

Birdtail Unit No. 2

Waterflood Progress Report 2017

January 1st through December 31st 2017

Prepared for:

Manitoba Industry, Economic Development and Mines

Petroleum Branch

Prepared by:

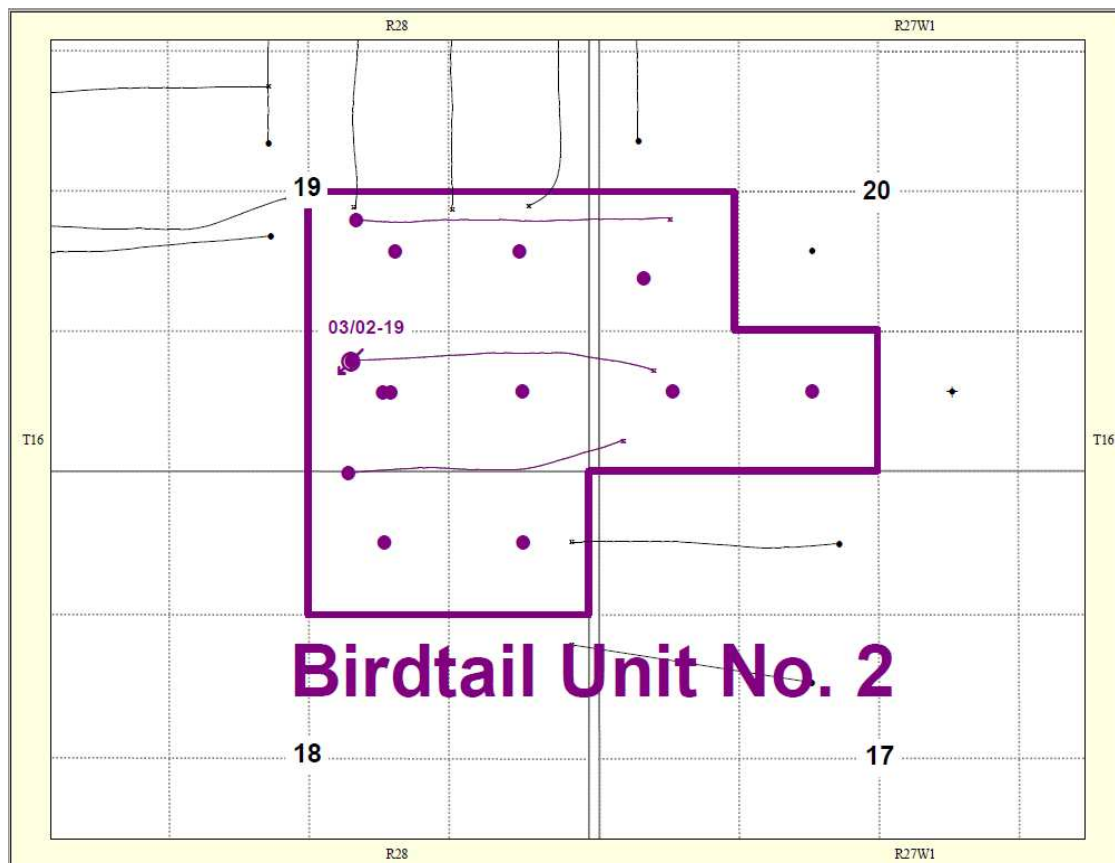
Tundra Oil and Gas

July 26, 2018

INTRODUCTION

Birdtail Unit No. 2 Enhanced Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No. 8 effective December 1, 2000 with Progress Energy Production Partnership as Operator. Tundra acquired the unit from Progress Energy Production Partnership and become operator in October 2003. The EOR project area contains 13 wells in 9 LSDs in Township 16, Range 27 W1 as shown in the figure below.

Figure 1: Birdtail Unit No. 2 Area Outline



Birdtail Unit No. 2

Tundra Oil and Gas (Tundra), as the operator of the Birdtail Unit No. 2 Enhanced Oil Recovery (EOR) project hereby submits the 2017 EOR report as per section 73 of the Drilling and Production Regulations.

