

**EWART UNIT NO. 8**  
**WATERFLOOD EOR PROJECT**  
**ANNUAL REPORT FOR 2017**

**May 3, 2018**

**Tundra Oil and Gas Partnership**

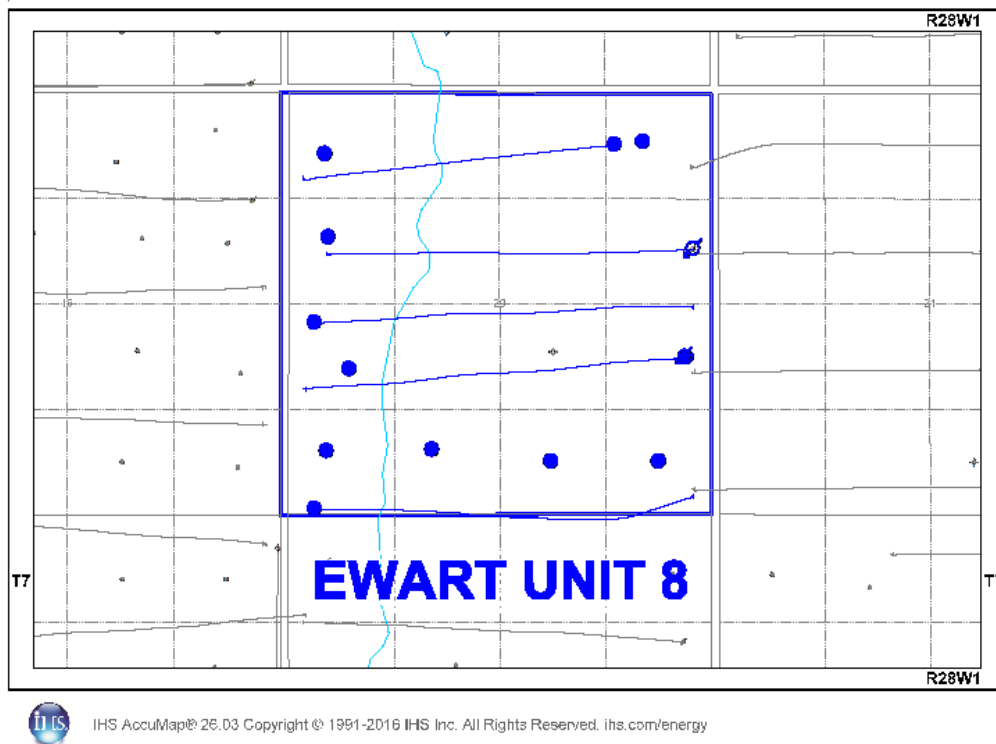
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## **INTRODUCTION**

Ewart Unit No. 8 Enhanced Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No. 41, effective January 1, 2015 with Tundra Oil and Gas (Tundra) as Operator. The EOR project area, outlined in blue in Figure 1, contains 8 vertical and 3 horizontal producing wells and 2 horizontal injection wells in 16 LSDs in Township 7, Range 28W1. Well list and well status is available in Appendix A.

**Figure 1: Ewart Unit No. 8 Area Outline**



In accordance with Section 73 of the Manitoba Drilling and Production Regulation, Tundra submits the following 2017 Annual Progress Report for Ewart Unit No. 8.

## **DISCUSSION**

### **Production History**

For the wells included in Ewart Unit No. 8, production started in December 2004 with the 00/13-20-007-28W1/00 well. Oil production peaked at 42.8 m<sup>3</sup>/d in March of 2009. In 2017, the average production for the unit was 12.41 m<sup>3</sup>/d of oil and 23.22 m<sup>3</sup>/d of water, and the average WOR was 1.89 m<sup>3</sup>/m<sup>3</sup>. Water injection commenced in Ewart Unit No. 8 in July 2015. The rates and WOR are presented in Figure 2.

