

**SINCLAIR UNIT NO. 3**  
**WATERFLOOD EOR PROJECT**  
  
**ANNUAL REPORT FOR 2014**

**May 1, 2015**

**Tundra Oil and Gas Partnership**

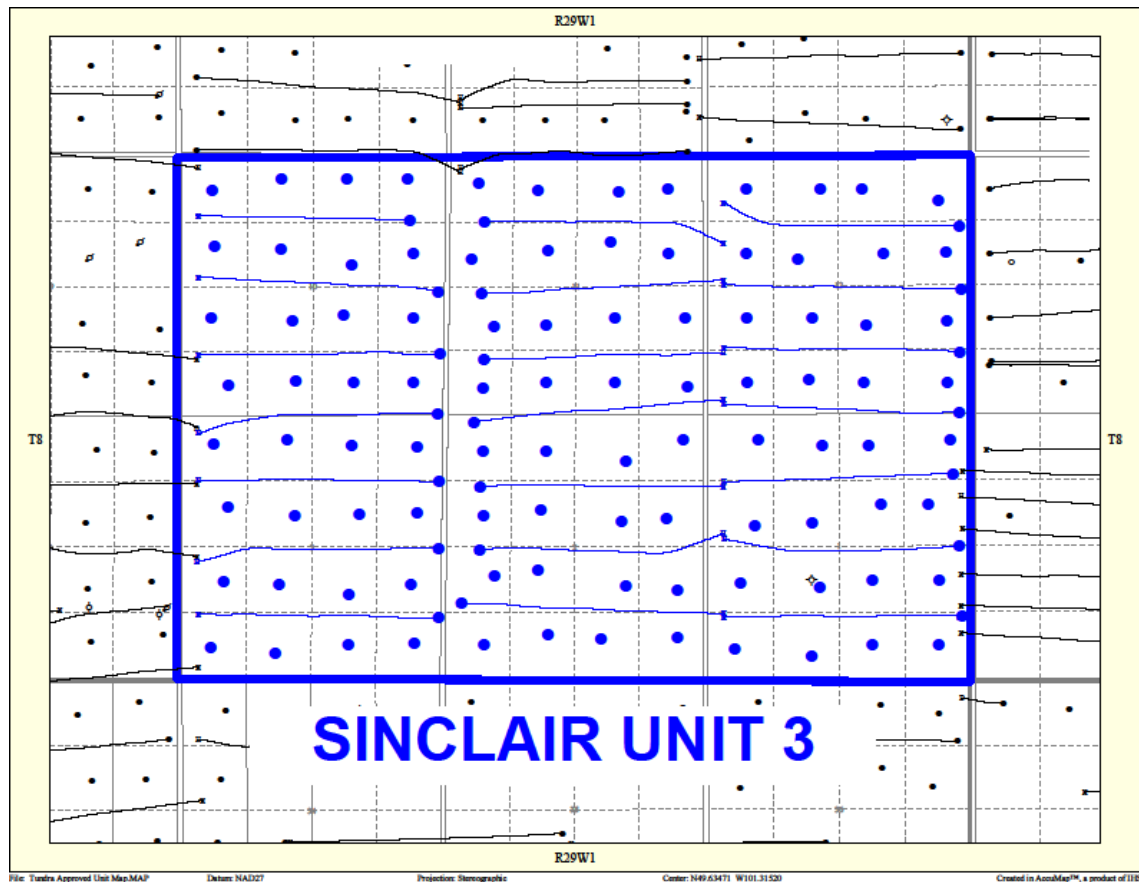
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## **INTRODUCTION**

Sinclair Unit No. 3 Enhanced Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No 18 effective November 1, 2009 with Tundra Oil and Gas (Tundra) as Operator. The EOR project area contains 98 producing wells and 19 horizontal injectors in 6 sections in Township 8, Range 29 W1 as shown in the figure below.

**Figure 1: Sinclair Unit No. 3 Area Outline**



In accordance with Section 73 of the Manitoba Drilling and Production Regulation, Tundra hereby submits the 2014 Annual Progress Report for Sinclair Unit No. 3 as required by Waterflood Order No 18.

## **DISCUSSION**

### **Production History**

For the wells included in Sinclair Unit No. 3, production started in November 2004 with the 00/09-10-008-29W1 and 00/16-10-008-29W1 wells. Oil production peaked at 4.9 m<sup>3</sup>/d in September of 2006. This production was coming from 96 wells and totaled 468 m<sup>3</sup>/d for the whole Unit. Water injection began in July 2010. Water injection rates were 297.4 m<sup>3</sup>/d in December 2014 through 20 wells and the Unit was producing 156.3 m<sup>3</sup>/d of oil and 95.3 m<sup>3</sup>/d of water. The rates and WOR are plotted in Figure 2.

**Figure 2: Sinclair Unit No. 3 Production/Injection Rates and WOR vs Time**

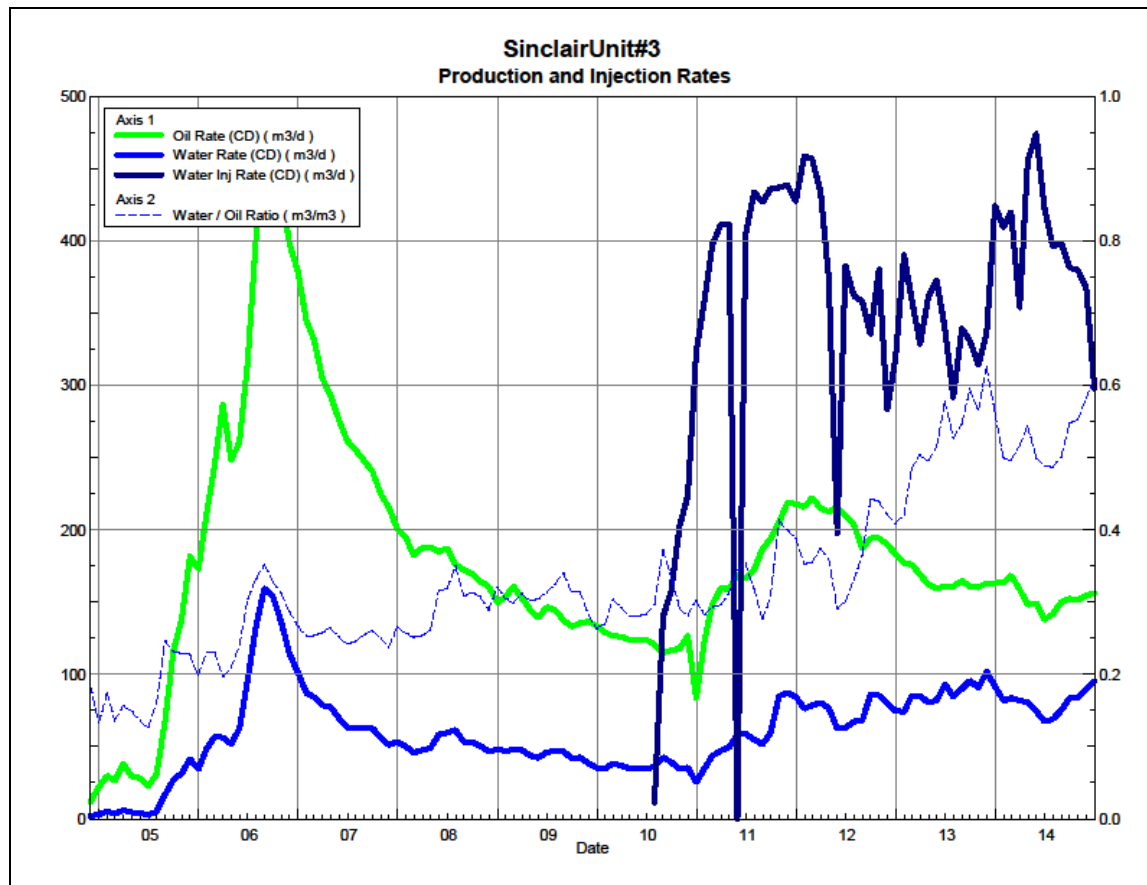
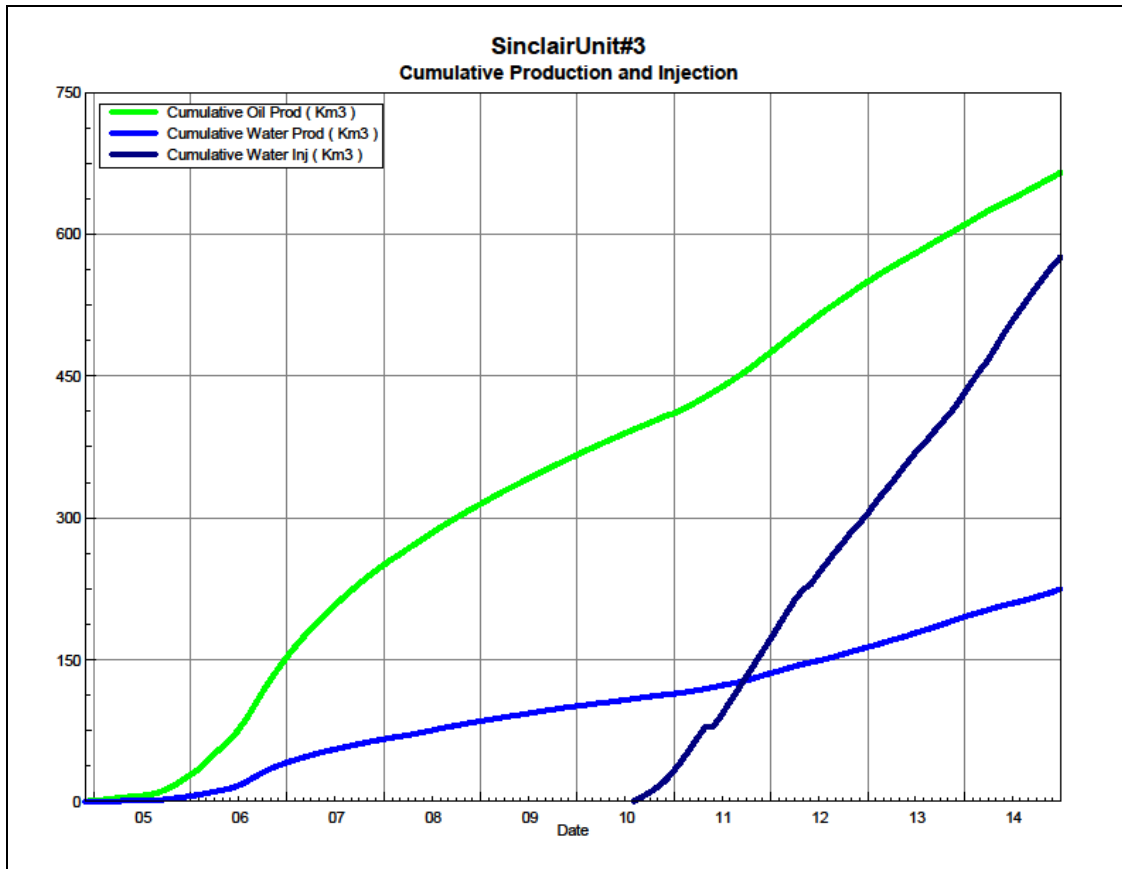


Figure 3 shows the cumulative production for Sinclair Unit No. 3 to the end of December 2014 as 665 e<sup>3</sup>m<sup>3</sup> of oil and 225 e<sup>3</sup>m<sup>3</sup> of water, representing a 13.6% recovery factor of the OOIP. The cumulative water injected is 576 E<sup>3</sup>m<sup>3</sup>.

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



## **Waterflood Development Plan**

### **Sinclair Unit No. 3 Waterflood (WF) Development Plan**

Sinclair Unit No. 3 is still in the early stages of water injection, with injection beginning in July 2010. As of December 2014, the Unit has 20 active horizontal injectors. In April 2014, the 02/13-11-008-29W1 well was converted to an injector. It is currently anticipated that the 02/09-12-008-29W1 well will be converted to injector prior to the end of 2015. All injection wells are fracture stimulated to improve the injection rates.

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 Sinclair Unit No. 3 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 pressure, for each injector well, is summarized in Appendix B. Since injection in this Unit is still in the early stages, many of the injectors are still building up to a target injection pressure of 6300 kPaa.

### **Reservoir Pressure**

Where possible, Tundra is committed to collecting pressures from every new injection well drilled. Currently, for Unit 3 the pressure data from 18 locations is available. Appendix A summarizes these results. The pressures were corrected to a common datum of -450 m SS for comparison. The table shows quite a range in pressure, from a low of 2100 kPaa to a high of 4900 kPaa. These values appear reasonable given their location in the pool and the corresponding production voidage in the surrounding area.

### **Well Servicing**

The following table summarizes the well servicing performed within Sinclair Unit No. 3 during 2014:

**Table 1: Sinclair Unit No. 3 Well Servicing**

100.16-01-008-29W1.00	Pump Change	1/29/2014
102.09-12-008-29W1.00	Pump Change	2/10/2014
100.10-03-008-29W1.00	Pump Change	3/20/2014
100.01-12-008-29W1.00	Suspension	3/25/2014
102.05-11-008-29W1.00	Add Frac	7/19/2014
100.08-01-008-29W1.00	Polish Rod Repair	7/29/2014
102.01-01-008-29W1.00	Add Frac	8/22/2014
100.05-11-008-29W1.00	Refrac Bakken Vertical	8/24/2014
100.16-03-008-29W1.00	Refrac Bakken Vertical	8/24/2014
100.07-10-008-29W1.00	Refrac Bakken Vertical	9/4/2014
100.04-02-008-29W1.00	Pump Change	10/30/2014
100.06-02-008-29W1.00	Pump Change	10/30/2014
100.05-03-008-29W1.00	Pump Change	11/3/2014
100.10-11-008-29W1.00	Pump Change	11/24/2014
100.05-10-008-29W1.00	Tubing Leak	11/25/2014

## **Voidage Replacement**

Water is being injected to re-pressurize the reservoir due to cumulative primary production voidage and corresponding pressure depletion. During the initial fill-up period, the instantaneous voidage replacement ratio (VRR) averages approximately 1.25 to 2.0 by individual patterns. The injector pattern VRRs will be discussed in the waterflood performance section of the report.

## **Waterflood Performance Discussion**

At the end of 2014, Sinclair Unit No. 3 waterflood area had 21 injector patterns in place. However, only 20 of these patterns are on active water injection and the remaining pattern should be on injection prior to the end of 2015. Water injection started in July 2010 at the 02/01-03, 03/01-10 and 02/08-10 injectors. From August 2010 to January 2011, 15 additional wells were converted to injectors. All 21 injection patterns are set up with a single horizontal injection well supporting production from four vertical wells to the north and four vertical wells to the south.

An overall summary for each injector pattern is presented in Appendix C. Plots of the production and injection data along with the VRR information are presented in Appendix D for each of the injector patterns.

## List of Appendices

Appendix A: Sinclair Unit No. 3 Reservoir Pressure Summary Table

Appendix B: Monthly Injection Wellhead Pressures Table and Plots

Appendix C: Sinclair Unit No. 3 Injection Pattern Summary

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

02/01-01-008-29W1  
02/09-01-008-29W1  
02/16-01-008-29W1  
02/05-02-008-29W1  
03/05-02-008-29W1  
02/12-02-008-29W1  
02/13-02-008-29W1  
02/01-03-008-29W1  
02/08-03-008-29W1  
02/16-03-008-29W1  
02/01-10-008-29W1  
03/01-10-008-29W1  
02/08-10-008-29W1  
02/16-10-008-29W1  
02/04-11-008-29W1  
02/05-11-008-29W1  
02/13-11-008-29W1  
02/01-12-008-29W1  
03/01-12-008-29W1  
02/08-12-008-29W1  
02/09-12-008-29W1



# Appendix A

## Sinclair Unit #3 - Pressure Summary

### Sinclair Horizontal Well Pressures

-450 m SS (datum depth)  
8.25 kPa/m (pressure gradient)  
93 kPa added to gauge pressure

Location	KB m	Open Hole	mKB	mTVD	MPP mKB	MPP mTVD	MPP mSS	Last Stable P	Pres @ MPP (kPaa)	Corrected to Datum	Start Date	End Date	Shut-in (days)	Last Temp °C
102/01-01-008-29W1/00	510.15	1065.0	1732.5	957.5	966.0	1398.8	961.7	3954	4113	4100	3-Dec-10	18-Dec-10	15	30.8
102/09-01-008-29W1/00	505.33	1051.0	2353.0	948.9	947.3	1702.0	948.1	2299	2430	2489	6-Jul-10	6-Aug-10	31	31.1
102/16-01-008-29W1/00													0	
102/05-02-008-29W1/00	505.07	1064.0	2427.0	950.0	956.13	1745.5	953.1	1857	2107	2124	13-Jul-10	7-Aug-10	25	30.9
103/05-02-008-29W1/00														
102/12-02-008-29W1/00													0	
102/13-02-008-29W1/00	503.82	980.0	2430.0	943.1	951.8	1740.5	947.4	3368	3621	3674	4-Mar-10	8-Jun-10	96	30.4
102/01-03-008-29W1/00	525.98	1086.0	2406.0	982.0	978.75	1746.0	980.4	2772	2901	2865	8-Jun-10	23-Jun-10	15	30.7
102/08-03-008-29W1/00	525.00	1077.5	2428.0	977.6	974.91	1752.8	976.3	1017	2556	2546	28-Jun-10	9-Jul-10	11	28.8
102/16-03-008-29W1/00	525.36	1078.0	2397.0	974.4	980.0	1737.5	977.2	2530	2780	2765	11-Mar-10	29-Jun-10	110	30.5
102/01-10-008-29W1/00	528.28	1090.5	2408.0	975.2	972.48	1749.3	973.8	2878	2619	2655	5-Jul-10	10-Jul-10	5	31.4
103/01-10-008-29W1/00	525.17	1073.0	2402.0	972.1	970.55	1737.5	971.3	2482	3046	3078	30-Jun-10	6-Jul-10	6	31.2
102/08-10-008-29W1/00	528.49	1080.0	2399.0	972.8	968.26	1739.5	970.5	2382	2569	2634	31-May-10	25-Jun-10	25	30.6
102/16-10-008-29W1/00	527.99	1093.5	2218.0	972.2	970.0	1503.0	971.1	3077	3220	3277	25-Jul-11	30-Jul-11	5	31.3
102/04-11-008-29W1/00													0	
102/05-11-008-29W1/00	509.12	1047.0	2380.0	944.9	951.19	1713.5	948.0	4545	4756	4847	15-Jun-10	28-Jul-10	43	30.6
102/13-11-008-29W1/00	511.01	1063.5	2380.0	947.1	951.49	1721.8	949.3	2476	2623	2720	26-Aug-11	5-Sep-11	10	30.2
102/01-12-008-29W1/00	503.78	1037.5	2329.0	943.4	935.64	1683.3	939.5	2976	3131	3249	10-Mar-10	7-Jun-10	89	30.6
103/01-12-008-29W1/00	505.97	1051.0	2342.0	943.8	937.36	1696.5	940.6	4895	4777	4904	15-Jun-10	25-Jul-10	40	30.5
102/08-12-008-29W1/00	508.93	1051.0	2350.0	945.1	935.0	1700.5	940.0	4453	4617	4773	24-Jun-10	24-Jul-10	30	30.2
102/09-12-008-29W1/00	510.02	1064.5	2367.0	943.8	936.16	1715.8	940.0	2751	2865	3030	2-Sep-11	12-Sep-11	10	31.2

Cemented liner - no pressure available

<b>AVERAGE</b>	<b>515.3</b>	<b>1061.9</b>	<b>2338.1</b>	<b>958.5</b>	<b>957.8</b>	<b>1693.1</b>	<b>958.1</b>	<b>-442.9</b>	<b>3219</b>	<b>3278</b>			<b>28.3</b>	<b>30.6</b>
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## Appendix B

### Average Monthly Injection Pressure (kPag)

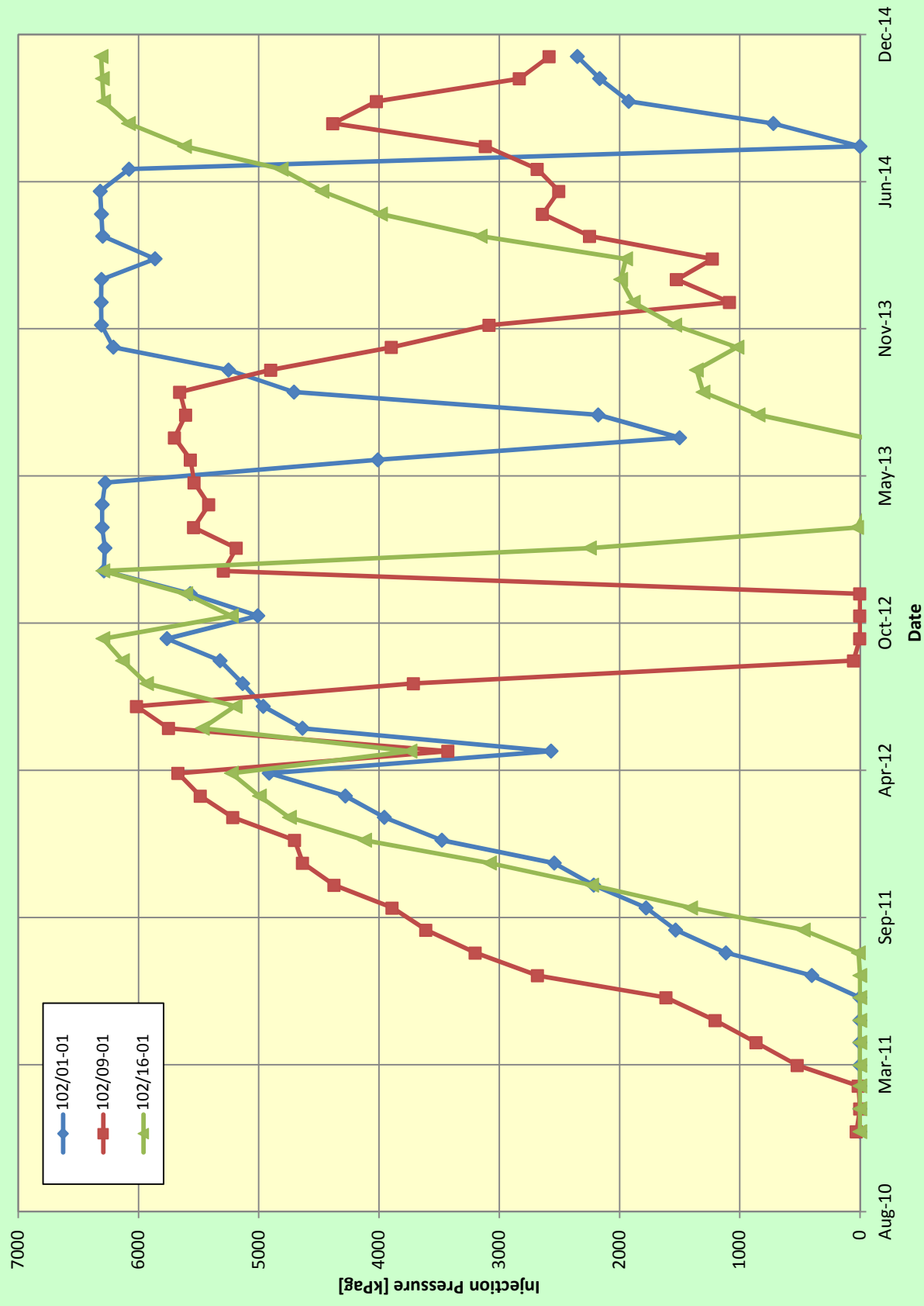
Month	Injection Pressure									
	Section 01			Section 02				Section 03		
	102/01-01	102/09-01	102/16-01	102/05-02	103/05-02	102/12-02	102/13-02	102/01-03	102/08-03	102/16-03
Jul-10	-	-	-	-	-	-	-	0	-	-
Aug-10	-	-	-	-	-	-	0	0	0	0
Sep-10	-	-	-	-	-	-	85	0	0	0
Oct-10	-	0	-	7	-	-	976	0	0	0
Nov-10	-	0	-	0	-	-	1712	0	0	0
Dec-10	-	29	0	213	-	0	3111	810	0	0
Jan-11	0	0	0	0	0	0	4226	1703	35	0
Feb-11	0	13	0	0	0	0	4823	2307	625	225
Mar-11	0	520	0	0	0	0	4826	2811	1156	785
Apr-11	0	863	0	0	0	0	4913	3387	1630	1237
May-11	0	1203	0	0	0	0	4642	3803	2082	1782
Jun-11	0	1611	0	0	0	0	4908	4147	2391	2170
Jul-11	402	2682	0	37	555	477	5461	4629	3181	2600
Aug-11	1116	3200	13	42	1292	1442	5497	4995	3898	2981
Sep-11	1534	3609	471	59	1763	2289	6024	5225	4278	3260
Oct-11	1779	3890	1408	470	1925	2568	6158	5201	4484	3622
Nov-11	2215	4372	2232	1129	2424	3441	6286	4926	4886	4194
Dec-11	2544	4634	3082	1504	2171	4318	6162	4409	5054	4327
Jan-12	3477	4701	4120	2445	3414	4969	6291	5277	5360	4784
Feb-12	3956	5215	4745	3124	3994	5004	6288	5490	5707	5187
Mar-12	4280	5485	4995	3544	4427	4989	6293	5511	5935	5421
Apr-12	4913	5671	5228	4072	3011	5042	6289	5569	6076	5457
May-12	2570	3426	3742	758	557	4013	5284	4209	3929	3495
Jun-12	4636	5750	5469	1103	0	5504	6299	6116	5580	5371
Jul-12	4963	6016	5196	1899	0	5487	6283	6284	5826	5817
Aug-12	5135	3713	5933	3400	0	6060	6262	6305	6225	5933
Sep-12	5323	53	6134	3976	0	6094	6202	6170	6103	5821
Oct-12	5763	0	6296	5084	354	6294	6289	6261	6285	6259
Nov-12	5009	0	5228	4877	695	5086	5780	5643	5585	5551
Dec-12	5570	0	5607	3641	1770	5297	5952	5838	5809	5730
Jan-13	6288	5294	6296	-84	2974	6287	5992	6277	6293	6306
Feb-13	6280	5186	2249	-84	3585	6106	6283	6264	6274	6282
Mar-13	6302	5542	28	352	4568	6278	6219	6300	6284	6304
Apr-13	6302	5415	-73	3393	4993	6298	6287	6320	6305	6304
May-13	6278	5536	-74	4856	5565	6302	6299	6283	6302	6303
Jun-13	4011	5567	-69	5799	5827	4208	6308	6284	6294	6290
Jul-13	1500	5700	-35	4906	6062	-13	6291	6280	6294	6289
Aug-13	2178	5608	847	6265	6257	610	6300	3397	6206	6261
Sep-13	4708	5657	1306	5224	6186	2314	6153	1655	4115	6272
Oct-13	5252	4899	1360	4359	6071	2982	3329	2093	1330	6001
Nov-13	6210	3897	1285	5835	6291	3839	899	2526	1947	6302
Dec-13	6310	3084	1541	6020	6285	5044	3339	3191	3055	6304
Jan-14	6310	1083	1885	6266	6288	5491	5185	4143	3754	6302
Feb-14	6308	1525	1990	6282	6283	5731	5717	4638	4102	6246
Mar-14	5862	1228	1948	5701	5842	5326	5057	4497	3987	5929
Apr-14	6298	2249	3158	6256	6271	6122	6048	5286	4973	6281
May-14	6309	2639	3988	6272	6280	6309	6108	5772	5595	6296
Jun-14	6319	2504	4474	6311	8286	6309	6203	6120	5930	6304
Jul-14	6080	2684	4812	6242	6260	6219	6155	6101	5989	6228
Aug-14	0	3116	5618	6292	6303	6275	6090	7968	6165	6303
Sep-14	721	4383	6084	6305	6292	6315	6138	5249	5235	6286
Oct-14	1923	4020	6290	6288	6295	6301	6076	4933	4908	6300
Nov-14	2165	2833	6301	6242	6259	6262	6150	4755	4714	6283
Dec-14	2350	2585	6311	6265	6172	6309	6203	3990	4053	4555

