

**EWART UNIT NO. 2  
WATERFLOOD EOR PROJECT  
ANNUAL REPORT FOR 2017**

**May 2, 2018**

**Tundra Oil and Gas Partnership**

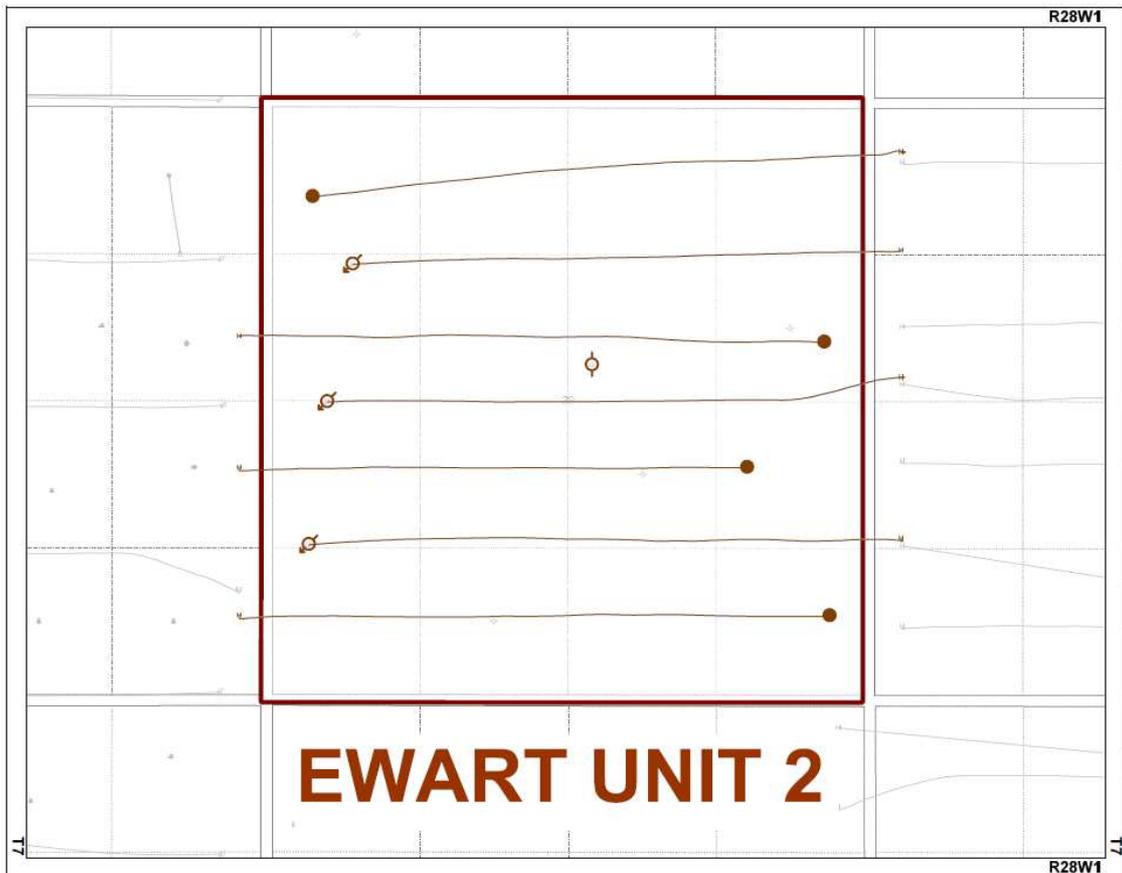
## Table of Contents

Introduction	3.
Discussion	3.
Production History	3.
Waterflood Development Plan	5.
Waterflood EOR Operating Strategy and Performance	6.
Water Source and Quality	6.
Injection Wellhead Pressures	6.
Reservoir Pressure	6.
Well Servicing	6.
Waterflood Performance Discussion	6.
List of Appendices	7.
Appendix A: Injection Pattern Summary	
Appendix B: Reservoir Pressure Summary	
Appendix C: Average Monthly Injection Pressure Summary	
Appendix D: Injector Pattern Production/Injection Rates, Cumulative and VRR Plots for the following injectors:	
100/05-29-007-28W1	
102/05-29-007-28W1	
100/12-29-007-28W1	

## **INTRODUCTION**

Ewart Unit No. 2 Enhance Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No. 29 effective August 1, 2013 with Tundra Oil and Gas (Tundra) as Operator. The Unit area contains 4 producing horizontal wells, 3 horizontal injectors and 1 vertical observation well in 16 LSDs in Township 7 Range 28 W1 as shown in the figure below.

**Figure 1: Ewart Unit No. 2 Area Outline**



In accordance with Section 73 of the Manitoba Drilling and Production Regulation, Tundra hereby submits the following 2017 Annual Progress Report for Ewart Unit No. 2.

