

*Little Tom (San Miguel)
Waterflood workshop*

March 15, 2010

Dallas, Texas

In Attendance

- *For Dyami Energy, LLC*
 - *Eric Johnson*
 - *James Cassina*
 - *Buddy Dawsey*
- *For Cobb & Associates*
 - *Don Bailey*
 - *Deacon Marek*

Field Background

- *Discovered in 1950's*
- *Four San Miguel sands: A, B, C, and D (D1 and D2)*
- *Depth ranges from 2,600 to 2,900 feet*
- *Rock quality is good*
 - *Porosity in the 15% to 32% range*
 - *Permeability in the 5 to 1,000 md. range*
- *Oil is poor quality*
 - *API gravity is 14° to 19°*
 - *Viscosity at reservoir conditions ~ 170 to 275 cp.*

Field Background – Cont.

- *Prior drilling activity*
 - *Approximately 40 wells in field area*
 - *25 to 30 on Dyami leases*
 - *No currently active producers*
- *Cumulative production is ~ 97 MBO*
- *Dyami estimated OOIP ~ 150 MMBO*
 - *83 MMBO in sands A through C*
 - *67 MMBO in the D1 sand*

Workshop Goals

- *Perform D1 sand pattern model simulation studies*
 - *Primary production prediction*
 - *Waterflood predictions*
 - *40 acre spacing*
 - *20 acre spacing*
 - *10 acre spacing*
- *Develop recommendations for:*
 - *Pilot waterflood design*
 - *Field-wide pattern design*
 - *Audit of Dyami OOIP estimates*

Pattern Simulation Model

San Miguel D1 Sand Only

Data Common to All Models

- *20 layers based on Matthews #4 core*
 - *Permeability*
 - *Porosity*
- *Oil PVT properties*
 - *No laboratory data available*
 - *Used fluid correlation*
 - *Oil viscosity ~ 170 to 275 cp at reservoir conditions*

Variable Data in Studies

- *Low side cases*
 - *Connate water saturation = 35%*
 - *Residual oil saturation = 35%*
 - *Moveable oil saturation = 30%*
- *High side cases*
 - *Connate water saturation = 15%*
 - *Residual oil saturation = 25%*
 - *Moveable oil saturation = 60%*

Variable Data in Studies – Cont.

- *Well spacing*
 - *40 acre spacing*
 - *20 acre spacing*
 - *10 acre spacing*
- *Pattern type and injector/producer ratio*
 - *Five spot*
 - *Nine spot*

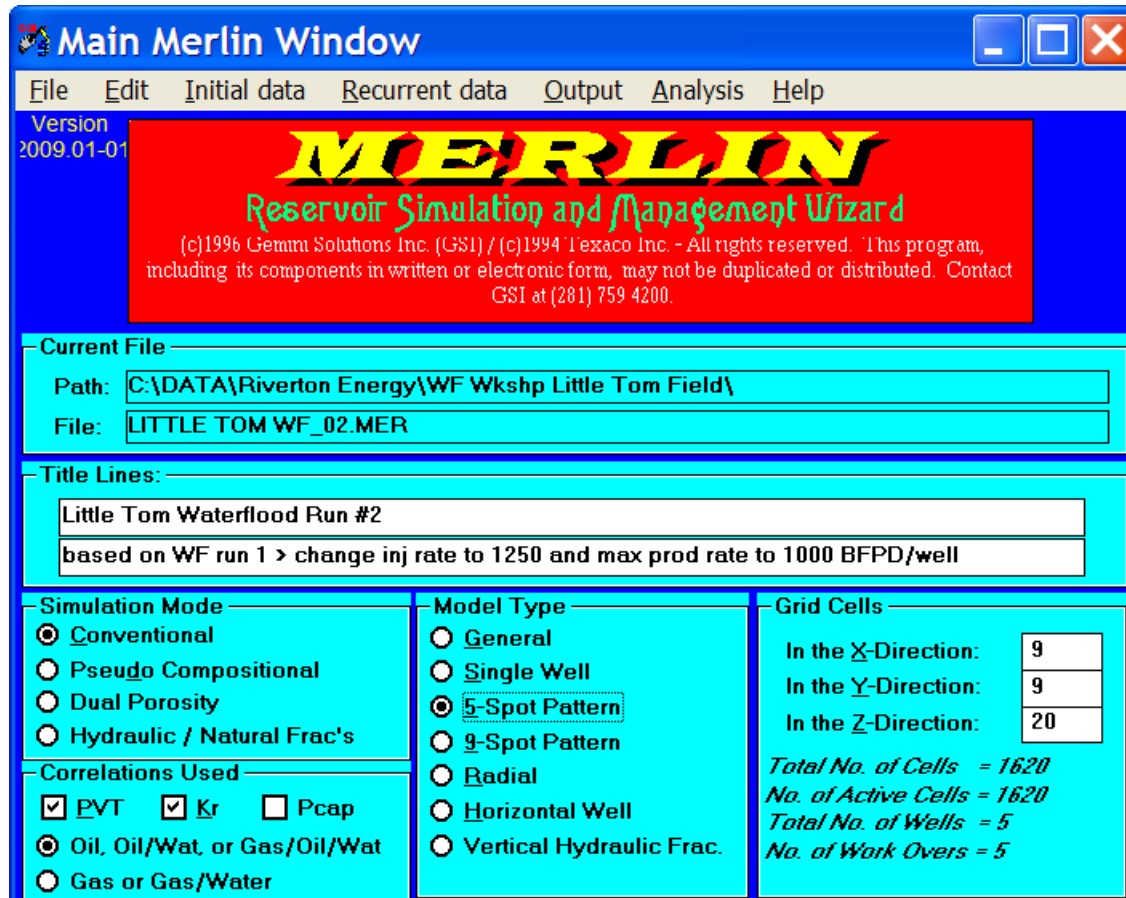
Little Tom (San Miguel D1 Sand)

80 Acre Pattern Model

Type	Pattern	Rel. Perm. Curves	Pattern Size Acres	Net Well Count			Well Spacing ac/well	Rate Limits per Well	
				Prod	Inj	Tot		producer BFPD	injector BWiPD
primary	5-spot	low side	80	2	0	2	40	250	0
waterflood	5-spot	low side	80	1	1	2	40	1,000	1,000
waterflood	5-spot	high side	80	1	1	2	40	1,000	1,250
waterflood	9-spot	high side	80	3	1	4	20	700	2,500
waterflood	9-spot	high side	80	6	2	8	10	1,000	3,000

