

**Daly Unit #13**  
**2019 Annual EOR Report**

## **Executive Summary**

In 2019 oil production from Daly Unit #13 was 16.5 m<sup>3</sup>/d (104 bbl/d), totaling 6.1 10<sup>3</sup>m<sup>3</sup> (38.1 mbbbl). Annual production declined 28.8% from 2018 to 2019, this calculation is using the average production year over year. Using the production of December 2018 and December 2019 there would be an annual decline in production of 49.8%, due to the drilling of a new crossover horizontal well. Cumulative oil production from the Daly Unit #13 was 205.5 10<sup>3</sup>m<sup>3</sup> (1.29 mmbbl) at the end of 2018.

In December 2019, there were 13 active oil producers, 5 horizontal injection wells, and one disposal well which is suspended. In 2019, one crossover horizontal well was drilled within the unit.

## Discussion

Historically, the unit produced through vertical wells completed in the Lodgepole formation. The first well was drilled in 1964, then in 1965 another two wells were drilled. Further development did not occur until 1984, and between 1984 and 1986, 14 additional vertical wells had been drilled. In 1986 a disposal well was implemented to handle the water production in the unit. Over time, some of the wells were deepened to the Bakken formation, some of the Lodgepole zones being abandoned, others commingled with the Bakken. In 2013 and 2014, Corex continued to develop the unit through horizontal multistage fractured wells. Currently, the unit has twelve horizontal wells placed in the Lodgepole formation. After several years of primary production and pressure depletion it was deemed beneficial to implement a waterflood. In 2017, three wells were converted to injection. 103/13-25-009-29W1/00 and 103/01-36-009-29W1/00 were converted in March 2017, with some mechanical difficulties with 103/01-36-009-29W1/00, where it did not inject for some time. In November 2017, 103/12-25-009-29W1/00 was converted to injection. In March 2018, an additional two wells were converted to injection, 103/04-25-009-29W1/00 and 103/05-25-009-29W1/00.

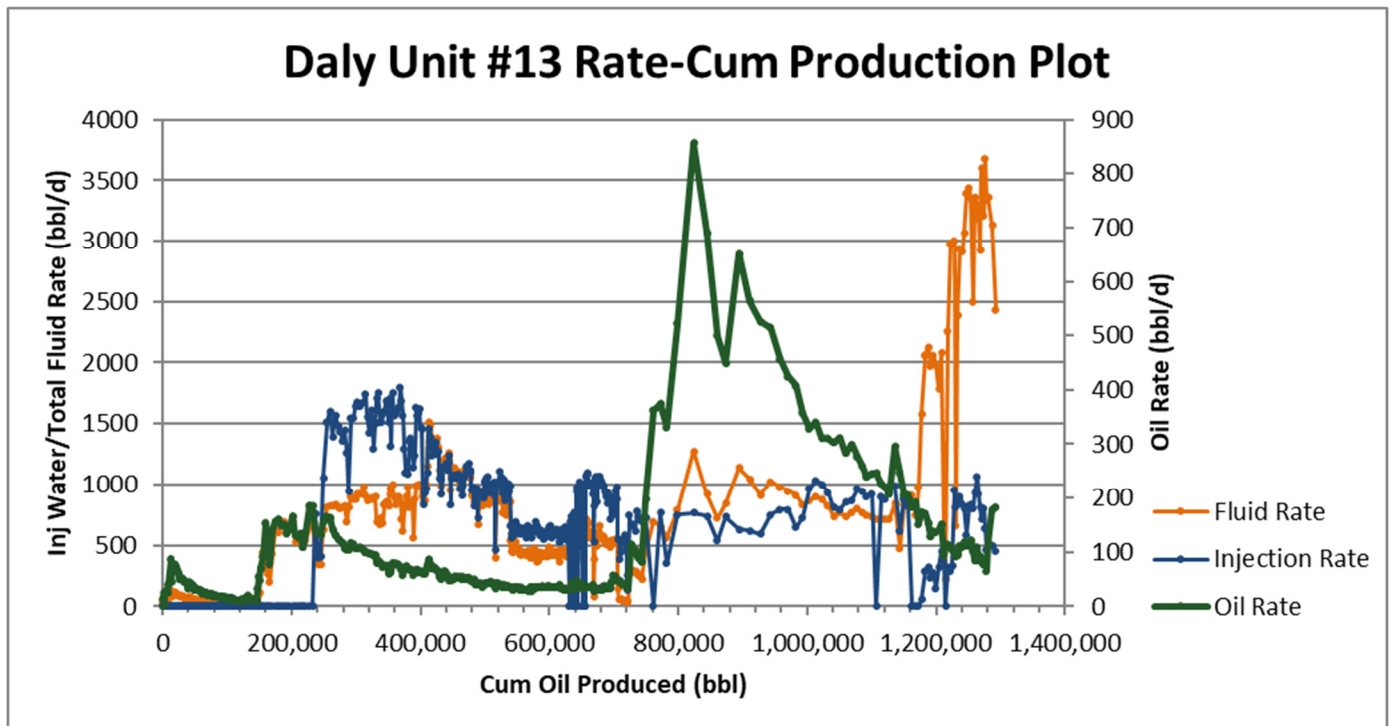
With the conversion of water injection wells Corex suspended the 100/08-36-009-29W1/00 water disposal well and all water is disposed outside of the unit. Water injection in 2019 in Daly Unit #13 was  $114\text{m}^3/\text{d}$  (717 bbl/d), totaling  $41.6 \times 10^3\text{m}^3$  (261.6 mbbbl). The producing WOR of the unit is  $12 \text{ m}^3/\text{m}^3$ . This is a decrease compared to last year due to the production of a new horizontal well.

