult to obtain for this zone. An estimate of the production cost for each month is obtained by applying a weighted cost index factor to a cost per barrel value for the base year. The full year price devaluation was considered a normal year, and as such, the base year.

The Residual Maintenance costs are then obtained by subtracting the production costs calculated by the formula described above from the total Shallow Zone Operating costs. Since no Residual Maintenance program exists for the Stevens Zone, production costs may be obtained directly. Some available production cost figures are tabulated below:

<u>Zone</u>	<u>Year</u>	<u>Av. Cost per Barrel</u>
Shallow	1948	0.1400
	1951	0.1588
	1952	0.1610
	1953	0.1598
Stevens	1952	0.328

Readiness Maintenance costs have varied but in recent years have been about equal to ordinary production costs.

Materials.¹⁴⁷ Most materials necessary for the Unit Operation of N.P.R. No. 1 are purchased by the Operator through Standard's Purchase and Stores Department. The materials charged to the Unit Operation at the same price paid by Standard plus a fee for storage and issuing service if the material is stored at Standard's 11-C Camp.

Standard's Purchasing Office in Los Angeles does all the purchasing for the Unit Operation.

Storage Costs. Navy does not own any large crude oil storage tanks at the Reserve. Consequently, to provide the necessary temporary storage space required for the collection and gauging of Navy's share of the crude production prior to its being delivered to the buyer, Navy rents four tanks from Standard. These tanks are of approximately 45,000 barrel capacity and are located on Standard's Section 16-G tank farm, south of the Reserve.

In 1953 the storage cost to the Navy was \$0.005 per barrel of tank capacity per month.

Year	Av. Cost Per Barrel	Notes
1948	0.1407	Standard
1951	0.1888	
1952	0.1610	
1953	0.1888	
1954	0.328	Standard

Readiness Maintenance costs have varied but in recent years have been about equal to ordinary production costs. Materials that are necessary for the Unit Operation of R.P.R. No. 1 are purchased by the Operator through Standard's Purchase and Stores Department. The materials stored to the Unit Operation at the same price paid by Standard plus a fee for storage and handling services if the material is stored at Standard's I-C Camp. Standard's Purchasing Office in Los Angeles does all the purchasing for the Unit Operation. Storage Costs. Navy does not own any large cranes or storage tanks at the Reserve. Consequently, to provide the necessary temporary storage space required for the collection and loading of Navy's share of the arms production prior to its being delivered to the Navy, Navy rents four tanks from Standard. These tanks are of approximately 45,000 barrel capacity and are located at Standard's Section I-C tank farm, south of the Reserve. In 1953 the storage cost to the Navy was \$0.002 per barrel of tank capacity per month.

Passenger Car and Truck Rental.¹⁴⁷ The Unit Operation owns no cars or trucks, but rents all motor vehicles from the Motor Transport Department of Standard located at Standard's 11-C Camp in Taft.

All refined petroleum products necessary for these vehicles and for other miscellaneous operations are normally purchased by the Unit from Standard.

Miscellaneous Costs. In November, 1952, a new gas processing and pressure maintenance plant of 50 million cubic feet capacity was completed at a cost of about 5.5 million dollars. This 35-R Gas Plant is "mothballed" but can be activated in three months time. This plant has never been fully tested.

The older 3-G Gas Plant was repaired, overhauled, and modified during 1952 to more efficiently process current gas production and to serve as a booster station for compressing gas to 450 psi for delivery to the new 35-R Plant. The cost for this overhaul came to \$555,500.

Over 100 miles of new gathering and injection lines serving the Gas Plants above were laid during 1952 at a cost of approximately 1.5 million dollars.

Estimated Major Costs in the Near Future. In 1954 a pipeline proposal was submitted to Congress for the construction of a 14-inch pipeline 100 miles long from Elk Hills to Los Angeles to deliver the field's capacity of over 100,000 barrels per day to the refineries in case of an emergency. As of April 1954 no action had been taken by Congress on this item.

Research and Development 127
 The Department of Energy, Office of Energy Research and Development, is the lead agency for the development of advanced nuclear reactors. The Department is currently conducting research and development on advanced nuclear reactors, including the development of advanced gas-cooled reactors (AGCRs). The Department is also conducting research and development on advanced water-cooled reactors (AWCRs). The Department is currently conducting research and development on advanced water-cooled reactors (AWCRs). The Department is also conducting research and development on advanced gas-cooled reactors (AGCRs).

All related personnel projects necessary for these activities and for other miscellaneous operations are normally purchased by the Unit from Standard.

Miscellaneous Costs. In November, 1962, a new gas processing and pressure maintenance plant of 50 million cubic feet capacity was completed at a cost of about 2.5 million dollars. This 25-R Gas Plant is "scrubbed" but can be adjusted in three months time. This plant has never been fully tested.

The other 25-R Gas Plant was repaired, overhauled, and modified during 1962 to more efficiently process natural gas production and to serve as a booster station for compressing gas to 450 psi for delivery to the new 25-R Plant. The cost for this overhaul was \$1,388,500.

Over 100 miles of new gathering and injection lines serving the Gas Plants were laid during 1962 at a cost of approximately 1.8 million dollars.

Estimated Major Costs in the Near Future. In 1964 a legislative proposal was submitted to Congress for the construction of a 14-foot diameter gas pipeline from the Gulf of Mexico to deliver the field's capacity of over 100,000 barrels per day to the refineries in case of an emergency. As of April 1964 no action had been taken by Congress on this item.

If the exploratory drilling of the deep Carneros Zone is continued and this zone is developed like the Stevens and the Shallow Zones, development costs will soar to new heights.

As the age of the wells and associated equipment increases, repair and replacement costs, especially for the old wells of 1919 to 1930 vintage, will become increasingly heavy. Tubing and casing will need replacing, pumping equipment will tend to deteriorate, and many other items will require renewal.

At the laboratory building of the Army Research Office
 in Dayton and this work is devoted to the design and
 the design of the development of the Army Research Office
 - As the use of the work and associated equipment in
 process, repair and replacement costs, especially for the air
 wells of this to 1930 vintage, will become increasingly heavy.
 Tubing and seals will need replacing, pumping equipment will
 tend to deteriorate, and many other items will require renewal.

The work is being done in the laboratory of the Army Research Office
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 tend to deteriorate, and many other items will require renewal.

STATUS OF COSTS AND REIMBURSEMENTS
FROM INCEPTION TO 30 JUNE 1953*

<u>Charges under all contracts</u>	<u>Charged to</u>		<u>Total</u>
	<u>Navy</u>	<u>Standard</u>	
Shallow Zone (Exhibit C)	\$22,144,657	\$7,424,543	\$29,569,200
Stevens Zone (Exhibit D)	33,376,495	2,111,061	35,487,556
Dry Gas Zone (Exhibit E)	9,119	2,716	11,835
Carneros Zone (Exhibit F)	838,106	-0-	838,106
Wet Gas Handling Facilities (Exhibit G)	6,084,806	8,250	6,093,056
Deep Zone (Exhibit H)	357,854	-0-	357,854
Totals	\$62,811,037	\$9,546,570	\$72,357,607
	(Exhibit B) (Exhibit B) (Exhibit B)		

Reimbursement of Contractor by Navy

Payments for appropriations:

17X1300 (Contract N0d 4220, P.V. #1 - #51, #63- #76)	\$12,402,500
1760307 (Contract N0d 4220, P.V. #15 - #56)	7,250,000
1760307 (Contract N0d 7166, P.V. #1 - #14)	256,127
1790307 (Contract N0d 4220, P.V. #52 - #81)	8,995,000
1701307 (Contract N0d 4220, P.V. #64 - #87)	9,329,000
1711307 (Contract N0d 4220, P.V. #79 - #93)	3,898,000
1721307 (Contract N0d 4220, P.V. #93 - #116)	11,360,700
1731307 (Contract N0d 4220, P.V. #116 - #127)	6,675,852

Total reimbursements \$60,167,179

Materials and services furnished by Navy 2,643,858

Total charged to Navy \$62,811,037

*Exhibit A from Interim Audit Report #13¹⁴⁸ of 13 September 1953 under Contracts N0d 4219, 4220, 8477, and 7166.

SUMMARY OF COSTS, ALL ZONES, FROM INCEPTIONTO 30 JUNE 1953*

	<u>Navy</u>	<u>Charged to Standard</u>	<u>Total</u>
Production expenses	\$ 4,642,151	\$5,284,500	\$ 9,926,651
Productive wells			
Tangible well equipment	11,068,474	740,668	11,809,142
Intangible development costs	32,085,515	2,744,631	34,830,146
Unproductive wells	2,591,155	570,513	3,161,668
Geophysical exploration costs	63,135	16,472	79,607
Division and lease equipment			
Oil collection system	3,068,178	84,624	3,152,802
Gas collection system	1,897,124	16,182	1,913,306
Gas distribution system	145,355	18,384	163,739
Electric system	3,092	(701)	2,391
Water system	302,329	33,043	335,372
Telephone system	14,407	1,239	15,646
Waste water system	3,822	-	3,822
Racks and platforms	14,804	789	15,593
3G Gas plant	1,051,067	20,364	1,071,431
35R Gas plant	4,030,905	-	4,030,905
Buildings	204,734	8,601	213,335
Cottages	115,150	3,749	118,899
Garages	21,136	2,393	23,529
Recreational facilities	21,002	684	21,686
Construction equipment	11,183	243	11,426
Depth pressure equipment	23,099	2,403	25,502
Drilling and well pulling equipment	333,360	12,727	346,087
Engineering equipment	2,963	-	2,963
Fire equipment	2,611	(33)	2,578
Miscellaneous equipment	28,953	5,917	34,870
Motor equipment	(987)	2,233	1,246
Office equipment	17,823	1,112	18,935
Production tools	23,737	156	23,893
Plant tools	158	-	158
Inventories	994,637	5,642	1,000,279
Material transfers	29,965	(29,965)	-

Total of Exhibits C-H incl. \$62,811,037 \$9,546,570 \$72,357,607

(Exhibit A) (Exhibit A) (Exhibit A)

*Exhibit B from Interim Audit Report #13¹⁴⁸ of the N.C.I. under Contracts NOD 4219, 4220, 8477, and 7166.