Simulation Model

Input Data



MERLIN (1157815311): Grid Data: LITTLE TOM WF_02.MER

Form Edit Modify Grid All Grids Analyze Calculate Help

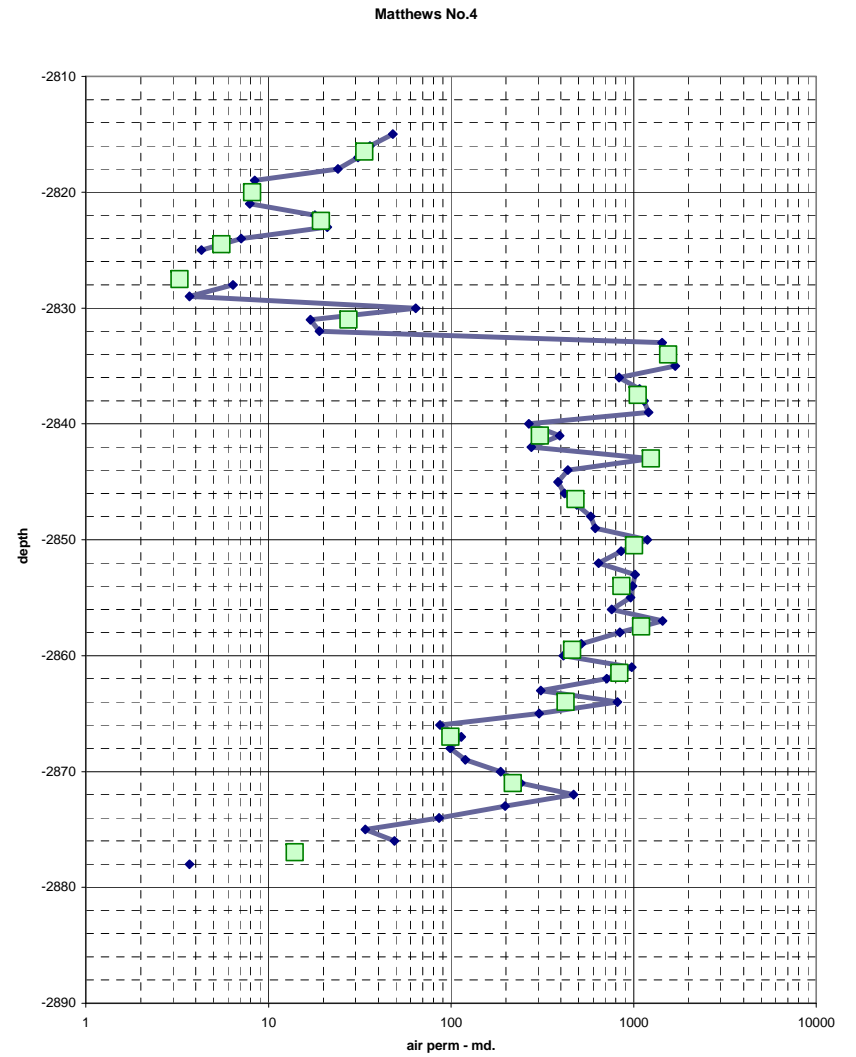
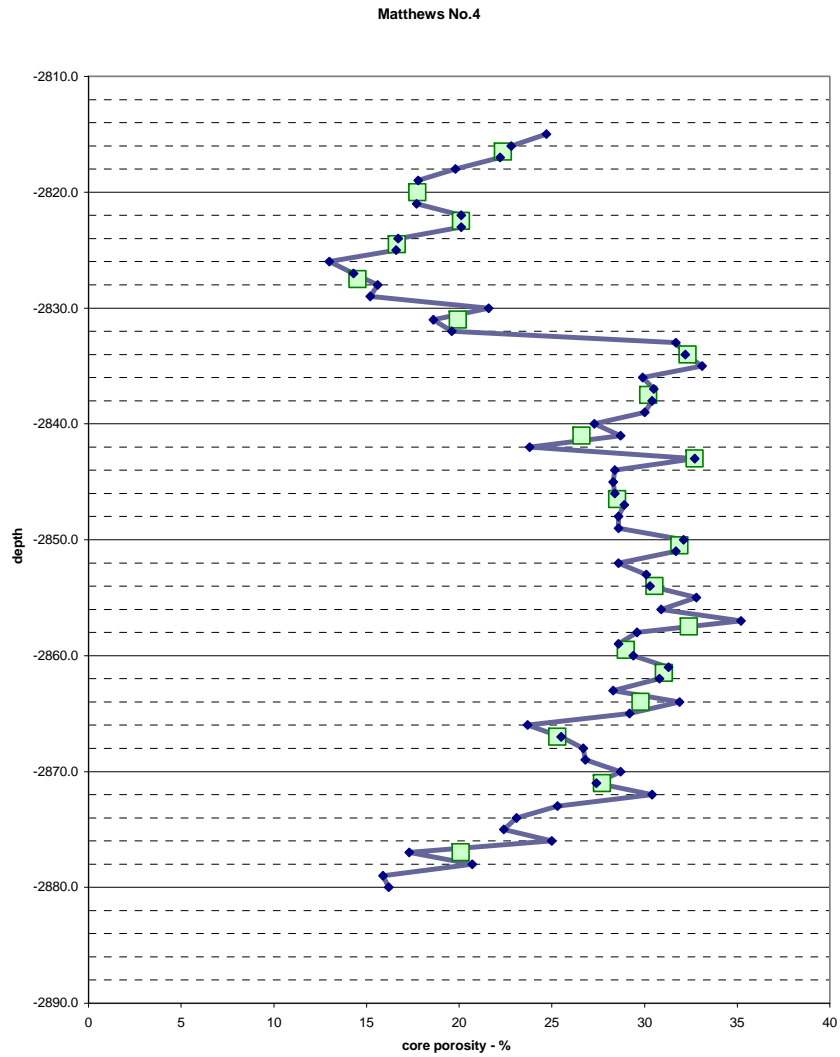
Model Area EXIT Button Options: DEPTH Entry by
 Constant By Layer Map Data

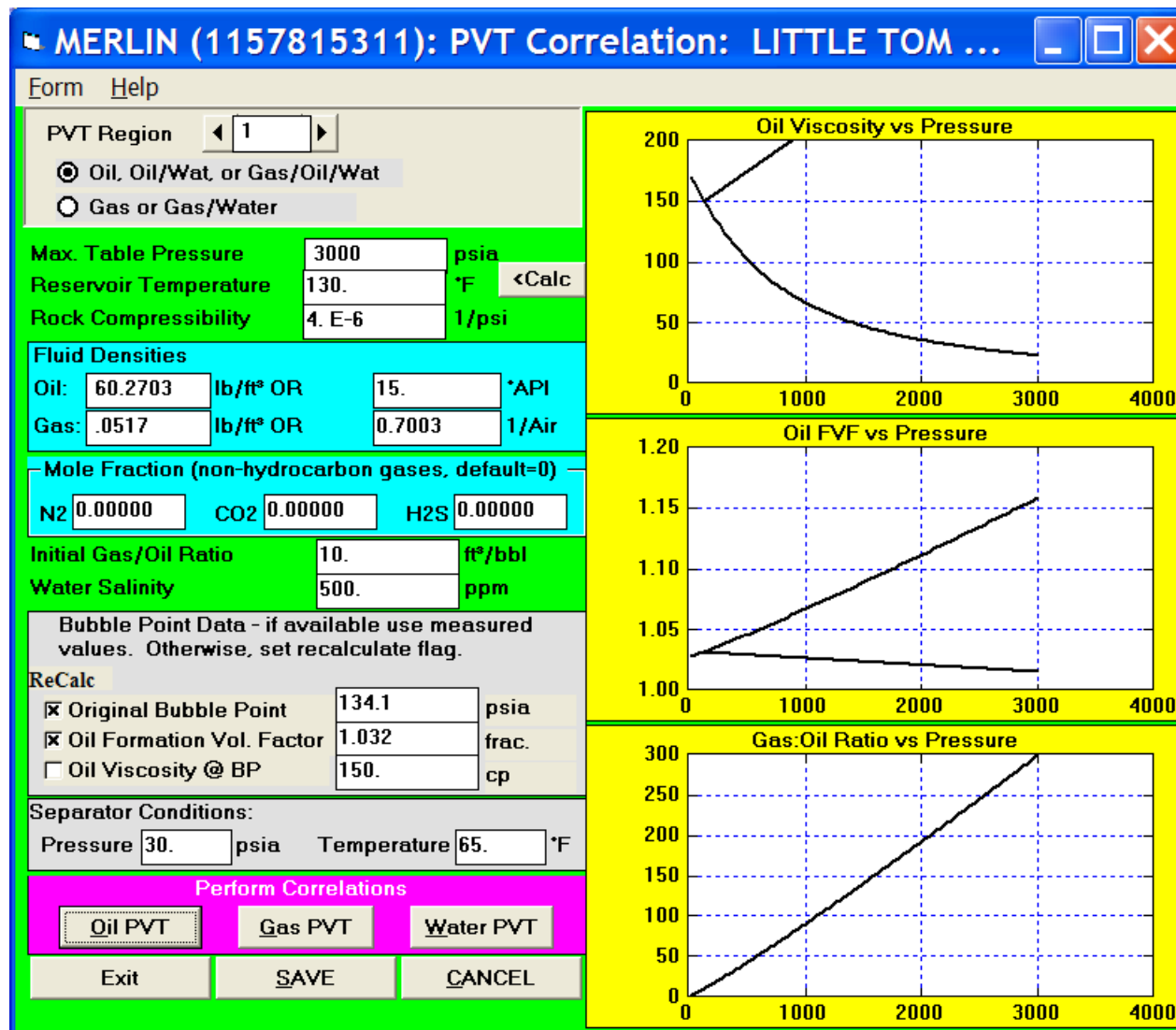
Depth
 Thickness
 Net Gross SAVE By Layer Cancel By Col By Row

Transmissibility
 Porosity
 Permeability
 K_x K_y K_z
 Regions

Layer	Depth (ft)	H-net (ft)	H-gross (ft)	Por (frac)	Kx (md)	Ky (md)	Kz (md)
1	2815	4	4	0.224	16.84	16.84	1.684
2	2819	3	3	0.178	4.07	4.07	0.407
3	2822	2	2	0.201	9.72	9.72	0.972
4	2824	2	2	0.167	2.76	2.76	0.276
5	2826	4	4	0.145	1.64	1.64	0.164
6	2830	3	3	0.199	13.72	13.72	1.372
7	2833	3	3	0.323	773.27	773.27	77.327
8	2836	4	4	0.302	527.43	527.43	52.743
9	2840	3	3	0.266	153.68	153.68	15.368
10	2843	1	1	0.327	621.5	621.5	62.15
11	2844	6	6	0.285	240.71	240.71	24.071
12	2850	2	2	0.319	503.84	503.84	50.384
13	2852	5	5	0.305	430.13	430.13	43.013
14	2857	2	2	0.324	549.47	549.47	54.947
15	2859	2	2	0.29	230.98	230.98	23.098
16	2861	2	2	0.311	418.03	418.03	41.803
17	2863	3	3	0.298	212.62	212.62	21.262
18	2866	3	3	0.253	49.7	49.7	4.97
19	2869	5	5	0.277	109.39	109.39	10.939
20	2874	6	6	0.201	6.98	6.98	0.698

Matthews #4 Core Data





MERLIN (1157815311): Pressure & Satu... [-] [] [X]

Form Help

Exit

SAVE

CANCEL

Region

1

Equilibrium Values

PRESSURE DISTRIBUTION

The initial pressure distribution will be determined from the following values and the gravitational gradient.