## Appendix B

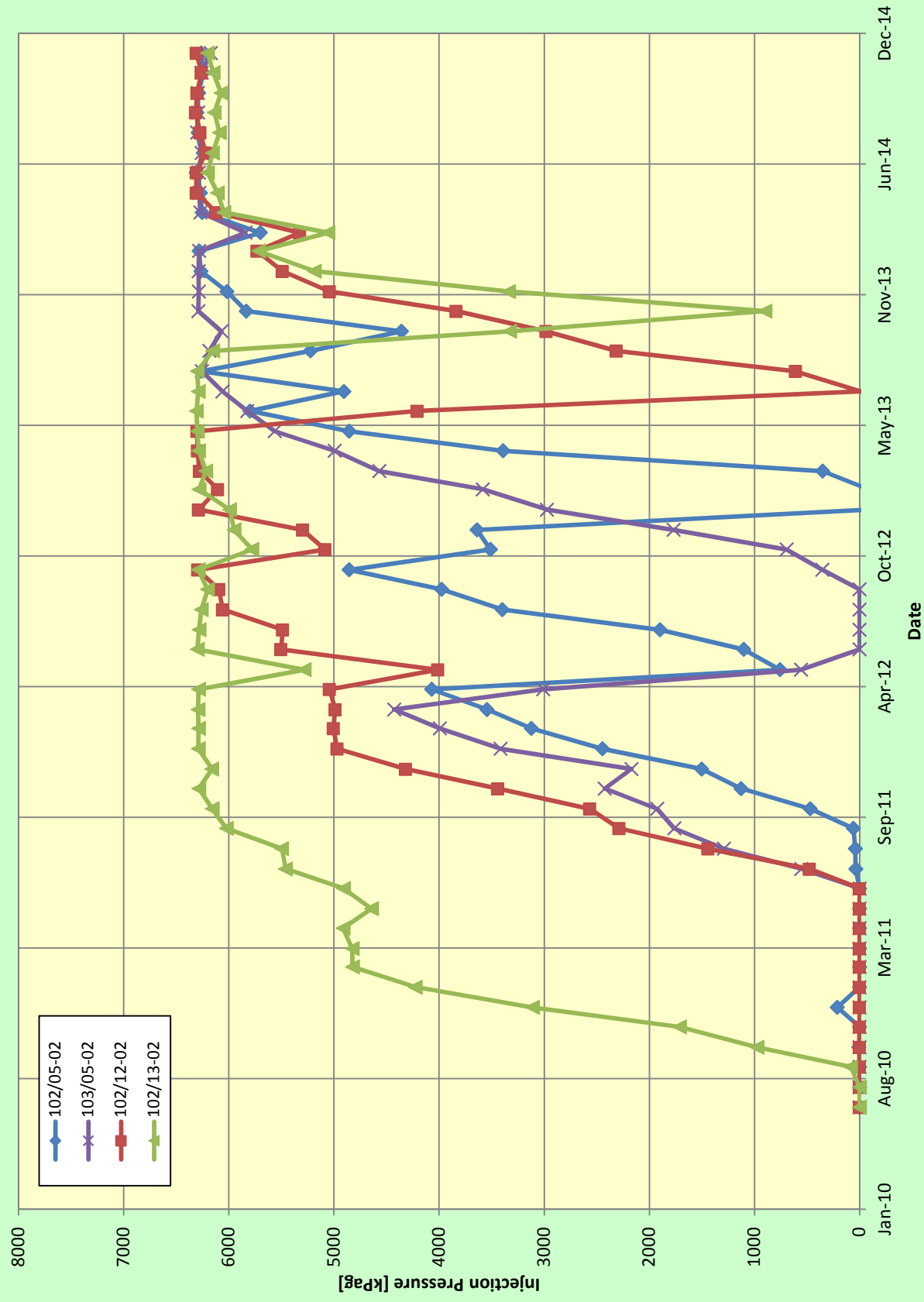
### Average Monthly Injection Pressure (kPag)

	Injection Pressure									
	Section 10				Section 11			Section 12		
Month	102/01-10	103/01-10	102/08-10	102/16-10	102/04-11	102/05-11	102/13-11	102/01-12	103/01-12	102/08-12
Jul-10	-	0	0	-	-	-	-	-	-	-
Aug-10	0	0	0	-	-	-	-	0	-	-
Sep-10	0	0	0	-	-	-	-	0	-	-
Oct-10	0	0	0	-	-	0	-	0	0	0
Nov-10	41	0	0	-	-	57	-	240	0	0
Dec-10	1099	0	0	-	0	119	-	1419	94	361
Jan-11	2288	435	37	-	45	661	-	2392	700	1122
Feb-11	3127	1134	533	-	1104	1996	-	3250	1305	1423
Mar-11	3695	1713	867	-	2226	3185	-	3740	2465	2544
Apr-11	4028	2242	1281	-	3060	3807	-	3925	3130	3045
May-11	4255	2569	1800	-	3561	4255	-	4190	3765	3503
Jun-11	4474	2910	2192	-	3805	4610	-	4487	4253	3773
Jul-11	4979	3505	2551	-	4339	4761	-	4523	4608	4190
Aug-11	5368	4095	2753	-	4648	4889	-	4900	4744	4427
Sep-11	5678	4228	3002	-	4846	4946	-	4994	4880	4592
Oct-11	5749	4520	3257	-	5169	5216	-	5196	4608	4904
Nov-11	6091	5043	3884	-	4993	5399	-	5463	5019	4956
Dec-11	6260	5103	4242	-	5064	5480	-	5513	5176	4989
Jan-12	6255	5525	4680	-	5439	5649	-	5745	5468	5344
Feb-12	6297	5865	4884	-	5009	5858	-	5668	5495	5483
Mar-12	6302	6141	4967	-	5443	6031	-	5408	5501	5478
Apr-12	6209	6190	5355	-	5626	6076	-	5761	5494	5499
May-12	4777	4098	3323	-	4897	5067	-	4490	4325	4166
Jun-12	6254	6289	5318	-	6308	6186	-	5965	5490	5494
Jul-12	6237	6152	5449	-	6304	6275	-	6144	5494	5490
Aug-12	6215	6260	5434	-	6227	6277	-	6259	5781	5760
Sep-12	6161	6142	5273	-	6126	6102	-	6160	6008	5584
Oct-12	6264	6301	5879	-	6300	6298	-	6294	6181	6250
Nov-12	5529	4215	4749	-	5449	5618	-	5614	5493	5355
Dec-12	5878	5302	5494	-	5792	5843	-	5484	5825	5774
Jan-13	6292	6298	6250	-	3875	6603	-	6287	6290	6286
Feb-13	6268	6076	6260	-	3908	6238	-	6279	6380	6187
Mar-13	6295	6308	6292	0	3713	6300	-	6269	6297	6297
Apr-13	6341	6305	6148	-61	4124	6283	-	6295	6298	6290
May-13	6297	6302	6315	-94	4185	6295	-	6296	6298	6299
Jun-13	6303	6297	6334	-91	4094	6294	-	6297	6289	6281
Jul-13	6300	6321	6333	-86	4194	6295	-	6302	6292	6281
Aug-13	6295	2289	6317	-75	1964	6304	-	6314	6123	6289
Sep-13	6199	2880	6266	1	3225	6280	-	5359	6272	6262
Oct-13	5900	3208	5943	434	3695	5844	-	2390	5875	5789
Nov-13	4049	3737	6279	880	3897	6299	-	181	6313	6295
Dec-13	2649	4662	6250	2144	3754	6059	-	688	6236	6238
Jan-14	3886	5482	6235	3095	2678	6041	-	1497	6135	6116
Feb-14	4427	5930	6219	3944	3418	6049	-	2883	6132	6150
Mar-14	4316	5666	5853	3628	4325	5864	-	3247	5458	5784
Apr-14	5442	6193	6235	4970	5652	6062	0	4668	5984	6030
May-14	6243	6301	6317	5634	6068	6077	706	5501	6085	6071
Jun-14	6302	6298	6333	5985	6185	4126	-83	5938	6179	6165
Jul-14	6250	6200	6278	6108	6158	-1923	-71	5890	7675	6119
Aug-14	6303	6303	6330	6301	6063	2896	-78	5907	6057	6021
Sep-14	6105	6307	6220	6313	8217	3523	-77	6058	6104	4723
Oct-14	6145	6306	6301	6302	6056	3815	-75	6016	6038	5988
Nov-14	6236	6294	6264	6276	6069	4089	-45	6079	6076	6024
Dec-14	5532	5306	4764	4742	6179	4405	298	6156	6164	6119

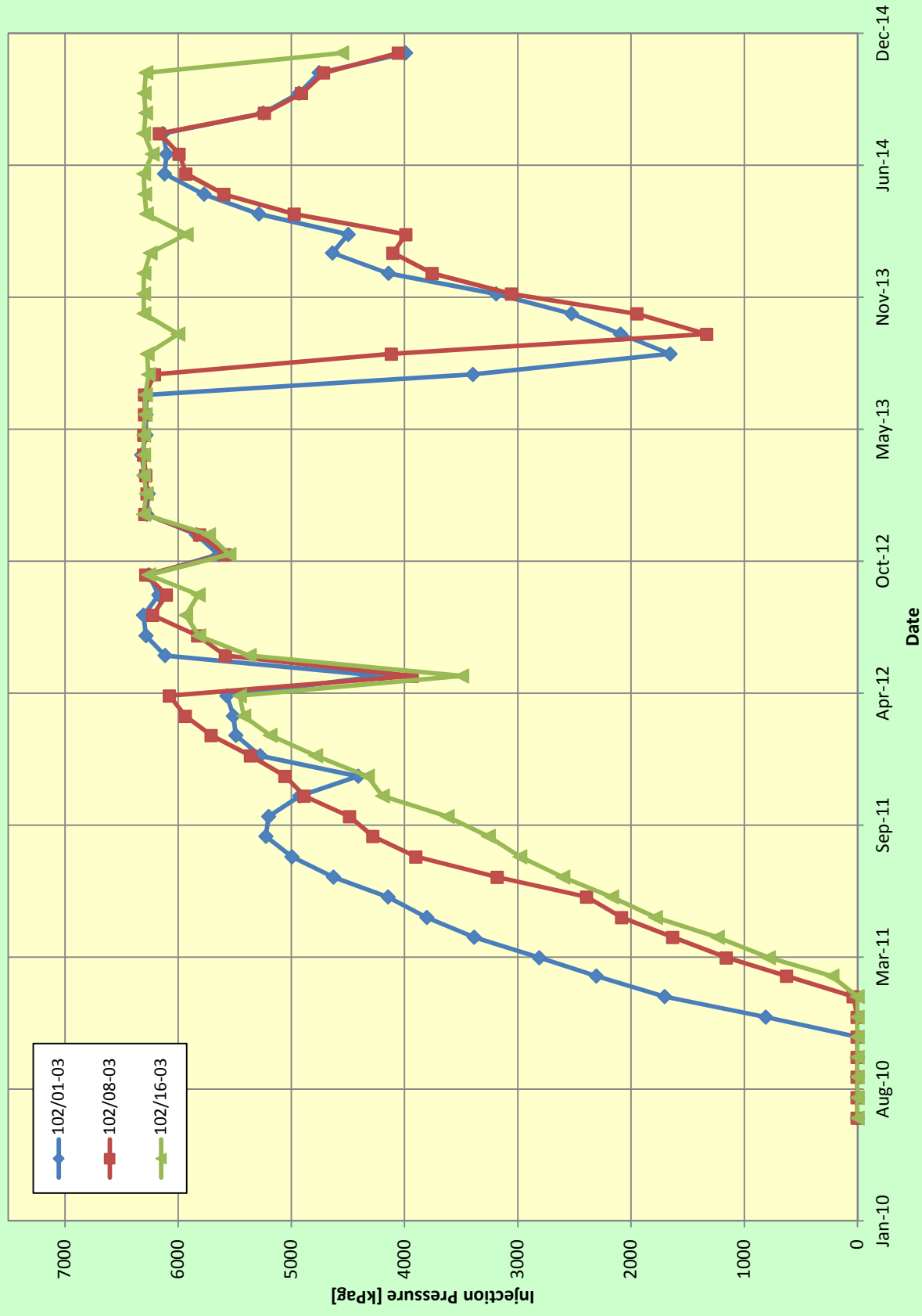
## Section 1 Injection Pressures vs Time



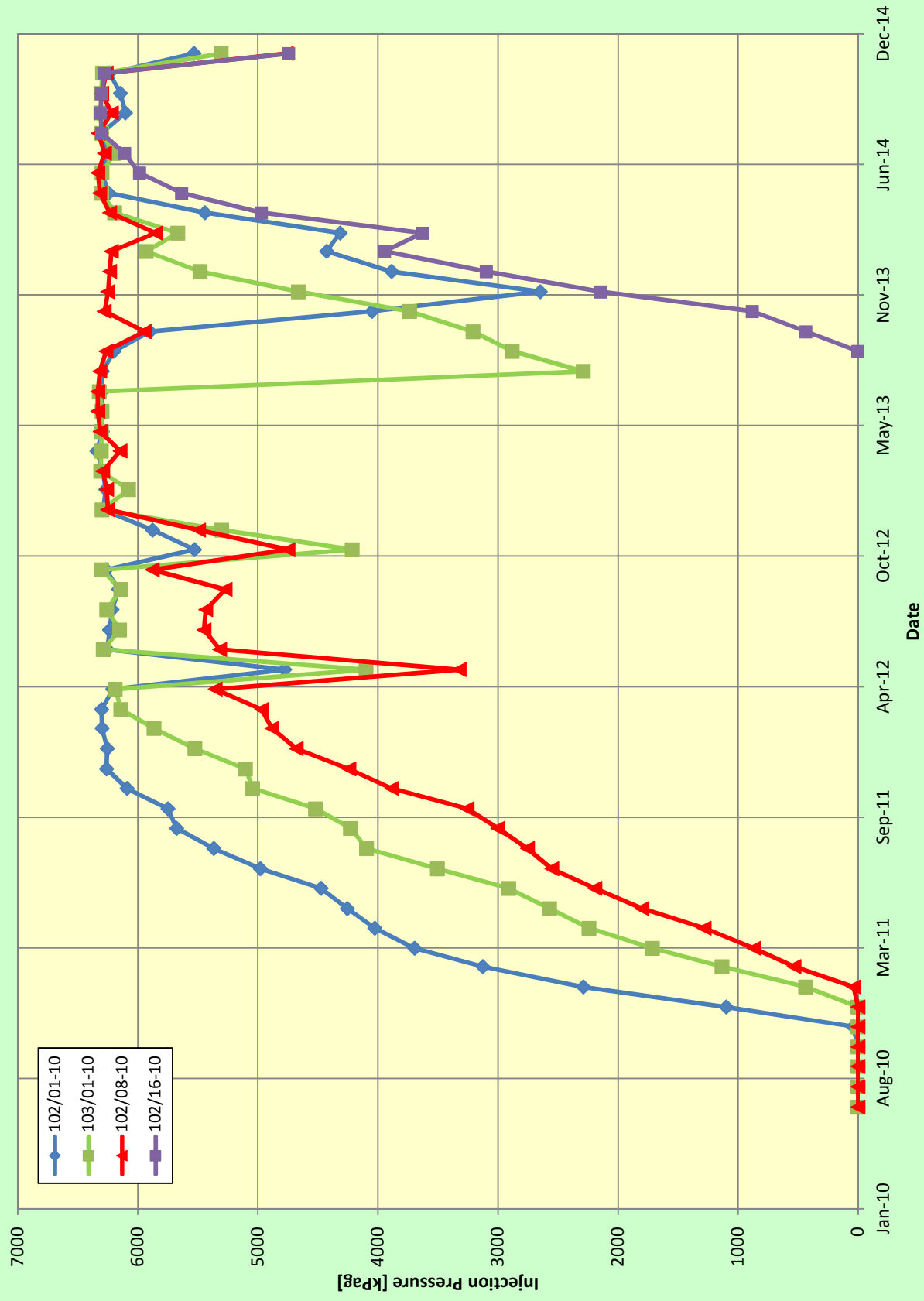
## Section 2 Injection Pressures vs Time



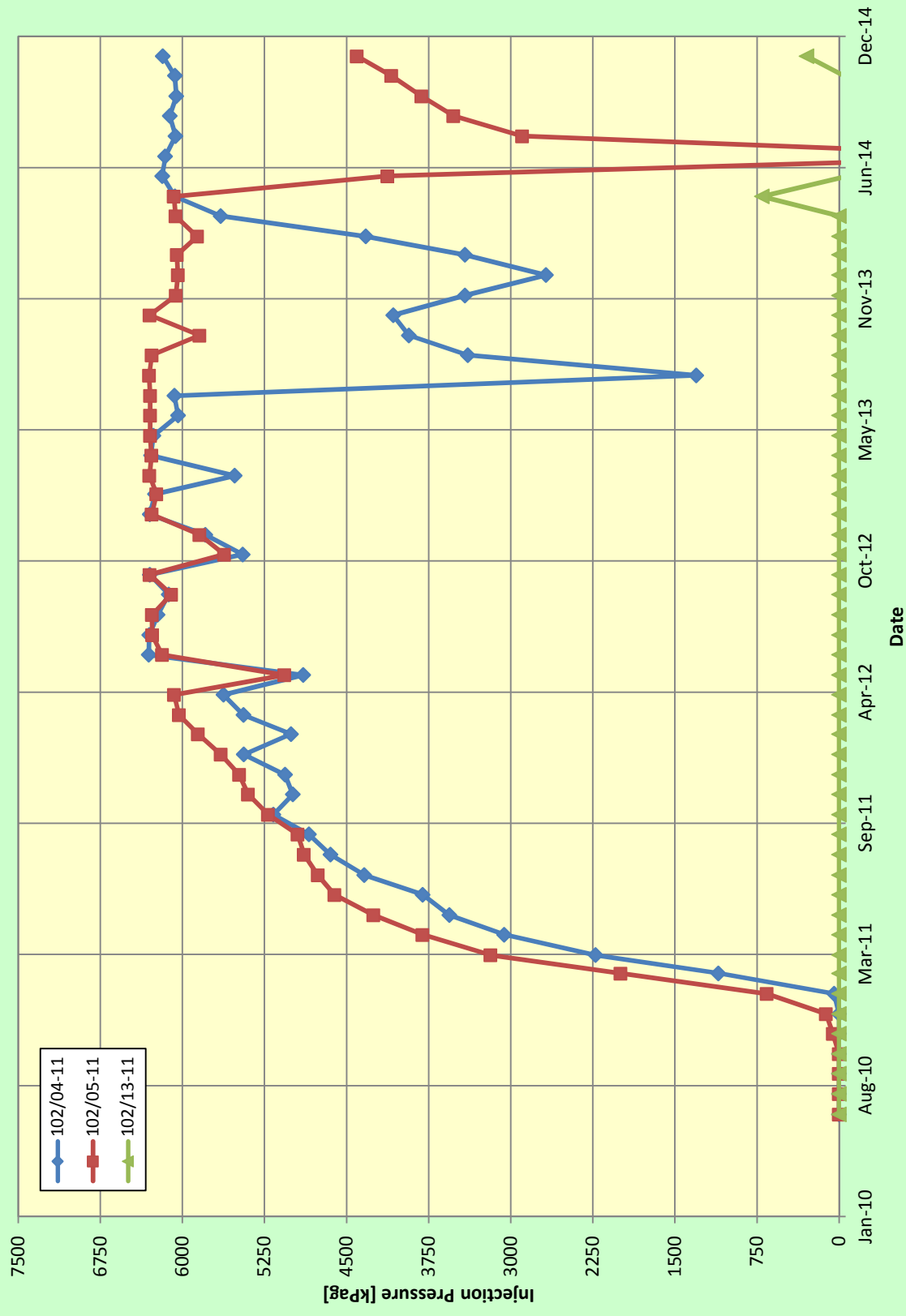
### Section 3 Injection Pressures vs Time



