

**EBOR UNIT NO. 2**  
**WATERFLOOD EOR PROJECT**  
**ANNUAL REPORT FOR 2012**

**March 1, 2013**

**Tundra Oil and Gas Partnership**

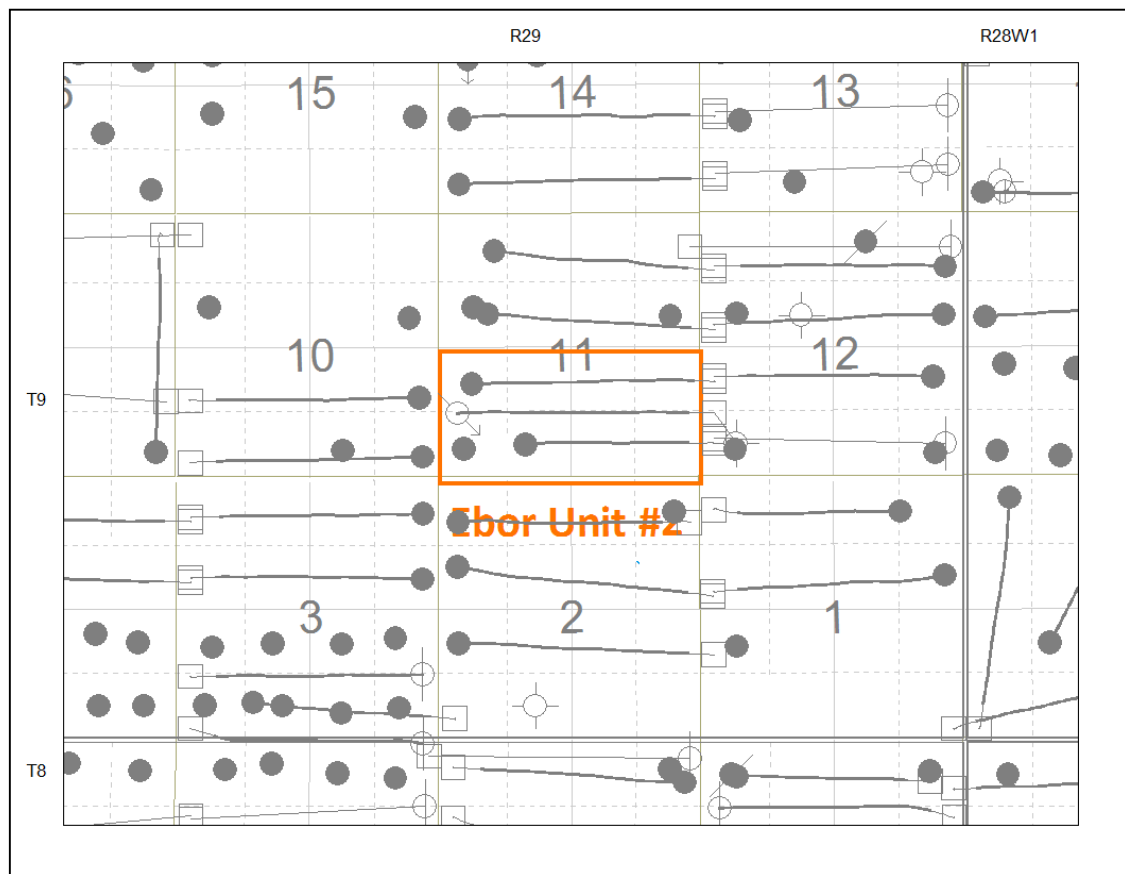
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## **INTRODUCTION**

Ebor Unit No. 2 Enhanced Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No. 20 effective March 2010 with Tundra Oil and Gas (Tundra) as Operator. The EOR project area, outlined in Orange in Figure 1, contains 4 wells in the South half of Section 11 in Township 9, Range 29 W1. A well list and status is included as Appendix A.

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



In accordance with Section 73 of the Manitoba Drilling and Production Regulation, Tundra submits the following 2012 Annual Progress Report for Ebor Unit No. 2 as required by Waterflood Order No 20.

