

**Routledge Unit #1**  
**2016 Annual EOR Report**

## **Executive Summary**

In 2016 oil production in the Routledge Unit #1 was 39.2 m<sup>3</sup>/d (247 bbl/d) totaling 14.3 e<sup>3</sup>m<sup>3</sup> (90.03 mmbbl). Annual production declined 12.7% from 2015 to 2016. By the end of 2016 cumulative oil production from the Routledge Unit #1 was 2 609 e<sup>3</sup>m<sup>3</sup> (16.4 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. Further development with infills and injector conversions will result in improved recovery within the unit. In December 2016, there were 46 active oil producers, three 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 2016 are as follows:

- March 2016, converted the 102/09-29-009-25W1/00 horizontal well to injection.
- March 2016, abandoned the 100/10-21-009-25W1/00 vertical well.

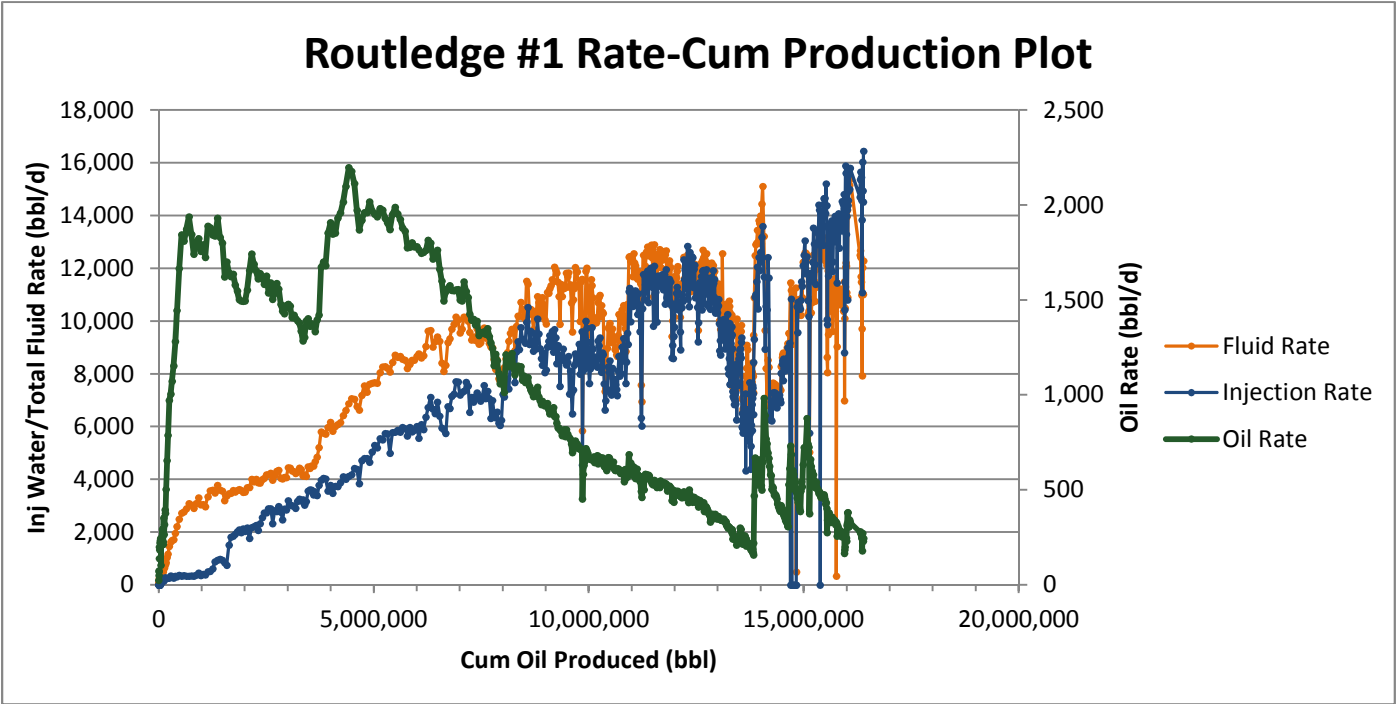
In April 2015, two Scallion horizontal wells were converted to injection (102/11-21-009-25W1/00 and 102/04-27-009-25W1/00). In 2016 another well was converted to injection, the 102/09-29-009-25W1/00 horizontal well. In 2016, the wells injected a total volume of  $155.6 \times 10^3 \text{ m}^3$  (978.3 mbbbl) of water, at an average per annum rate of  $426.2 \text{ m}^3/\text{d}$  (2,680 bbl/d) of water. The average producing WOR for the unit was 45 m<sup>3</sup>/m<sup>3</sup>.