Datum Depth ft Pressure Gradient psi/ft
 OR
 Pressure at Datum psia

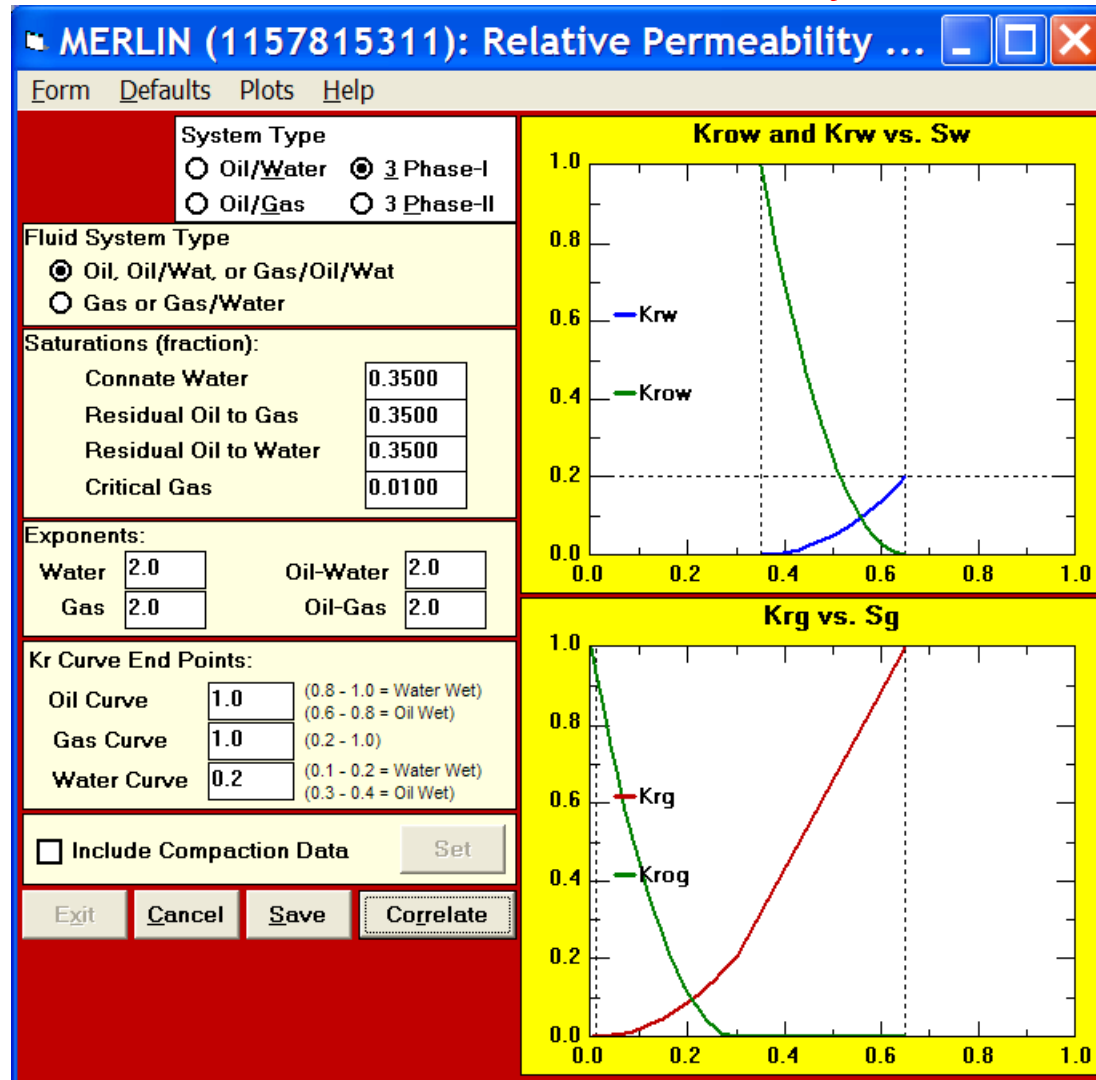
SATURATION DISTRIBUTION

The initial saturation distribution for S_o , S_w , S_g may be input as a constant or calculated from the Gas-Oil and Oil-Water contact depths.

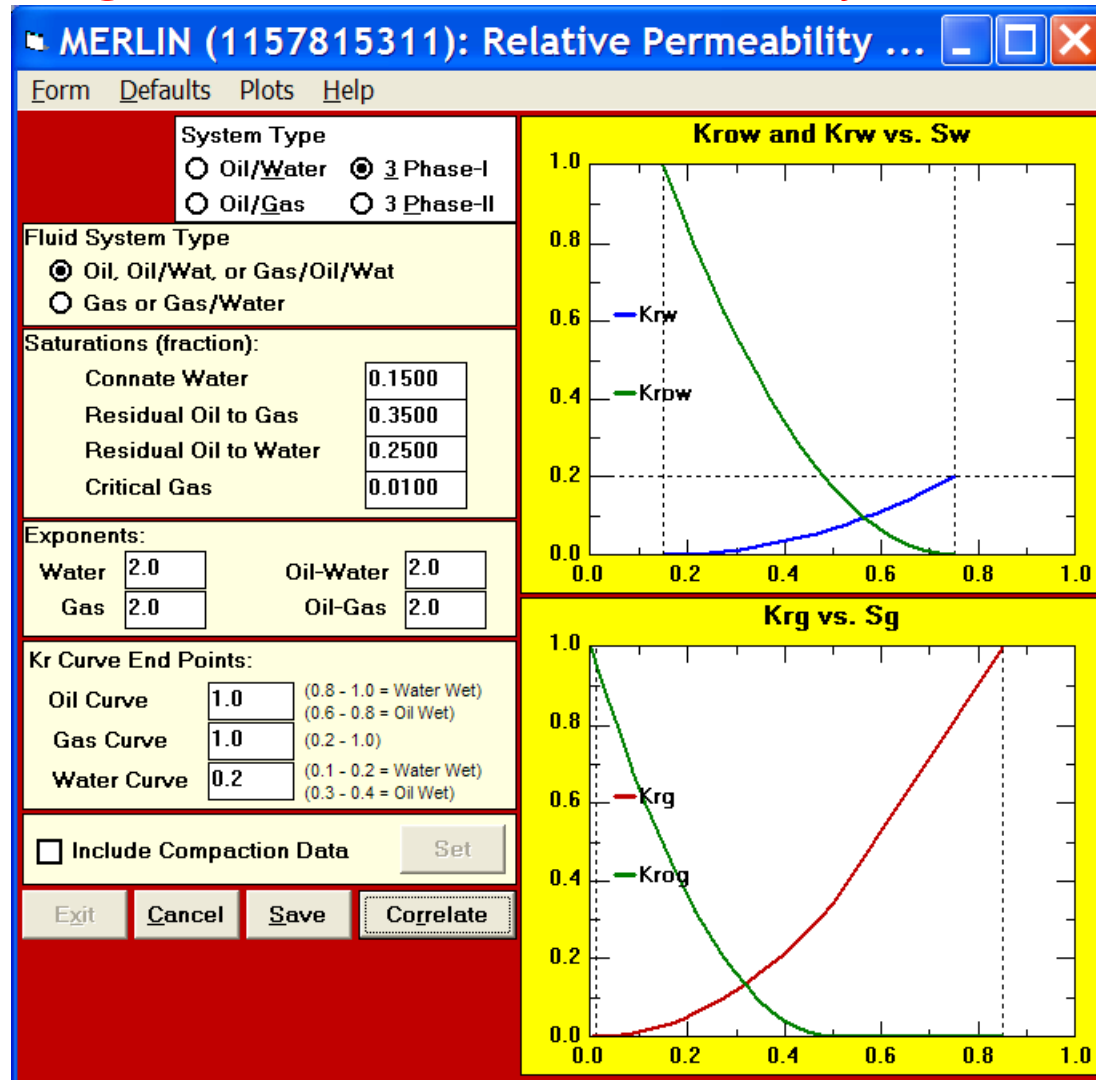
Distribute from Gas-Oil and/or Water-Oil Contacts
 Set Constant for all cells in the Model

Depth to GOC ft Depth to WOC ft

Low Side Relative Permeability Curves



High Side Relative Permeability Curves



80 Acre 5-Spot Pattern

- *Two net wells in pattern*
- *40 acre well spacing*
- *Both producers for primary production*
- *For waterflood:*
 - *One net producer*
 - *One net injector*
- *See next slide.....*

80 Acre 5-Spot Pattern

MERLIN (1157815311): Well Definition: Little Tom Hi_WF_02.MER

Form Edit Options Help

Well Information

Well #	Name	Start up	Qo-bbl	Qtot-bbl	FBHP-psia	dP-psia	D-Fact-1/Mcf	Rw-ft	Mult
1	P1	0.000	250	250	100	0	0.	0.25	4

Type: (Oil + Liq.) Rate Prod.

