ODSI's Automated Reservoir and Production Engineering Software

March 30, 2016

Total - Pau

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Based on SPE Paper 171512

Outline

- **Intro to Oilfield Data Services (ODSI)**
- **Bias! & INMP**
- **Surveillance & Visualization**
- **Critical Issues for Automation**
- **Instrumentation by Well Type**
- **Background Physics for ODSI's Wellbore Model**
- **Well/Reservoir Analysis Techniques/Tools**
- **Case Studies**
- **Conclusions**

ODSI Consulting Business I

* **Data Processing, PVT, Rate and Wellbore Modeling**
  * Data QC, Filtering and Condensing
  * Rate & Water Cut Calculations
  * Mid-Completion (Datum) BHP Calculations
* **Well Test & Production Analysis**
  * PTA/RTA – Skin, Perm, P*, Boundaries, Volumes
  * Static MBAL and Decline Analysis (In-place, Connected and Mobile **HC Volumes**)
  * Blind Energy Mapping (don't show us your maps!)
  * Damage/Invasion Mapping (do show us your logs!)

ODSI Consulting Business II

* **Frac Design/Evaluation**
  * Building Geo-Mechanical Models
  * Designing the frac to minimize waste
  * Frac Replay Analysis ←→ Flowback Analysis
    * Where did your frac really go?
  * Post-Job review/optimization
* **Remote and On-Site Supervision of Complex Operations**
  * Job Planning
  * Frac Jobs
  * Exploration DSTs/TSTs

ODSI's Software - Basics

- **Operate in "Real-Time" or on Historic Data**
- **Work Within an Operator's Existing Framework**
- **Link to the Database inside the Operator's IT Firewall**
- **Honor the Physics and do the Math in the Background**
  - **Don't Use Correlations**
  - **Don't Force the data to "fit" a model**
- **Do the "grunt" work behind the scenes & do it right!**
  - **Petro-physics, Well Geometry, PVT & Thermal Modeling**
- **Provide Results that Explain a Well's/Reservoir's Performance**

PRIMARY GOAL: VALID RATES AND VALID BHP!

Secondary Goal: Remove Bias from the Decision-Making Process

ODSI Software – Automated Results

* Calculated Rates and/or Water Cuts
* Calculated Datum (mid-completion) BHP
* Apparent Oil and/or Water Content in Gas Wells
  * DP-PBU
  * Re-Injection Cycle
* PBU, DD and 2-rate Well Test Interpretation
  * Skin, Perm, Productivity, Completion Efficiency; P*
* Static MBAL & Decline Analysis
  * In-place, Hydraulically Connected & Mobile HC Volumes
  * Relative Productivity/Relative Inverse Productivity

Bias, Bullies & “It’s not my Problem”

Bias in Decisions

- Confirmation/Expectation Bias
  - Decision Already Made
  - Answer Already "given"
- The Inside View
- Risk Compensation
- Gambler's Fallacy
- Ownership/Sunk Cost Bias
- Unintended Consequences - Incentives
- Gotta Spend it…(budgets)

Turds in the Pool

* **The "Expert"**
* **The "Smartest Guy in the Room"**
* **The Information Hoarder**
* **The Bully**
* **The Grenade Tosser**
* **The Hold-out**
* **The Amateur Epidemiologist**
* **Mister Minutia**
* **The Investment Banker**

Whose Problem is it?

* Drilling: We got the hole down – it's not my problem
* Completions: The well flowed – it's not my problem
* Frac'ing: We pumped all the sand – INMP
* Facilities: I designed it for what you told me the rate was going to be - INMP
* Production: Not a wellbore or skin problem – see my nodal
* Reservoir: It's not a perm/Vc issue – see my nodal
* Geology/Exp: It HAS to be big! Must be someone else's fault/problem
* Geo-physics: The interpreted log says it's HC bearing – the water must be coming from somewhere else

Well…

* Drilling: Fluid Type/Losses can induce damage
* Completions: Fluid Type/Losses, Completion Type and Execution affect performance
* Frac'ing: If you frac out of zone or the proppant gets crushed, your frac may not be any good
* Facilities: Do the best you can with what you have
* Production/Reservoir: Find the pressure drop that shouldn't be there!
* Geology/Exp: Communicate with RE – How big is it?
* Geo-physics: Try digging up the 'raw" *.las data; don't assume that the service co. "interpreted" it correctly

It's Everybody's Problem

* **Understand what happened in the Past**
* **Understand what's happing Now**
* **Get an idea of what's going to happen in the Future**

Need Non-Biased (non-bullying) way to sort things out

What is Good Surveillance?

- **Always have a handle on:**
  - **How much oil or gas is in the ground**
  - **How much of it is likely to be recovered**
  - **What is the current well performance? Can anything be done to improve the performance?**
  - **Are there problems developing in the well bore?**
  - **Are there problems developing in the completion?**
  - **Are there problems developing in the reservoir?**
- **Is anything changing?**
- **If something happens, what is the current NPV of the asset?**

What is Bad Surveillance

- Only accept information about the well/reservoir that fits your or the company's beliefs
- Change the "static" or geologic model until you get the answer you want
- Wait until something bad happens:
  - Call it bad luck & move on
  - Say it's too late to fix it & move on
  - Call in a technical expert & move on
  - Use Nodal Analysis or Simulation to muddy the waters
- Be reactive… or just do nothing