Water disposal in 2016 in the Routledge Unit #1 was  $1,953 \text{ m}^3/\text{d}$  (12,280 bbl/d), totaling  $713 \times 10^3 \text{ m}^3$  (4,482 mbbbl). Water was disposed into two wells (100/15-17-009-25W1/00 predominantly and 100/16-17-009-25W1/00).

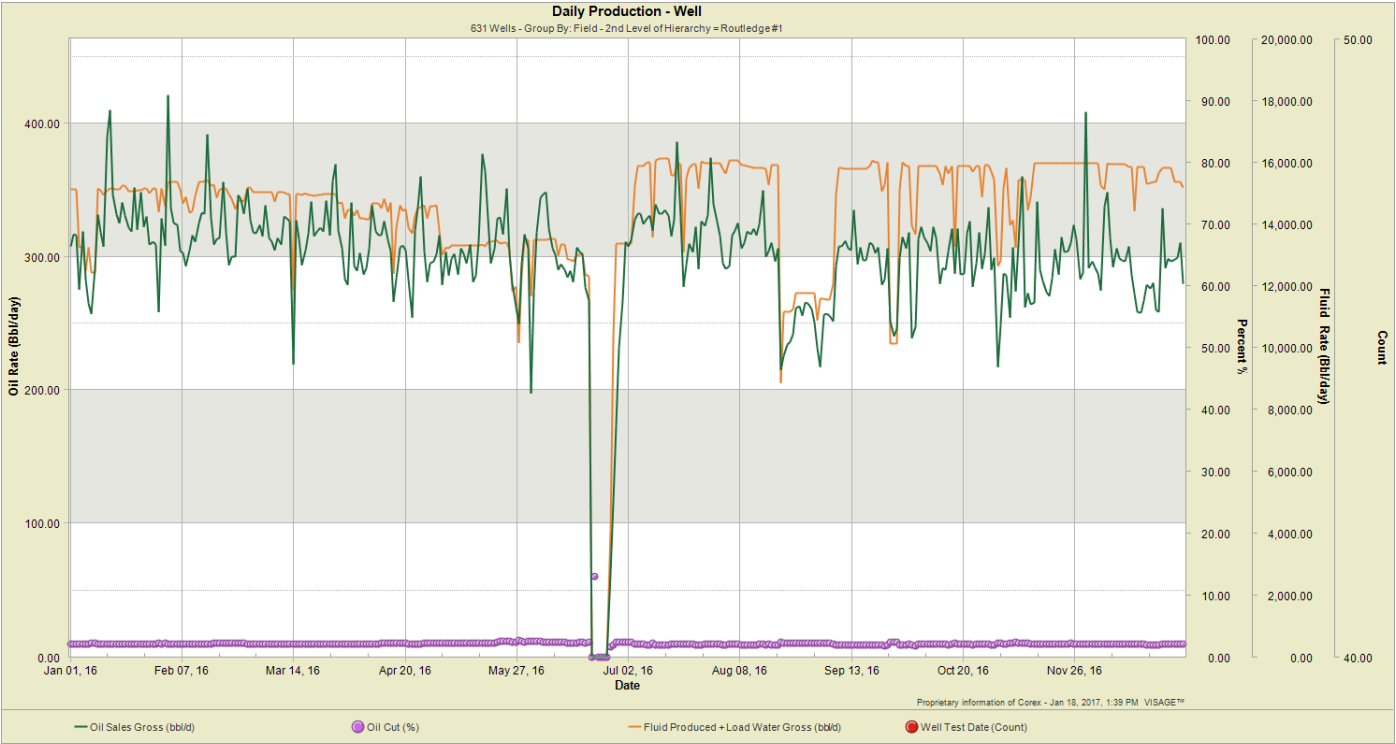
Detailed production, injection, voidage tables and plots for the total unit and each injection pattern are at the end of this report.