Significant activity in 2019 is as follows:

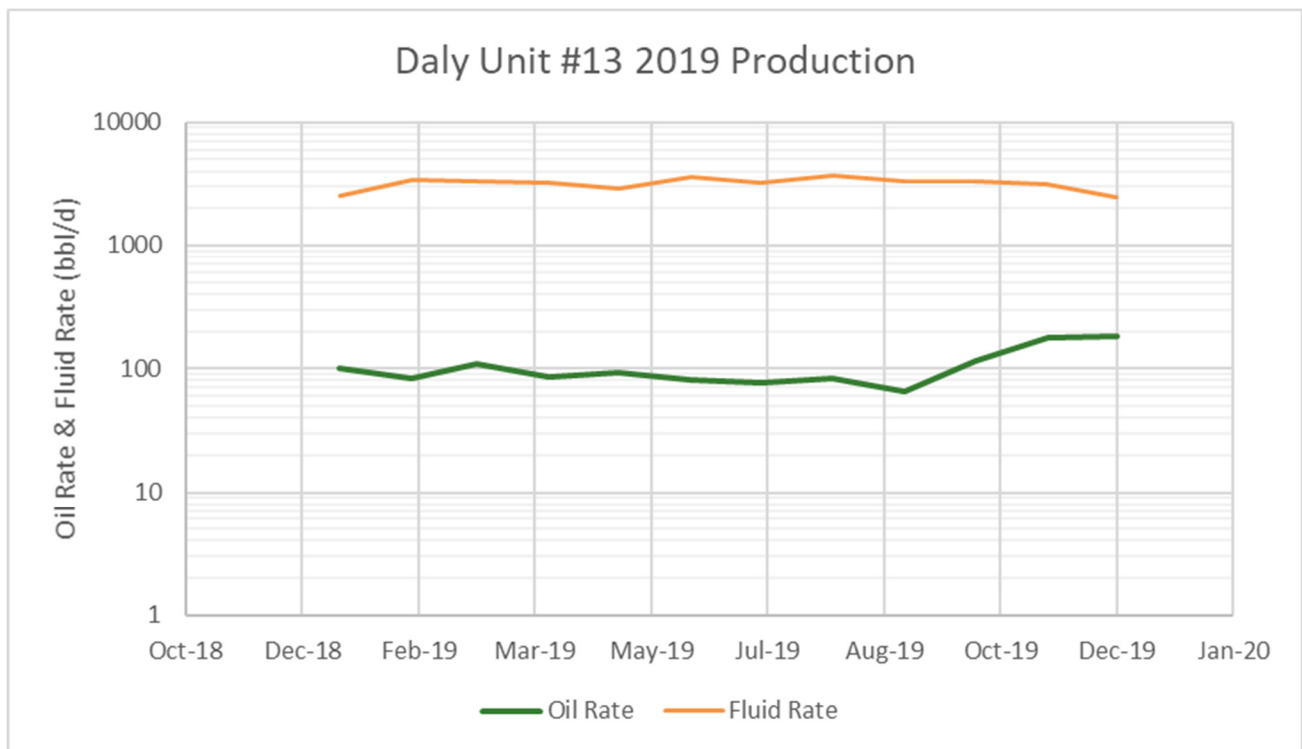
- August 2019, attempt to remove the ICD in the 103/13-25-009-29W1/00 horizontal well.
- September 2019, drill the 100/09-36-009-29W1/00 horizontal crossover well in the Flossie.
- November 2019, continue to remove the ICD in the 103/13-25-009-29W1/00 horizontal well and place the well back on injection.

The waterflood was first implemented in 2018. Early results are encouraging. Oil production has inclined and remained flat. The waterflood clearly has arrested the decline in the unit and increased production. For a tight oil waterflood the results are very promising. Corex will continue to operate the waterflood and further incremental reserves to be gained through secondary recovery.

## Daly #13 – Rate vs Cum Oil Production



## Daly #13 – Rate vs Time



## 2019 Reservoir Pressure Surveys

In 2019, only one fall off pressure on an injection well was recorded in Daly Unit #13. This pressure and other historical pressures taken within the unit are below:

Unit	UWI	License	Test Type	Date of Pressure	Duration of SI (days)	Datum BHP (kPaa)
Daly Unit #13	103/04-25-009-29W1/00	9660	BH BU	3/3/2014	27	7,575
Daly Unit #13	100/08-36-009-29W1/00	3616	Surface Recorder	8/23/2014	1	8,396

Unit	UWI	License	Test Type	Date of Pressure	Duration of SI (days)	Datum BHP (kPaa)
Daly #13	103/12-25-009-29W1/00	9715	BH FO	2019-08-30	36	12,341

The estimated initial reservoir pressure for the Lodgepole is 8,200 kPaa, which is slightly over pressure. As the Lodgepole formation is quite large, with multiple oil bearing zones the pressures could vary with depth within the Lodgepole. However, the majority of the production from this unit out of the Lodgepole is from only one member, as are the pressures that were taken. The pressures taken in 2014 are close to the estimated initial reservoir pressure. Due to the inter well spacing and the length of the production period it is likely that the current reservoir pressure has been depleted and is lower than the initial reservoir pressure. However, with the initiation of injection in the unit, the pressure may be increasing. Due to the low permeability of the reservoir rock, obtaining representative buildup pressures is quite challenging and unlikely to be accurate in any way. The fall off test conducted showed a high near wellbore pressure, but did not reach far into the reservoir, even after a long shut-in duration, indicating the low permeability of the reservoir.