Section 10 Injection Pressures vs Time

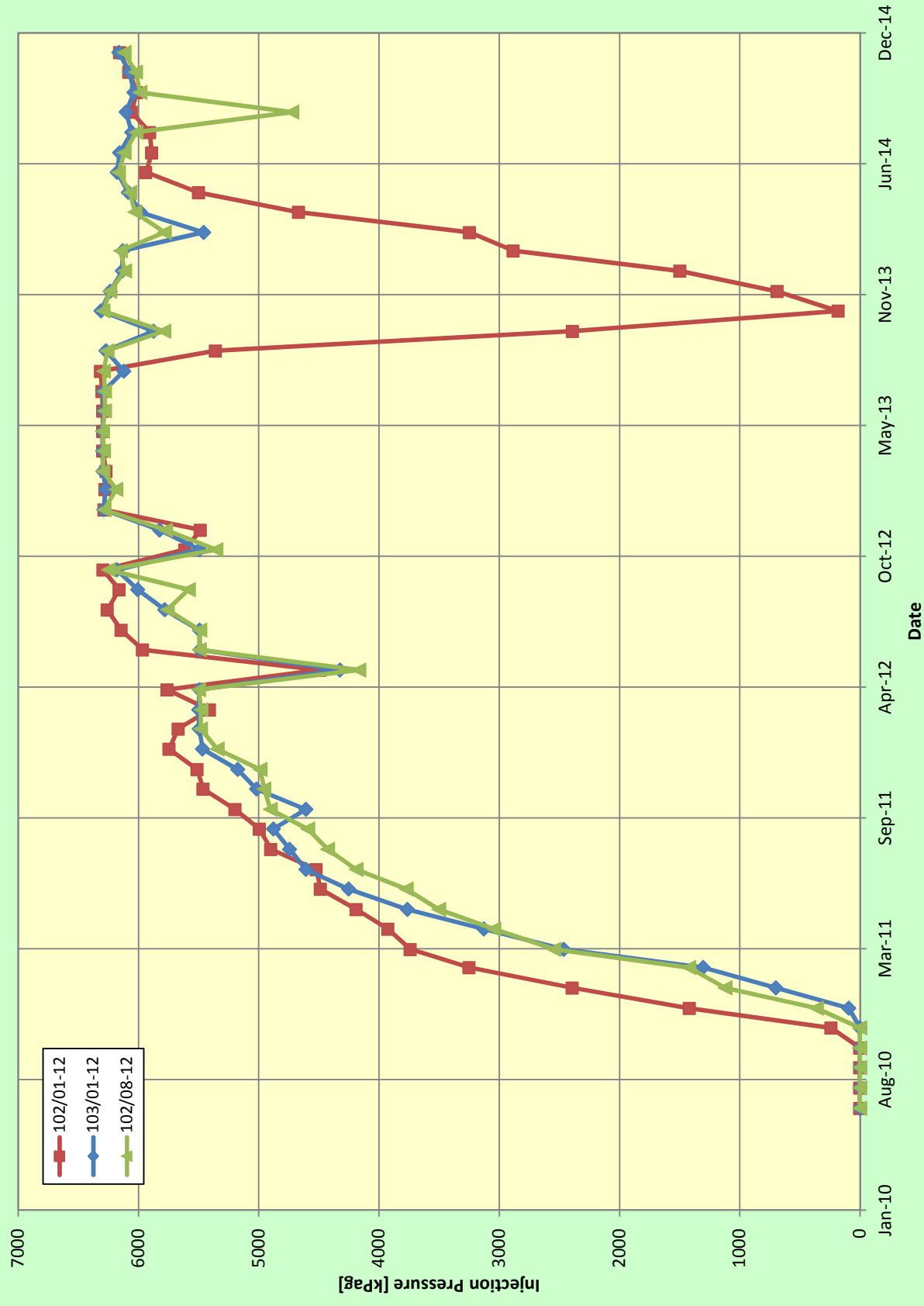


## Section 11 Injection Pressures vs Time





Section 12 Injection Pressures vs Time



## Appendix C

### Sinclair Unit #3 Injection Pattern Summary as of December 2014

Pattern Name	Injector BH Location (008-29W1)	Injector Surf. Location (008-29W1)	Status	Supported Wells (008-29W1)	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 Water (E³m³)	Cum Inj Water (E³m³)	Monthly VRR	Cum VRR	
02/01-01-008-29W1 Injector	02/01-01	04-01	WTR Injection	01-01, 02-01, 03-01, 04-01	4	0.7	Nov 2005	Jan 2011	9.1	1.2	0.13	18.7	35.4	7.7	28.1	1.73	0.62
				05-01, 02/06-01, 07-01, 08-01	4	0.5											
02/09-01-008-29W1 Injector	02/09-01	12-01	WTR Injection	05-01, 02/06-01, 07-01, 08-01, 09-01, 10-01, 11-01, 12-01	8	0.5	Jan 2006	Oct 2010	10.0	7.0	0.69	24.3	34.6	16.4	42.5	1.37	0.80
02/16-01-008-29W1 Injector	02/16-01	13-01	WTR Injection	09-01, 10-01, 11-01, 12-01, 13-01, 14-01, 15-01, 16-01	8	0.5	Jun 2006	Dec 2010	10.0	7.9	0.79	24.1	31.7	17.3	34.3	1.30	0.67
03/05-02-008-29W1 Injector	03/05-02	08-01	WTR Injection	01-02, 02-02, 03-02, 04-02	4	0.7	Mar 2005	Jan 2011	9.0	4.6	0.51	16.0	32.5	7.5	28.7	1.13	0.68
				05-02, 06-02, 07-02, 08-02	4	0.5											
02/05-02-008-29W1 Injector	02/05-02	12-01	WTR Injection	05-02, 06-02, 07-02, 08-02, 09-02, 10-02, 11-02, 12-02	8	0.5	Jan 2006	Oct 2010	8.6	4.5	0.52	22.7	32.9	8.4	35.8	1.66	0.82
02/12-02-008-29W1 Injector	02/12-02	13-01	WTR Injection	09-02, 10-02, 11-02, 12-02, 13-02, 14-02, 15-02, 16-02	8	0.5	Jan 2006	Dec 2010	9.4	3.1	0.33	15.4	32.9	7.9	27.4	1.17	0.64
02/13-02-008-29W1 Injector	02/13-02	04-12	WTR Injection	13-02, 14-02, 15-02, 16-02, 01-11, 02-11, 03-11, 04-11	8	0.5	Dec 2005	Aug 2010	6.6	2.1	0.32	14.7	25.9	8.0	23.9	1.60	0.67
02/01-03-008-29W1 Injector	02/01-03	05-03	WTR Injection	01-03, 02-03, 03-03, 04-03	4	0.7	Mar 2005	Jul 2010	6.0	3.1	0.51	6.7	30.9	7.2	34.0	0.71	0.84
				05-03, 06-03, 07-03, 08-03	4	0.5											
02/08-03-008-29W1 Injector	02/08-03	05-03	WTR Injection	05-03, 06-03, 07-03, 08-03, 09-03, 10-03, 11-03, 12-03	8	0.5	Sep 2005	Aug 2010	8.5	4.0	0.48	6.8	35.9	7.9	38.0	0.52	0.82
02/16-03-008-29W1 Injector	02/16-03	13-03	WTR Injection	09-03, 10-03, 11-03, 12-03, 13-03, 14-03, 15-03, 16-03	8	0.5	Aug 2005	Aug 2010	9.6	4.5	0.47	7.1	33.8	7.2	35.6	0.48	0.82
03/01-10-008-29W1 Injector	03/01-10	13-03	WTR Injection	13-03, 14-03, 15-03, 16-03, 01-10, 02-10, 03-10, 04-10	8	0.5	Aug 2005	Jul 2010	7.3	4.8	0.66	8.5	28.8	8.0	33.6	0.68	0.87
02/01-10-008-29W1 Injector	02/01-10	04-10	WTR Injection	01-10, 02-10, 03-10, 04-10, 05-10, 06-10, 07-10, 08-10	8	0.5	Sep 2005	Aug 2010	7.2	4.7	0.65	9.0	29.3	8.5	29.4	0.73	0.74
02/08-10-008-29W1 Injector	02/08-10	12-10	WTR Injection	05-10, 06-10, 07-10, 08-10, 09-10, 10-10, 11-10, 12-10	8	0.5	Nov 2004	Jul 2010	7.4	5.5	0.74	7.4	30.6	9.0	36.1	0.55	0.87
02/16-10-008-29W1 Injector	02/16-10	13-10	WTR Injection	09-10, 10-10, 11-10, 12-10, 13-10, 14-10, 15-10, 16-10	8	0.5	Nov 2004	Apr 2013	6.0	3.9	0.65	10.0	30.0	9.3	15.4	0.97	0.37
02/04-11-008-29W1 Injector	02/04-11	04-12	WTR Injection	01-11, 02-11, 03-11, 04-11, 05-11, 06-11, 07-11, 08-11	8	0.5	Dec 2005	Dec 2010	3.7	2.3	0.61	10.5	15.7	7.0	17.1	1.67	0.72
02/05-11-008-29W1 Injector	02/05-11	12-12	WTR Injection	05-11, 06-11, 07-11, 08-11, 09-11, 10-11, 11-11, 12-11	8	0.5	Dec 2004	Oct 2010	4.1	2.3	0.57	19.0	16.3	5.1	23.8	2.85	1.05
02/13-11-008-29W1 Injector	02/13-11	12-12	Capable of OIL Prod	09-11, 10-11, 11-11, 12-11, 13-11, 14-11, 15-11, 16-11	8	0.5	Dec 2004	Apr 2014	4.3	1.4	0.33	19.5	28.1	7.7	4.4	3.3	0.1
02/01-12-008-29W1 Injector	02/01-12	04-12	WTR Injection	13-01, 14-01, 15-01, 16-01, 01-12, 02-12, 03-12, 04-12	8	0.5	May 2006	Aug 2010	7.2	3.1	0.43	25.4	27.3	10.5	34.8	2.36	0.88
03/01-12-008-29W1 Injector	03/01-12	05-12	WTR Injection	01-12, 02-12, 03-12, 04-12, 05-12, 06-12, 07-12, 08-12	8	0.5	May 2006	Nov 2010	2.9	6.6	2.26	14.1	16.8	14.6	26.6	1.46	0.82
02/08-12-008-29W1 Injector	02/08-12	12-12	WTR Injection	05-12, 06-12, 07-12, 08-12, 09-12, 10-12, 11-12, 12-12	8	0.5	Feb 2005	Oct 2010	3.2	7.4	2.34	13.6	17.0	16.8	26.2	1.25	0.75
02/09-12-008-29W1 Injector	02/09-12	13-12	Capable of OIL Prod	09-12, 10-12, 11-12, 12-12, 13-12, 14-12, 15-12, 16-12	8	0.5	Feb 2005		5.9	4.3	0.73		25.9	15.1	0.0	0.0	0.0

## **Appendix D**

### **Rates and VRR Plots**

# Pattern: 02/01-01-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.13 m3/m3

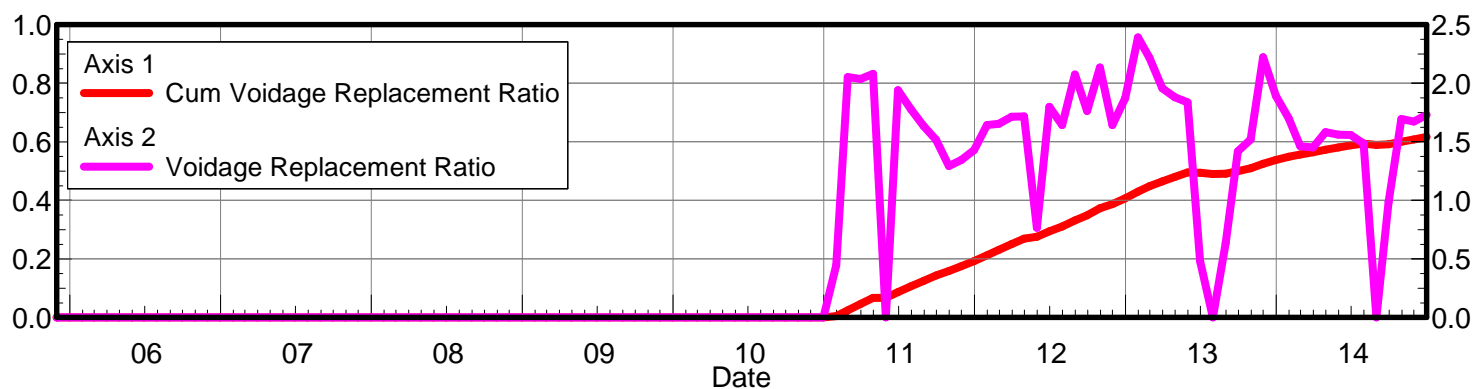
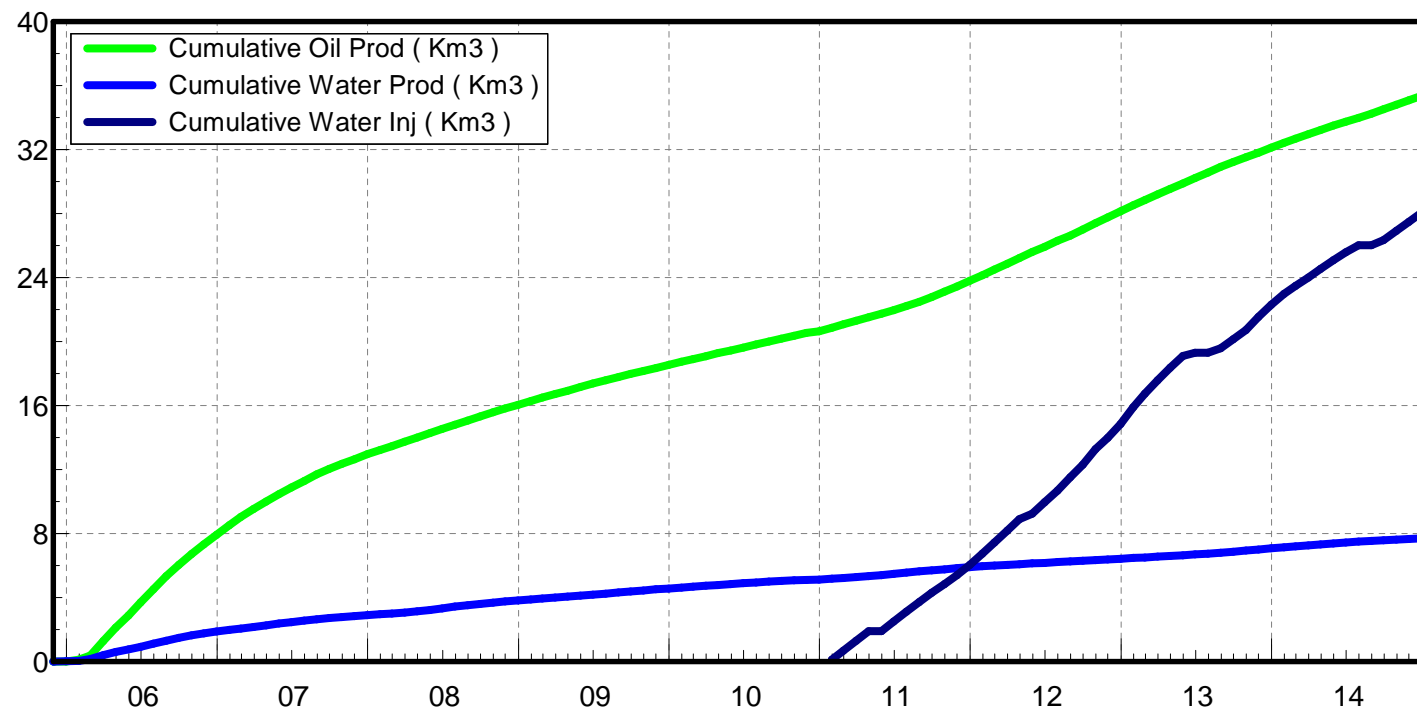
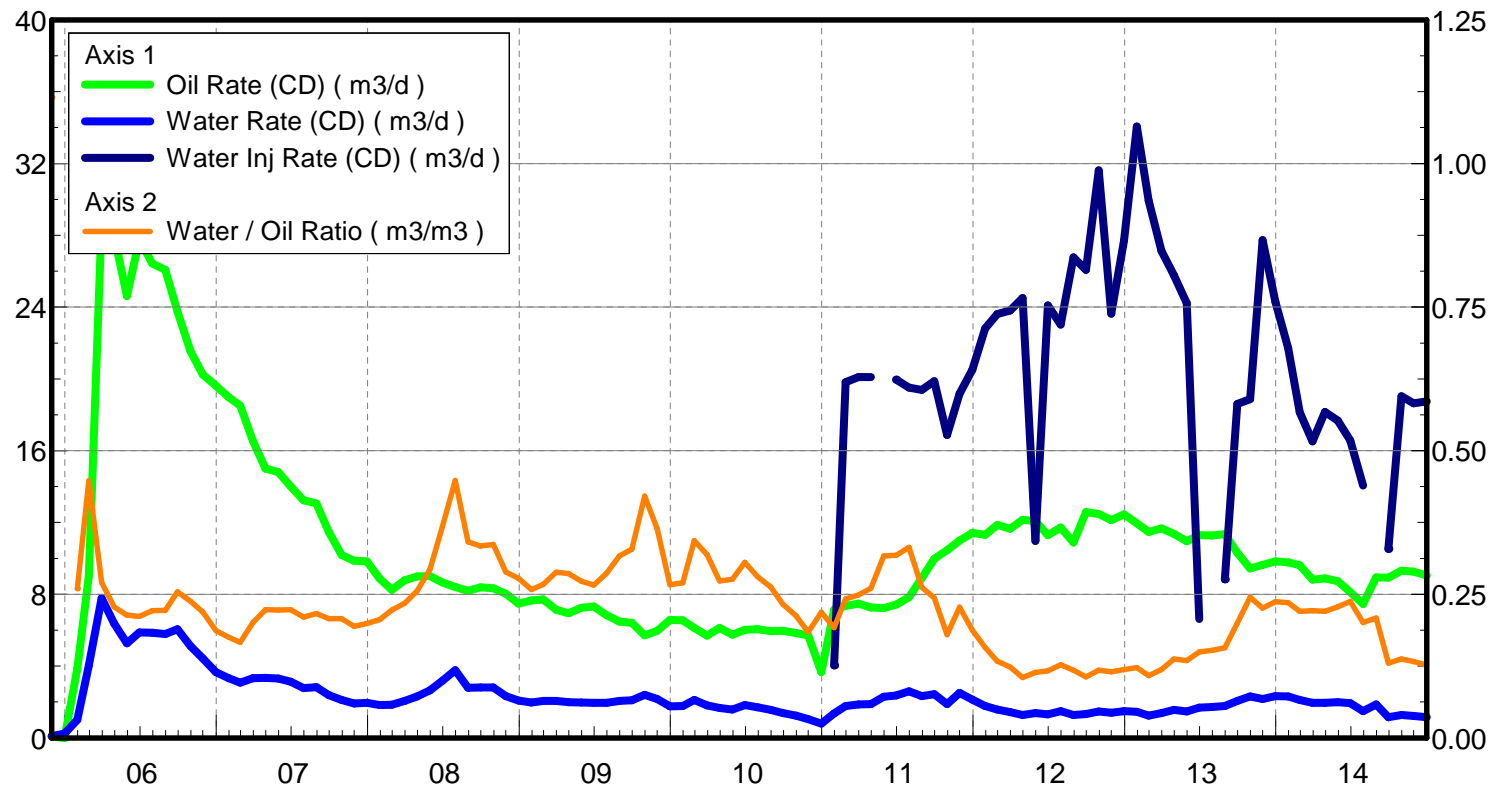
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 9.05 m3/d

Water Rate (CD) : 1.15 m3/d

Water Inj Rate (CD) : 18.74 m3/d



# Pattern: 02/09-01-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.69 m3/m3

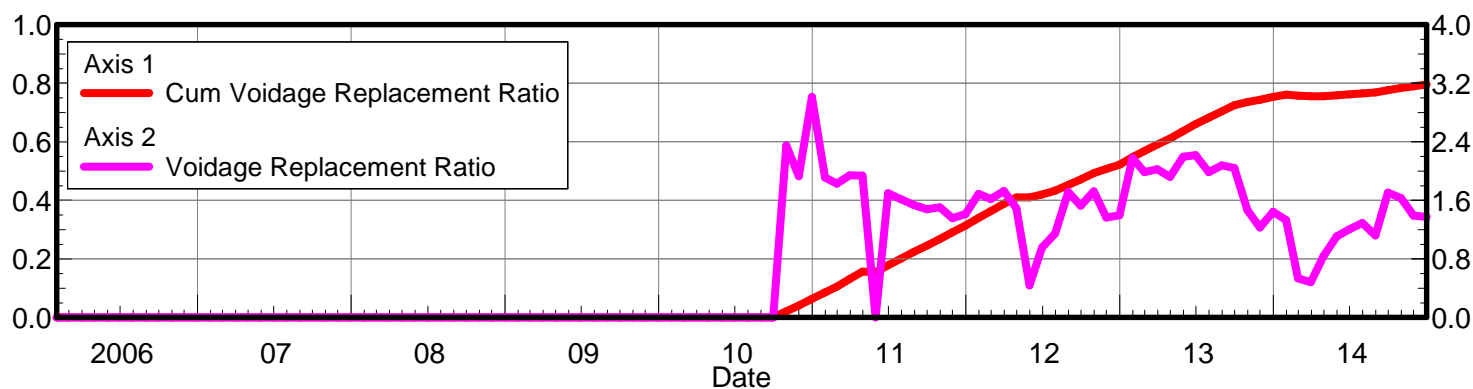
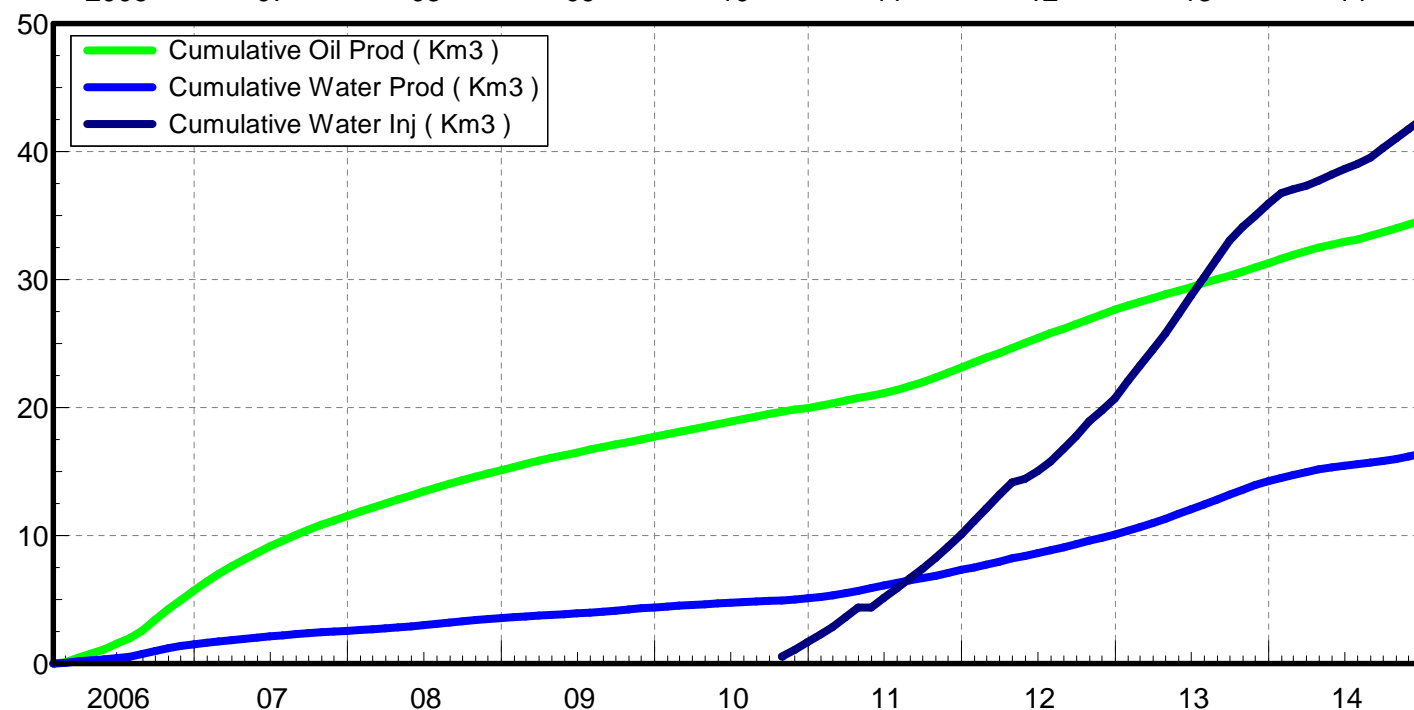
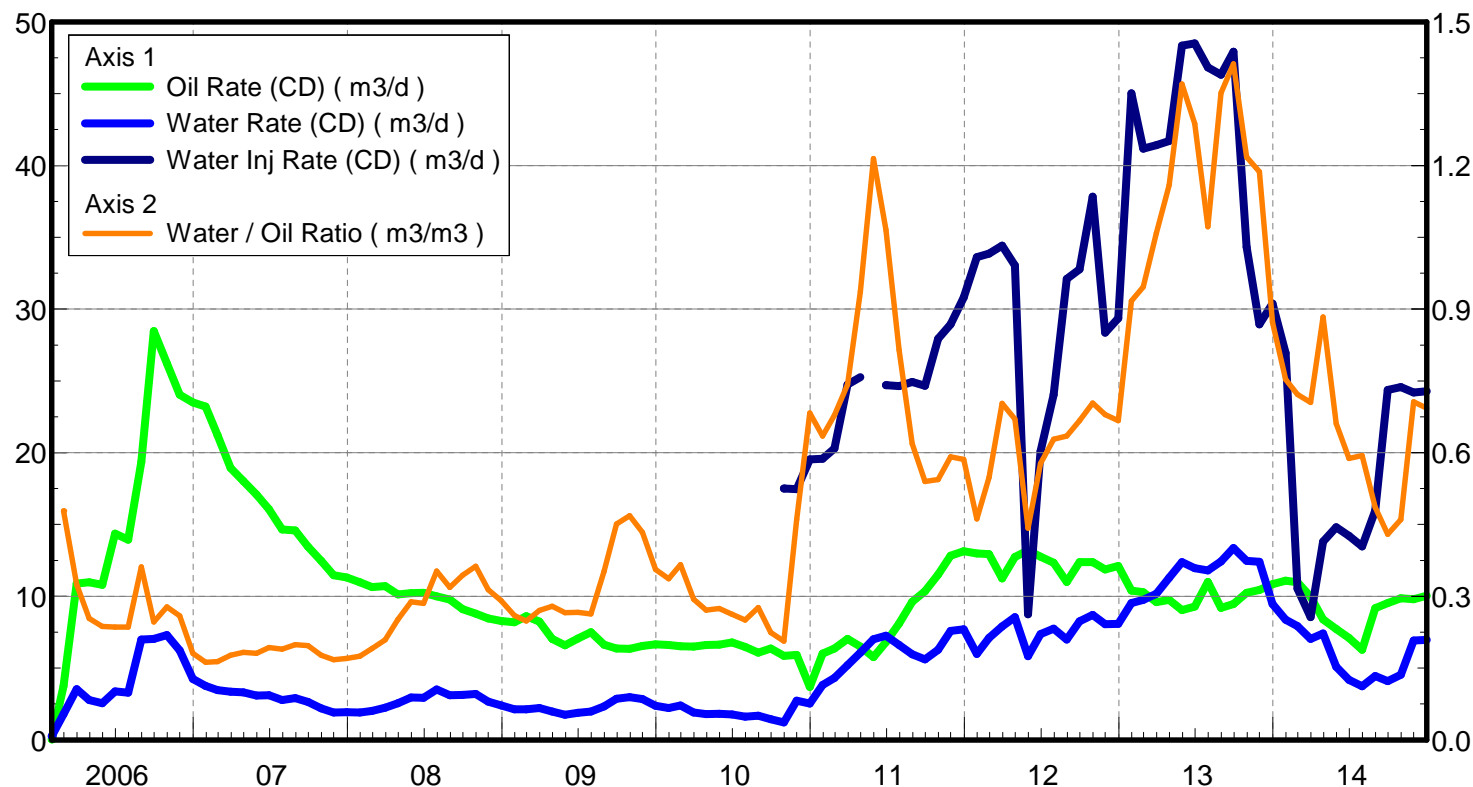
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 10.04 m3/d

Water Rate (CD) : 6.96 m3/d

Water Inj Rate (CD) : 24.29 m3/d



# Pattern: 02/16-01-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.79 m3/m3

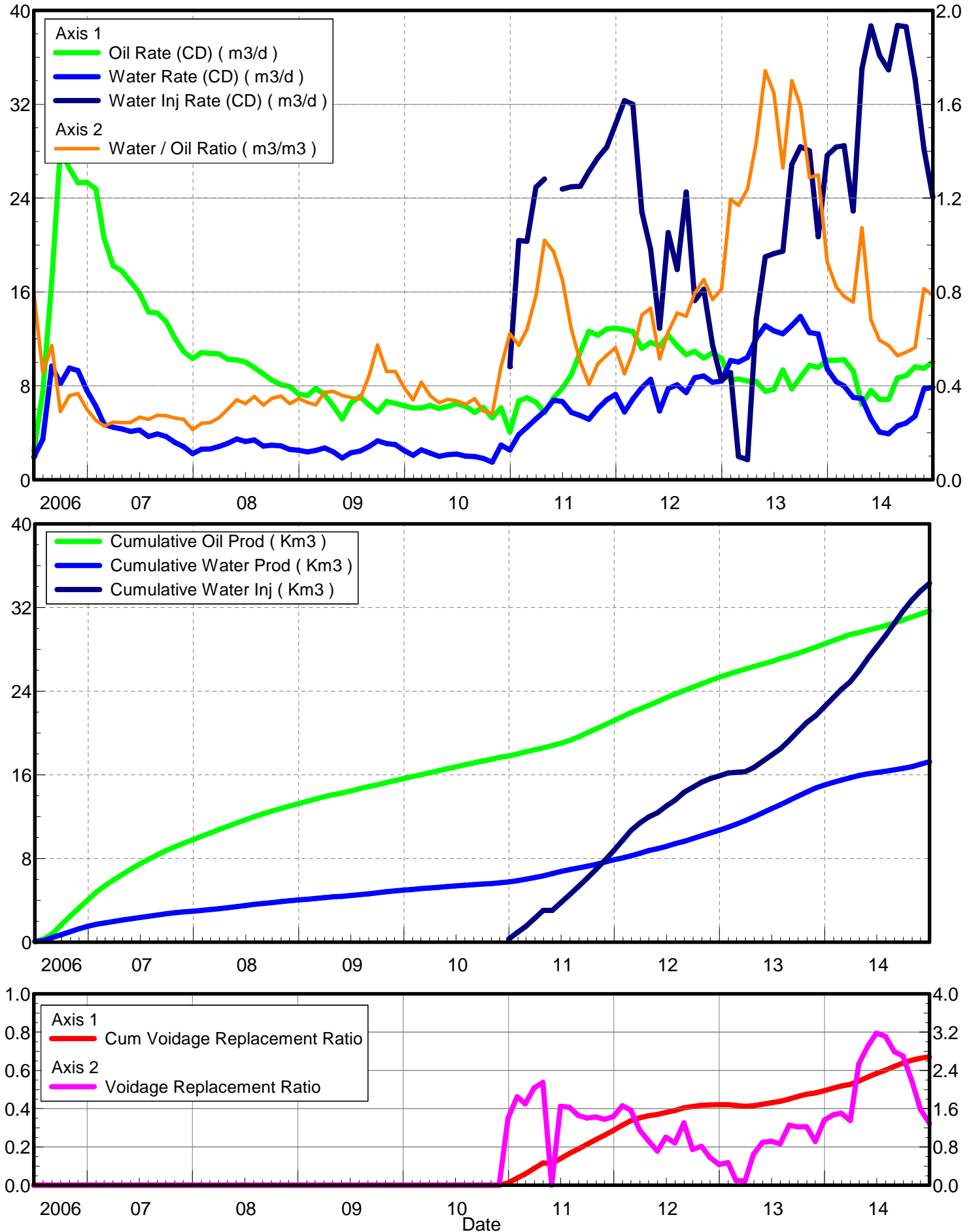
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 10.02 m3/d

