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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS  
JANUARY, FEBRUARY, MARCH, 1959

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CHEMICAL EFFLUENTS TECHNOLOGY WASTE DISPOSAL INVESTIGATIONS  
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## INTRODUCTION

The Chemical Effluents Technology Operation performs research to investigate the chemical and physical aspects of environmental contamination resulting from plant effluents or from potential process disasters. This report is primarily concerned with plant assistance research in the field of waste disposal during the quarter January-March, 1959.

The ground-water monitoring data utilized in this report were obtained from well-water samples. These samples are collected routinely by the Regional Monitoring Operation and analyzed by the Radiological Chemical Analysis Operation.

### I. INTERPRETATION OF GROUND-WATER MONITORING DATA (P. P. Rowe)

The probable extent of ground-water contamination is shown in Fig. 1. The concentration of radioactive contamination in the ground water is based on the gross beta activity densities averaged for all samples collected from a well during the period January-March, 1959. The boundaries of the contaminated zones are rather indefinite. This is especially true for the range of activity between  $1.5 \times 10^{-7}$  and  $1.0 \times 10^{-6}$   $\mu\text{c/cc}$ . The concentration in wells outside of the contaminated zones averaged less than  $1.5 \times 10^{-7}$   $\mu\text{c/cc}$ . Samples in which the gross beta activity exceeds  $1.0 \times 10^{-4}$   $\mu\text{c/cc}$  are usually analyzed for  $\text{Co}^{60}$ ,  $\text{Sr}^{90}$ , and  $\text{Cs}^{137}$ . Except for two cases discussed below, these isotopes were not found in the ground water. Laboratory analyses indicate that the radioactive material in the ground water is chiefly  $\text{Ru}^{106}$ .

#### 200-East Area

Fig. 1 shows two zones of contaminated ground water beneath 200-East Area. The depth to water ranges from about 200 feet in the northeast part of the area to about 350 feet in the southwest part. The main sources of contamination or potential contamination are the waste effluents from the following three general sites.

- (1) 216-BY and 241-B cribs. -- Although these cribs are no longer in use, wastes continue to drain from the sediments into the ground water. (See A, Fig. 1). During this quarter the maximum average concentration in this zone was  $8.6 \times 10^{-3}$   $\mu\text{c/cc}$  at well 299-E33-12. A slight rise in activity in some of the wells to the east of the cribs occurred, but no long-term trend is yet indicated.