SUMMARY OF COSTS, ALL WORK, FROM INQUIRY

TO 30 JUNE 1952*

	Charged to	MAINT	General	Total
Material transfers	28,285	(70,385)		-
Inventories	394,637	5,842		1,000,279
Plant tools	128	-		158
Production tools	23,727	166		23,893
Office equipment	14,523	1,112		15,635
Motor equipment	(987)	2,923		1,936
Miscellaneous equipment	28,225	5,917		34,142
Fire equipment	2,211	(52)		2,159
Engineering equipment	2,923	-		2,923
Equipment	323,280	12,727		336,007
Drilling and well pulling	22,023	2,402		24,425
Depth pressure equipment	11,125	243		11,368
Construction equipment	21,008	524		21,532
Recreational facilities	21,128	2,228		23,356
Cottages	112,120	2,749		114,869
Buildings	204,734	2,807		207,541
25R Gas plant	4,020,902	-		4,020,902
3G Gas plant	1,081,087	20,384		1,101,471
Racks and platforms	12,202	722		12,924
Waste water system	2,222	-		2,222
Telephone system	14,427	1,222		15,649
Water system	202,222	22,222		224,444
Electric system	2,022	(701)		1,321
Gas distribution system	142,222	12,222		154,444
Gas collection system	1,207,124	12,122		1,219,246
Oil collection system	2,022,124	24,224		2,046,348
Division and lease equipment	2,022,124	24,224		2,046,348
Geophysical exploration costs	23,122	12,422		35,544
Unproductive wells	2,221,122	270,212		2,491,334
Intangible development costs	22,022,212	2,744,221		24,766,433
Productive wells	11,222,474	710,222		11,932,696
Production expenses	4,222,121	22,221,222		26,443,343

Total of Exhibits C-H incl. 22,221,222, 22,221,222, 22,221,222

(Exhibit A) (Exhibit A) (Exhibit A)

Exhibit B from Interim Audit Report filed of the S.C.I. under Contract No. 4220, 2477, and 2122.

COST SHARING

Standard pays all costs each month and is then reimbursed by Navy for Navy's accrued share of the expenditures after audit of the monthly statement by the Navy Cost Inspector.

The Unit Plan Contract and Supplemental Agreement provide for the ultimate sharing of all costs, except certain exploratory costs, on the basis of participating percentages. The present participating percentage interests are as follows:¹²⁵

<u>ZONE</u>	<u>NAVY</u>	<u>STANDARD</u>
1. Dry Gas Zone	77.0492%	22.9508%
2. Shallow Oil Zone	66.9152%	33.0848%
3. Stevens Zone	79.3089%	20.6911%
4. Carneros Zone	100%	(Participating percentage for Standard has not been established.)

Under the development, production and cost provisions of the Contract, few costs are shared currently according to the participating percentages listed above.

For example, all normal operating and production costs for the Shallow Oil Zone are shared currently on the basis of production received each month by the participants. Currently Navy and Standard are out of balance, according to the participating percentages, on the production received from the Shallow Oil Zone. This situation resulted after the end of the World War II emergency production period. From 23 August 1945, the cutoff date, to the end of the extended primary period under

UNIT VES

Standard pays all costs each month and is then reimbursed by Navy for Navy's accrued share of the expenditures after audit of the monthly statement by the Navy Cost Inspector.

The Unit VES Contract and Supplemental Agreement provide also for the alternate sharing of all costs, except certain laboratory costs, on the basis of participating percentages. The present participating percentage interests are as follows:

STANDARD	NAVY	ZONE
22.00%	77.00%	1. Dry Gas Zone
33.00%	67.00%	2. Shallow Oil Zone
50.00%	50.00%	3. Deeper Zone
		4. Deeper Zone

(Participating percentage for Standard has not been established.)

Under the agreement, production and cost provisions of the Contract, few costs are shared currently according to the participating percentages listed above.

For example, all normal operating and production costs for the Shallow Oil Zone are shared currently on the basis of production received each month by the participants. Currently Navy and Standard are out of balance, according to the participating percentages, on the production received from the Shallow Oil Zone. This situation resulted after the end of the World War II emergency production period from August 1945, the actual date, to the end of the extended primary period which

the amended contract on 2 August 1950, Standard received practically all of the production from the Shallow Oil Zone. Navy is now receiving approximately 89 per cent of the production; all operating costs including Readiness Maintenance costs for this Zone are currently shared on the same basis.

Exploratory, prospecting and development costs with certain specific exceptions are to be shared ultimately according to the final revised participating percentages.¹⁵⁰ However, under terms of the Contract, the cost of wells drilled by Navy for development, readiness and exploratory purposes are paid currently 100 per cent by Navy. Standard shares current costs only for wells drilled for immediate production as the Section 14-B wells, or for protective or exploratory wells on which Standard has agreed to share the current costs.

The cost of new facilities for increasing the gas processing capacity, such as the new 5.5 million dollar gas plant, are paid currently 100 per cent by Navy, with costs to be shared ultimately.

Stevens Zone operating costs are currently shared according to the present participating percentages listed, as is the production from this Zone. All costs will be ultimately shared according to the final revised participating percentages.

The Carneros Zone production and expenses are still 100 per cent Navy. As this Zone is developed and proved commercially productive, participating percentage interests will be established under terms of the Unit Contract.

The best summary of cost sharing between Navy and

The amount of production from the 1957-58 season is estimated to be 100,000 tons. This is a decrease of 10% over the 1956-57 season. The decrease is due to a number of factors, including a late start to the season and a number of wells which are currently being developed.

Exploration, production and development costs for the 1957-58 season are estimated to be \$10 million. This is a decrease of 10% over the 1956-57 season. The decrease is due to a number of factors, including a late start to the season and a number of wells which are currently being developed.

The cost of the 1957-58 season is estimated to be \$10 million. This is a decrease of 10% over the 1956-57 season. The decrease is due to a number of factors, including a late start to the season and a number of wells which are currently being developed.

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Standard is shown on Figure 8-1, which graphs cost allocations between Navy and Standard from inception of the Unit Contract to 1 January 1954. 125

Standard is shown on Figure 3-1, which graphs cost allocation
between Navy and Standard from inception of the Life Contract
to 1 January 1954. 123

The cost of the contract is shown on the graph as follows:

1. The cost of the contract is shown on the graph as follows:

2. The cost of the contract is shown on the graph as follows:

3. The cost of the contract is shown on the graph as follows:

4. The cost of the contract is shown on the graph as follows:

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17. The cost of the contract is shown on the graph as follows:

18. The cost of the contract is shown on the graph as follows:

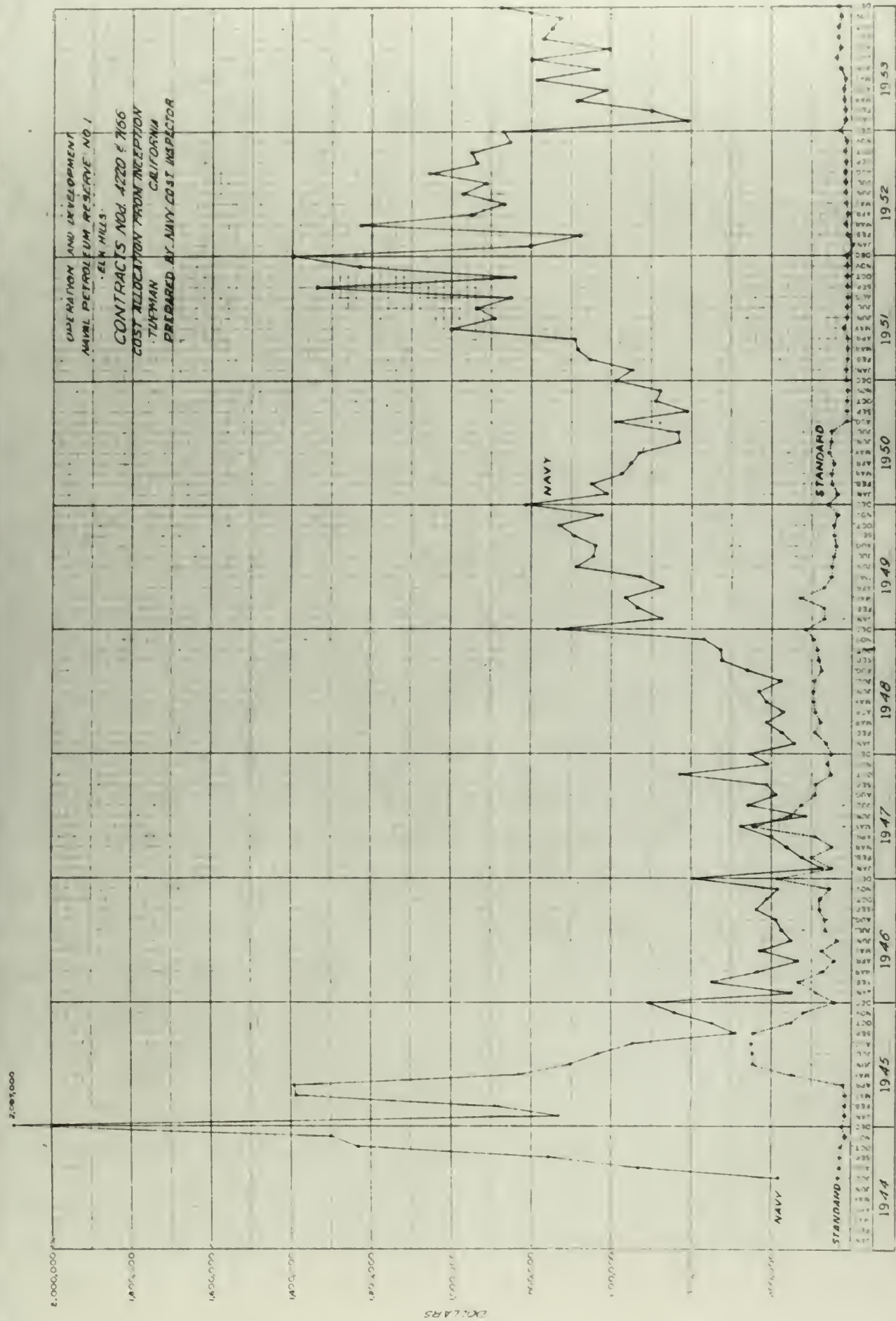


FIG. 8-1, Showing Cost Distribution Between Navy and Standard Since Inception in 1944.
(Current Not Ultimate Distribution)

COST PROBLEMS

Ultimate Payment of Costs. As of 30 June 1953, Navy had paid an excess of over 9 million dollars above its ultimate share of the total cost to date in exploring, developing, and operating the Reserve.

Under the terms of the Contracts controlling the Unit Operation of the Reserve, this large differential was correctly obtained; and the Unit Contract even provides for the "ultimate" payment of any such differential, which under the terms of the Contract is certain to necessitate a large payment by Standard to Navy. Nevertheless, the nebulous manner in which the Contract provides for the "ultimate" payment and the relatively rapid rate at which the excess paid by Navy is growing have caused some concern on the part of both Standard and Navy. If the Stevens Zone is further developed and if it should prove feasible to develop the Carneros Zone extensively, the excess paid by Navy will soar to an excessively high figure if this development is carried out during non-emergency production periods. However, if Carneros production is obtained only from under Navy's lands, then the Carneros development may not affect the "excess" as the participating percentage for Standard will remain zero.

To the interest of both parties, a more definite time, arrangement, and formula should be developed for bringing costs, as well as production, into agreement on the participating percentage basis. "Uneconomic production," as presently used in the Contract, should be defined more clearly. A specific

COST PROBLEMS

Ultimate Payment of Costs. As of 30 June 1963, Navy had paid an excess of over 9 million dollars above its ultimate share of the total cost to date in exploring, developing, and operating the Reserve.