Water Rate (CD) : 7.88 m3/d

Water Inj Rate (CD) : 24.06 m3/d



# Pattern: 02/05-02-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.52 m3/m3

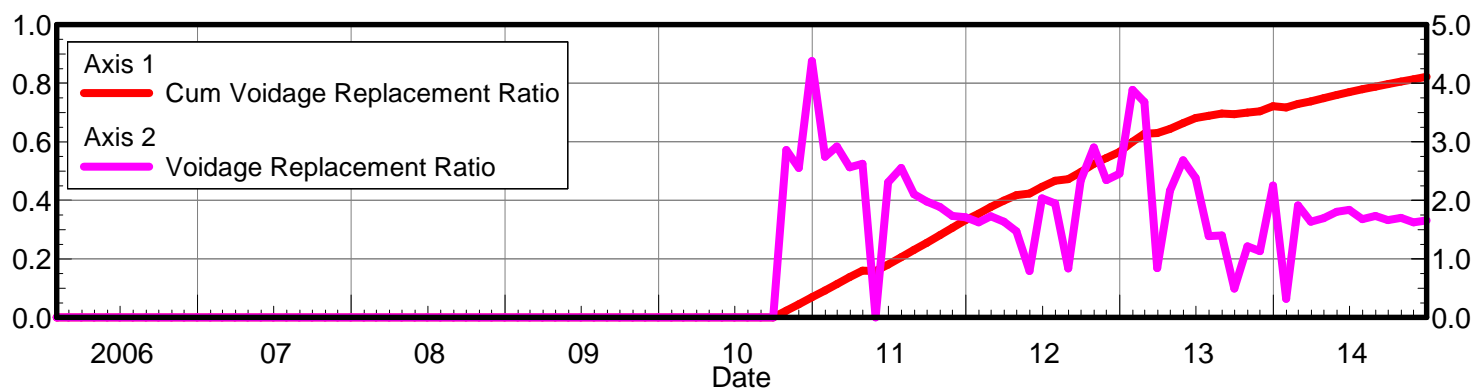
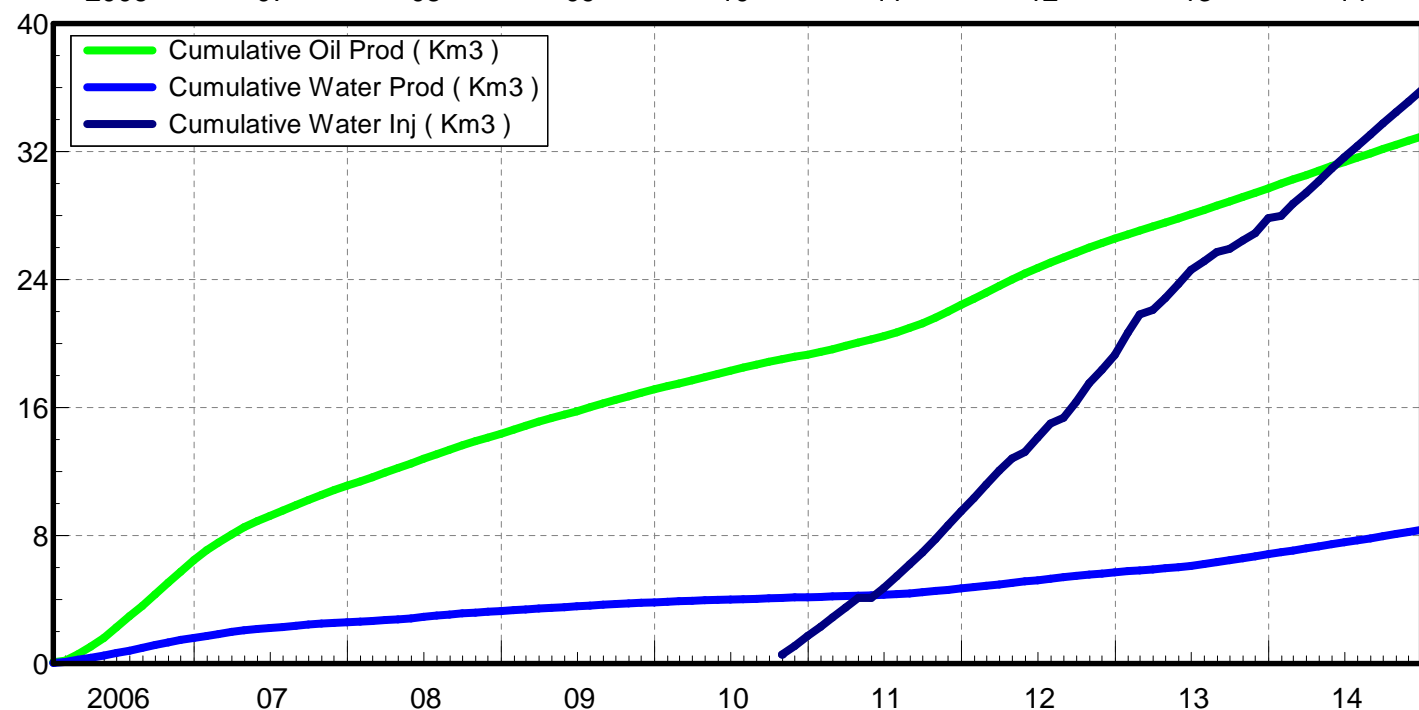
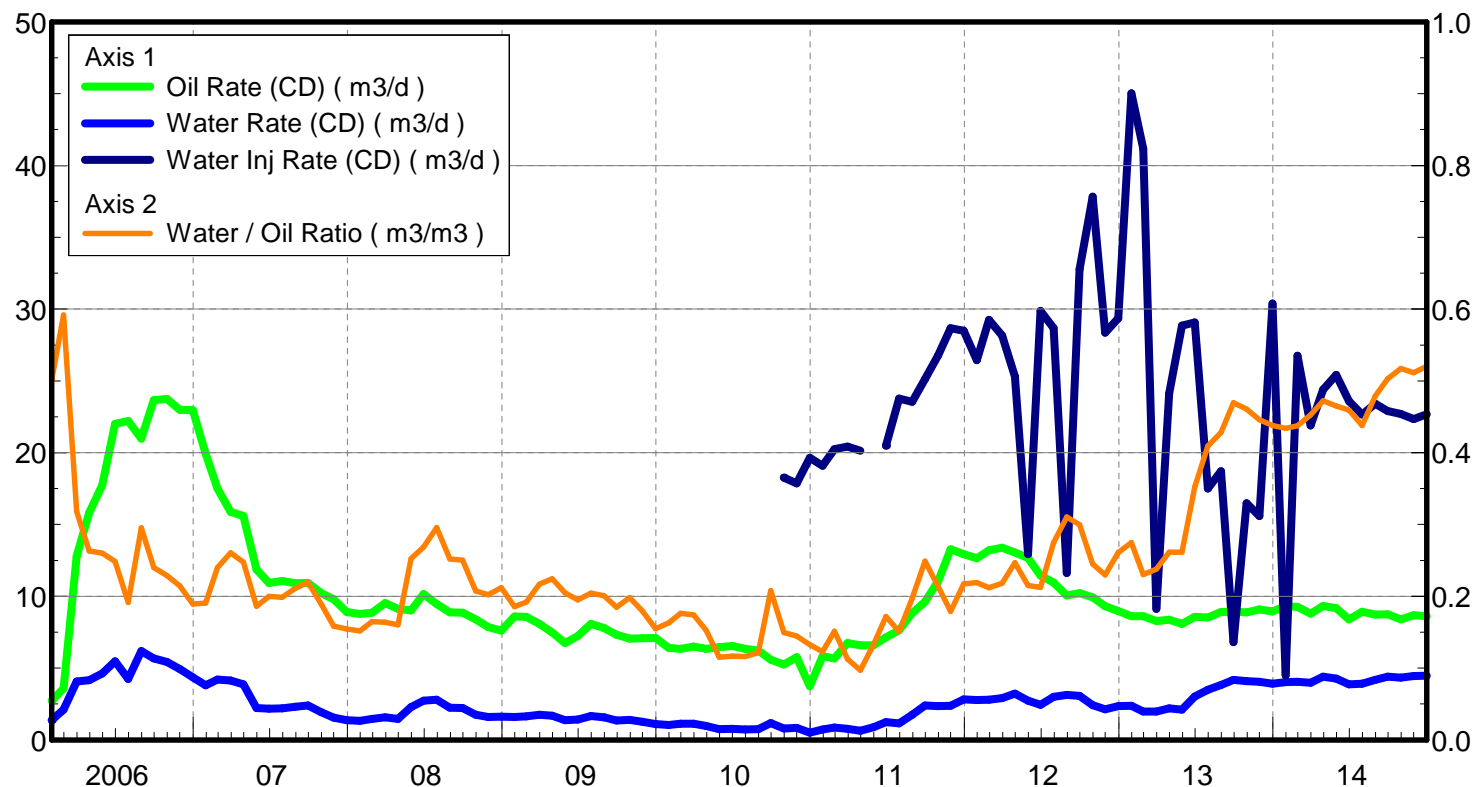
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 8.61 m3/d

Water Rate (CD) : 4.48 m3/d

Water Inj Rate (CD) : 22.68 m3/d



# Pattern: 03/05-02-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.51 m3/m3

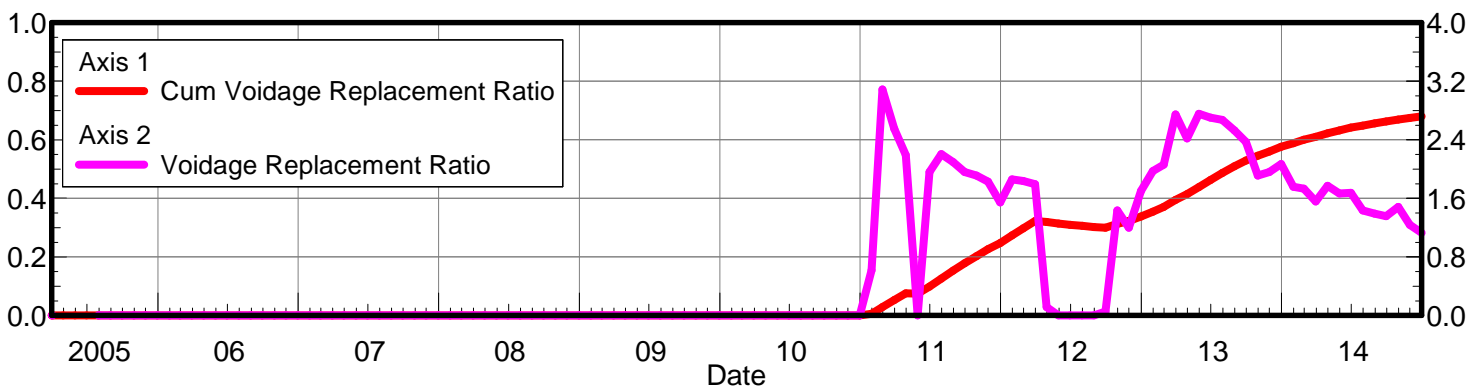
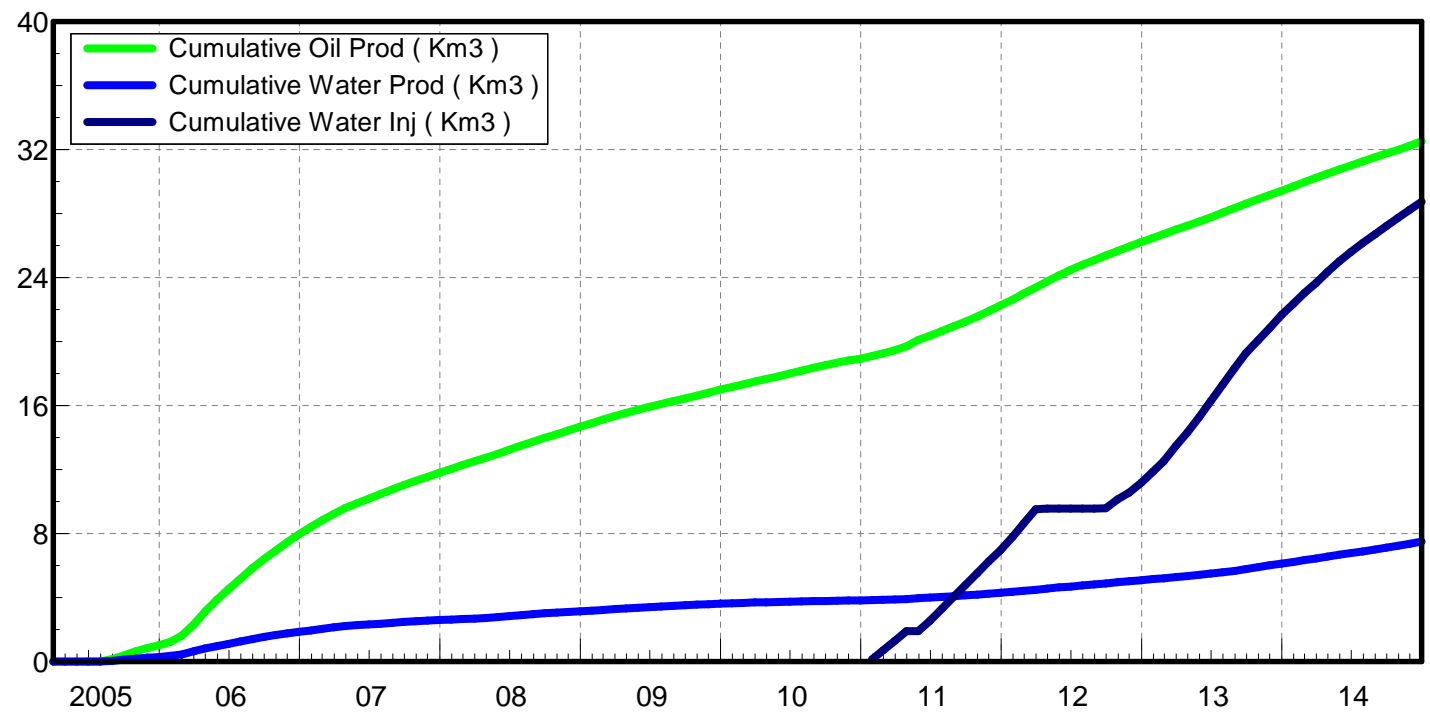
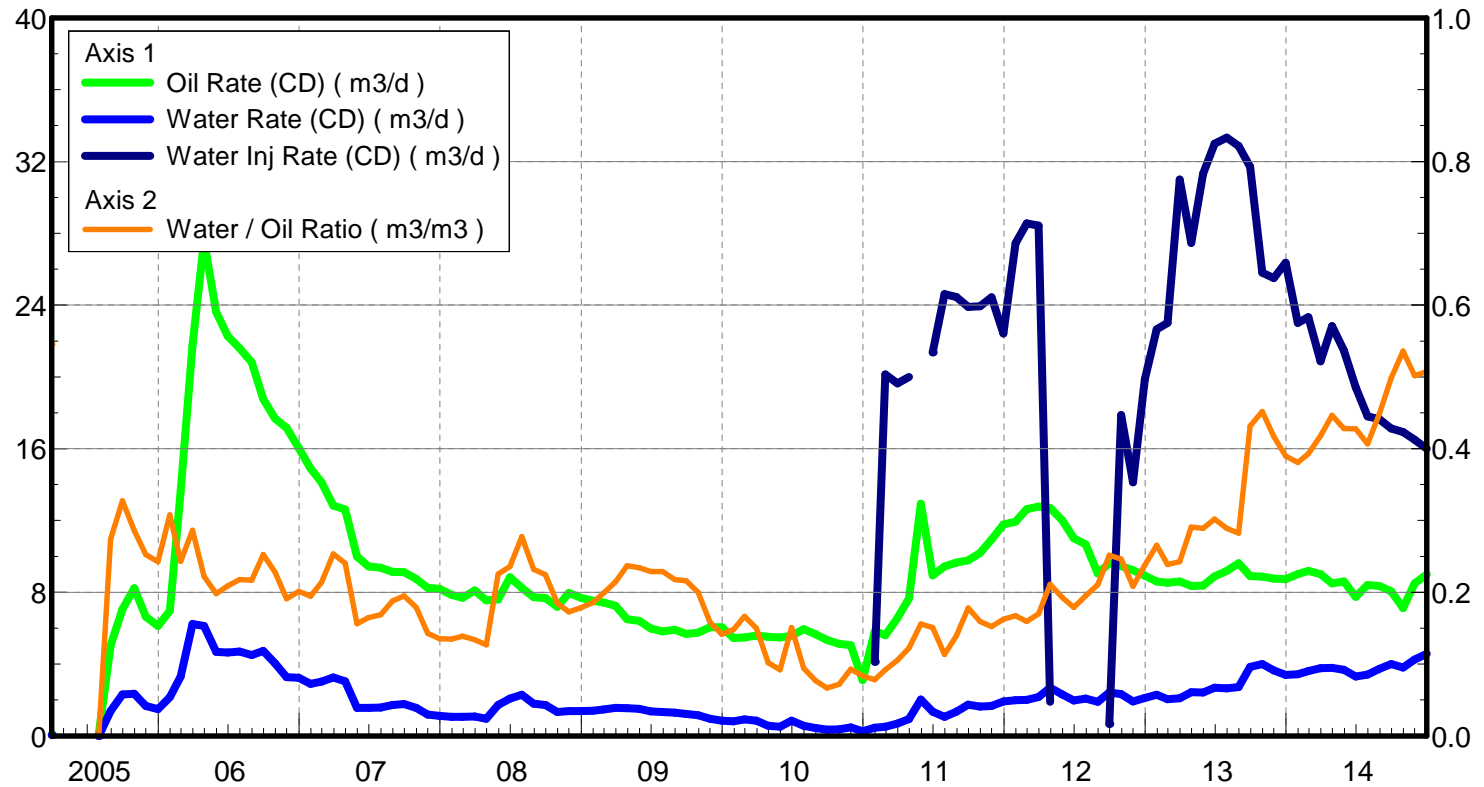
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 9.00 m3/d

Water Rate (CD) : 4.57 m3/d

Water Inj Rate (CD) : 16.00 m3/d





# Pattern: 02/12-02-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.33 m3/m3

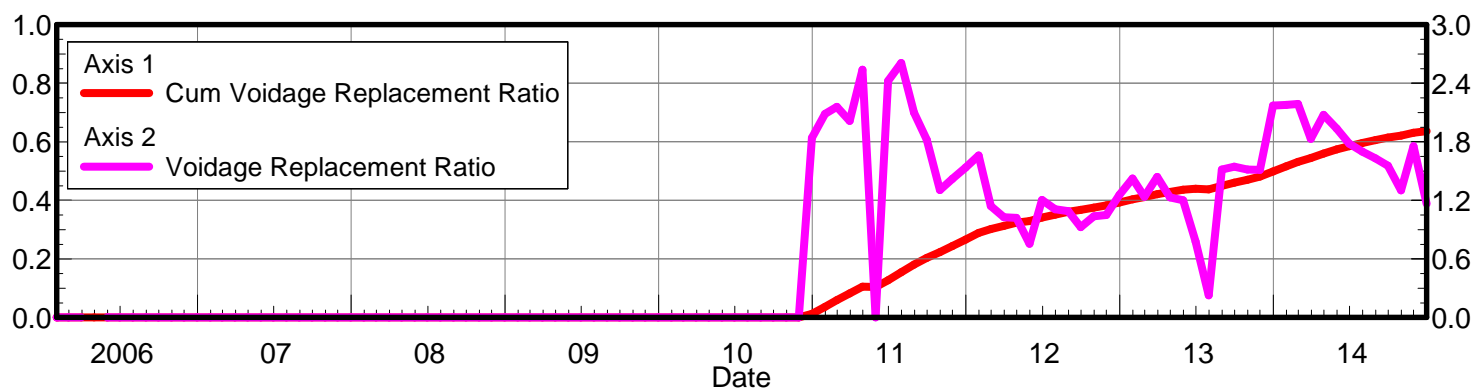
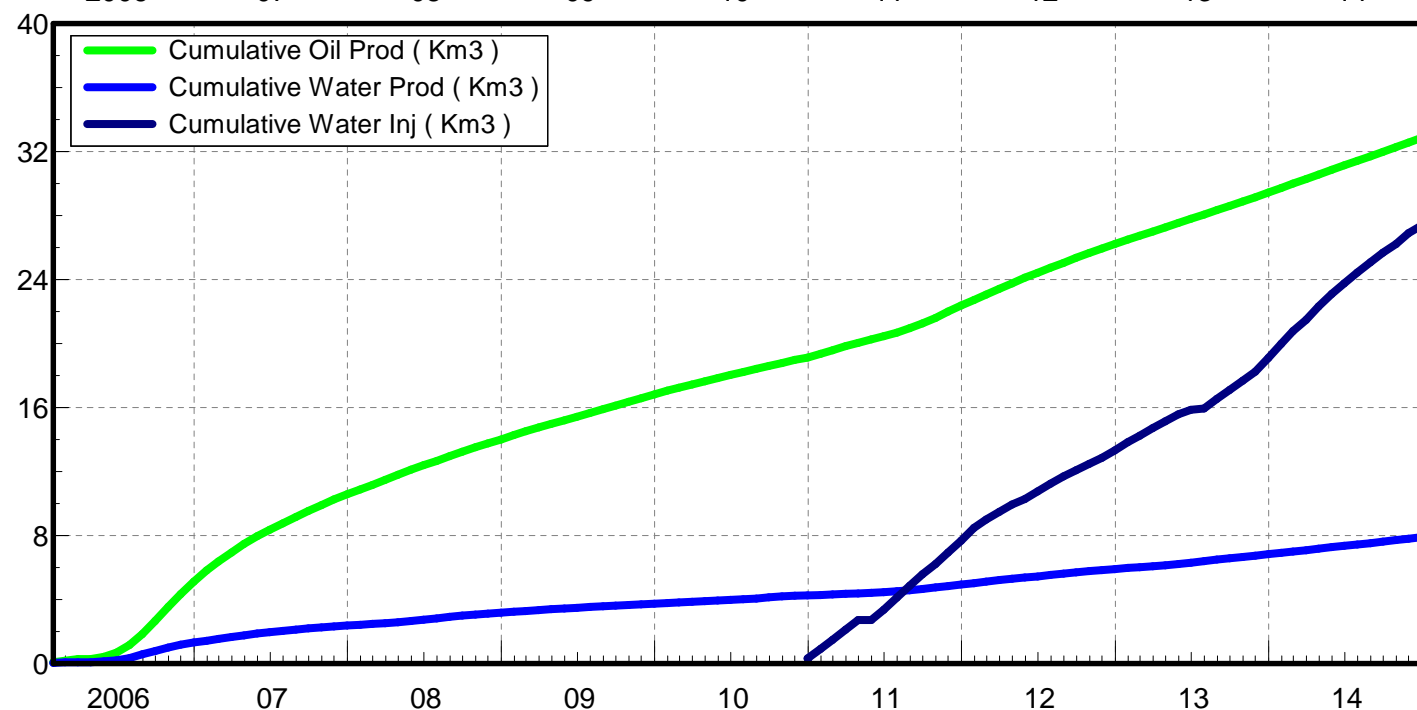
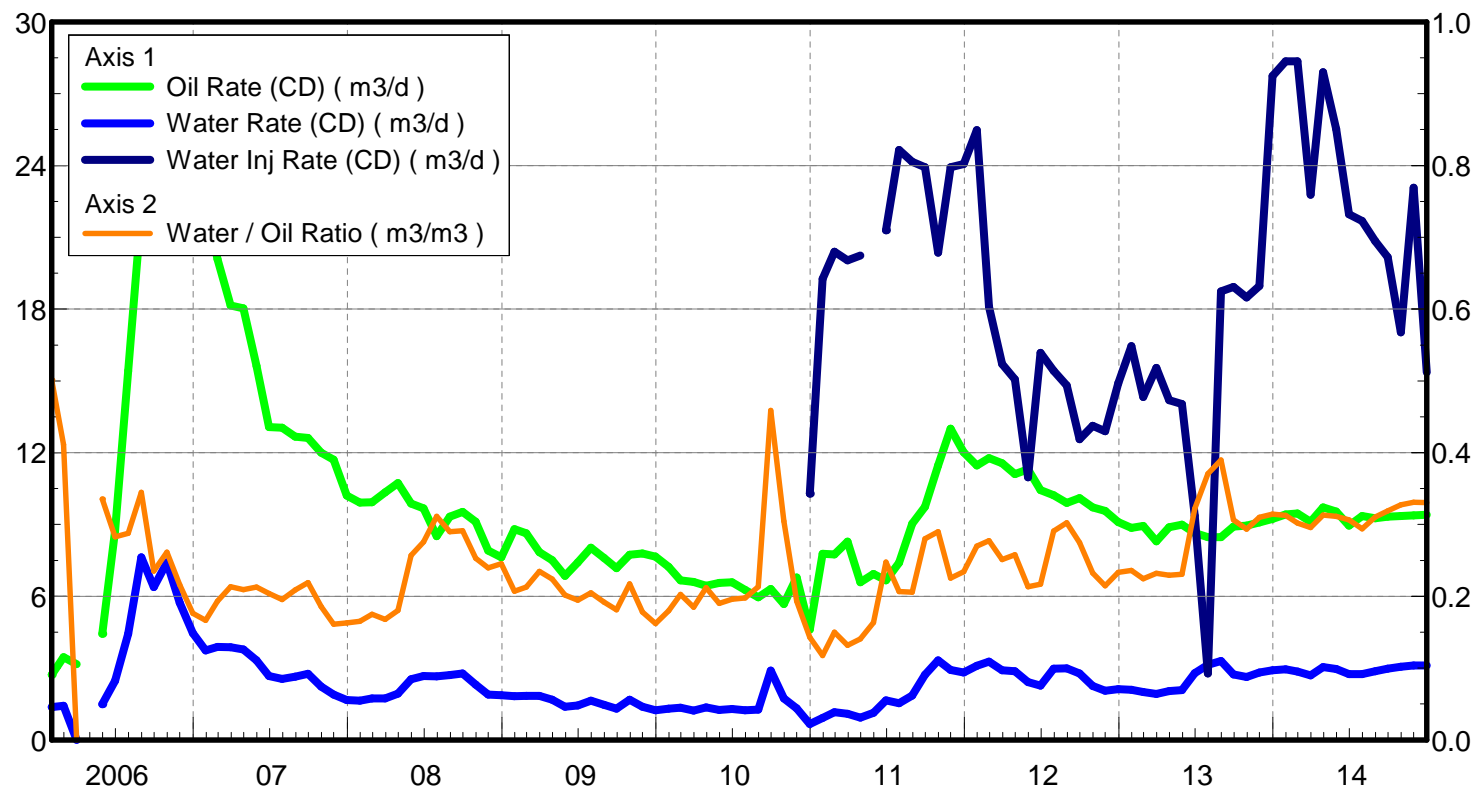
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 9.41 m3/d

