

**Routledge Unit #1**  
**2019 Annual EOR Report**

## Executive Summary

In 2019 oil production in Routledge Unit #1 was 31 m<sup>3</sup>/d (195 bbl/d) totaling 11.3 e<sup>3</sup>m<sup>3</sup> (71.2 mbbbl). Annual production declined 41% from 2018 to 2019, based on the yearly average, a huge decline due to unexpected shut downs in Routledge Unit #1 during the year. This is using the average yearly production, however, if you use December 2018 to December 2019 the unit production declined by 5%. By the end of 2019 cumulative oil production from the Routledge Unit #1 was 2,657 e<sup>3</sup>m<sup>3</sup> (16.7 mmbbl).

In Routledge Unit #1 development began in 1955 and was developed primarily with vertical wells. The unit was largely left to primary decline with minimal water injection schemes implemented; most of the water was disposed and did not support the declining wells. Active programs of drilling horizontal wells in 2001, 2006, and 2007 revived the unit, increasing production to half the primary peak production rates. In 2014, three Scallion wells were drilled within the unit. In 2015 two wells were converted to injection and another in 2016. In 2017, two Scallion wells were drilled, as well as, one Oolite well and one Virden well. In 2018, there was no drilling activity within the unit. In 2019, two horizontal wells were drilled and three wells were converted to injection. Further development with infills and injector conversions will result in improved recovery within the unit. In December 2019, there were 32 active oil producers, six injection wells and two disposal wells.

## Discussion

With the approval for waterflooding Corex has begun to inject into the Lodgepole and continued infill drilling within the unit. Due to the surface conditions in the area most activity is required to be completed in the winter when the ground is frozen. Further injector conversions for waterflooding and pressure maintenance and continued infill drilling will help to gain incremental reserves from the unit. Considering the performance of other units in Virden secondary recovery should result in significant upside.

Significant events in 2019 are as follows:

- August 2019, convert the 102/11-32-009-25W1/00 horizontal well to injection.
- August 2019, convert the 102/02-32-009-25W1/00 horizontal well to injection.
- September 2019, convert the 102/04-22-009-25W1/00 horizontal well to injection.
- December 2019, drill the 102/12-16-009-25W1/00 horizontal well in the Oolites.
- December 2019, drill the 102/04-16-009-25W1/00 horizontal well in the Virden.

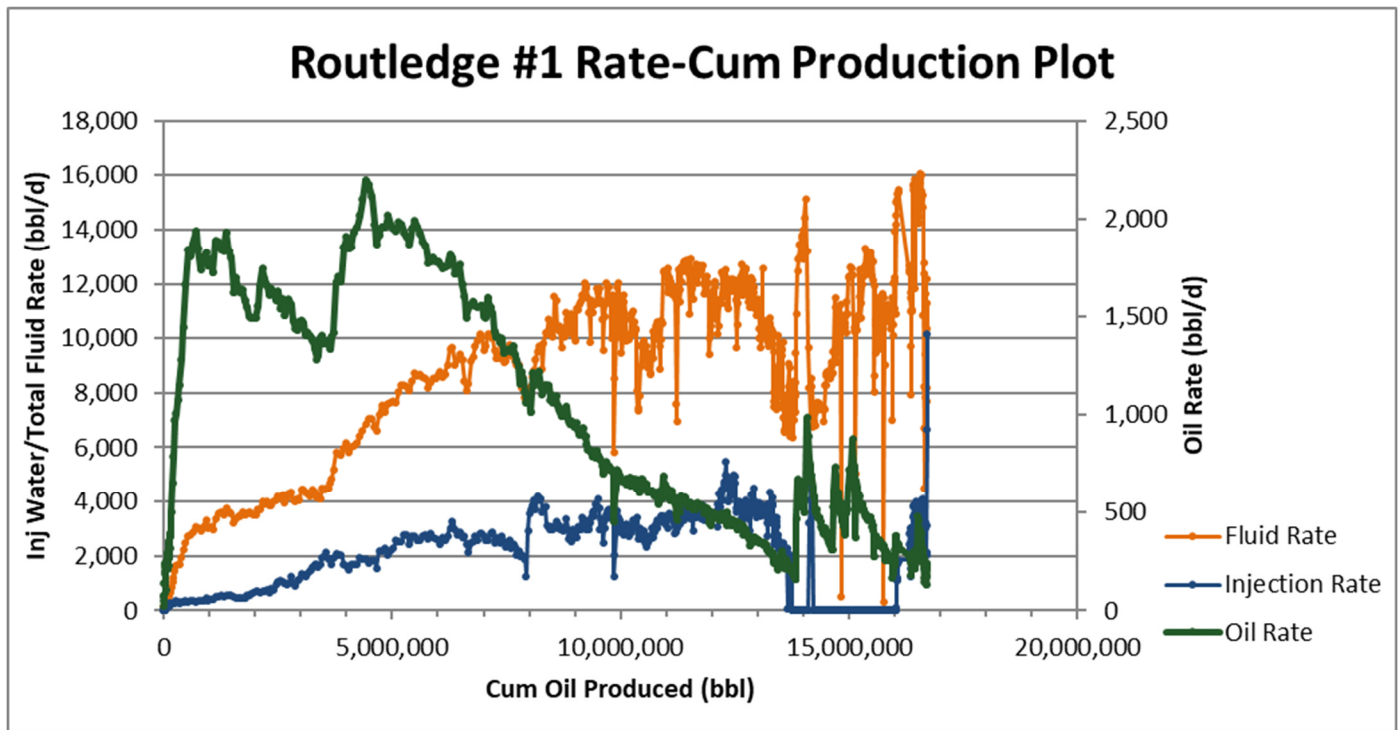
In April 2015, two Scallion horizontal wells were converted to injection (102/11-21-009-25W1/00 and 102/04-27-009-25W1/00). In 2016 another well was converted to injection, the 102/09-29-009-25W1/00 horizontal well. In 2019, an additional three wells were converted to injection. In 2019, the wells injected an average per annum rate of 592 m<sup>3</sup>/d (3,721 bbl/d) of water. Currently, all six of the designated patterns are currently injecting. In December 2019, the producing WOR for the unit was 48 m<sup>3</sup>/m<sup>3</sup>.

Water disposal in 2019 in the Routledge Unit #1 was 1,277 m<sup>3</sup>/d (8,033 bbl/d). Water was disposed into two wells (100/15-17-009-25W1/00 predominantly and 100/16-17-009-25W1/00).

