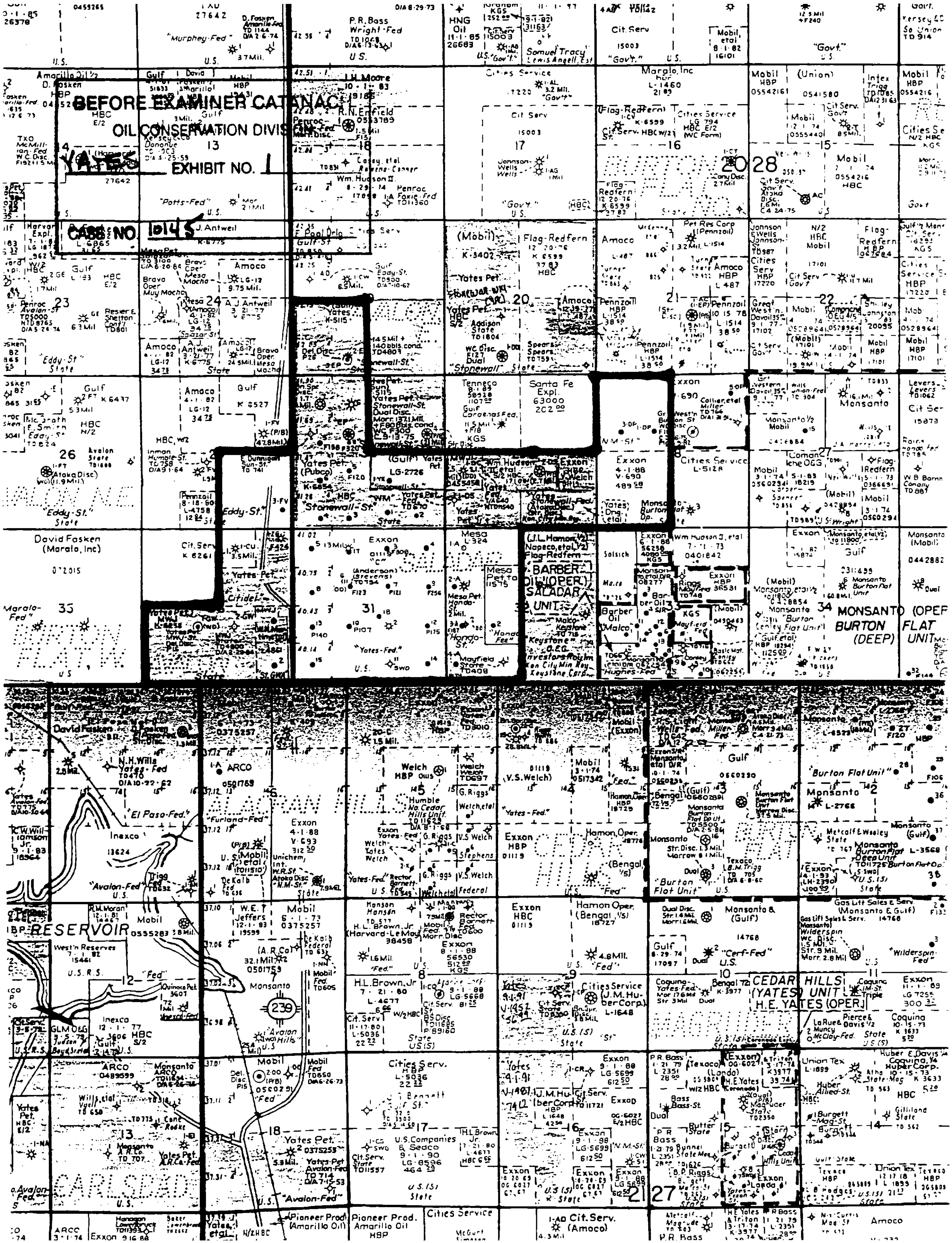