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



## 2016 Reservoir Pressure Surveys

Unit	UWI	License	Test Type	Date of Pressure	Datum BHP (kPaa)
Routledge	100/13-17-009-25W1/00	1572	FL Shot	6/23/2016	5,071
Routledge	100/14-17-009-25W1/00	1623	FL Shot	6/23/2016	5,603
Routledge	100/01-20-009-25W1/00	1646	FL Shot	6/23/2016	7,560
Routledge	102/01-20-009-25W1/00	4731	FL Shot	6/23/2016	7,375
Routledge	100/06-20-009-25W1/00	1636	FL Shot	6/23/2016	7,477
Routledge	100/09-20-009-25W1/00	1705	FL Shot	6/23/2016	6,077
Routledge	100/15-20-009-25W1/00	6543	FL Shot	6/23/2016	6,985
Routledge	102/01-21-009-25W1/00	5701	FL Shot	6/27/2016	5,252
Routledge	100/01-21-009-25W1/00	1559	FL Shot	6/27/2016	4,995
Routledge	102/09-21-009-25W1/00	5010	FL Shot	6/27/2016	3,958
Routledge	102/11-21-009-25W1/00	5048	FL Shot	6/27/2016	6,800
Routledge	100/14-21-009-25W1/00	1673	FL Shot	6/23/2016	6,168
Routledge	102/16-21-009-25W1/00	6432	FL Shot	6/27/2016	3,789
Routledge	100/03-22-009-25W1/00	1621	FL Shot	6/27/2016	4,166
Routledge	100/04-22-009-25W1/00	1622	FL Shot	6/27/2016	3,437
Routledge	102/04-22-009-25W1/00	5681	FL Shot	6/27/2016	3,677
Routledge	100/05-22-009-25W1/00	1569	FL Shot	6/27/2016	3,529
Routledge	100/06-22-009-25W1/00	1570	FL Shot	6/27/2016	1,066
Routledge	102/07-22-009-25W1/00	6445	FL Shot	6/27/2016	3,923
Routledge	100/11-22-009-25W1/00	1520	FL Shot	6/27/2016	2,015
Routledge	100/12-22-009-25W1/00	1515	FL Shot	6/27/2016	3,410
Routledge	100/14-22-009-25W1/00	1528	FL Shot	6/27/2016	3,681
Routledge	102/14-22-009-25W1/00	5103	FL Shot	6/27/2016	3,562
Routledge	102/03-27-009-25W1/00	5649	FL Shot	6/27/2016	3,883
Routledge	102/04-27-009-25W1/00	4999	FL Shot	6/27/2016	5,379
Routledge	100/01-28-009-25W1/00	1445	FL Shot	6/27/2016	5,613
Routledge	102/01-28-009-25W1/00	5097	FL Shot	6/27/2016	4,696

Unit	UWI	License	Test Type	Date of Pressure	Datum BHP (kPaa)
Routledge	100/02-28-009-25W1/00	1358	FL Shot	6/27/2016	4,535
Routledge	102/03-28-009-25W1/00	6258	FL Shot	6/23/2016	5,502
Routledge	100/03-28-009-25W1/00	1365	FL Shot	6/23/2016	5,170
Routledge	100/04-28-009-25W1/00	6292	FL Shot	6/23/2016	6,657
Routledge	100/07-28-009-25W1/00	1339	FL Shot	6/23/2016	6,306
Routledge	102/09-28-009-25W1/00	5004	FL Shot	6/23/2016	3,780
Routledge	100/09-28-009-25W1/00	1557	FL Shot	6/23/2016	3,216
Routledge	103/12-28-009-25W1/00	10227	FL Shot	6/23/2016	4,376
Routledge	102/12-28-009-25W1/00	5104	FL Shot	6/23/2016	3,600
Routledge	102/14-28-009-25W1/00	5772	FL Shot	6/27/2016	4,066
Routledge	100/14-28-009-25W1/00	888	FL Shot	6/27/2016	3,742
Routledge	100/15-28-009-25W1/00	985	FL Shot	6/27/2016	2,800
Routledge	102/16-28-009-25W1/00	6446	FL Shot	6/23/2016	2,921
Routledge	102/01-29-009-25W1/00	5773	FL Shot	6/23/2016	6,138
Routledge	102/09-29-009-25W1/00	6542	FL Shot	6/23/2016	7,123
Routledge	102/16-29-009-25W1/00	10226	FL Shot	6/23/2016	4,301
Routledge	102/01-32-009-25W1/00	5774	FL Shot	6/23/2016	5,316
Routledge	102/02-32-009-25W1/00	10316	FL Shot	6/23/2016	4,205
Routledge	102/06-32-009-25W1/00	5650	FL Shot	6/23/2016	3,998
Routledge	100/09-32-009-25W1/00	1896	FL Shot	6/23/2016	3,177
Routledge	102/10-32-009-25W1/00	5049	FL Shot	6/23/2016	2,435
Routledge	102/11-32-009-25W1/00	6267	FL Shot	6/23/2016	2,270
Routledge	100/11-32-009-25W1/00	1938	FL Shot	6/27/2016	1,534
Routledge	102/15-32-009-25W1/00	5096	FL Shot	6/23/2016	2,270
Routledge	100/03-33-009-25W1/00	807	FL Shot	6/27/2016	3,272
Routledge	100/12-33-009-25W1/00	2091	FL Shot	6/27/2016	1,544
Routledge	102/13-33-009-25W1/00	6271	FL Shot	6/23/2016	2,809
Routledge	102/03-05-010-25W1/00	6561	FL Shot	6/23/2016	1,862