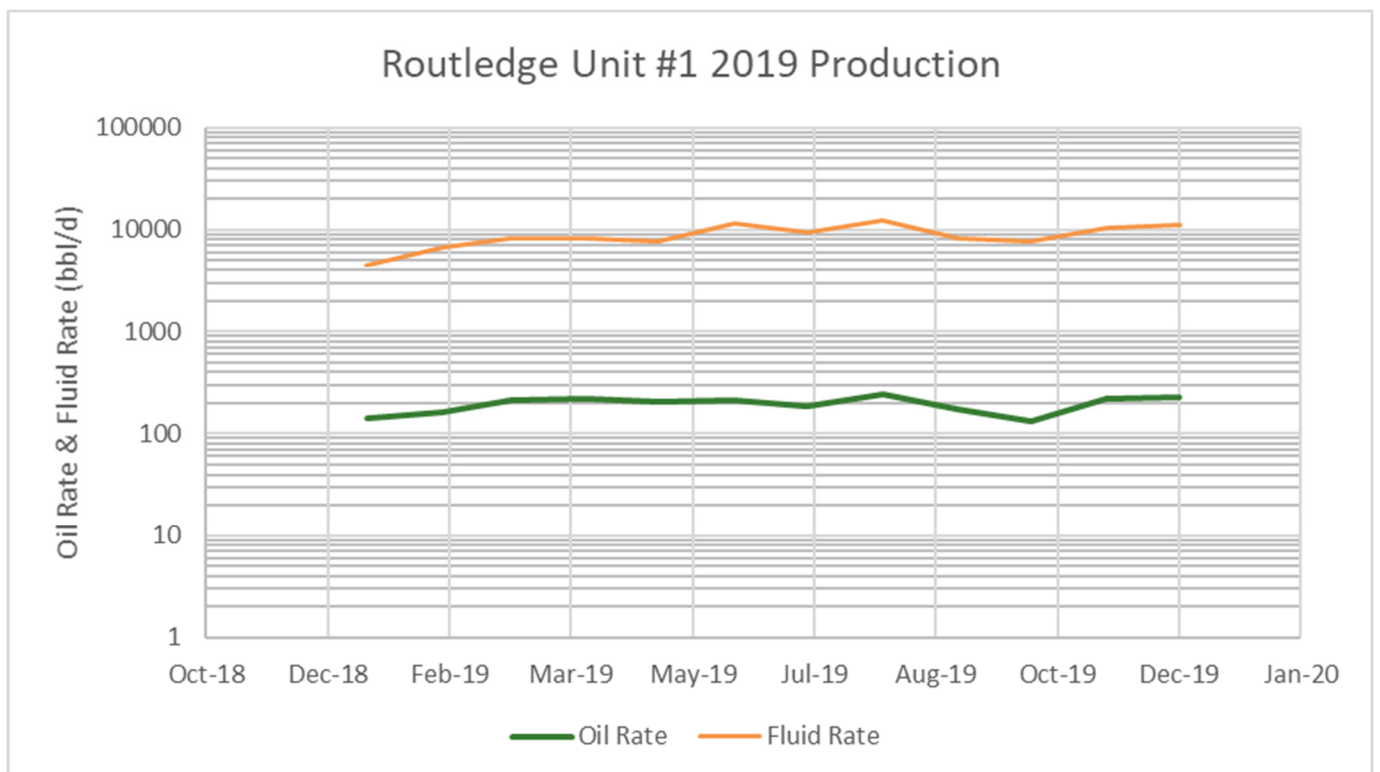
Detailed production, injection, voidage tables and plots for the total unit and each injection pattern are at the end of this report.

Below, in the composite rate – cumulative oil plot the historical unit production can be seen.

## Routledge #1 – Rate vs Cum Oil Production



## Routledge #1 – Rate vs Time



## 2019 Reservoir Pressure Surveys

Unit	UWI	License	Test Type	Date of Pressure	Duration of SI (days)	Datum BHP (kPaa)
Routledge	102/03-27-009-25W1/00	5649	AWS	2018-10-16	6	4,126
Routledge	103/12-28-009-25W1/00	10227	AWS	2018-10-16	6	4,825
Routledge	102/01-29-009-25W1/00	5773	AWS	2018-10-16	6	6,019
Routledge	102/01-32-009-25W1/00	5774	AWS	2018-10-16	6	5,425
Routledge	103/02-32-009-25W1/00	10678	AWS	2018-10-16	6	4,900
Routledge	102/13-33-009-25W1/00	6271	AWS	2018-10-16	6	3,207