SAVE Cancel

Completion Data

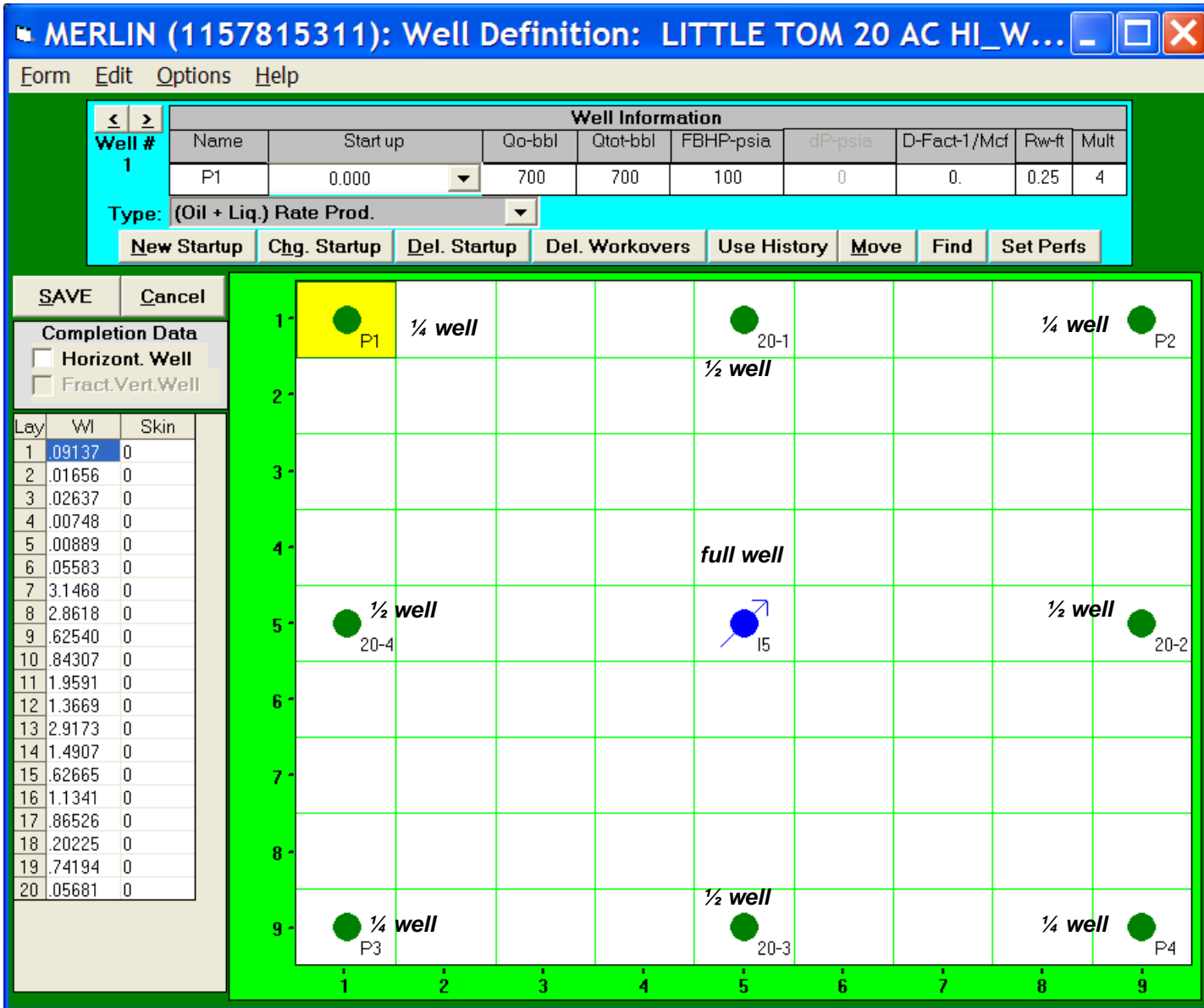
Horizont. Well

Fract.Vert.Well

Lay	Wl	Skin
1	.09137	0
2	.01656	0
3	.02637	0
4	.00748	0
5	.00889	0
6	.05583	0
7	3.1468	0
8	2.8618	0
9	.62540	0
10	.84307	0
11	1.9591	0
12	1.3669	0
13	2.9173	0
14	1.4907	0
15	.62665	0
16	1.1341	0
17	.86526	0
18	.20225	0
19	.74194	0
20	.05681	0

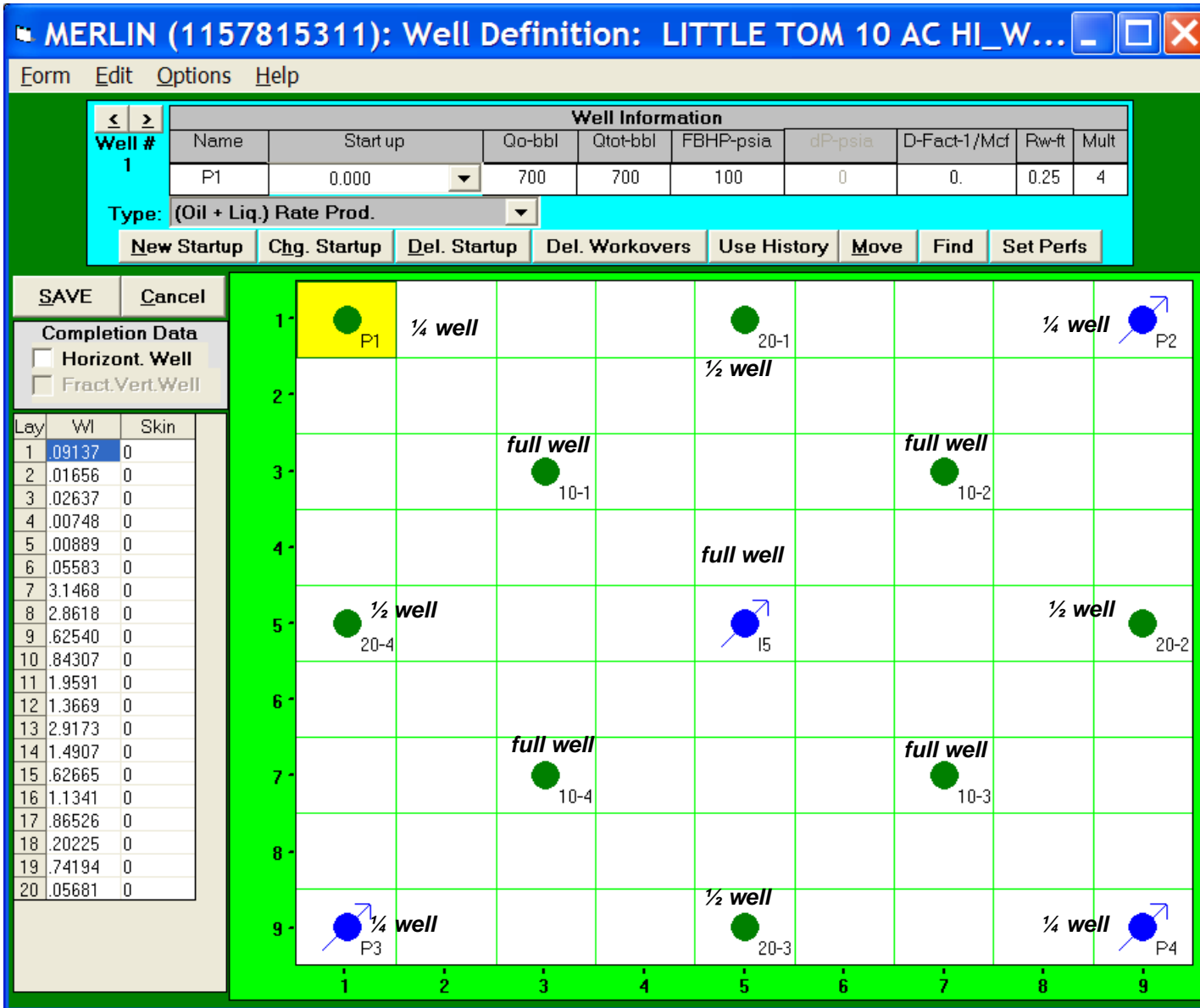
80 Acre 9-Spot Pattern

- *Four net wells in pattern*
- *20 acre well spacing*
- *For waterflood:*
 - *Three net producers*
 - *One net injector*
- *See next slide.....*



40 Acre 9-Spot Pattern

- *Eight net wells in model (two patterns)*
- *10 acre well spacing*
- *For waterflood:*
 - *Six net producers*
 - *Two net injectors*
- *See next slide.....*



Model consists of two 40-acre 9-spot patterns

MERLIN (1157815311): Well Definition: LITTLE TOM 10 AC HI_W...

Form Edit Options Help

Well Information									
Well #	Name	Start up	Qo-bbl	Qtot-bbl	FBHP-psia	dP-psia	D-Fact-1/Mcf	Rw-ft	Mult
1	P1	0.000	700	700	100	0	0.	0.25	4

Type: (Oil + Liq.) Rate Prod.

New Startup Chg. Startup Del. Startup Del. Workovers Use History Move Find Set Perfs

SAVE Cancel

Completion Data
 Horizont. Well
 Fract.Vert.Well

Lay	WI	Skin
1	.09137	0
2	.01656	0
3	.02637	0
4	.00748	0
5	.00889	0
6	.05583	0
7	3.1468	0
8	2.8618	0
9	.62540	0
10	.84307	0
11	1.9591	0
12	1.3669	0
13	2.9173	0
14	1.4907	0
15	.62665	0
16	1.1341	0
17	.86526	0
18	.20225	0
19	.74194	0
20	.05681	0

*Little Tom D1 Sand
Pattern Model
Results of Predictions*

Little Tom (San Miguel D1 Sand)

80 Acre Pattern Model

Type	Pattern	Rel. Perm. Curves	Pattern Size Acres	Net Well Count			Well Spacing ac/well	Peak Oil Rate - BOPD		Ultimate Oil Rec. %OOIP
				Prod	Inj	Tot		pattern	producer	
primary	5-spot	low side	80	2	0	2	40	151	75.5	4.27%
waterflood	5-spot	low side	80	1	1	2	40	90	90.0	18.68%
waterflood	5-spot	high side	80	1	1	2	40	92	92.0	21.77%
waterflood	9-spot	high side	80	3	1	4	20	219	73.0	28.89%
waterflood	9-spot	high side	80	6	2	8	10	467	77.8	29.25%

