Waskada Unit No. 7

Waterflood Progress Report

January 1st – December 31st, 2013

PennWest

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Table of Contents:

Introduction

Unit Information and Geology

Discussion

Production Performance
Voidage Replacement Ratio
Pressure Surveys
Corrosion and Scale Prevention

Summary and Recommendationas

Attachments

1 Area Map.
1A Area Map of New Drills
2 A Summary of the Unit Well List and History. Includes New Drills.
3 A Production and Injection plot of the Unit.
3A A Production plot of the New Drills.
4 A Summary of Unit Annual Volumes and Rates.
5 A Cumulative Production and Injection plot of the Unit.
6 A Unit Voidage Replacement Ratio Plot.
7 Individual Injection Well Performance Plots (5).

Introduction:

The Waskada Unit No.7 pressure maintenance project commenced water injection into the Lower Amaranth designed and in accordance with Manitoba Energy and Mines Approval No. PM 58.

Please refer to Attachment 1 – Area Map.

PRESSURE MAINTENANCE: Governed by Board Order No. PM 58

Unit Information

UNITIZED ZONE: Lower Amaranth
Original Unit, November 1, 1986 Board Order – Voluntary

POOL: Waskada Lower Amaranth A (03 29A)

This report documents the performance of the Waskada Unit No. 7 pressure maintenance project for the period of January 1 to December 31, 2013. The Unit had 24 active producers and no active injectors at the end of 2013. There were 3 new drills in 2013.

Please refer to Attachment 1A – Area Map of New Drills

Unit No. 7 is part of the main Waskada field. The Waskada field is situated on the northeast rim of the Williston Basin in southern Manitoba. It comprises a large portion of Township 1 and 2, Ranges 25 and 26 W1.

Geology

The Waskada Fields produce light density crude (approximately 36^{o} API), predominantly from the Lower Amaranth formation. This is an interlaminated, shallow marine to subtidal succession of sandstones, siltones, and shale progressively onlaps the Mississippian unconformity surface from basin center, up dip to the north and eastern basin limits in Saskatchewan and Manitoba. The fine grained reservoir rock has a complex reservoir characterization with 13 to 16 % porosity and permeability on the order of 0.5 to15 md. The Lower Amaranth, the oldest Mesozoic unit, is a clastic red bed sequence lying directly on the Paleozoic erosional surface. It consists of a series of dolomitic siltstones and sandstones interbedded with argillaceous siltstones and shales. The section is usually subdivided into a lower sandy unit and an overlying shale unit. The lower sequence is the oil production zone. The bulk of pay is found in the laminated sandstone/siltstone facies.

The Lower Amaranth has been classified into four general lithological types:

1. Interbedded shale/siltstone/sandstone by grain size, color and texture

2. Siltstone – This lithology occurs in distinct intervals up to two or three metres in thickness. It is generally light green in color and dolomitic.
3. Laminated sandstone – This occurs in distinct sandy intervals with a wide range of grain sizes and primary sedimentary structures.
4. Massive sandstone – This lithology occurs in thin intervals and usually associated with the laminated sandstones facies. Beds are usually light grey to reddish grey in color and coarse to medium – grained.

Discussion

Production and Injection Performance

Board Order No. PM 58 provided for pressure maintenance operations in Waskada Unit No.7. From the startup of injection in January 1987, injection rates fluctuated to the same degree in each injector, making it difficult to link any production responses to any injector. The Unit includes 5 injection wells; at the end of 2013 none are currently active. Injection ceased essentially in 1998. There are currently 24 active producers; 2 horizontal wells were drilled in 2013 briefly adding to Unit production.

Please refer to Attachment 2 – A Summary of the Unit Well List and History with New Drills
Please refer to Attachment 3 – A Production and Injection plot of the Unit.
Please refer to Attachment 3A – A Production Plot of the New Drills
Please refer to Attachment 4 – A Summary of Unit Annual Volumes and Rates.
Please refer to Attachment 5 – A Cumulative Production and Injection plot of the Unit.

Voidage Replacement Ratio Calculation:

The Cumulative VRR from production start is at 0.18; the Cumulative VRR from injection start is at 0.2. Both have dropped from 0.95 and 1.95 significantly in the last 4 years due to essentially no injection from 1998 onwards and the startup of new producers. Currently there are no active injectors in this Unit hence Monthly VRR is zero. PennWest has no plans to reactivate at this time any of the old injectors.

Please refer to Attachment 6 – A Unit Voidage Replacement Ratio Plot.
Please refer to Attachment 7 – Individual Injection Well Performance Plots (5).

Pressure Surveys:

There were no pressure surveys conducted in 2013.

Corrosion and Scale Prevention Program:

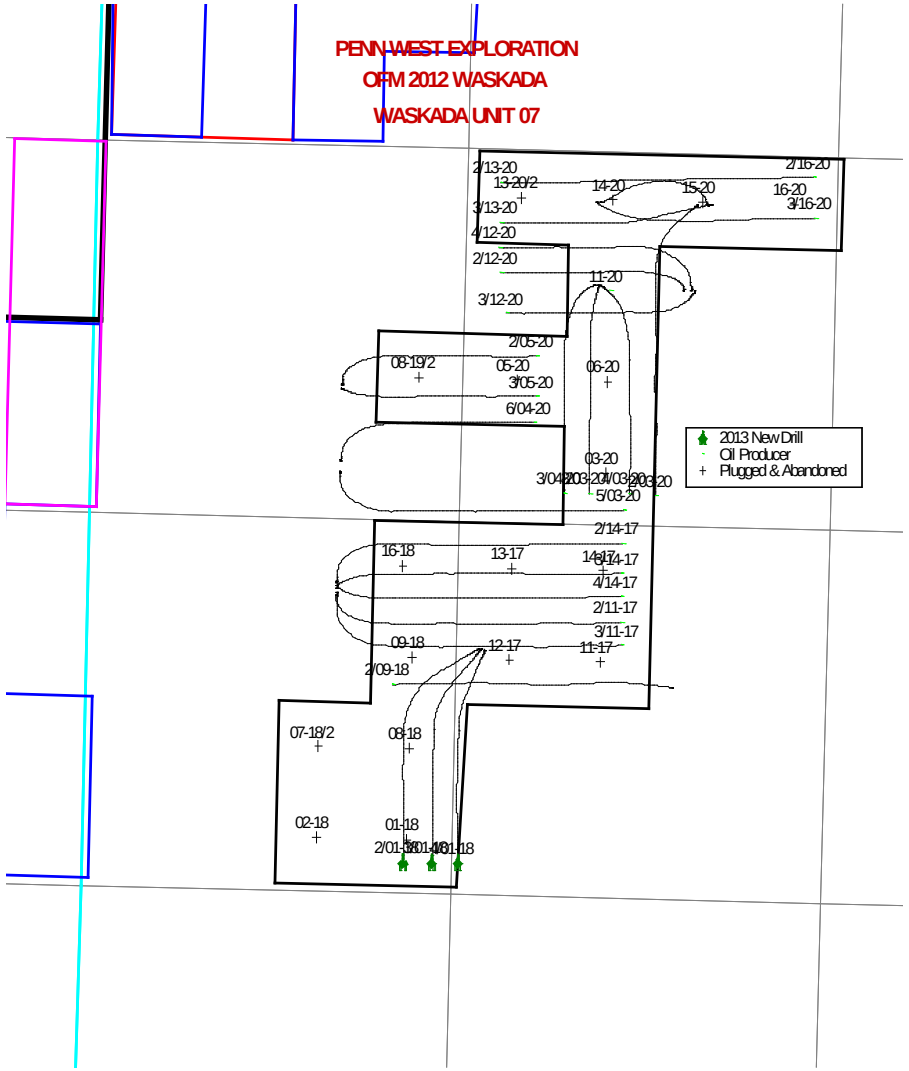
We currently inject ScalCor down all the new horizontal wells. PennWest will be installing cathodic protection on the wells. The new gathering system is Fibreglass and as such is not susceptible to corrosion.