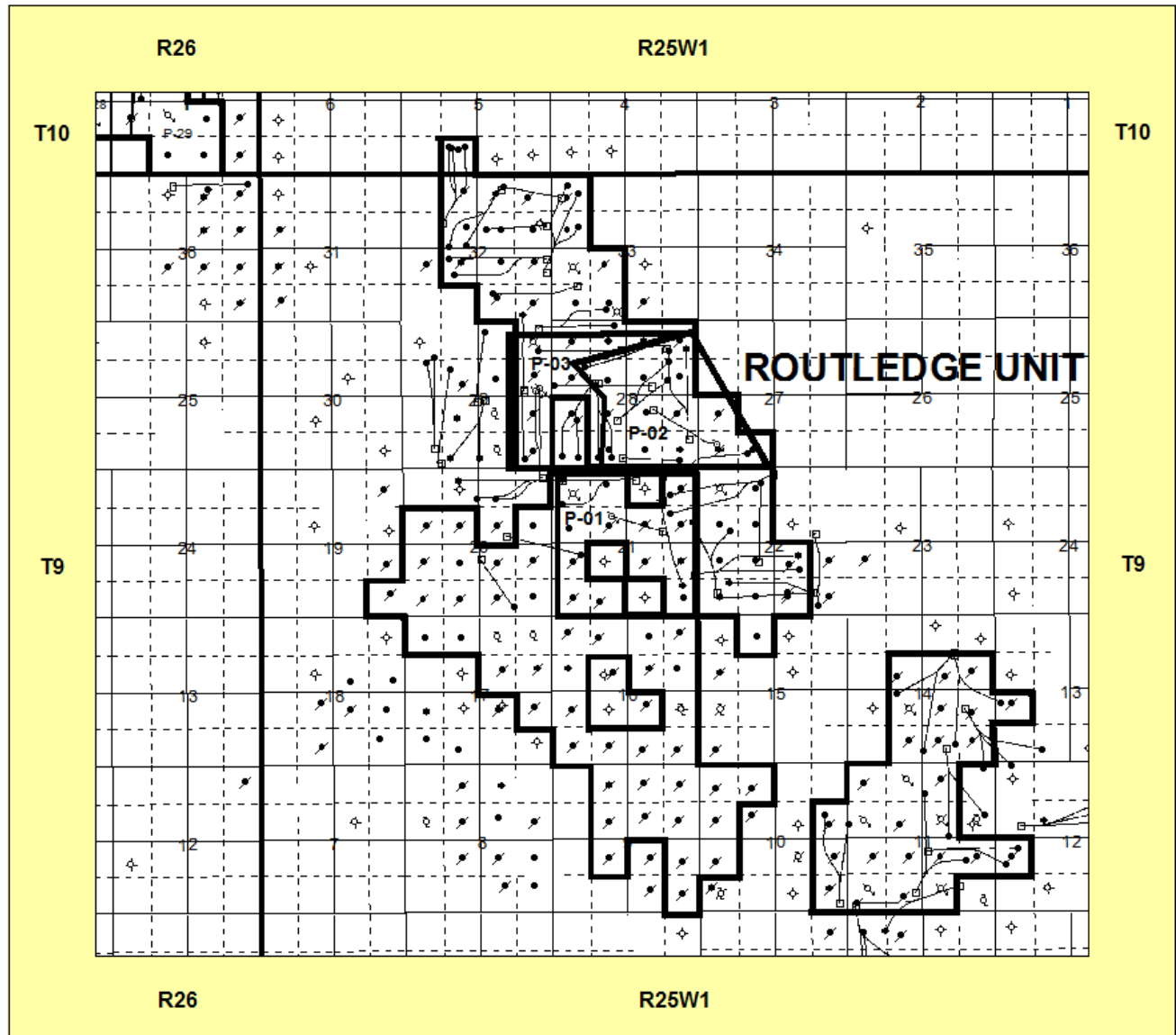
Pressure measurements were taken in 2016 throughout the whole unit during a turnaround. Across the unit the average reservoir pressure is 4,300 kPa. Note that the initial reservoir pressure was estimated at 6,700 kPa. Pressure is lower than the initial reservoir pressure and higher than the pressure data recorded in 2014 (ranging between 1,057 kPa to 6,869 kPa, with an average of 3,842 kPa). The pressure data would indicate that implementing the 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. 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.