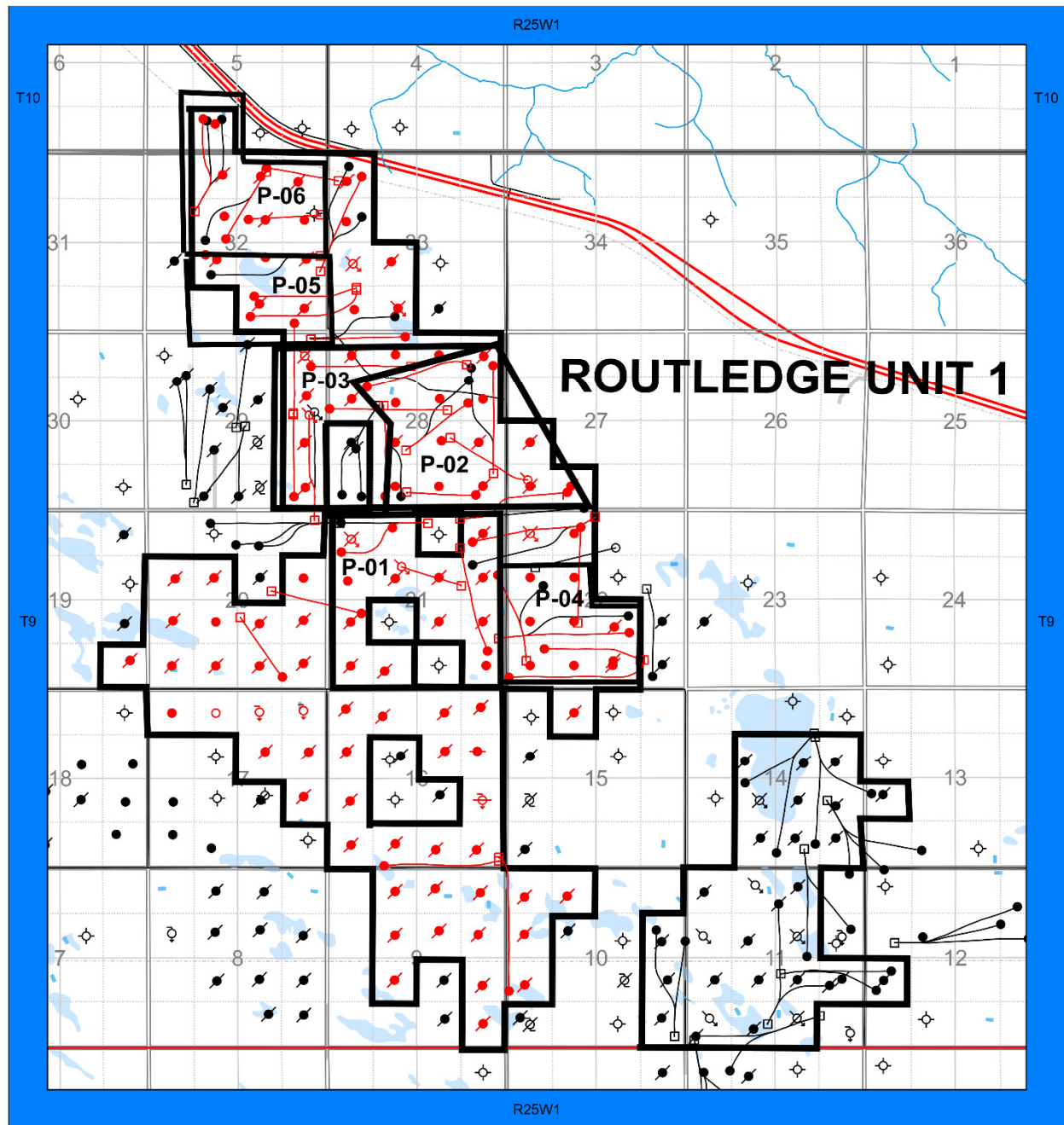
In 2019, eighteen pressures were recorded in the unit giving an average reservoir pressure of ~4,900 kPa. The pressures were taken throughout the unit, although concentrated in the lower pressure northern area of the unit, and the average pressure recorded is slightly higher than the previous year, perhaps indicating some increase due to the injection in the unit. Four pressures listed, were taken in the southern portion of the unit and are close to estimated initial reservoir pressure, and as there has been no injection in the area, this may indicate pressure support from an aquifer. In 2018, six pressures were taken giving an average reservoir pressure of 4,750 kPa. Note that the initial reservoir pressure was estimated at 6,700 kPa. The pressure data would indicate that the resulting injector conversions have helped to increase the reservoir pressure; however, the reservoir pressure in some areas is quite low and further conversions would be beneficial. It is hoped that the new conversions performed this year will improve oil recovery and increase the average reservoir pressure within the unit. Overall, the low pressures of the unit relative to the initial reservoir pressure suggest that additional water injection is needed for pressure support and to improve recovery.

In 2019 the instantaneous VRR was 1.32 and the cumulative VRR was 0.92, if you include the disposal within the unit. Excluding the focused disposal within the unit the VRR is 0.42, and the cumulative VRR would be 0.22. This indicates that there is still plenty of voidage to be replaced within the unit and further injector conversions would be beneficial. As discussed, there is partial support from an aquifer within the unit that is not taken into account within the VRR calculations.

## 2019 Well Servicing

UWI	Unit	Licence	Start Date	Operation	Objective
HEADER UPGRADE	RU#1	FF19VIR001	2019-10-17	Facilities	Header / Separator Install
102/04-16-009-25W1/00	RU#1	11232	2019-03-09	Construction	Construction
102/04-16-009-25W1/00	RU#1	11232	2019-12-06	Drilling	Drilling - original
102/04-16-009-25W1/00	RU#1	11232	2019-12-10	Completion/Workover	Initial Completion
102/12-16-009-25W1/00	RU#1	11233	2019-07-04	Facilities	Equip & Tie-In
102/12-16-009-25W1/00	RU#1	11233	2019-12-01	Drilling	Drilling - original
102/12-16-009-25W1/00	RU#1	11233	2019-12-10	Completion/Workover	Initial Completion
HEADER ABANDONMENT - 16-16-09-25	RU#1	RE19VIR007	2019-08-01	Facilities	Reclamation
102/03-16-009-25W1/00	RU#1	10771	2019-12-08	Completion/Workover	Downsize Pump
102/03-27-009-25W1/00	RU#1	005649	2019-05-28	Completion/Workover	Pump Repair
EMULSION LINE REPLACEMENT	RU#1	P18VIR006	2019-08-20	Facilities	Pipeline / Flowline Replacement
BATTERY UPGRADE - F19VIR001	RU#1	F19VIR001	2019-05-29	Facilities	Battery Upgrade
TURNAROUND	RU#1	T19VIR005	2019-09-23	Facilities	Turnaround
EMULSION PIPELINE	RU#1	P19VIR010	2019-07-03	Facilities	Pipeline / Flowline Replacement
DEAD LEG REMOVAL	RU#1	RM19VIR010	2019-08-27	Facilities	Dead Leg Removal
EMULSION PIPELINE	RU#1	P19VIR009	2019-06-26	Facilities	Pipeline / Flowline Replacement
EMULSION PIPELINE	RU#1	P19VIR011	2019-06-25	Facilities	Pipeline / Flowline Replacement
REMOVE VENT STACK	RU#1	RM18VIR022	2019-02-15	Facilities	Major Surface R&M
102/16-28-009-25W1/00	RU#1	6446	2019-12-05	Completion/Workover	Pump Repair
102/11-32-009-25W1/00	RU#1	6267	2019-08-17	Completion/Workover	Injection Conversion
102/09-28-009-25W1/00	RU#1	005004	2019-08-20	Completion/Workover	Pump Repair