Figure 2: Ewart Unit No. 8 Production/Injection Rates and WOR vs. Time

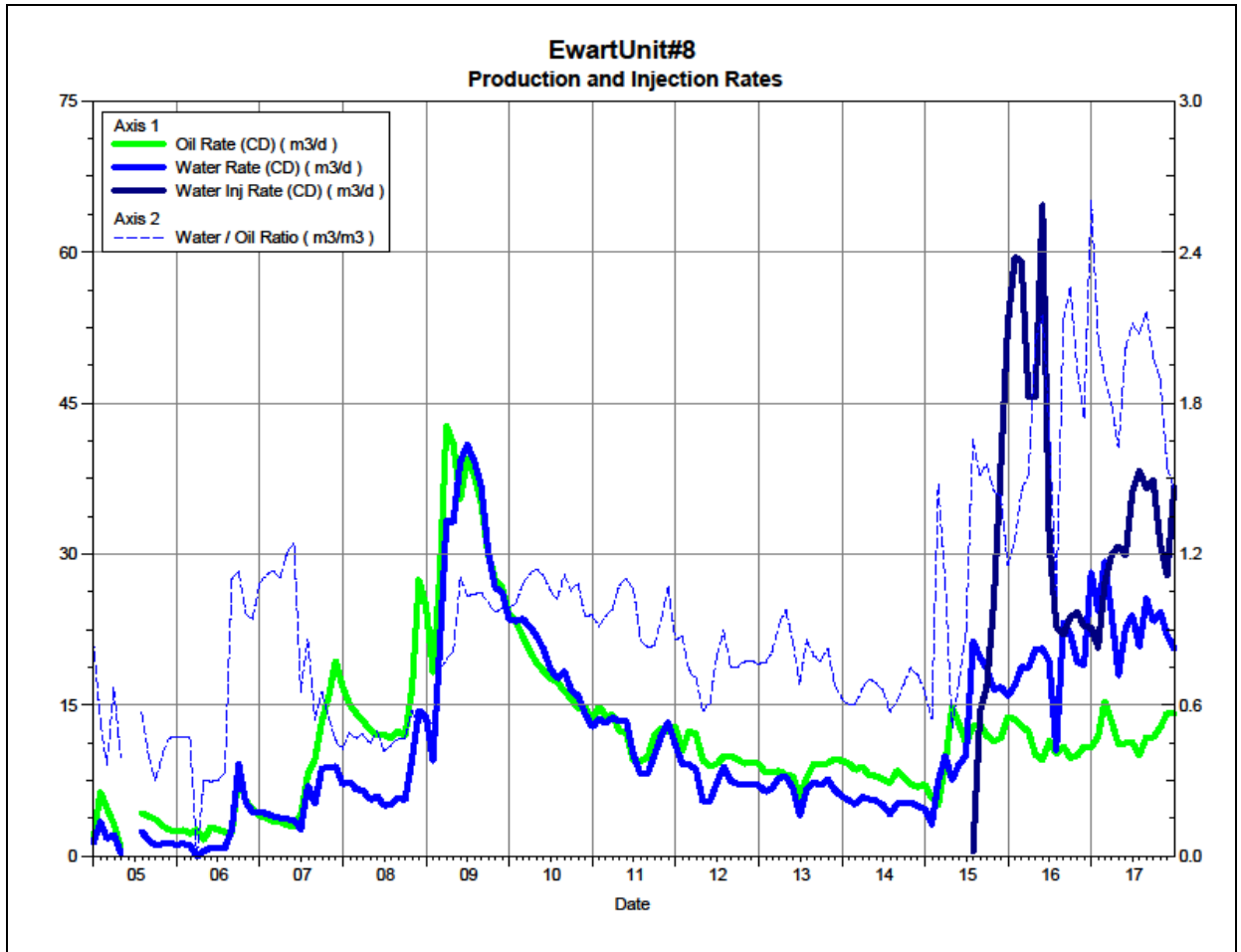
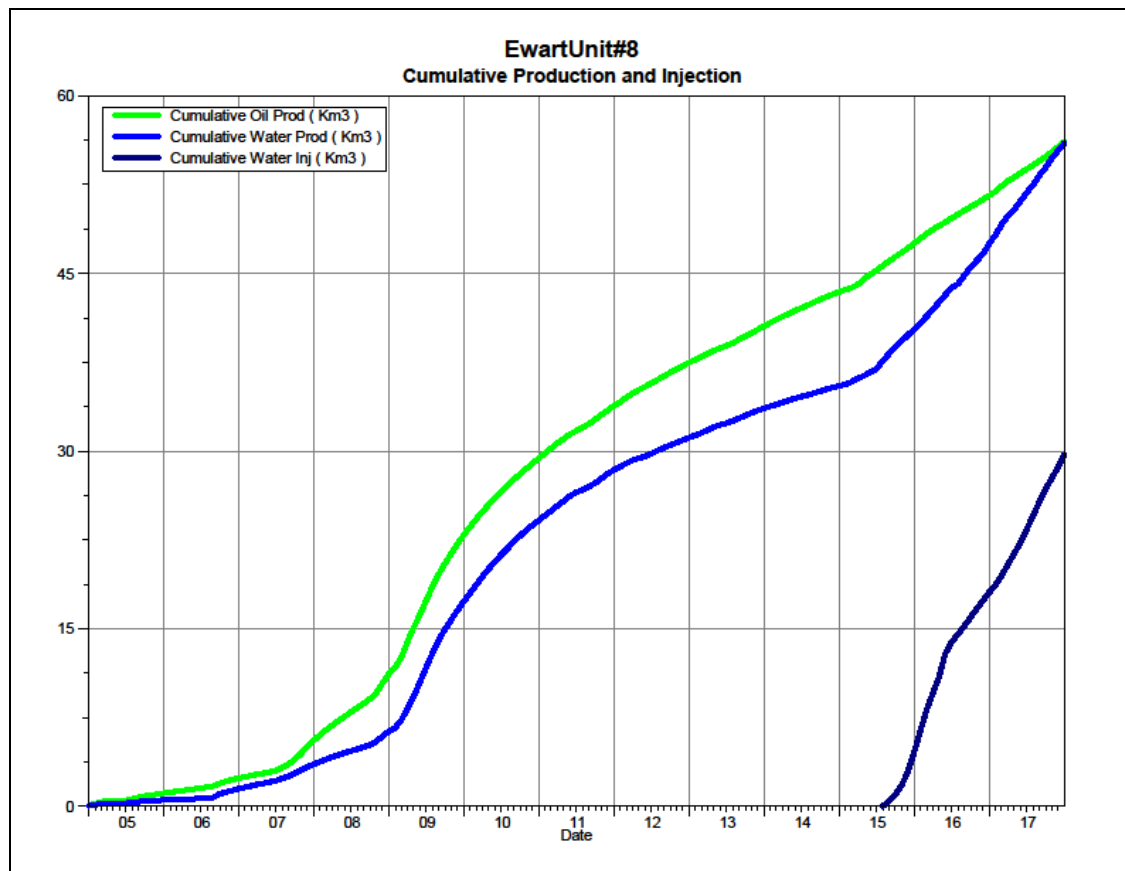