The VRR in December 2019 was 0.18, this would say that there is not enough injection volumes going into the zone. However, this is including one well that likely has a large portion of out of zone water production, that does not need to be replaced. When looking at the individual patten instantaneous VRR's most of them are near or above 1, and the ones that are not include the out of zone water production. The cumulative VRR at year end was 0.07, indicating that there is a long way until voidage is reached. An oil formation volume factor of  $1.06 \text{ rm}^3/\text{sm}^3$  and a water formation volume factor of  $1.04 \text{ rm}^3/\text{sm}^3$  were used in the VRR calculations.

## 2019 Well Servicing

UWI	Unit	Licence	Start Date	Operation	Objective
103/12-25-009-29W1/00	DU#13	9715	2019-07-24	Completion/Workover	Pressure Build-up/Survey
103/12-25-009-29W1/00	DU#13	9715	2019-12-30	Completion/Workover	Acid Treatment
103/13-25-009-29W1/00	DU#13	9712	2019-08-21	Completion/Workover	Injection Workover
103/01-36-009-29W1/00	DU#13	9438	2019-03-06	Completion/Workover	Pressure Build-up/Survey
103/01-36-009-29W1/00	DU#13	9438	2019-12-29	Completion/Workover	Acid Treatment
HIGH WATT HEAT TRACE & INSULATE	DU#13	RM19DAL002	2019-03-01	Facilities	Major Surface R&M
TURNAROUND	DU#13	T19DAL001	2019-09-02	Facilities	Turnaround
103/05-25-009-29W1/00	DU#13	9716	2019-12-29	Completion/Workover	Acid Treatment
103/04-25-009-29W1/00	DU#13	9660	2019-12-29	Completion/Workover	Acid Treatment
100/09-36-009-29W1/00	DU13 / DNU	11274	2019-04-29	Construction	Construction
100/09-36-009-29W1/00	DU13 / DNU	11274	2019-08-28	Facilities	Equip & Tie-In
100/09-36-009-29W1/00	DU13 / DNU	11274	2019-09-09	Drilling	Drilling - original
100/09-36-009-29W1/00	DU13 / DNU	11274	2019-09-15	Completion/Workover	Initial Completion
100/10-36-009-29W1/02	DALY UNIT 13 & 14	3707	2019-07-18	Completion/Workover	Pump Repair
102/04-25-009-29W1/00	DU#13	9659	2019-05-27	Completion/Workover	Pump Repair
102/13-25-009-29W1/00	DU#13	9711	2019-03-04	Completion/Workover	Pump Repair
BATTERY UPGRADE	DU#13	F19DAL002	2019-07-20	Facilities	Battery Upgrade



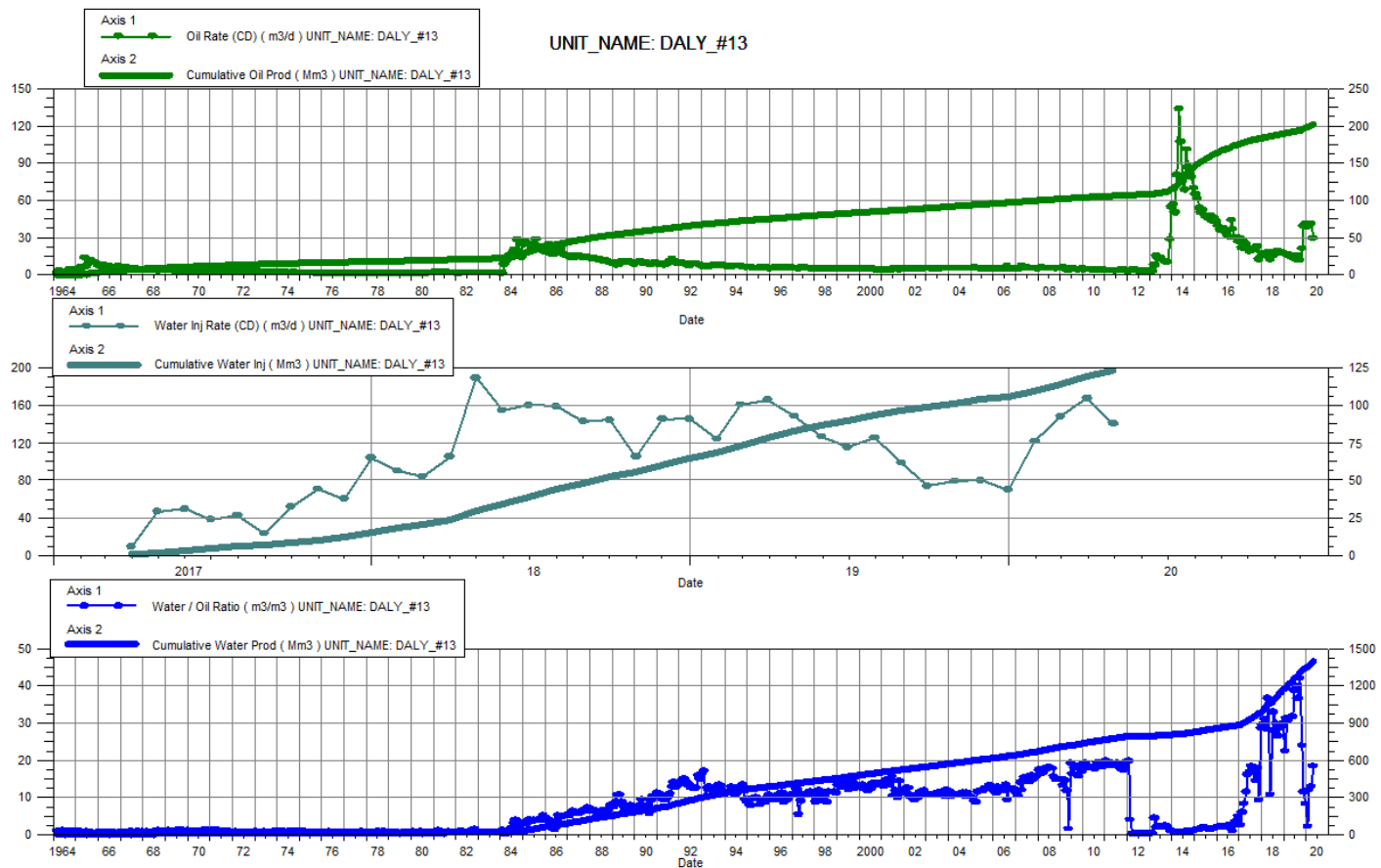
## Waterflood Patterns and Corresponding Injectors

