

**EWART UNIT NO. 2  
WATERFLOOD EOR PROJECT  
ANNUAL REPORT FOR 2016**

**April 21, 2017**

**Tundra Oil and Gas Partnership**

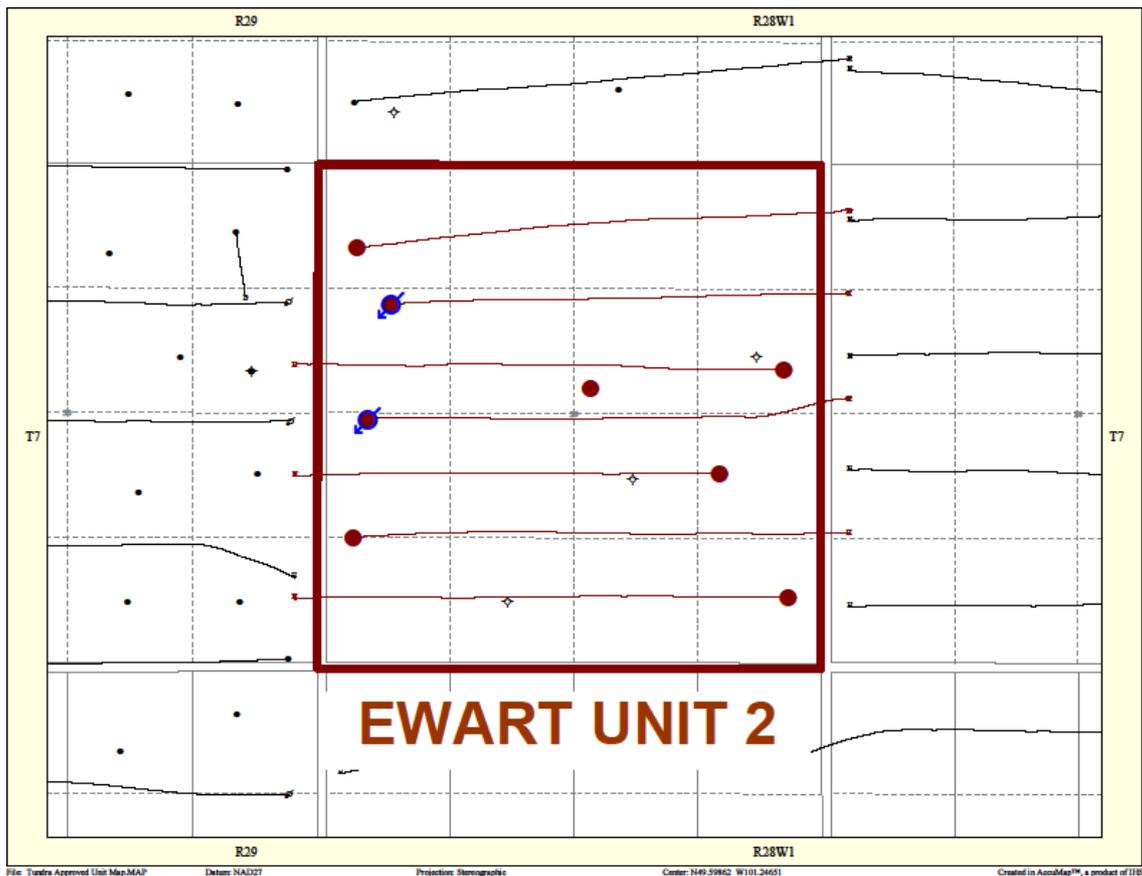
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100/05-29-007-28W1	
102/05-29-007-28W1	
100/12-29-007-28W1	

## **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 5 producing horizontal wells, 2 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 2016 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 2015, the Unit was producing 3.42 m<sup>3</sup>/d of oil and 13.69 m<sup>3</sup>/d of water and the average WOR was 3.83 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**