Under the terms of the Contracts controlling the Unit Operation of the Reserve, this large differential was correctly obtained; and the Unit Contract even provides for the "ultimate" payment of any such differential, which under the terms of the Contract is certain to necessitate a large payment by Standard to Navy. Nevertheless, the nebulous manner in which the Contract provides for the "ultimate" payment and the relatively rapid rate at which the excess paid by Navy is growing have caused some concern on the part of both Standard and Navy. If the Stevens Zone is further developed and if it should prove feasible to develop the Gardner Zone extensively, the excess paid by Navy will soon to an excessive amount if this development is carried out during non-emergency production periods. However, if Gardner production is obtained only from under Navy's lands, then the Gardner development may not affect the "excess" as the participating percentage for Standard will remain zero.

To the interest of both parties, a more definite time arrangement, and formula should be developed for bringing costs, as well as production, into agreement on the participating percentage basis. "Economic production," as presently used in the Contract, should be defined more clearly. A specific

formula for ultimate payment would be desirable. Also, it would be desirable to decide now whether the changing value of the dollar is to be considered when ultimate payment is made; for it is unlikely that Standard will wish to make ultimate payment with a dollar at a higher value than the dollar value at the time of the expenditures. In other words, should a cost index be applied?

A recent ruling by the Navy's Judge Advocate General, not seen by the writer but explained to him, apparently interprets the Contract to provide for equalization of costs as well as production should the field be put on full production and before the end of the economic life of the field. This ruling, if agreed to by Standard, may solve the ultimate cost problem to some extent, by bringing total costs as well as production receipts into balance during any extended period of full production.

Other Pending Cost Problems. Currently pending cost problems of a minor and probably temporary nature which serve to illustrate the types of cost distributing problem constantly being encountered in the Unit Operation of the Reserve, are briefly described below:

- (1) Under mobilization preparations Navy has paid all costs for plans for new buildings. The problem is whether or not the costs of these plans ultimately will be shared.
- (2) Standard as Operator has paid all costs for the new 35-R Gas Plant for which Navy is currently

Formula for ultimate payment would be identical. Also, it would be desirable to decide now whether the amounting value of the dollar is to be considered when ultimate payment is made; for it is unlikely that standards will wish to make other payments with a dollar at a higher value than the dollar value at the time of the expenditures. In other words, should

a cost index be applied? A recent ruling by the Navy's Judge Advocate General, not seen by the witness but explained to him, apparently later-gets the Contract to provide for equalization of costs as well as production should the field be put on full production and before the end of the economic life of the field. This ruling, if agreed to by Standard, may solve the ultimate cost problem to some extent, by bringing cost costs as well as production receipts into balance during any extended period of full production.

Other Pending Cost Problems. Generally, pending cost

problems of a minor and possibly temporary nature which serve to illustrate the types of cost-alleviating problem occasionally being encountered in the unit operation of the Reserve, are briefly described below:

- (1) Under mobilization preparations Navy has paid all costs for glass for new buildings. The problem is whether or not the costs of these glass windows will be covered.
- (2) Standard as Operator has paid all costs for the new 32-2 set lines for which Navy is currently

obligated to reimburse Standard in full. The Navy Cost Inspector maintains that a final payment of about \$6000 should not be made to Standard until formal acceptance of the new plant by Standard is given to the contractor. [Note: Plant has been accepted and final payment will be made in June 1954.]

- (3) Standard has requested surcharges be made to Unit Operations for a supervisory geologist not stationed at the Reserve and for office expenses of the supervisor's office. Navy Cost Inspector disapproves this claim for charges.
- (4) When production varies annually by three or more thousand barrels, a new formula must be devised for determining production cost per barrel. This item is important, for it determines how certain costs are distributed between Standard and Navy.

An example of a cost problem which has recently been settled is the following:

Navy drilled a deep exploratory well to hit the Carneros Zone, which was not found. Well was plugged back to the Stevens Zone and brought in as a commercially productive well. It was agreed that the cost of drilling and plugging from the plugged depth to the total depth would be charged entirely to Navy on its non-participating account. The cost of drilling to the productive Stevens Zone would be shared ultimately by Standard and Navy.

Standard is to be released to the Navy. The Navy
Cost Inspector maintains that a final payment of
about \$6000 should not be made to Standard until
formal acceptance of the new plant by Standard is
given to the contractor. [Note: Plant has been
accepted and final payment will be made in June

1941.]

(2) Standard has requested surcharges be made to Unit
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at the Reserve and for office expenses of the super-
visor's office. Navy Cost Inspector disapproves
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thousand barrels, a new formula must be devised for
determining production cost per barrel. This item
is important, for it determines how certain costs
are distributed between Standard and Navy.

An example of a cost problem which has recently been
settled is the following:

Navy drilled a deep exploratory well to hit the Cameron
Zone, which was not found. Well was plugged back to the
Stevens Zone and proved to be a commercially productive well.
It was agreed that the cost of drilling and plugging from the
plugged depth to the level depth would be charged entirely to
Navy on its non-participating account. The cost of drilling
to the productive Stevens Zone would be shared ratably by

Standard and Navy.

INCOME TO NAVY

Production Share. Under terms of the Contract, Navy and Standard ultimately will share in the production of petroleum from each Zone according to their respective participating percentage interests in each Zone -- the latest revisions being listed under the Cost Sharing section of this chapter.

Only the production from the Stevens Zone and Dry Gas Zone is currently shared on this basis. As regards the Shallow Oil Zone production, Navy is now receiving approximately 89 per cent and will continue to do so until the lack of balance in production receipts is brought into agreement with the participating percentages. The Carneros Zone exploration and production is still strictly a Navy undertaking, with Navy receiving all of the minor test production to date.

Sales. As provided under the Unit Contract and explained in Chapter VII of this report, Navy receives from the Operator its share of petroleum products and sells these products to buyers under sales contracts obtained through competitive bidding. Sales of these products from all zones in calendar year 1952 amounted to over 5.5 million dollars and are tabulated below:¹²⁵

<u>Product</u>	<u>Amount Sold</u>	<u>Sales Value</u>
Oil	2,585,642.03 Bbls.	\$5,531,761.11
Gas	37,468.00 MCF	5,507.36
Gasoline	553,742.00 Gals.	39,683.98
TOTAL		<u>\$5,576,952.45</u>

INCOME TO NAVY

Production Shares. Under terms of the Contract, Navy and Standard Oil Company will share in the production of petroleum from each zone according to their respective participating percentage interests in each zone -- the latest revisions being listed under the Cost Sharing section of this chapter.

Only the production from the Stevens Zone and Dry Gas Zone is currently shared on this basis. As regards the shallow Oil Zone production, Navy is now receiving approximately 85 per cent and will continue to do so until the lack of balance in production receipts is brought into agreement with the participating percentages. The Germana Zone exploration and production is still entirely a Navy undertaking, with Navy receiving all of the minor test production to date.

Sales. As provided under the Unit Contract and explained in Chapter VII of this report, Navy receives from the Operator its share of petroleum products and sells these products to buyers under sales contracts obtained through competitive bidding. Sales of these products from all zones in calendar year 1952 amounted to over 2.5 million dollars and

are tabulated below:

<u>Product</u>	<u>Amount sold</u>	<u>Sales Value</u>
Oil	2,385,842.00 Bbls.	\$2,531,751.11
Gas	37,488.00 MCF	\$2,507.53
Gasoline	552,742.00 Gals.	\$9,883.98
TOTAL		<u>\$2,544,142.62</u>

In 1953, total receipts from the sale of all petroleum products belonging to Navy rose to 13 million dollars. All receipts from sales are deposited in the Treasury of the United States under Miscellaneous Receipts.¹²⁵

Unit Sale Values of Products. Of reference interest to some individuals may be the following compilation of approximate unit sale prices obtained by the Navy for its petroleum products over recent years:

<u>Year</u>	<u>Av. Price per Bbl. Stock Tank Oil, Dollars</u>		
	<u>Shallow Zone Oil (°API)</u>	<u>Stevens Zone Oil (°API)</u>	<u>Carneros Zone Oil (°API)</u>
1942*	0.9431		
1943*	0.9745		
1944-1946*	0.9786		
1947**	2.215		
1948	2.53		
1949	2.62		
1951	2.40		
1952#	2.17	2.70	
1953#	2.27	3.15	3.17

<u>Year</u>	<u>Natural Gasoline and Butane - Av. Price per Gallon, Dollars##</u>	
	<u>Natural Gasoline</u>	<u>Butane</u>
1942-1943*	0.05375	0.025
1944-1945*	0.0537	0.0373
1946*	0.05583	0.0242
1947**	0.0670	0.0327
1948	0.0868	0.0237
1949	0.0944	-----
1950	0.0558	0.0550
1951	0.0726	0.0390
1952	0.0717	-----

In 1953, total receipts from the sale of all petroleum products belonging to Navy were 15 billion dollars. All receipts from sales are deposited in the Treasury of the United States under Miscellaneous Receipts. ¹⁹⁵³

Unit Sale Values of Products. Of petroleum interest to some individuals may be the following compilation of approximate unit sale prices obtained by the Navy for its petroleum products over recent years:

Year	Shallow Edge Oil (GAL)	Stevens Edge Oil (GAL)	Av. Price per Gal. Stevens Tank Oil, Collier
1953	2.27	2.18	2.17
1952	2.40	2.10	2.10
1951	2.55		
1950	2.55		
1948	2.55		
1947	2.12		
1944-1946	0.275		
1943	0.275		
1942	0.243		

Year	Regular Gasoline	Av. Price per Gallon, Dollars
1953	0.071	0.069
1952	0.075	0.070
1951	0.075	0.075
1950	0.075	0.075
1949	0.075	0.075
1948	0.075	0.075
1947	0.070	0.070
1946	0.065	0.065
1944-1945	0.057	0.057
1943-1944	0.057	0.057
1942	0.055	0.055

<u>Year</u>	<u>Natural Gas - Av. Price per M.C.F., Dollars^{##}</u>
1942 -	
June 1947*	0.06
July 1947**	0.10
1948	0.1079
1949	-----
1950	0.12-0.14
1951-1953	0.14

*O.P.A. Ceiling Prices of World War II.

**O.P.A. Ceiling Prices were lifted.

#O.P.A. Ceiling Prices were terminated 2/12/53.

##Some values taken from the record of product prices obtained by Navy for royalty products from N.P.R. #2.

In 1953 it was estimated that the value of Shallow Zone oil with contained gas and natural gasoline was \$2.33 per barrel; the value of Stevens Zone oil with contained gas and natural gasoline, \$4.07 per barrel -- nearly twice the value of Shallow Zone oil.

Yearly - Average Price per Bbl. of Natural Gas - Dollars

Year	Price (Dollars)
1942 -	0.08
July 1941	0.10
1943	0.1075
1944	0.12-0.14
1945	0.14

O.P.A. Ceiling Prices of World War II.
 O.P.A. Ceiling Prices were lifted.
 O.P.A. Ceiling Prices were terminated 2/12/53.
 Some values taken from the record of product prices obtained by Navy for royalty products from W.P.A. '52.