Summary and Recommendations

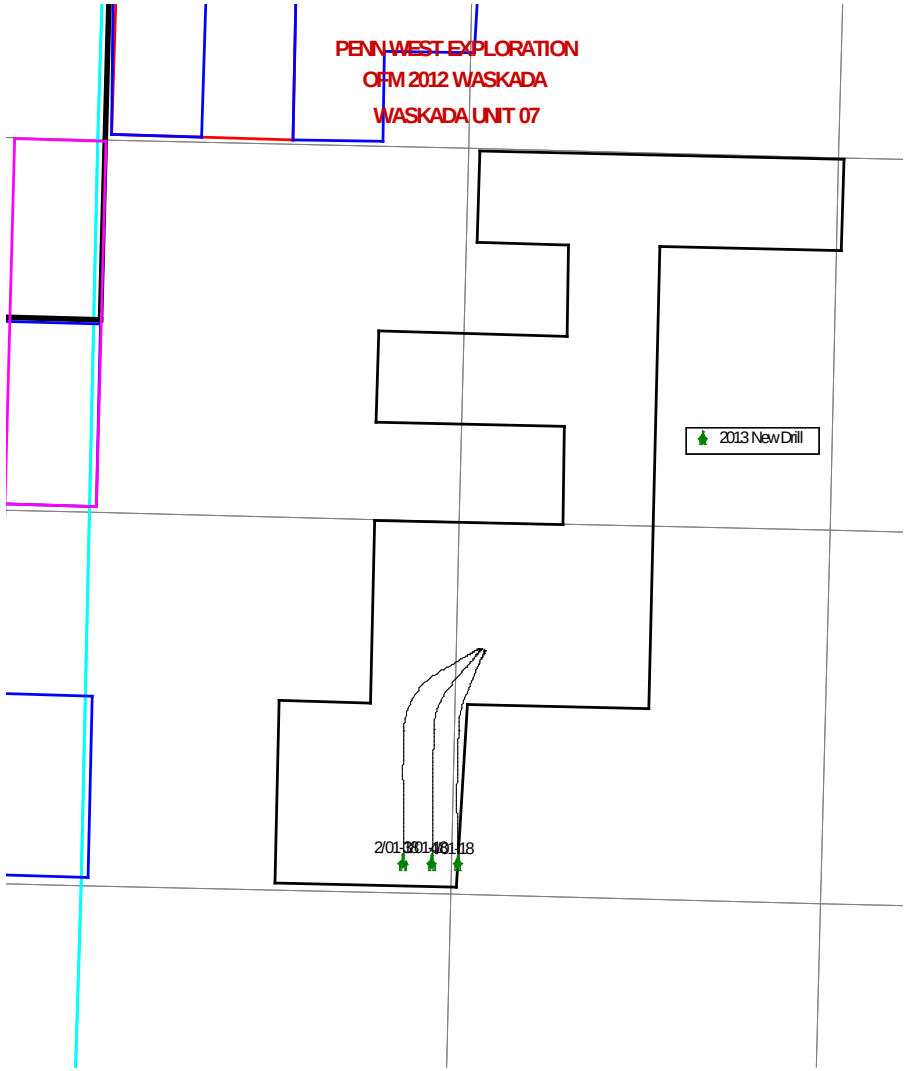
The behaviour of Waskada Unit 7 producers are indicated by good initial oil productivity, rapidly declining to low rates, with almost no discernible water flood response. It is also believed that fracture stimulation treatments, performed on these wells prior to initiation of water injection, "broke through" into the higher productivity Mississippian and that the majority of injected water to date has entered this zone. This is one of the major explanations for lack of waterflood response to date and the continued decline in oil productivities.

A horizontal producer and conversion of vertical producers to injector well pilot was contemplated for the Lower Amaranth targeting Unit 13 with results scalable to all Lower Amaranth Units. It is currently inactive pending evaluation of alternative schemes.