Water Rate (CD) : 3.11 m3/d

Water Inj Rate (CD) : 15.35 m3/d



# Pattern: 02/13-02-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.32 m3/m3

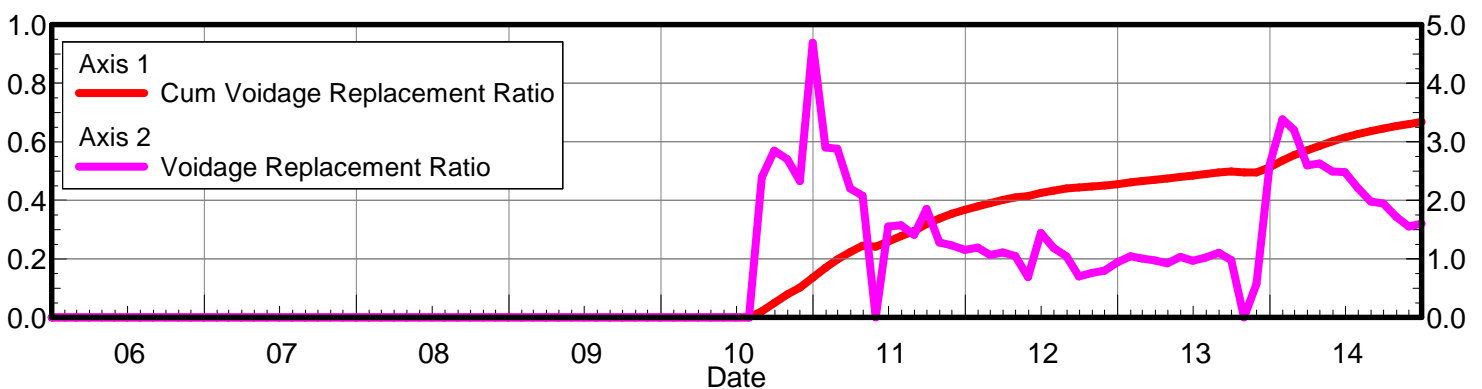
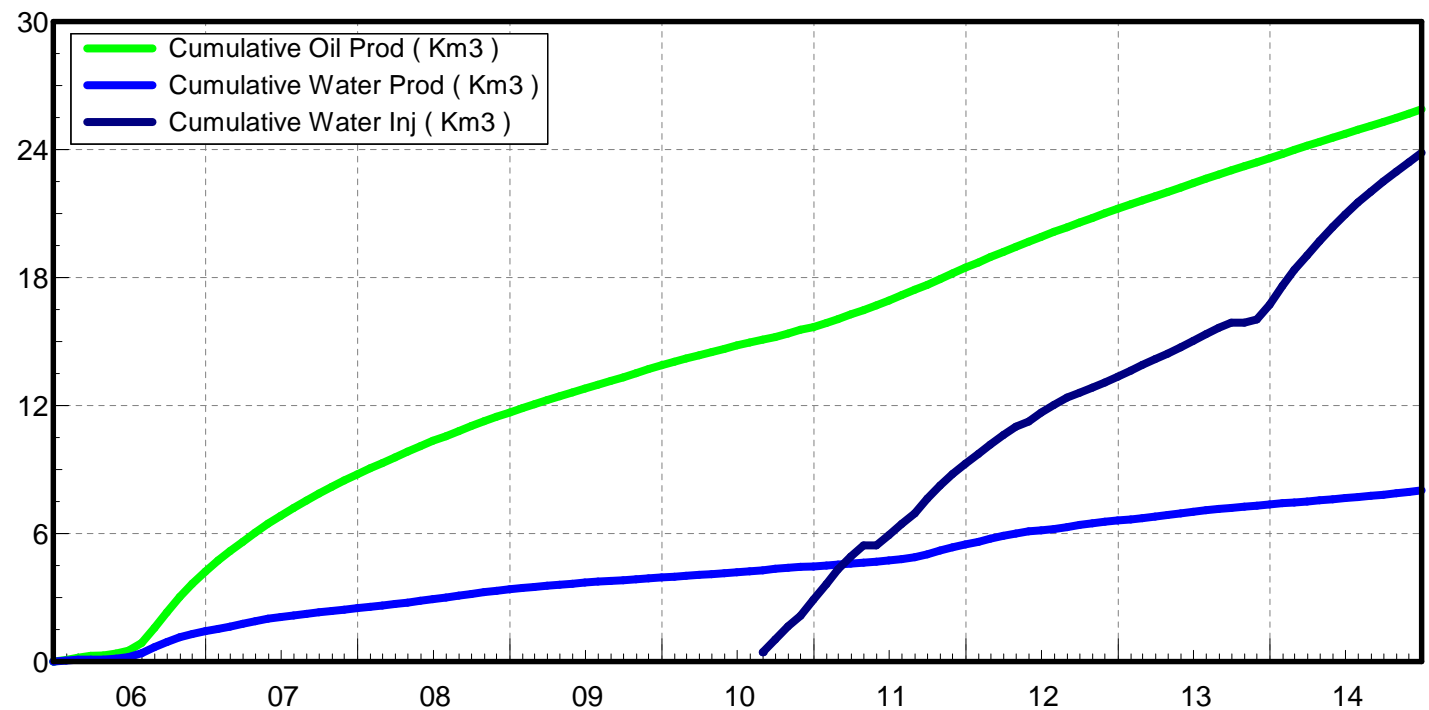
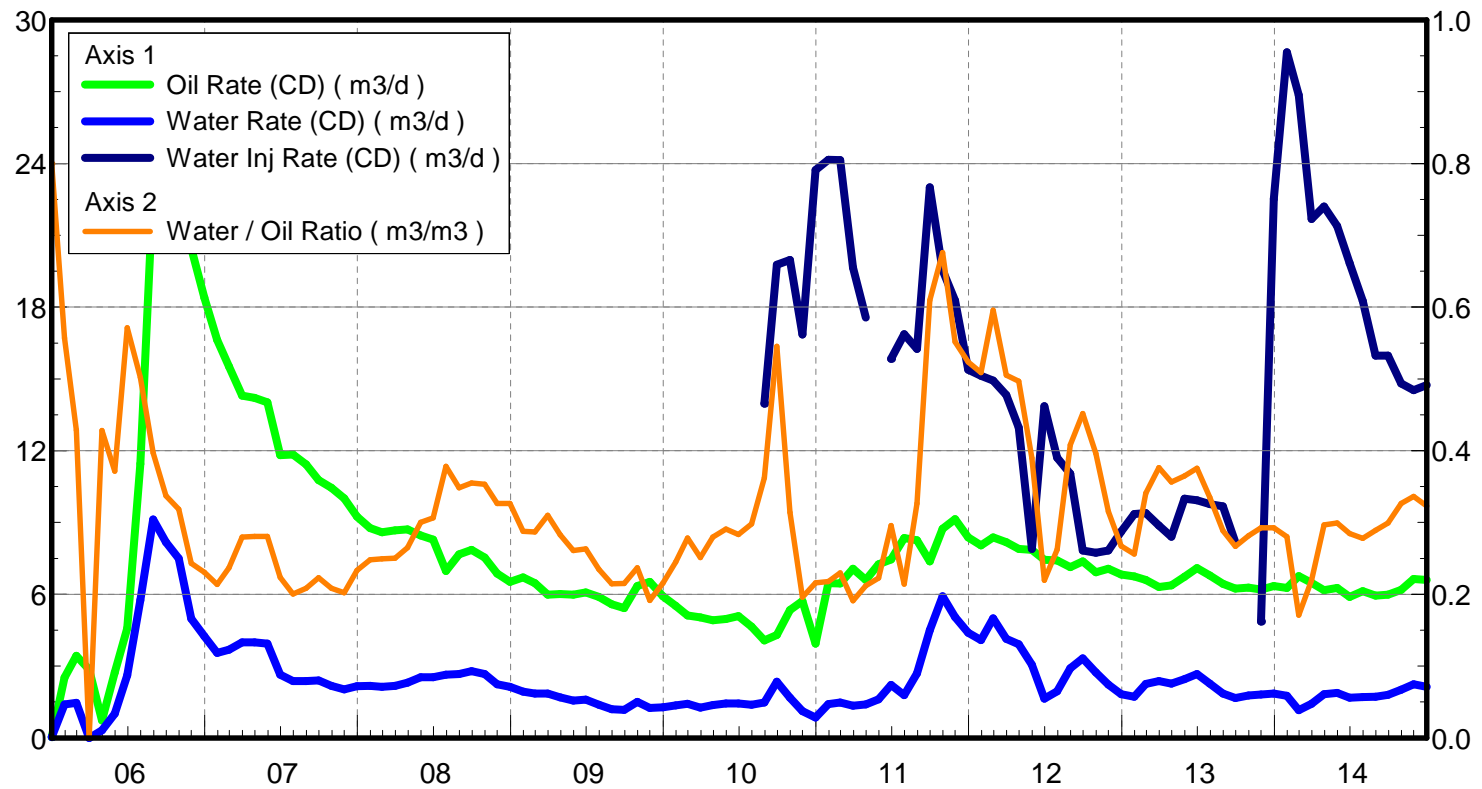
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 6.60 m3/d

Water Rate (CD) : 2.13 m3/d

Water Inj Rate (CD) : 14.74 m3/d



# Pattern: 02/01-03-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.51 m3/m3

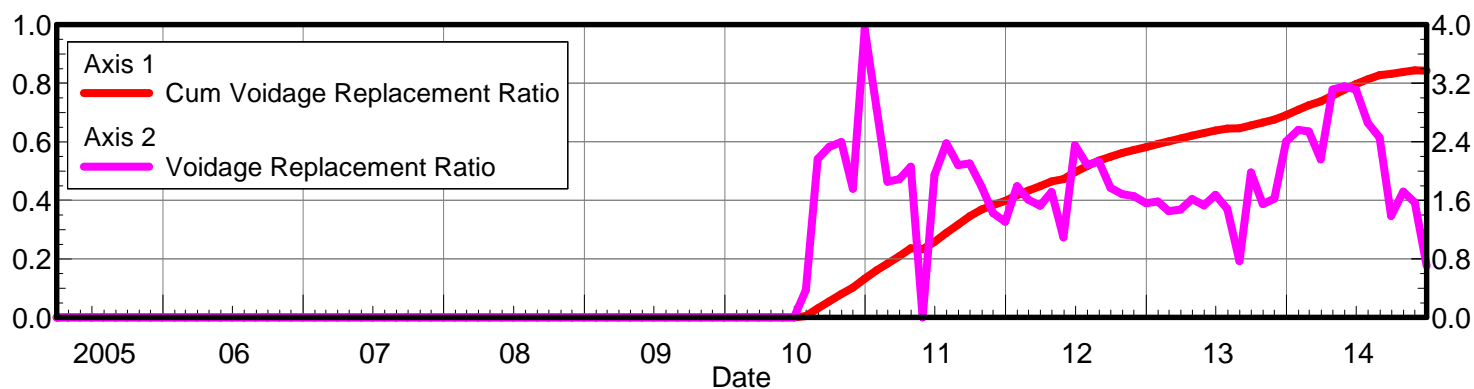
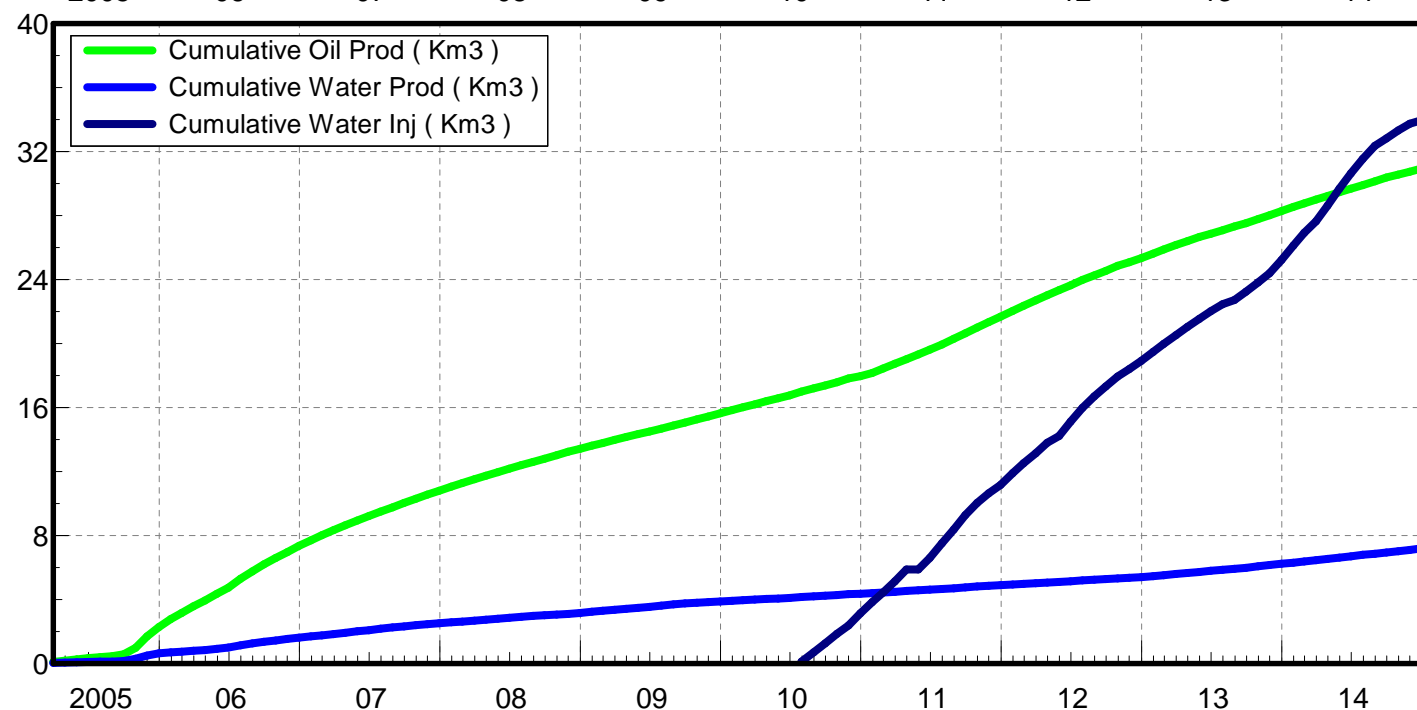
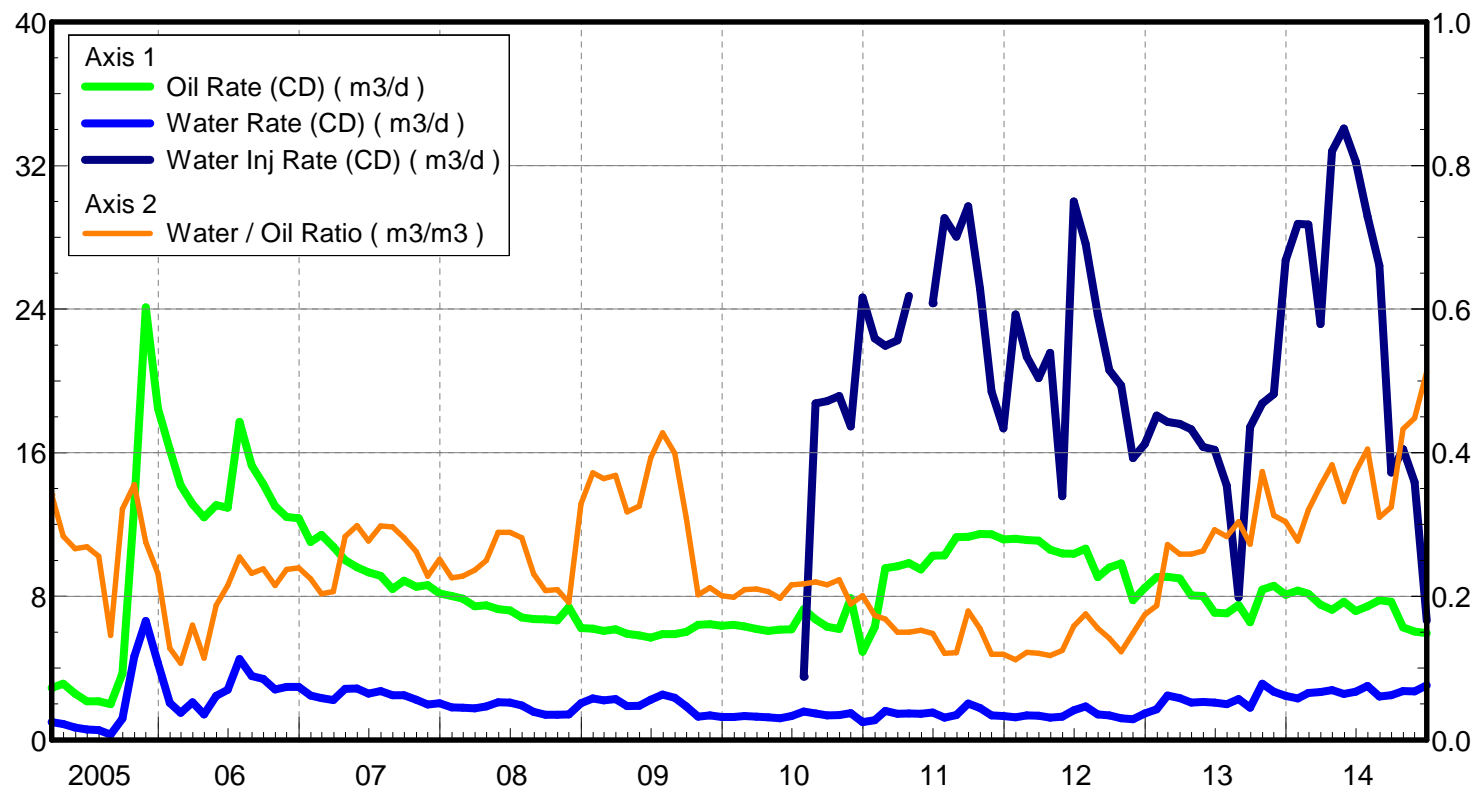
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 5.95 m3/d

Water Rate (CD) : 3.05 m3/d

Water Inj Rate (CD) : 6.65 m3/d



# Pattern: 02/08-03-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

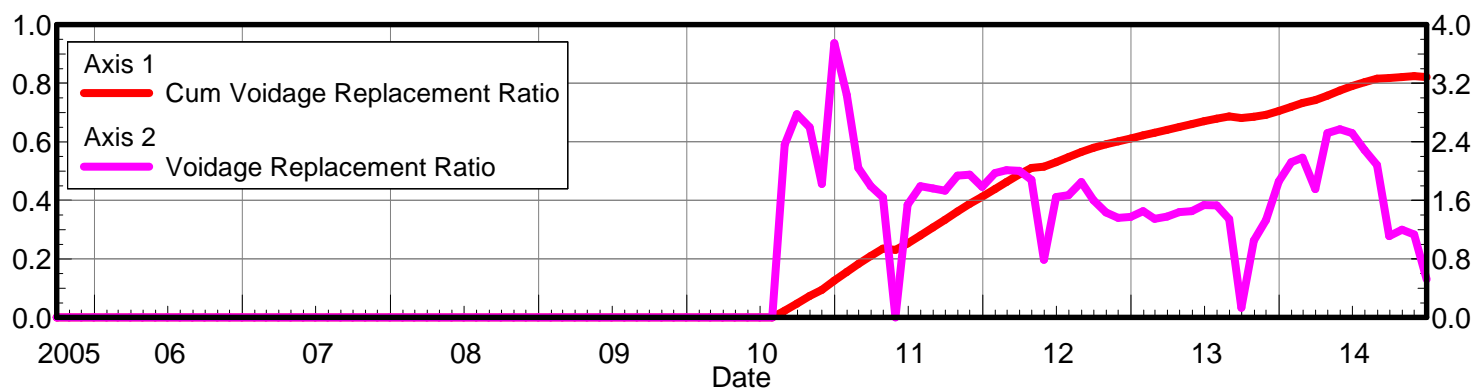
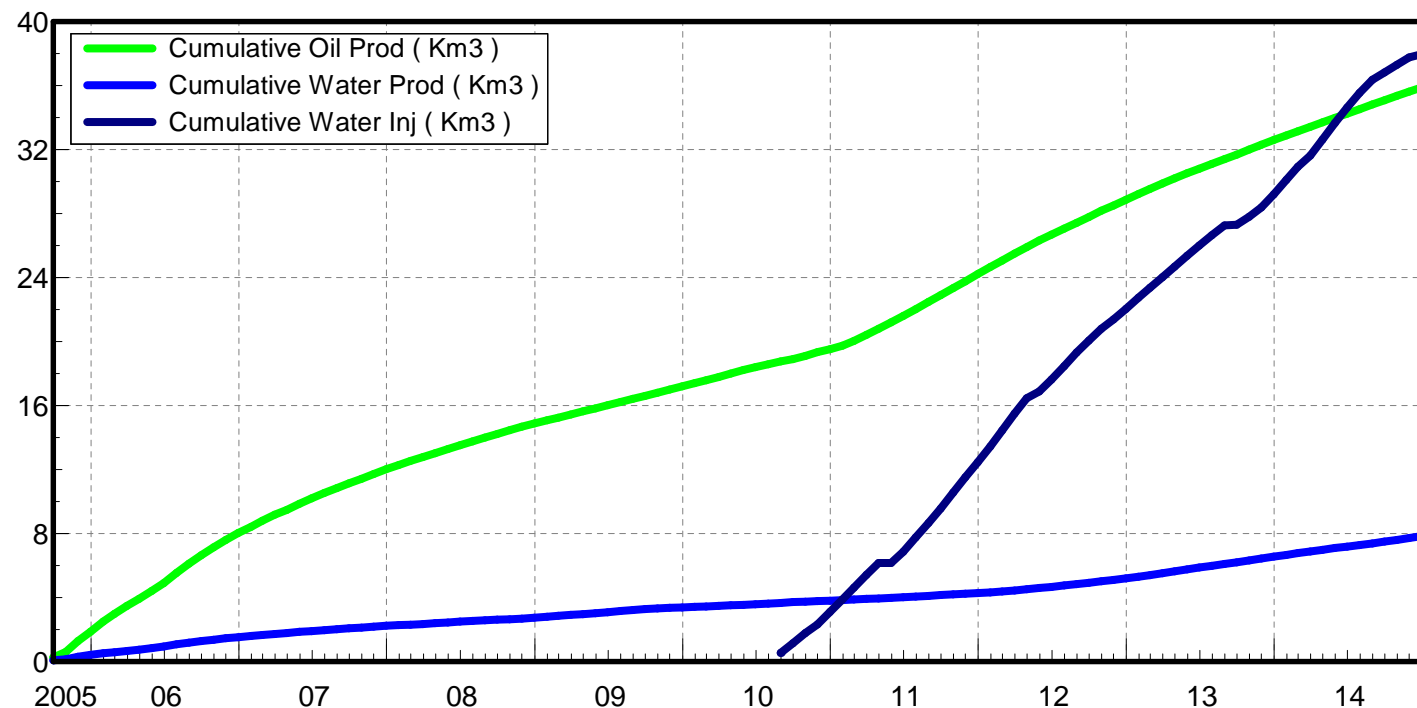
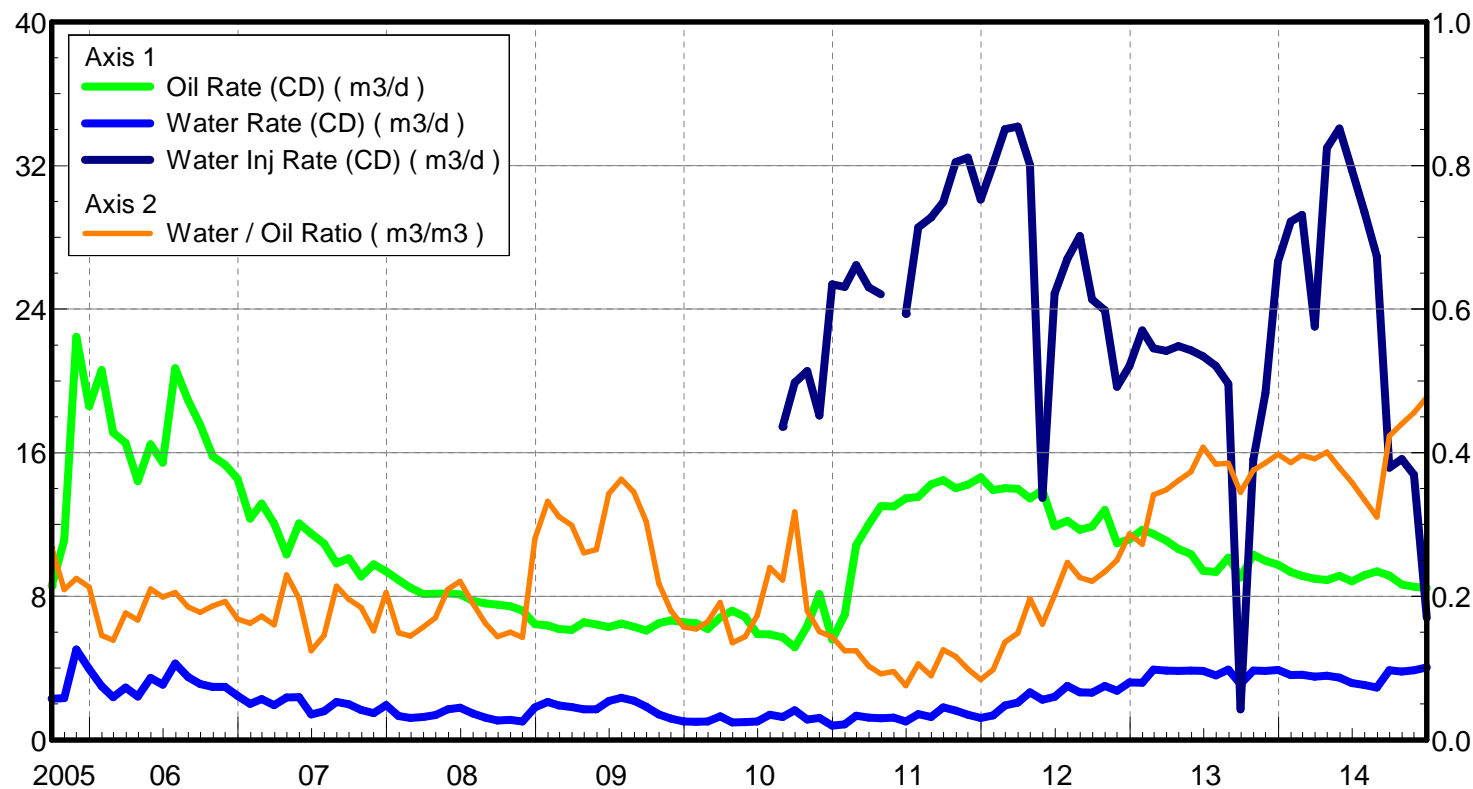
Water / Oil Ratio : 0.48 m3/m3