Current Surveillance Programs

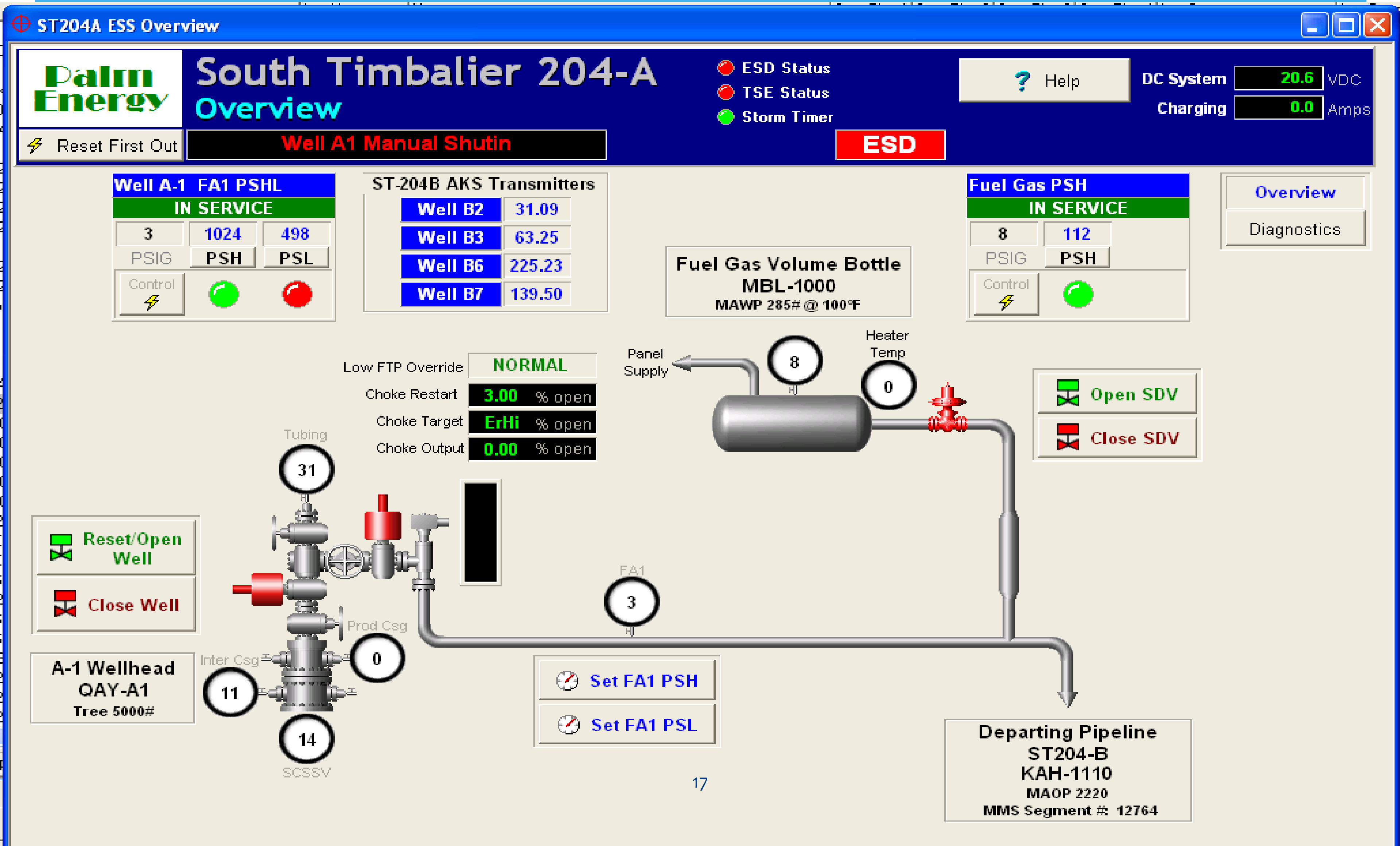
* **Some Operators STILL don't even have Scada**
* **Some have Scada, but no data visualization**
* **Some have Scada & Visualization, but only for some departments**
* **Some have alarms, triggers, automatic PBU recognition**
* **Some have links to internal & external software packages**

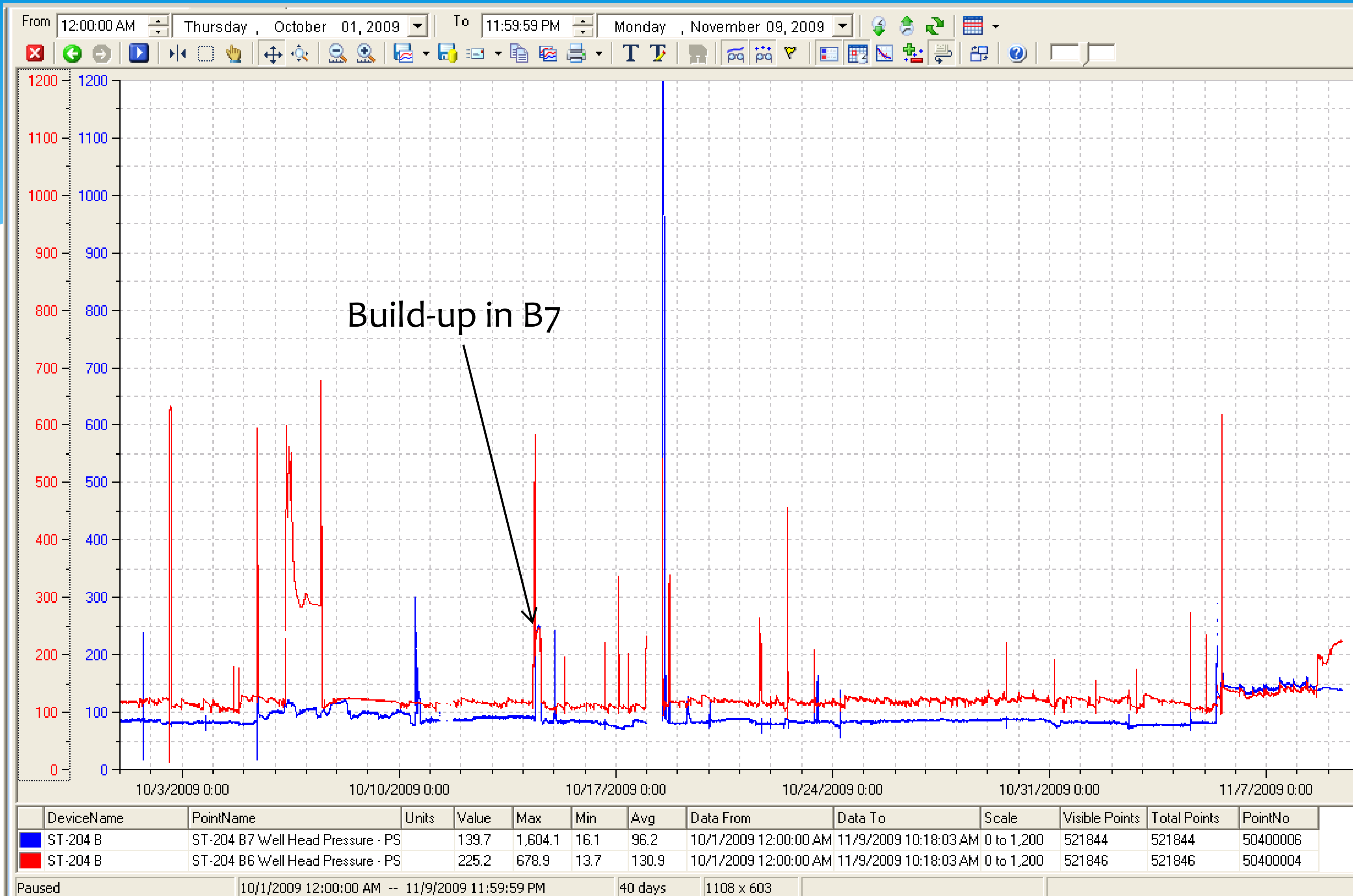
Drowning in Data?