ATTACHMENT 1 – Unit Area Map



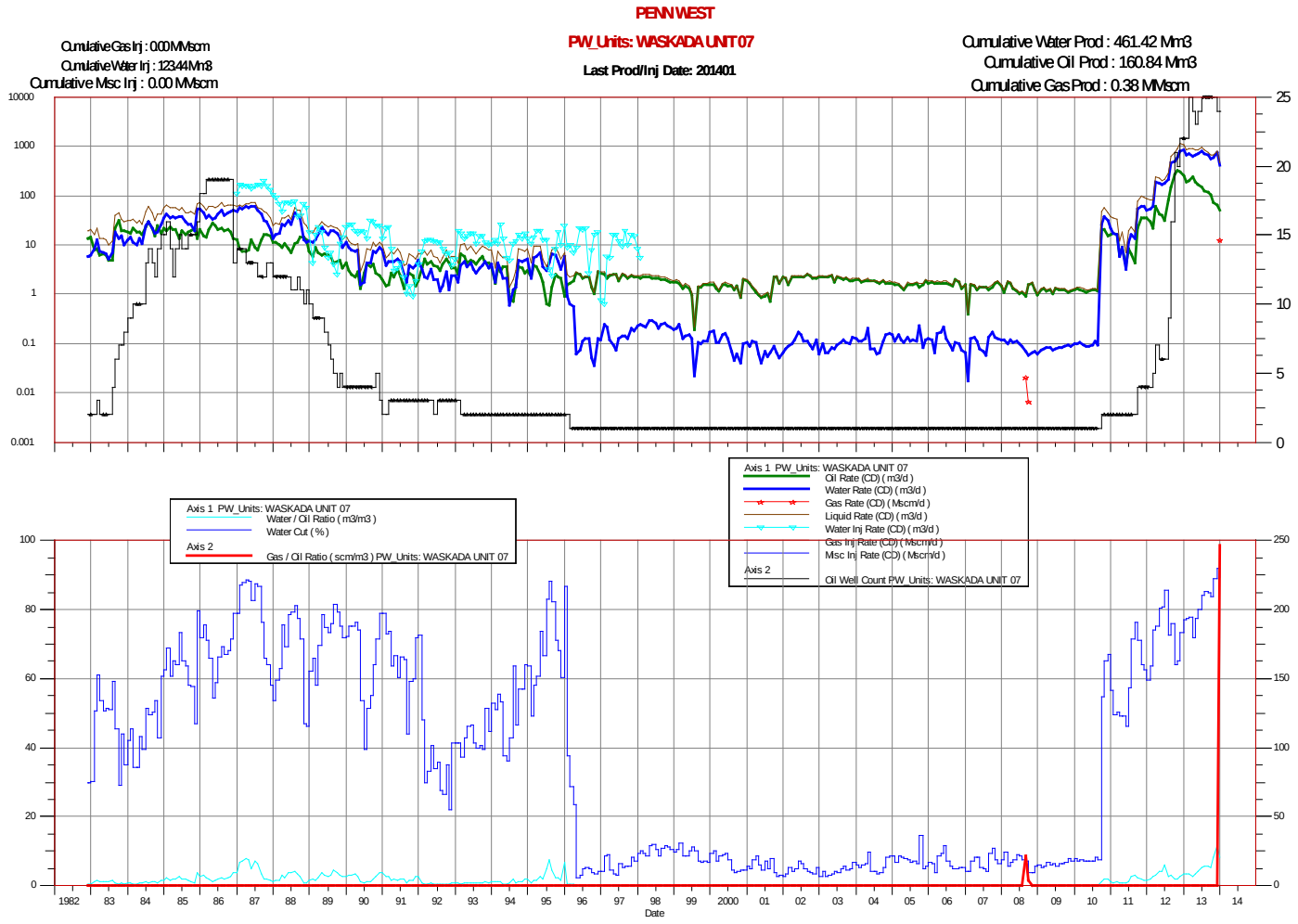
ATTACHMENT 1B – Area Map of New Drills



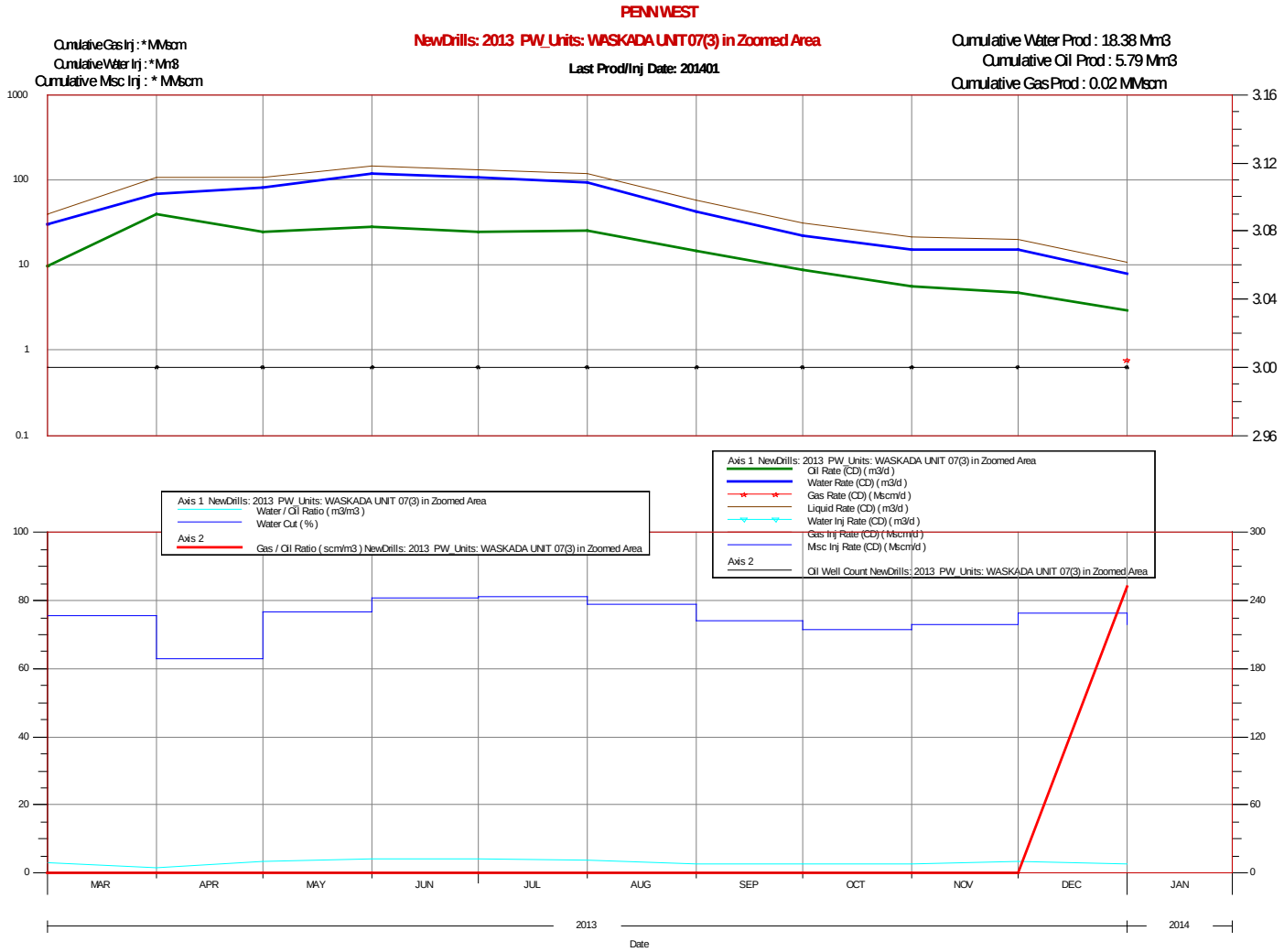
ATTACHMENT 2 Unit History: WASKADA UNIT 07														
					Kelly			Cum	Cum			Cum	Cum	
				New	Bushing	Total	First	Oil	Water	Last	First	Water	Gas	Last
Well	Completion	OPERATOR	STATUS	Drills	Elevation	Depth	Production	Prod	Prod	Production	Injection	Inj	Inj	Injection
	Date				m	m	Date	Mm3	Mm3	Date	Date	Mm3	MMscm	Date
02/01-18-001-25W1/0	1/20/2013	PENN_WEST	OIL	2013	475	1858	3/1/2013	1.66	5.46	1/1/2014		0	0	
03/01-18-001-25W1/0	1/27/2013	PENN_WEST	OIL	2013	475	1778	3/1/2013	1.98	5.58	1/1/2014		0	0	
04/01-18-001-25W1/0	2/1/2013	PENN_WEST	OIL	2013	475	1734	3/1/2013	2.15	7.34	1/1/2014		0	0	
00/11-17-001-25W1/0	8/18/1983	OMEGA_HYDROC	ABD-OIL	<N/A>	473.2	950	9/1/1983	3.11	2.82	3/1/1991		0	0	
02/11-17-001-25W1/0	8/14/2012	PENN_WEST	OIL	<N/A>	472.3	2097	10/1/2012	3.95	6.02	1/1/2014		0	0	
03/11-17-001-25W1/0	8/20/2012	PENN_WEST	OIL	<N/A>	472.4	2140	10/1/2012	1.95	3.75	1/1/2014		0	0	
00/12-17-001-25W1/0	8/14/1983	PENN_WEST	ABD-OIL	<N/A>	471.5	945.1	9/1/1983	2.45	3.73	1/1/1991		0	0	
00/13-17-001-25W1/0	8/5/1983	PENN_WEST	ABD-WINJ	<N/A>	473.4	942	8/1/1983	0.58	0.55	11/1/1986	1/1/1987	18.71	0	3/1/1991
00/14-17-001-25W1/0	11/10/1982	PENN_WEST	ABD-OIL	<N/A>	471.6	952	12/1/1982	3.33	3.41	2/1/1991		0	0	
02/14-17-001-25W1/0	7/29/2012	PENN_WEST	OIL	<N/A>	471.8	2108	10/1/2012	2.2	6.86	1/1/2014		0	0	
03/14-17-001-25W1/0	8/3/2012	PENN_WEST	OIL	<N/A>	471.7	2075	10/1/2012	2.08	7.52	1/1/2014		0	0	
04/14-17-001-25W1/0	8/9/2012	PENN_WEST	OIL	<N/A>	472.2	2078	10/1/2012	2.87	11.15	1/1/2014		0	0	
00/01-18-001-25W1/0	6/28/1984	OMEGA_HYDROC	ABD-OIL	<N/A>	470.9	951	7/1/1984	1.22	4.17	9/1/1989		0	0	
00/02-18-001-25W1/0	6/7/1984	OMEGA_HYDROC	ABD-OIL	<N/A>	471.2	957.5	7/1/1984	0.47	2.01	1/1/1989		0	0	
00/07-18-001-25W1/2	6/12/1984	PENN_WEST	ABD-OIL	<N/A>	471.4	951.5	7/1/1984	0.55	1.36	11/1/1986	1/1/1987	22.09	0	6/1/1989
00/08-18-001-25W1/0	11/12/1983	OMEGA_HYDROC	ABD-OIL	<N/A>	472.3	971.3	1/1/1984	0.99	1.77	6/1/1989		0	0	
00/09-18-001-25W1/0	11/4/1983	OMEGA_HYDROC	ABD-OIL	<N/A>	474	940	12/1/1983	0.47	0.8	5/1/1989		0	0	
02/09-18-001-25W1/0	7/27/2010	PENN_WEST	OIL	<N/A>	471.8	2042	10/1/2010	5.6	10.37	1/1/2014		0	0	
00/16-18-001-25W1/0	7/29/1983	OMEGA_HYDROC	ABD-OIL	<N/A>	472.4	933.9	8/1/1983	0.39	1.63	9/1/1987		0	0	
00/08-19-001-25W1/2	7/26/1985	PENN_WEST	ABD-OIL	<N/A>	472.9	957	9/1/1985	1.43	0.68	2/1/1993		0	0	
00/03-20-001-25W1/0	3/12/1983	PENN_WEST	ABD-OIL	<N/A>	471.7	957	3/1/1984	0.62	1.3	7/1/1988		0	0	
02/03-20-001-25W1/0	1/27/2012	PENN_WEST	OIL	<N/A>	475.6	2128	3/1/2012	0.91	20.31	1/1/2014		0	0	
03/03-20-001-25W1/0	7/14/2012	PENN_WEST	OIL	<N/A>	469.7	1686	8/1/2012	2.28	18.26	1/1/2014		0	0	
04/03-20-001-25W1/0	7/10/2012	PENN_WEST	OIL	<N/A>	473.3	1704.5	9/1/2012	4.27	45.86	1/1/2014		0	0	
05/03-20-001-25W1/0	7/9/2012	PENN_WEST	OIL	<N/A>	472.3	2106	9/1/2012	3.9	8.34	1/1/2014		0	0	
03/04-20-001-25W1/0	7/20/2012	PENN_WEST	OIL	<N/A>	473.6	1701	8/1/2012	4.34	8.27	1/1/2014		0	0	
06/04-20-001-25W1/0	7/24/2012	PENN_WEST	OIL	<N/A>	472.6	1692	9/1/2012	3.79	8.12	1/1/2014		0	0	
00/05-20-001-25W1/0	8/4/1985	PENN_WEST	ABD-OIL	<N/A>	472.6	959	9/1/1985	0.3	0.03	11/1/1986	1/1/1987	19.24	0	1/1/1998
02/05-20-001-25W1/0	7/25/2012	PENN_WEST	OIL	<N/A>	467.7	1687	9/1/2012	3.7	16.95	1/1/2014		0	0	
03/05-20-001-25W1/0	7/30/2012	PENN_WEST	OIL	<N/A>	471.7	1665	9/1/2012	5.07	3.16	1/1/2014		0	0	
00/06-20-001-25W1/0	8/1/1985	PENN_WEST	ABD-OIL	<N/A>	473.5	959	12/1/1985	1.74	15.35	11/1/1989		0	0	