April 01, 2015  
Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 8.46 m3/d

Water Rate (CD) : 4.04 m3/d

Water Inj Rate (CD) : 6.81 m3/d



# Pattern: 02/16-03-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

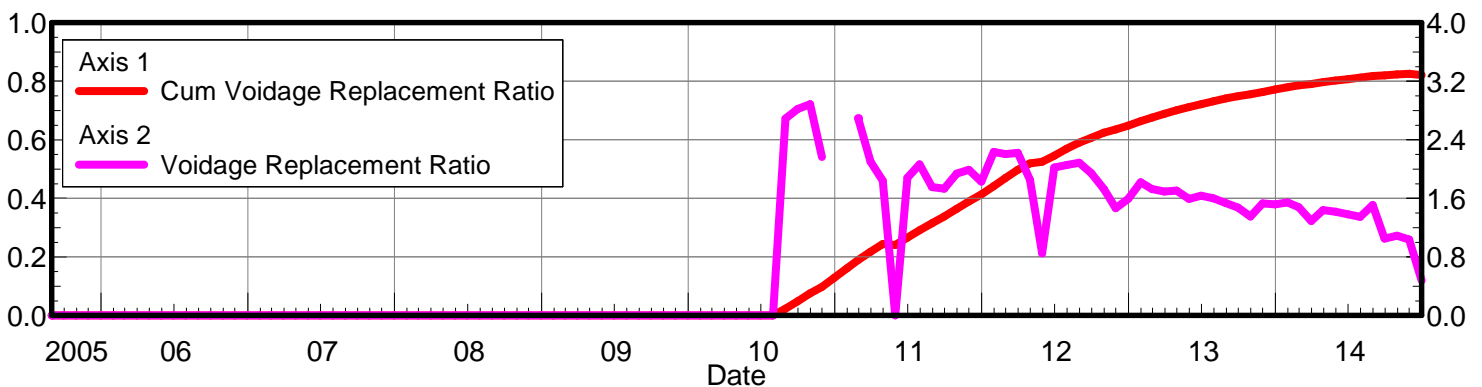
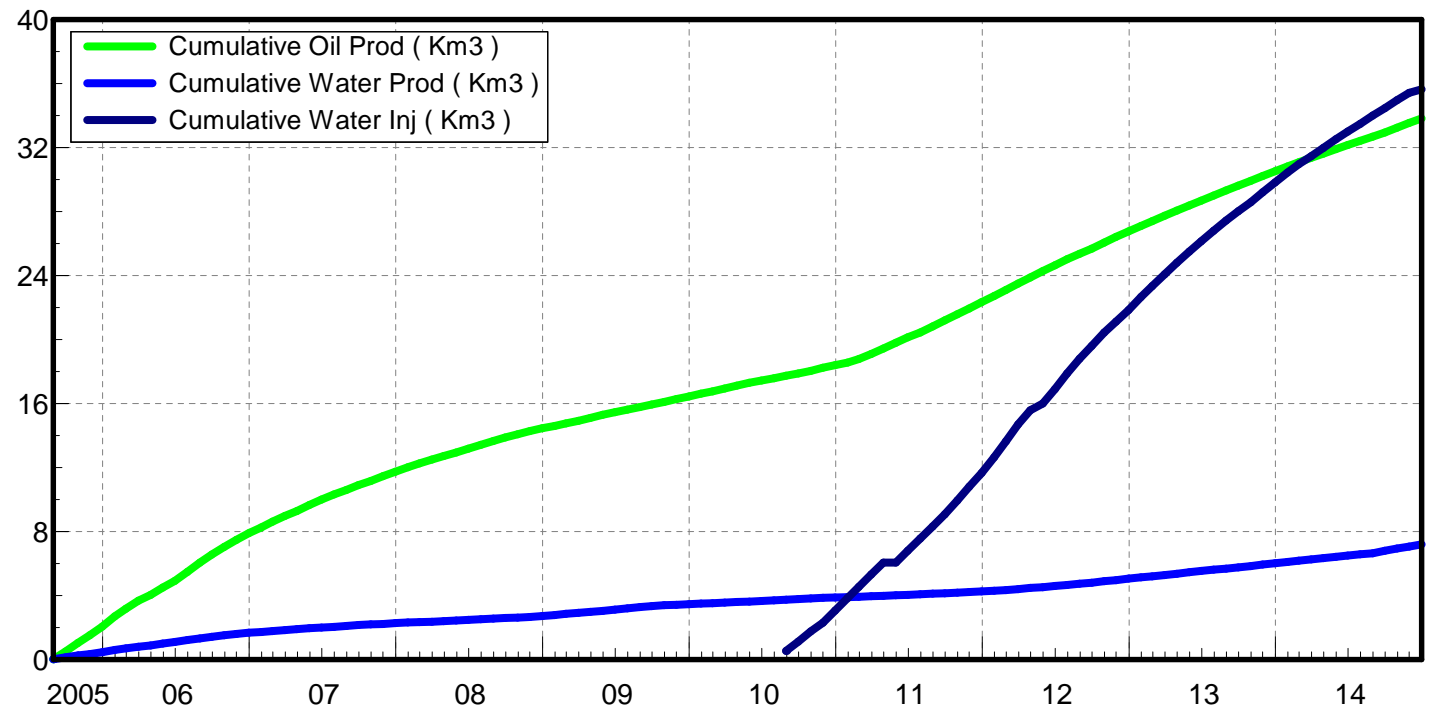
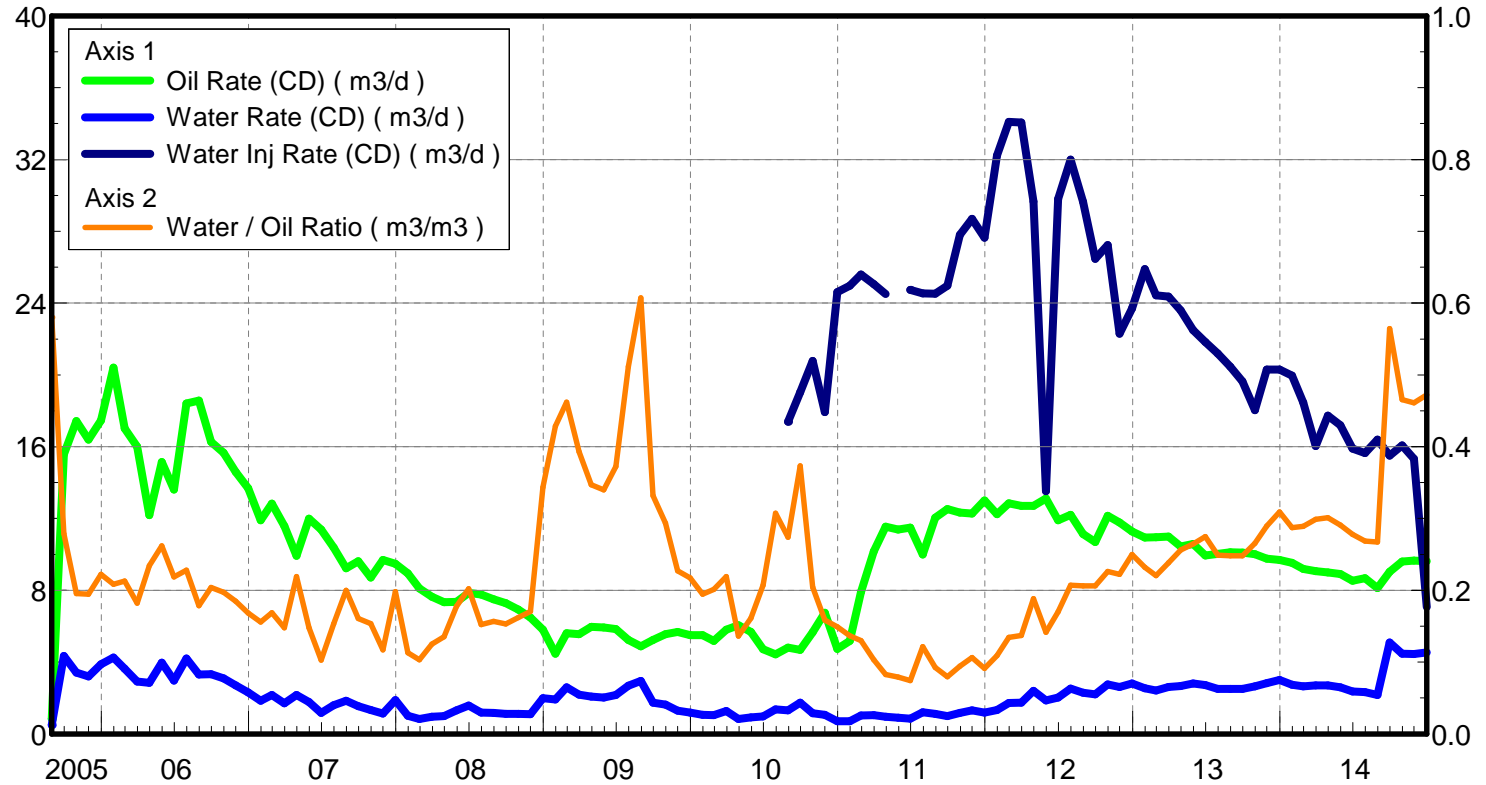
Water / Oil Ratio : 0.47 m3/m3

April 01, 2015  
Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 9.61 m3/d

Water Rate (CD) : 4.54 m3/d

Water Inj Rate (CD) : 7.06 m3/d



# Pattern: 02/01-10-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.65 m3/m3

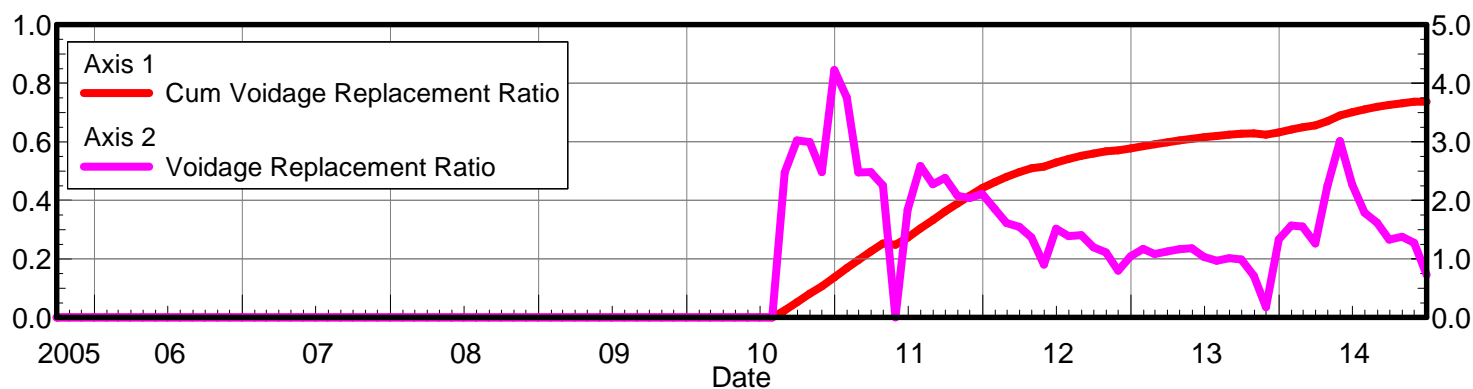
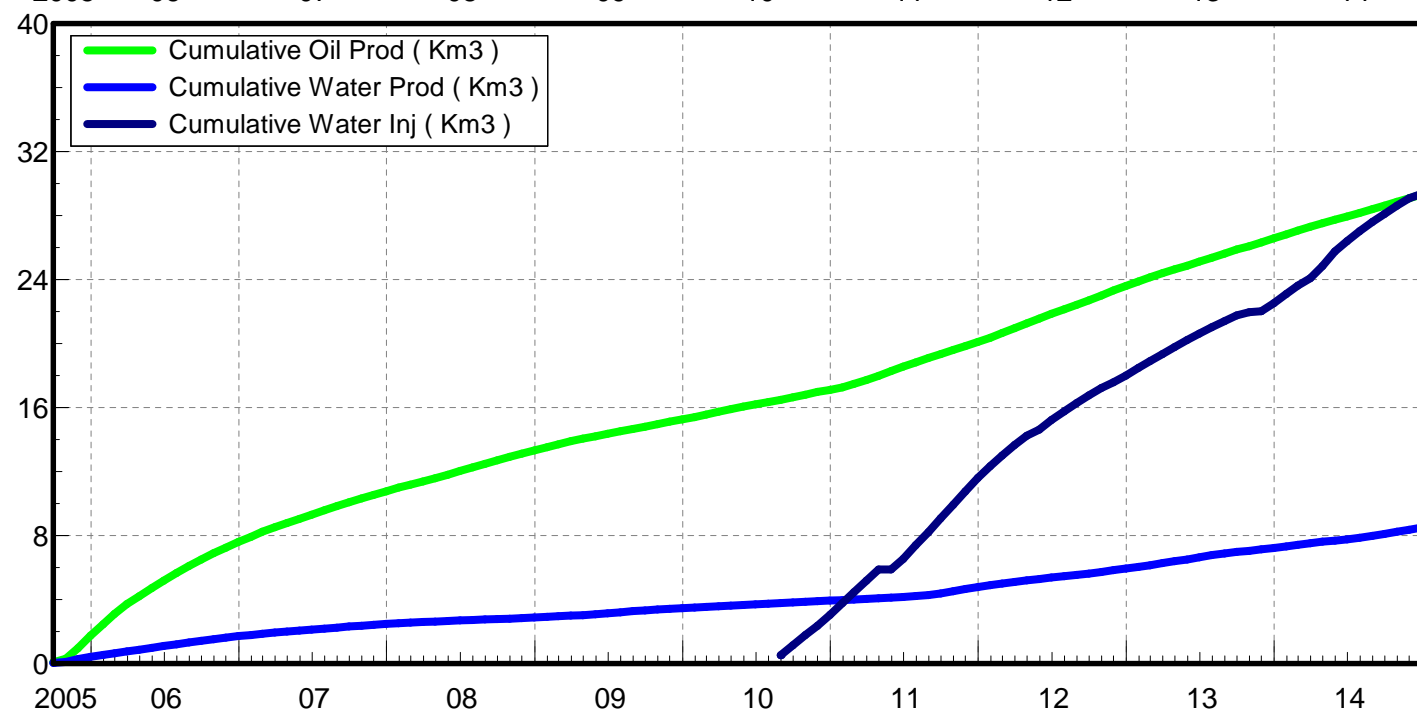
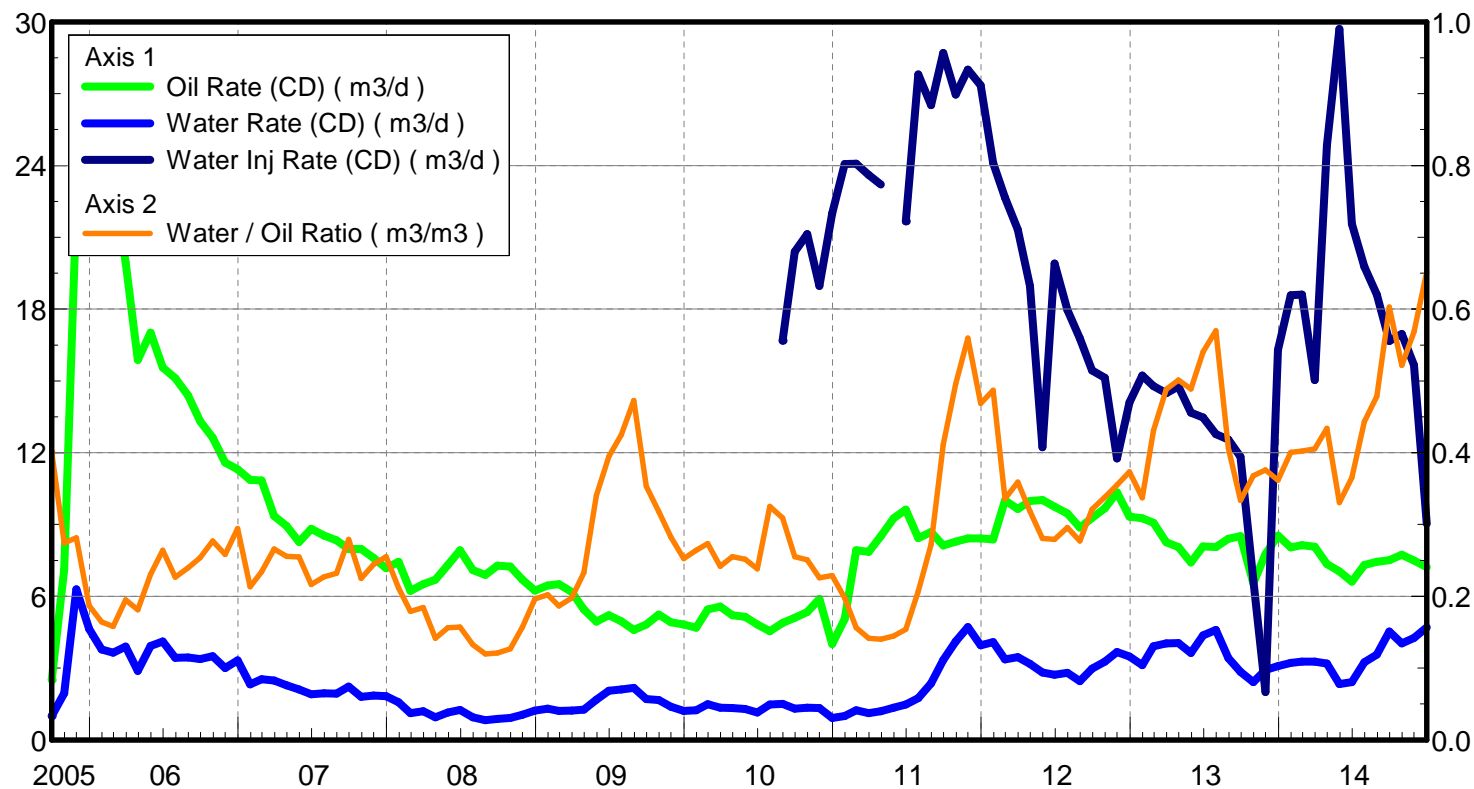
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 7.21 m3/d