# Waterflood Pattern Map



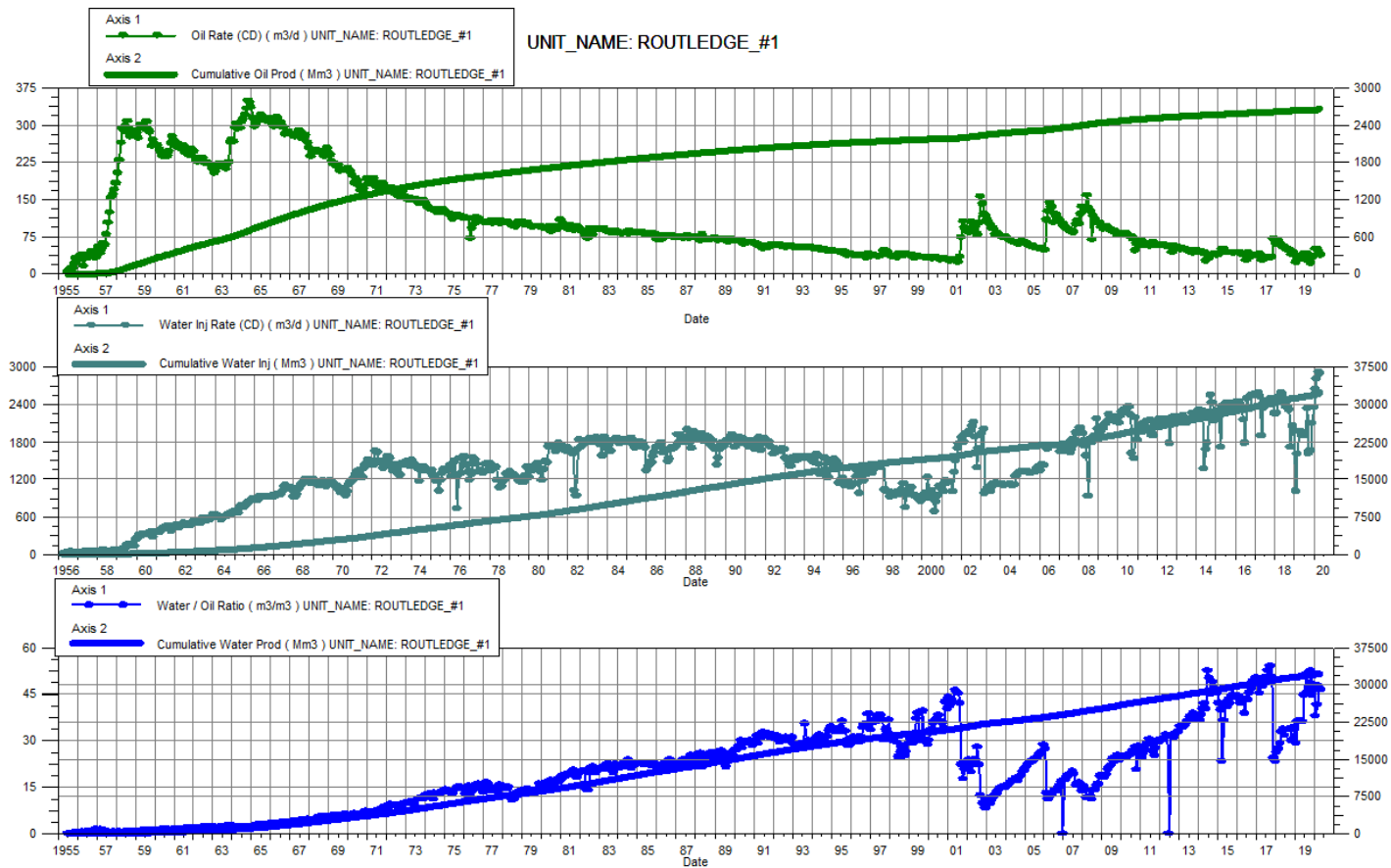
## Waterflood Pattern Table

Pattern	Well
P-01	102/11-21-009-25W1/00
P-02	102/04-27-009-25W1/00
P-03	102/09-29-009-25W1/00
P-04	102/04-22-009-25W1/00
P-05	102/02-32-009-25W1/00
P-06	102/11-32-009-25W1/00



# Total for Routledge Unit #1

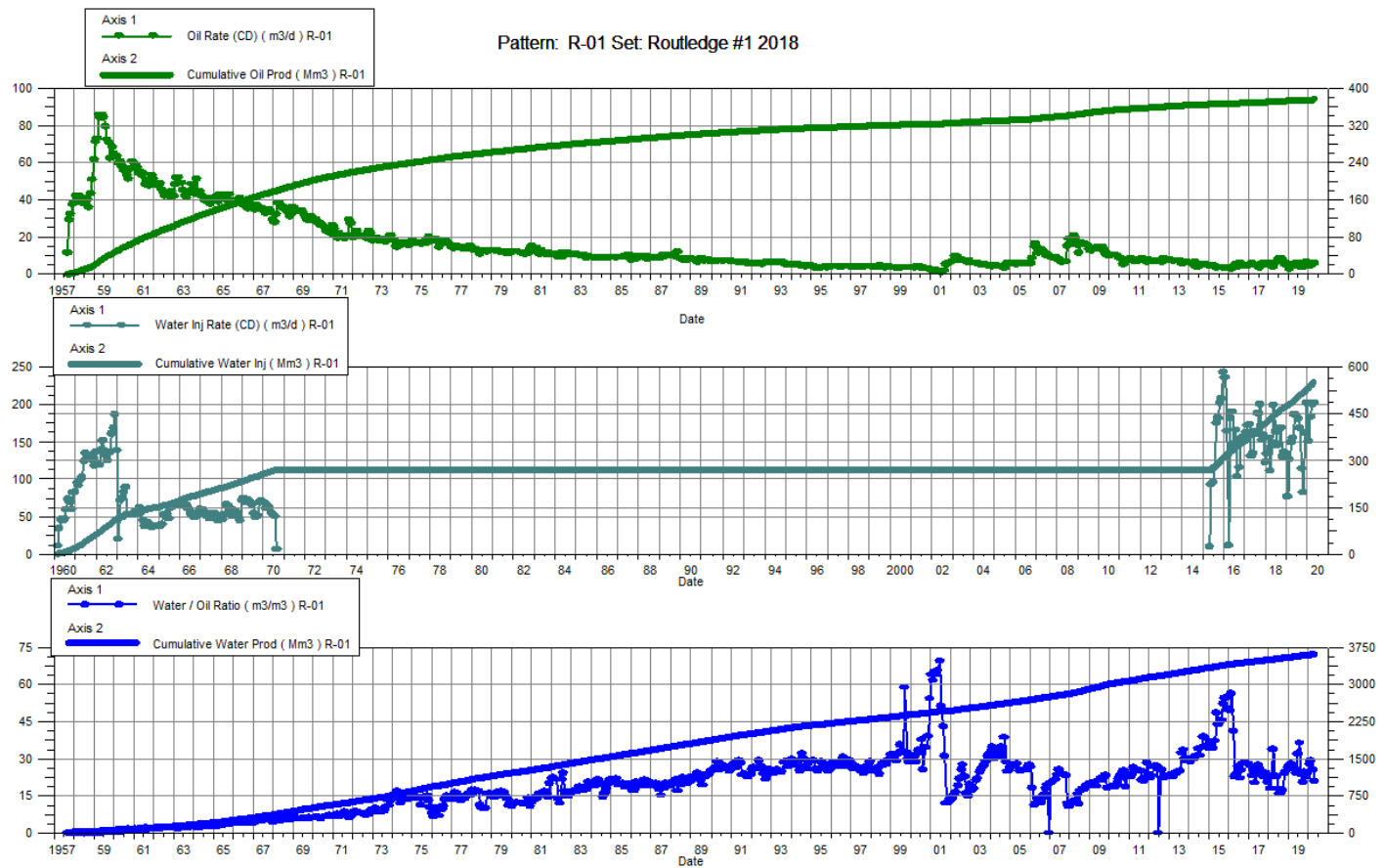
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPa
1-31-2019	23.81	2641.91	689.89	31518.35	1010.65	31410.69	28.98	1.42	0.92	2,981.66
2-28-2019	28.54	2642.71	1035.29	31547.34	1607.30	31455.70	36.27	1.51	0.92	3,437.34
3-31-2019	35.03	2643.80	1271.88	31586.76	1972.96	31516.86	36.31	1.51	0.92	4,451.20
4-30-2019	34.72	2644.84	1257.20	31624.48	1969.70	31575.95	36.21	1.52	0.92	4,439.87
5-31-2019	33.62	2645.88	1211.75	31662.05	1908.66	31635.12	36.05	1.53	0.92	4,128.72
6-30-2019	40.51	2647.10	1810.59	31716.36	1903.55	31692.22	44.69	1.03	0.92	3,580.09
7-31-2019	28.65	2647.99	1465.36	31761.79	1919.22	31751.72	51.14	1.28	0.92	4,502.96
8-31-2019	41.83	2649.28	1896.81	31820.59	2342.33	31824.33	45.35	1.21	0.92	4,979.79
9-30-2019	27.86	2650.12	1274.67	31858.83	1619.94	31872.93	45.75	1.24	0.92	4,952.46
10-31-2019	22.84	2650.83	1199.76	31896.02	1669.13	31924.67	52.52	1.37	0.92	3,300.68
11-30-2019	36.07	2651.91	1609.63	31944.31	2109.27	31987.95	44.62	1.28	0.92	5,922.08
12-31-2019	36.67	2653.05	1755.93	31998.75	2358.75	32061.07	47.88	1.32	0.92	6,156.61