In 1953 it was estimated that the value of Shallow Zone oil with contained gas and natural gasoline was \$2.35 per barrel; the value of Shallow Zone oil with contained gas and natural gasoline, \$4.07 per barrel -- nearly twice the value of Shallow Zone oil.

STATUS OF APPROPRIATIONS AS OF 30 JUNE 1953*

<u>Summary of All Appropriations</u>	<u>Amount of Appropriation</u>	<u>Expended</u>	<u>Balance</u>
1731307 O & C NPR #1 - 1953	\$12,663,000.00	\$ 6,675,851.69	\$5,987,148.31
1721307 O & C NPR #1 - 1952	11,360,700.00	11,360,700.00	-0-
1711307 O & C NPR #1 - 1951	3,898,000.00	3,898,000.00	-0-
1701307 O & C NPR #1 - 1950	9,329,000.00	9,329,000.00	-0-
1790307 O & C NPR #1 - 1949	8,995,000.00	8,995,000.00	-0-
1760307 O & C NPR #1 - 1946	7,506,127.13	7,506,127.13	-0-
17X1300 Naval Emergency Fund	12,402,500.00	12,402,500.00	-0-
Totals	\$66,154,327.13	\$60,167,178.82	\$5,987,148.31

*Exhibit J from Interim Audit Report #13¹⁴⁸ of 13 September 1953 by NCI under Contracts NOD 4219, 4220, 8477, and 7166.

BUDGET

The preparation and submission of the budget for Naval Petroleum Reserve No. 1 is controlled by the DNPR, who submits cost estimates for the operation of all the Reserves for each fiscal year to the Secretary of the Navy. These cost estimates are submitted 8 to 12 months before the budget for the Federal government is submitted to Congress. The budget for the Reserves forms a part of the overall Navy Department budget submitted by the Secretary of the Navy to the Director of the Budget.

OPERATOR'S ACCOUNTING PROCEDURES¹⁴⁷

1. Under Contract N0d 4220, Standard Oil Company, Producing Department, established a separate accounting unit at the Reserve to accomplish:
 - (a) The determination of all costs of operation, current and cumulative.
 - (b) The determination of quantities of production, oil, gas natural gasoline, and associated hydrocarbons, by zone and programs.
2. This unit of about 12 employees is under the supervision of a chief clerk, with functional supervision through the Northern District Accounting Supervisor to the Manager, Accounting Division, Producing Department in San Francisco. It accomplishes its duties under the guidance of accounting and other pertinent manuals which are in company-wide use.
3. At the inception of the contract, conferences were held to reconcile Standard's accounting procedures to Navy's accounting and auditing requirements, there being only minor differences at that time. Similar conferences are held periodically, when necessary, to revise, enlarge, or amend the procedures or form of data presentation, in accordance with the then current operational programs being accomplished under Contract N0d 4219.
4. Standard's procedures are based on:
 - (a) Cross-entry journal vouchers summarizing direct or indirect costs.
 - (b) Voucher Register. A voucher register is maintained by

STANDARD'S ACCOUNTING PROCEDURES

1. Under contract with the Department, Standard Oil Company, producing a separate accounting with the

reserve to accomplish:

(v) The determination of all costs of production, current

and cumulative.

(v) The determination of quantities of production, oil, gas

natural gasoline, and associated hydrocarbons, by zone

and programs.

2. This unit of account is employees as under the supervision of

a chief clerk, with functional supervision through the

Northern District Accounting Supervisor to the Manager,

Accounting Division, Producing Department in San Francisco.

It accomplishes its duties under the guidance of accounting

and other pertinent manuals which are in company-wide use.

3. At the inception of the contract, conferences were held to

reconcile Standard's accounting procedures to Navy's account-

ing and auditing requirements, there being only minor dif-

ferences at that time. Similar conferences are held

periodically, when necessary, to revise, change, or amend

the procedures or form of data presentation, in accordance

with the then current operational programs being accomplished

under Contract W04 4519.

4. Standard's procedures are based on:

(a) Cost-accounting journal vouchers summarized direct or

indirect costs.

(b) Warner Register. A Warner register is maintained by

months in which each voucher is spread by accounts and prorated to the expenditure control accounts. After balancing, totals are posted to the general ledger.

(c) General Ledger. The general ledger consists of all the main cost accounts affecting the project together with such intra-company accounts affecting this activity as are necessary for the operator to maintain. A trial balance is prepared monthly.

(d) Work in Progress Accounts. Certain general ledger accounts are Work In Progress accounts; Incomplete Construction, Incomplete Wells Plant, Incomplete Development Costs, and Incomplete Shop Orders. On completion of wells or construction jobs they are closed by journal entry to Plant and/or Intangible Development Costs.

5. Cost Statement

A statement of costs is prepared monthly showing costs for the month by zone and program with the allocation of the costs to Navy and Standard; the cumulative costs are similarly shown from inception to date.

6. Production Costs

A statement of production is prepared monthly showing the production for the month of oil, gas, and natural gasoline by zone, and the allocation of the production to Navy and Standard; the cumulative production is similarly shown from inception to date.

7. Payrolls

(a) Field. Daily time cards are prepared and signed by each

months in which each account is closed by accounts and
 credited to the expenditure control accounts. Also
 debited, totals are posted to the general ledger.
 (c) General Ledger. The general ledger consists of all the
 main cost accounts affecting the project together with
 such intra-company accounts affecting this activity as
 are necessary for the operator to maintain a trial
 balance is prepared monthly.

(d) Work in Progress Accounts. Certain general ledger
 accounts are work in progress accounts; incomplete con-
 struction, incomplete wells plant, incomplete development
 costs, and incomplete shop orders. On completion of wells
 or construction jobs they are closed by journal entry
 to fixed and/or incomplete development costs.

5. Cost Statement

A statement of costs is prepared monthly showing costs
 for the month by zone and program with the allocation of the
 costs to heavy and standard; the cumulative costs are simi-
 larly shown from inception to date.

6. Production Costs

A statement of production is prepared monthly showing
 the production for the month of oil, gas, and natural gas
 line by zone, and the allocation of the production to heavy
 and standard; the cumulative production is similarly shown
 from inception to date.

7. Payrolls

(a) Field. Daily time cards are prepared and signed by each

field employee and approved by the supervisor in charge. They are reviewed in the accounting office for proper cost distribution, summarized on a bi-weekly time sheet, then sent to 11-C for processing on IBM.

(b) Office. Classified confidential and unclassified confidential payrolls are prepared in 11-C and San Francisco respectively, based on a semi-monthly time report prepared at this activity.

8. Drilling Contracts

All drilling costs, substantiated by verified contractor's invoices, are distributed to cost accounts, and to subaccounts for wells, the credits to Accrued Contract Drilling account. Payments by San Francisco office, offset these credits.

9. Material Sales

In accordance with Contract NOd 4220, Section 6 (d), Standard is required to sell scrap, materials, or equipment, no longer needed for current or future operations, with prior concurrence of the Operating Committee. The credit for these sales is given to the party or parties in the same percentage participation in which the charge was made.

The majority of the above section on Accounting Procedures consists of direct excerpts, not necessarily complete, from a mimeographed but unpublished report prepared by the Navy Cost Inspector, Mr. Spencer Herrick, revised about 1 July 1952. This report summarizes cost accounting instructions, operator's accounting procedures, and audit procedures.

This matter was approved by the supervisor in charge. It was reviewed in the accounting office for proper cost distribution, summarized on a bi-weekly time sheet, then sent to I-0 for processing on I.M.

(b) Office. Classified confidential and unclassified confidential reports are prepared in I-0 and San Francisco respectively, based on a semi-monthly time report prepared at this activity.

8. Drilling Contracts

All drilling costs, substantiated by verified contracts, are distributed to cost accounts, and to subaccounts for wells. The credits to Account Contract Drilling account. Payments by San Francisco office, after these credits.

9. Material Sales

In accordance with Contract No. 2350, Section 9 (b), Standard is required to sell surplus materials, or equipment, no longer needed for current or future operations, with prior concurrence of the Operating Committee. The credit for these sales is given to the party or parties to the same percentage participation in which the charge was made.

The majority of the above section on accounting procedures consists of direct expenses, not necessarily complete, from a standpoint but unclassified report prepared by the San Francisco office, dated March 1, 1944. This report submitted with accounting instructions, supervisor's accounting procedures, and audit procedures.

COST INSPECTION

Office Established. On 15 July 1944 the Secretary of the Navy established a Cost Inspection Office at Naval Petroleum Reserve No. 1. Prior to this date there had been no Navy cost inspection service at the Reserve. Practically all costs from the actual inception of the unit operation in November 1942 to June 1944 had been paid by Standard. These expenditures were credited to Standard on the Unit Operations accounts, and a post audit was made by the Cost Inspection Office to determine the correctness of cost allocations back to 20 November 1942.

Organizational Relationships of the Navy Cost Inspector (NCI).^{147, 152} The Resident Navy Cost Inspector and his staff at the Reserve are under the control of the Comptroller for the Navy; with chain of command through the Supervisory Cost Inspector for the Western Area located in San Francisco and the Supervisor in the Branch Office at Los Angeles. He is directly responsible to the above officials and no others.

The Navy Cost Inspector at the Reserve (NCI), however, does supply information, advice, and various reports to officials directly connected with the operation of Elk Hills. He provides the DNPR* and INPR in C** with copies of all fiscal reports, either directly or through chain of command. He consults with INPR in C and NMOC on the status of expenditures

*DNPR: Director of Naval Petroleum Reserves.

** INPR in C: Inspector Naval Petroleum Reserves in California.

COST ACCOUNTING

Office Established. On 15 July 1944 the Secretary of the Navy established a Cost Accounting Office at Naval Reserve Base. Prior to this date there had been no Navy cost accounting service at the Reserve. Practically all costs from the actual inception of the unit operation in November 1942 to June 1944 had been held by Standard. These expenditures were credited to Standard on the Unit Operations accounts and a post audit was made by the Cost Accounting Office to determine the correctness of cost allocations back to 30 November 1942.

Organizational Relationship of the Navy Cost Inspector

The Resident Navy Cost Inspector and his staff at the Reserve are under the control of the Comptroller for the Navy; with chain of command through the Supervisory Cost Inspector for the Western Area located in San Francisco and the Supervisor in the Branch Office at Los Angeles. He is directly responsible to the above officials and no others. The Navy Cost Inspector at the Reserve (NCI), however, does supply information, advice, and various reports to officials directly connected with the operation of the Reserve. He provides the NCI and IAW in C with copies of all fiscal reports, either directly or through chain of command. He consults with IAW in C and WMO on the status of expenditures

IAW in C, Inspector Naval Petroleum Reserves in California.
NCP: Director of Naval Petroleum Reserves.

and appropriations and on the allowability of certain costs. On this latter item, the Operating Committee may override the NCI. The NCI has no relationship with such bodies as the Engineering Committee or the Eleventh Naval District.