Water Rate (CD) : 4.70 m3/d

Water Inj Rate (CD) : 9.03 m3/d



# Pattern: 03/01-10-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

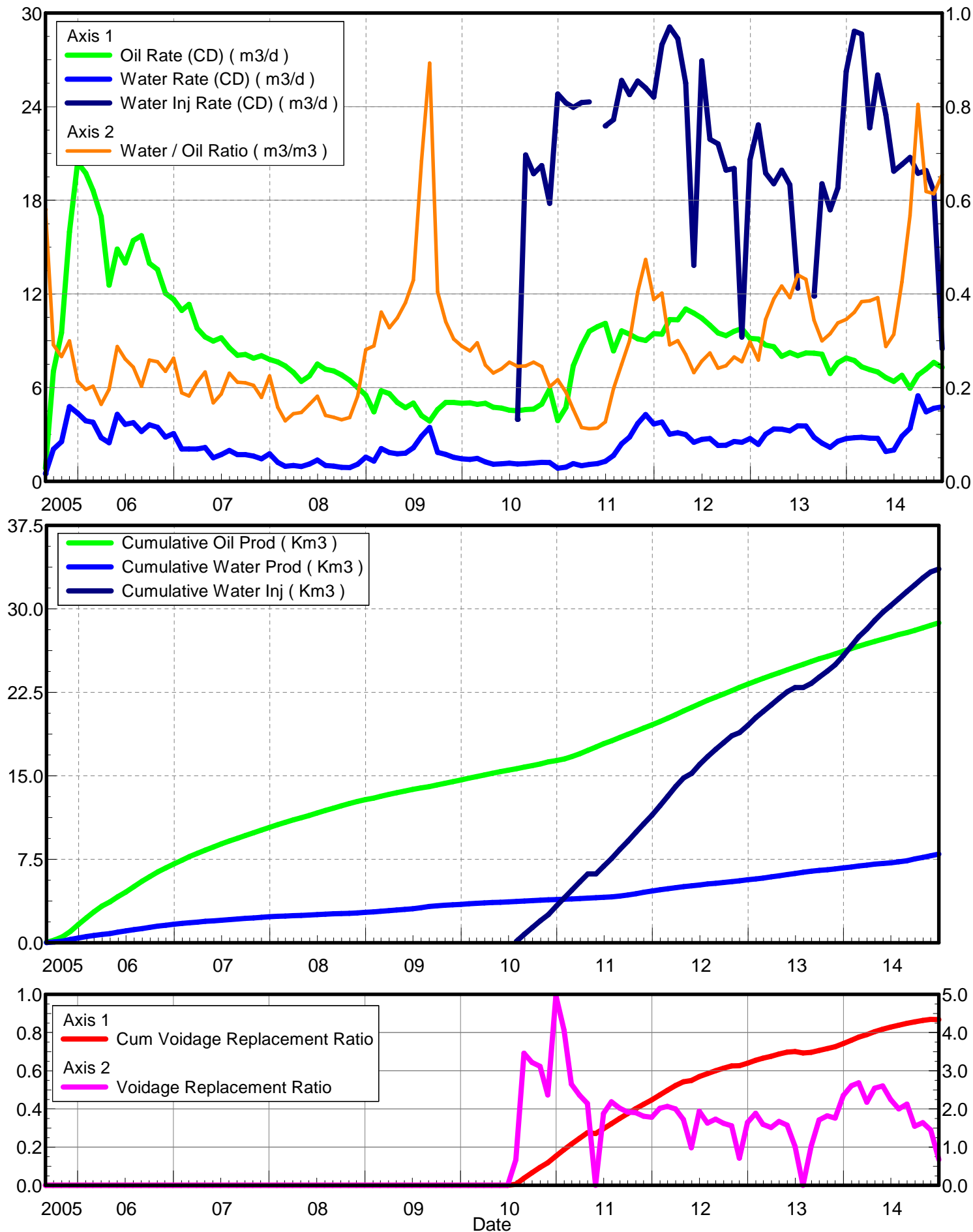
Water / Oil Ratio : 0.66 m3/m3

April 01, 2015  
Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 7.29 m3/d

Water Rate (CD) : 4.77 m3/d

Water Inj Rate (CD) : 8.48 m3/d



# Pattern: 02/08-10-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.74 m3/m3

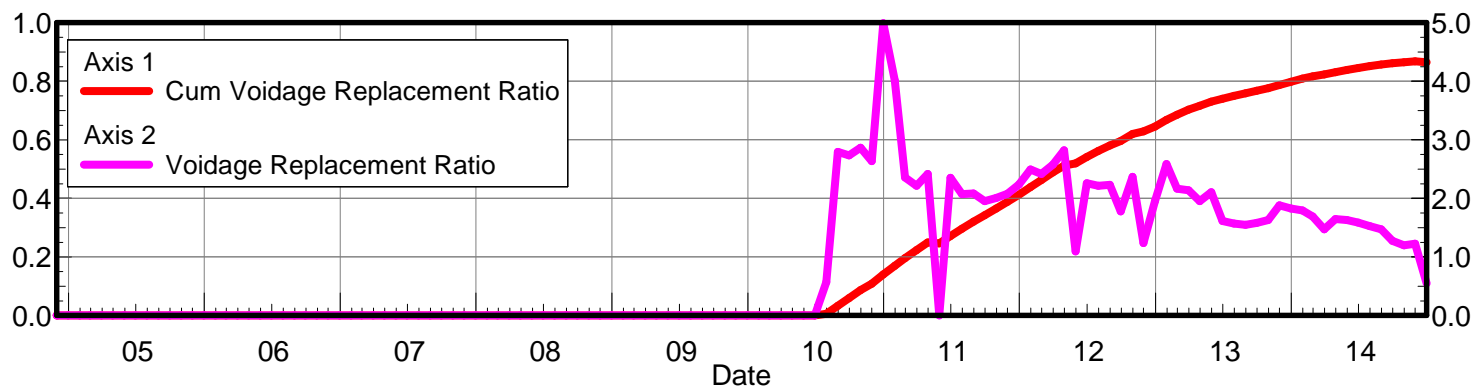
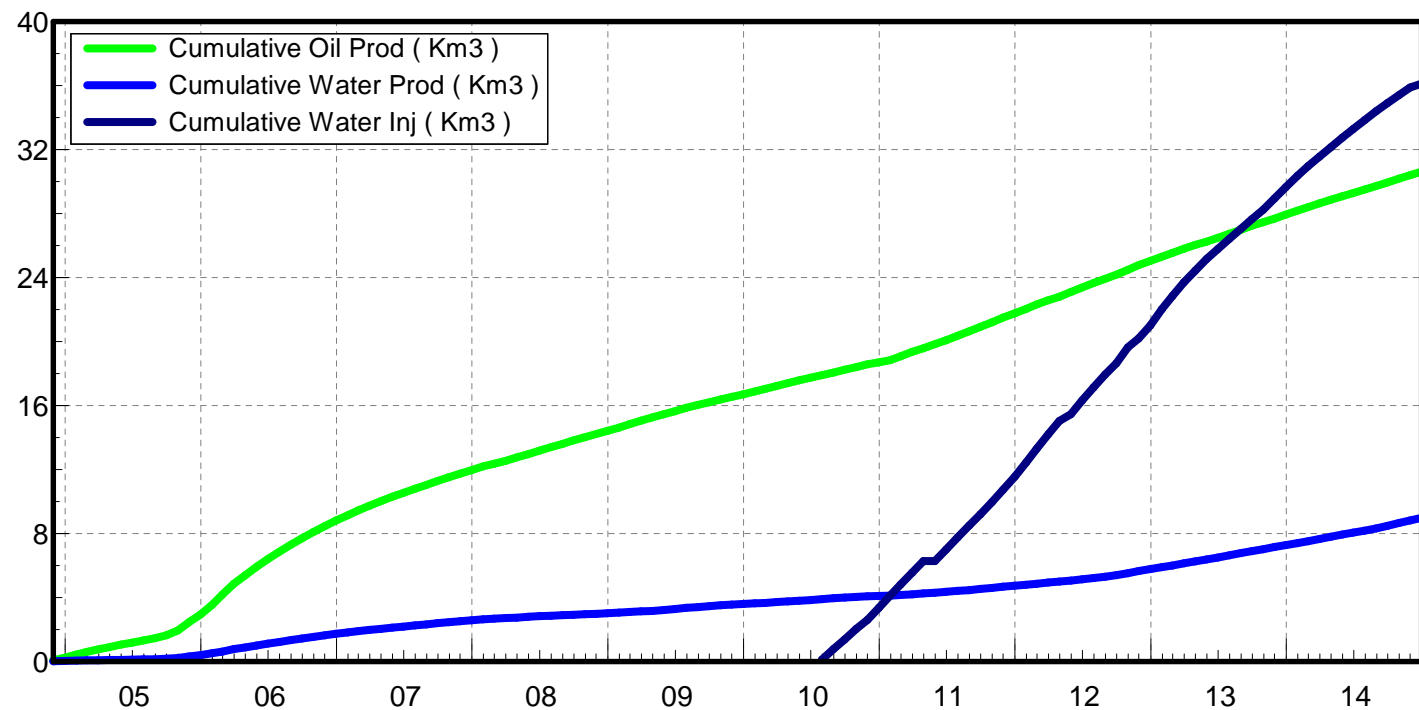
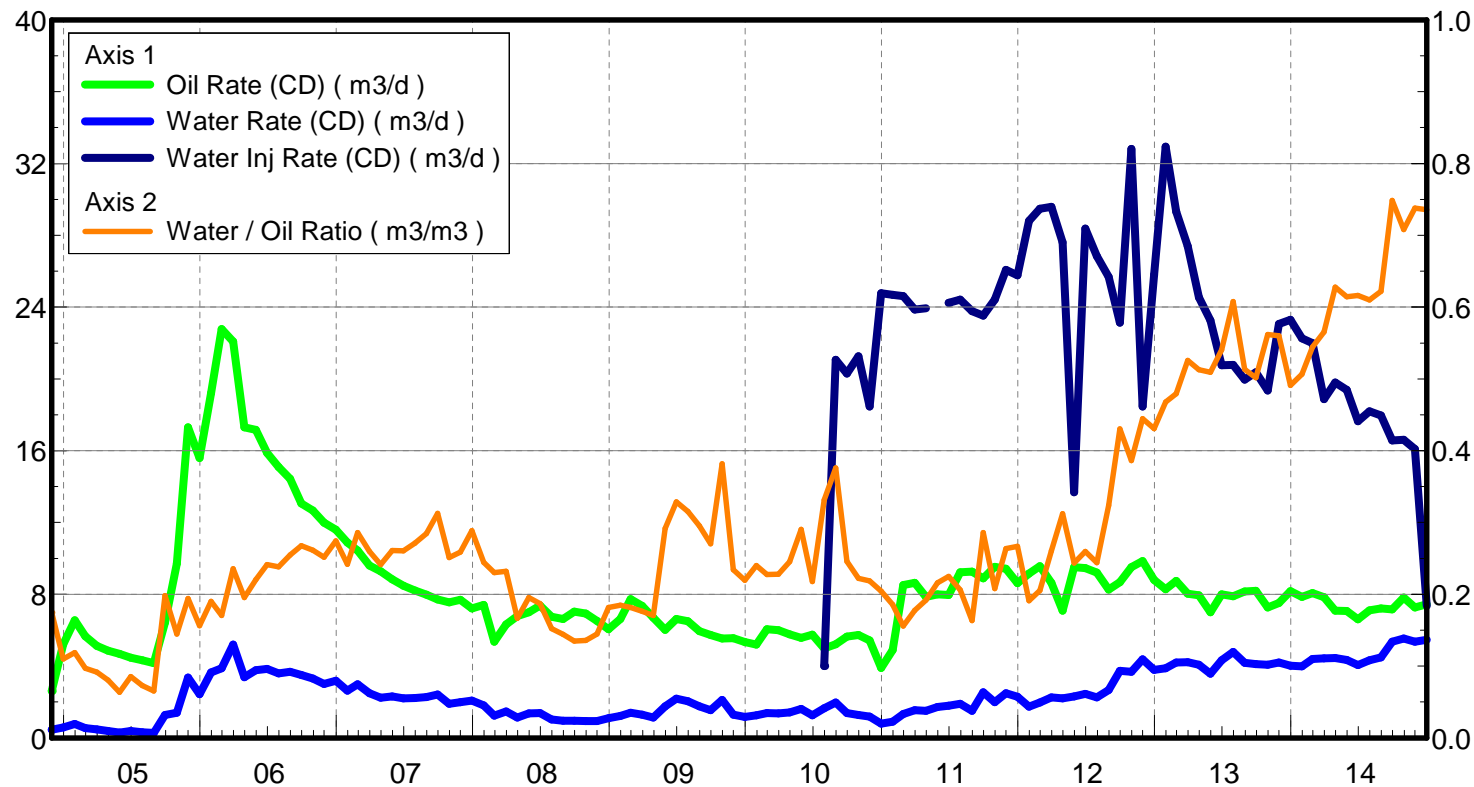
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 7.44 m3/d

Water Rate (CD) : 5.47 m3/d

Water Inj Rate (CD) : 7.35 m3/d





# Pattern: 02/16-10-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

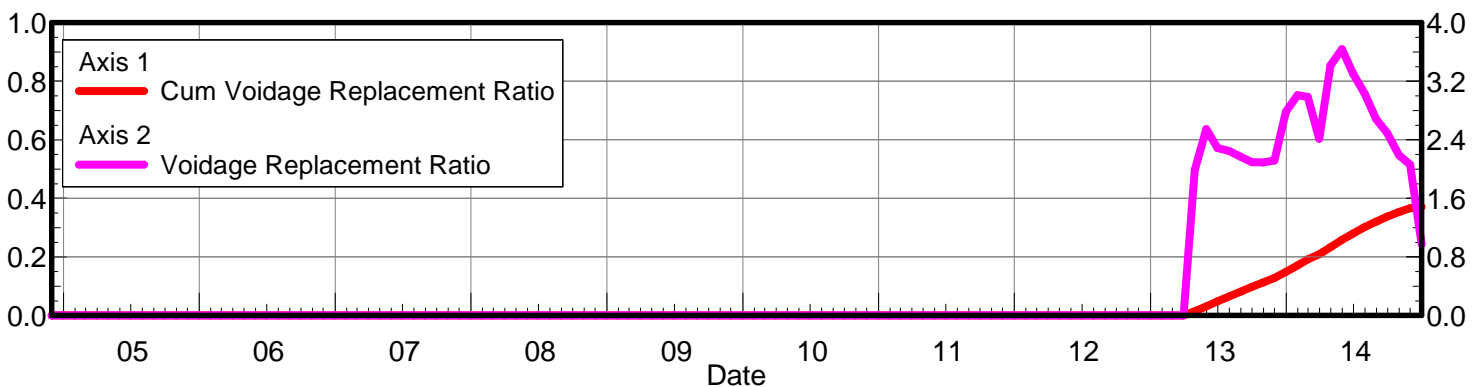
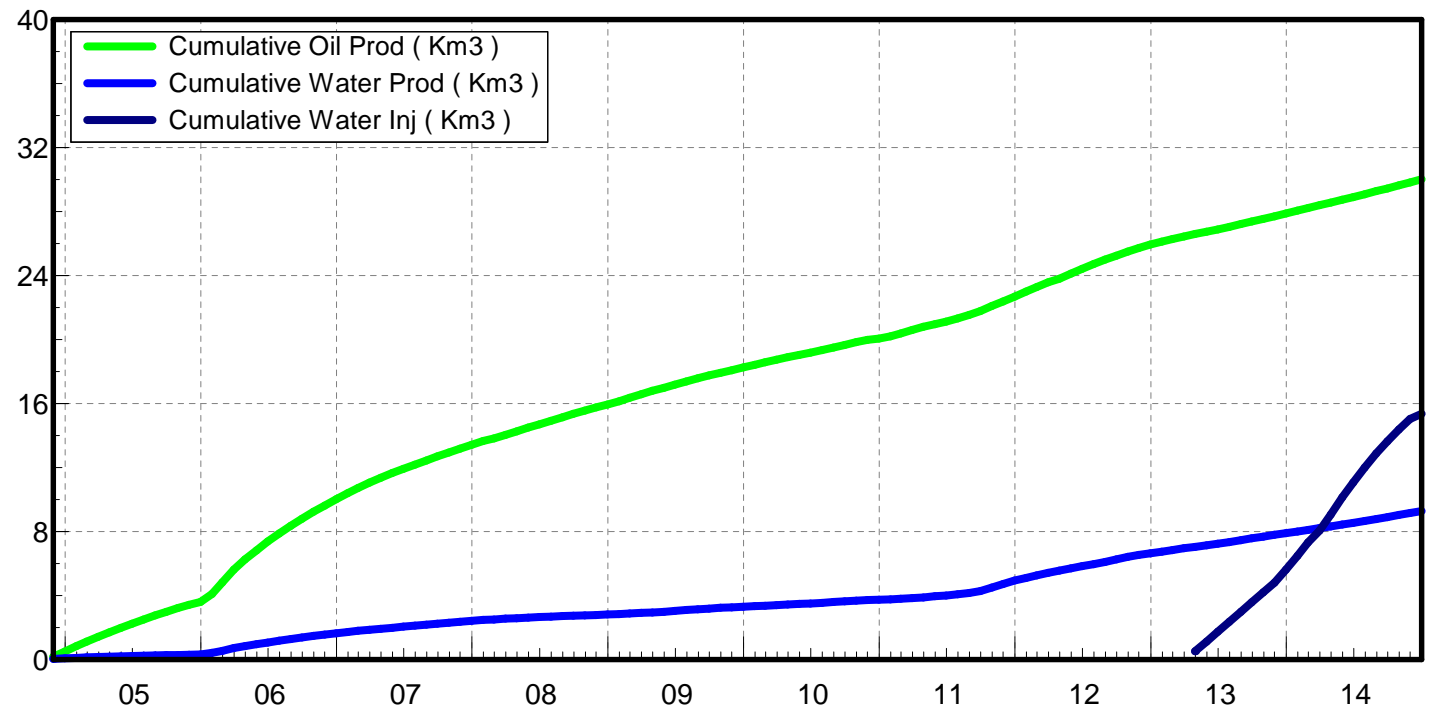
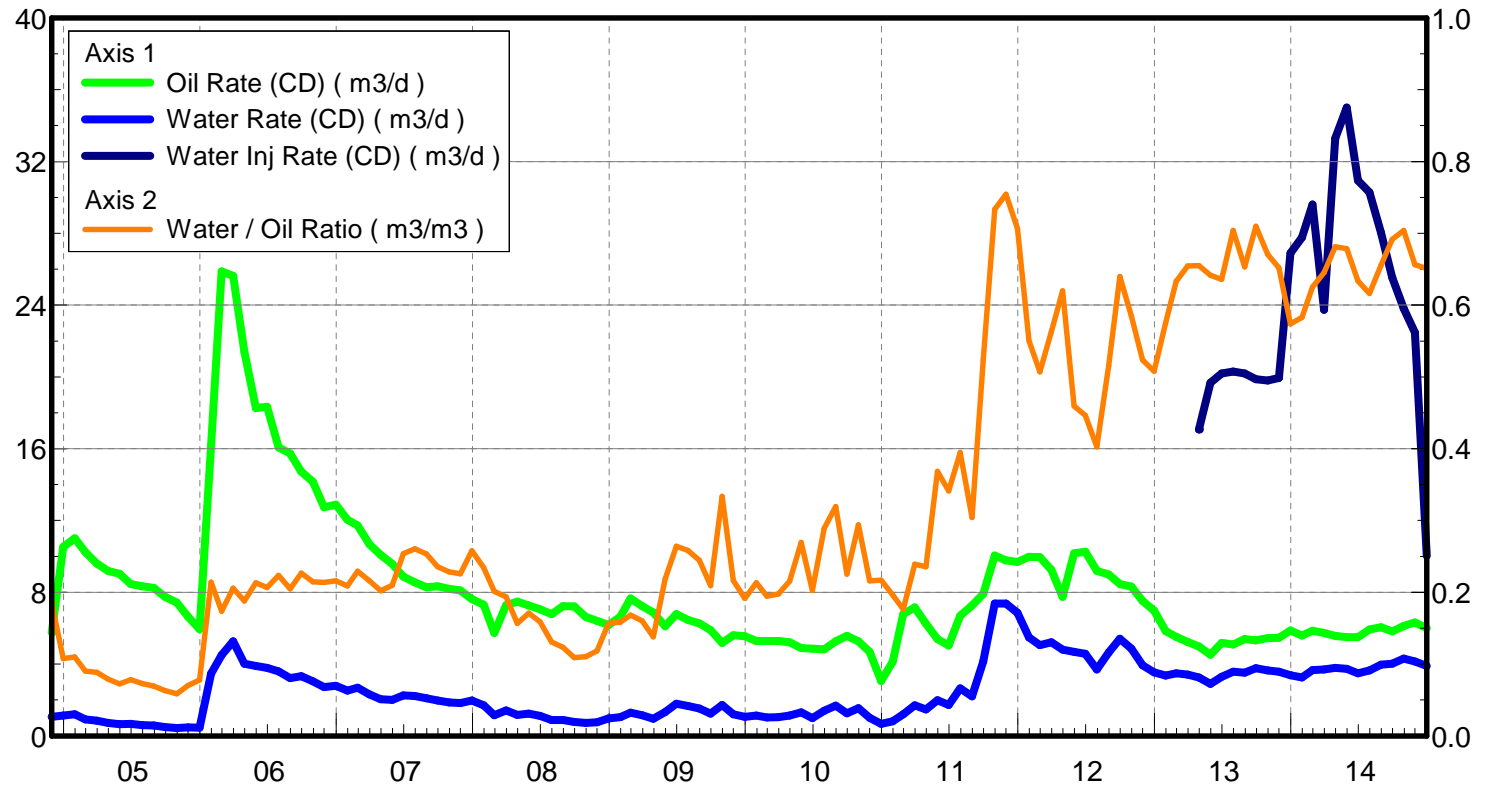
Water / Oil Ratio : 0.65 m3/m3

April 01, 2015  
Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 6.00 m3/d

Water Rate (CD) : 3.90 m3/d

Water Inj Rate (CD) : 10.03 m3/d



# Pattern: 02/04-11-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

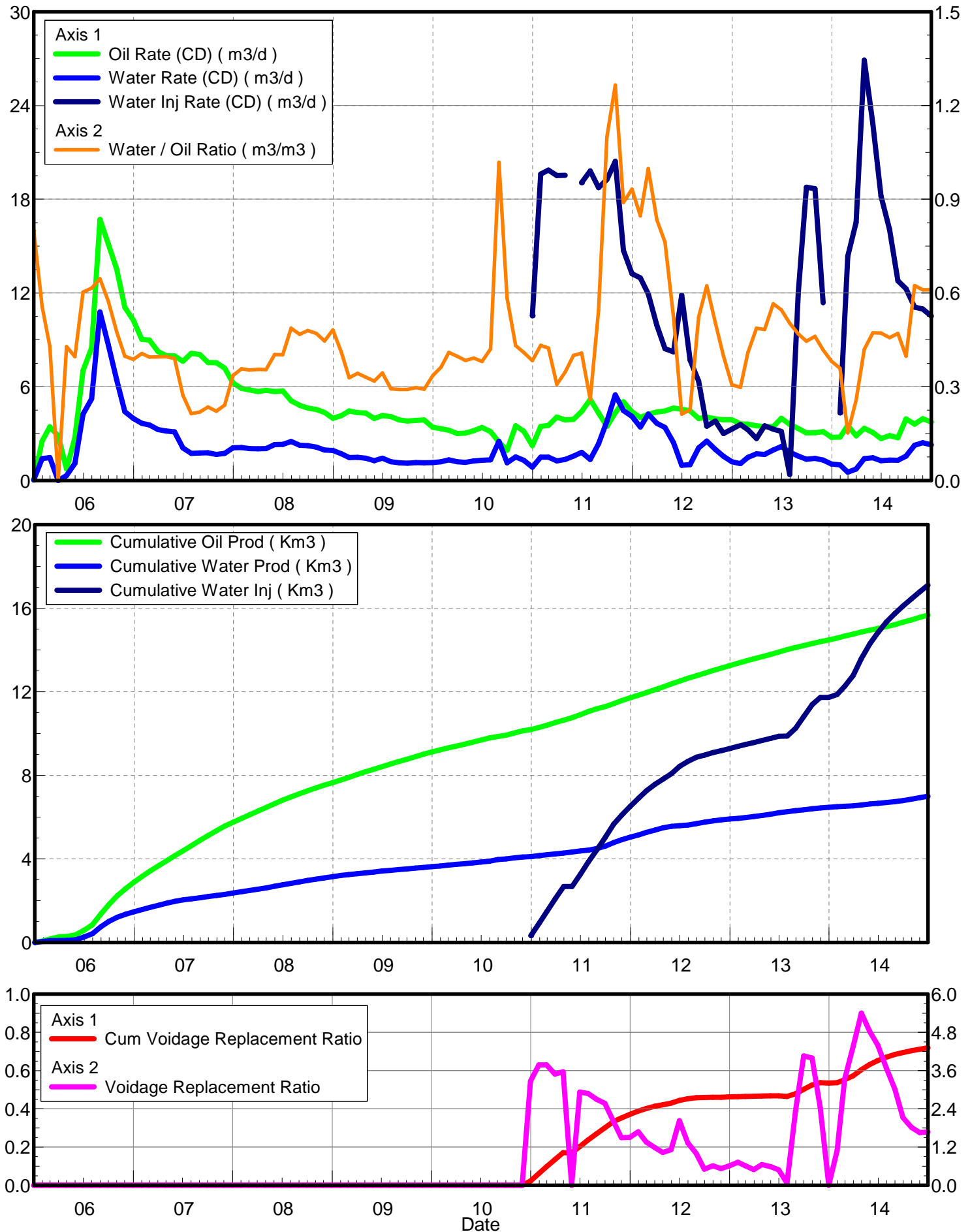
Water / Oil Ratio : 0.61 m3/m3

April 01, 2015  
Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 3.74 m3/d

Water Rate (CD) : 2.28 m3/d

Water Inj Rate (CD) : 10.52 m3/d



# Pattern: 02/05-11-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.57 m3/m3

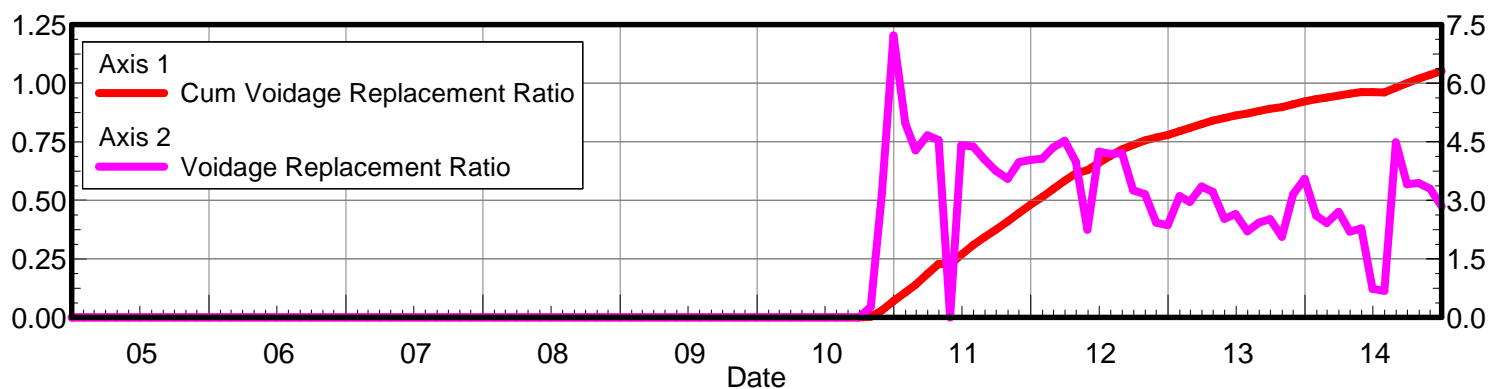
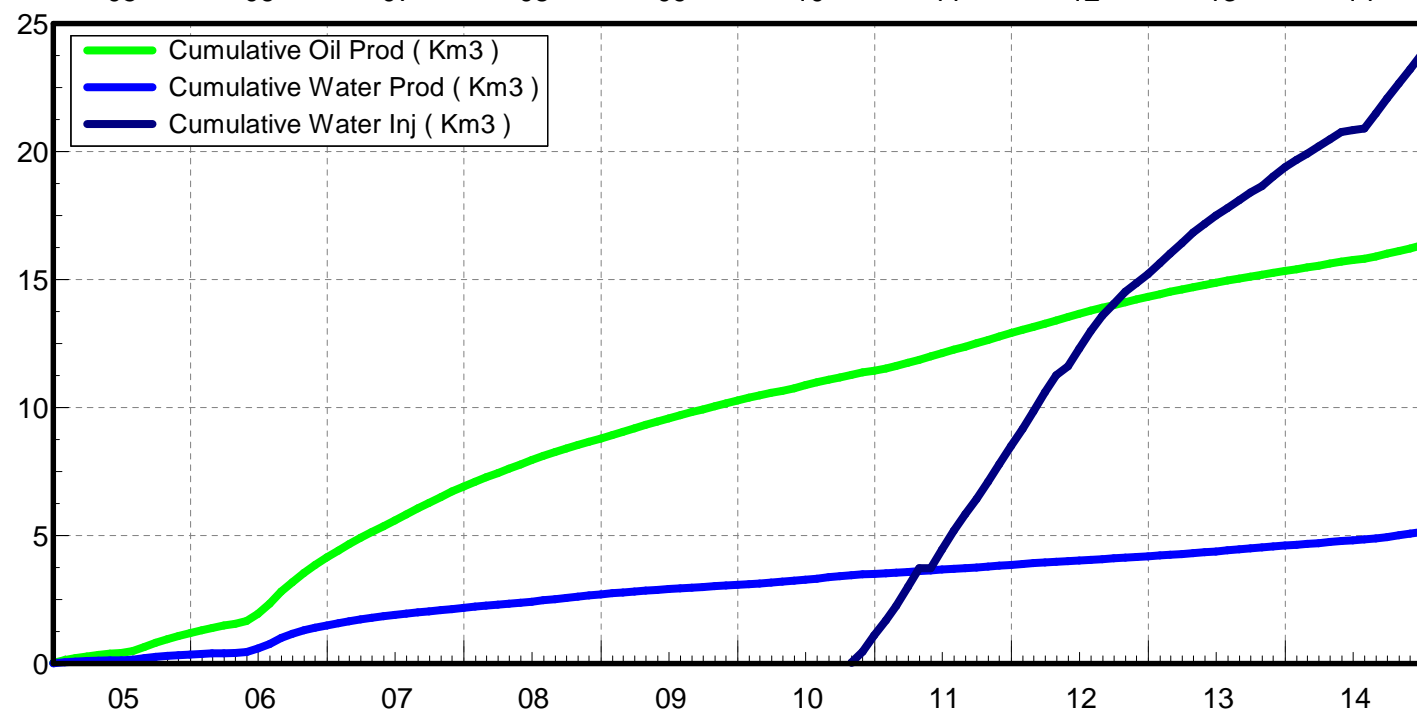
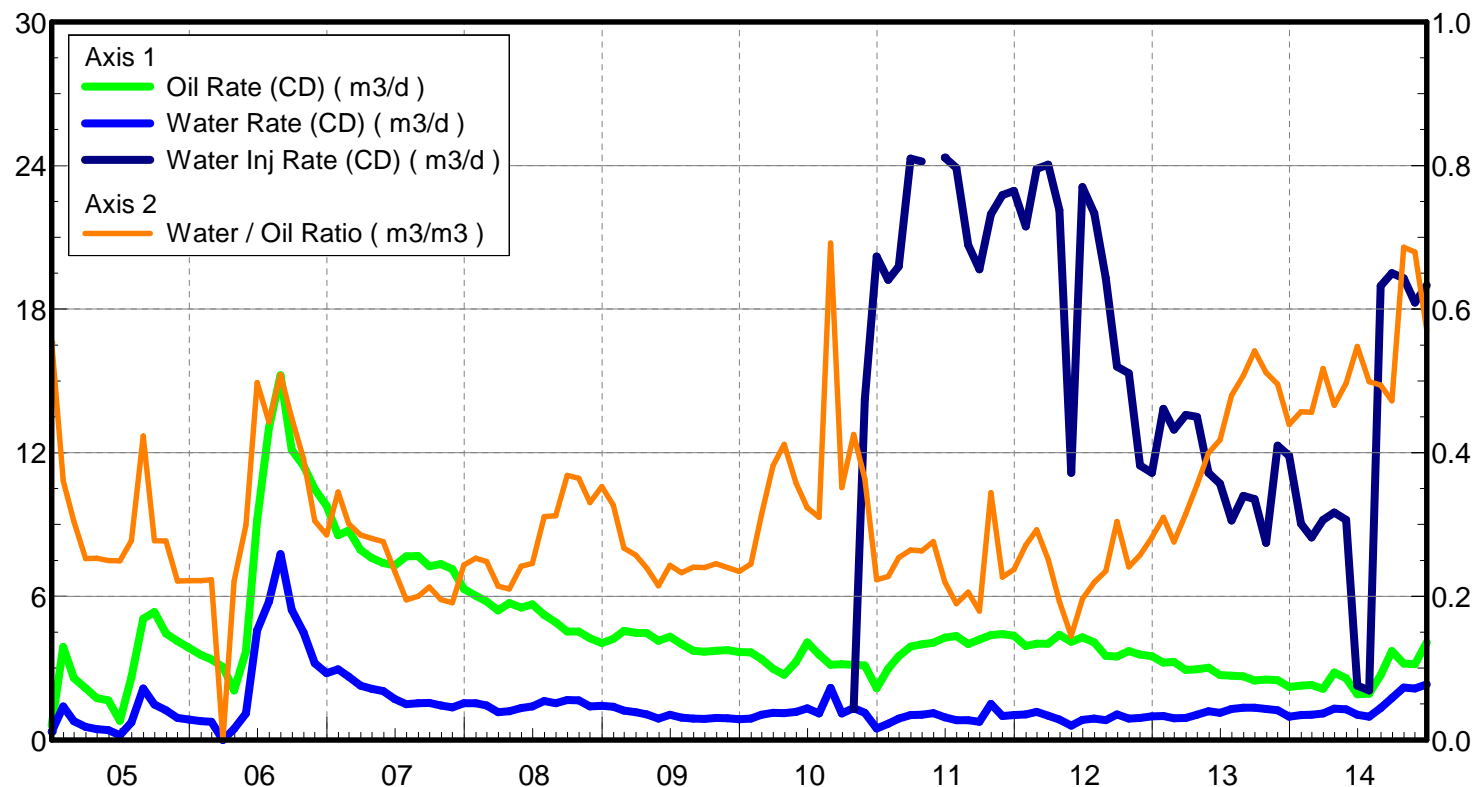
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 4.07 m3/d