# Routledge Unit No. 1

## Pattern P-01 - 02/11-21-009-25W1/00

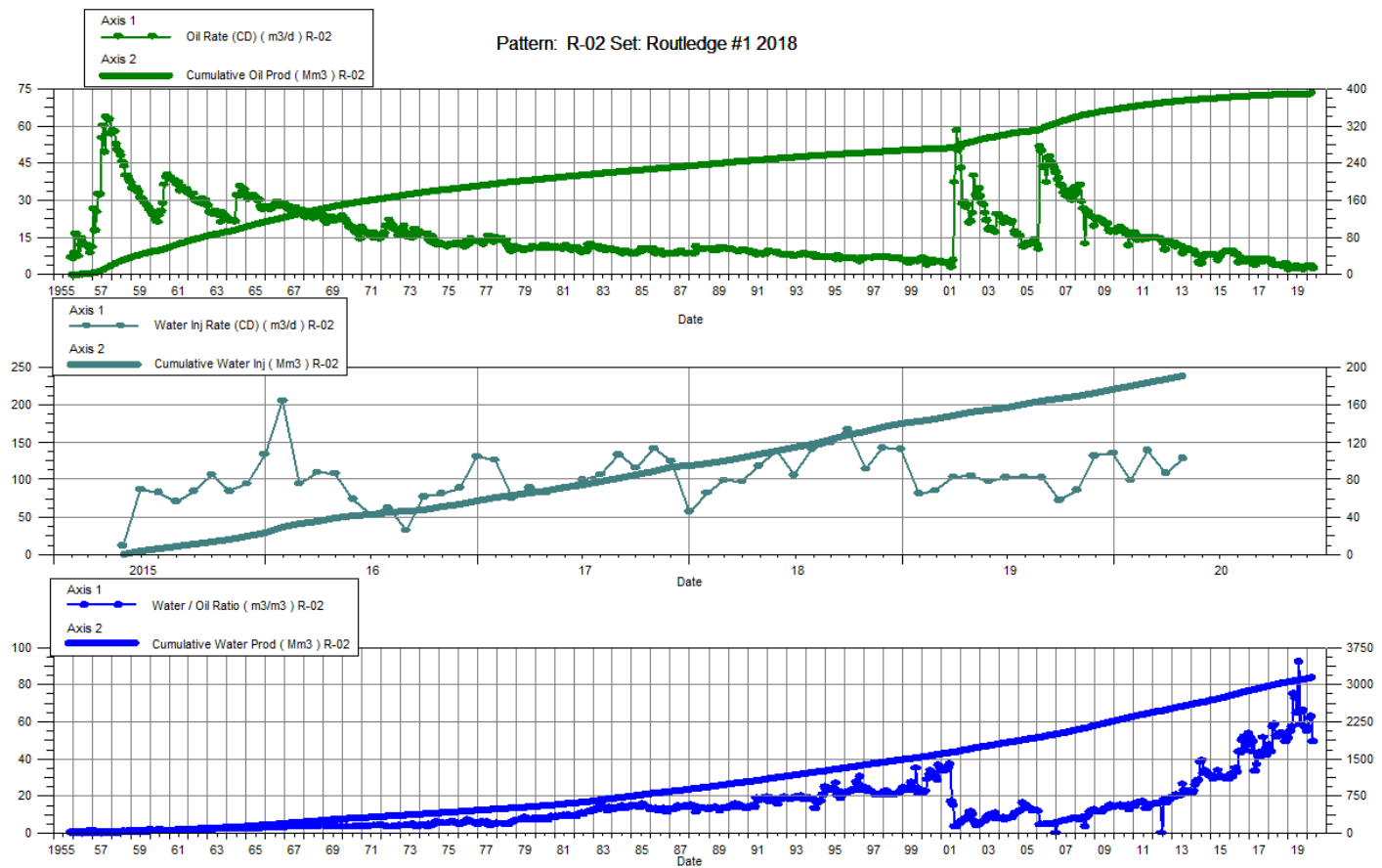
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	2.96	374.01	76.50	3540.20	77.04	478.59	25.83	0.97	0.12	2,685.71
2-28-2019	4.22	374.13	117.87	3543.50	126.51	482.13	27.93	1.04	0.12	3,673.58
3-31-2019	5.79	374.31	149.76	3548.15	149.53	486.76	25.86	0.96	0.12	5,225.08
4-30-2019	5.88	374.49	150.92	3552.67	155.51	491.43	25.66	0.99	0.13	5,237.19
5-31-2019	6.13	374.68	148.15	3557.27	187.20	497.23	24.15	1.21	0.13	5,061.95
6-30-2019	5.35	374.84	170.60	3562.38	184.98	502.78	31.90	1.05	0.13	5,118.26
7-31-2019	4.24	374.97	153.83	3567.15	180.86	508.39	36.26	1.14	0.13	4,974.62
8-31-2019	6.10	375.16	145.02	3571.65	168.47	513.61	23.78	1.11	0.13	4,991.61
9-30-2019	4.86	375.30	99.06	3574.62	114.57	517.05	20.40	1.10	0.13	-
10-31-2019	4.13	375.43	101.87	3577.78	82.36	519.60	24.66	0.78	0.13	4,865.36
11-30-2019	6.71	375.63	152.62	3582.36	162.84	524.49	22.74	1.02	0.13	5,675.77
12-31-2019	5.85	375.81	140.69	3586.72	202.39	530.76	24.06	1.38	0.13	5,884.65