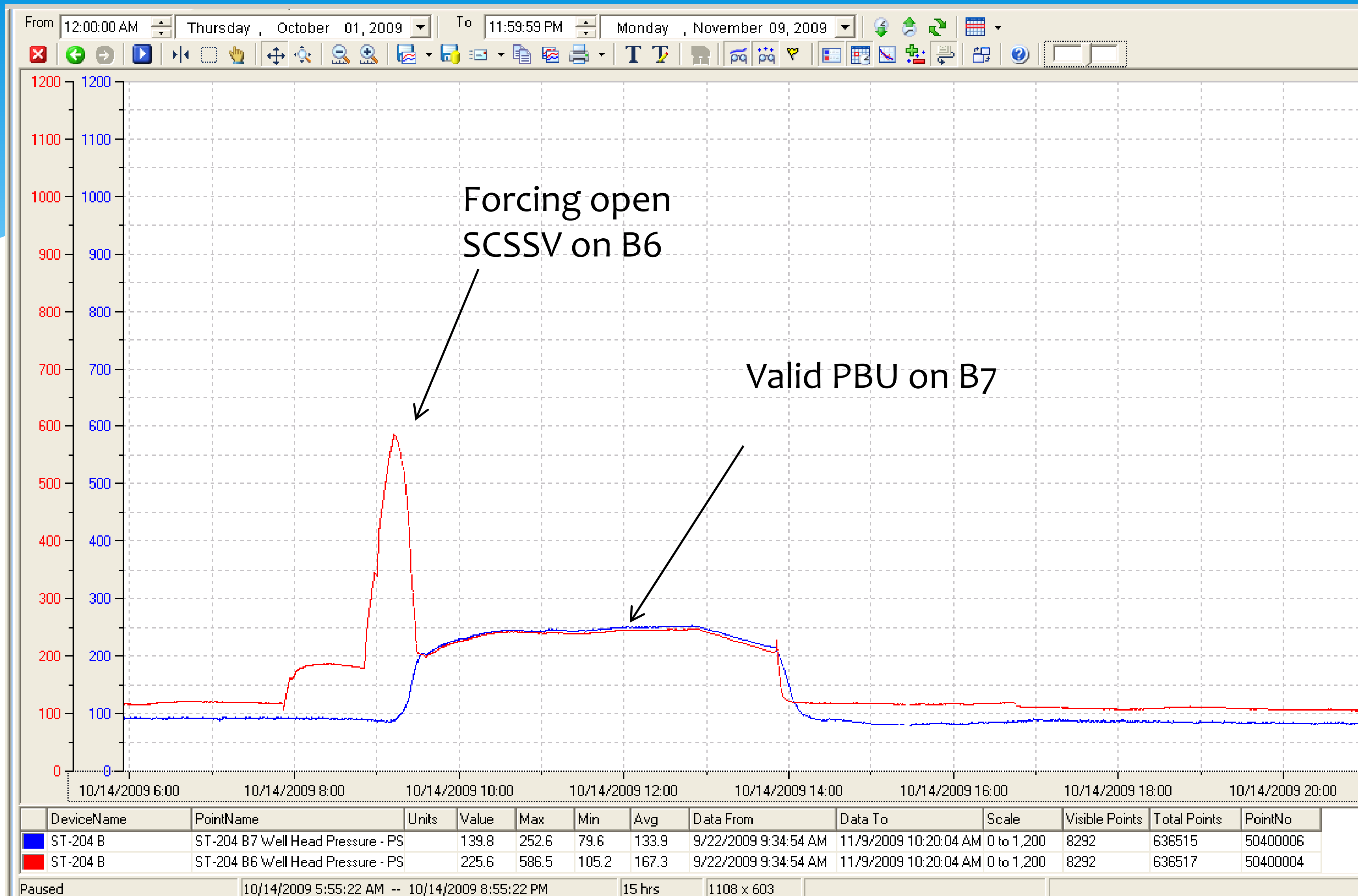
* **Engineers doing surveillance work spend over half their time just looking for data**
* **Many data systems are still designed as if computer storage/memory were expensive**
* **Many software packages cannot handle multi-million point data sets**

* **Need a common framework that engineers and managers can use and understand & visualize!**

Data Visualization




From 12:00:00 AM Thursday , October 01, 2009
To 11:59:59 PM Monday , November 09, 2009
Build-up in B7
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
10/3/2009 0:00
10/10/2009 0:00
10/17/2009 0:00
10/24/2009 0:00
10/31/2009 0:00
11/7/2009 0:00
DeviceName PointName Units Value Max Min Avg Data From Data To Scale Visible Points Total Points PointNo
ST-204 B ST-204 B7 Well Head Pressure - PS 139.7 1,604.1 16.1 96.2 10/1/2009 12:00:00 AM 11/9/2009 10:18:03 AM 0 to 1,200 521844 521844 50400006
ST-204 B ST-204 B6 Well Head Pressure - PS 225.2 678.9 13.7 130.9 10/1/2009 12:00:00 AM 11/9/2009 10:18:03 AM 0 to 1,200 521846 521846 50400004
Paused
10/1/2009 12:00:00 AM -- 11/9/2009 11:59:59 PM
40 days
1108 x 603



	DeviceName	PointName	Units	Value	Max	Min	Avg	Data From	Data To	Scale	Visible Points	Total Points	PointNo
	ST-204 B	ST-204 B7 Well Head Pressure - PS		139.8	252.6	79.6	133.9	9/22/2009 9:34:54 AM	11/9/2009 10:20:04 AM	0 to 1,200	8292	636515	50400006
	ST-204 B	ST-204 B6 Well Head Pressure - PS		225.6	586.5	105.2	167.3	9/22/2009 9:34:54 AM	11/9/2009 10:20:04 AM	0 to 1,200	8292	636517	50400004