00/06-20-001-25W1/0	8/1/1985	PENN_WEST	ABD-OIL	<N/A>	473.5	959	12/1/1985	1.74	15.35	11/1/1989		0	0	
00/11-20-001-25W1/0	3/1/1983	PENN_WEST	OIL	<N/A>	473.6	950	3/1/1983	17.02	2.24	11/1/2013		0	0	
02/12-20-001-25W1/0	3/2/2012	PENN_WEST	OIL	<N/A>	474.2	1617	8/1/2012	9.02	8.06	1/1/2014		0	0	
03/12-20-001-25W1/0	6/30/2012	PENN_WEST	OIL	<N/A>	473.9	1636	8/1/2012	9.82	7.98	1/1/2014		0	0	
04/12-20-001-25W1/0	7/4/2012	PENN_WEST	OIL	<N/A>	474	1694	8/1/2012	4.42	24.88	1/1/2014		0	0	
00/13-20-001-25W1/2	9/30/1983	PENN_WEST	ABD-WINJ	<N/A>	473.7	944	12/1/1983	1.8	3.16	11/1/1986	1/1/1987	26.63	0	2/1/1998
02/13-20-001-25W1/0	12/10/2011	PENN_WEST	OIL	<N/A>	474.6	1712	3/1/2012	14.4	27.96	1/1/2014		0	0	
03/13-20-001-25W1/0	12/19/2011	PENN_WEST	OIL	<N/A>	475.7	1720	4/1/2012	7.18	88.83	1/1/2014		0	0	
00/14-20-001-25W1/0	6/30/1984	PENN_WEST	ABD-OIL	<N/A>	473.9	950	11/1/1984	14.47	31.84	2/1/1996		0	0	
00/15-20-001-25W1/0	10/29/1982	PENN_WEST	ABD-OIL	<N/A>	474.7	952.8	12/1/1982	2.11	1.14	11/1/1986	1/1/1987	36.76	0	2/1/1998
00/16-20-001-25W1/0	7/13/1984	PENN_WEST	ABD-OIL	<N/A>	475.2	941	8/1/1984	0.47	2.59	8/1/1989		0	0	
02/16-20-001-25W1/0	3/7/2011	PENN_WEST	OIL	<N/A>	474.4	1731	10/1/2011	5.08	8.18	1/1/2014		0	0	
03/16-20-001-25W1/0	3/2/2011	PENN_WEST	OIL	<N/A>	474.4	1734	10/1/2011	4.69	21.59	1/1/2014		0	0	
3/12/2014 10:33	/													