## **DISCUSSION**

### **Production History**

For the wells included in Ewart Unit No. 2, production started in August 2008 with the 00/008-29-007-28W1 well. Average oil production peaked at 13.8 m<sup>3</sup>/d per well in April of 2009. This production was coming from 3 wells and totaled 41.41 m<sup>3</sup>/d for the Unit. In

December 2017, the Unit was producing 2.56 m<sup>3</sup>/d of oil and 9.86 m<sup>3</sup>/d of water and the average WOR was 3.57 m<sup>3</sup>/m<sup>3</sup>. Water injection commenced in Ewart Unit No. 2 in November 2013. The rates and WOR are presented in Figure 2.

**Figure 2: Ewart Unit No. 2 Production/Injection Rates and WOR vs Time**

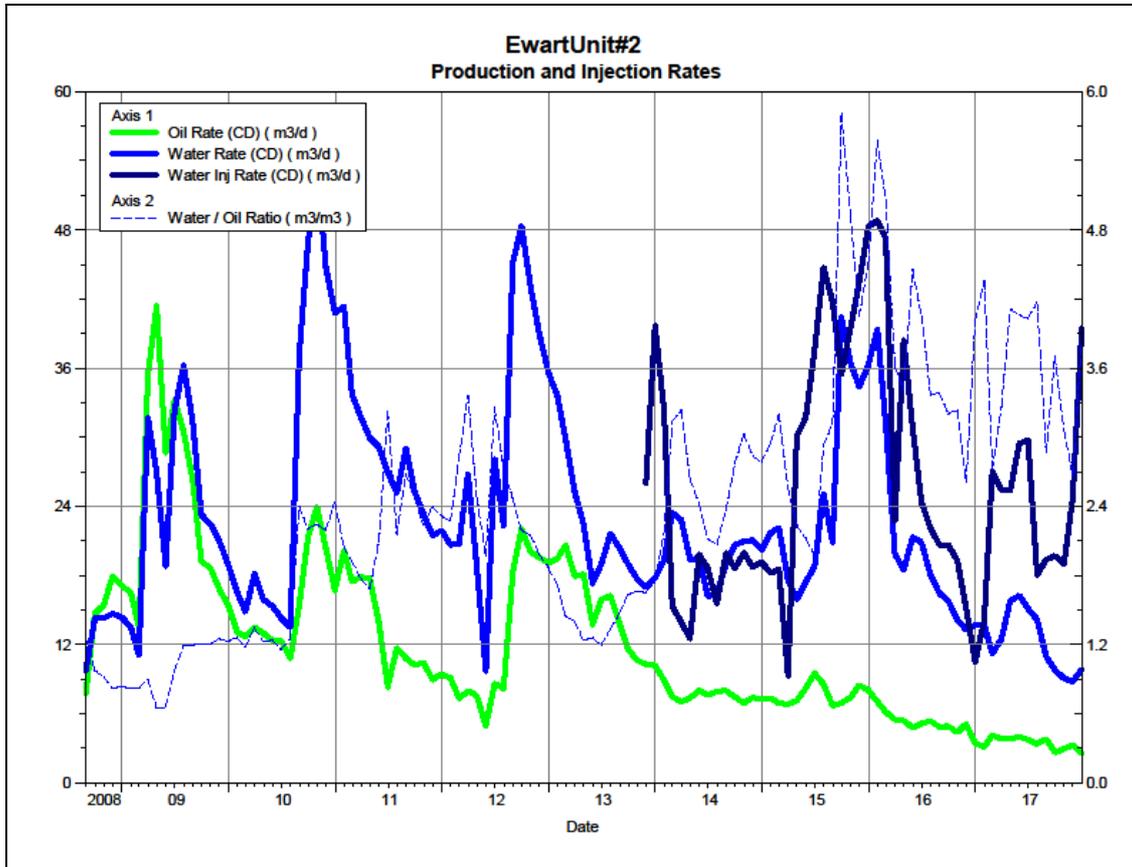
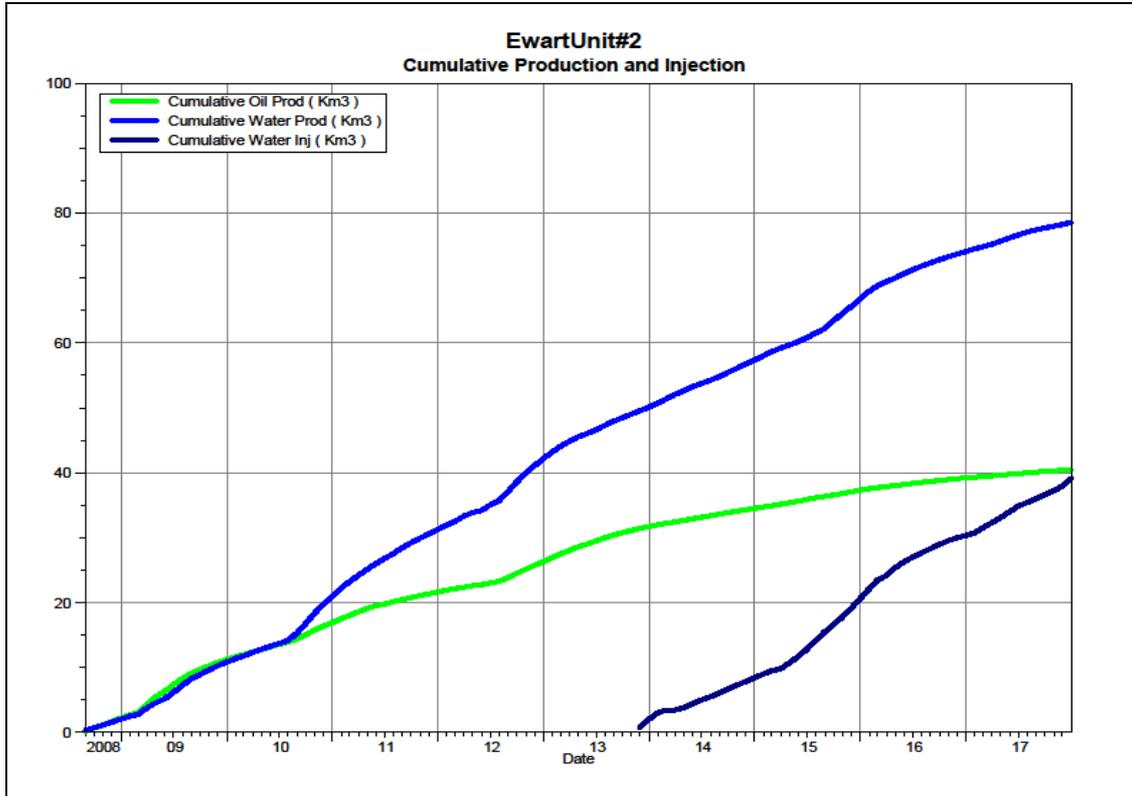