Common Framework - Basics

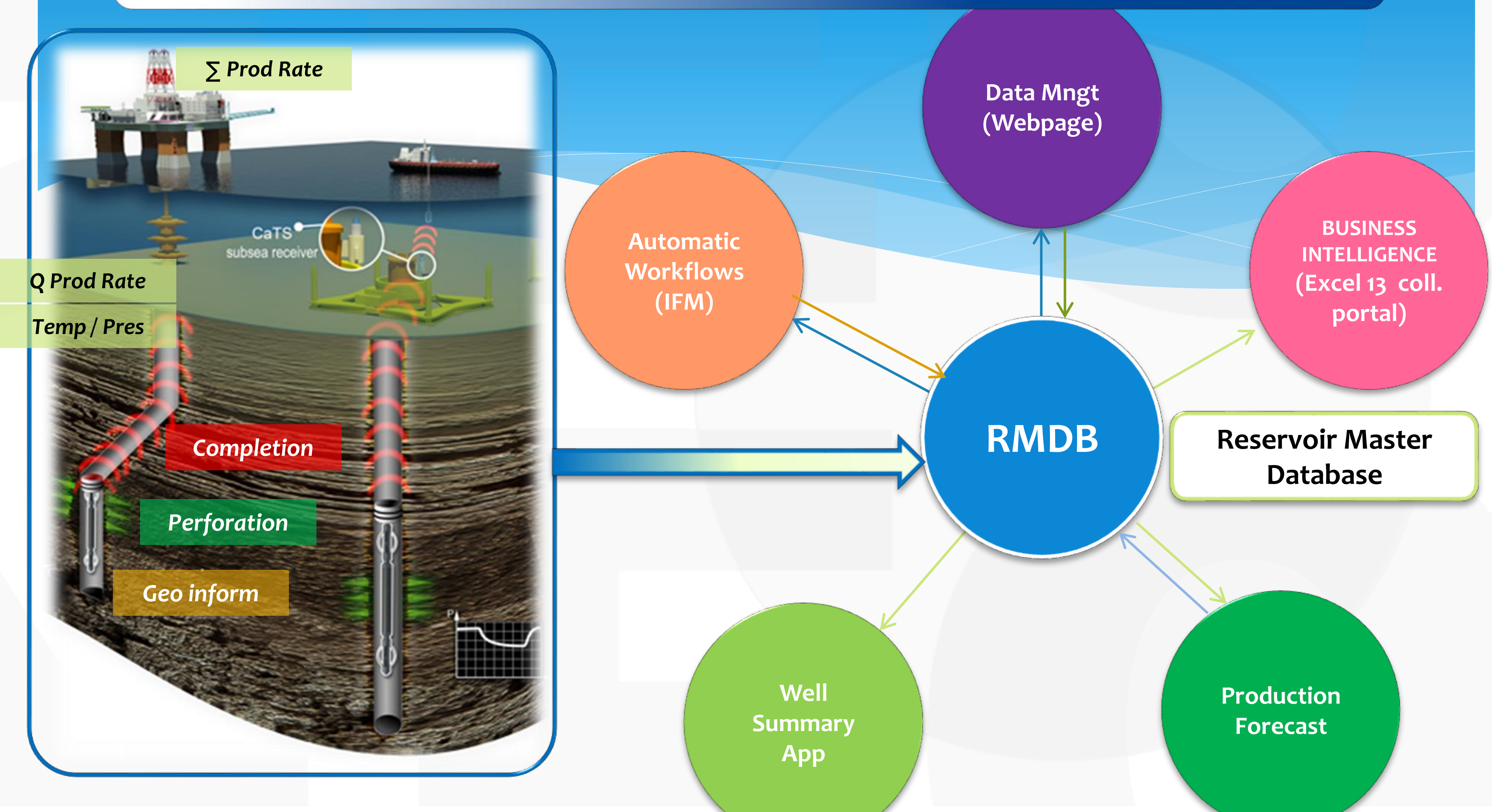
* Easy Access to Data
* Ability to do diagnostic graphs, with annotations
* Links to Email
* Process Alarms

* Ability to Plug & Play with other software packages, not just the Framework's software

This forms the basics for Automated Real-Time Analysis!