*Little Tom D1 Sand
Pattern Model
Graphical Output*

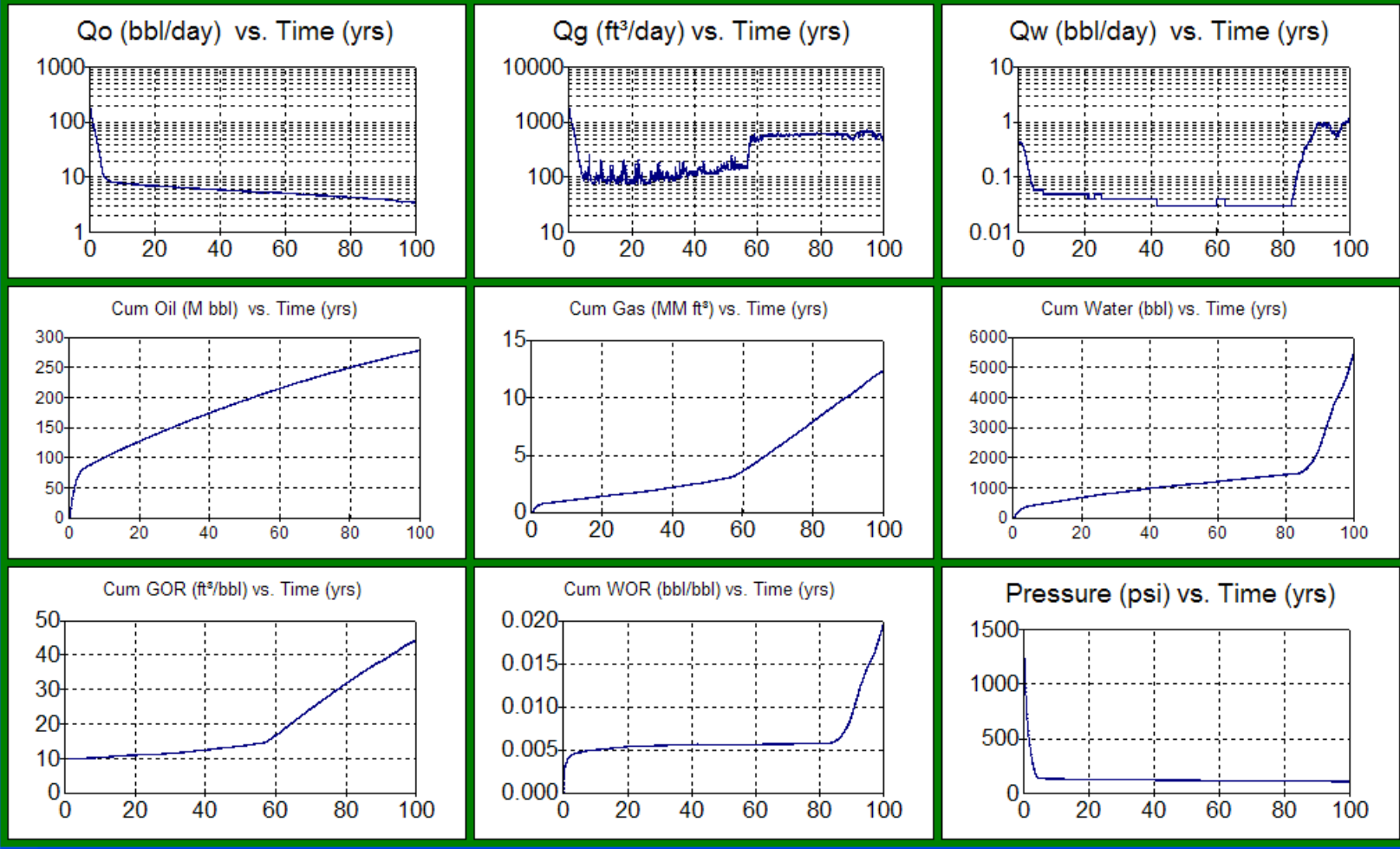
Primary Run

- *80 acre pattern/40 acre spacing*
- *Well Count = 2 net wells*
 - *2 net producers*
- *Low side Kr curves*
- *OOIP = 6,536 MBO*
- *Oil recovery = 4.27% OOIP*

MERLIN (1157815311): Field Summary: Little Tom Rim_03.MER

Form Plots Compare Help

Little Tom Primary Run #3
based on prim 2 > changes Rsi from 25 to 10



Waterflood Run

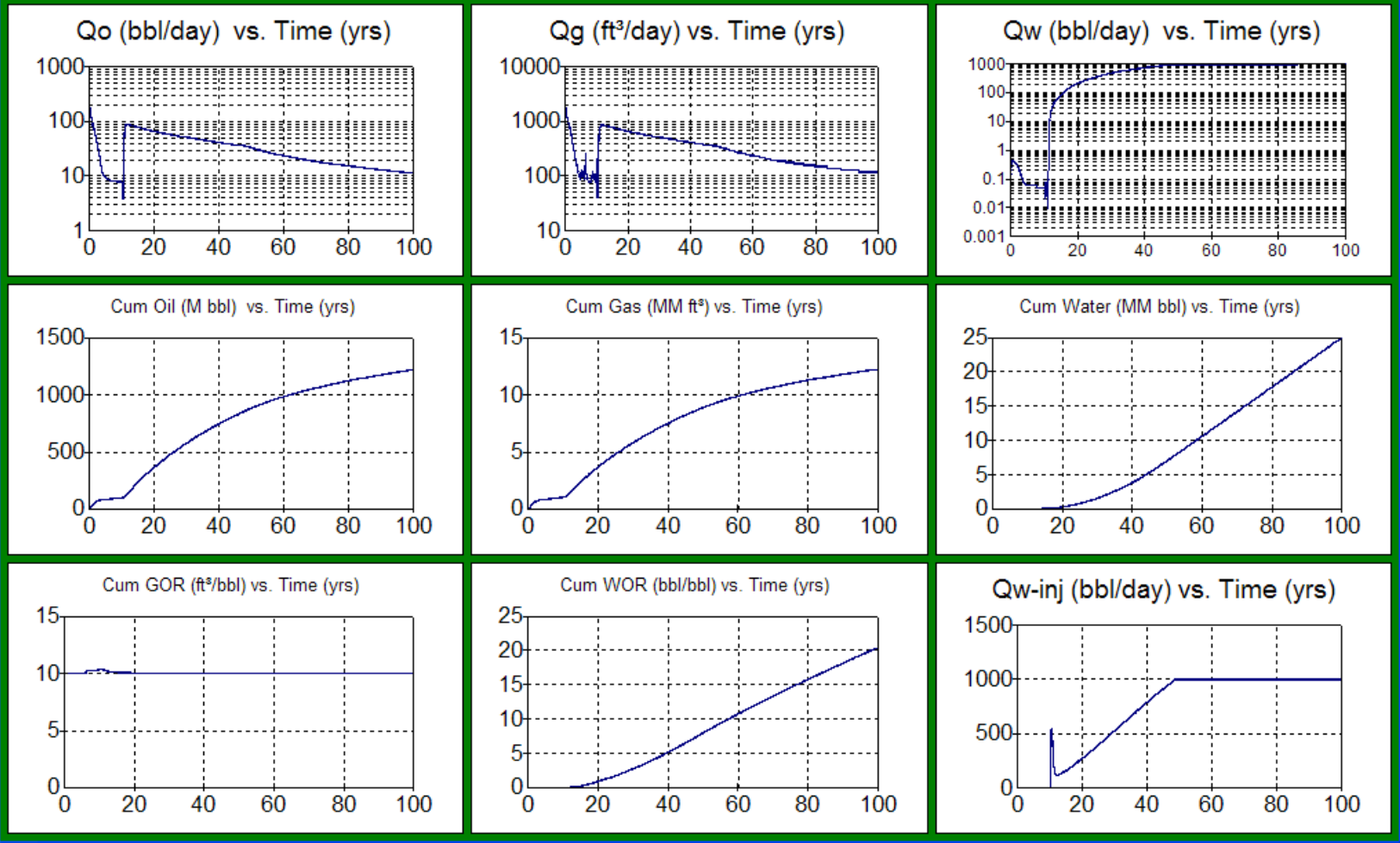
- *80 acre 5-Spot pattern/40 acre spacing*
- *Well Count = 2 net wells*
 - *1 net producer*
 - *1 net injector*
- *Low side Kr curves*
- *OOIP = 6,536 MBO*
- *Oil recovery = 18.68% OOIP*

MERLIN (1157815311): Field Summary: LITTLE TOM WF_02.MER



Form Plots Compare Help

Little Tom Waterflood Run #2
 based on WF run 1 > change inj rate to 1250 and max prod rate to 1000 BFPD/well