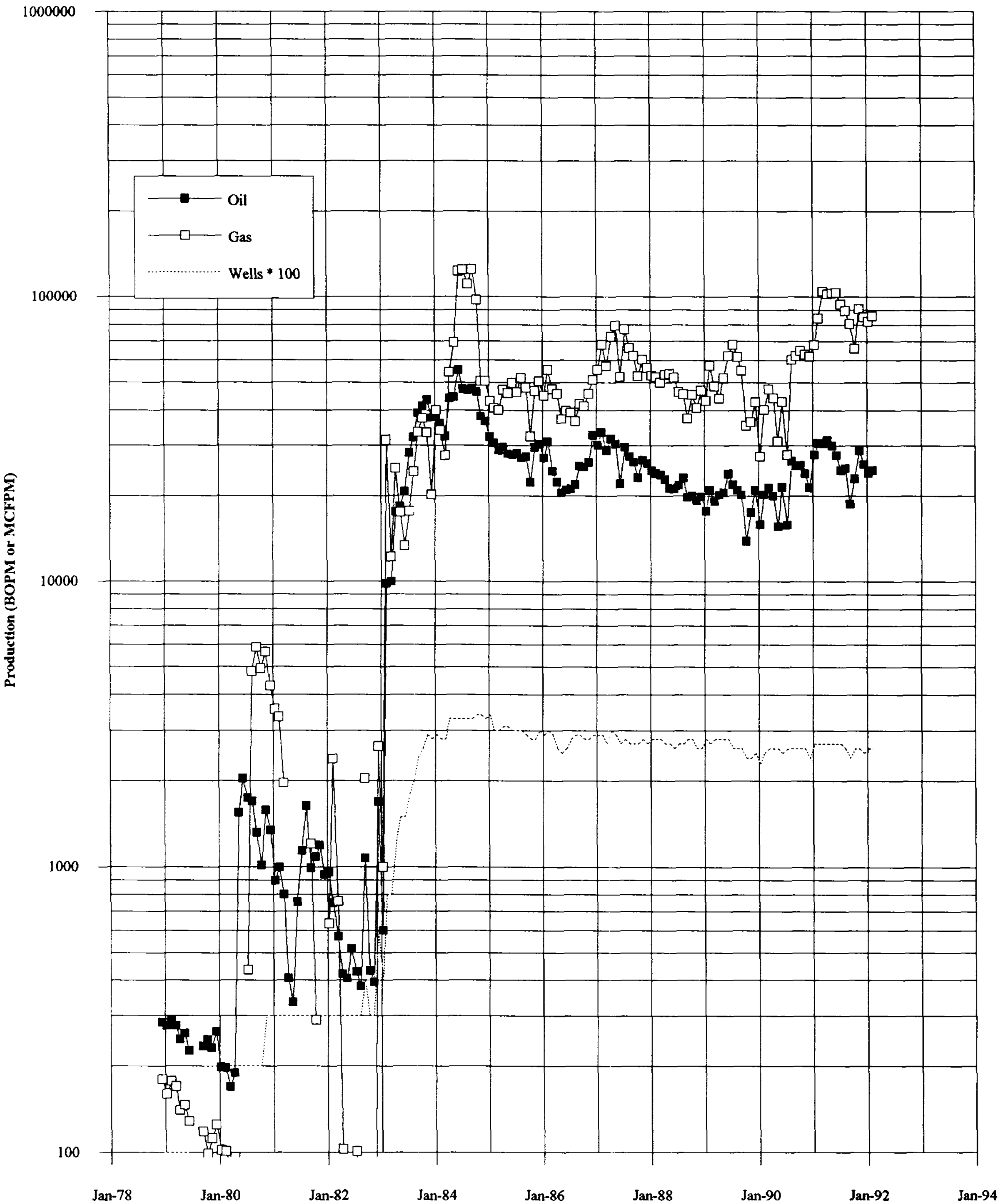


BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
YATES EXHIBIT NO. 1
CASE NO. 10145
BARBER OIL (OPER.) SALADAR UNIT
MONSANTO (OPER.) BURTON FLAT (DEEP) UNIT
CEDAR HILLS (YATES) UNIT H.E. YATES (OPER.)
"Burton Flat Unit"
RESERVOIR
Stonewall-State
Yates-Fed.
Eddy-St.
Avalon-Fed
El Paso-Fed.
Furland-Fed

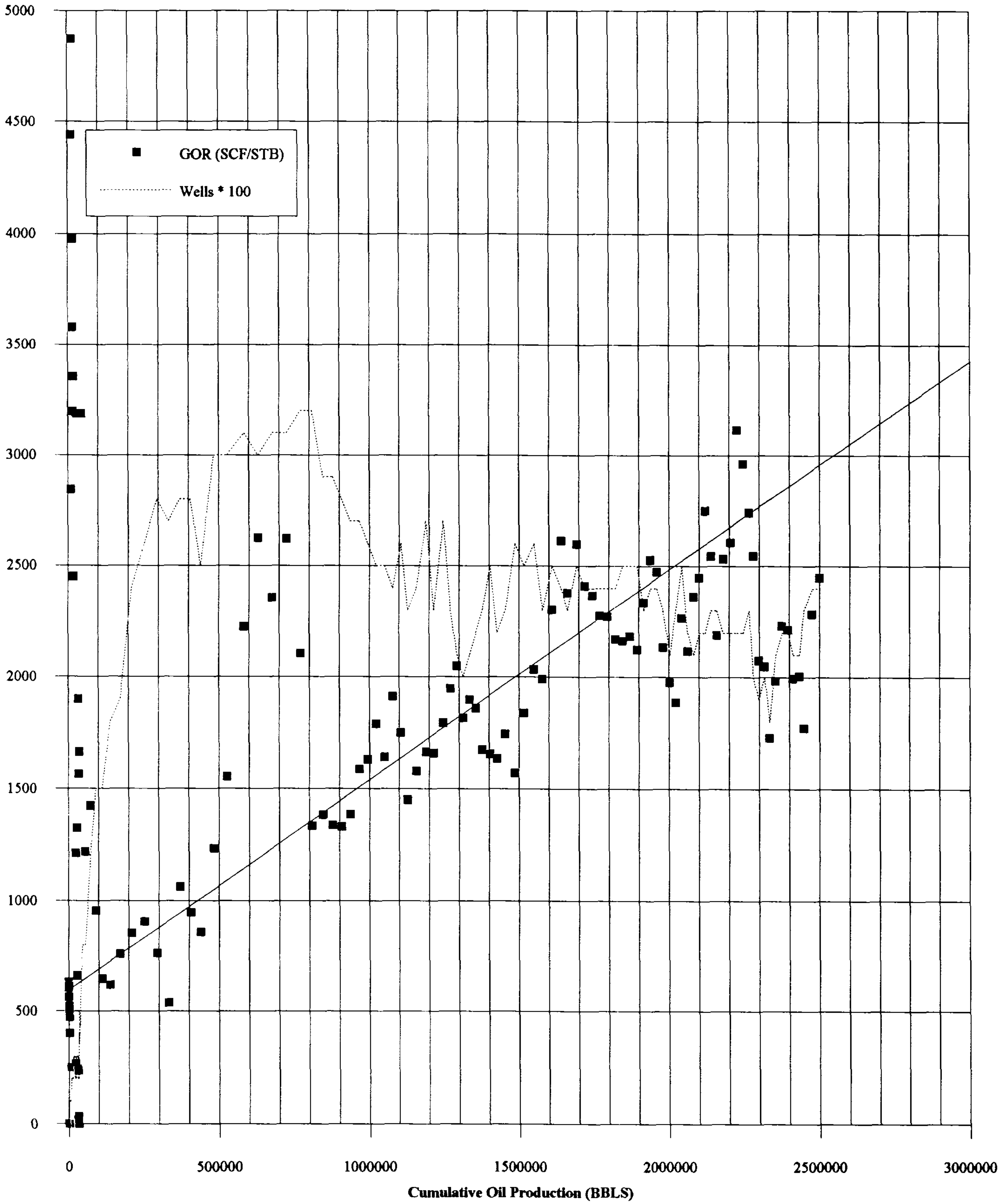
BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
YATES EXHIBIT NO 2
CASE NO. 10145

Avalon Delaware Field



BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
YATES EXHIBIT NO. 3
CASE NO. 10145