Figure 3 shows the cumulative production for Ewart Unit No. 2 to the end of December 2017 as 40.5 e<sup>3</sup>m<sup>3</sup> of oil, and 78.6 e<sup>3</sup>m<sup>3</sup> of water, representing a 14.0% recovery factor of the OOIP (288.9 e<sup>3</sup>m<sup>3</sup>). The cumulative water injected is 39.2 e<sup>3</sup>m<sup>3</sup>.

**Figure 3: Ewart Unit No. 2 Cumulative Oil, Water and Water Injected vs Time**



## **Waterflood Development Plan**

### **Ewart Unit No. 2 Waterflood (WF) Development Plan**

Ewart Unit No. 2 is still in the development phase at the end of 2017. The three (3) proposed horizontal injection wells were drilled in 2011 between the existing horizontal producing wells, completing an effective 20 acre line drive waterflood pattern. All horizontal wells are fracture stimulated to improve the injection rates. In 2012, the proposed injectors were put on production and in November 2013, the 02/05-29 and 00/12-29-007-28W1 wells were converted to injectors. In October 2017, Tundra converted the 00/05-29-007-28W1 (00/05-29) producer to an injector.

Production performance by injector pattern is summarized in Appendix A.

Any future revisions to the waterflood development or surveillance plan would be based on new production or performance response data, technical studies, or observed reservoir behavior and reserves recovery interpretations.

## **Waterflood EOR Operating Strategy and Performance**

### **Water Source and Quality**

The injection water for Ewart Unit No. 2 was sourced from the 02/16-32-007-29W1 well (Lodgepole formation) until June 2016 when it was switched over to the newly recompleted source water well at 02/14-30-007-28W1 (Mannville formation). The water is treated at the 04-01-008-29W1 filtration plant where it is filtered to 0.1 microns and has scale inhibitor and biocide added. The injection water is then distributed to the injectors through the dedicated infrastructure system.

### **Injection Wellhead Pressures**

Injection started in this Unit in November 2013. The average monthly wellhead injection pressure for each injector is summarized in Appendix C. Since injection in this Unit is still in the early stages, the injectors are still building up to a target injection pressure of 6300 kPaa.

### **Reservoir Pressure**

Where practical, Tundra is committed to collecting pressure data from newly drilled injection wells. For Ewart Unit No. 2, pressure data is currently available for the 02/05-29, 00/10-29 and 00/12-29-007-28W1 locations. A summary table is presented in Appendix B. Pressures are corrected to a common datum of -450 m SS for comparison with other units in the area.