Pattern	Well
P-01	103/01-36-009-29W1/00
P-02	103/13-25-009-29W1/00
P-03	103/12-25-009-29W1/00
P-04	103/05-25-009-29W1/00
P-05	103/04-25-009-29W1/00



## Total for Daly Unit No. 13

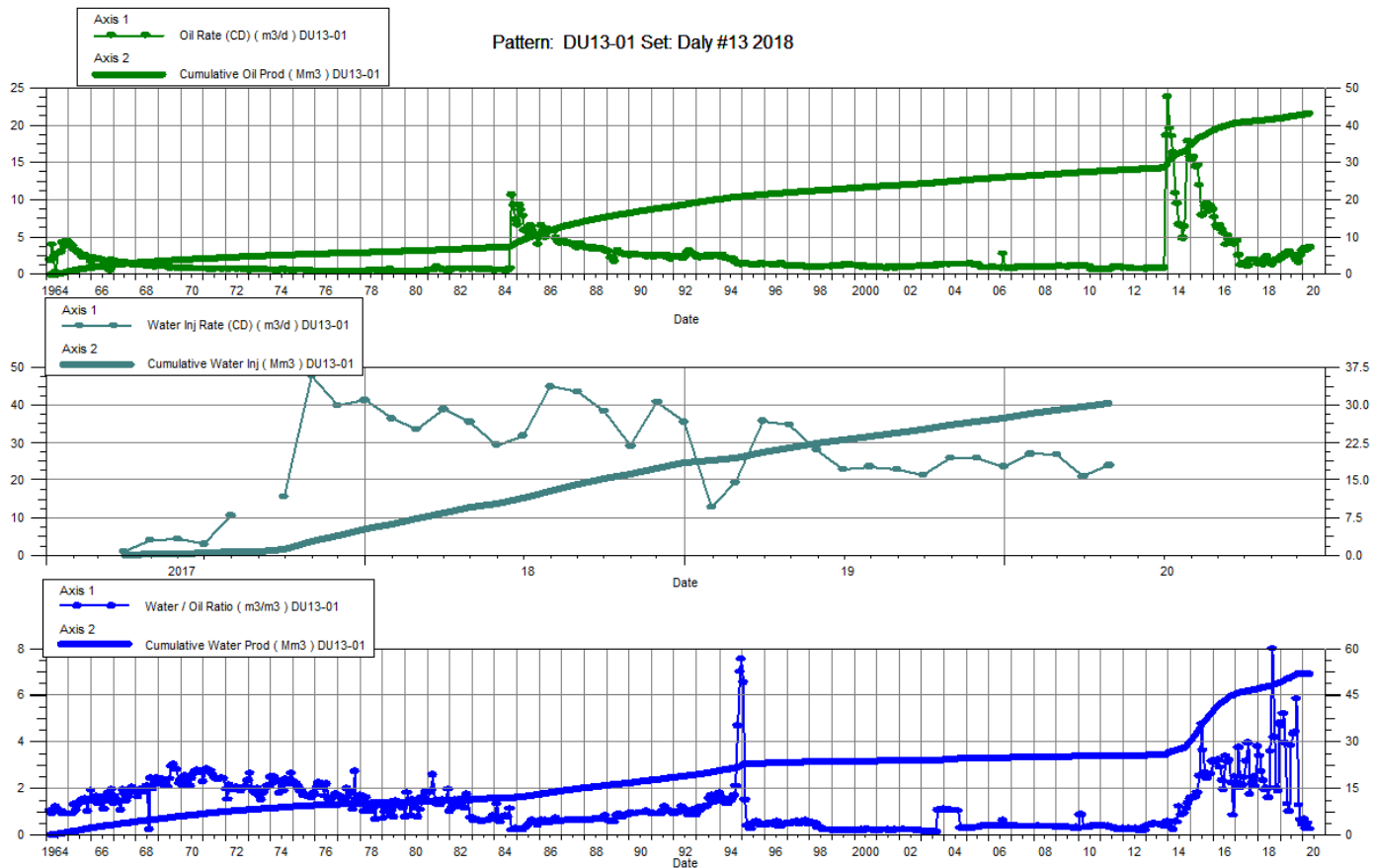
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPa
1-31-2019	16.98	190.79	380.59	1178.47	124.61	68.65	22.41	0.31	0.05	343.50
2-28-2019	16.60	191.25	517.64	1192.96	160.89	73.16	31.18	0.30	0.05	6,456.93
3-31-2019	16.66	191.77	509.03	1208.74	166.48	78.32	30.56	0.32	0.06	7,169.54
4-30-2019	15.57	192.24	491.84	1223.50	148.77	82.78	31.60	0.29	0.06	7,164.89
5-31-2019	14.20	192.68	451.00	1237.48	126.71	86.71	31.77	0.27	0.06	7,163.73
6-30-2019	14.42	193.11	558.92	1254.24	115.50	90.17	38.77	0.20	0.06	6,968.81
7-31-2019	12.50	193.50	498.12	1269.69	125.84	94.07	39.84	0.25	0.06	7,133.56
8-31-2019	15.52	193.98	568.70	1287.32	98.84	97.14	36.64	0.17	0.07	7,132.67
9-30-2019	12.34	194.35	517.75	1302.85	73.83	99.35	41.96	0.14	0.07	7,132.67
10-31-2019	21.50	195.01	512.40	1318.73	79.20	101.81	23.83	0.15	0.07	7,132.67
11-30-2019	39.51	196.20	457.76	1332.47	80.07	104.21	11.59	0.16	0.07	7,132.67
12-31-2019	41.68	197.49	344.94	1343.16	69.94	106.38	8.28	0.18	0.07	7,132.67