ATTACHMENT 3 – Unit Production and Injection Plot

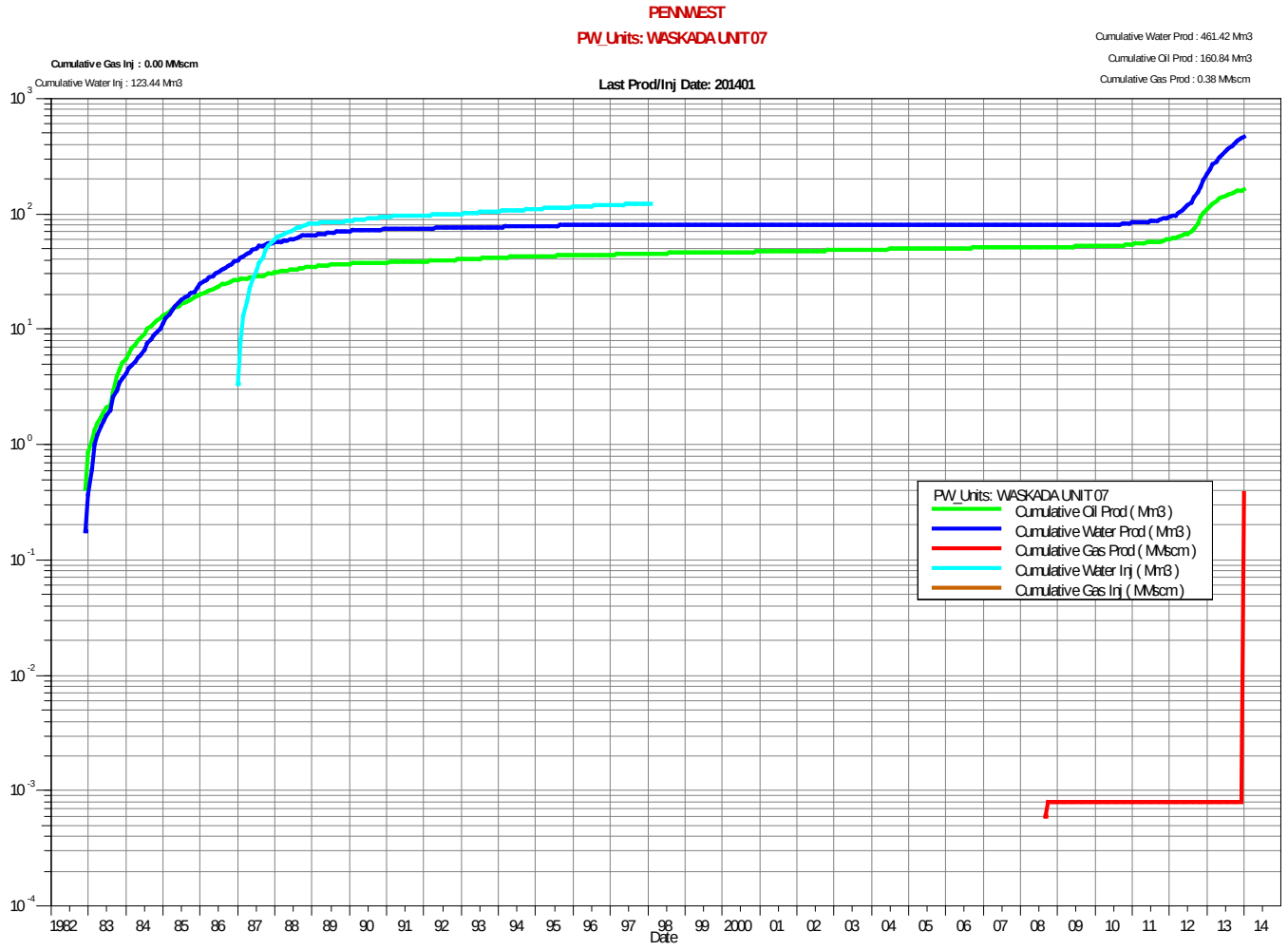


ATTACHMENT 3A – 2013 New Drills Production Plot

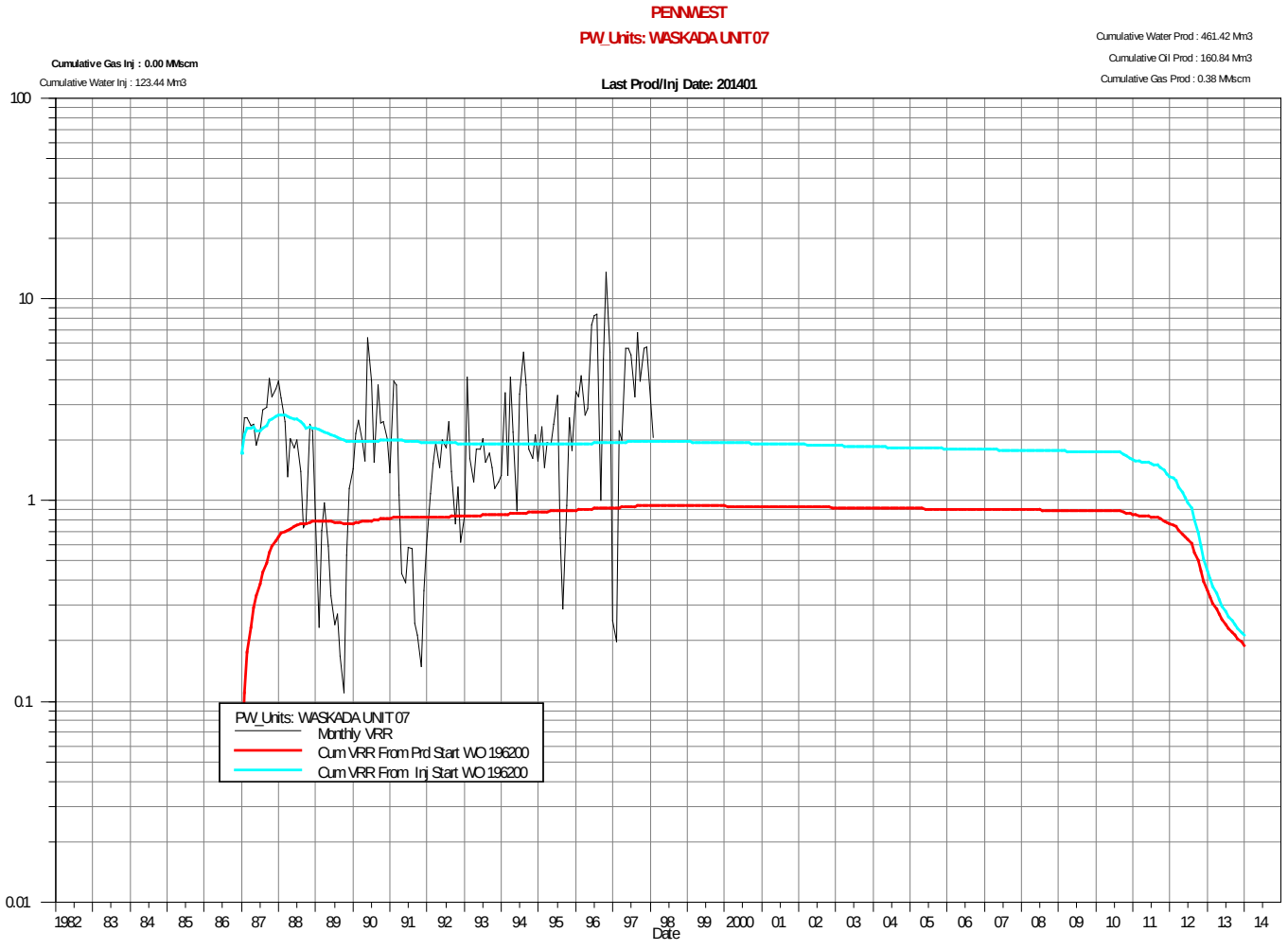


ATTACHMENT 4	PW_Units: WASKADA UNIT 07								
Rates and Volume History									
	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	
	Oil	Oil	Water	Water	Water	Water Inj	Gas	Gas Inj	
	Prod	Rate	Prod	Rate	Inj	Rate	Inj	Rate	
Date	m3	m3/d	m3	m3/d	m3	m3/d	Mscm	Mscm/d	
1/1/1981									
1/1/1982	409.2	1.12	175.4	0.48					
1/1/1983	4630.4	12.69	3543.8	9.71					
1/1/1984	7337.3	20.05	6432.7	17.58					
1/1/1985	6906	18.92	12628.1	34.6					
1/1/1986	7259	19.89	15665.5	42.92					
1/1/1987	4083.3	11.19	17409.2	47.7	56975	156.1	0	0	
1/1/1988	3990	10.9	9108.4	24.89	24688	67.45	0	0	
1/1/1989	2166.9	5.94	5782.5	15.84	4055	11.11	0	0	
1/1/1990	1090.3	2.99	2399.2	6.57	8295	22.73	0	0	
1/1/1991	780.7	2.14	1532.7	4.2	2560	7.01	0	0	
1/1/1992	1420.4	3.88	870.7	2.38	3335	9.11	0	0	
1/1/1993	1698.1	4.65	1271	3.48	5099	13.97	0	0	
1/1/1994	961.8	2.64	1065.1	2.92	4636	12.7	0	0	
1/1/1995	806.1	2.21	1750.3	4.8	4386	12.02	0	0	
1/1/1996	700.4	1.91	270.2	0.74	5135	14.03	0	0	
1/1/1997	855	2.34	53.8	0.15	3863	10.58	0	0	
1/1/1998	762.3	2.09	88.5	0.24	409	1.12	0	0	
1/1/1999	492.4	1.35	49.4	0.14					
1/1/2000	524.5	1.43	39.6	0.11					
1/1/2001	504.7	1.38	27.5	0.08					
1/1/2002	796.4	2.18	38.9	0.11					
1/1/2003	774.1	2.12	33.8	0.09					
1/1/2004	661.2	1.81	42.1	0.12					
1/1/2005	561.8	1.54	47	0.13					
1/1/2006	601.8	1.65	43.1	0.12					
1/1/2007	496.6	1.36	36.9	0.1					
1/1/2008	480.8	1.31	34.1	0.09					
1/1/2009	430.6	1.18	29.2	0.08					
1/1/2010	2053	5.62	2896.2	7.93					
1/1/2011	5472.6	14.99	8828.2	24.19					
1/1/2012	42105.3	115.04	105717	288.84					
1/1/2013	57489.1	157.5	250798	687.12					
	----------		----------		----------				
	159302		448708		123437				Sum
3/12/2014 10:42	/								