Staff of the Navy Cost Inspector

World War II. During the emergency development and production period of the War, a joint Navy-Civil Service staff of about ten members, headed by a Naval Supply Corps Officer, made complete audits of the Operator's expenditures.

Post-War. From 1945 to 1950 the number of employees was reduced to six; from 1950 to 1952, to three. Complete audits were still made but the production and drilling activities had greatly diminished.

Current. About 1 November 1952, the Cost Inspection force was reduced to two members -- the Inspector (Civil Service Accountant, GS-12) and an assistant (GS-8). Comprehensive audits were instituted in lieu of complete audits. These changes followed an inspection by the Navy's Industrial Survey Board. It was determined (1) that operations requiring audit had been reduced, (2) that the Operator's system of internal control was quite adequate, and (3) that the Operator was considered to be of the highest integrity -- a well-earned star in Standard's operation of the Reserve. The Board permits the NCI to continue to make comprehensive audits in lieu of complete audits as long as conditions (1), (2), and (3) above are met, in the opinion and judgment of the NCI.

and appropriations and on the availability of certain assets. On this latter item, the Operating Committee may override the RCI. The RCI has no relationship with such bodies as the Engineering Committee or the Elavenski Navy District.

Staff of the Navy Cost Inspector

World War II. During the emergency development and production period of the war, a Joint Navy-Civil Service staff of about ten members, headed by a Naval Supply Corps Officer, made complete audits of the Operator's expenditures.

Post-War. From 1945 to 1950 the number of employees was reduced to six; from 1950 to 1952, to three. Complete audits were still made but the production and building activities had greatly diminished.

Current. About 1 November 1952, the Cost Inspector force was reduced to two members -- the Inspector (Civil Service Accountant, GS-12) and an Assistant (GS-8). Comprehensive audits were instituted in lieu of complete audits. These

changes followed an inspection by the Navy's Industrial Survey Board. It was determined (1) that operations regarding audits had been reduced, (2) that the Operator's system of internal control was quite adequate, and (3) that the Operator was con-

sidered to be of the highest integrity -- a well-earned star in the Operator's operation of the Reserve. The Board permits the RCI to continue to make comprehensive audits in lieu of complete audits as long as conditions (1), (2), and (3) above are met, in the opinion and judgment of the RCI.

Duties and Responsibilities of the Navy Cost Inspector¹⁴⁷

1. Review the Contractor's (Standard's) accounting procedures and system of internal control from time to time in order to determine their adequacy for the Navy audit.
2. On all vouchers presented by Standard for Unit Operation charges or credits, determine the nature of and reason for the charge or credit, and perform the necessary audit. Establish specific auditing procedures for all recurring vouchers insuring that all expenditures are within the scope of the Contract. The Operating Committee may override the NCI on the allowability of disputed costs.
3. Audit Standard's monthly cost statement, reimbursement voucher, and other monthly reports and records. Audited reimbursement voucher is forwarded to the Disbursing Officer, Eleventh Naval District, for payment.
4. Monthly, submit the following principal cost accounting reports to the INPR in C, such reports being forwarded to DNPR:
 - (a) Status of Funds and Expenditures for the Fiscal Year as of the Last of the Month. The effect of this report is to give the Unit Operation staff an idea as to the funds still available for operation and drilling costs.
 - (b) Reconciliation of Costs and Reimbursements from Inception to the Last of the Month.
 - (c) Status of Appropriations as of the Last of the Month.

Costs and Responsibilities in the Navy Cost Inspector

1. Review the Contractor's (Standard's) accounting procedures and system of internal control from time to time in order to determine their adequacy for the Navy audit.

2. On all vouchers presented by Standard for Unit Operation charges or credits, determine the nature of and reason for the charge or credit, and perform the necessary audit. Establish specific auditing procedures for all recurring vouchers insuring that all expenditures are within the scope of the contract. The Operating Committee has authority the CFI on the allowance of disputed costs.

3. Audit Standard's monthly cost statement, reimbursement voucher, and other monthly reports and records. Audited reimbursement voucher is forwarded to the District Officer, Fleet, Naval District, for payment.

4. Monthly, submit the following principal cost accounting reports to the CFI in C, such reports being forwarded to OWR:

(a) Status of Units and Responsibilities for the Fiscal Year as of the last of the month. The effect of this report is to give the Unit Operation staff an idea as to the funds still available for operation and auditing costs.

(b) Reconciliation of Costs and Reimbursements from Inspection to the last of the month.

(c) Status of Appropriations as of the last of the month.

Reports (b) and (c) cover not only current monthly costs, reimbursements, and annual and special appropriations, but also cumulative totals for these items since inception of the Unit Operation.

5. Render monthly and special statements as required which relate and coordinate operating costs with production costs.
6. Semi-annually prepare a proof of payment schedule, i.e., verification of payment of invoices with cross references to vouchers.
7. Prepare and submit to the Navy an annual fiscal report, termed an Interim Audit Report, on the four inter-related contracts entered into by Navy and Standard. This report summarizes all costs, production, appropriations, cost allocations, and current status of funds and expenditures -- for all zones and for each zone -- from inception of the Unit Contract in June 1944 (retroactive to November 1942) to the end of each fiscal year.

Inspections or Reviews of the NCI Office.

1. Annually, by the Field Supervisor of the Los Angeles Branch Office, who checks accounting and auditing procedures.
2. Periodic review every 6 to 12 months, by a representative of the Government's independent General Accounting Office, who makes a detailed review of vouchers and supporting statements. This audit may result in "informal inquiries," which, if not properly explained, lead to "formal exceptions" and a possible reversal of the Resident Cost

Reports (a) and (b) cover not only current monthly

costs, relationships, and annual and special con-

tributions, but also cumulative totals for these

items since inception of the Unit Operation.

6. Report monthly and special statements as required with re-

late and quarterly operating results with production costs.

7. Semi-annually prepare a report of payment schedule, i.e.,

verification of payment of invoices with cross references

to vouchers.

8. Prepare and submit to the Navy an annual fiscal report,

based on Internal Audit Report, or the form later-

related concepts shared into by Navy and Government. This

report summarizes all costs, production, appropriations,

cost allocations, and current status of funds and expendi-

tures -- for all zones and for each zone -- from inception

of the Unit Contract in June 1944 (retrospective to November

1942) to the end of each fiscal year.

Inspection of Records of the Unit Office.

1. Annually, by the Chief Inspector of the Internal Control

Office, who shall coordinate and supervise procedures.

2. Periodic review every 6 to 12 months, by a representative

of the Government's Independent General Accounting Office

who makes a detailed review of vouchers and supporting

statements. This review may result in "discovery" of errors,

which, if not properly explained, lead to "fiscal excep-

tions" and a possible reversal of the fiscal cost.

Accountant's decision on a certain item. Although 25 informal inquiries have occurred, all were properly explained and reasons accepted except in one case. The formal exception on this one item, however, was properly cleared. The last informal inquiry occurred in January 1951, over three years ago.

The complete absence of any uncleared formal inquiries and the occurrence of relatively few informal inquiries reflect the excellence of the cost inspection service at the Reserve and the high integrity and excellent accounting procedures of the Operator.

SELECTED REFERENCES IN THE BIBLIOGRAPHY

2, 109, 111, 125, 147, 148, 150, 170,
173.

... certain items. ...
... all were properly ex-
... accepted except in one case. The
... on this one item, however, was properly
... in January. The last informal inquiry occurred in January
... over three years ago.

The complete absence of any unfiled formal inquiries
and the occurrence of relatively few informal inquiries
reflect the excellence of the cost inspection service at
the Reserve and the high integrity and excellent account-
ing procedures of the Operator.

SELECTED REFERENCES TO THE BIBLIOGRAPHY

- 2, 108, 111, 113, 147, 148, 150, 170,
- 175.

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A. HISTORY and POLICY :

1. FERGUSON, W. H.: "The Public Domain and Naval Reserves," Our Oil Resources, edited by L. M. Fanning, Part 1, Chpt. VIII, pp. 230-237, 1945.
2. History of the Naval Petroleum and Oil Shale Reserves. Issued by the Office of the Naval Petroleum Reserves. (Amended to March 1953.)
3. ISE, JOHN: "The United States Oil Policy," 1926, Chpt. XXV; The Naval Reserves and the Teapot Dome Investigation, p. 356.
4. PETTENGILL, S. B.: "HOT OIL, The Problem of Petroleum," 1936, Chpt. 18; Uncle Sam - Landlord, p. 182.
5. RAGLAND, R. W.: "A History of the Naval Petroleum Reserves and of the Development of the Present National Policy Respecting Them," May 2, 1944.
6. TRACIE, R. G.: History of the Origin and Development of the Navy Department's Policy Relating to Naval Petroleum Reserves. 1 Feb. 1953 (unpublished report filed in Office, DNPR, Wash., D. C.).

B. ORGANIZATION:

7. "Organizational Manual of the Office of the Director Naval Petroleum Reserves, October, 1953.

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- A. HISTORY and POLICY
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A. HISTORY and POLICY:

- 1. FERGUSON, W. R.: "The Pacific Domain and Naval Reserves," Our Oil Reserves, edited by J. M. Manning, Part I, Geol. Surv. of Canada, 1942.
- 2. History of the Naval Petroleum and Oil Shale Reserves. Issued by the Office of the Naval Petroleum Reserves. (Amended to March 1953.)
- 3. HAN, JOHN: "The United States Oil Policy," 1950, Geol. Surv. of Canada, Bulletin 1000.
- 4. HAYES, S. B.: "MOT OIL, The Problem of Petroleum," 1930, Geol. Surv. of Canada, Bulletin 1000.
- 5. HOLLAND, R. V.: "A History of the Naval Petroleum Reserves and of the Development of the Present National Policy Respecting Them," May 9, 1944.
- 6. HUGHES, S. G.: "History of the Origin and Development of the Navy Department's Policy Relating to Naval Petroleum Reserves. 1917-1953 (unpublished report filed in Office, ONPR, Wash., D. C.)."

B. ORGANIZATION:

- 7. Organizational Manual of the Office of the Director, Naval Petroleum Reserves, October, 1953.

C. EXECUTIVE ORDERS:

8. No. 3474 of May 31, 1921 - Committing administration of Naval Petroleum Reserves to Department of Interior.
9. No. 4614 of March 17, 1927 - Revoking Executive Order No. 3474 of May 31, 1921.

(Note: Additional Executive Orders Pertaining to Each Reserve Are Listed under the Selected Bibliography for the Respective Reserve.)