January February March 1959

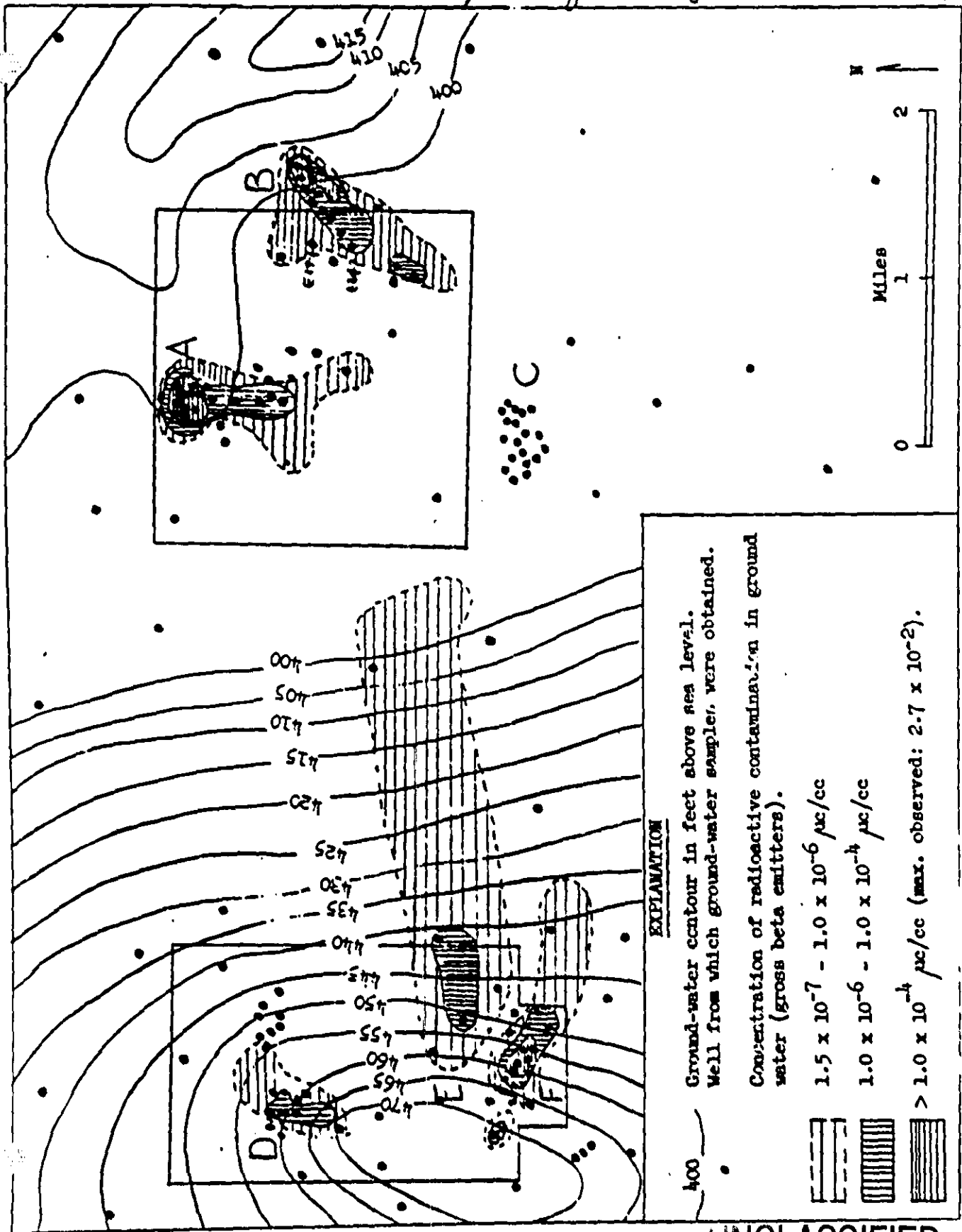


Figure 1. - Map of Separations area showing probable extent of ground-water contamination and contours on the water table, March, 1959

Three monitoring wells at the 216-BY crib site were reperforated on 12/31/58 and water samples were collected weekly until 2/11/59. The concentration of gross beta emitters in samples from well 299-E33-3 decreased from  $1.2 \times 10^{-2}$  to  $9.8 \times 10^{-4}$   $\mu\text{c/cc}$  during this period; in 299-E33-4 from  $2.3 \times 10^{-3}$  to  $1.2 \times 10^{-3}$   $\mu\text{c/cc}$ ; and in 299-E33-7 from  $2.3 \times 10^{-3}$  to  $6.7 \times 10^{-5}$   $\mu\text{c/cc}$ . The differences may indicate that the original perforations in the monitoring wells were plugged in some manner, thus inhibiting free movement of water into the well casing and resulting in samples that were apt to be nonrepresentative of the true ground-water contamination.

Isotopic analyses showed seven wells with  $\text{Co}^{60}$  concentrations in excess of  $1/10$  MPC ( $4 \times 10^{-5}$   $\mu\text{c/cc}$ ), with a maximum of  $1.6 \times 10^{-4}$   $\mu\text{c/cc}$  at well 299-E33-12.  $\text{Sr}^{90}$  and  $\text{Cs}^{137}$  were not found in any wells in excess of the analytical sensitivity levels of  $7 \times 10^{-8}$  and  $5.0 \times 10^{-7}$   $\mu\text{c/cc}$ , respectively.

- (2) 216-A cribs. -- The 216-A-8 crib was inactivated in May 1958 and the wastes diverted to the 216-A-24 crib. Zone B (Fig. 1) indicates that southwestward movement of contamination has occurred. Wells 299-E27-3 and 299-E24-3 showed concentrations greater than  $1.5 \times 10^{-7}$   $\mu\text{c/cc}$ , in the first quarter of 1959. These same wells did not indicate any contamination during the fourth quarter of 1958.

Fission product analyses of wells in the area of the 216-A cribs indicated no  $\text{Co}^{60}$ ,  $\text{Sr}^{90}$ , or  $\text{Cs}^{137}$  above the analytical detection limits.

- (3) 216-BC cribs and trenches. -- None of the wells in the 216-BC site had concentrations of gross beta in excess of  $1.5 \times 10^{-7}$   $\mu\text{c/cc}$  during the first quarter of 1959. (See C, Fig. 1). The intermittent appearance of contamination has been previously reported.

#### 200-West Area

There are three separate zones in 200-West that show contamination at the present time. (See zones D, E, and F, Fig. 1). The depth to water varies from about 200 feet in the western part to about 280 feet in the eastern part.