Figure 3 shows the cumulative production for Ewart Unit No. 8 to the end of December 2017 as 56.10 e³m³ of oil and 55.98 e³m³ of water, representing a 9.1% recovery factor of the OOIP (616.0 e³m³). The cumulative water injected is 29.70 e³m³.

**Figure 3: Ewart Unit No. 8 Cumulative Oil, Water and Water Injected vs. Time**



### **Waterflood History**

Ewart Unit No. 8 is still in the development phase at the end of 2017. In 2015, the 00/08-20 and 00/09-20-007-28W1 existing horizontal producers were converted to horizontal injection wells. This unit will have a combination of waterflood patterns at 20 acre and 40 acre spacing having utilized the existing horizontal and vertical wells in the area. An inter-unit horizontal well was drilled at 02/04-20-007-28W1/0 (02/04-20) in December 2014. Tundra has no immediate plans to convert this inter-unit well to an injector and will continue to produce it. All of the horizontal wells are fracture stimulated to improve the injection rates.

Production performance by injector pattern are summarized in Appendix B.

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. 8 will be sourced from the 02/14-30-007-28W1 well (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 July 2015. 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 kPa(a).

### **Reservoir Pressure**

Where practical, Tundra is committed to collecting pressure data from newly drilled injection wells. For Ewart Unit No. 8, pressure data is currently available for the 02/04-20 location. The reservoir pressure is 5281 kPa(a), 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. 8 in 2017.

**Table 1: Service and Maintenance in Ewart Unit No. 8**

100.04-20-007-28W1.00	Broken Polish Rod	10/11/2017
100.13-20-007-28W1.00	Pump Change	1/18/2017

### **Waterflood Performance Discussion**

At the end of 2017, Ewart Unit No. 8 had 2 injection patterns in place, 00/08-20 and 00/09-20-007-28W1. Since injection started in July 2015, there is no waterflood analysis that can be done at this time. This unit has a combination of waterflood patterns at 20 acre and 40 acre spacing having utilized the existing horizontal and vertical wells in the area. The waterflood area also had a future inter-unit injection well drilled in December 2014 at 02/04-20, which is currently on production.