## **DISCUSSION**

### **Production History**

For the wells included in Ebor Unit No. 2, production started in August 2007 with 00/04-11-009-29W1/0. Oil production peaked at 17.65 m<sup>3</sup>/d in January of 2009, when 00/05-11-009-29W1/0 came on production. In December 2012, the Unit was producing

2.32 m<sup>3</sup>/d of oil and 11.72 m<sup>3</sup>/d of water. The water oil ratio (WOR) averaged 3.51 m<sup>3</sup>/m<sup>3</sup> in 2012. The rates and WOR are presented in Figure 2.

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

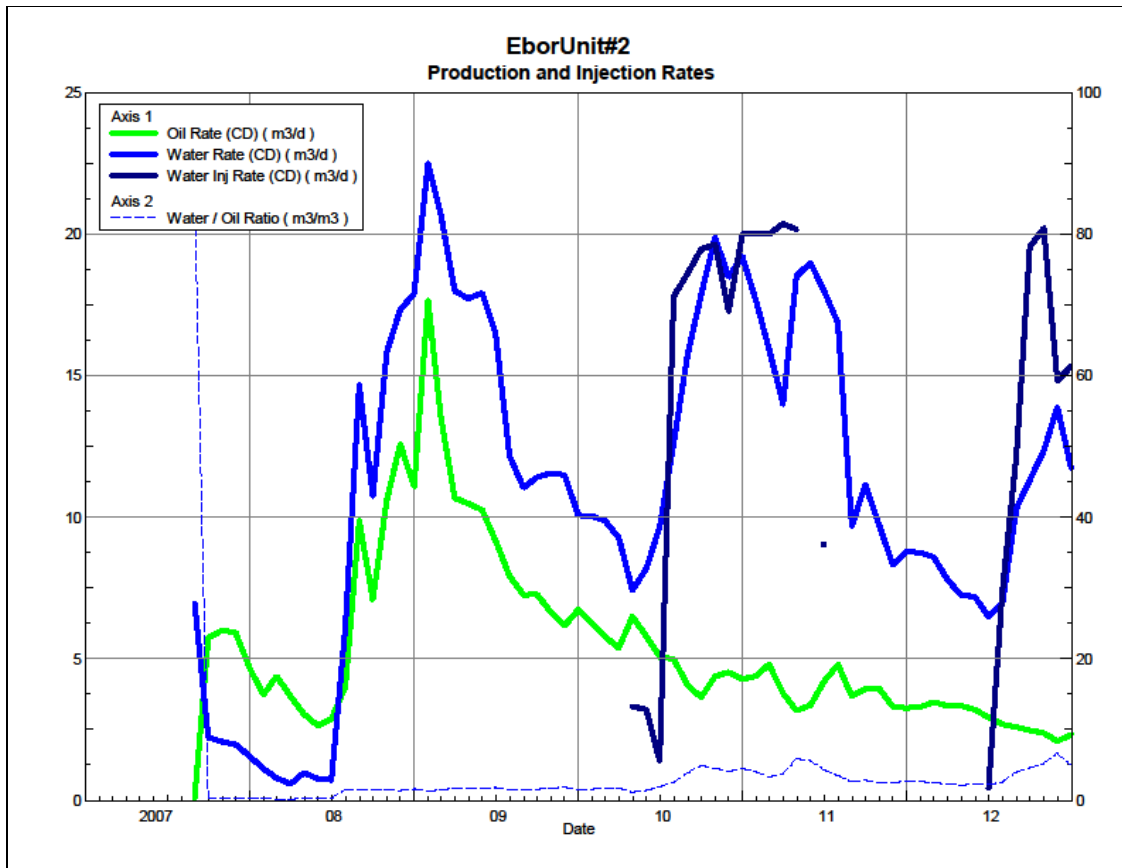
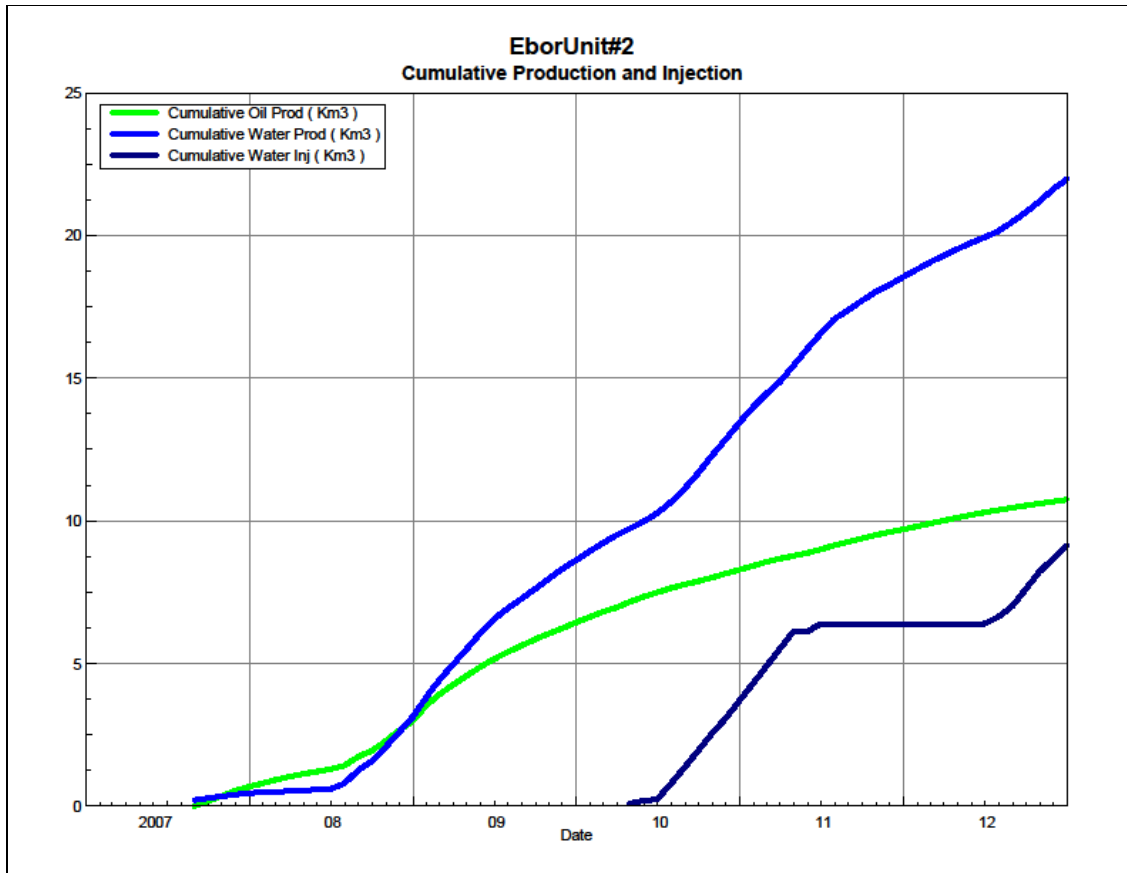