Avalon Delaware Field



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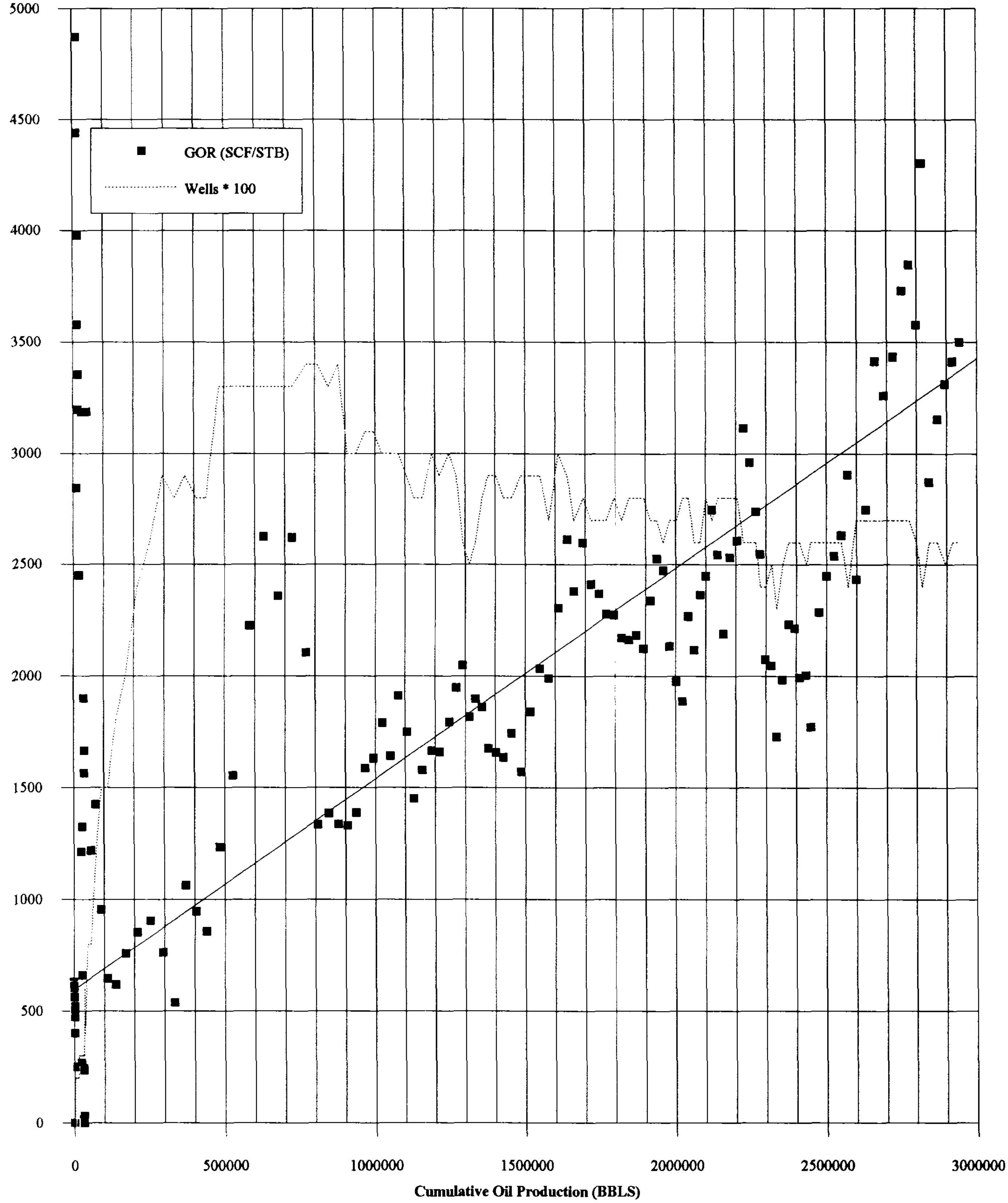