- (1) T-Plant cribs and trenches. -- These facilities are no longer in use but wastes continue to drain from the underlying sediments. (See D, Fig. 1). There continues to be a slight decrease in concentration of contamination in most of the wells. The highest average concentration detected during the quarter was  $3.0 \times 10^{-7}$   $\mu\text{c/cc}$ .

Water samples from critical monitoring wells were analyzed for  $\text{Sr}^{90}$  and  $\text{Cs}^{137}$ . No concentrations exceeded the respective analytical sensitivity levels.

- (2) Contaminated Zone E (Fig. 1). -- This zone lies partly beneath U-Plant and extends about three miles eastward. The ground-water contamination is believed to have originated with T-Plant wastes. These wastes continue to move eastward with the ground water. The maximum average concentration detected in this zone was  $1.2 \times 10^{-5}$   $\mu\text{c/cc}$  at well 299-W19-2.

Samples from the 216-WR monitoring well showed no positive indications of  $\text{Cs}^{137}$  or  $\text{Sr}^{90}$ .

- (3) Redox cribs. -- The 216-S-1, 2, and 7 cribs are responsible for the ground-water contamination beneath Redox. (See F, Fig. 1). The highest average concentration detected beneath the 216-S-1 and 2 cribs was  $9.2 \times 10^{-4}$   $\mu\text{c/cc}$ .

The average concentration of gross beta activity beneath the 216-S-7 crib increased from  $1.1 \times 10^{-2}$  to  $2.3 \times 10^{-2}$   $\mu\text{c/cc}$  during the quarter.

Water samples from monitoring wells at these cribs were analyzed for  $\text{Sr}^{90}$  and  $\text{Cs}^{137}$ . Samples from well 299-W22-2 contained  $\text{Sr}^{90}$  concentrations exceeding the detection limit, the maximum concentration being  $2.1 \times 10^{-6}$   $\mu\text{c/cc}$ . Positive concentrations were not detected in any of the other monitoring wells.

## II. PLANT WASTE DISPOSAL PRACTICE

### Chemical Processing Department (W. A. Haney)

Disposal to ground. -- The use of  $\text{Cs}^{137}$  as a precursor for  $\text{Sr}^{90}$  breakthrough into the regional ground water under the Purex 216-A-24 tank farm condensate crib is not likely. Laboratory results indicate that in this particular waste stream  $\text{Sr}^{90}$  will appear in the regional ground water in significant concentrations prior to the appearance of  $\text{Cs}^{137}$  in detectable concentrations. Therefore, future abandonment of this facility will have to be based on the appearance of  $\text{Sr}^{90}$  in ground water or on extrapolated laboratory data.

Personnel in the Chemical Processing Department have expressed an interest in financing a mineral bed "test facility" out of the FY-1960 Research and Development Budget. Such a facility would be used to determine the applicability of this method for decontaminating low-level wastes, such as the Redox process condensate (D-2). A successful, large-scale demonstration would be a major step toward reducing the quantity of radioactive material discharged to the ground.



Engineering studies are being made of the application of anion exchange resins for the removal and recovery of plutonium from Recuplex process waste. Sufficient engineering and laboratory data have been presented to Research and Engineering Operation, Chemical Processing Department, for detailed design of a prototype resin column. Further studies are planned to evaluate the effects that solids in the waste may have on the pressure drop across the resin bed; backwash characteristics will also be investigated.

300 Area Wastes. -- Composite samples of 300 Area cribbed waste are being analyzed for dissolved solids content in order to determine the feasibility of discharging such waste into self-concentrating storage tanks rather than to the 216-SL Redox laboratory waste crib. Based on several analytical results, about 1,500 pounds per month of dissolved solids (150 pounds of sodium) will be contained in the 150,000 gallons of waste collected. This amount of sodium would be a relatively small contribution to the total quantity discharged each month to the self-concentrating waste tanks at Purex. Recommendations for such a disposal revision will be dependent upon the analytical results of the remaining January and February samples. The addition of this waste to the self-concentrating tanks in place of much of the raw water that is now added each month will have multiple benefits. It will reduce the activity cribbed in the 200 Areas by 50-100 beta curies/month and will prolong the life of the 216-SL crib, and should result in lower personnel exposure and waste disposal costs due to the shorter hauling distance.

HW-58943-RD, "Revised Hazards Study - Underground Storage of Radioactive Liquid Wastes," January 20, 1959 (CONFIDENTIAL - UNDOCUMENTED), was issued.