D. LEGISLATION RELATING TO NAVAL PETROLEUM RESERVES:

10. Act of June 25, 1910 (36 Stat. 847) "Pickett Act." An act to authorize the President of the United States to make withdrawals of public lands in certain cases.
11. Act of March 2, 1911 (36 Stat. 1015). An act to protect the locators in good faith of oil and gas lands who shall have effected an actual discovery of oil or gas on the public lands of the United States, or their successors in interest.
12. Act of August 25, 1914 (38 Stat. 708. - Amending Act of March 2, 1911 to grant relief to certain claimants.
13. Act of February 25, 1920 (41 Stat. 437) - "Minerals Leasing Act." An act to promote the mining of coal, phosphate, oil, oil shale, gas and sodium on the public domain.
14. Act of June 4, 1920 (41 Stat. 813). - Naval Appropriation Act for fiscal year ending June 30, 1921. Vested in the Secretary of the Navy the conservation, care, protection and operation of naval petroleum reserves.
15. Act of February 8, 1924 (43 Stat. 5). Joint resolution directing the President to institute and prosecute suits to cancel certain leases of oil lands in Naval Petroleum Reserves and incidental contracts.
16. Act of February 27, 1924 (43 Stat. 16) - Joint resolution providing an appropriation for the prosecution of suits to cancel certain oil and gas leases and incidental contracts in Naval petroleum reserves.
17. Act of February 25, 1928 (45 Stat. 148) - An act vesting administration of certain leases made pursuant to provisions of the Act of Feb. 25, 1920 in the Secretary of the Navy.
18. Act of May 13, 1930 (46 Stat. 277) - Joint resolution authorizing settlement in case U.S. v Sinclair Crude Oil Purchasing Company relating to purchase of production by Mammoth Oil Company from Naval Petroleum Reserve No. 3 (Teapot Dome) in Wyoming.
19. Act of June 27, 1930 (46 Stat. 822) - An act authorizing repayment of excess payments made under oil and gas leases.
20. Act of March 4, 1931 (46 Stat. 1523) - An act amending

6. Act of May 21, 1911 - Commercial Administration of
NAVAL PETROLEUM RESERVES to Department of Interior.
7. Act of March 17, 1917 - Executive Executive Order
8. Act of May 31, 1911.

(Note: Additional Executive Orders pertaining to each
Reserve are listed under the related bibliography for
the respective Reserves.)

LEGISLATION RELATING TO NAVAL PETROLEUM RESERVES:

- 10. Act of June 22, 1910 (36 Stat. 947) "Private Act." An
act to authorize the President of the United States
to make assignments of public lands in certain cases.
- 11. Act of March 2, 1911 (36 Stat. 1015). An act to pro-
vide that the location in good faith of oil and gas lands
which shall have effected an actual discovery of oil or
gas on the public lands of the United States, or lands
thereof, shall be in interest.
- 12. Act of August 23, 1914 (38 Stat. 708) - Amending act of
March 2, 1911 to grant relief to certain claimants.
- 13. Act of February 25, 1920 (41 Stat. 427) - "Minerals
Leasing Act." An act to provide for the leasing of coal,
petroleum, oil, oil shale, gas and sulfur on the
public domain.
- 14. Act of June 4, 1920 (41 Stat. 815) - "Naval Appropria-
tion Act for fiscal year ending June 30, 1921."
Whereas it is necessary for the construction,
care, protection and operation of naval petroleum
reserves.
- 15. Act of February 2, 1924 (43 Stat. 81) - Joint resolution
directing the President to institute and execute
acts to cancel certain leases of oil lands in Naval
Petroleum Reserves and to conduct conferences.
- 16. Act of February 27, 1924 (43 Stat. 10) - "Oil Reser-
ves" - Providing an appropriation for the protection
of acts to cancel certain oil and gas leases and
additional contracts in Naval petroleum reserves.
- 17. Act of February 28, 1925 (44 Stat. 143) - "Oil Reser-
ves" - Providing for the cancellation of certain leases made pursuant
to provisions of the Act of June 22, 1910 in the
interest of the Navy.
- 18. Act of May 13, 1920 (42 Stat. 277) - "Joint resolution
authorizing settlement in case U.S. & Sinclair Oils
Oil Refining Company relating to purchase of pro-
duction by Sinclair Oil Company from Naval Petroleum
Reserve No. 2 (Leased down) in Wyoming.
- 19. Act of June 27, 1920 (42 Stat. 825) - "An act authoriz-
ing the payment of excess payments made under oil and
gas leases.
- 20. Act of March 4, 1921 (42 Stat. 1823) - "An act amend-
ing

- Secs. 17 and 27 of the Act of Feb. 25, 1920 to authorize cooperative or unit plans of development.
21. Act of August 9, 1933 (47 Stat. 798) - An act amending Act of Feb. 25, 1920, adding Sec. 39 thereto, providing for extension of lessee's tenure during approved suspensions of operations.
 22. Act of May 3, 1933 (48 Stat. 30) - An act authorizing the Attorney General with the concurrence of the Secretary of the Navy to release claims of the United States against Pan American Petroleum and Richfield Oil Companies in connection with judgment rendered against Pan American in E-G-I Case B-115M.

*Additional Acts of Congress are listed on page B-23.

E. CONGRESSIONAL REPORTS RELATING TO NAVAL PETROLEUM RESERVES:

23. No. 398 House Committee on Public Lands, re leasing bill S2775 66th Cong.
24. No. 600 Conference Committee report on S2775.
25. Report of House Committee on Appropriations re Naval Appropriation Act of 1921.
26. No. 794 June 6, 1924 - Report of sub-committee (Walsh Committee) of Senate Committee on Public Lands and Surveys investigating oil and gas leases made by the Department of the Interior within naval petroleum reserves.
27. March 31, 1925 - Report of President's (Coolidge's) Naval Oil Reserve Commission established March 25, 1924.
28. No. 317 April 9, 1937 - Committee on Naval Affairs, U.S. Senate on S.1131 (Act of June 30, 1938).
29. No. 2672 June 9, 1938 - House Committee on Naval Affairs on S1131 (Act of June 30, 1938).
30. No. 1529 May 29, 1944 - House Committee on Naval Affairs on HR 4771 (Act of June 17, 1944).
31. No. 948 June 5, 1944 - Senate Naval Affairs Committee on HR 4771 (Act of June 17, 1944).
32. No. 420 June 27, 1945 - Senate Committee on Naval Affairs on HR 3269 (Act of July 6, 1945).
33. No. 846 June 30, 1945 - House Appropriations Committee on HR 3579 (Second deficiency Appropriation Bill 1945) providing appropriation for exploratory drilling on Naval Petroleum Reserve No. 1.
34. No. 2085 May 21, 1946 House Appropriation Committee on HR 6496 Naval appropriations for fiscal year 1947,
35. No. 263 House Special Sub-committee on Petroleum, Committee on Armed Services (Short Committee) 1948.
36. No. 133 Part I March 27, 1953; Part II April 1, 1953 - Senate Committee on Interior and Insular Affairs on S.J. 13 Joint Resolution to confirm and establish the titles of the States to lands beneath navigable waters within State boundaries and to the natural resources within such lands.
37. No. 411 June 15, 1953 - Senate Committee on Interior and Insular Affairs on S 1901 to provide for the

21. Act of August 2, 1933 (47 Stat. 788) - An act amending Act of Feb. 25, 1930, adding sec. 28 relative to providing for extension of leases' terms during approved operations of operations.
 22. Act of May 3, 1933 (47 Stat. 50) - An act authorizing the Attorney General with the concurrence of the Secretary of the Navy to release claim of the United States against Pan American Petroleum and Nickfield Oil Companies in connection with judgment rendered against Pan American in E-3-1 Case 8-112.
 *Additional Acts of Congress are listed on page B-23.

23. H. R. 230 House Committee on Public Lands, no listing will 2274 65th Cong.
 24. H. R. 600 Conference Committee report on 2275.
 25. Report of House Committee on Appropriations re Navy Appropriation Act of 1911.
 26. H. R. 704 June 8, 1914 - Report of sub-committee (Navy Committee) of Senate Committee on Public Lands and Forestry Investigating oil and gas leases made by the Department of the Interior with Navy petroleum reserves.
 27. March 21, 1925 - Report of President's (Coolidge's) Naval Oil Reserves Commission established March 29, 1924.
 28. H. R. 317 April 9, 1927 - Committee on Naval Affairs U.S. Senate on S. 1151 (Act of June 30, 1926).
 29. H. R. 2875 June 8, 1923 - House Committee on Naval Affairs on S. 1151 (Act of June 30, 1926).
 30. H. R. 1828 May 22, 1924 - House Committee on Naval Affairs on H. R. 4771 (Act of June 17, 1924).
 31. H. R. 248 June 8, 1924 - Senate Naval Affairs Committee on H. R. 4771 (Act of June 17, 1924).
 32. H. R. 430 June 27, 1924 - Senate Committee on Naval Affairs on H. R. 1828 (Act of May 22, 1924).
 33. H. R. 642 June 30, 1924 - House Appropriations Committee on H. R. 2875 (Second Extension Appropriation Bill - 1923) providing appropriations for exploratory drilling on Navy petroleum reserves No. 1.
 34. H. R. 2000 May 21, 1924 House Appropriations Committee on H. R. 642 Navy Appropriation for fiscal year 1925.
 35. H. R. 202 House Special sub-committee on Petroleum Committee on Army Services (Sub-committee) 1924.
 36. H. R. 122 June 1 March 27, 1925; April 11 April 1, 1928 - Senate Committee on Interior and Insular Affairs on S. 13 Joint Resolution to confirm and establish for titles of the States to lands beneath navigable waters within State boundaries and to the several reserves within such lands.
 37. H. R. 411 June 10, 1925 - Senate Committee on Interior and Insular Affairs on S. 1301 to provide for the

jurisdiction of the United States over submerged lands of the outer continental shelf, and to authorize the Secretary of the Interior to lease such lands for certain purposes.

F. CONGRESSIONAL HEARINGS INVOLVING LEGISLATION AND OTHER MATTERS RELATING TO NAVAL PETROLEUM RESERVES:

38. H.R. 24070 House Committee on the Public Lands on a bill to Authorize the President of the United States to make withdrawals of Public Lands in certain cases. 61st Cong. 2nd Session - May 13-17, 1910.
39. H.R. 31437 House Committee on the Public Lands - On a bill to protect the locators in good faith of oil and gas lands who shall have effected an actual discovery of oil or gas on the public lands of the United States or their successors in interest. 61st Cong. 3rd Session June 21, 1911 "Pickett Act."
40. Jan. 30, 1914 House Committee on Naval Affairs - Testimony of Secretary of the Navy (Daniels) on naval petroleum reserves.
41. S. 5434 Senate Sub-Committee of Committee on Public Lands on a bill to provide for the leasing of oil and gas lands withdrawn from entry. 63rd Cong. 2nd Session May 21, 22, 1914.
42. S. 4898 Senate Sub-Committee of the Committee on Public Lands on a bill to encourage and promote the mining of coal, phosphate, oil, gas, potassium and sodium on the public domain. 63rd Cong. 2nd Session May 25, 1914.
43. H.R. 14094 House Committee on the Public Lands on a bill To authorize exploration for and disposition of oil, gas, potassium, phosphate and coal. 63rd Cong. 2nd Session Mar 25 - Apr 3, 1914.
44. Report of the Attorney General, Supplemental to annual report for the year 1915, upon the litigation over withdrawn oil lands of the United States.
45. H.R. 406 Senate Committee on Public Lands on a bill To authorize exploration for and disposition of coal, phosphate, oil, gas, potassium or sodium. 64th Cong. 1st Session Feb 2 - Mar 2, 1916. Supplement Apr. 24, 1916.
46. H.R. 406 Special Joint Conference of Committees on Public Lands, United States Congress. 64th Cong. 2nd Session Dec. 18-23, 1916.
47. H.R. 406 Senate Committee on Naval Affairs. 64th Cong. 2nd Session Jan 17-23, 1917.
48. Senate Committee on Public Lands on a bill To encourage and promote the mining of coal, phosphate, oil, gas, potassium and sodium on the public domain. 65th Cong. 1st Session June 13 - 28, 1917.
49. Senate Sub-Committee of the Committee on Naval Affairs on a bill To further provide for the common defense

jurisdiction of the United States over...
lands of the United States...
the Secretary of the Interior to issue...
for certain purposes.