# Routledge Unit No. 1

## Pattern P-02 - 02/04-27-009-25W1/00

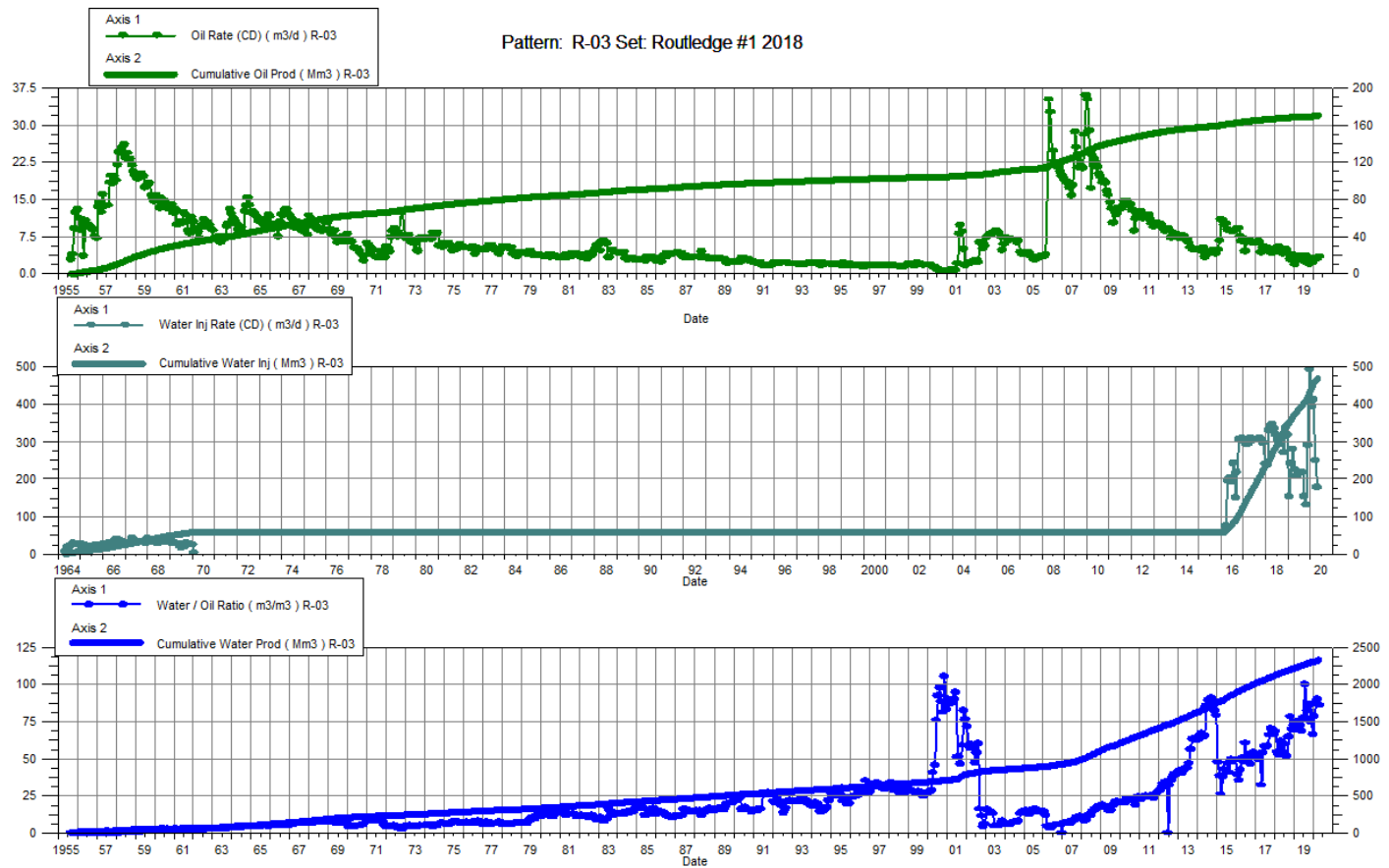
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	2.23	389.63	113.25	3050.48	81.05	143.23	50.73	0.70	0.04	3,196.33
2-28-2019	3.18	389.72	174.67	3055.37	85.12	145.62	54.86	0.48	0.04	2,831.17
3-31-2019	3.49	389.83	200.27	3061.58	103.35	148.82	57.43	0.51	0.04	3,014.20
4-30-2019	2.42	389.90	181.37	3067.02	104.84	151.97	74.89	0.57	0.04	2,967.87
5-31-2019	2.50	389.98	181.47	3072.64	97.18	154.98	72.63	0.53	0.05	2,358.47
6-30-2019	3.85	390.10	248.27	3080.09	102.90	158.07	64.57	0.41	0.05	866.27
7-31-2019	2.70	390.18	247.93	3087.78	103.47	161.27	91.99	0.41	0.05	3,599.65
8-31-2019	3.37	390.28	197.53	3093.90	102.90	164.46	58.57	0.51	0.05	4,958.17
9-30-2019	2.88	390.37	187.28	3099.52	72.57	166.64	65.14	0.38	0.05	4,956.55
10-31-2019	2.30	390.44	151.77	3104.22	85.67	169.30	66.13	0.56	0.05	4,956.46
11-30-2019	2.83	390.53	161.21	3109.06	132.24	173.26	56.97	0.81	0.05	5,937.32
12-31-2019	3.41	390.63	185.44	3114.81	135.39	177.46	54.44	0.72	0.05	6,151.28