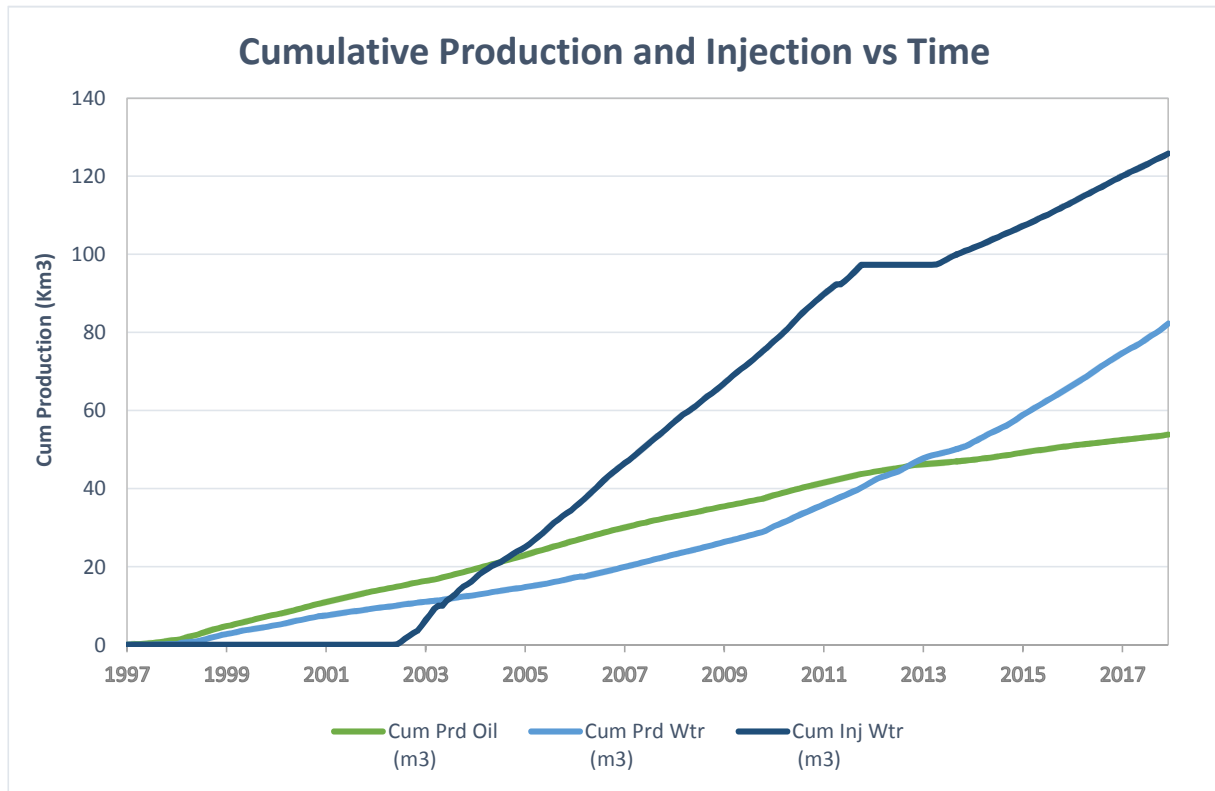
a) Monthly oil and water production rates, injection rate, GOR and WOR

MONTH	Cal Dly Oil m ³ /day	Cal Dly Wtr m ³ /day	Cal Inj Wtr m ³ /day	WOR m ³ /m ³	GOR m ³ /m ³
Jan-2017	3.76	20.01	18.19	5.31	0
Feb-2017	3.85	21.95	17.82	5.70	0
Mar-2017	3.79	19.19	17.65	5.07	0
Apr-2017	3.72	18.42	16.80	4.96	0
May-2017	3.96	18.41	16.55	4.65	0
Jun-2017	4.13	24.39	17.17	5.91	0
Jul-2017	3.68	22.73	14.52	6.18	0
Aug-2017	3.34	22.75	18.29	6.81	0
Sep-2017	3.68	21.65	18.30	5.88	0
Oct-2017	4.55	22.48	17.29	4.95	0
Nov-2017	6.15	28.36	17.40	4.61	0
Dec-2017	5.89	28.63	17.35	4.86	0

b) Cumulative volume of oil, gas and water produced and fluid injected

2017 PRODUCTION	
Produced Oil (m ³)	1,536
Produced Gas (m ³)	0
Produced Water (m ³)	8,179
Fluid Injected (m ³)	6,304
CUMULATIVE PRODUCTION	
Produced Oil (m ³)	53,912
Produced Water (m ³)	82,329

Birdtail Unit No. 2



c) Monthly wellhead injection pressure for each injection well

MONTH	03/02-19 Inj		Birdtail Unit 2	
	Inj Water (m ³)	Avg Inj P (kPa)	Inj Water (m ³)	Avg Inj P (kPa)
Jan-2017	564.0	3999	564.0	3999
Feb-2017	499.0	3931	499.0	3931
Mar-2017	547.0	3999	547.0	3999
Apr-2017	504.0	4000	504.0	4000
May-2017	513.0	4000	513.0	4000
Jun-2017	515.0	4000	515.0	4000
Jul-2017	450.0	3811	450.0	3811
Aug-2017	567.0	3956	567.0	3956
Sep-2017	549.0	4001	549.0	4001
Oct-2017	536.0	4002	536.0	4002
Nov-2017	522.0	3998	522.0	3998
Dec-2017	538.0	3999	538.0	3999
Total	6304.0		6304.0	
Avg Inj P		3975		3975

MONTH	Jan-2017	Feb-2017	Mar-2017	Apr-2017	May-2017	Jun-2017	Jul-2017	Aug-2017	Sep-2017	Oct-2017	Nov-2017	Dec-2017
Total m3	564.0	499.0	547.0	504.0	513.0	515.0	450.0	567.0	549.0	536.0	522.0	538.0
Daily (m³/d)	18.19	17.82	17.65	16.80	16.55	17.17	14.52	18.29	18.30	17.29	17.40	17.35