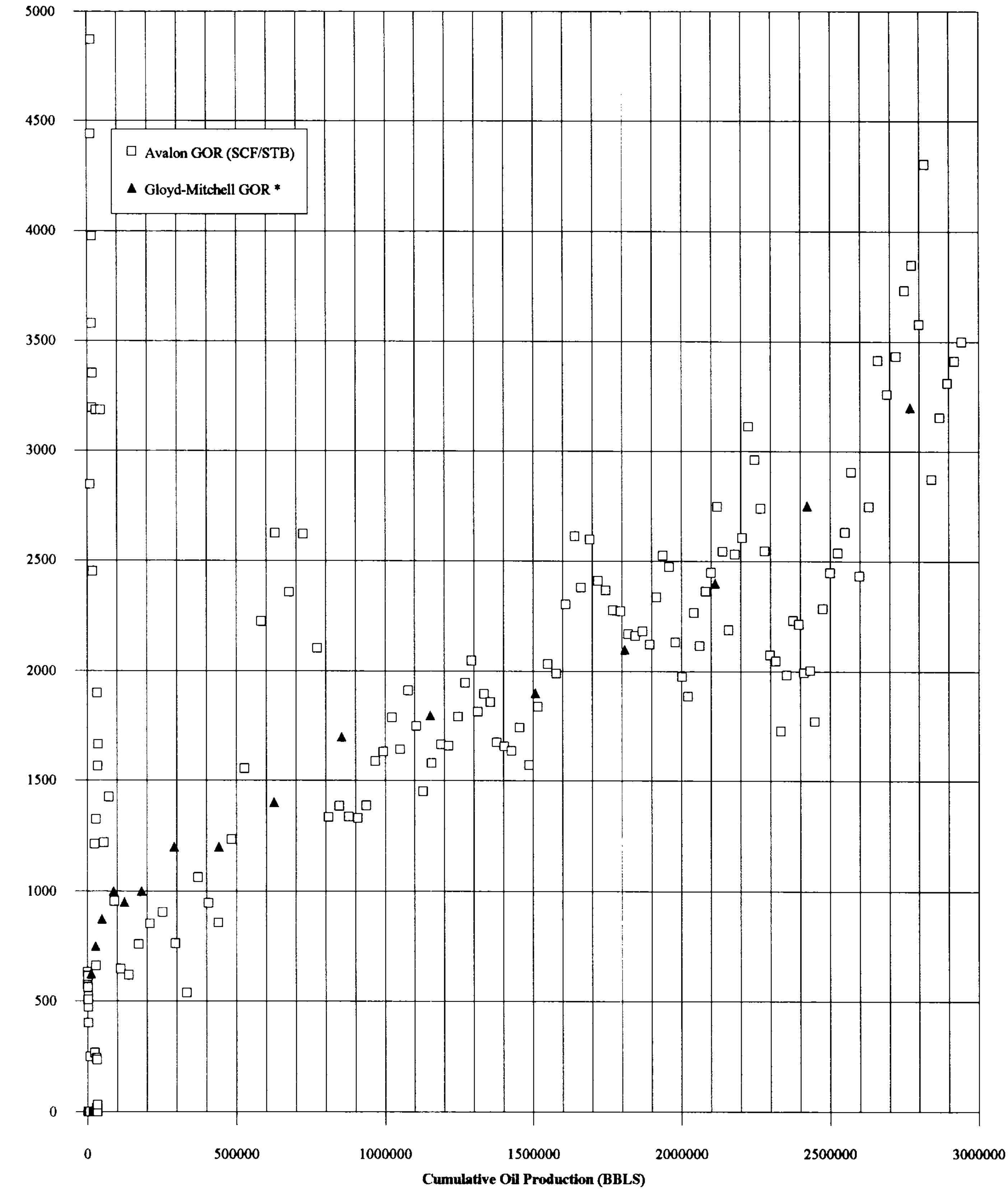
OIL CONSERVATION DIVISION
YATES EXHIBIT NO. 4
CASE NO. 10145