## 2016 Well Servicing

UWI	Unit	Licence	Operation	Date	Objective
REPLACE WATER INJ PUMP	RU#1	RM16VIR018	Major Surface R&M	1-Sep-16	
100/16-17-009-25W1/00	RU#1	001635	Cathodic	28-Sep-16	
HEADER REPAIR	RU#1	FF16VIR005	Header Repair	14-Jun-16	
102/09-29-009-25W1/00	RU#1	6542	Injection Conversion	5-Mar-16	
102/09-29-009-25W1/00	RU#1	6542	Injection - Pipeline	8-Mar-16	
102/03-05-010-25W1/00	RU#1	6561	Pump Repair	28-Apr-16	
100/05-22-009-25W1/00	RU#1	001569	Major Surface R&M	15-Aug-16	
INSTALL WATCHDOG	RU#1	FF16VIR013	Watchdog Install	12-Dec-16	
102/16-21-009-25W1/00	RU#1	6432	Pump Repair	8-Apr-16	
100/10-21-009-25W1/00	RU#1	001688	Inhibitor Squeeze	3-Feb-16	
100/10-21-009-25W1/00	RU#1	001688	Abandon Well	21-Mar-16	
100/13-17-009-25W1/00	RU#1	001572	Pump Repair	17-Jun-16	
TURNAROUND	RU#1	T16VIR006	Turnaround	13-Jun-16	