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38. H. R. 2140 House Committee on the Public Lands on a bill to authorize the President of the United States to make withdrawals of Public Lands in certain cases. 67th Cong., 1st Session - Nov 13-14, 1901.
39. H. R. 2147 House Committee on the Public Lands - on a bill to protect the interests in good faith of all gas lands and wells which have effected an actual discovery of oil or gas on the public lands of the United States or their successors in interest. 67th Cong., 1st Session June 21, 1901 "H. R. 2147".
40. H. R. 20, 1911 House Committee on Naval Affairs - on a bill of Secretary of the Navy (Daniels) on naval petroleum reserves.
41. S. 2222 Senate Sub-Committee of Committee on Public Lands on a bill to provide for the leasing of oil and gas lands withdrawn from survey. 67th Cong., 1st Session May 21, 22, 1901.
42. S. 1822 Senate Sub-Committee of the Committee on Public Lands on a bill to encourage and promote the leasing of coal, phosphate, oil, gas, potassium and sodium on the public lands. 67th Cong., 1st Session May 22, 1901.
43. H. R. 1404 House Committee on the Public Lands on a bill to authorize expiration for and disposition of oil, gas, potassium, phosphate and coal. 67th Cong., 1st Session May 22 - 23, 1901.
44. Report of the Attorney General, supplemented to annual report for the year 1901, upon the litigation over withdrawal of lands of the United States.
45. H. R. 404 Senate Committee on Public Lands on a bill to authorize expiration for and disposition of coal, phosphate, oil, gas, potassium or sodium. 67th Cong., 1st Session Feb 2 - 23, 1901. Supplemental and 44, 1901.
46. H. R. 406 Special Joint Committee of Congress on Public Lands, United States Congress. 67th Cong., 1st Session Dec. 19-21, 1901.
47. H. R. 406 Senate Committee on Naval Affairs. 67th Cong., 1st Session Jan 17-22, 1901.
48. Senate Committee on Public Lands on a bill to encourage and promote the leasing of coal, phosphate, oil, gas, potassium and sodium on the public lands. 67th Cong., 1st Session June 13 - 22, 1901.
49. Senate Sub-Committee of the Committee on Naval Affairs on a bill to further provide for the second release

- and general welfare of the United States with respect to the production, use, and conservation of oil and gas in naval petroleum reserves, and for other purposes. 65th Cong. 2nd Session Feb. 6, 28, Mar. 14, 1918.
50. H.R. 3232 House Committee on the Public Lands.
 51. S. 2812 A bill To authorize Exploration for and disposition of coal, phosphate, oil, gas, potassium or sodium. 65th Cong. 2nd Session Feb. 5 - Mar 5, 1918.
 52. S. 2775 House Committee on the Public Lands on a bill To promote the mining of coal, phosphate, oil, oil shale, gas and sodium on the public domain. 66th Congress Oct. 6 - 8, 1919.
 53. S. Doc. No. 210, June 3, 1922, Message from the President of the United States transmitting in response to a Senate Resolution of Apr. 29, 1922, A communication from the Secretary of the Interior submitting information concerning the Naval Reserve oil leases.
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 56. H. Doc. 139 Jan. 30, 1924 House Committee on Naval Affairs on a Hearing on Naval Oil Leases under the Act of June 4, 1920.
 57. H. Doc. 139 Jan. 24, Feb. 3, 4, 1928 Senate Committee on Public Lands and Surveys on Leases upon Naval Oil Reserves.
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 59. S. 1129 Senate Committee on Naval Affairs on a bill To authorize the Secretary of the Interior to accept from the State of Utah title to a certain State owned section of land and to patent other land to the State in lieu thereof and for other purposes. 75th Cong. 1st Session Mar. 9, 1937.
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61. S. 1131 House Committee on Naval Affairs, same title, 75th Cong. 1st Session May 3, 5, 6, 1937. 75th Cong. 3rd Session June 7, 8, 9, 1938. (Act of June 30, 1938).
62. H.R. 2596 House Committee on the Public Lands on a bill To protect Naval Petroleum Reserve No. 1. 78th Cong. 1st Session May 11 - July 6, 1943. 78th Cong. 2nd Session Jan. 18 - Mar. 29, 1944.
63. H. Doc. 126 June 25, 1943 Statement of the Secretary of the Navy relative to the agreement between the Navy Department and Standard Oil Co. of California on Elk Hills Oil Reserve.
64. Confidential Committee Print, House Committee on Naval Affairs, Nov. 9, 1943, Hearing on The question of the Navy's contract with Standard Oil Co. of California on the Elk Hills Petroleum Reserve.
65. H. Doc. 160 House Committee on Naval Affairs Dec. 8, 1943 Statement of Attorney General Biddle before the House Naval Affairs Committee on Elk Hills Petroleum Reserve Contract.
66. S. Doc. 187 May 2, 1944 History of Naval Petroleum Reserves prepared by the Navy Department at the request of the Chairman, Senate Committee on Naval Affairs.
67. H.R. 4771 House Committee on Naval Affairs on a bill to amend the part of the Act entitled "An act making appropriations for the naval service for the fiscal year ending June 30, 1921 and for other purposes," approved June 4, 1920, as amended, relating to the conservation, care, custody, protection, and operation of Naval petroleum and oil shale reserves. (Act of June 17, 1944.) Confidential Committee Print Statement on the Elk Hills matter by Hon. Carl Vinson, Chairman. 78th Cong. 2nd Session, May 15, 1944.
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73. Sept. 9, 1946 House Committee on Naval Affairs.

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- 62. H. R. 2808 House Committee on the Pacific Islands on a bill to protect Naval Petroleum Reserves No. 1. 70th Cong., 1st Session May 11 - July 6, 1908. 70th Cong., 2nd Session Jan. 18 - Mar. 23, 1909.
- 63. S. Doc. 128 June 25, 1908 Statement of the Secretary of the Navy relative to the agreement between the Navy Department and Secretary Oil Co. of California on the Bill of Reserves.
- 64. Confidential Committee Print, House Committee on Naval Affairs, Nov. 9, 1908, Hearing on the question of the Navy's contract with Standard Oil Co. of California on the Bill of Reserves.
- 65. H. Doc. 150 House Committee on Naval Affairs Dec. 6, 1908 Statement of Attorney General Michie before the House Naval Affairs Committee on Bill of Reserves.
- 66. S. Doc. 151 May 2, 1908 History of Naval Petroleum Reserves prepared by the Navy Department at the request of the Chairman, Senate Committee on Naval Affairs.
- 67. H. R. 2771 House Committee on Naval Affairs on a bill to amend the part of the Act entitled "An act making appropriations for the naval service for the fiscal year ending June 30, 1901 and for other purposes," approved June 4, 1900, as amended, relating to the contract for oil, gas, and other petroleum, and operation of Naval Petroleum and Oil shale reserves. (Act of June 17, 1904.) Confidential Committee Print House Committee on Naval Affairs written by Sen. Carl Vinson. Chairman, 70th Cong., 2nd Session, May 13, 1908.
- 68. (S. 1908 Senate Committee on Naval Affairs. (A bill) (same title) (act of June 17, 1904). 70th Cong., 2nd Session May 28, 1908.
- 69. H. Doc. 28 House Committee on Naval Affairs on Explorations in Naval Petroleum Reserves No. 1. April 23, 1908.
- 70. H. R. 218 House Committee on Naval Affairs relative to the protection of petroleum for the national defense from Naval Petroleum Reserves No. 1. 70th Cong., 1st Session June 20, 1908.
- 71. H. Res. 127 House Committee on Naval Affairs on continuation of exploration for oil in Naval Petroleum Reserve No. 4 (Alaska). 70th Cong., 2nd Session, Dec. 4, 1908.
- 72. H. Res. 128 House Committee on Naval Affairs, Resolution relative to the history, development, and operation of Naval Petroleum Reserves No. 1 (Bill) by General D. Morgan, 70th Cong., 2nd Session, August 27, 1908. 70th Cong., 2nd Session.
- 73. S. P. 1918 House Committee on Naval Affairs.

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74. Nov. 18, 1946 Hearing on amendment proposed to Unit Plan Contract governing development and operation of Naval Petroleum Reserve No. 1. (Elk Hills).
 75. H. Res. 141 and 447 House Spl. Sub-Committee (Short Committee) on Petroleum Committee on Armed Services on Resolutions Authorizing and directing the Armed Services Committee to conduct thorough studies and investigations relating to matters coming within the jurisdiction of such committee. 80th Cong. 2nd Session Feb. 16-20, 1948.
 76. H. Doc. 31 House Committee on Armed Services Hearings on Naval Petroleum Reserve No. 2 (re: 27-B Pool unit agreement). 80th Cong. 2nd Session Mar. 15, 1949.
 77. H. Doc. 5 House Committee on Armed Services Hearings on Naval Petroleum Reserves on No. 1, Elk Hills, Calif.; No. 2, Buena Vista Hills, Calif.; No. 3, Teapot Dome, Wyo.; and No. 4, Point Barrow, Alaska. 83rd Cong. 1st Session. Feb. 25, 26, Mar. 6, 1953.
 78. S.J. Res. 13, S. 294, S. 107, and S.J. Res. 18 Senate Committee on Interior and Insular Affairs on a bill to confirm and establish the titles of the States to lands beneath navigable waters within State boundaries and to the natural resources within such lands and waters, to provide for the use and control of said lands and resources and to confirm the jurisdiction and control of the United States over the natural resources of the seabed of the Continental Shelf seaward of State boundaries (Submerged Lands Act, Act of Aug. 7, 1953). 83rd Cong. 1st Session Feb. 16 - Mar. 4, 1953.
 79. S. 1901 and S. 1901 Amendment Senate Committee on Interior and Insular Affairs on a bill To provide for the jurisdiction of the United States over submerged lands of the outer continental shelf, and to authorize the Secretary of the Interior to lease such lands for certain purposes. (Outer Continental Shelf Act, Act of May 22, 1953). 83rd Cong. 1st Session May 16 - June 1, 1953.