Figure 3 shows the cumulative production for Ebor Unit No. 2 to the end of December 2012 as 10.75 E<sup>3</sup>m<sup>3</sup> of oil, and 21.98 E<sup>3</sup>m<sup>3</sup> of water, representing a 4.7 % recovery factor of the OOIP. Cumulative water injected at the end of 2012 is 9.14 E<sup>3</sup>m<sup>3</sup>.

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



### **Waterflood Development Plan**

The Ebor Unit No. 2 has one horizontal water injector, 02/04-11-009-29W1/2 (02/04-11), which started injecting in April 2010. Injection for this unit was suspended in June 2011, to try and mitigate the water breakthrough that had occurred at 00/05-11-009-29W1 (00/05-11) in July 2010.

The 02/04-11 injector had a very high reservoir pressure (~6559 kPaa) when it was placed on injection. It is Tundra's belief that placing an injector with such high reservoir pressure leads to premature water breakthrough. The learning's from this Unit has played a major role in Tundra's new protocol of producing the newly drilled injector wells first prior to putting them on injection to clean-up the area near the wellbore and to reduce the pressure surrounding the injection well. This should lead to better waterflood performance and minimize premature breakthroughs.

It is evident in Figure 2, that since shutting in the injection at 02/04-11 well, the amount of water being produced from this Unit has decreased without substantially sacrificing the oil production. It is our belief that once the pressure is relieved from this injector, the breakthrough channel that was created between the 02/04-11 and 00/05-11 wells should relax and heal. At that point, we will restart injection to displace oil towards the producers

instead of recycling water as was happening until the middle of 2011. Cumulative water injection for this well is  $9.14 \text{ E}^3\text{m}^3$  as of the end of 2012.

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 Ebor Unit No. 2 is 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**

The monthly wellhead injection pressures for 02/04-11 are summarized in Appendix C. The injection pressures in April and May 2010 are pre-hydraulic fracture. The injection rates during these months were low and hence the well was fractured after which the injection rates improved but lead to a water breakthrough at 00/05-11 well.

### **Reservoir Pressure**

No reservoir pressure measurements were taken at Ebor Unit No. 2 in 2012.

### **Well Servicing**

Table 1 lists the maintenance that was required in Ebor Unit No. 2 in 2012.

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

00/05-11-009-29W1/0	Pump Change	09/07/2012
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### **Voidage Replacement**

As discussed earlier, the injection was suspended in June 2011. The cumulative VRR had been on a decline with final cumulative VRR for Dec 2011 being 0.221. Tundra restarted injection in Ebor Unit No. 2 in June 2012, to understand if the water channels have been healed from relieving the pressure in this Unit. In December 2012, the monthly VRR was 1.079 and the cumulative VRR for Ebor Unit No. 2 was 0.273.

### **Waterflood Performance Discussion**

At yearend 2012, Ebor Unit No. 2 waterflood area had 1 injector pattern in place. Water injection started in the April 2010 and was suspended in June 2011. In June 2012, injection was restarted. Plots and tables of the production and injection data along with the VRR information are presented in Appendix D.

## **List of Appendices**

Appendix A: Ebor Unit No. 2 Well List and Status

Appendix B: Ebor Unit No. 2 Injection Pattern Summary

Appendix C: Monthly Injection Wellhead Pressures Table

Appendix D: Production/Injection Rates, Cumulatives and VRRs



## Appendix A

UWI	Surface Location	Well Status
00/03-11-009-29W1/0	04-12-009-29W1	Capable of Oil Production
00/04-11-009-29W1/0		Capable of Oil Production
02/04-11-009-29W1/2	02/04-12-009-29W1	WTR Injection
00/05-11-009-29W1/0	05-12-009-29W1	Capable of Oil Production

## Appendix B

### Ebor Unit No. 2 Pattern Summary as of December 2012

Pattern Name	Injector BH Location (009-29W1)	Injector Surf Location (009-29W1)	Status	Supported Wells (009-29W1)	No. of Supported Wells	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
02/04-11-09-29W1/2 Injector	02/04-11	02/04-12	Water Injection	03-11, 04-11, 05-11	3	1	Aug 2007	Apr 2010	2.32	11.72	5.05	15.3	10.8	22.0	9.1	1.1	0.27

## Appendix C

Month	102/04-11
Mar-10	-
Apr-10	4663
May-10	5158
Jun-10	0
Jul-10	0
Aug-10	0
Sep-10	0
Oct-10	0
Nov-10	0
Dec-10	0
Jan-11	0
Feb-11	0
Mar-11	94
Apr-11	481
May-11	540
Jun-11	703
Jul-11	750
Aug-11	0
Sep-11	0
Oct-11	0
Nov-11	0
Dec-11	0
Jan-12	0
Feb-12	0
Mar-12	0
Apr-12	0
May-12	0
Jun-12	0
Jul-12	73
Aug-12	0
Sep-12	140
Oct-12	975
Nov-12	881
Dec-12	693