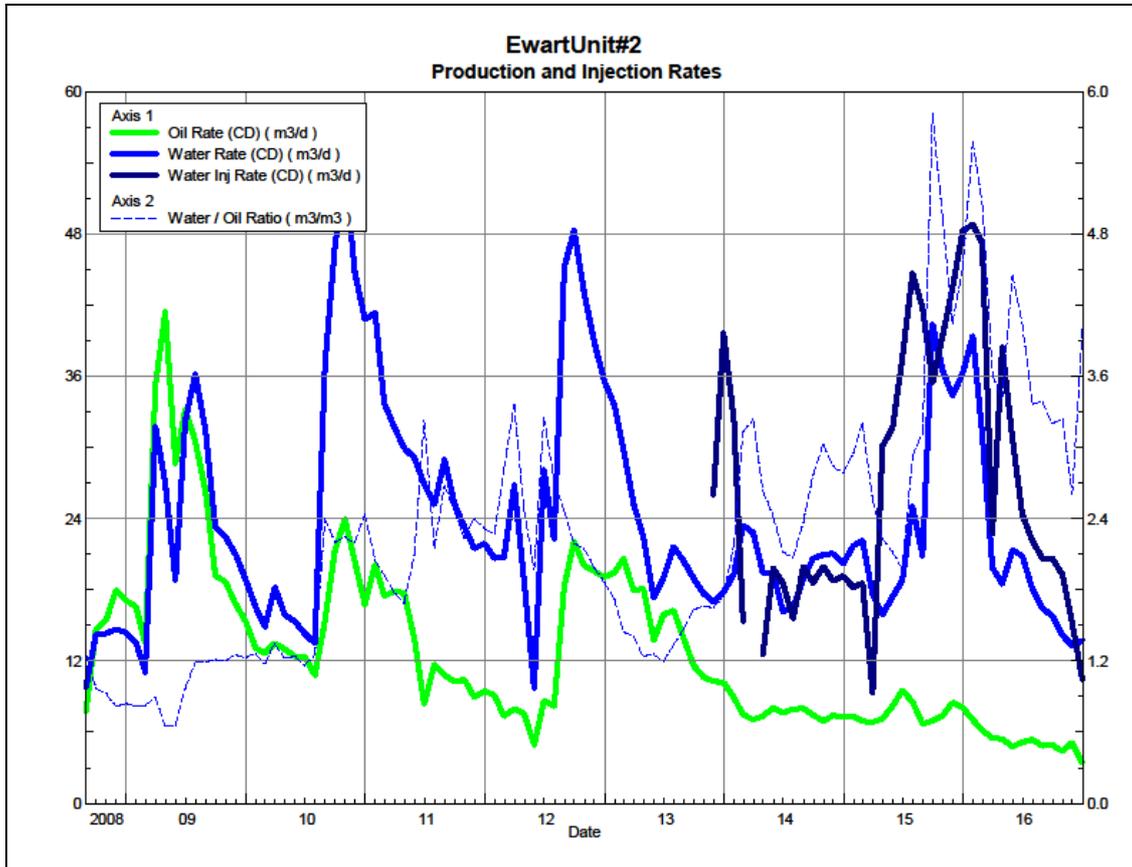
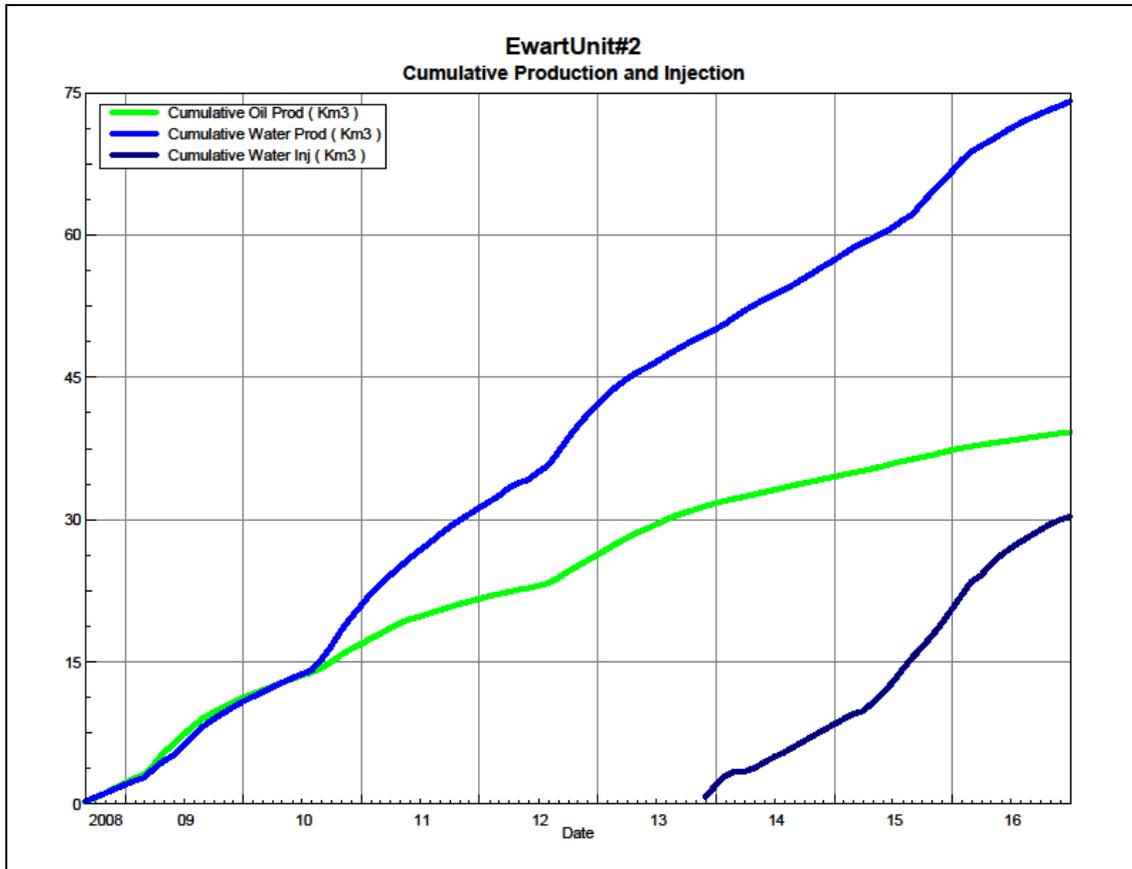