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

## **List of Appendices**

Appendix A: Well List and Well Status

Appendix B: Injection Pattern Summary

Appendix C: Average Monthly Injection Pressures

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

00/08-20-007-28W1/0

00/09-20-007-28W1/0

## Appendix A

UWI	Well Status
100/01-20-007-28W1/00	Capable of OIL Prod
100/02-20-007-28W1/00	Capable of OIL Prod
100/03-20-007-28W1/00	Capable of OIL Prod
100/04-20-007-28W1/00	Capable of OIL Prod
102/04-20-007-28W1/00	Capable of OIL Prod
102/05-20-007-28W1/00	Capable of OIL Prod
103/05-20-007-28W1/00	Capable of OIL Prod
100/08-20-007-28W1/00	WTR Injection
100/09-20-007-28W1/00	WTR Injection
100/12-20-007-28W1/00	Capable of OIL Prod
100/13-20-007-28W1/00	Capable of OIL Prod
100/16-20-007-28W1/00	Capable of OIL Prod
102/16-20-007-28W1/00	Capable of OIL Prod



## Appendix B

### Ewart Unit No. 8 Pattern Summary as of December 2017

Pattern Name	Injector Location (007-28W1)	Status	No. of Supported Wells	Supported Wells (007-28W1)	Allocation Factor	Pattern Prod Start Month	Inj Start Month	Oil Rate (m³/d)	Water Rate (m³/d)	WOR (m³/m³)	Water Injection (m³/d)	Cum Oil (E³m³)	Cum Water (E³m³)	Cum Inj Water (E³m³)	Monthly VRR	Cum VRR
00/08-20-007-28 Injector	00/05-20	Water Injection	7	02/04-20, 03/05-20 01-20, 02-20, 03-20, 04-20, 02/05-20	0.5 1.0	Aug 2006	Dec 2015	5.43	6.98	1.29	18.0	24.4	23.1	12.4	1.408	0.253
00/09-20-007-28 Injector	00/12-20	Water Injection	5	03/05-20, 13-20, 16-20, 02/16-20 12-20	0.5 1.0	Dec 2004	Jul 2015	4.65	7.99	1.72	18.7	21.1	20.7	17.3	1.438	0.400

## Appendix C

### Average Monthly Injection Pressure (kPag)

Month	100/08-20	100/09-20
Jun-15	0	0
Jul-15	0	-19
Aug-15	0	-76
Sep-15	0	132
Oct-15	0	385
Nov-15	0	1630
Dec-15	-61	2508
Jan-16	778	2985
Feb-16	2515	3200
Mar-16	2962	3356
Apr-16	2710	3391
May-16	3835	4032
Jun-16	3229	4084
Jul-16	3287	3962
Aug-16	3459	3904
Sep-16	3278	4454
Oct-16	3276	4953
Nov-16	3357	4912
Dec-16	3628	4949
Jan-17	3860	4937
Feb-17	4464	4972
Mar-17	5324	4933
Apr-17	5680	4972
May-17	5884	4968
Jun-17	6044	5617
Jul-17	6110	6232
Aug-17	6261	6363
Sep-17	6253	6363
Oct-17	6110	6280
Nov-17	5583	5575
Dec-17	6411	6485