**Appendix D**  
**Rates and VRR**  
**Plots and Tables**

# Pattern: 02/04-11-009-29Inj Set: EborUnit#2

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 5.05 m3/m3

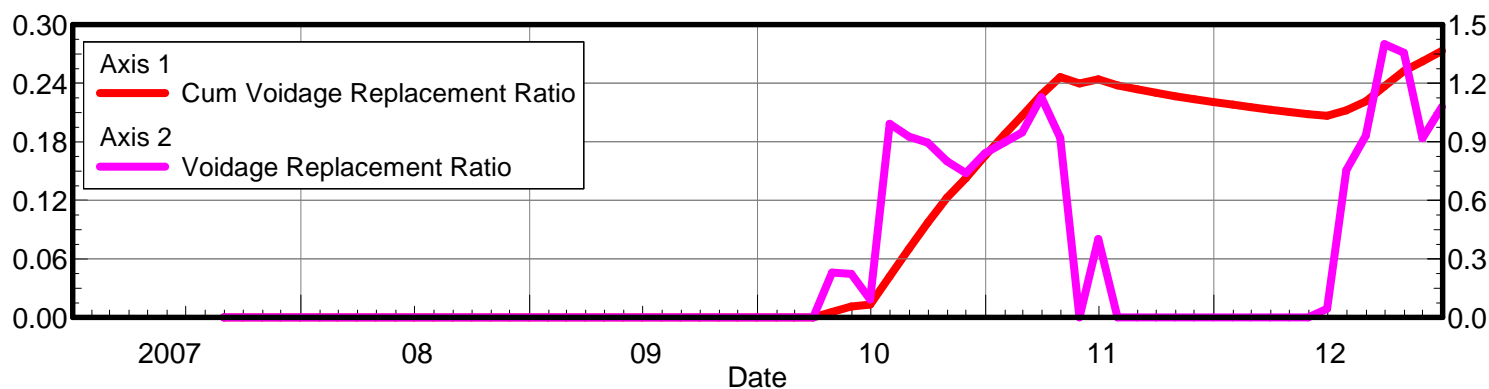
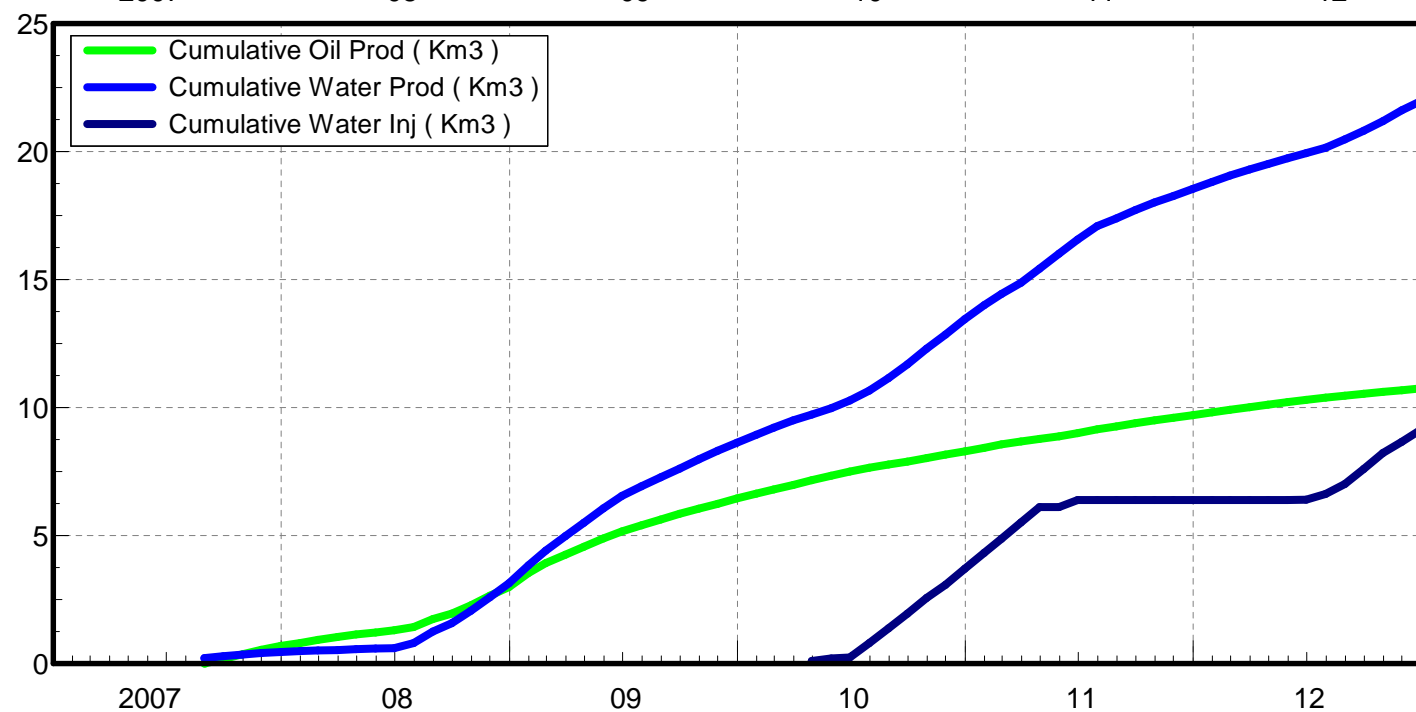
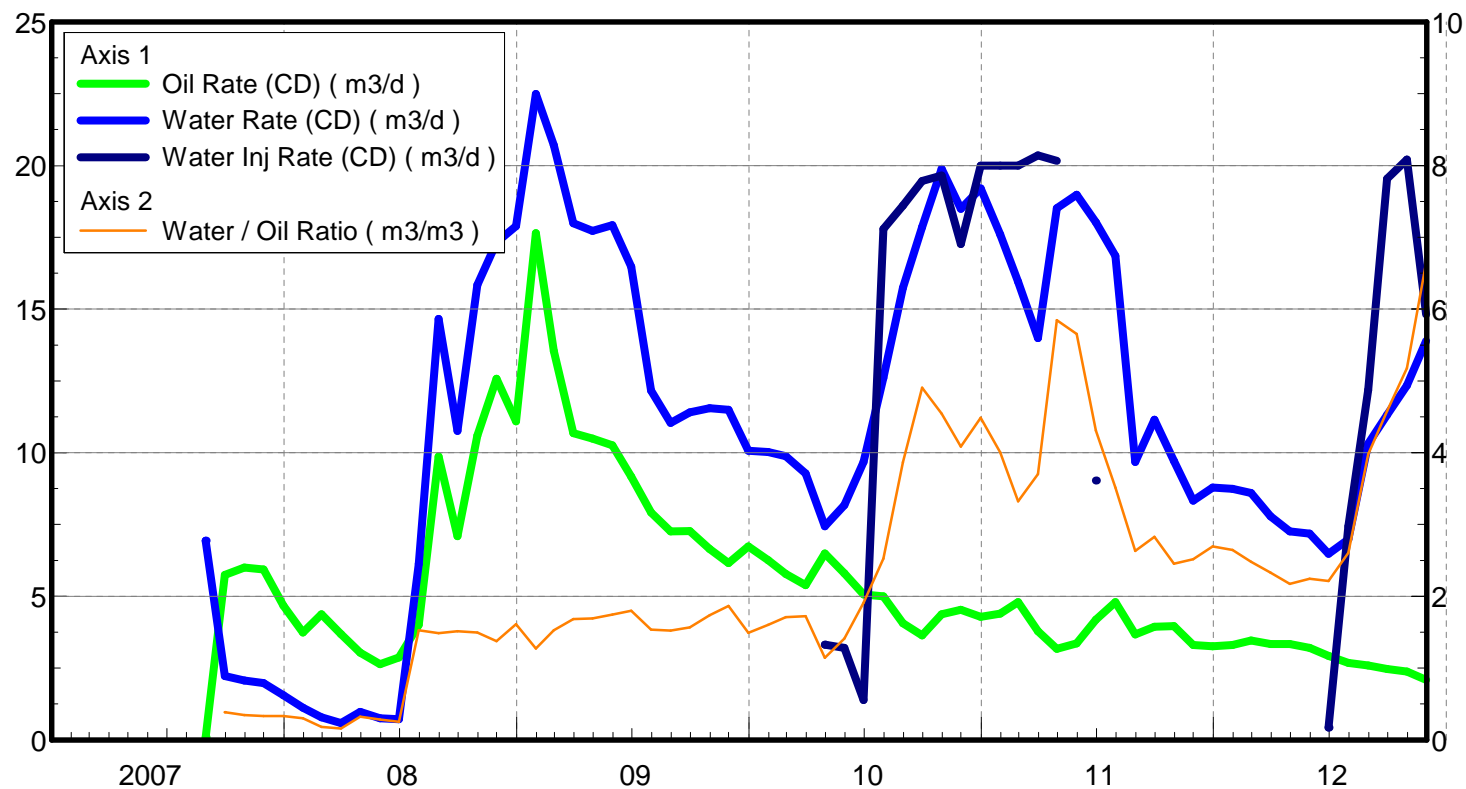
February 21, 2013