### **Well Servicing**

Table 1 lists the maintenance that was required in Ewart Unit No. 2 in 2017.

**Table 1: Service and Maintenance in Ewart Unit No. 2**

100/05-29-007-28W100	WIW Conversion	10/05/2017
----------------------	----------------	------------

### **Waterflood Performance Discussion**

At the end of 2017, Ewart Unit No. 2 waterflood area had 3 injection patterns in place. In October 2017, Tundra converted the 00/05-29 producer to an injector. Since water injection started in November 2013, there is no waterflood analysis that can be done at this time.

A summary table of the injector pattern(s) is presented in Appendix A. Plots of the production and injection data along with the VRR information are presented in Appendix D for each of the injector pattern(s).

## List of Appendices

Appendix A: Injection Pattern Summary

Appendix B: Reservoir Pressure Summary

Appendix C: Average Monthly Injection Pressure Summary

Appendix D: Injector Pattern Production/Injection Rates, Cumulative and VRR Plots  
for the following injectors:

100/05-29-007-28W1

102/05-29-007-28W1

100/12-29-007-28W1

**Appendix A**

**Ewart Unit No. 2 Injection Pattern Summary as of December 2017**

Pattern Name	Injector BH Location (007-28W1)	Injector Surf. Location (007-28W1)	Status	No. of Supported Wells	Supported Wells (007-28W1)	Allocation Factor	Pattern Prod Start Month	Inj Start Month	Oil Rate (m <sup>3</sup> /d)	Water Rate (m <sup>3</sup> /d)	WOR (m <sup>3</sup> /m <sup>3</sup> )	Water Injection (m <sup>3</sup> /d)	Cum Oil (E <sup>3</sup> m <sup>3</sup> )	Cum Water (E <sup>3</sup> m <sup>3</sup> )	Cum Inj Water (E <sup>3</sup> m <sup>3</sup> )	Monthly VRR	Cum VRR
00/05-29-007-28W1 Injector	00/05-29	00/05-28	Water Injection	2	01-29, 08-29	0.5	Aug 2008	Oct 2017	1.0	2.6	2.45	9.9	16.8	18.8	0.5	2.706	0.015
02/05-29-007-28W1 Injector	02/05-29	00/12-28	Water Injection	2	08-29, 02/09-29	0.5	Aug 2008	Nov 2013	0.4	2.1	5.31	15.1	9.7	17.1	12.2	5.999	0.443
00/12-29-007-28W1 Injector	00/12-29	02/13-28	Water Injection	2	02/09-29, 13-29	0.5	Feb 2009	Nov 2013	0.2	2.4	9.99	14.5	5.5	24.8	26.5	5.497	0.862

## APPENDIX B

### Ewart Unit No. 2 - Pressure Summary

Location	Test Date	Final Pressure (kPaa)	MPP (mTVD)	KB	Datum Depth	Gradient	Pressure @ -450 masl
102/05-29-007-28W1/00	Nov 24, 2011 - June 29, 2012	5664.5	952.3	499.8	-450	8.25	5644
100/10-29-007-28W1/00	Nov 30, 2011 - Feb 8, 2012	9050.4	960.0	494.0	-450	8.25	8918
100/12-29-007-28W1/00	Nov 20 - Dec 12, 2011	8877.7	951.6	500.4	-450	8.25	8867

## Appendix C

**Average Monthly Injection Pressure (kPag)**

Month	100/05-29	102/05-29	100/12-29
Mar-13	0	0	0
Apr-13	0	0	0
May-13	0	0	0
Aug-13	0	0	0
Sep-13	0	0	0
Oct-13	0	0	0
Nov-13	0	0	0
Dec-13	0	0	568
Jan-14	0	0	1057
Feb-14	0	0	1100
Mar-14	0	0	705
Apr-14	0	0	1234
May-14	0	0	1815
Jun-14	0	0	1582
Jul-14	0	0	2246
Aug-14	0	0	2477
Sep-14	0	0	2799
Oct-14	0	0	2999
Nov-14	0	0	3092
Dec-14	0	0	3105
Jan-15	0	0	3331
Feb-15	0	0	3331
Mar-15	0	-18	3308
Apr-15	0	86	3404
May-15	0	710	3576
Jun-15	0	1444	3801
Jul-15	0	2031	3816
Aug-15	0	1595	3591
Sep-15	0	2044	3547
Oct-15	0	1958	3847
Nov-15	0	2690	4286
Dec-15	0	3087	4502
Jan-16	0	3287	4626
Feb-16	0	680	4251
Mar-16	0	1629	4567
Apr-16	0	1034	4860
May-16	0	37	4949
Jun-16	0	-83	4977
Jul-16	0	316	5130
Aug-16	0	653	4975
Sep-16	0	450	4977
Oct-16	0	588	4515
Nov-16	0	667	3635
Dec-16	0	733	4093
Jan-17	0	1052	5429
Feb-17	0	1408	5507
Mar-17	0	1737	5628
Apr-17	0	1747	6023
May-17	0	1981	6137
Jun-17	0	2042	5222
Jul-17	0	2179	5260
Aug-17	0	2163	5359
Sep-17	785	2049	5252
Oct-17	139	2537	4998
Nov-17	-93	4488	5476
Dec-17	155	985	3549