#### Irradiation Processing Department (W. N. Koop)

Decontamination of reactor coolant. -- Engineering studies were initiated to evaluate the feasibility of a Chemical Research Operation proposal to decontaminate spent reactor coolant. This proposal involves passing the reactor effluent through beds of aluminum turnings prior to releasing to the river. Horizontal passage through permeable dams across retention basins is being considered. An alternative involves the downward passage through beds of aluminum in the river outfall structures. Various sources of aluminum turnings are being investigated in order to find inexpensive but suitable bed material. Waste aluminum from the manufacture of reactor fuel elements is one possibility.

Arrangements were made with the Chemical Development Operation to conduct a series of pressure-drop tests across beds of different types of aluminum turnings. The tests were started on March 23, 1959 in the 321 Building. The data from these experiments will be useful in determining the

design of the beds, the modifications needed in effluent facilities, and in the choice of bed material. Meanwhile, the Chemical Research Operation has expanded its investigation to learn more about effects of bed length, coolant velocity, and temperature on decontaminating efficiencies. The overall objective is to provide the Irradiation Process Department with engineering data and information which will be necessary for applying the process in a prototype or scaled-up facility.

#### Uranium Oxidation and Fission Product Volatilization Studies

(R. K. Hilliard)

Experiments designed to measure the release of fission products from low-level irradiated, unclad uranium were continued. Variables were limited almost exclusively to time and temperature, although in a few experiments atmospheres other than air and different gas velocities were studied.

It was found that xenon, iodine, and tellurium behaved similarly. These elements were released at a rate in proportion to the rate of oxidation of the uranium metal. About 80% of these elements were released when the metal was completely oxidized. Prolonged heating at a 1215° C furnace temperature did not drive off a measurable quantity of the remaining 20% of these elements.

As expected, increased temperature caused an increase in the fission product release rate of the seven elements studied (Xe, I<sup>131</sup>, Te<sup>132</sup>, Ru<sup>103</sup>, Ba<sup>140</sup>, Cs, and Sr). The range of temperatures investigated was 620° to 1440° C. Air-flow rate was found to have a minor effect on the total amount released from the metal, but it affected strongly the deposition pattern of the elements after release. A much higher fraction remained in the furnace tube at an air flow equal to 1/20th of that used in most of the studies. These results suggest that rather large decontamination factors of the off-gas would be achieved by deposition in the duct work leading to the stack of a reactor where the gas velocities would be small as compared to those in the reactor core.

Ruthenium behaved peculiarly. At 1215° C it was released at a steady rate until a total of 2% was volatilized at the time of complete uranium oxidation, or in about 50 minutes. Then a greatly accelerated release occurred until an additional 44% had been released during 70 minutes of prolonged heating. Strontium and barium releases were functions of temperature only, varying from 0.004% at 620° to 0.15% at 1440° C, while cesium varied from 0.05% to 1.0% over the same temperature range.

HW-58022, a topical report on the "Oxidation of Uranium in Air at High Temperatures," by R. K. Hilliard, was published this quarter. It is

expected that during the next quarter the fission product release studies will be extended to include steam atmospheres as a variable.

### III. LABORATORY EVALUATION OF WASTES (A. E. Reisenauer)

#### Purex Tank Farm Condensate

The previously reported capacity of 4.5 column volumes for the 216-A-24 crib was confirmed by column reruns which indicated a capacity of 4.2 column volumes. Because of some uncertainty regarding the present degree of utilization of the four crib sections, it is necessary to make four predictions, based on assumptions as to the number of sections receiving wastes.

| <u>No. of Sections<br/>being used</u> | <u>Col. Vol. waste re-<br/>ceived to Jan. 1959</u> | <u>Life expectancy at<br/>present flow</u> |
|---------------------------------------|--|--|
| 1                                     | 4.5  | January - 1959                             |
| 2                                     | 2.25   | August - 1959                              |
| 3                                     | 1.53   | March - 1960                               |
| 4                                     | 1.16   | October - 1960                             |

No correlations were found between the breakthrough curves of  $\text{Sr}^{90}$  and those of  $\text{Ru}^{106}$  and  $\text{Cs}^{137}$ . The  $\text{Ru}^{106}$  broke through the columns with the first liquid, whereas the  $\text{Cs}^{137}$  in this waste showed no detectable breakthrough in 50 column volumes, even when the concentration of the  $\text{Cs}^{137}$  in the influent was increased to 100 times that in the waste. The use of either of these radionuclides as indicators of impending  $\text{Sr}^{90}$  breakthrough does not appear to be practical.