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 2.32 m3/d

Water Rate (CD) : 11.72 m3/d

Water Inj Rate (CD) : 15.33 m3/d



Date	Oil Rate (CD) m3/d	Water Rate (CD) m3/d	Water Oil Ratio m3/m3	Water Inj Rate (CD) m3/d	Cum Oil Prod Km3	Cum Water Prod Km3	Cum Water Inj Km3	Voidage Replacement Ratio	Cum Voidage Replacemt Ratio
8/31/2007	0.08	6.94	86.04		0.00	0.22	0.00	0.000	0.000
9/30/2007	5.74	2.22	0.39		0.17	0.28	0.00	0.000	0.000
10/31/2007	6.01	2.07	0.34		0.36	0.35	0.00	0.000	0.000
11/30/2007	5.93	1.98	0.33		0.54	0.41	0.00	0.000	0.000
12/31/2007	4.67	1.56	0.33		0.68	0.45	0.00	0.000	0.000
1/31/2008	3.74	1.12	0.30		0.80	0.49	0.00	0.000	0.000
2/29/2008	4.38	0.79	0.18		0.93	0.51	0.00	0.000	0.000
3/31/2008	3.68	0.58	0.16		1.04	0.53	0.00	0.000	0.000
4/30/2008	3.04	0.98	0.32		1.13	0.56	0.00	0.000	0.000
5/31/2008	2.63	0.75	0.29		1.21	0.58	0.00	0.000	0.000
6/30/2008	2.87	0.72	0.25		1.30	0.60	0.00	0.000	0.000
7/31/2008	4.01	6.12	1.53		1.42	0.79	0.00	0.000	0.000
8/31/2008	9.87	14.66	1.48		1.73	1.25	0.00	0.000	0.000
9/30/2008	7.10	10.76	1.52		1.94	1.57	0.00	0.000	0.000
10/31/2008	10.59	15.84	1.50		2.27	2.06	0.00	0.000	0.000
11/30/2008	12.58	17.32	1.38		2.65	2.58	0.00	0.000	0.000
12/31/2008	11.09	17.89	1.61		2.99	3.14	0.00	0.000	0.000
1/31/2009	17.65	22.49	1.27		3.54	3.83	0.00	0.000	0.000
2/28/2009	13.55	20.71	1.53		3.92	4.41	0.00	0.000	0.000
3/31/2009	10.68	17.99	1.68		4.25	4.97	0.00	0.000	0.000
4/30/2009	10.49	17.73	1.69		4.56	5.50	0.00	0.000	0.000
5/31/2009	10.26	17.92	1.75		4.88	6.06	0.00	0.000	0.000
6/30/2009	9.16	16.48	1.80		5.16	6.55	0.00	0.000	0.000
7/31/2009	7.92	12.16	1.54		5.40	6.93	0.00	0.000	0.000
8/31/2009	7.26	11.04	1.52		5.63	7.27	0.00	0.000	0.000
9/30/2009	7.27	11.41	1.57		5.85	7.61	0.00	0.000	0.000
10/31/2009	6.65	11.55	1.74		6.05	7.97	0.00	0.000	0.000
11/30/2009	6.16	11.49	1.87		6.24	8.32	0.00	0.000	0.000
12/31/2009	6.74	10.06	1.49		6.45	8.63	0.00	0.000	0.000
1/31/2010	6.26	10.03	1.60		6.64	8.94	0.00	0.000	0.000
2/28/2010	5.78	9.88	1.71		6.80	9.22	0.00	0.000	0.000
3/31/2010	5.38	9.28	1.72		6.97	9.50	0.00	0.000	0.000
4/30/2010	6.49	7.43	1.15	3.32	7.16	9.73	0.10	0.231	0.006
5/31/2010	5.80	8.18	1.41	3.21	7.34	9.98	0.20	0.223	0.011
6/30/2010	5.06	9.67	1.91	1.39	7.50	10.27	0.24	0.092	0.013
7/31/2010	4.99	12.60	2.52	17.79	7.65	10.66	0.79	0.992	0.042
8/31/2010	4.07	15.74	3.87	18.61	7.78	11.15	1.37	0.926	0.070
9/30/2010	3.64	17.86	4.91	19.47	7.89	11.68	1.95	0.895	0.097
10/31/2010	4.37	19.88	4.54	19.65	8.02	12.30	2.56	0.800	0.123
11/30/2010	4.53	18.49	4.08	17.27	8.16	12.86	3.08	0.740	0.143
12/31/2010	4.28	19.20	4.49	20.00	8.29	13.45	3.70	0.841	0.166
1/31/2011	4.39	17.60	4.01	20.00	8.43	14.00	4.32	0.897	0.188
2/28/2011	4.80	15.95	3.32	20.00	8.56	14.44	4.88	0.948	0.207
3/31/2011	3.78	13.99	3.70	20.35	8.68	14.88	5.51	1.129	0.228
4/30/2011	3.17	18.51	5.85	20.17	8.77	15.43	6.12	0.921	0.246
5/31/2011	3.36	18.98	5.65		8.88	16.02	6.12	0.000	0.240
6/30/2011	4.18	18.02	4.31	9.03	9.00	16.56	6.39	0.402	0.244
7/31/2011	4.79	16.86	3.52		9.15	17.08	6.39	0.000	0.238