Figure 3 shows the cumulative production for Ewart Unit No. 2 to the end of December 2016 as 39.2 e<sup>3</sup>m<sup>3</sup> of oil, and 74.1 e<sup>3</sup>m<sup>3</sup> of water, representing a 13.5% recovery factor of the OOIP. The cumulative water injected is 30.3 e<sup>3</sup>m<sup>3</sup>.

**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 2016. 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. Tundra expects to convert the 00/05-29-007-28W1 (00/05-29) producer to an injector in Q3 2017.

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 will be sourced from the 16-32-007-29W1 well (Lodgepole formation). The water is treated at the 03-04-008-29W1 battery where it is filtered to 0.5 microns and has scale inhibitor 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 2016.

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

102.09-29-007-28W1.00	Pump Change	03/04/2016
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### **Waterflood Performance Discussion**

At the end of 2016, Ewart Unit No. 2 waterflood area had 2 injection patterns in place. Since water injection started in November 2013, there is no waterflood analysis that can be done at this time. Tundra currently plans to produce the 00/05-29 producer until the latter part of 2017 and then convert it to an injector.

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 2016**

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	Capable of Oil Production	2	01-29, 08-29	0.5	Aug 2008	-	1.8	4.5	2.48	-	16.1	17.6	0.0	0.000	0.000
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	0.7	1.4	2	4.2	9.5	16.5	10.0	1.949	0.376
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	3.6	16.83	6.3	5.4	23.5	20.3	1.650	0.692