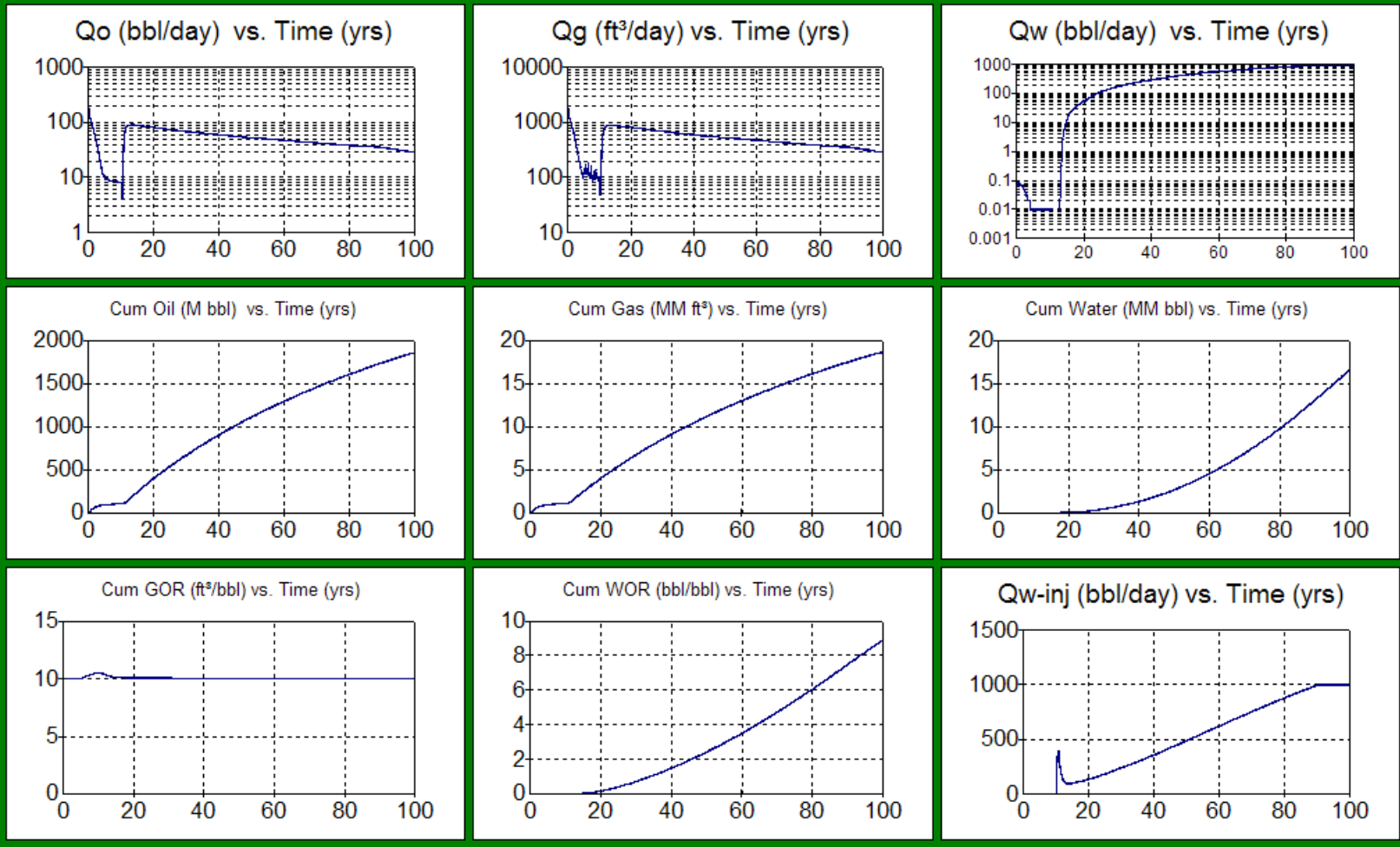
Waterflood Run

- *80 acre 5-Spot pattern/40 acre spacing*
- *Well Count = 2 net wells*
 - *1 net producer*
 - *1 net injector*
- *High side Kr curves*
- *OOIP = 8,547 MBO*
- *Oil recovery = 21.77% OOIP*

MERLIN (1157815311): Field Summary: Little Tom Hi_WF_02.MER

Form Plots Compare Help

Little Tom Waterflood Run #2 high side
based on WF run 2 > Swc = 0.15 and Sorw = 0.25

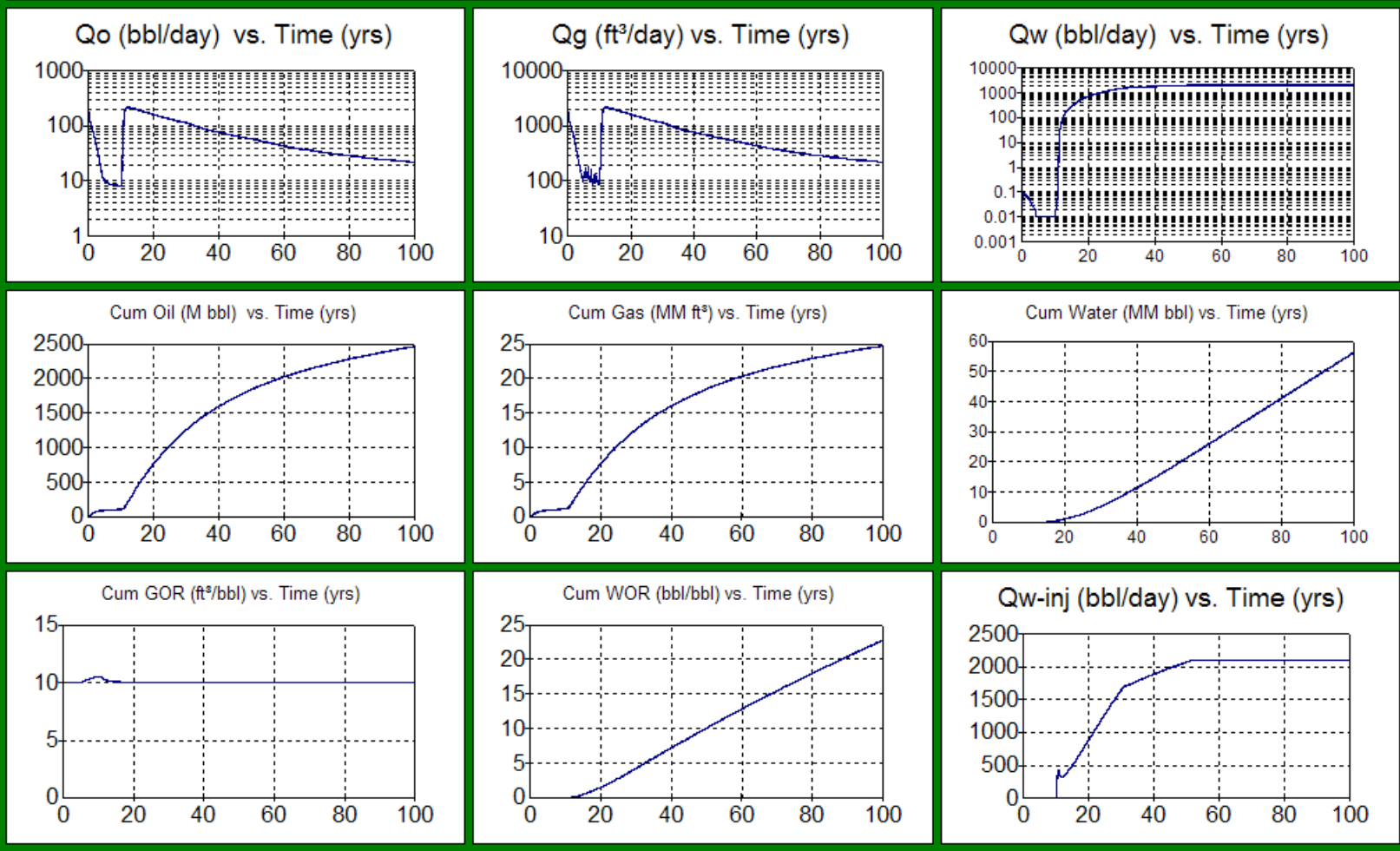


Waterflood Run

- *80 acre **9-Spot** pattern/**20** acre spacing*
- *Well Count = **4** net wells*
 - ***3** net producers*
 - ***1** net injector*
- *High side K_r curves*
- *OOIP = 8,547 MBO*
- *Oil recovery = **28.89%** OOIP*