# Waterflood Pattern Map

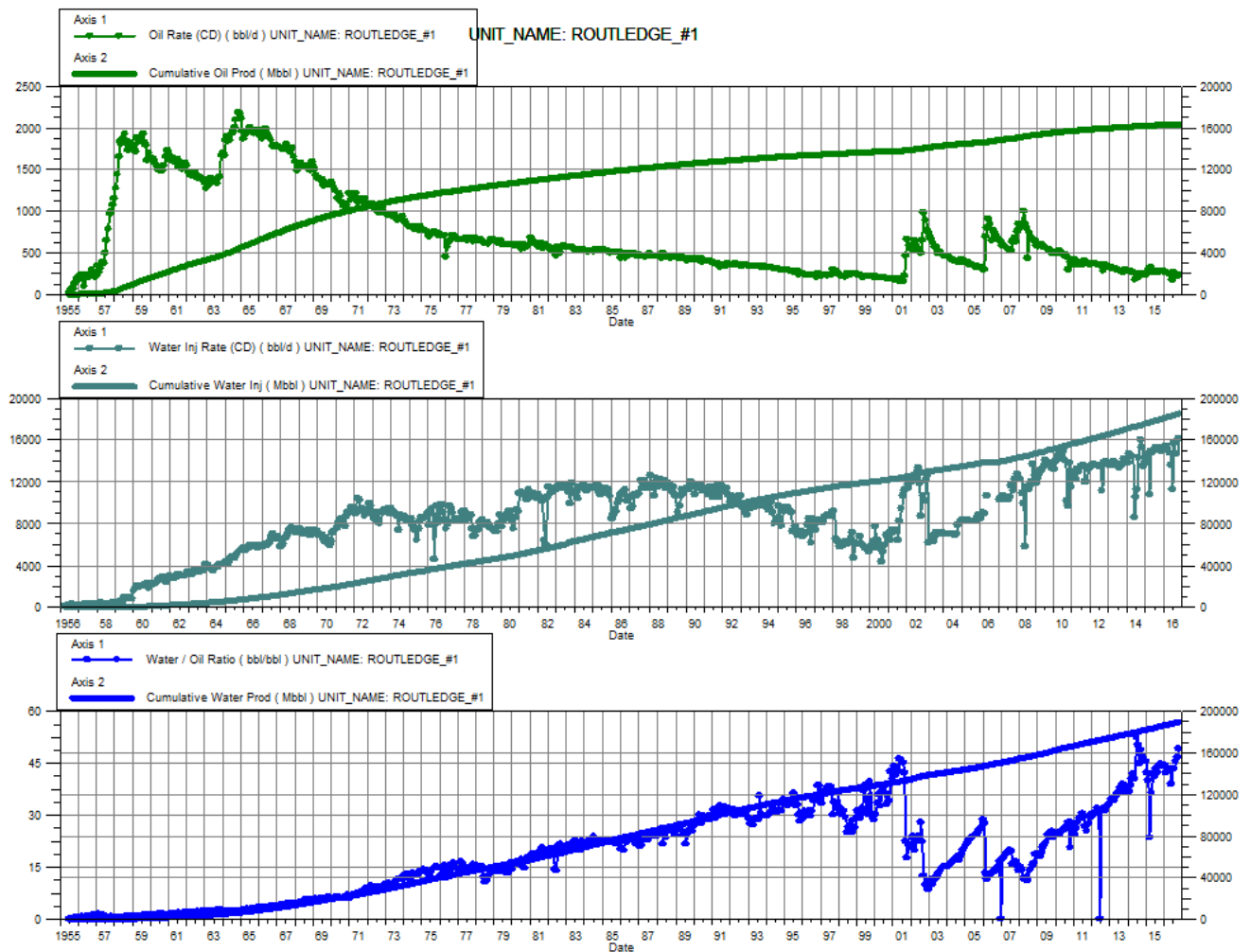


## Waterflood Pattern Table

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

# Total for Routledge Unit #1

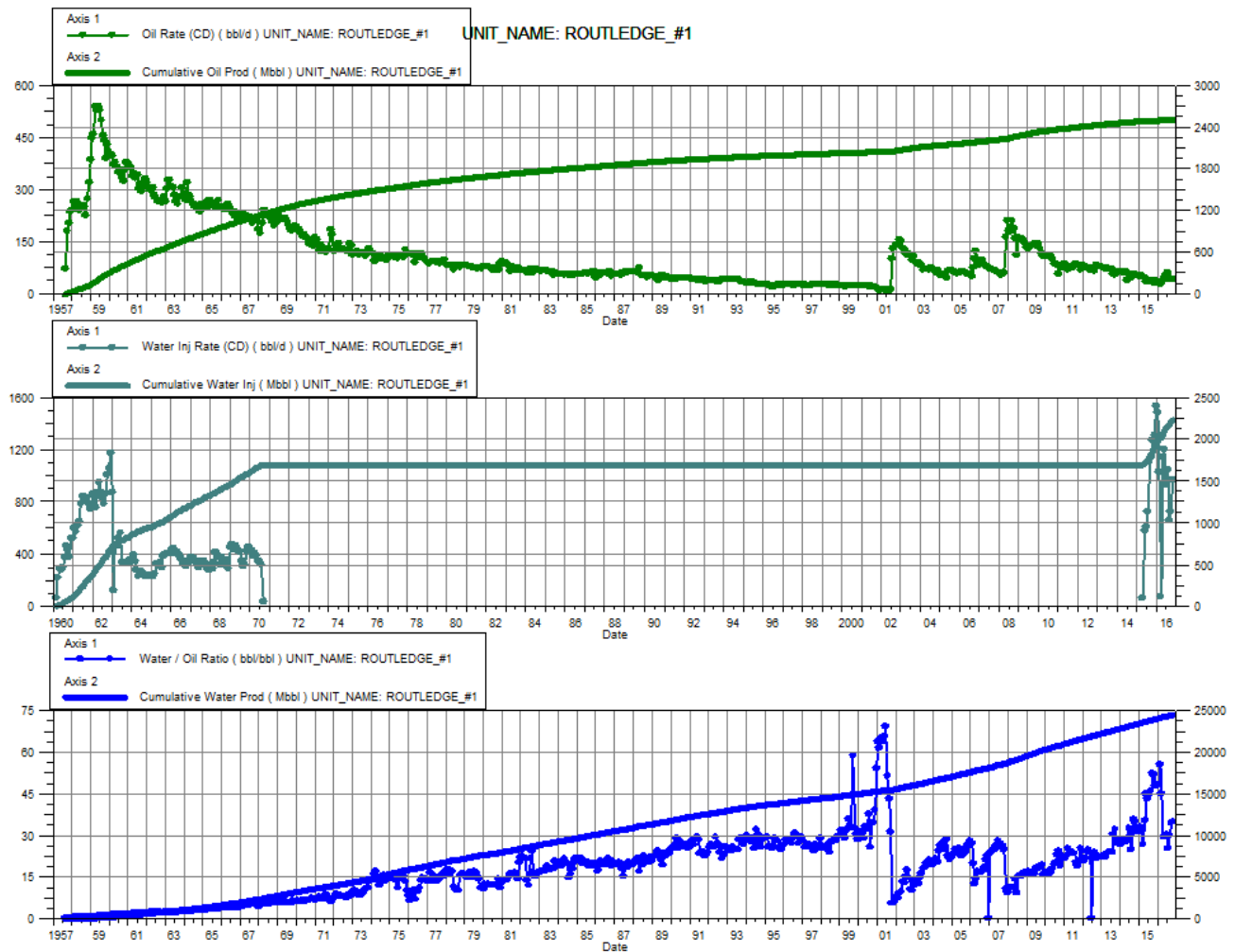
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacemt Ratio	Water Inj Pressure kPa
1/31/2016	43.36	2594.24	1930.13	29688.64	2440.81	28865.83	44.51	1.24	0.89	5,050
2/29/2016	43.18	2595.50	1815.55	29741.29	2448.97	28936.85	42.05	1.32	0.89	5,082
3/31/2016	41.64	2596.79	1784.14	29796.60	2409.16	29011.54	42.85	1.32	0.89	4,962
4/30/2016	39.52	2597.97	1707.02	29847.81	2348.43	29081.99	43.19	1.34	0.90	4,641
5/31/2016	38.77	2599.17	1504.20	29894.44	2156.42	29148.84	38.80	1.40	0.90	5,051
6/30/2016	28.49	2600.03	1231.54	29931.38	1785.73	29202.41	43.23	1.42	0.90	5,033
7/31/2016	43.31	2601.37	1869.47	29989.34	2499.90	29279.91	43.17	1.31	0.90	5,033
8/31/2016	37.83	2602.54	1715.44	30042.52	2329.26	29352.12	45.34	1.33	0.90	4,714
9/30/2016	36.66	2603.64	1713.36	30093.92	2338.73	29422.28	46.74	1.34	0.90	4,592
10/31/2016	38.98	2604.85	1913.29	30153.23	2563.06	29501.73	49.08	1.31	0.90	4,513
11/30/2016	38.96	2606.02	1889.15	30209.90	2552.90	29578.32	48.49	1.32	0.90	4,054
12/31/2016	38.21	2607.21	1924.99	30269.58	2578.68	29658.26	50.38	1.31	0.90	4,204