## 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

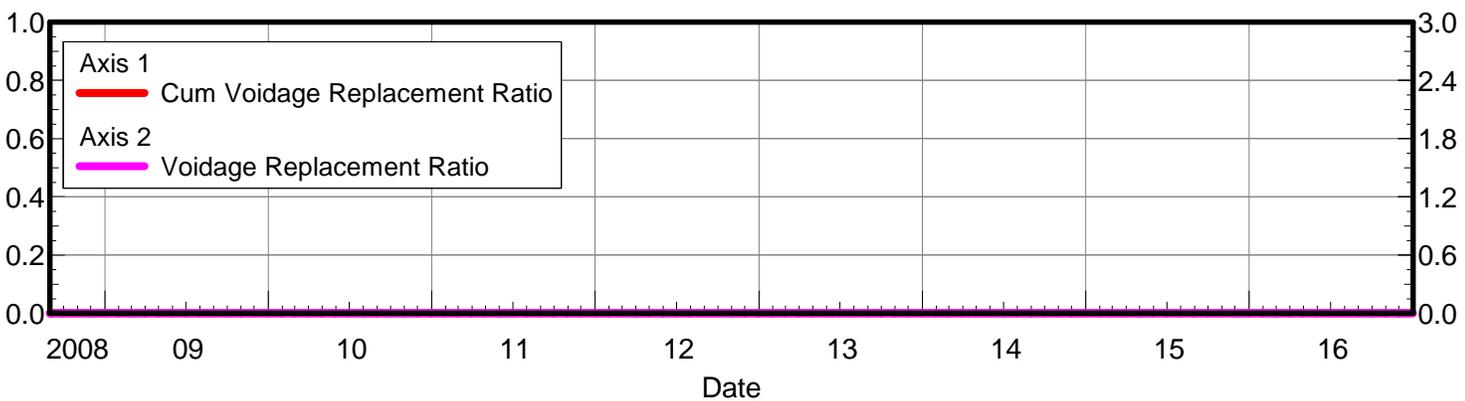
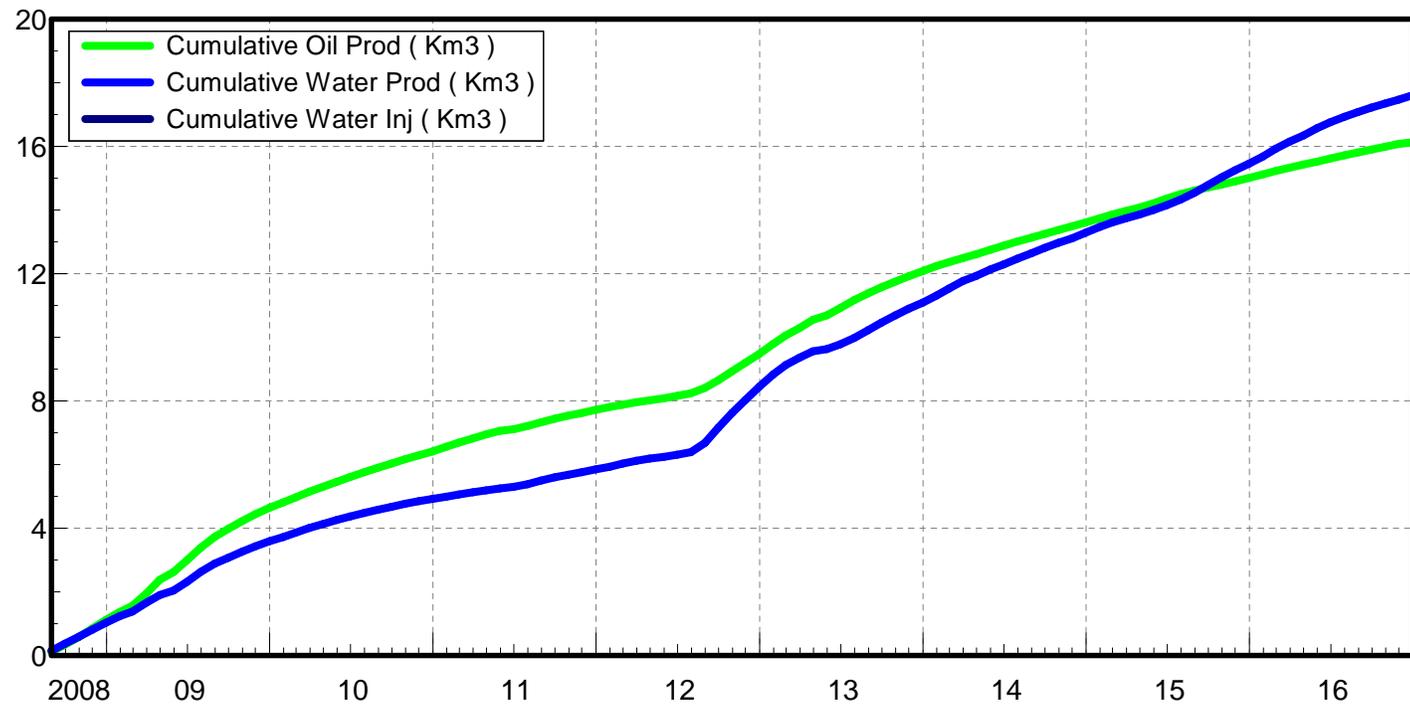
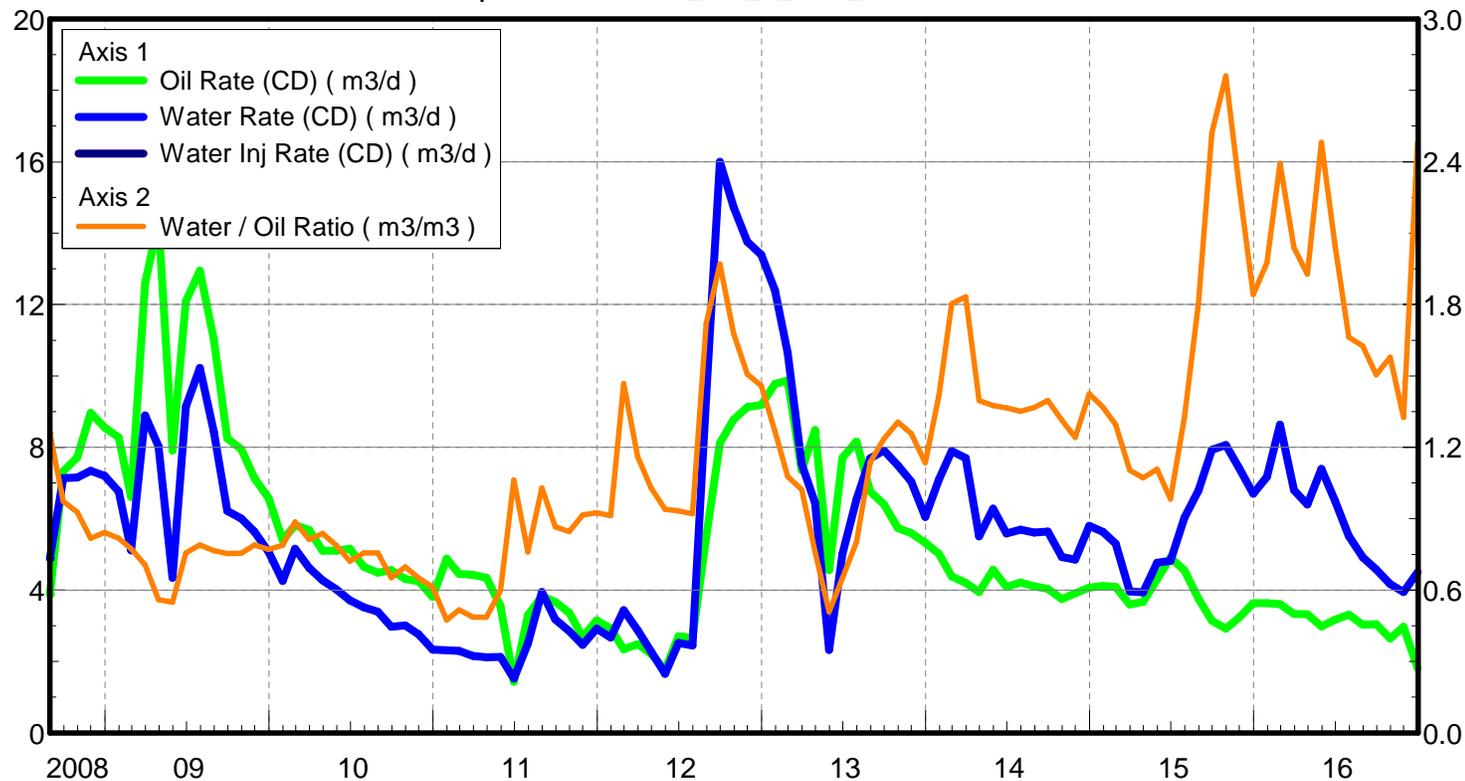
## Appendix C