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## Pattern P-03 - 02/09-29-009-25W1/00

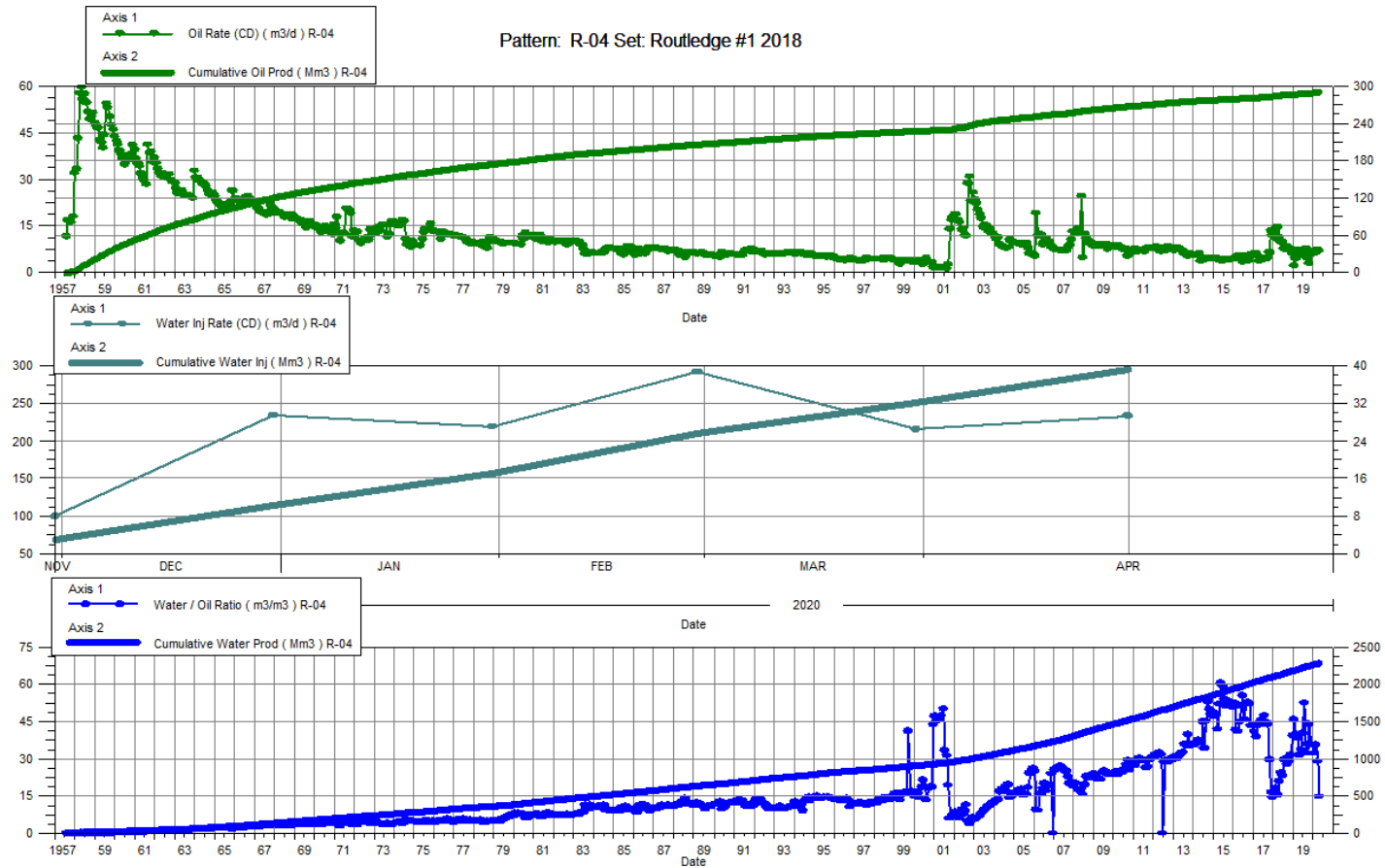
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	1.94	168.76	133.81	2215.33	154.50	352.10	69.13	1.14	0.15	3,062.95
2-28-2019	2.81	168.84	209.55	2221.19	241.69	358.87	74.48	1.14	0.15	3,807.28
3-31-2019	3.80	168.95	262.81	2229.34	280.11	367.55	69.15	1.05	0.15	5,114.32
4-30-2019	3.70	169.06	266.05	2237.32	225.99	374.33	71.82	0.84	0.16	5,114.54
5-31-2019	3.62	169.18	248.61	2245.03	207.45	380.76	68.69	0.82	0.16	4,965.72
6-30-2019	3.59	169.28	275.46	2253.29	214.25	387.19	76.84	0.77	0.16	4,755.75
7-31-2019	2.40	169.36	239.78	2260.73	217.61	393.94	99.98	0.90	0.16	4,934.60
8-31-2019	3.75	169.47	289.03	2269.69	218.13	400.70	77.16	0.75	0.16	4,989.60
9-30-2019	2.44	169.55	199.91	2275.68	153.78	405.31	81.82	0.76	0.17	4,948.37
10-31-2019	2.05	169.61	175.95	2281.14	131.30	409.38	85.96	0.74	0.17	4,934.48
11-30-2019	2.92	169.70	218.31	2287.69	290.99	418.11	74.78	1.32	0.17	6,023.28
12-31-2019	2.39	169.77	158.25	2292.59	494.84	433.45	66.30	3.08	0.18	6,253.21