Little Tom 20 acre infill high side Waterflood Run #3

based on Hi WF run 2 > max production = 700 BFPD/well and max inj = 2500 BWPD



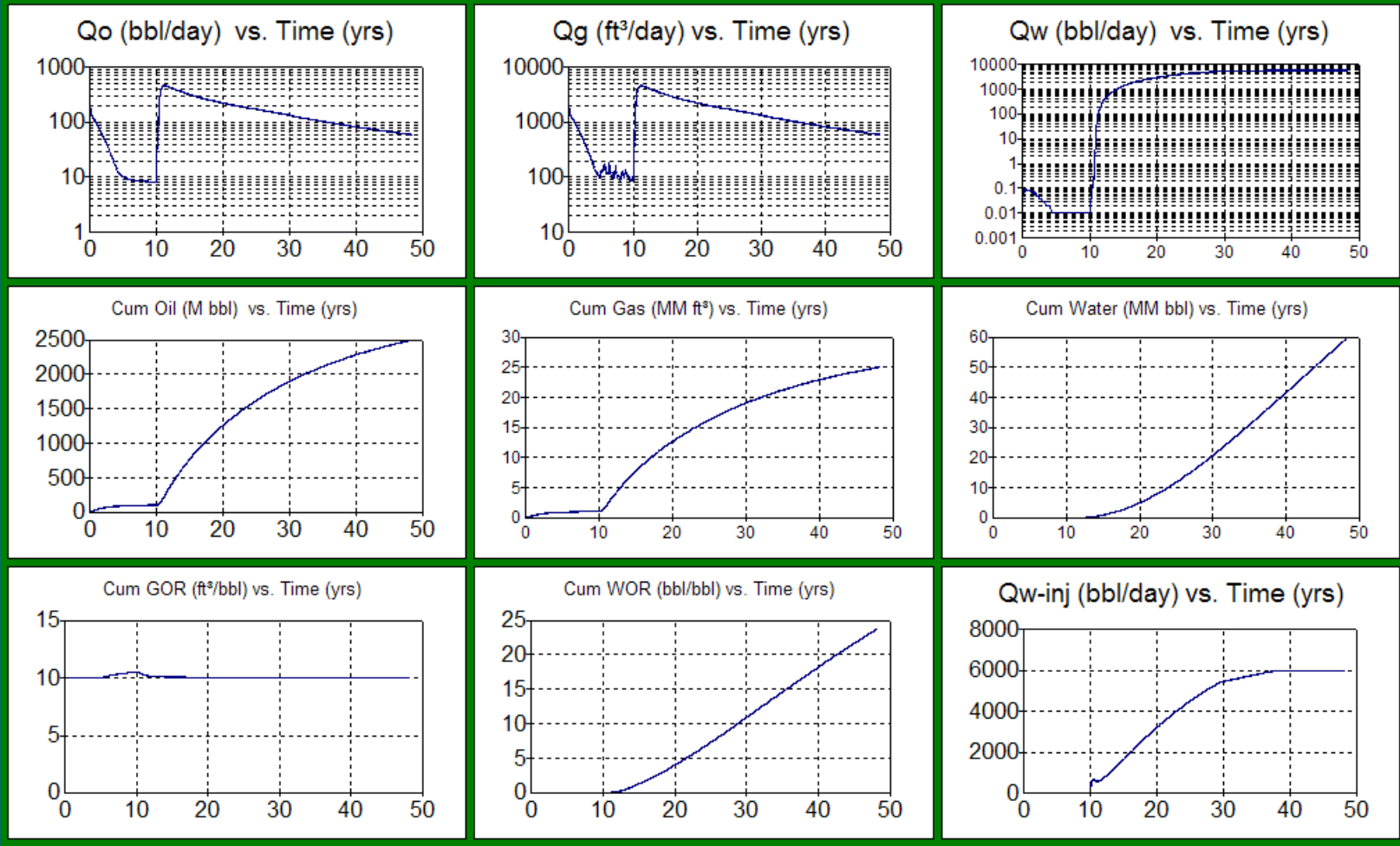
Waterflood Run

- *80 acre **9-Spot** pattern/**10** acre spacing*
- *Well Count = **8** net wells*
 - ***6** net producers*
 - ***2** net injector*
- *High side Kr curves*
- *OOIP = 8,547 MBO*
- *Oil recovery = **29.25%** OOIP*



Form Plots Compare Help

Little Tom 10 acre infill high side Waterflood Run #2
 based on 10 ac Hi WF run 1 > 1000 BFPD/w limit and 3000 BWIPD/w

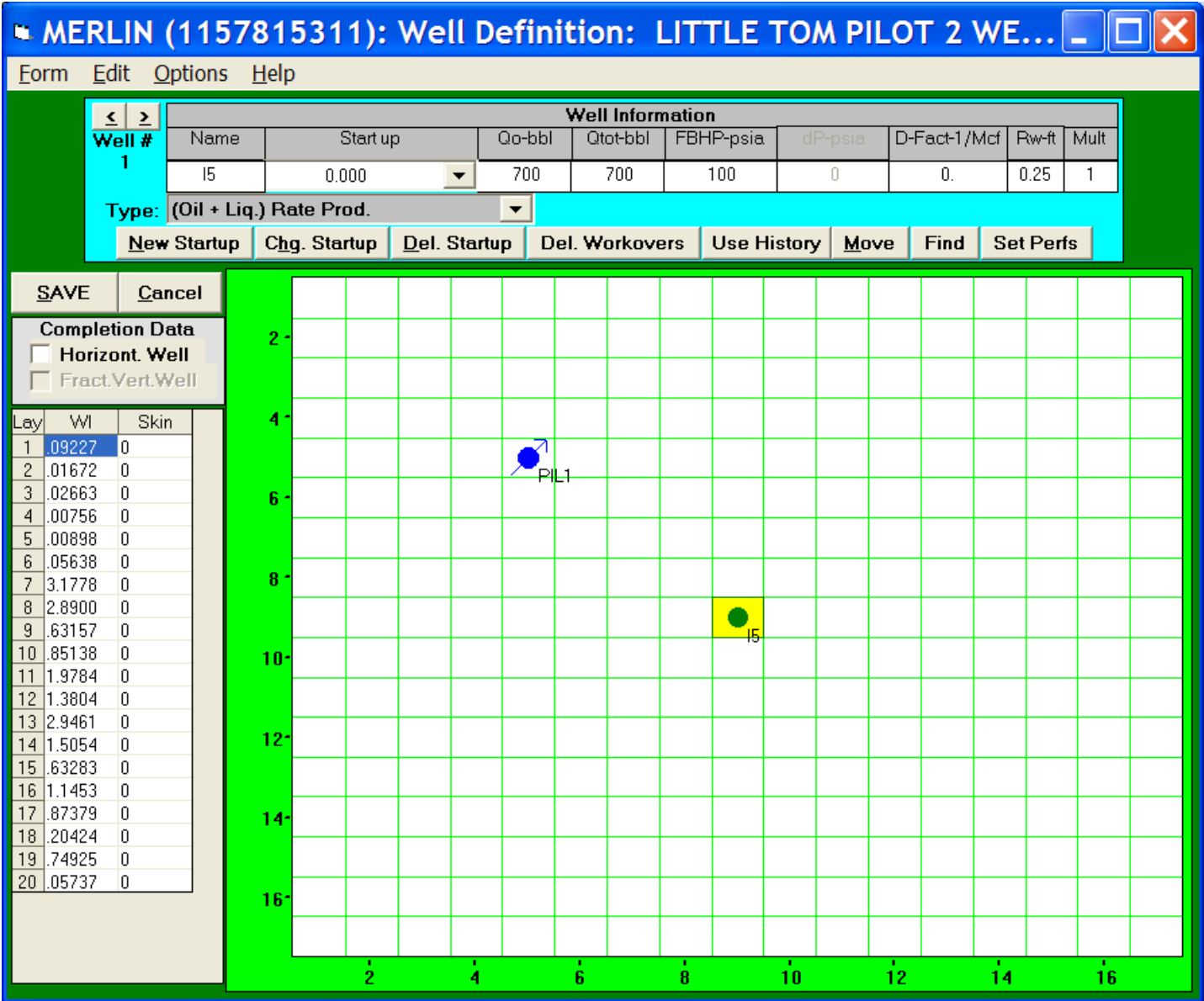


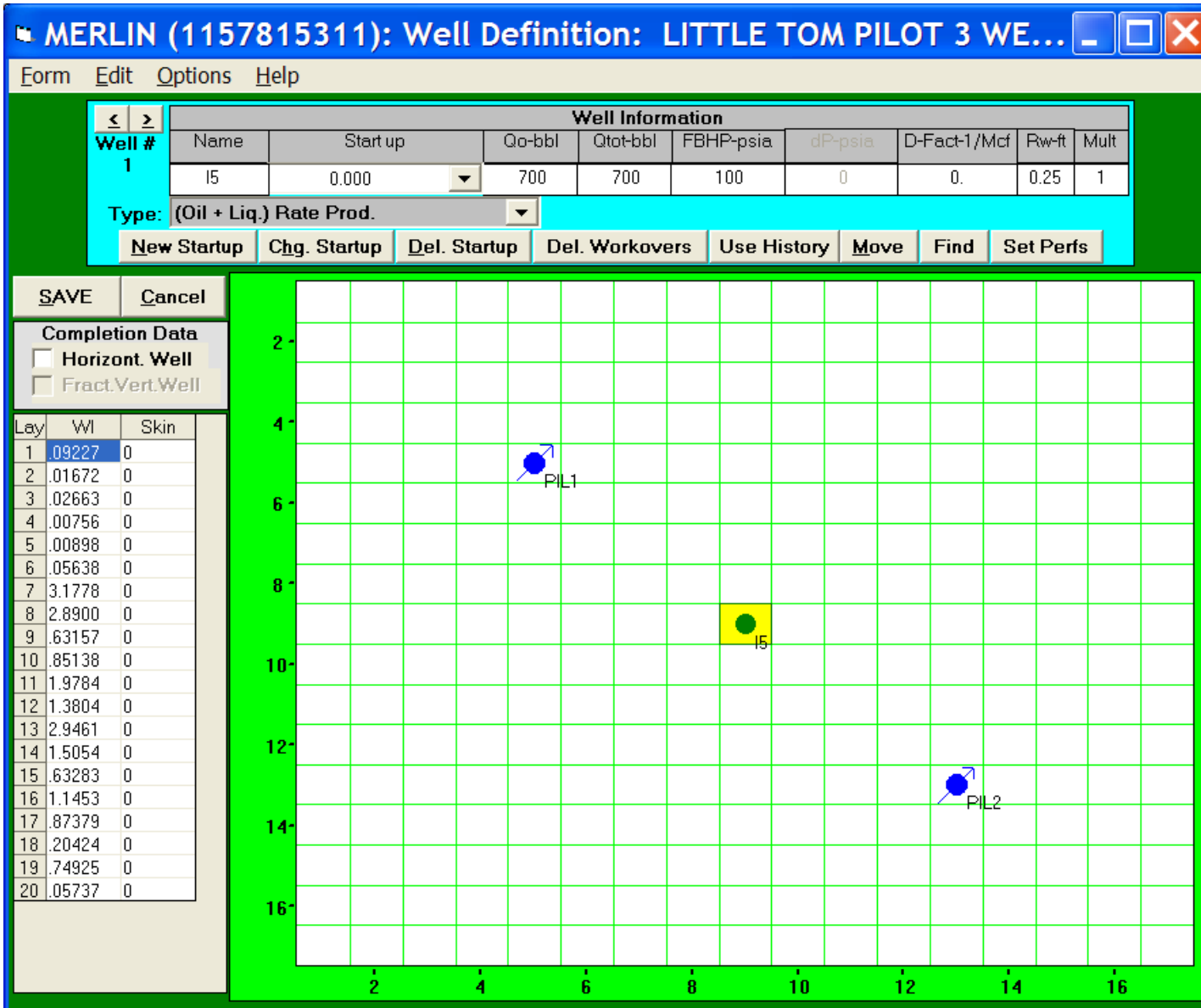
Potential Pilot Project

Simulator Predictions

Pilot Project Predictions

- *Model area = 290 acres*
- *All other reservoir rock and fluid parameters identical to high side pattern model*
- *Ran two cases*
 - *Two wells on 40 acre spacing*
 - *One producer*
 - *One injector*
 - *Three wells on 40 acre spacing*
 - *One producer*
 - *Two injectors*