## Daly Unit No. 13

### Pattern P-01 - 03/01-36-009-29W1/0

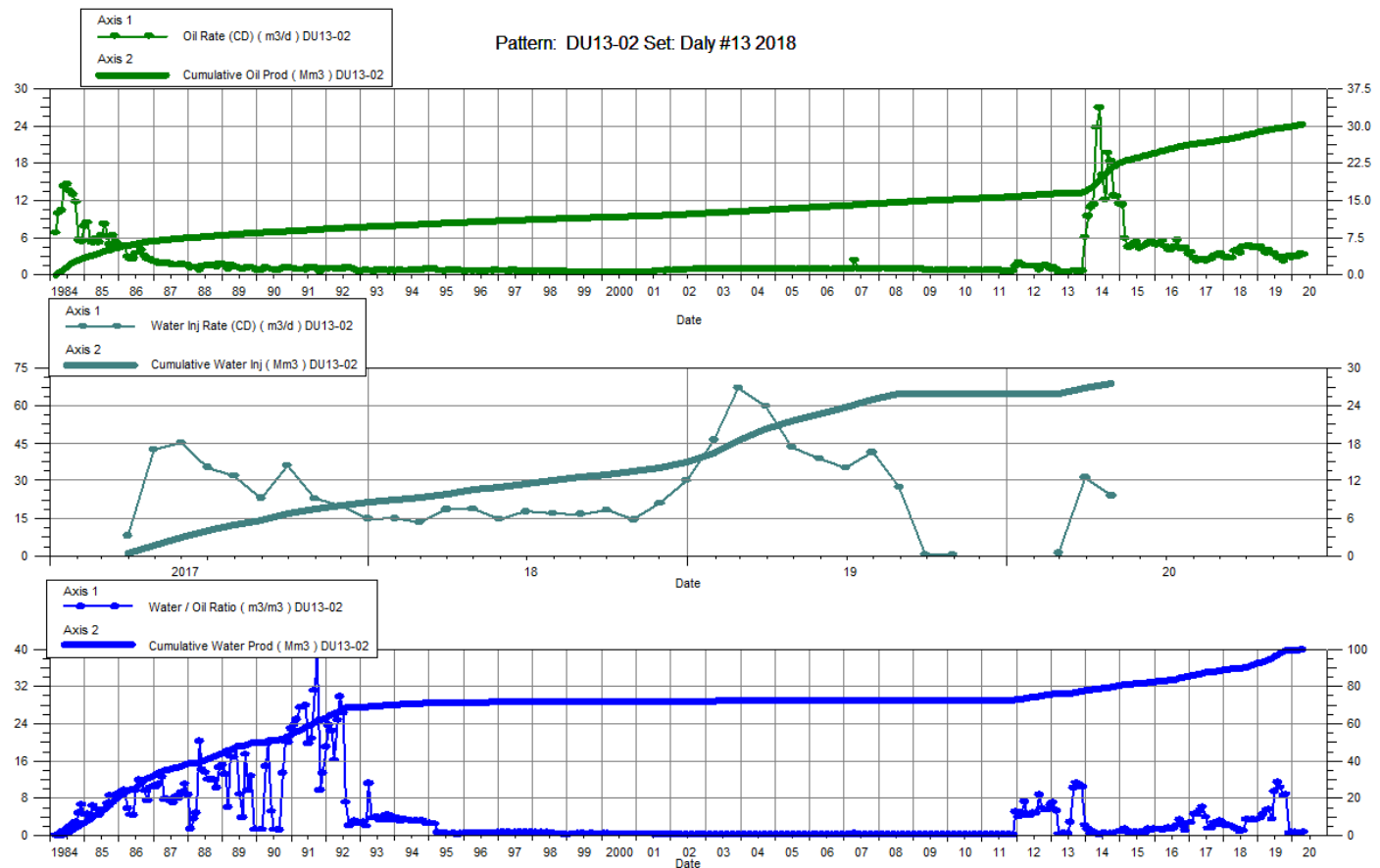
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	2.51	42.07	11.72	49.35	12.77	18.87	4.66	0.89	0.21	0.79
2-28-2019	2.42	42.14	12.56	49.70	19.39	19.41	5.19	1.29	0.21	4,966.36
3-31-2019	2.72	42.22	10.73	50.03	35.84	20.52	3.94	2.66	0.22	9,058.06
4-30-2019	2.73	42.31	3.62	50.14	34.77	21.56	1.32	5.43	0.23	8,866.73
5-31-2019	3.05	42.40	3.05	50.24	28.10	22.43	1.00	4.56	0.24	8,808.32
6-30-2019	2.80	42.48	10.73	50.56	22.87	23.12	3.83	1.68	0.25	8,461.67
7-31-2019	2.57	42.56	11.10	50.90	23.55	23.85	4.31	1.72	0.25	8,617.23
8-31-2019	2.65	42.65	11.71	51.27	22.84	24.56	4.42	1.58	0.26	8,615.00
9-30-2019	1.97	42.71	11.50	51.61	21.27	25.20	5.84	1.58	0.27	8,615.00
10-31-2019	1.68	42.76	2.14	51.68	25.89	26.00	1.28	6.72	0.27	8,615.00
11-30-2019	2.60	42.84	1.70	51.73	25.93	26.78	0.65	5.96	0.28	8,615.00
12-31-2019	3.19	42.93	1.42	51.77	23.61	27.51	0.44	5.06	0.29	8,615.00