Total's Solution: T-MORE

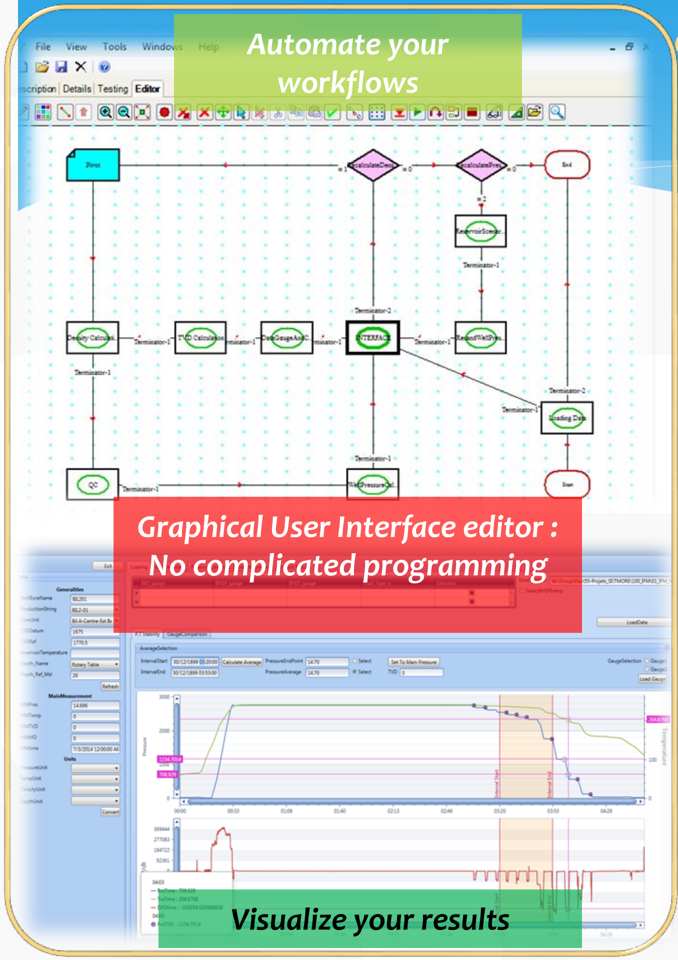
T-MORE→ DATABASES AND INTERFACES

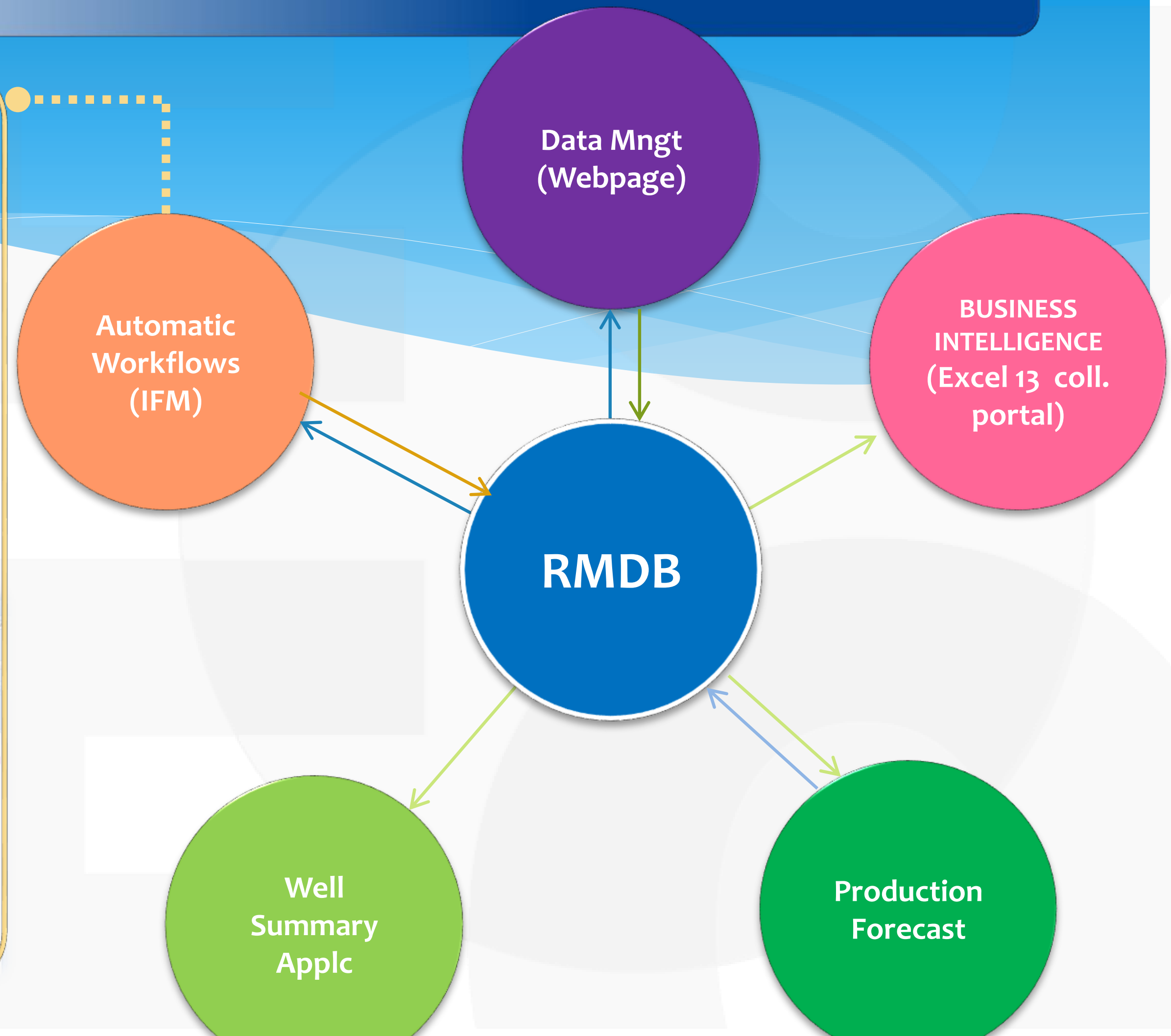


T-MORE fully integrates the loop from data collection and management to Reservoir management processes

Where Does ODSI Fit in this Set-up?

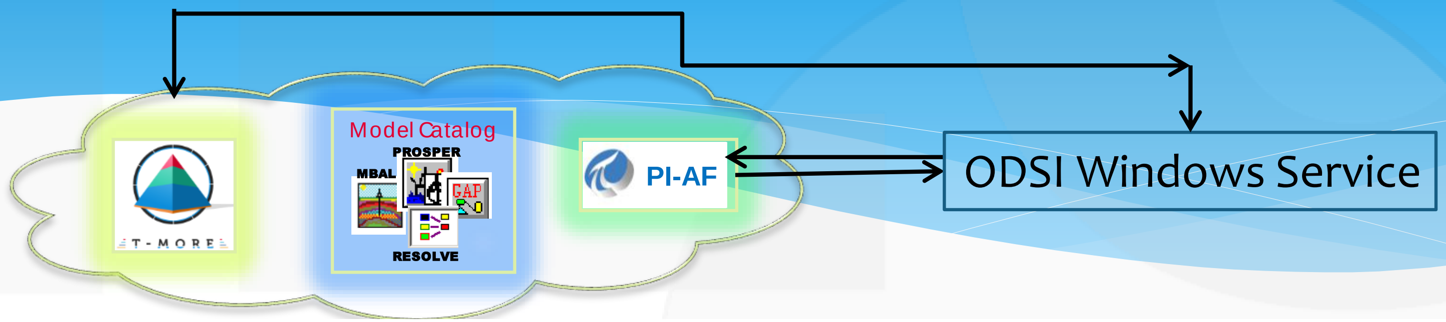
T-MORE→ DATABASES AND INTERFACES





AUTOMATE YOUR RESERVOIR WORKFLOWS

ODSI-PI (or T-MORE) Interface



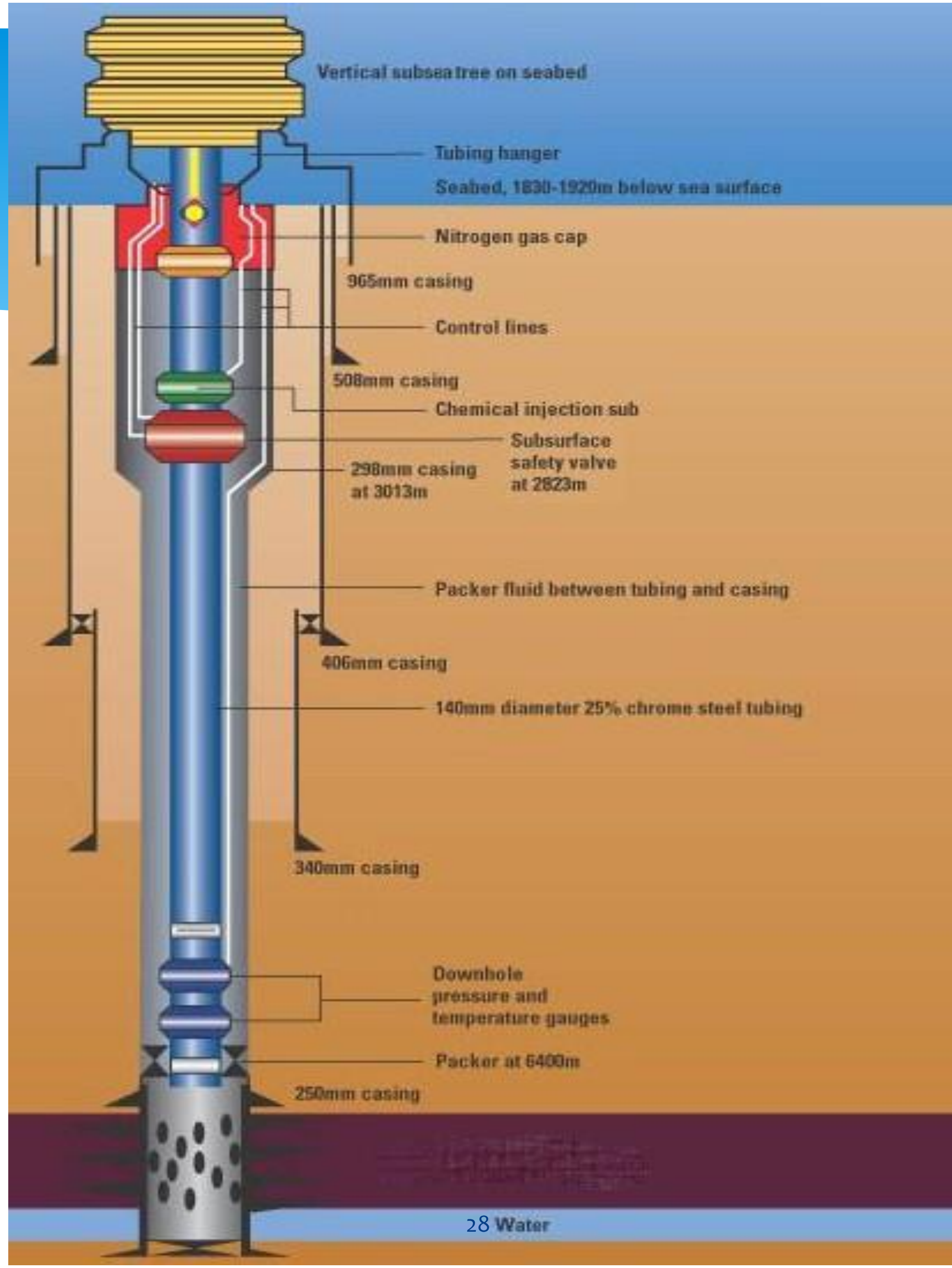
- ODSI's Windows Service is installed on the PI Server, inside the firewall
- ODSI WS Reads the PI Tags it needs to perform the calculations
- ODSI WS then Writes the Results of the Calculations back to PI
  - Qgas, BHP, Perm, Skin, P*, PI, etc.
- These calculations are then available for IFM to utilize
- Automated Reports (Well Test Analysis, Decline Analysis, Static MBAL) are Written to a Shared Folder within the Network
- Digital Versions of the results are maintained in a *.csv file
- Engineers and T-MORE can access results, reports and summary files through IFM or a dedicated T-MORE/ODSI interface