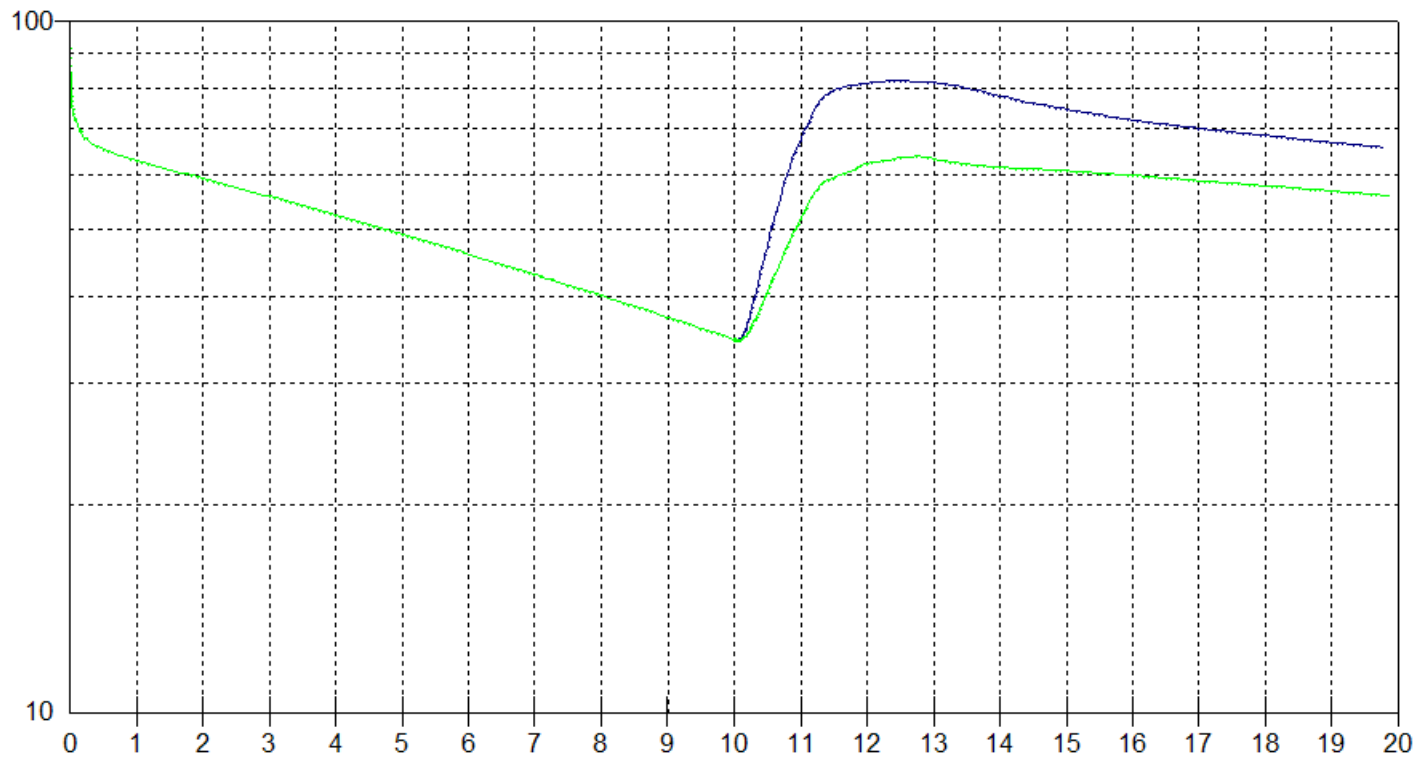


Little Tom Pilot run 2
three wells on 40 acre spacing

LITTLE TOM PILOT 3 WELLS

LITTLE TOM PILOT 2 WELLS

Qo (bbl/day) vs. Time (yrs)

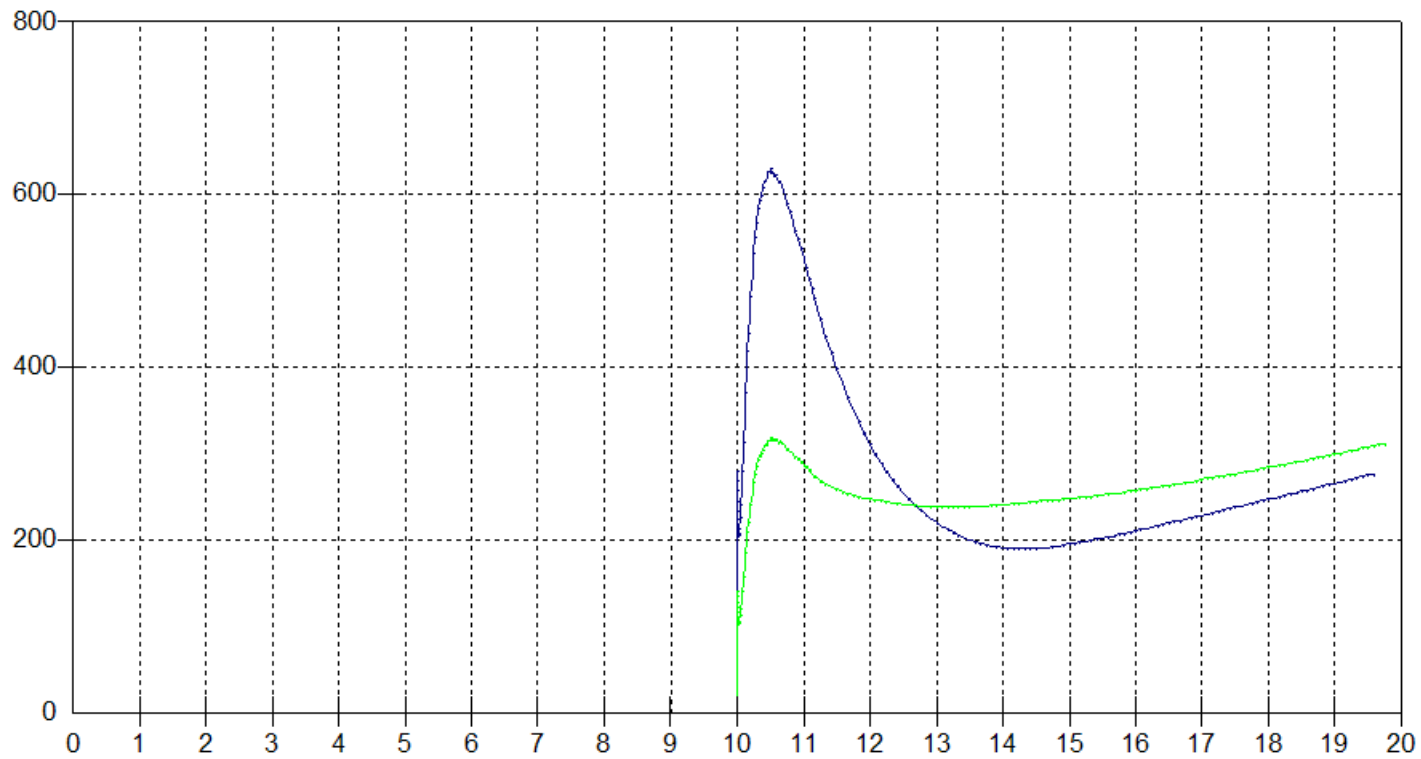


Little Tom Pilot run 2
three wells on 40 acre spacing

LITTLE TOM PILOT 3 WELLS

LITTLE TOM PILOT 2 WELLS

Qw-inj (bbl/day) vs. Time (yrs)



Advantages of 3 Well Pilot

- *Faster oil response*
- *Higher peak oil rate*
- *Reduces geological risk of encountering a flow barrier between producer and injector*

Little Tom Field

Recommended Future Action Items

Future Action Items

- 1. Design waterflood pattern for the entire field*
 - Collaborative effort Cobb/Dyami*
- 2. Design a waterflood pilot with well locations consistent with total field pattern*
 - Collaborative effort Cobb/Dyami*
- 3. Audit Dyami's OOIP values*
 - To be performed by Cobb*
 - Pending proposal and approval*