G. LITIGATION INVOLVING NAVAL PETROLEUM RESERVES:

80. U.S. v. Midwest Oil Co. - Reported: 236 U.S. 459, Feb. 23, 1915.
81. U.S. v Honolulu Oil Co. - Reported: 249 Fed. 169, Feb. 28, 1922.
82. U.S. v Southern Pacific RR. (Elk Hills Case) - Reported: Dist. Court none; Court of Appeals 249 Fed. 795, May 6, 1918. Supreme Court 251 U.S. 1, Nov. 17, 1919.
83. U.S. v Southern Pacific (Consolidated Cases) - Reported: 26 Fed. 511 Aug. 28, 1919.
84. U.S. v Pan American Petroleum and Transport Co. et al. B-100M.
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 Administration of Naval Petroleum Reserves (H.R. 1, 81st Congress)
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 Petroleum Reserves (H.R. 1, 81st Congress) and
 Administration of Naval Petroleum Reserves (H.R. 1, 81st Congress)
 77. H. Res. 112 House of Representatives (House
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 78. H. Res. 113 House of Representatives (House
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 79. H. Res. 114 House of Representatives (House
 Committee on Naval Petroleum Reserves) on Naval Petroleum
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LITIGATION INVOLVING NAVAL PETROLEUM RESERVES

- 80. U.S. v. Midwest Oil Co. - Reported: 332 U.S. 413, 48 S.Ct. 1015, 78-1 USTC ¶10,000
- 81. U.S. v. National Oil Co. - Reported: 344 Fed. 101, 78-1 USTC ¶10,000
- 82. U.S. v. Southern Pacific Co. (Hill Bill Case) - Reported: 344 U.S. 236, 73 S.Ct. 1015, 78-1 USTC ¶10,000
- 83. U.S. v. Southern Pacific Co. (Consolidated Cases) - Reported: 344 U.S. 236, 73 S.Ct. 1015, 78-1 USTC ¶10,000
- 84. U.S. v. Pan American Petroleum and Transport Co. et al. - Reported: 344 U.S. 236, 73 S.Ct. 1015, 78-1 USTC ¶10,000

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- U.S. Supreme Court 273 U.S. 456 Feb. 28, 1927.
- 85. U.S. v Mammoth Oil Company
 - U.S. District Court 5 Fed 2d 330 June 19, 1925
 - U.S. Court of Appeals 14 Fed 2d 705 Sept. 28, 1926
 - U.S. Supreme Court 275 U.S. 13 Oct. 10, 1927
- 86. U.S. v Belridge Oil Company
 - U.S. District Court, not reported July 17, 1925
 - U.S. Court of Appeals 13 Fed 2d 562 July 12, 1926
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- 87. U.S. v Pan American Petroleum Company et al. B115-M
 - U.S. District Court 45 Fed 2d 821 Nov. 8, 1930
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- 88. West v Standard Oil Company et al. Sec. 36 Case
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 - U.S. Court of Appeals 23 Fed 2d 750 Dec. 5, 1927
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- 89. U.S. v Standard Oil Company Sec. 36 Case
 - U.S. District Court 20 Fed Sup 427 Aug 25, 1937
 - U.S. District Court 21 Fed. Sup 646 Dec 4, 1937
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- 90. U.S. v Ohio Oil Co. 240 Fed. 996; 236 Fed. 481
- 91. North American Oil Cons. 242 Fed. 723; 245 Fed. 533
- 92. Midway Northern Oil Co. et al., 232 Fed. 619; 229 Fed. 1022
- 93. G. W. McCutchen et al., 217 Fed 650; 238 Fed 575
- 94. David Kinsey et al., 234 Fed 702
- 95. Brookshire Oil Co. 242 Fed. 718
- 96. Thirty-Two Oil Co. 242 Fed. 730
- 97. Record Oil Co. et al., 242 Fed. 746; 245 Fed. 521
- 98. Devil's Den Consolidated Oil Co. 236 Fed. 973
- 99. Stockton Midway Oil Co., 240 Fed. 1006
- 100. Dominion Oil Co. 241 Fed. 425

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- 101. Navy Contract Law, Nav Pers 10841, Prepared by Office of the General Counsel, April 1949.
- 102. Navy Real Estate Law, Nav Pers 10844, Prepared by Bureau of Yards and Docks (Real Estate Branch), Sept. 1944.

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- B. UNIT OPERATION: Contracts, Cost Inspection, etc.
- C. EXECUTIVE ORDERS
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APPENDIX

ALPHABETICALLY

- A. TECHNICAL
- B. UNIT OPERATING CONTRACTS, OIL INDUSTRY, ETC.
- C. EXHIBITIVE DOCUMENTS
- D. COMMERICAL MATTERS: Legislation, Reports, Hearings.

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- 181. No. 3862, June 11, 1923 - Revoking in part Executive Order of December 13, 1912 (except as to the oil and gas deposits therein) and reserving said lands for townsite purposes. This order set aside a portion of Sec 12, T. 32S., Range 23E., MDM for Ford City Townsite.
- 182. No. 4225, May 16, 1925 eliminating additional lands from the reserve (excepting as to the oil and gas deposits therein). This order enlarged area set aside for Ford City Townsite and covered other lands in Sec 12 comprising first addition to Ford City Townsite.
- 183. No. 6444, November 25, 1933 - Order restoring certain drill sites embraced in above Executive Orders of June 11, 1922 and May 16, 1925 to Naval Petroleum Reserve No. 2, California.
- 184. No. 10075, August 18, 1949 - Eliminating Certain Public Lands from Naval Petroleum Reserve No. 2 and reserving them for Townsite purposes. This order made certain of the drill sites in Ford City townsite and the first addition thereto available for townsite purposes.

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[The following text is extremely faint and largely illegible due to fading and bleed-through from the reverse side of the page. It appears to contain a list of executive orders, likely numbered 185 through 200, detailing land reservations and townsite designations.]

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243. Public Land Order No. 289, July 20, 1945 - Amending Executive Order No. 3797-A of February 27, 1923 withdrawing certain lands in Alaska as a Naval Petroleum Reserve.
244. Public Land Order No. 82, January 22, 1943 - Withdrawing certain public lands north of the Brooks Range in Alaska "for use in connection with the prosecution of the war." The lands covered by this order included all of the area comprising Naval Petroleum Reserve No. 4 as well as the remainder of the Barrow Basin.

VI.

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A. TECHNICAL

B. EXECUTIVE ORDERS

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B. EXECUTIVE ORDERS Relating to:NAVAL OIL SHALE RESERVE NO. 1, COLORADO NO. 1:

250. December 6, 1916 - Setting aside Naval Oil Shale Reserve No. 1, Colorado No. 1.
251. June 12, 1919 - Order of restoration affecting certain lands in Naval Oil Shale Reserve No. 1, Colorado No. 1. Embraces approximately 3880 acres in T. 6S., R. 95W., 6th PM, Colorado.

NAVAL OIL SHALE RESERVE NO. 2, UTAH NO. 1:

252. December 6, 1916 - Setting aside Naval Oil Shale Reserve No. 2, Utah No. 1 (Embraced approximately 86,531 acres).
253. November 17, 1924 - Order of modification including additional lands in Naval Oil Shale Reserve No. 2, Utah No. 1.

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NAVY OIL SHALE RESERVE AND REFINED LUBRICANTS

A. TECHNICAL

B. EXECUTIVE SUMMARY

A. TECHNICAL

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B. EXECUTIVE SUMMARY Referring to:

NAVY OIL SHALE RESERVE NO. 1, COLORADO NO. 1

250. December 6, 1918 - Section on the Navy Oil Shale Reserve No. 1, Colorado No. 1.

251. June 20, 1919 - Order of investigation respecting reserves in Navy Oil Shale Reserve No. 1, Colorado No. 1. Report approximately 5000 acres in N. 20. W. 20. S. 20. T. 20. R. 20. Colorado.

NAVY OIL SHALE RESERVE NO. 2, UTAH NO. 1

252. December 6, 1918 - Section on the Navy Oil Shale Reserve No. 2, Utah No. 1 (approximately 5000 acres).

253. November 14, 1924 - Order of investigation regarding additional lands in Navy Oil Shale Reserve No. 2, Utah No. 1.

NAVAL OIL SHALE RESERVE NO. 3, COLORADO NO. 2:

254. September 27, 1924 - Setting aside Naval Oil Shale Reserve No. 3 in Colorado. Approximately 22,600 acres adjoining NOSR No. 1 on West, South and East.

SUBMERGED LANDS:

255. No. 10,426, January 16, 1953 - Setting aside submerged lands of the Continental Shelf as a Naval Petroleum Reserve.

256. No. 10,525, April 1, 1954 - Transferring from the Secretary of the Navy to the Secretary of the Interior interest in and control over certain funds. Covered moneys deposited by Navy in accordance with provisions of Executive Order No. 10,426 of January 16, 1953.

I. D. ADDITIONAL LEGISLATION RELATING TO NAVAL PETROLEUM RESERVES:

257. Act of June 16, 1933 (48 Stat. 311) - An act providing that any suit for damages shall not abate by reason of death of the defendant (directed against E. L. Doheny).
258. Act of August 21, 1935 (49 Stat. 674) - An act amending Secs. 13, 14, 17 and 28 of the Act of Feb. 25, 1920.
259. Act of June 30, 1938 (52 Stat. 1252) - An act amending Act of June 4, 1920 relating to care, custody, protection and operation of Naval petroleum reserves, to permit protecting Naval Petroleum Reserve No. 1 by compensatory royalty agreements, exchange of lands, or acquisition of private lands therein by purchase or condemnation.
260. Act of June 17, 1944 (58 Stat. 280) - An act further amending Act of June 4, 1920, to permit unit operation of private and government lands in Naval Petroleum Reserve No. 1.
261. Act of June 17, 1944 (58 Stat. 283) - Joint resolution authorizing development and operation of Naval Petroleum Reserve No. 1.
262. Act of July 6, 1945 (59 Stat. 465) - Joint resolution to extend operations on Naval Petroleum Reserve No. 1 to Dec. 31, 1946.
263. Act of July 6, 1945 (59 Stat. 465) - An act amending the Act of June 4, 1920 to terminate leases of lands in Naval Petroleum Reserve No. 1 as extended by Executive Order No. 9257 of Oct. 15, 1952.
264. Act of August 8, 1946 (60 Stat. 950) - Amending Act of Feb. 25, 1920 to permit cooperative and unit operations on government lands to promote conservation of oil and gas.
265. Act of May 22, 1953 (67 Stat. 29) - An act to confirm and establish the titles of the States to lands beneath navigable waters within State boundaries and to the natural resources within such lands and boundaries. Submerged Lands Act.
266. Act of August 7, 1953 (67 Stat. 462) - An act to provide for the jurisdiction of the United States over the submerged lands of the outer continental shelf and to authorize the Secretary of the Interior to lease such lands for certain purposes. Outer Continental Shelf Lands Act.

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