## Daly Unit No. 13

### Pattern P-02 - 03/13-25-009-29W1/0

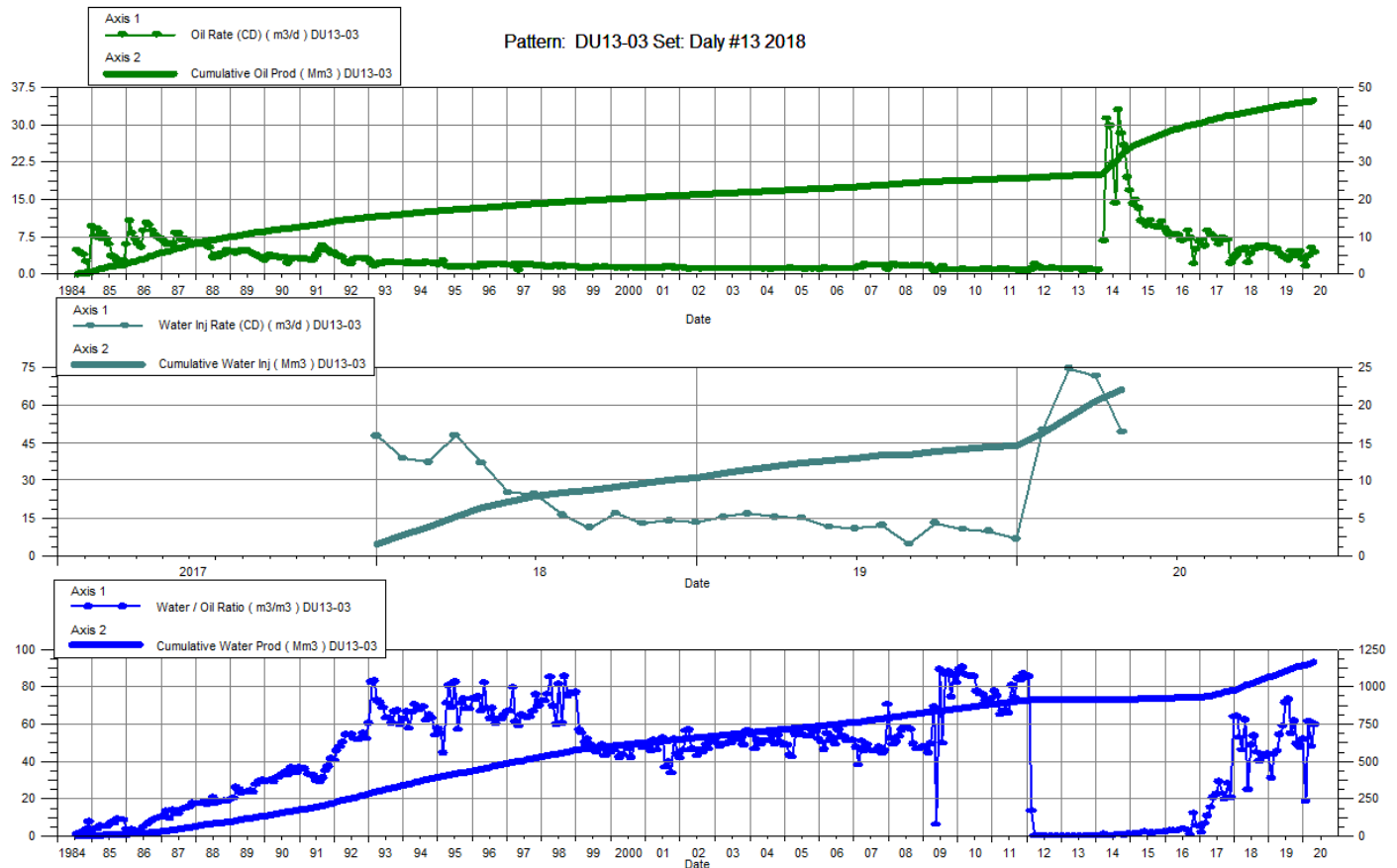
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	4.62	28.90	16.92	92.65	46.52	16.52	3.66	2.15	0.14	512.13
2-28-2019	4.08	29.02	18.86	93.17	67.32	18.41	4.63	2.93	0.15	8,489.68
3-31-2019	3.57	29.13	19.55	93.78	60.06	20.27	5.48	2.59	0.16	8,341.23
4-30-2019	3.97	29.25	22.41	94.45	43.63	21.58	5.64	1.65	0.17	8,364.53
5-31-2019	3.59	29.36	12.46	94.84	38.77	22.78	3.47	2.41	0.18	8,379.42
6-30-2019	3.56	29.46	33.77	95.85	35.23	23.84	9.50	0.94	0.19	8,176.37
7-31-2019	2.91	29.55	33.16	96.88	41.42	25.12	11.38	1.15	0.20	8,393.13
8-31-2019	2.94	29.64	30.25	97.82	27.32	25.97	10.31	0.82	0.20	8,394.00
9-30-2019	2.36	29.72	20.18	98.42	0.30	25.98	8.56	0.01	0.20	8,394.00
10-31-2019	2.90	29.81	25.63	99.22	0.39	25.99	8.84	0.01	0.20	8,394.00
11-30-2019	3.21	29.90	1.75	99.27		25.99	0.55		0.20	8,394.00
12-31-2019	2.94	29.99	2.03	99.33		25.99	0.69		0.20	8,394.00