Water Rate (CD) : 2.32 m3/d

Water Inj Rate (CD) : 19.00 m3/d



# Pattern: 02/13-11-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.33 m3/m3

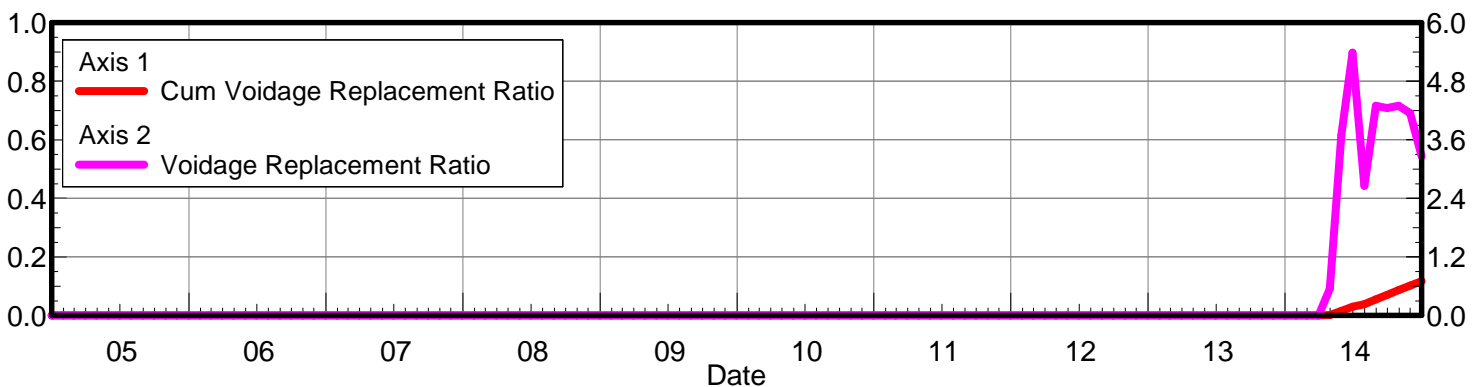
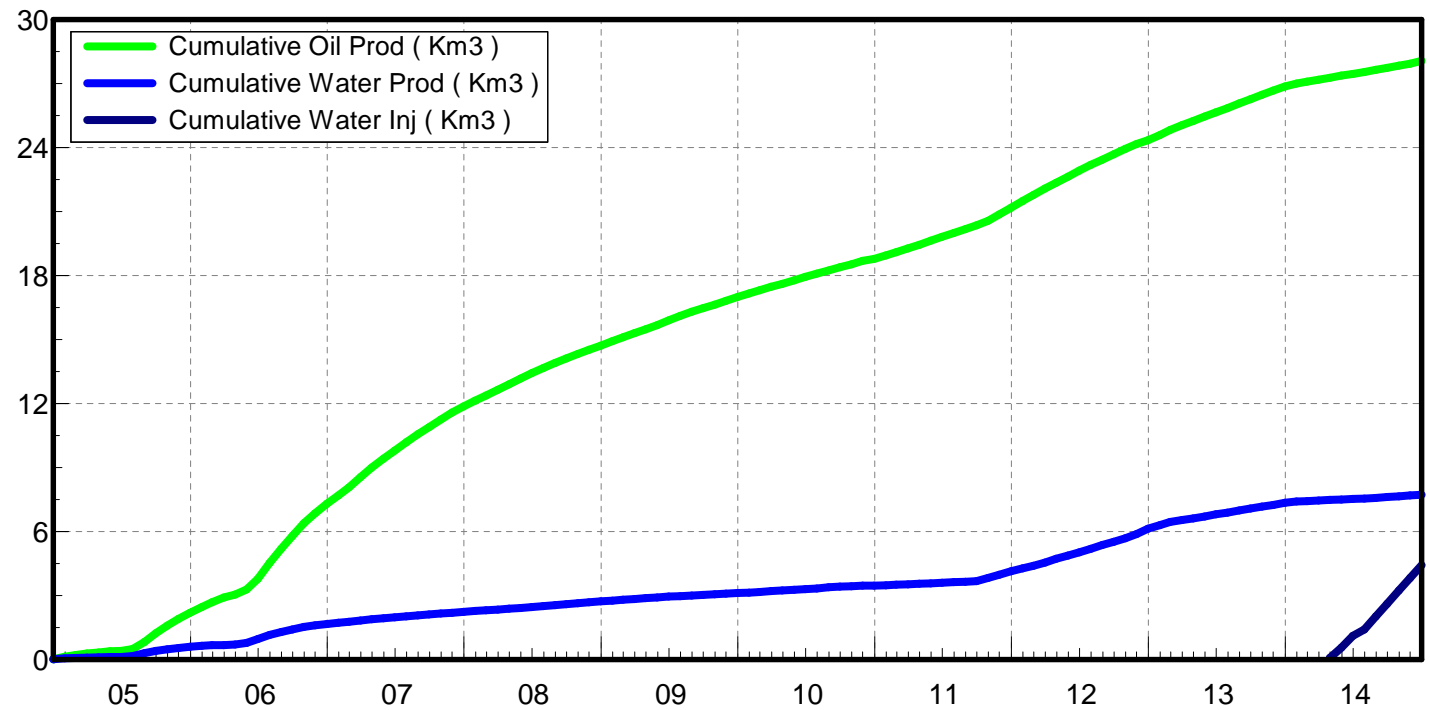
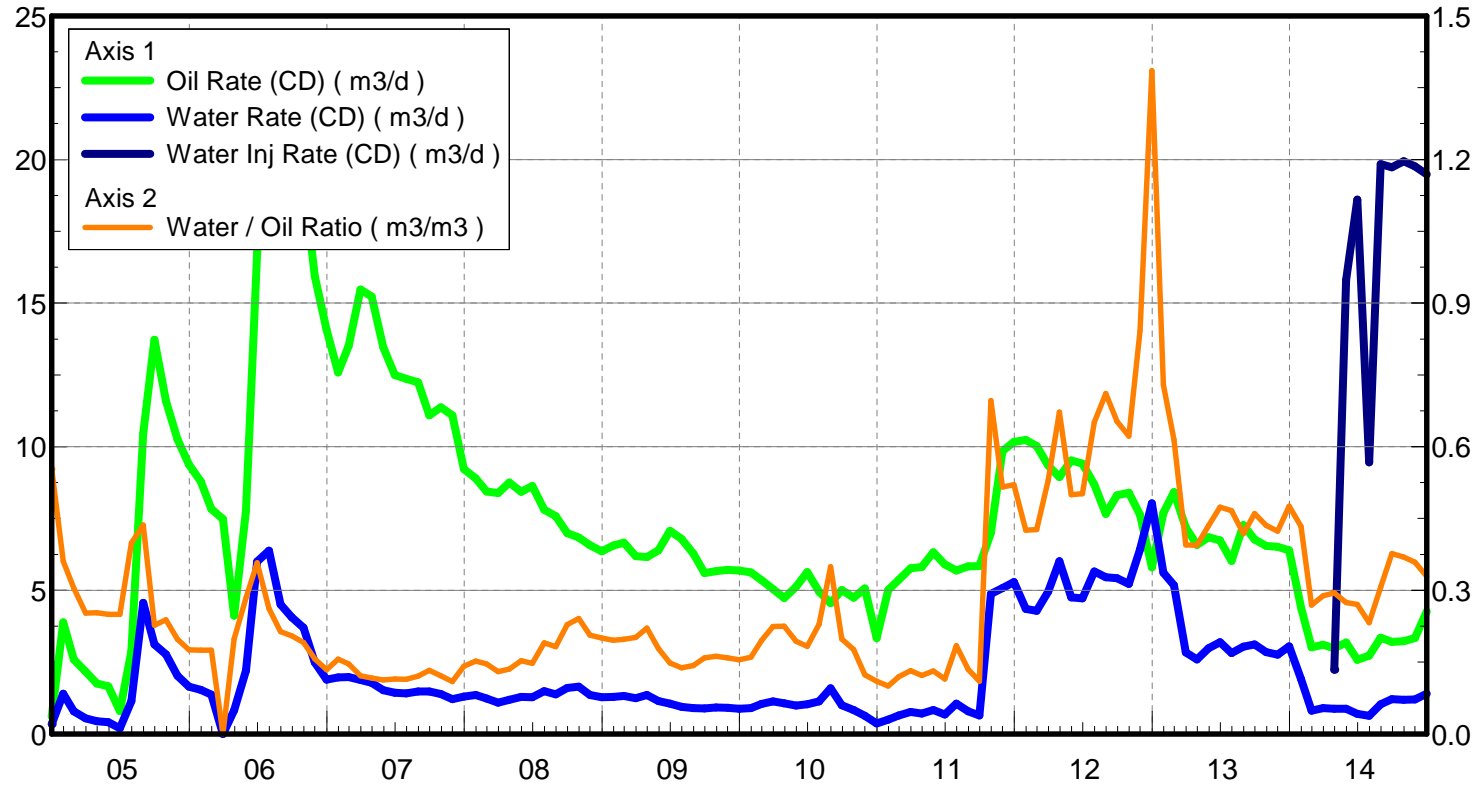
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 4.27 m3/d

Water Rate (CD) : 1.40 m3/d

Water Inj Rate (CD) : 19.48 m3/d



# Pattern: 02/01-12-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.43 m3/m3

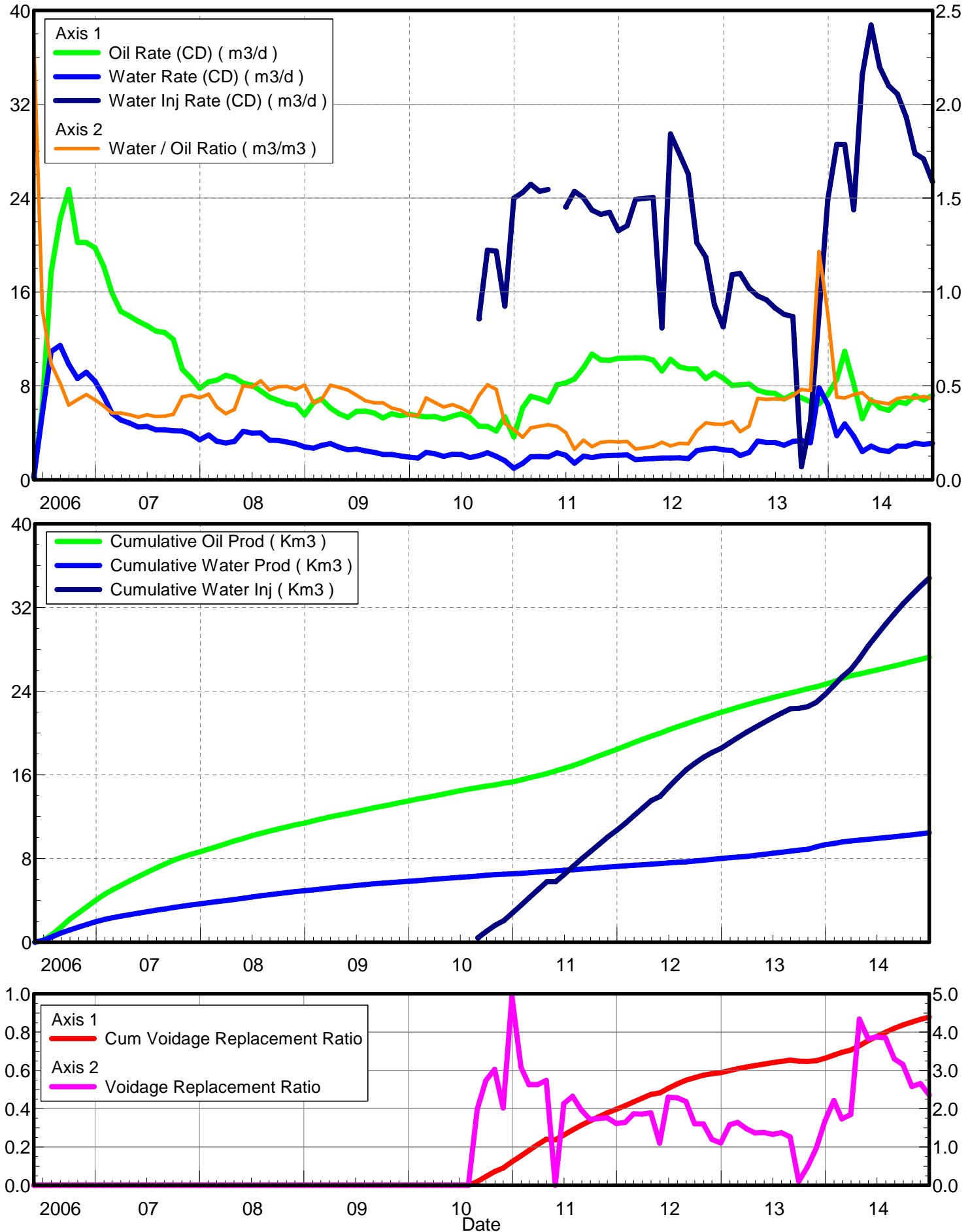
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 7.17 m3/d

Water Rate (CD) : 3.10 m3/d

Water Inj Rate (CD) : 25.39 m3/d



# Pattern: 03/01-12-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 2.26 m3/m3

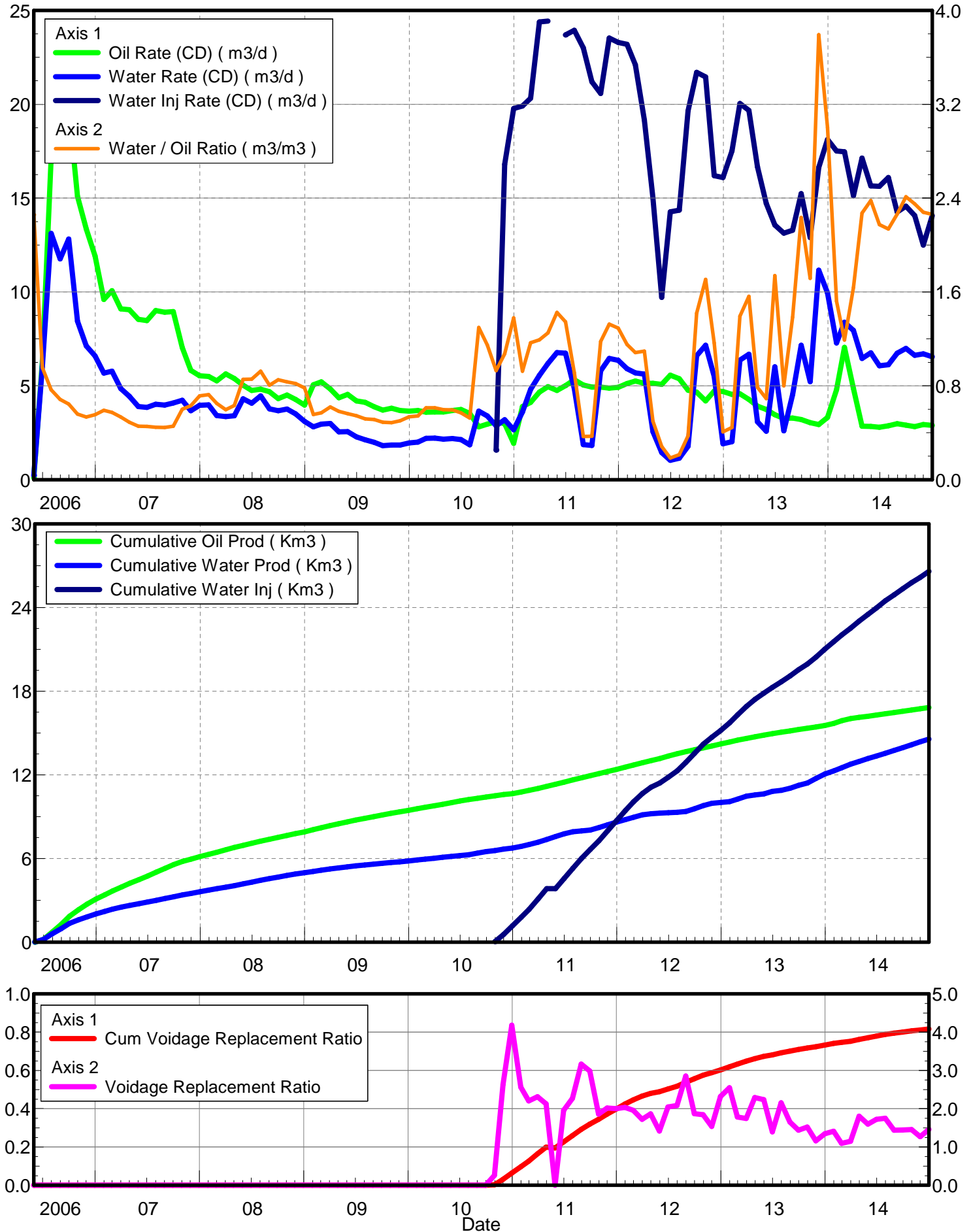
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 2.90 m3/d

Water Rate (CD) : 6.55 m3/d

Water Inj Rate (CD) : 14.06 m3/d



# Pattern: 02/08-12-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 2.34 m3/m3

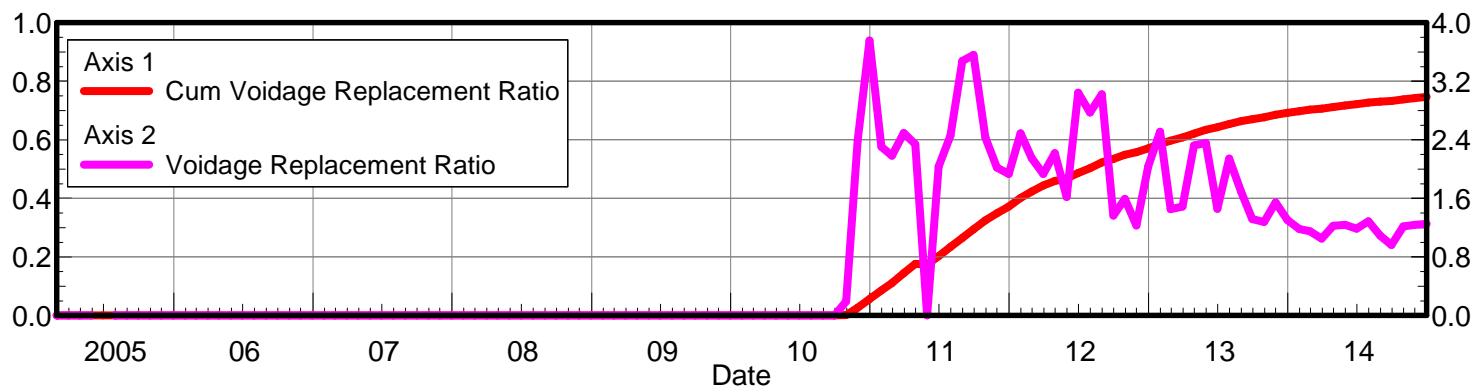
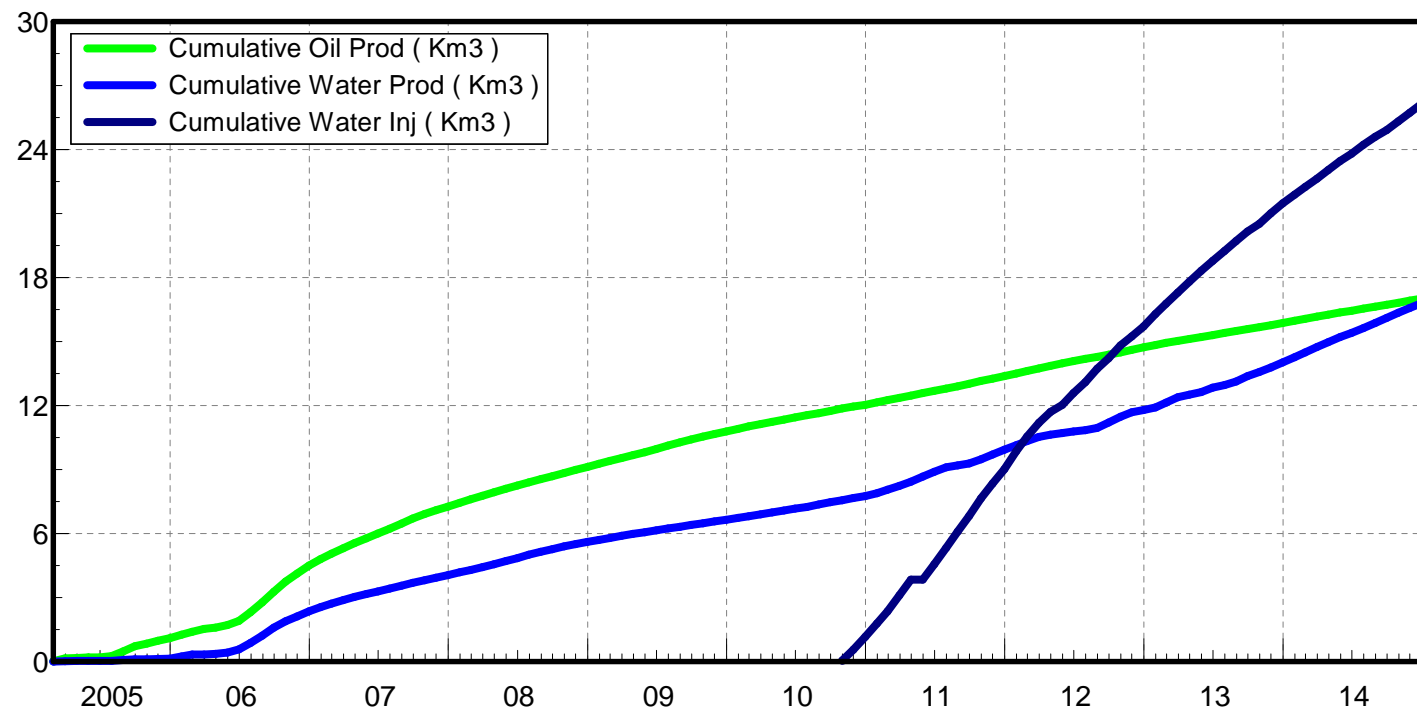
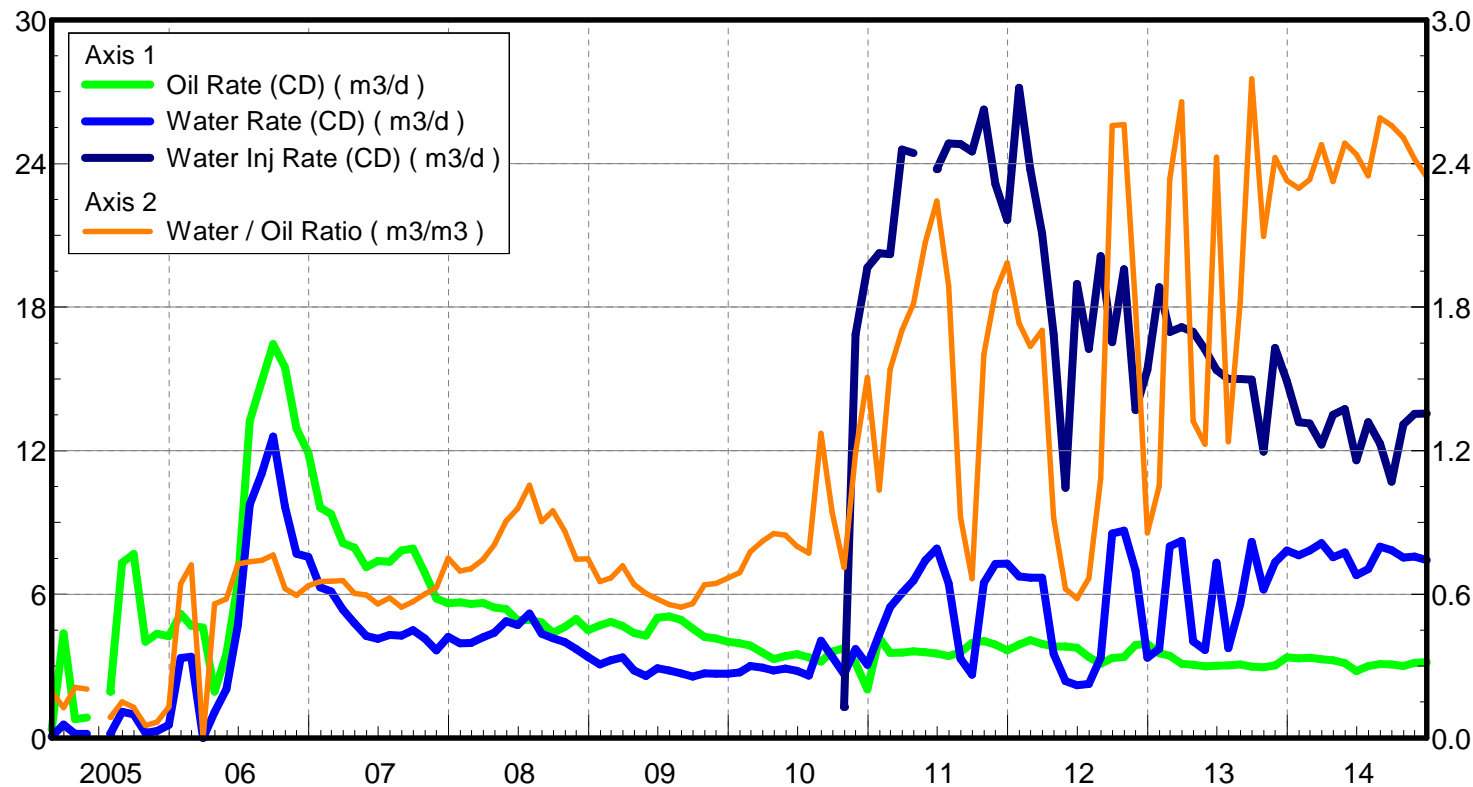
April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 3.17 m3/d

Water Rate (CD) : 7.43 m3/d

Water Inj Rate (CD) : 13.55 m3/d



# Pattern: 02/09-12-008-29Inj Set: Unit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 0.73 m3/m3

April 01, 2015

Operator: Tundra\_O&G\_Prtshp

Oil Rate (CD) : 5.86 m3/d

Water Rate (CD) : 4.29 m3/d

Water Inj Rate (CD) : \* m3/d