#### Purex Process Condensate

A sample of the Purex process condensate was neutralized with 50% NaOH to a pH of 7.8 and run through soil columns in order to study the effect of NaOH neutralization on the crib capacity for this waste. The plant waste is now being treated with limestone. The average breakthrough to 0.1 MPC is as follows:

| <u>Concentration<br/><math>\text{Sr}^{90}</math> in waste</u> | <u>Column volumes<br/>to breakthrough</u> |
|---|---|
| $8 \times 10^{-7}$ $\mu\text{C}/\text{ml}$                    | 142                                       |
| $8 \times 10^{-6}$ " "  | 47  |
| $8 \times 10^{-5}$ " "  | 22  |

In comparison, the capacities reported for this waste when neutralized with limestone are 11.4, 7.3, and 5.2, respectively.

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Recuplex (CAW) Waste

Plutonium was adsorbed on strong-base anion exchange resins from Recuplex process waste at 25° C and a flow rate of 3.5 ml/cm<sup>2</sup>/min. Column volumes processed to 5% breakthrough were 15 for Permutit SK, 90 for Amberlite IRA 401, and 215 for Amberlite IRA 400. The capacity of Amberlite IRA 401 and Permutit SK for adsorbing plutonium was reduced 50% at a flow rate of 8.1 ml/cm<sup>2</sup>/min. At a temperature of 60° C and a flow rate of 3.5 ml/cm<sup>2</sup>/min, Amberlite IRA 401 processed 220 column volumes of waste before reaching 5% breakthrough. At 25° C and a flow rate of 0.53 ml/cm<sup>2</sup>/min, 0.35M nitric acid eluted 95% of the plutonium from the resin columns within 2.2 column volumes for Permutit SK, 4.0 column volumes for Dowex LX4, 15 column volumes for Amberlite IRA 400, and 16 column volumes for Amberlite IRA 401. Increasing the elution temperature to 60° C reduced the volume of elution solution required to reach 95% plutonium removal to 5 column volumes for Amberlite IRA 400 and IRA 401 resins.

IV. GROUND-WATER HYDROLOGY (W. H. Bierschenk)

A map has been completed showing direction, rate, and volume of ground-water flow beneath the project. These data result from calculations and estimations of field permeability derived from various field tests. The estimated mean lateral path of ground-water contamination is shown as an arcuate line trending south and east of the Separations areas to the Columbia River above 300 Area. Based on average ground-water velocities, a "travel time" in the order of roughly 180 years is tentatively calculated for flow from the Separations areas to the river. It is emphasized that the maximum rate of movement of the ground water and even of some materials dissolved in it may be many times the average, while those dissolved constituents that enter into adsorption reactions may move far slower than the water.

Correlation of 44 soil samples from two wells indicate that a close approximation of the natural moisture content may be achieved by determining the centrifuge moisture-equivalent (drainage under 1000 gravities for one hour). The specific retention values as determined by the centrifuge technique averaged 2.1% by volume at one well and 3.4% at another well in 200-West Area. The natural moisture content in adjacent samples averaged 1.7% and 3.5%, respectively.

V. WELL DRILLING SUMMARY (D. J. Brown)Artesian Well & Pump Company

| <u>Well</u> | <u>Ft. drilled</u> | <u>Finished</u> | <u>Total Ft.</u> | <u>To Water</u> | <u>To Basalt</u> |
|-------------|--------------------|-----------------|------------------|-----------------|------------------|
| 699-31-53B  | 431                | 3-17-59         | 431              | Yes             | No               |

Bach Drilling Company

|           |     |         |     |     |     |
|-----------|-----|---------|-----|-----|-----|
| 699-19-58 | 165 | 1-24-59 | 300 | Yes | Yes |
| 699-18-48 | 44  | 1- 9-59 | 353 | "   | "   |
| 699-55-95 | 140 | 1-17-59 | 530 | "   | "   |
| 699-55-75 | 118 | 1-19-59 | 238 | "   | "   |

Midland Drilling Company

|            |     |         |     |     |    |
|------------|-----|---------|-----|-----|----|
| 299-W18-4  | 280 | 2- 9-59 | 280 | Yes | No |
| 299-W15-94 | 100 | 1-26-59 | 100 | No  | "  |
| 299-W15-95 | 100 | 1-21-59 | 100 | "   | "  |
| 299-W15-6  | 410 | 3-25-59 | 410 | Yes | "  |