## Daly Unit No. 13

### Pattern P-03 - 03/12-25-009-29W1/0

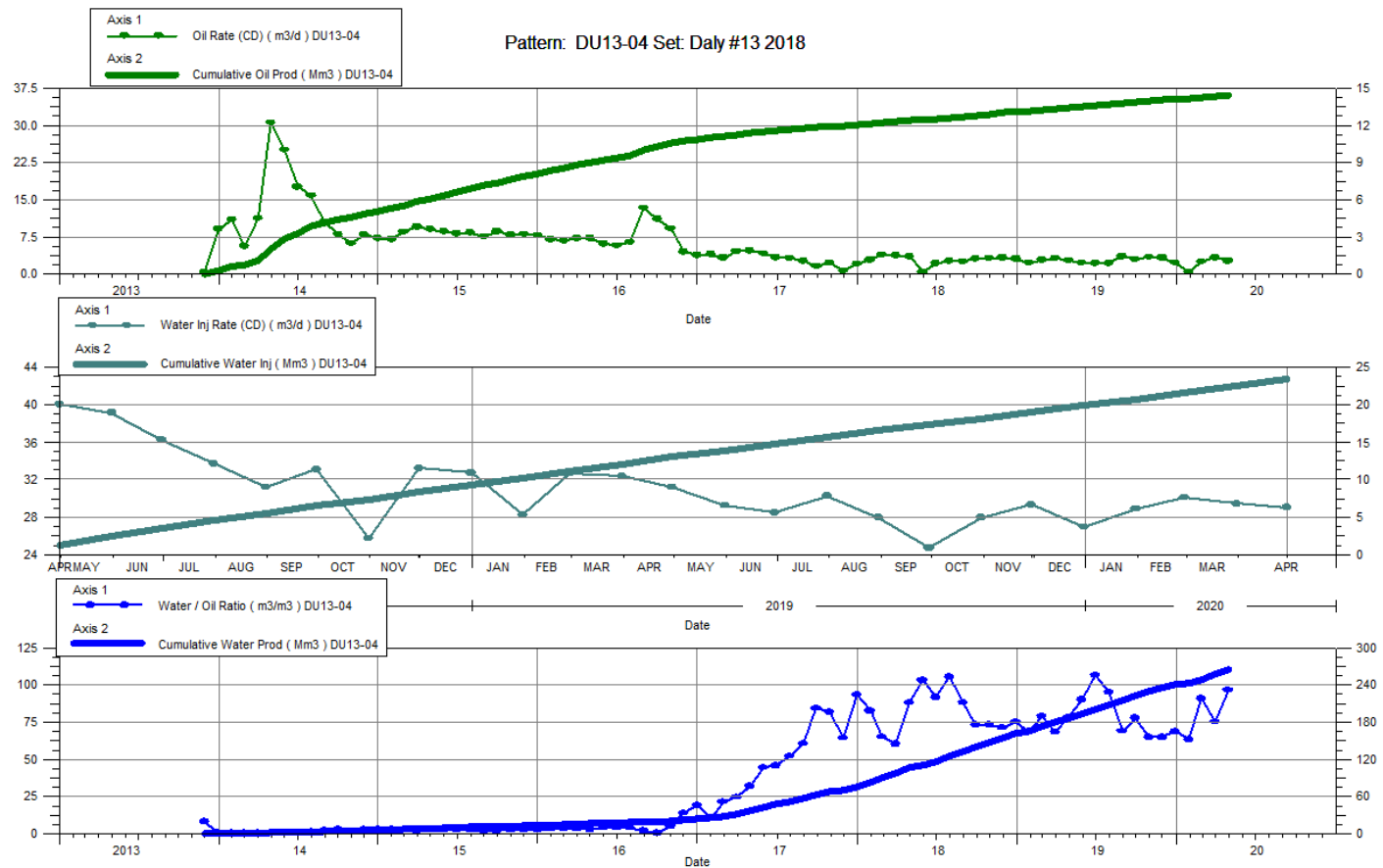
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	5.29	44.69	163.07	1065.39	15.35	10.90	30.85	0.09	0.01	539.87
2-28-2019	5.26	44.83	230.66	1071.85	16.75	11.37	43.88	0.07	0.01	8,422.96
3-31-2019	5.02	44.99	228.54	1078.93	15.35	11.85	45.49	0.07	0.01	8,449.90
4-30-2019	4.23	45.12	228.85	1085.80	15.13	12.30	54.06	0.07	0.01	8,555.83
5-31-2019	3.69	45.23	216.43	1092.51	11.29	12.65	58.70	0.05	0.01	8,570.52
6-30-2019	3.47	45.33	246.92	1099.92	10.77	12.98	71.19	0.04	0.01	8,364.07
7-31-2019	2.97	45.43	217.62	1106.66	12.00	13.35	73.33	0.05	0.01	8,555.84
8-31-2019	4.64	45.57	253.85	1114.53	4.52	13.49	54.72	0.02	0.01	8,551.00
9-30-2019	3.83	45.68	235.28	1121.59	12.97	13.88	61.51	0.05	0.01	8,551.00
10-31-2019	4.68	45.83	231.34	1128.76	10.44	14.20	49.39	0.04	0.01	8,551.00
11-30-2019	4.59	45.97	218.40	1135.31	9.70	14.49	47.62	0.04	0.01	8,551.00
12-31-2019	3.17	46.07	163.91	1140.40	6.59	14.70	51.72	0.04	0.01	8,551.00