Avalon Delaware Field



BEFORE EXAMINER CATANACH
OIL CONSERVATION DIVISION
YATES EXHIBIT NO. 5
CASE NO. 10145

Avalon Delaware Field



* Source: Applied Petroleum Reservoir Engineering by Craft and Hawkins pp 121-122

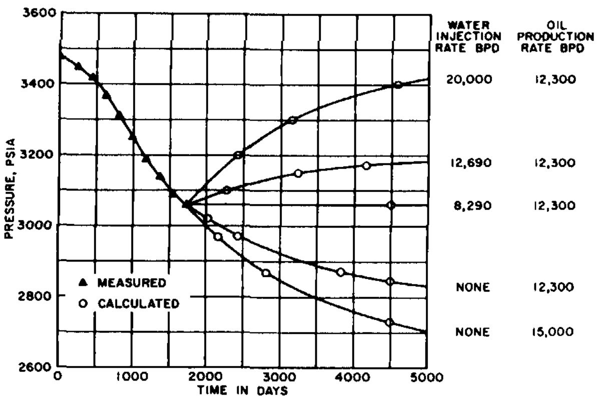


Fig. 4.15. Predicted performance of the Rockwell Field for various assumed production and injection rates.

the gas cap and by taking advantage of the increased recovery by primary pressure maintenance. Water injection at 12,690 BWPD would result in a longer flowing life, some increase in oil recovery if the reservoir had passed the point of critical gas saturation, and would practically eliminate pumping equipment except for a few edge wells. Water injection at 20,000 bbl per day, in addition to accomplishing the benefits mentioned above, would result in an earlier recovery of the oil reserves since in this instance the field allowable is based on the reservoir pressure.

If the field-producing rate is maintained without pressure maintenance, as the pressure declines the gas saturation in the oil zone will increase. When it reaches the critical gas saturation, free gas will begin to flow to the wells. If the critical gas saturation is known for the reservoir, then the pressure at which the gas-oil ratios of the wells will begin to increase can be estimated from a consideration of the single-phase and two-phase oil volume factors. For example, at 2800 psia, $B_t = 8.8181$ cu ft/STB and $B_o = 7.9003$ cu ft/STB, and the gas saturation of the oil zone in per cent of the total pore space is approximately

$$S_g = \frac{B_t - B_o}{B_t} \times (1 - S_w) \qquad (4.30)$$

$$= \frac{8.8181 - 7.9003}{8.8181}(1 - 0.27)$$

$$= 0.076 \text{ or } 7.6 \text{ per cent}$$

The indications are that the critical gas saturation is low for the high permeability, oölitic limestone of the *Rockwell Field, and that at 2800 psia* the gas-oil ratios would begin to rise and cause a lower recovery efficiency.

11. Maximum Efficient Rate (MER). Many studies indicate that the recovery from true solution gas-drive reservoirs by primary depletion is essentially independent of both individual well rates and total or reservoir production rates. **Kelly, Tracy, and Roe[22] have shown that this is true even for reservoirs with severe permeability stratification where the strata are separated by impermeable barriers and are hydraulically connected only at the wells.** The Gloyd-Mitchell zone of the Rodessa Field (see Chapter 3, Sec. 7) is an example of a solution gas-drive reservoir which is essentially not *rate sensitive*, i.e., the recovery is unrelated to the rate at which the reservoir is produced. The recovery from very permeable, uniform reservoirs under very active water drives may also be essentially independent of the rates at which they are produced.

On the other hand many reservoirs are clearly *rate sensitive* and there is a *maximum efficient rate* (MER)[23,24] above which there will be a significant reduction in the practical ultimate oil recovery. Rate sensitive reservoirs imply that there is some mechanism(s) at work in the reservoir, which, in a practical period of time, can substantially improve the recovery of the oil in place. These mechanisms include (a) partial water drive, (b) gravitational segregation, and (c) those effective in reservoirs of heterogeneous permeability.

Where initially undersaturated reservoirs are produced under partial water drive at voidage rates (gas, oil, and water) considerably in excess of the natural influx rate, they are produced essentially as solution gas-drive reservoirs, modified by a small water influx. Assuming that recovery by water displacement is considerably larger than by solution gas drive, there will be a considerable loss in recoverable oil by the high production rate, even where the oil zone is eventually entirely invaded by water. The loss is due to the increase in the viscosity of the oil and to the decrease in the volume factor of the oil at lower pressures, and also to the earlier abandonment of the wells which must be produced by artificial lift. Because of the higher oil viscosity at the lower pressure, producing water-oil ratios will be higher, and the economic limit of production rate will be reached at lower oil recoveries. Because of the lower oil volume factor at the lower pressure, at the same residual oil saturation in the invaded area, more stock tank oil will be left at low pressure. There are, of course, additional benefits to be realized by producing at such a *rate so as to maintain* high reservoir pressure. The Rockwell Field (see Fig. 4.15) is an example of a partial water-drive reservoir which is rate sensitive. If there is no appreciable gravitational segregation and the effects of reservoir heterogeneity are