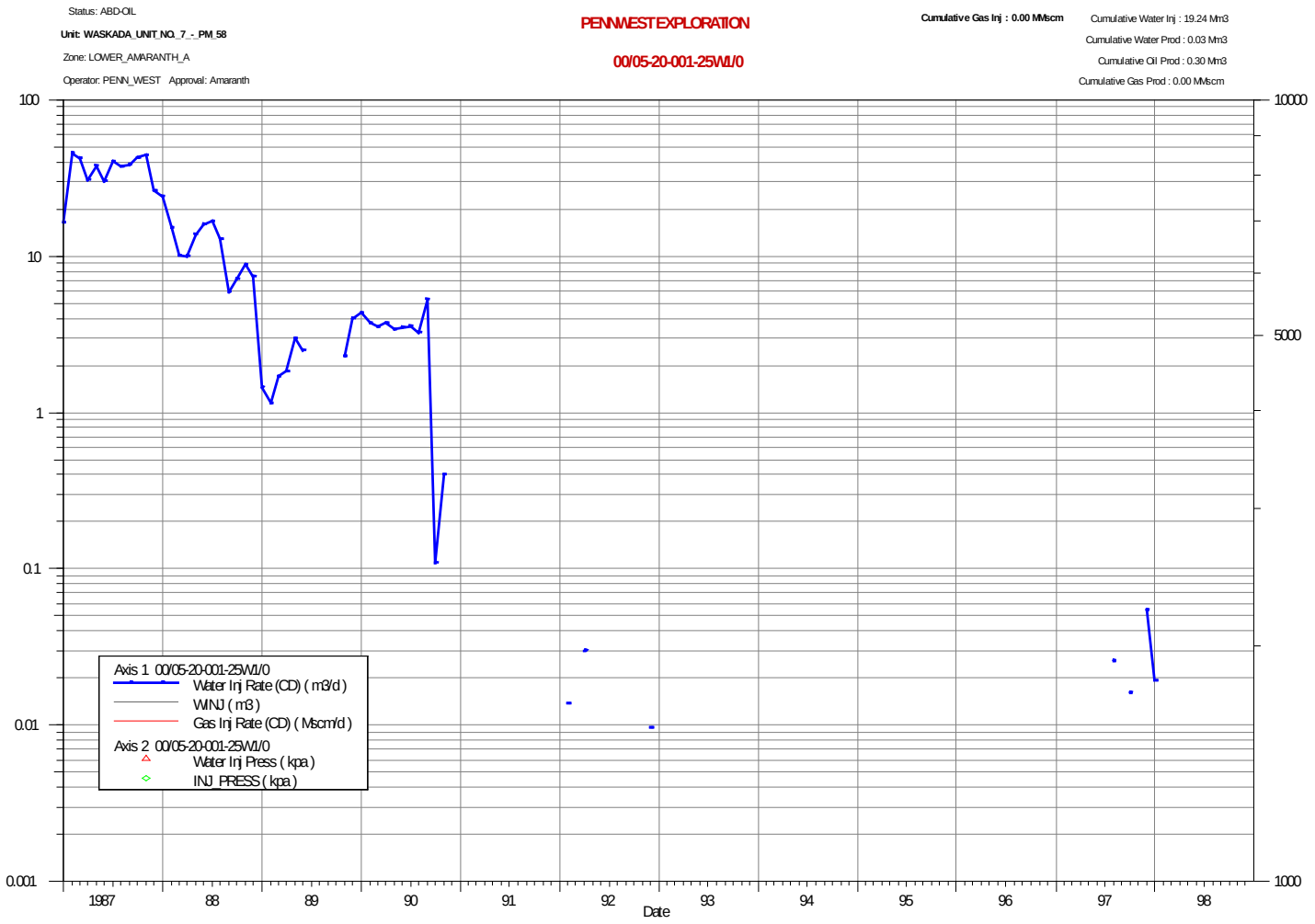
ATTACHMENT 5 – Unit Cumulative Production and Injection Plot