## **Appendix D**

### **Rates and VRR Plots**

# Pattern: 00/05-29-007-28Inj Set: EwartUnit#2

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 4.41 m3/m3

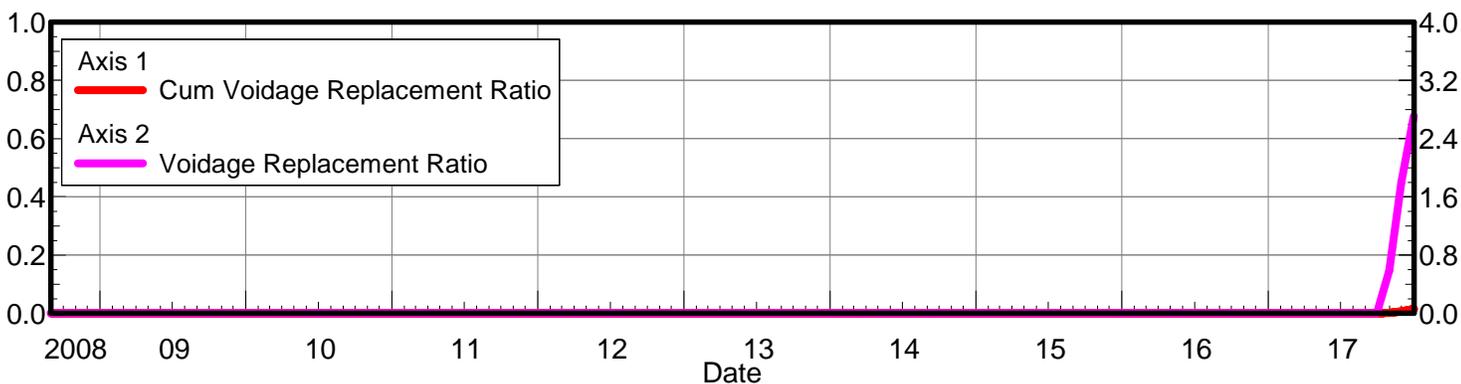
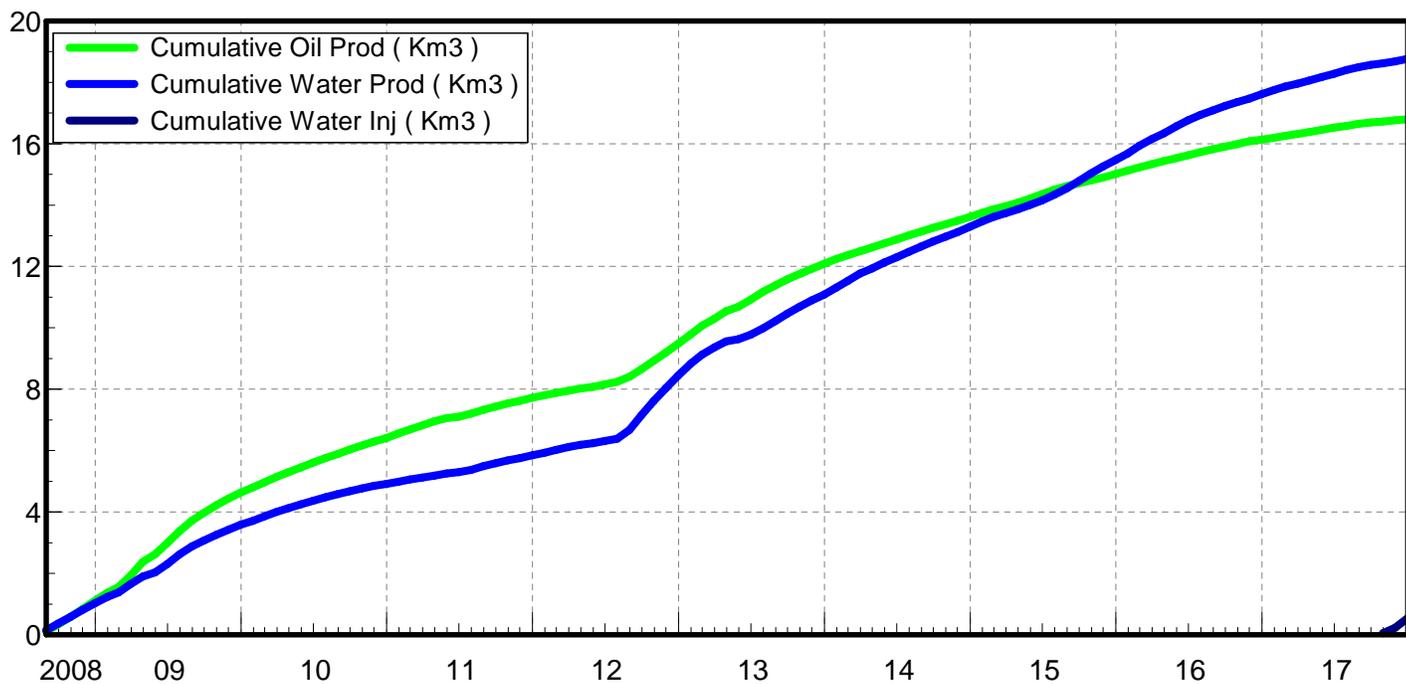
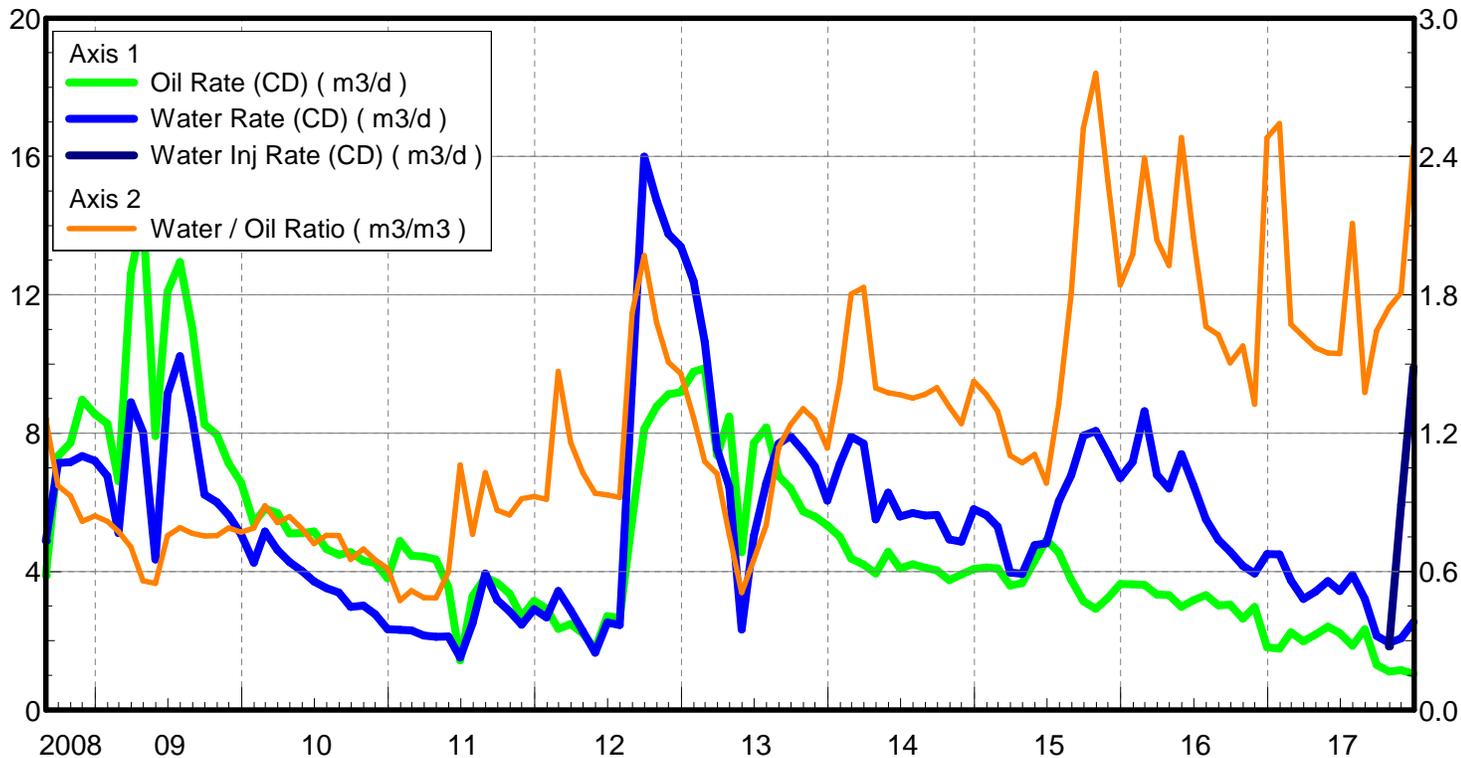
March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 1.04 m3/d