# Routledge Unit No. 1

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

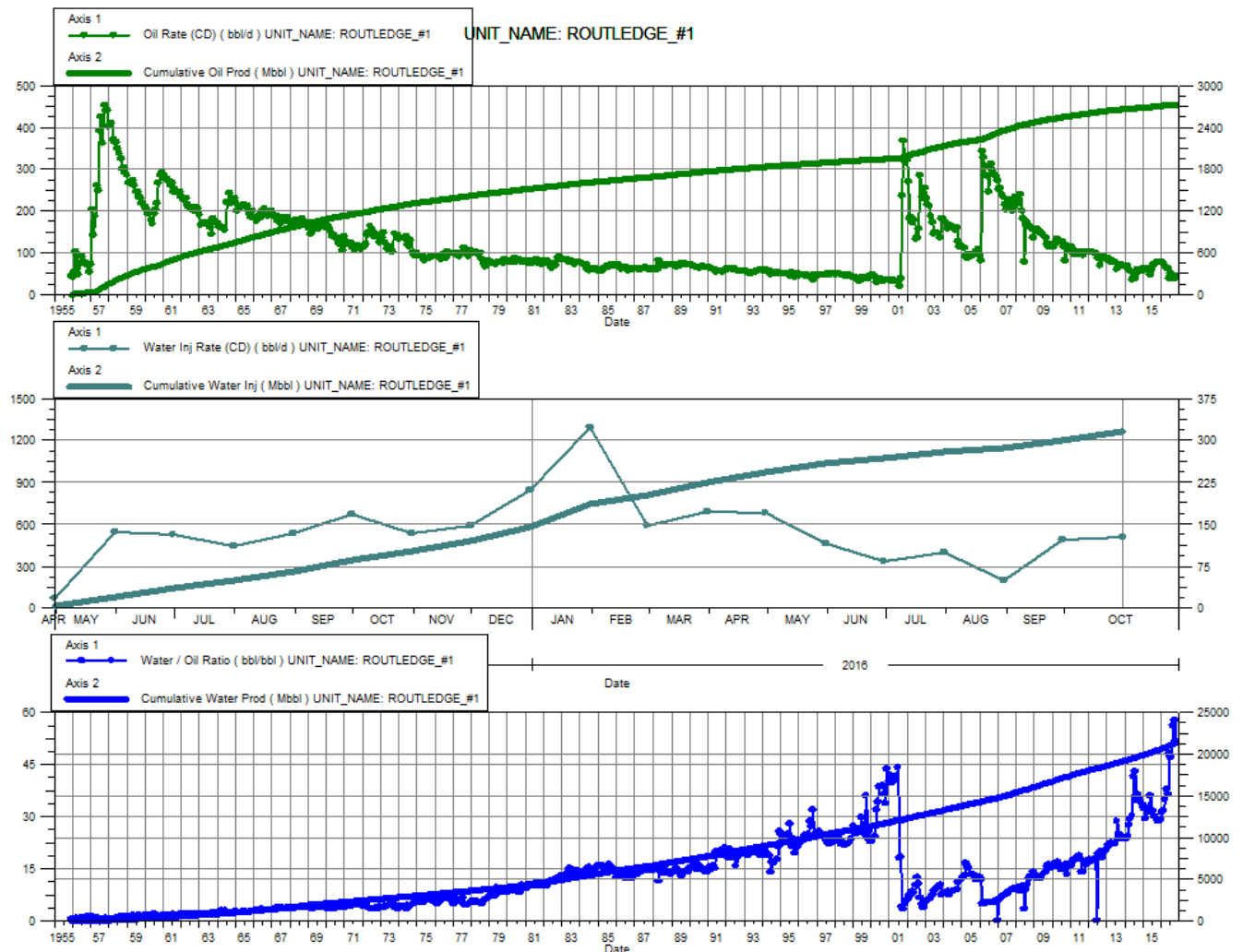
Date	Oil Rate (CD) m3/d	Cum Oil Prod Mm3	Water Rate (CD) m3/d	Cum Water Prod Mm3	Water Inj Rate (CD) m3/d	Cum Water Inj Mm3	Water Oil Ratio m3/m3	Voidage Replacement Ratio	Cum Voidage Replacement Ratio	Water Inj Pressure kPg
1/31/2016	5.74	396.76	276.37	3829.43	236.30	316.97	48.13	0.84	0.08	4,724.01
2/29/2016	4.47	396.89	247.06	3836.60	164.45	321.73	55.33	0.65	0.08	4,721.32
3/31/2016	5.33	397.06	238.28	3843.99	11.15	322.08	44.74	0.05	0.08	4,546.08
4/30/2016	6.97	397.27	204.50	3850.12	182.36	327.55	29.34	0.86	0.08	3,904.73
5/31/2016	8.09	397.52	239.13	3857.53	190.98	333.47	29.55	0.77	0.08	4,781.84
6/30/2016	6.64	397.72	202.35	3863.60	147.44	337.89	30.46	0.71	0.08	4,826.32
7/31/2016	9.47	398.01	239.90	3871.04	166.11	343.04	25.34	0.67	0.08	4,826.32
8/31/2016	7.45	398.24	223.15	3877.96	103.96	346.27	29.97	0.45	0.08	4,503.83
9/30/2016	6.72	398.44	232.59	3884.94	116.08	349.75	34.61	0.49	0.08	4,054.11
10/31/2016	6.90	398.66	241.11	3892.41	154.07	354.53	34.96	0.62	0.08	3,660.89
11/30/2016	6.92	398.86	244.42	3899.74	156.64	359.22	35.34	0.62	0.08	3,281.90
12/31/2016	6.73	399.07	237.59	3907.11	151.04	363.91	35.29	0.62	0.08	3,385.10