2017 AVG. ANNUAL DAILY INJECTION = 17.28 m3/d

CUMULATIVE INJECTION TO Dec 31, 2016 = 119,533 m3

TOTAL 2017 ANNUAL INJECTION = 6,304 m3
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CUMULATIVE INJECTION TO Dec 31, 2017 = 125,837 m3

d) Summary of the result of any survey of reservoir pressure conducted in 2017. N/A

e) **Date and type of any well servicing.**

Well	Service Description	Date
100.01-19-016-27W1.00	Pump Change / 1.5m3 Acid Job	6/1/2017
100.01-19-016-27W1.00	SCALE SQUEEZE SC-202	11/14/2017
100.07-19-016-27W1.00	Pump Change / Acid Job	10/19/2017
100.07-19-016-27W1.00	SCALE SQUEEZE SC-202	11/14/2017
102.07-19-016-27W1.00	Pump Change	10/11/2017
100.05-20-016-27W1.00	Pump Change / Acid Job	10/13/2017
100.05-20-016-27W1.00	SCALE SQUEEZE SC-202	11/14/2017

f) **Calculations of voidage replacement ratio on a monthly and cumulative basis**

VOIDAGE CALCULATIONS

OIL FORMATION VOLUME FACTOR (Rm3/Sm3) = 1.071

MONTH	Mth Oil Prod (m3)	Cum Oil Prod (Km3)	Mth Water Prod (m3)	Cum Water Prod (Km3)	Mth Water Inj (m3)	Cum Water Inj (Km3)	VRR	Cum VRR
Jan-2017	116.7	52.49	620.2	74.77	564.0	120.10	0.757	0.917
Feb-2017	107.8	52.60	614.5	75.38	499.0	120.60	0.684	0.916
Mar-2017	117.4	52.72	594.9	75.98	547.0	121.14	0.759	0.915
Apr-2017	111.5	52.83	552.7	76.53	504.0	121.65	0.750	0.914
May-2017	122.8	52.95	570.8	77.10	513.0	122.16	0.730	0.913
Jun-2017	123.9	53.08	731.7	77.83	515.0	122.68	0.596	0.911
Jul-2017	114.1	53.19	704.6	78.54	450.0	123.13	0.544	0.909
Aug-2017	103.6	53.29	705.4	79.24	567.0	123.69	0.695	0.907
Sep-2017	110.5	53.40	649.4	79.89	549.0	124.24	0.715	0.906
Oct-2017	140.9	53.54	696.8	80.59	536.0	124.78	0.632	0.905
Nov-2017	184.5	53.73	850.7	81.44	522.0	125.30	0.498	0.902
Dec-2017	182.6	53.91	887.6	82.33	538.0	125.84	0.497	0.898

g) **An outline of the method used for quality control and treatment of the injected fluid**

The injection water for Birdtail Unit No. 2 is sourced from the 00/02-19-016-27W/2 well (Lodgepole formation). The water is treated at the 09-05-16-27W1 battery where it is filtered to 0.50 microns and has scale inhibitor added.

h) **A report of any unusual performance problems and remedial measures taken or being considered. N/A**

i) **Any other information necessary to evaluate the project**

<i>UWI</i>	<i>Type</i>	<i>Status</i>	<i>Future Plans</i>
100/15-18-016-27W1/0	Vertical	Abandoned	-
102/15-18-016-27W1/0	Horizontal	Producing	-
100/16-18-016-27W1/0	Vertical	Producing	-
100/01-19-016-27W1/0	Vertical	Pumping	-
100/02-19-016-27W1/0	Vertical	Abandoned	-
102/02-19-016-27W1/0	Vertical	Abandoned	-
103/02-19-016-27W1/0	Horizontal	Injection	-
100/07-19-016-27W1/0	Vertical	Producing	-
102/07-19-016-27W1/0	Horizontal	Producing	-
100/08-19-016-27W1/0	Vertical	Producing	-
100/03-20-016-27W1/0	Vertical	Producing	-
100/04-20-016-27W1/0	Vertical	Injection	-
100/05-20-016-27W1/0	Vertical	Pumping	-

k) Discussion

The original oil-in-place (OOIP) of $393 \text{ e}^3\text{m}^3$ with cumulative oil recovered to date of $53.9 \text{ e}^3\text{m}^3$ results in a recovery factor of 13.7%. The ultimate expected recoverable reserve based on decline analysis is $64.7 \text{ e}^3\text{m}^3$ or an ultimate recovery factor of 16.4%. The overall performance of this waterflood has been good as indicated by an expected recovery factor of 16.4% and increased or flattened oil production since water injection began in 2002.

The vertical injectors at 02/02-19-016-27W1/0 (02/02-19) and 00/04-20-016-27W1/0 (00/04-20) were suspended in October 2011. The 03/02-19-016-27W1/0 (03/02-19) horizontal well was converted to a water injector in April 2013 after a short production period. Ultimately, it is expected that the 02/15-18-016-27W1/0 and 02/07-19-016-27W1/0 horizontal producers will benefit the most from the new 03/02-19 water injector. Tundra will continue to closely monitor the response of the reconfigured waterflood in this unit and make any appropriate changes as required to the injection targets and wells.