Water Rate (CD) : 2.55 m3/d

Water Inj Rate (CD) : 9.90 m3/d



# Pattern: 02/05-29-007-28Inj Set: EwartUnit#2

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 9.16 m3/m3

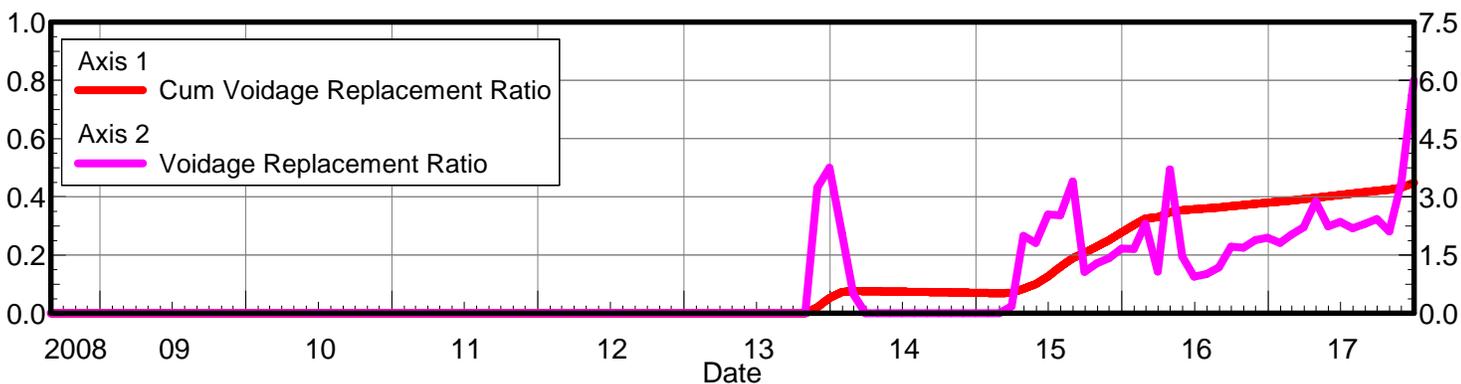
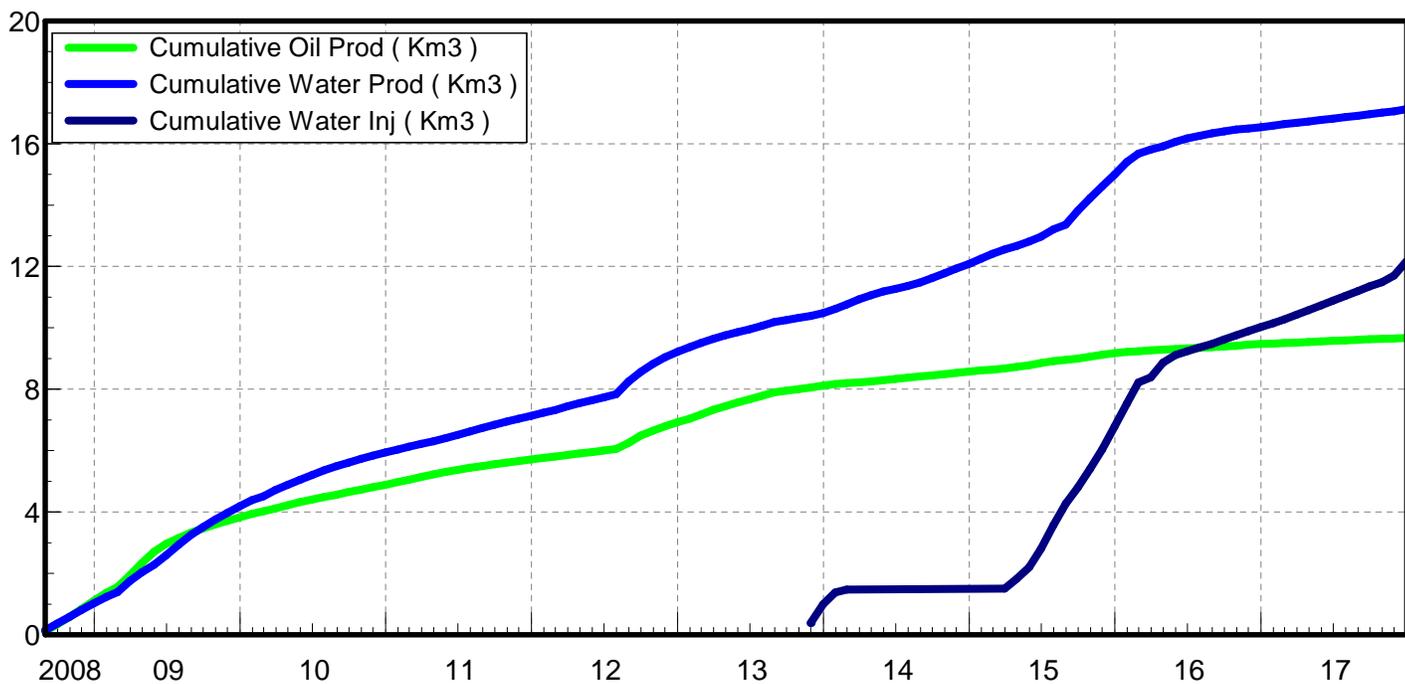
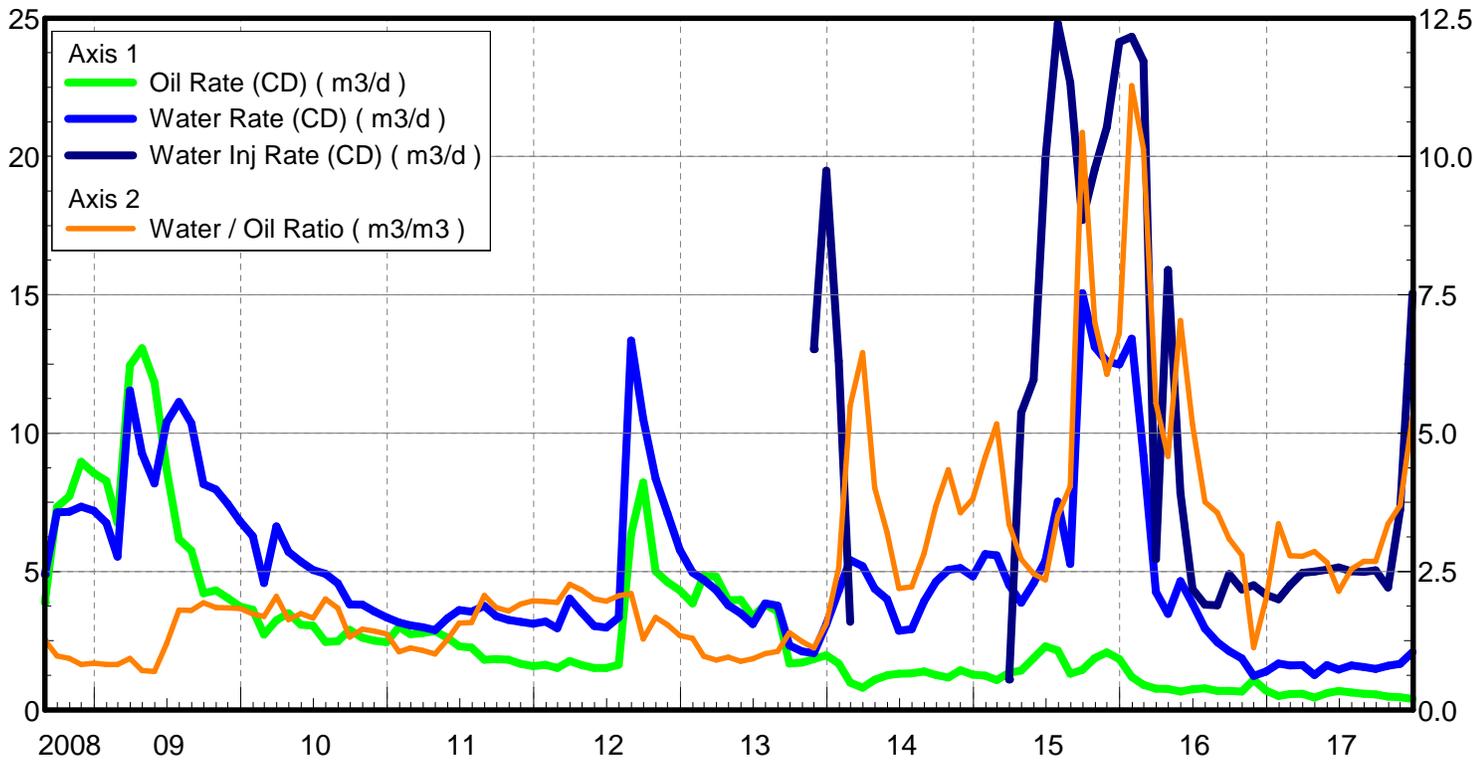
March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 0.39 m3/d

Water Rate (CD) : 2.09 m3/d

Water Inj Rate (CD) : 15.06 m3/d



# Pattern: 00/12-29-007-28Inj Set: EwartUnit#2

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 20.05 m3/m3

March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 0.24 m3/d

Water Rate (CD) : 2.39 m3/d

Water Inj Rate (CD) : 14.52 m3/d