# Daly Unit No. 13

## Pattern P-04 - 03/05-25-009-29W1/0

Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	2.38	13.18	162.80	165.98	28.19	10.19	68.43	0.17	0.06	510.10
2-28-2019	2.92	13.27	230.04	172.42	32.68	11.11	78.74	0.14	0.06	8,472.39
3-31-2019	3.32	13.37	226.74	179.45	32.35	12.11	68.27	0.14	0.06	8,596.52
4-30-2019	2.87	13.46	223.23	186.15	31.17	13.04	77.92	0.14	0.07	8,616.47
5-31-2019	2.39	13.53	214.41	192.79	29.23	13.95	89.82	0.14	0.07	8,629.19
6-30-2019	2.30	13.60	244.96	200.14	28.47	14.80	106.43	0.12	0.07	8,424.93
7-31-2019	2.28	13.67	216.33	206.85	30.26	15.74	94.92	0.14	0.07	8,640.26
8-31-2019	3.68	13.78	252.99	214.69	27.94	16.61	68.79	0.11	0.07	8,641.00
9-30-2019	3.02	13.87	234.53	221.73	24.67	17.35	77.66	0.10	0.07	8,641.00
10-31-2019	3.57	13.98	231.21	228.90	27.94	18.21	64.78	0.12	0.08	8,641.00
11-30-2019	3.38	14.09	218.78	235.46	29.30	19.09	64.82	0.13	0.08	8,641.00
12-31-2019	2.39	14.16	164.11	240.55	26.90	19.93	68.70	0.16	0.08	8,641.00



## Daly Unit No. 13

### Pattern P-05 - 03/04-25-009-29W1/0

Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	1.52	15.79	21.62	7.99	21.77	12.16	14.21	0.94	0.51	498.10
2-28-2019	1.29	15.83	20.77	8.57	24.75	12.86	16.13	1.12	0.52	8,390.18
3-31-2019	1.39	15.87	19.47	9.17	22.87	13.57	13.97	1.10	0.54	8,571.52
4-30-2019	1.18	15.90	10.80	9.50	24.07	14.29	9.14	2.01	0.56	8,585.77
5-31-2019	0.41	15.92	2.42	9.57	19.32	14.89	5.86	6.81	0.58	8,594.90
6-30-2019	1.37	15.96	19.57	10.16	18.17	15.43	14.34	0.87	0.58	8,385.80
7-31-2019	1.17	15.99	18.38	10.73	18.61	16.01	15.70	0.95	0.59	8,594.90
8-31-2019	1.09	16.03	17.49	11.27	16.23	16.51	16.02	0.87	0.60	8,595.00
9-30-2019	0.76	16.05	14.32	11.70	14.63	16.95	18.89	0.97	0.60	8,595.00
10-31-2019	1.25	16.09	13.67	12.13	14.54	17.40	10.98	0.97	0.61	8,595.00
11-30-2019	0.75	16.11	11.87	12.48	15.13	17.86	15.79	1.20	0.62	8,595.00
12-31-2019	4.10	16.24	10.25	12.80	12.84	18.25	2.50	0.89	0.62	8,595.00