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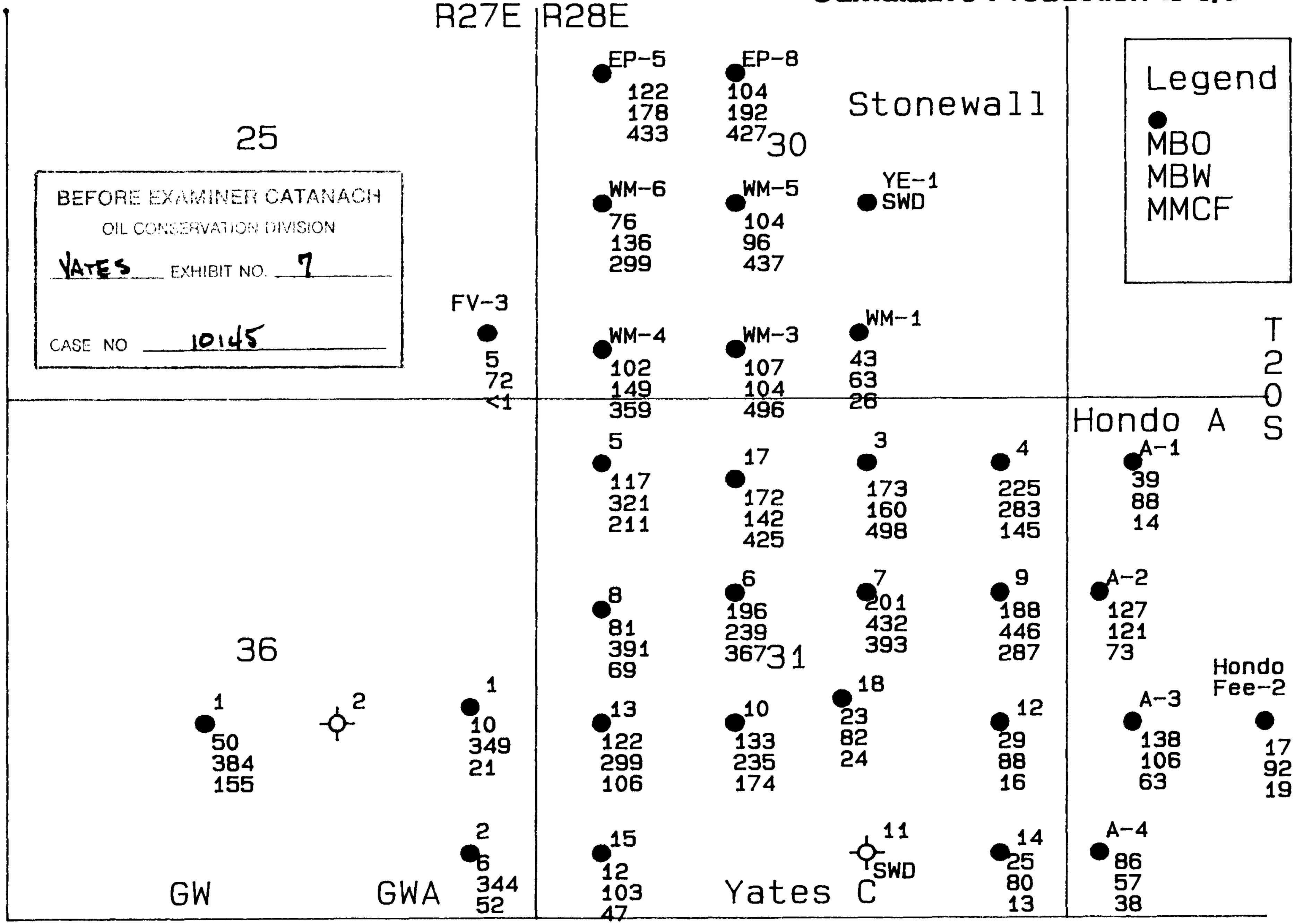
Cumulative Production to 3/92



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