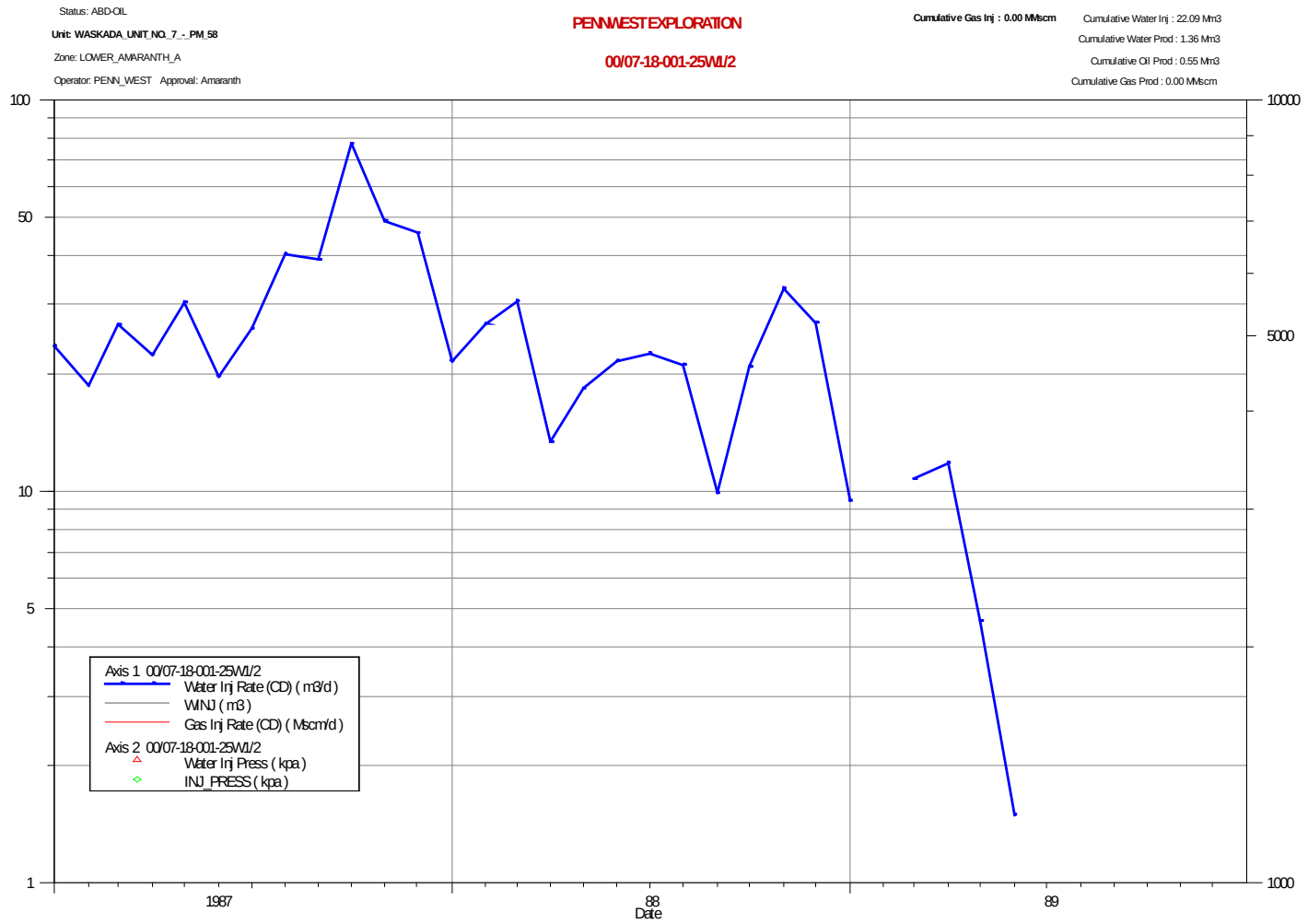


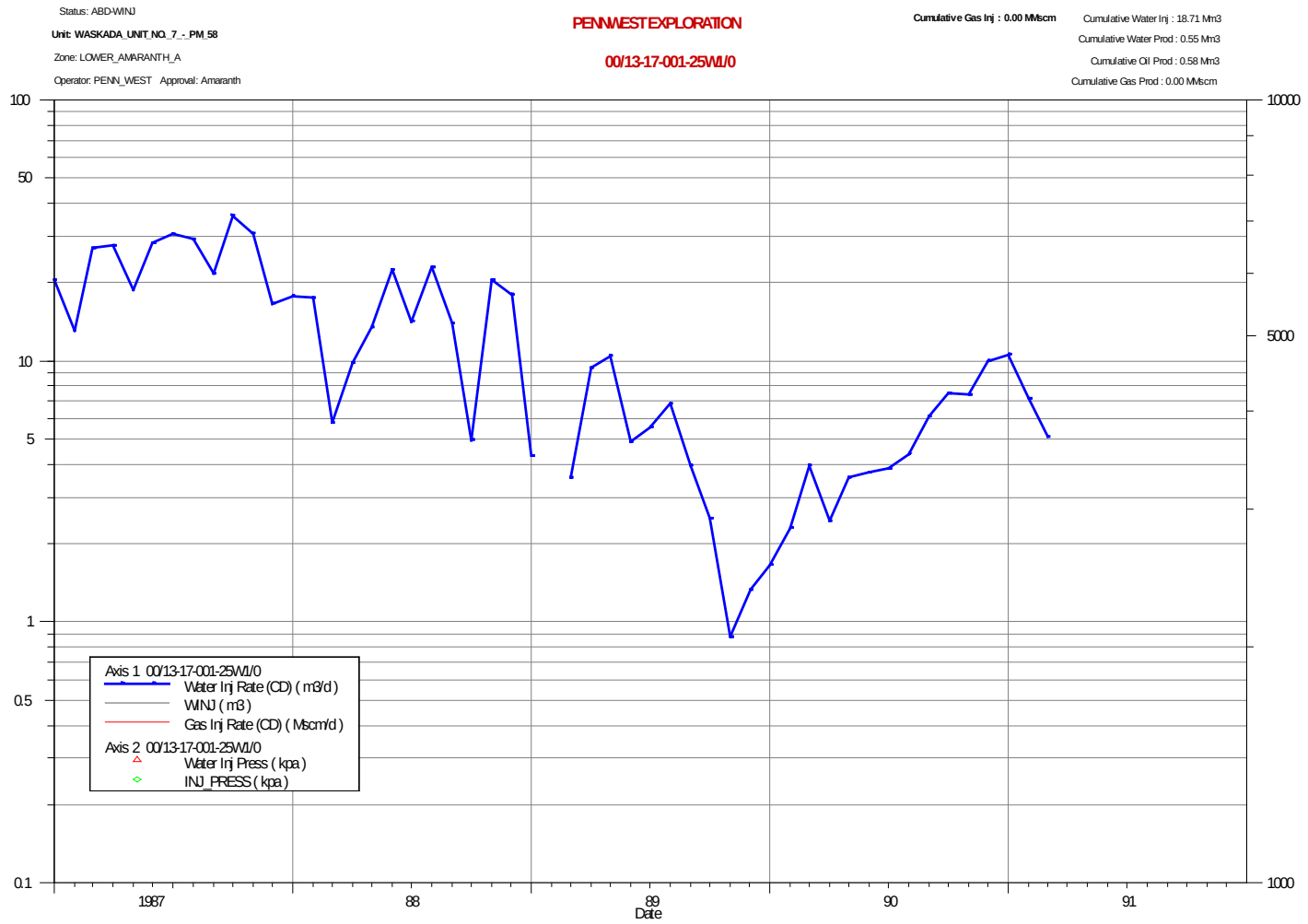
ATTACHMENT 6 – Unit Voidage Replacement Ratio Plot