### Average Monthly Injection Pressure (kPag)

Month	102/05-29	100/12-29
Mar-13	0	0
Apr-13	0	0
May-13	0	0
Aug-13	0	0
Sep-13	0	0
Oct-13	0	0
Nov-13	0	0
Dec-13	0	0
Jan-14	0	568
Feb-14	0	1057
Mar-14	0	1100
Apr-14	0	705
May-14	0	1234
Jun-14	0	1815
Jul-14	0	1582
Aug-14	0	2246
Sep-14	0	2477
Oct-14	0	2799
Nov-14	0	2999
Dec-14	0	3092
Jan-15	0	3105
Feb-15	0	3331
Mar-15	0	3331
Apr-15	-18	3308
May-15	86	3404
Jun-15	710	3576
Jul-15	1444	3801
Aug-15	2031	3816
Sep-15	1595	3591
Oct-15	2044	3547
Nov-15	1958	3847
Dec-15	2690	4286
Jan-16	3087	4502
Feb-16	3287	4626
Mar-16	680	4251
Apr-16	1629	4567
May-16	1034	4860
Jun-16	37	4949
Jul-16	-83	4977
Aug-16	316	5130
Sep-16	653	4975
Oct-16	450	4977
Nov-16	588	4515
Dec-16	667	3635

## **Appendix D**

### **Rates and VRR Plots**



April 21, 2017

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