## **Appendix D**

### **Rates and VRR Plots**

# Pattern: 00/08-20-007-28Inj Set: EwartUnit#8

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 1.36 m3/m3

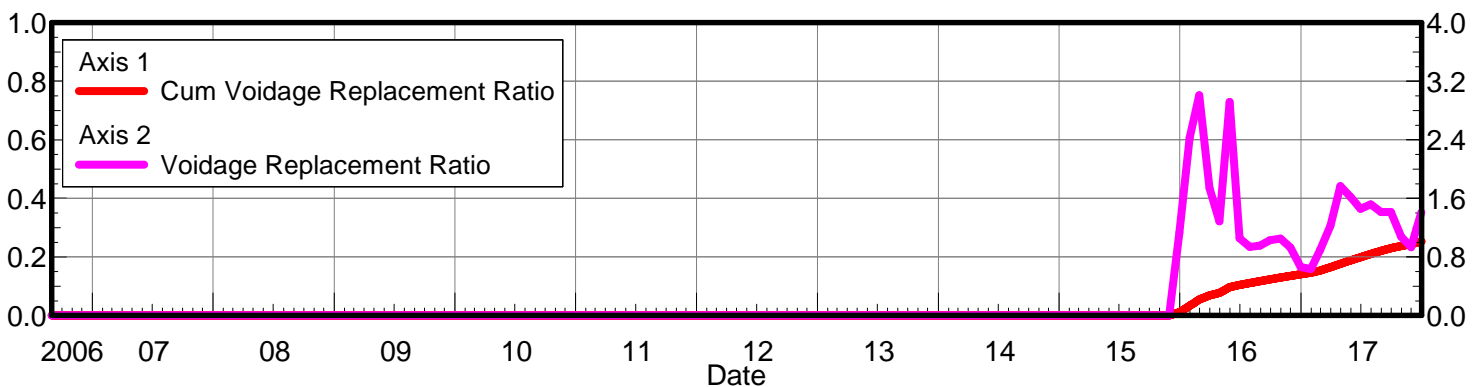
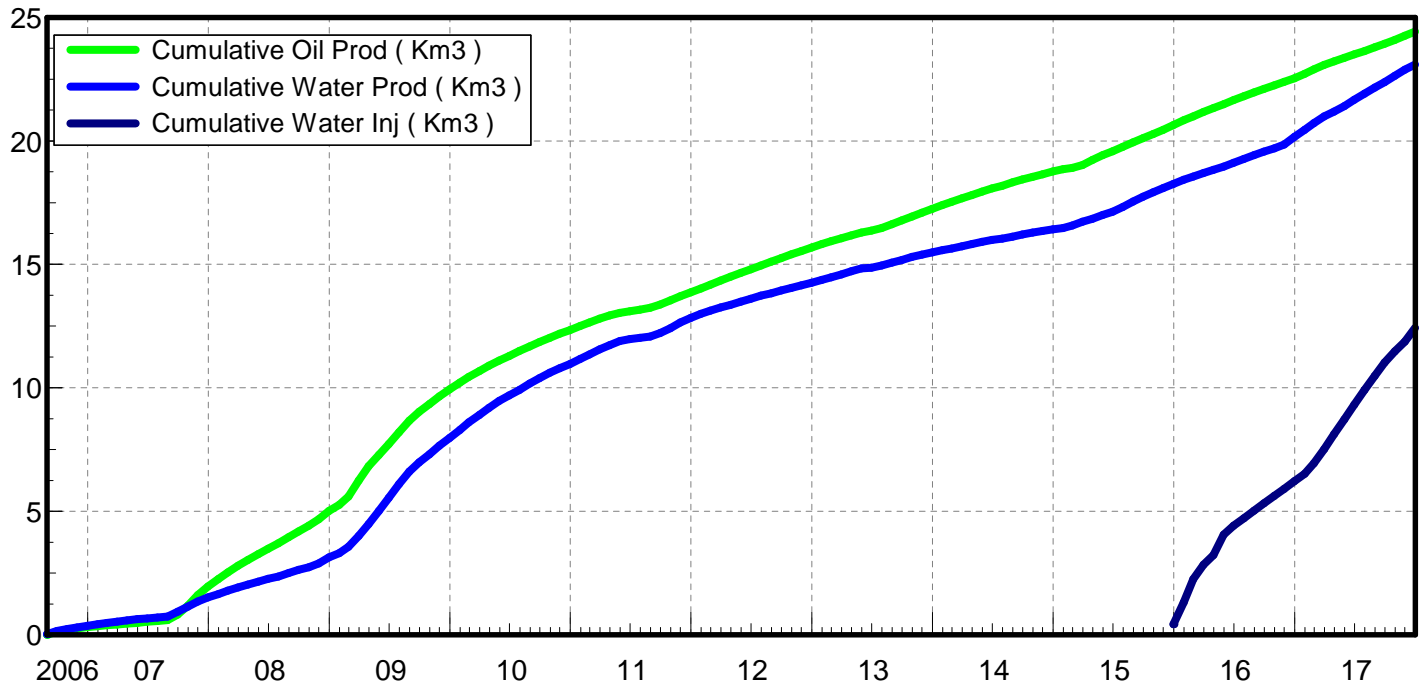
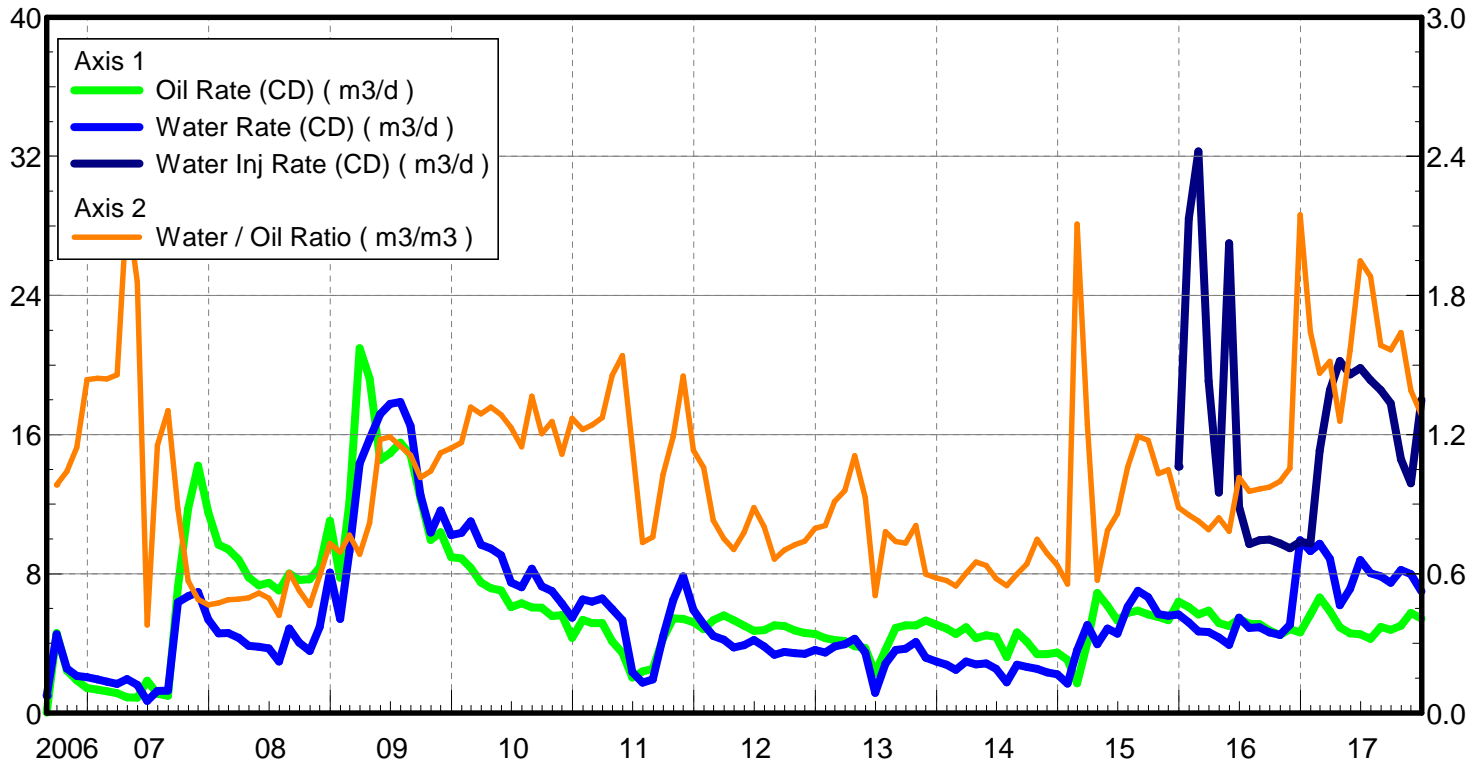
March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 5.43 m3/d

Water Rate (CD) : 6.98 m3/d

Water Inj Rate (CD) : 18.00 m3/d



# Pattern: 00/09-20-007-28Inj Set: EwartUnit#8

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 1.97 m3/m3

March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 4.65 m3/d

Water Rate (CD) : 7.99 m3/d

Water Inj Rate (CD) : 18.65 m3/d