# 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
1/31/2016	12.44	431.25	386.12	3287.94	205.74	29.53	31.04	0.52	0.01	5,375.68
2/29/2016	12.00	431.60	380.49	3298.98	94.21	32.26	31.72	0.24	0.01	5,442.10
3/31/2016	10.87	431.94	376.94	3310.66	109.49	35.65	34.68	0.28	0.01	5,377.90
4/30/2016	9.84	432.23	370.94	3321.79	107.97	38.89	37.70	0.28	0.01	5,377.90
5/31/2016	9.95	432.54	360.10	3332.95	73.73	41.18	36.20	0.20	0.01	5,320.08
6/30/2016	6.12	432.73	293.58	3341.76	52.42	42.75	47.97	0.18	0.01	5,240.01
7/31/2016	8.28	432.98	387.89	3353.78	62.53	44.69	46.86	0.16	0.01	5,240.01
8/31/2016	7.01	433.20	391.83	3365.93	31.68	45.67	55.90	0.08	0.01	4,924.18
9/30/2016	6.30	433.39	362.96	3376.82	77.06	47.98	57.58	0.21	0.01	5,129.69
10/31/2016	7.32	433.62	376.02	3388.48	81.36	50.51	51.35	0.21	0.01	5,364.56
11/30/2016	6.89	433.82	376.41	3399.77	88.69	53.17	54.63	0.23	0.01	4,826.32
12/31/2016	6.07	434.01	366.18	3411.12	131.09	57.23	60.35	0.35	0.02	5,022.04



# Routledge Unit No. 1

## 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
1/31/2016	10.99	200.29	330.16	2156.69		57.03	30.04		0.02	-
2/29/2016	10.57	200.60	298.44	2165.34		57.03	28.25		0.02	-
3/31/2016	8.39	200.86	292.67	2174.41	73.63	59.32	34.88	0.24	0.03	51.61
4/30/2016	7.21	201.07	299.44	2183.40	196.73	65.22	41.53	0.64	0.03	-
5/31/2016	7.70	201.31	302.83	2192.78	203.25	71.52	39.34	0.65	0.03	-
6/30/2016	5.25	201.47	253.50	2200.39	192.23	77.29	48.32	0.74	0.03	-
7/31/2016	7.72	201.71	311.77	2210.05	242.40	84.80	40.37	0.76	0.04	-
8/31/2016	7.12	201.93	312.61	2219.74	150.38	89.46	43.91	0.47	0.04	-
9/30/2016	6.91	202.14	292.81	2228.53	217.97	96.00	42.40	0.73	0.04	-
10/31/2016	6.55	202.34	303.95	2237.95	306.79	105.51	46.39	0.99	0.04	-
11/30/2016	6.31	202.53	307.89	2247.19	304.14	114.64	48.82	0.97	0.05	-
12/31/2016	6.28	202.72	295.49	2256.35	309.01	124.21	47.02	1.02	0.05	-