# Routledge Unit No. 1

## Pattern P-04 - 02/04-22-009-25W1/00

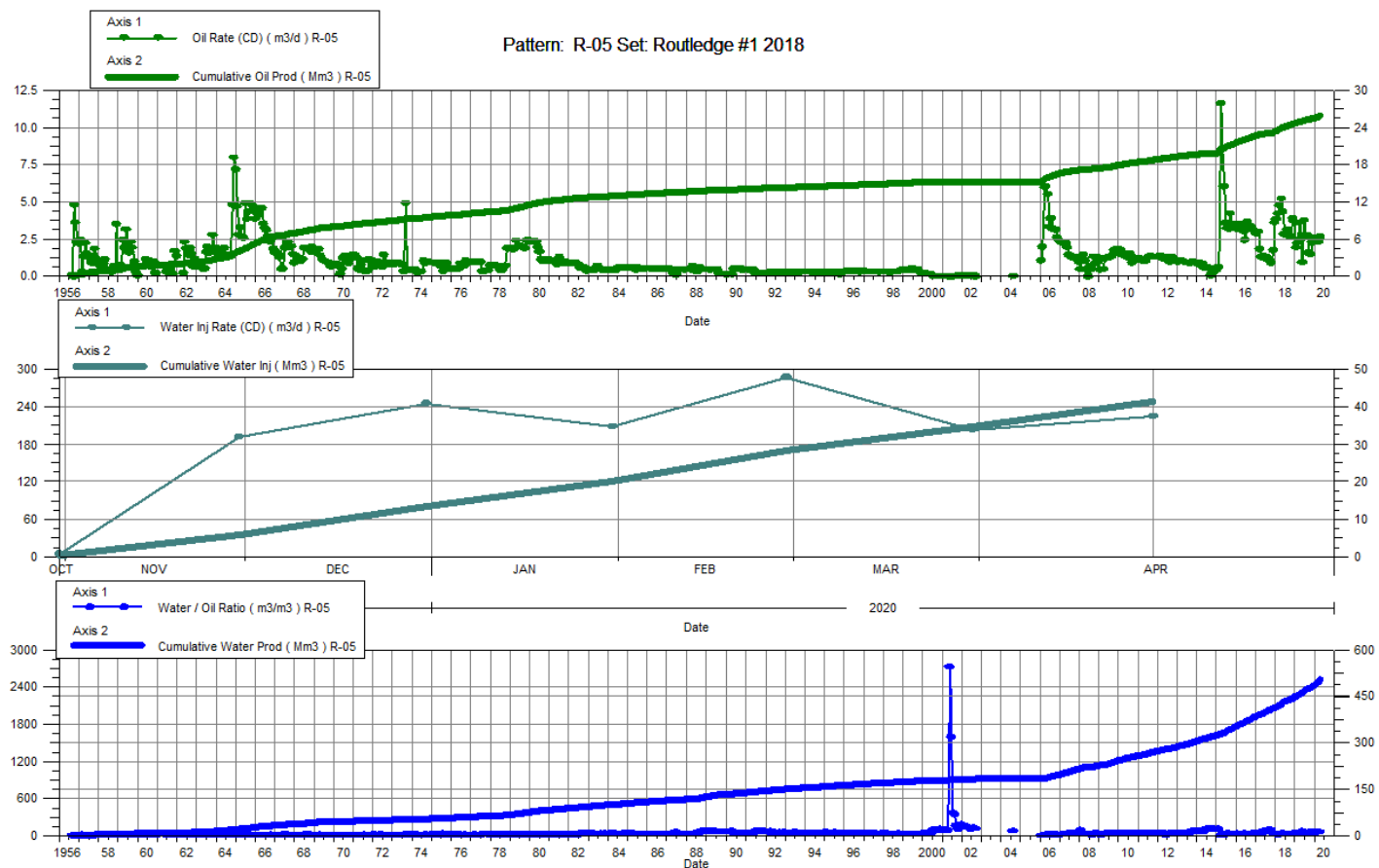
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1-31-2019	2.40	287.40	109.75	2179.18		0.00	45.67		0.00	-
2-28-2019	4.72	287.53	183.26	2184.32		0.00	38.80		0.00	-
3-31-2019	5.89	287.71	225.26	2191.30		0.00	38.24		0.00	-
4-30-2019	7.44	287.93	234.31	2198.33		0.00	31.49		0.00	-
5-31-2019	7.01	288.15	235.77	2205.64		0.00	33.64		0.00	-
6-30-2019	6.19	288.34	249.43	2213.12		0.00	40.29		0.00	-
7-31-2019	5.51	288.51	288.50	2222.06		0.00	52.40		0.00	-
8-31-2019	7.62	288.74	272.40	2230.51		0.00	35.74		0.00	-
9-30-2019	4.48	288.88	144.61	2234.85		0.00	32.27		0.00	-
10-31-2019	3.04	288.97	133.25	2238.98		0.00	43.79		0.00	-
11-30-2019	6.00	289.15	213.62	2245.39	99.70	2.99	35.58	0.45	0.00	5,901.92
12-31-2019	6.12	289.34	216.21	2252.09	234.87	10.27	35.33	1.06	0.00	6,117.18



# Routledge Unit No. 1

## Pattern P-05 - 02/02-32-009-25W1/00

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	1.93	24.76	64.83	448.69		0.00	33.64		0.00	-
2-28-2019	2.26	24.82	89.59	451.20		0.00	39.68		0.00	-
3-31-2019	3.63	24.94	126.77	455.13		0.00	34.91		0.00	-
4-30-2019	2.50	25.01	107.01	458.34		0.00	42.82		0.00	-
5-31-2019	0.94	25.04	67.71	460.43		0.00	72.38		0.00	-
6-30-2019	3.76	25.15	142.72	464.72		0.00	37.96		0.00	-
7-31-2019	2.77	25.24	151.13	469.40		0.00	54.48		0.00	-
8-31-2019	2.75	25.33	118.31	473.07		0.00	43.09		0.00	-
9-30-2019	1.63	25.37	74.46	475.30		0.00	45.68		0.00	-
10-31-2019	1.50	25.42	85.14	477.94	3.87	0.12	56.76	0.05	0.00	1,183.03
11-30-2019	2.27	25.49	108.77	481.21	191.97	5.88	47.90	1.73	0.01	5,911.12
12-31-2019	2.51	25.57	125.06	485.08	246.26	13.51	49.77	1.93	0.03	6,090.28



# Routledge Unit No. 1

## Pattern P-06 - 02/11-32-009-25W1/00

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	0.84	148.16	66.92	1990.91		0.00	79.33		0.00	-
2-28-2019	1.24	148.19	105.55	1993.87		0.00	84.80		0.00	-
3-31-2019	1.65	148.24	131.19	1997.93		0.00	79.28		0.00	-
4-30-2019	1.58	148.29	131.85	2001.89		0.00	83.72		0.00	-
5-31-2019	1.58	148.34	129.64	2005.91		0.00	82.10		0.00	-
6-30-2019	1.88	148.40	168.70	2010.97		0.00	89.57		0.00	-
7-31-2019	1.45	148.44	180.51	2016.56		0.00	124.35		0.00	-
8-31-2019	1.96	148.50	168.06	2021.77		0.00	85.69		0.00	-
9-30-2019	0.99	148.53	80.36	2024.19		0.00	81.31		0.00	-
10-31-2019	0.63	148.55	57.26	2025.96	10.48	0.33	90.56	0.18	0.00	564.08
11-30-2019	0.86	148.58	66.99	2027.97	195.23	6.18	78.20	2.88	0.00	6,083.06
12-31-2019	1.09	148.61	84.70	2030.60	270.97	14.58	77.45	3.16	0.01	6,443.08