Critical Issues for Automation

- Instrumentation Quality & Location
- Data Source, Data Acquisition Frequency, and Data Storage (dead-banding!!!)
- Well/Completion Type (every well is different)
- Reservoir "Signal" – Rate of Change in Pressure
  - The higher the kh, the smaller the "signal"
- Operationally Dependent Items
  - How is the well shut-in (Staged?)
  - How is the well brought on production (Stepped?)
  - How is the well produced (steady, swing?)
- How is rate "measured" or calculated?

Instrumentation by Well Type

- Possible Instrumentation (Upstream of Facilities)
- Instrumentation based on well type:
  - Natural Flow – Gas & Gas/Condy
  - Natural Flow – Oil
  - Artificial Lift – Oil
  - Annular Flow Wells (CBM/CSM)
  - Water Injection
  - Nat Gas injection
  - CO2 injection
  - Steam Injection


Vertical subsea tree on seabed
Tubing hanger
Seabed, 1830-1920m below sea surface
Nitrogen gas cap
965mm casing
Control lines
508mm casing
Chemical injection sub
Subsurface safety valve at 2823m
298mm casing at 3013m
Packer fluid between tubing and casing
406mm casing
140mm diameter 25% chrome steel tubing
340mm casing
Downhole pressure and temperature gauges
Packer at 6400m
250mm casing
Water

Pressure/Temperature Measurement

What do I really need to measure accurately?

* Wellhead Pressure
* Wellhead Temperature (Thermowell)
* Downhole Pressure
* Downhole Temperature
* Distributed Temperature (multi-zone wells)
* Line Pressure/Temperature
* Annular Pressures

Rates and Valve/Ck Status

- Flow Rates of Oil, Gas & Water
  - Multiphase Meters, Venturi Meters, Turbine Meters, d/p meters (Daniels), Coriolis meters, Ultrasonic Flowmeter
  - Dedicated Test Separator
  - Meter Prover
  - Virtual Rate Measurement (VRM)… based on what?
- Other bits
  - Choke Setting
  - SCSSV, MV, Control Valves
  - Injection lines

Instrumentation Needs

Based on Well Type

Basics: What do you need to evaluate your well/reservoir?

* Way to get Qgas, Qoil & Qwater
* Way to get Mid-Completion BHP

* Temperatures, Choke & Valve Settings are nice too!

Gas & Gas/Condy Wells

- Need at least one pressure and continuously measured Rates… OR
- Two pressures in/on well (can be used to calculate gas rate)
- Choke Setting
- Valve Status
- MPFM?

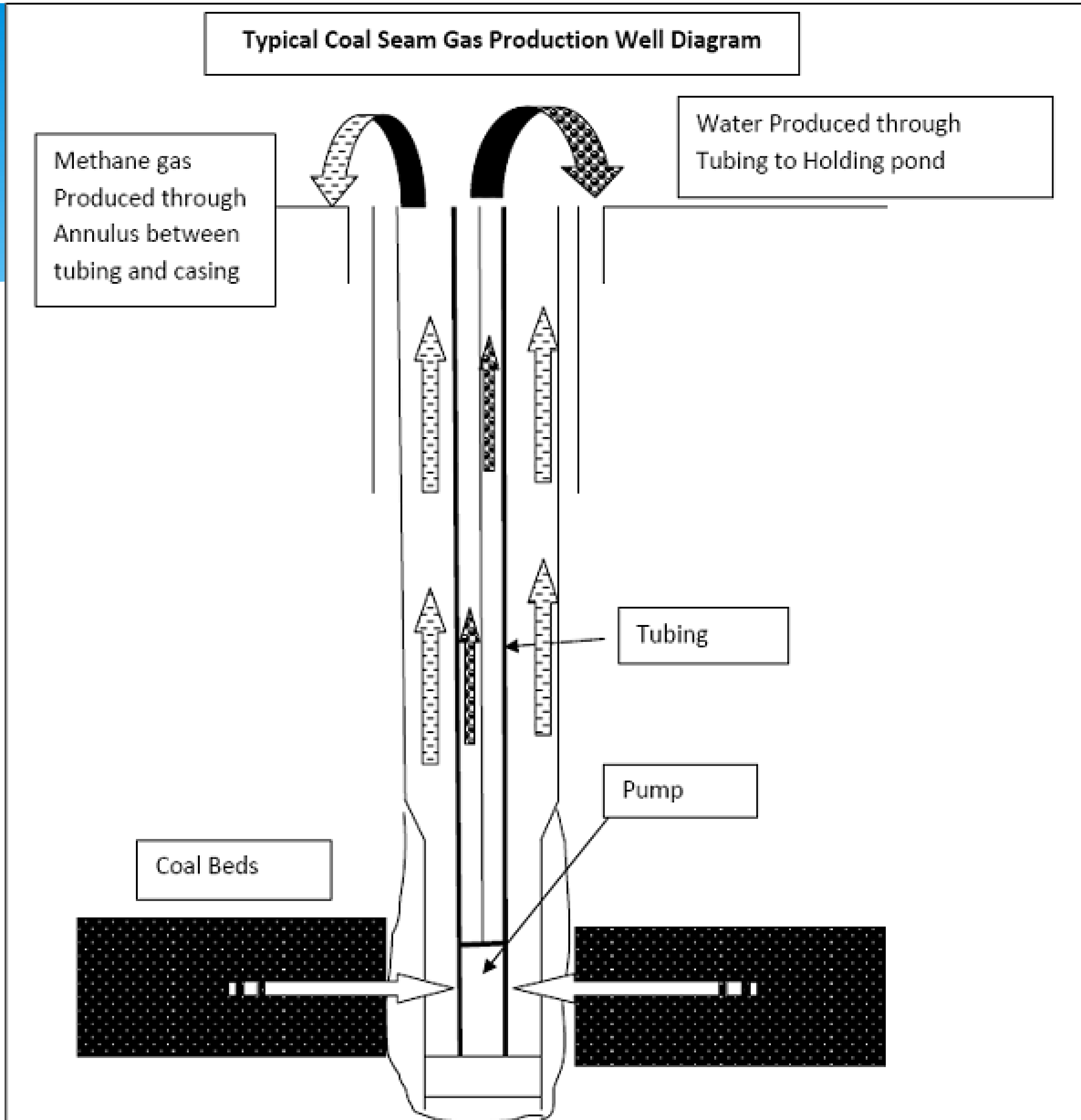
Note: If well is expected to make significant water or if the free Condensate yield is above 30 bbl/MMcf – dhgs are recommended