Date	Oil Rate (CD) m3/d	Water Rate (CD) m3/d	Water Oil Ratio m3/m3	Water Inj Rate (CD) m3/d	Cum Oil Prod Km3	Cum Water Prod Km3	Cum Water Inj Km3	Voidage Replacement Ratio	Cum Voidage Replacemt Ratio
8/31/2011	3.68	9.68	2.63		9.26	17.38	6.39	0.000	0.234
9/30/2011	3.94	11.15	2.83		9.38	17.72	6.39	0.000	0.230
10/31/2011	3.96	9.72	2.45		9.51	18.02	6.39	0.000	0.227
11/30/2011	3.31	8.33	2.52		9.60	18.27	6.39	0.000	0.224
12/31/2011	3.26	8.79	2.69		9.71	18.54	6.39	0.000	0.221
1/31/2012	3.30	8.75	2.65		9.81	18.81	6.39	0.000	0.218
2/29/2012	3.47	8.59	2.48		9.91	19.06	6.39	0.000	0.215
3/31/2012	3.34	7.78	2.33		10.01	19.30	6.39	0.000	0.213
4/30/2012	3.34	7.26	2.17		10.11	19.52	6.39	0.000	0.211
5/31/2012	3.20	7.19	2.25		10.21	19.74	6.39	0.000	0.208
6/30/2012	2.93	6.48	2.21	0.43	10.30	19.94	6.40	0.044	0.207
7/31/2012	2.68	6.98	2.61	7.44	10.38	20.15	6.63	0.755	0.212
8/31/2012	2.59	10.31	3.98	12.18	10.46	20.47	7.01	0.931	0.221
9/30/2012	2.47	11.31	4.58	19.54	10.54	20.81	7.59	1.400	0.237
10/31/2012	2.38	12.34	5.18	20.21	10.61	21.20	8.22	1.357	0.253
11/30/2012	2.09	13.89	6.65	14.82	10.67	21.61	8.66	0.919	0.262
12/31/2012	2.32	11.72	5.05	15.33	10.75	21.98	9.14	1.079	0.273