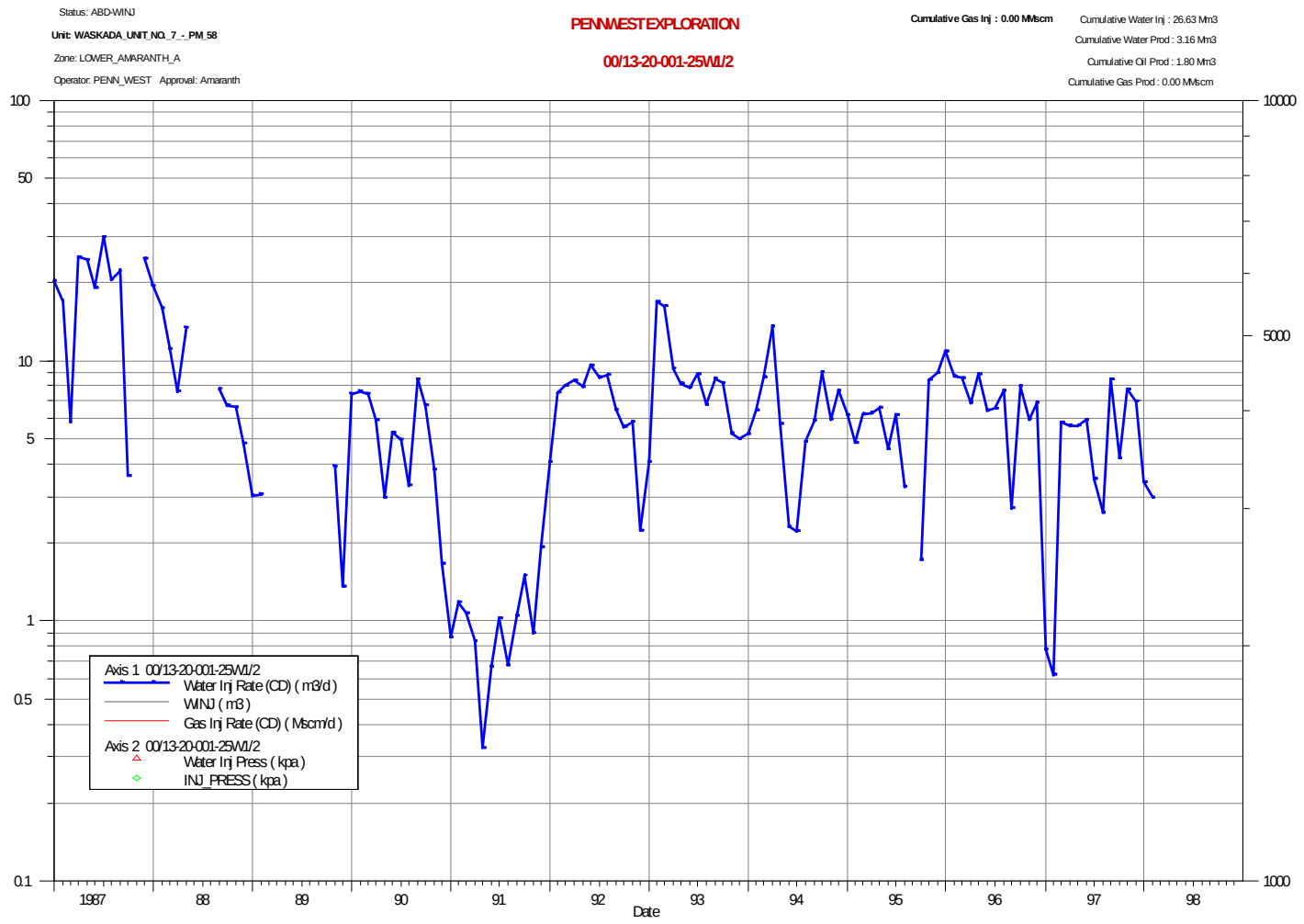


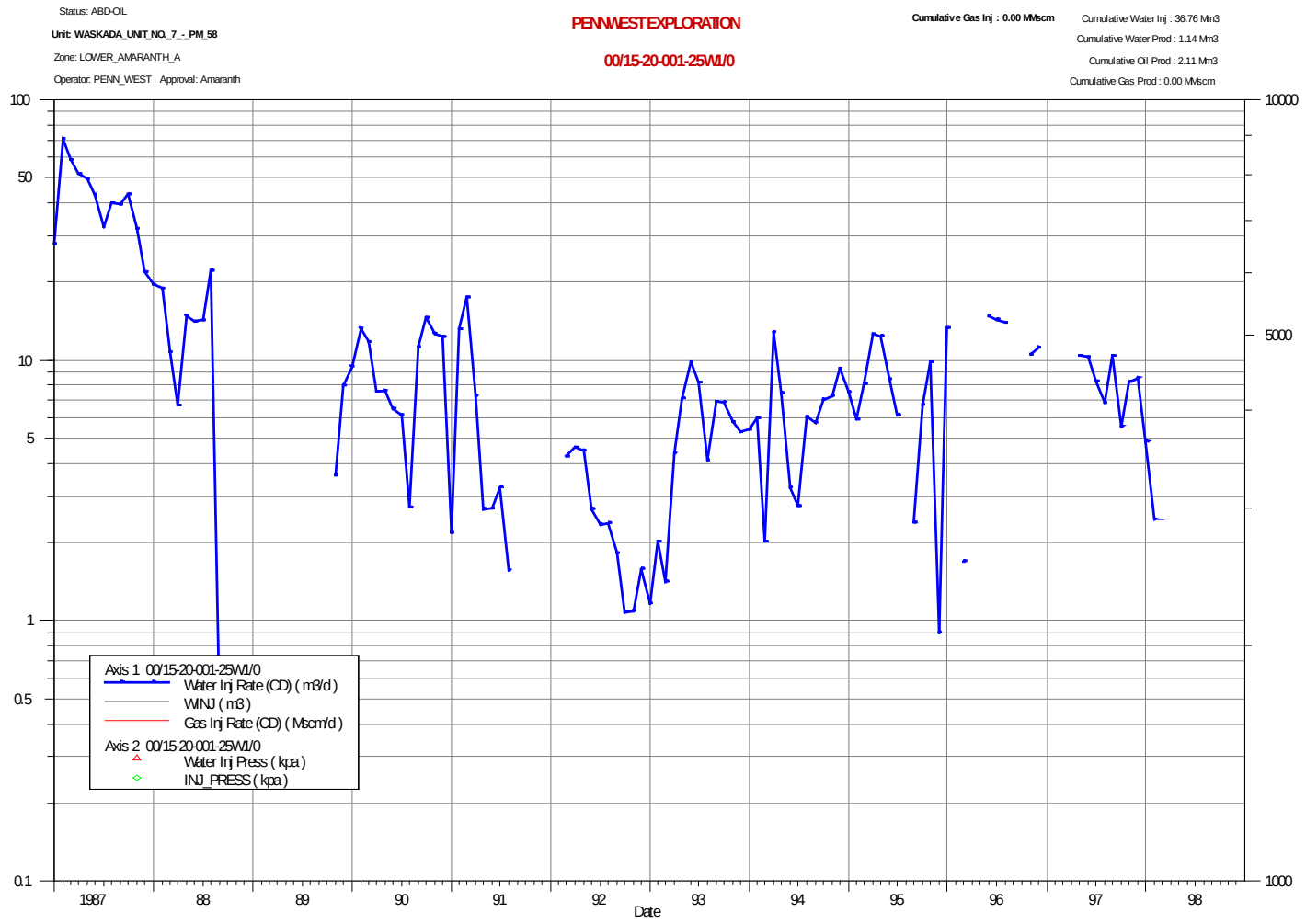
ATTACHMENT 7 – Individual Injection Well Performance Plots (5 Wells)




Status: ABD-OIL
Unit: WASKADA_UNIT NO. 7 - PM 58
Zone: LOWER_AMARANTH_A
Operator: PENN_WEST Approval: Amaranth
PENNWEST EXPLORATION
00/07-18-001-25W1/2
Cumulative Gas Inj : 0.00 MMscm
Cumulative Water Inj : 22.09 Mm3
Cumulative Water Prod : 1.36 Mm3
Cumulative Oil Prod : 0.55 Mm3
Cumulative Gas Prod : 0.00 MMscm
100
50
10
5
1
10000
5000
1000
Axis 1 00/07-18-001-25W1/2
Water Inj Rate (CD) (m3/d)
WINJ (m3)
Gas Inj Rate (CD) (Mscm/d)
Axis 2 00/07-18-001-25W1/2
Water Inj Press (kpa)
INJ_PRESS (kpa)
1987
88
89
Date


Status: ABD-WINJ
Unit: WASKADA_UNIT NO_7 - PM_58
Zone: LOWER_AMARANTH_A
Operator: PENN_WEST Approval: Amaranth
PENNWEST EXPLORATION
00/13-17-001-25W1/0
Cumulative Gas Inj : 0.00 MMscm
Cumulative Water Inj : 18.71 Mm3
Cumulative Water Prod : 0.55 Mm3
Cumulative Oil Prod : 0.58 Mm3
Cumulative Gas Prod : 0.00 MMscm
100
50
10
5
1
0.5
0.1
10000
5000
1000
Axis 1 00/13-17-001-25W1/0
Water Inj Rate (CD) (m3/d)
WINJ (m3)
Gas Inj Rate (CD) (Mscm/d)
Axis 2 00/13-17-001-25W1/0
Water Inj Press (kpa)
INJ_PRESS (kpa)
1987
88
89
90
91
Date


Status: ABD-WINJ
Unit: WASKADA_UNIT NO. 7 - PM 58
Zone: LOWER_AMARANTH_A
Operator: PENN_WEST Approval: Amaranth
PENNWEST EXPLORATION
00/13-20-001-25W1/2
Cumulative Gas Inj : 0.00 MMscm
Cumulative Water Inj : 26.63 Mm3
Cumulative Water Prod : 3.16 Mm3
Cumulative Oil Prod : 1.80 Mm3
Cumulative Gas Prod : 0.00 MMscm
100
50
10
5
1
0.5
0.1
10000
5000
1000
1987
88
89
90
91
92
93
94
95
96
97
98
Date
Axis 1 00/13-20-001-25W1/2
Water Inj Rate (CD) (m3/d)
WINJ (m3)
Gas Inj Rate (CD) (Mscm/d)
Axis 2 00/13-20-001-25W1/2
Water Inj Press (kpa)
INJ_PRESS (kpa)


Status: ABD-OIL
Unit: WASKADA_UNIT NO. 7 - PM 58
Zone: LOWER_AMARANTH_A
Operator: PENN_WEST Approval: Amaranth
PENNWEST EXPLORATION
00/15-20-001-25W1/0
Cumulative Gas Inj : 0.00 MMscm
Cumulative Water Inj : 36.76 Mm3
Cumulative Water Prod : 1.14 Mm3
Cumulative Oil Prod : 2.11 Mm3
Cumulative Gas Prod : 0.00 MMscm
100
50
10
5
1
0.5
0.1
10000
5000
1000
1987
88
89
90
91
92
93
94
95
96
97
98
Date
Axis 1 00/15-20-001-25W1/0
Water Inj Rate (CD) (m3/d)
WINJ (m3)
Gas Inj Rate (CD) (Mscm/d)
Axis 2 00/15-20-001-25W1/0
Water Inj Press (kpa)
INJ_PRESS (kpa)