Naturally Flowing Oil Wells

* Tree & DHG (Pressure & Temperature)
  * Can be used to calculate water cut
* Mass Flowmeter, Turbine Meter, MPFM, Integrated Tank Level flow indicator
* Choke Setting
* Valve Status

Artificial Lift Oil Wells

- Same as natural flow, but DHPG must be below the artificial lift system (and Tree pressure may be irrelevant)
  - Below pump for PCP, ESP or jet pump (in communication with reservoir)
  - Below standing valve for sucker-rod
  - Below mandrel for gas lift (+gas injection pressure)



As gas bubbles and water enter the well bore the gas will flow up the annulus, and the water be drawn into the pump and pumped through the tubing to a flow line to a holding pond.

Annular Flow (CSM)

* Annulus Pressure/Temperature
* WHT/WHP
* Pump torque & rpm
* DHG (below pump)
* Liquid Level indicator (avoid running pump dry)
* Water Rate (tubing) – tank level meter
* Gas Rate (annulus)

Water Injectors

- DHG – Pressure/Temperature
- Can use WHP if well doesn't go on vacuum during fall-off
- Qwater (turbine meter)
- Ways to measure/infer water gravity
  - Capacitance
  - Salinity
  - Density

Nat Gas, CO_2 & Steam Injectors

* If composition is constant, can get by with just WHP and Qgas-inj and Tinj
* If composition is variable or well is a recycler, need WHP, WHT, DHGP, DHGT and Qgas (mass flow)
* Valve Status
* Choke Status
* For CO_2 Injectors: DHG and Tree gauge required
  * PVT tuning & rate validation
* For Steam Injectors: Same as nat gas inj.

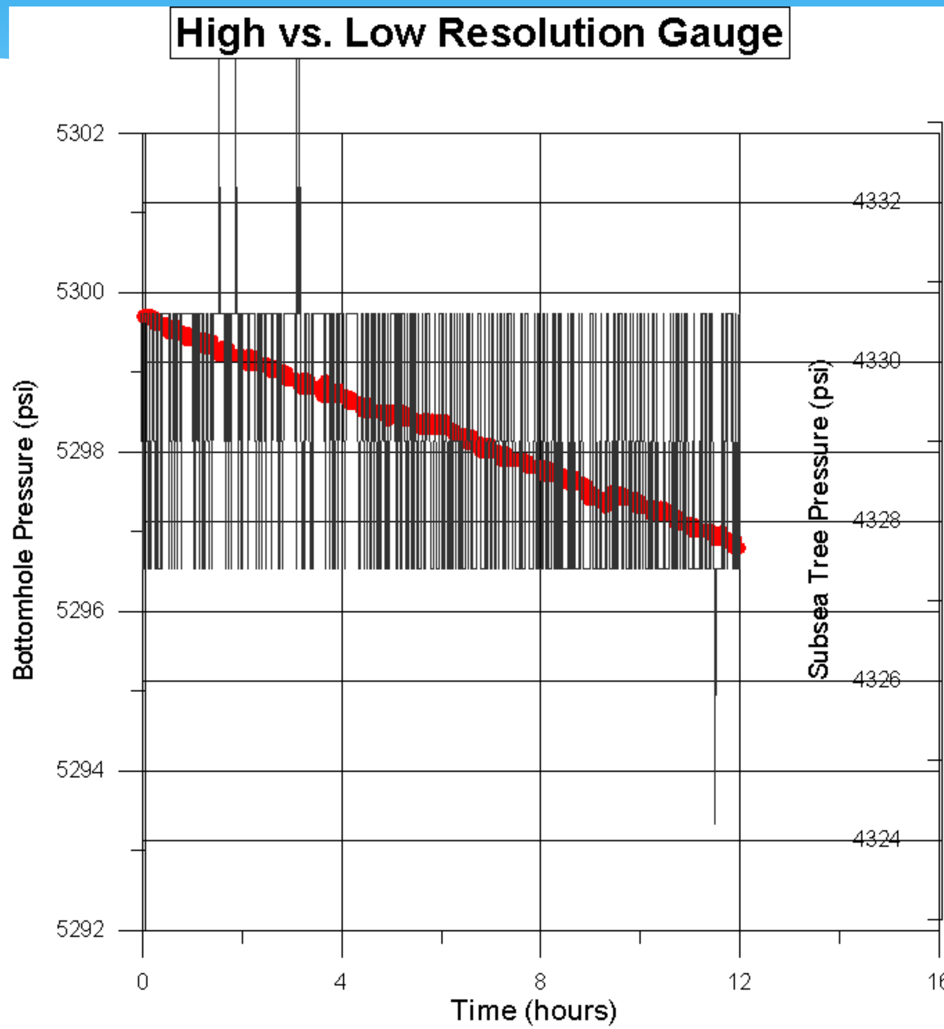
Comments on Instrumentation

- Instrumentation is relatively cheap
  - Price difference between good and crap equipment is small
  - Cable (TEC) and Rig Time are not
- Don’t drop bits!
  - Most transmitters are 18-24 bit
  - Don’t lose resolution over a $30 vs. a $50 I/O card
- **Let the end users spec the equipment!**

Data Transfer: Don't Lose Resolution!

- Before it gets to you, Your Data is likely to pass through:
  - One or two A/D converters
  - An I/O card on the Control Panel
  - Dead-band filters
  - Signal filters
  - Archive filters
- You can lose sampling resolution (frequency) and instrument resolution at any point along the way

Don't Lose Resolution!



How Do We Make Use of Automated Surveillance?

…may have to change the way we work and assign responsibility

One Last Form of Bias…

Automation Bias!

How to “Bird-Dog” a Well Production problem

* Is it a wellbore problem?
  * Scale/Wax/Asphaltenes, Loading, Parted String
* Is it a completion problem?
  * Skin Accretion, Screen Plugging, Completion Failure
* Is it a reservoir problem?
  * Perm?
  * Reserves?
  * Water Encroachment?

* Is it a combination of two or more of the above?

FIND THE PRESSURE DROP THAT SHOULDN’T BE THERE!

Remember: Every Well is Different!

* Well Geometry
* Completion type
* Data Source/Instrumentation
* Data Frequency & Management
* How Many Reservoir Layers?
* Reservoir Signal (how "flat" is the build-up?)
* Wellbore Lift Mechanism
* Reservoir Drive Mechanism
* How is the Well Operated?

Each Well's Data Acquisition Strategy
Needs to Consider All of These Items

Reservoir & Production Engineering Analysis/Evaluation Tools

What they are and what they tell you

Analysis Types and Their Objectives

* PTA (Pressure Transient Analysis)
  * Skin, Perm, Deliverability, Communication, Productivity, Reservoir Boundaries, Reserves, Reservoir Pressure (P*)
* RTA (Rate Transient Analysis)
  * Same as PTA, but with less reliability on boundaries
* P/z Plots (gas) & Static MBAL Plots (oil)
  * Oil and/or Gas in Place
* Decline Analysis: Flowing BHP or IP vs Time
  * Apparent HC Volumes – Running MBAL/EBAL
* Nodal Analysis: Interaction of WB/Comp/Res
  * Changes in well performance; short-term rate predictions
* Reservoir Simulation: Cell/Gridblock disposition of Saturations, Pressures (Energy)
  * Field Optimization; longer-term rate/withdrawal predictions

Analysis Type Examples

* Build-up PTA Derivative
* Drawdown PTA Semilog
* Horner – P*
* Proper RTA (Rate Transient Analysis)
* MBAL/EBAL “bookends”
* P/z (gas) or Static MBAL (oil)
* Conventional Decline Analysis (Running MBAL)
* TTA/IPA (Running EBAL)
* NODAL ANALYSIS
* Simulated Rates/Pressure vs. Actual

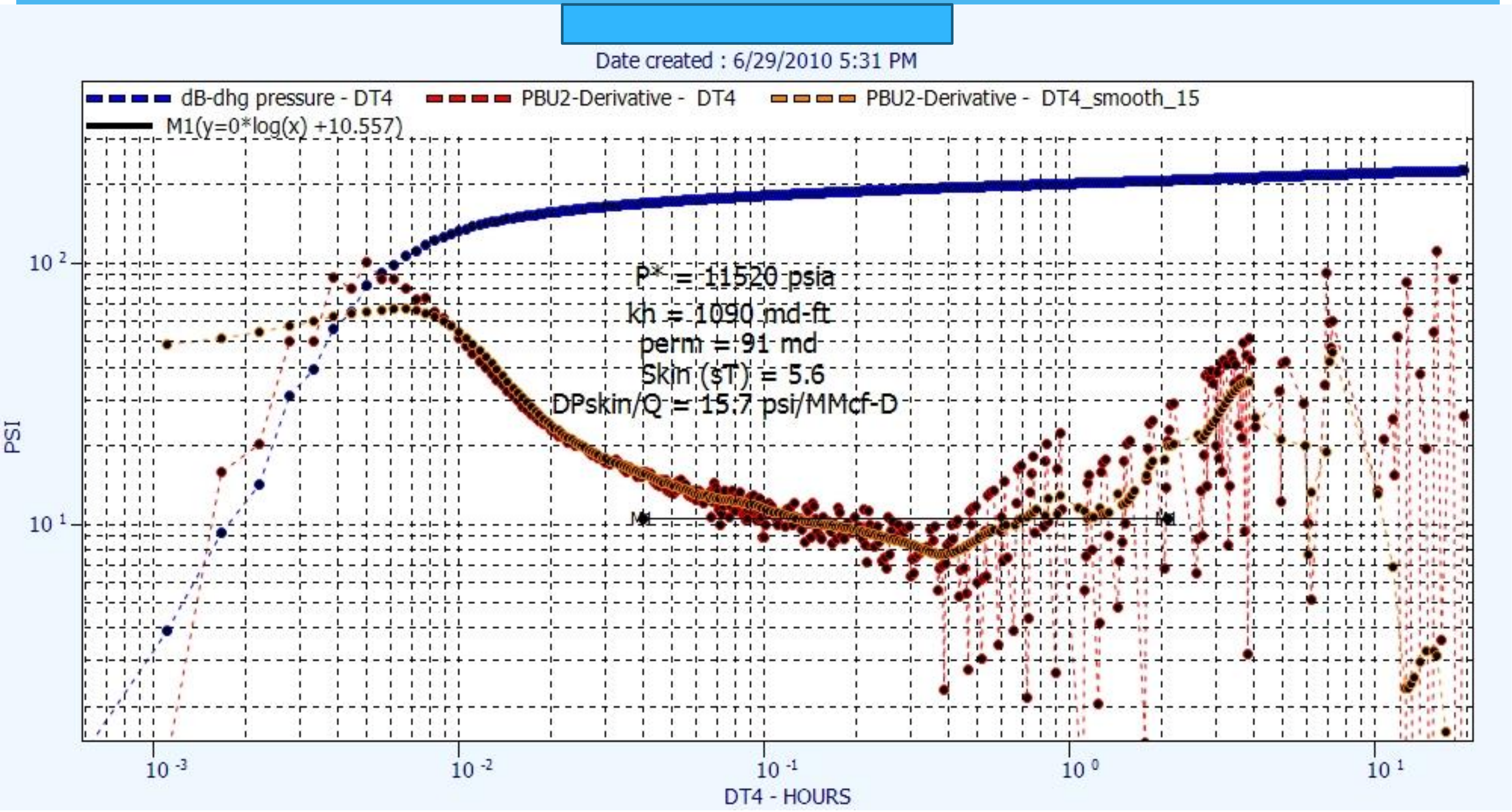
Analysis/Evaluation Tools: PTA

- Build-up: After flowing the well for a while, shut it in and observe the pressure response
  - If Long Enough, Valid P*
- Drawdown: After shutting in the well for a while, flow it on a constant choke and observe the pressure and rate response
- 2-rate: Change the rate enough to create a new transient; observe P & Q
- Multi-rate: Change the rates and compare DP vs Q
- Communication: Shut-in a well and see if a neighboring well causes the Pressure to drop

Build-up PTA

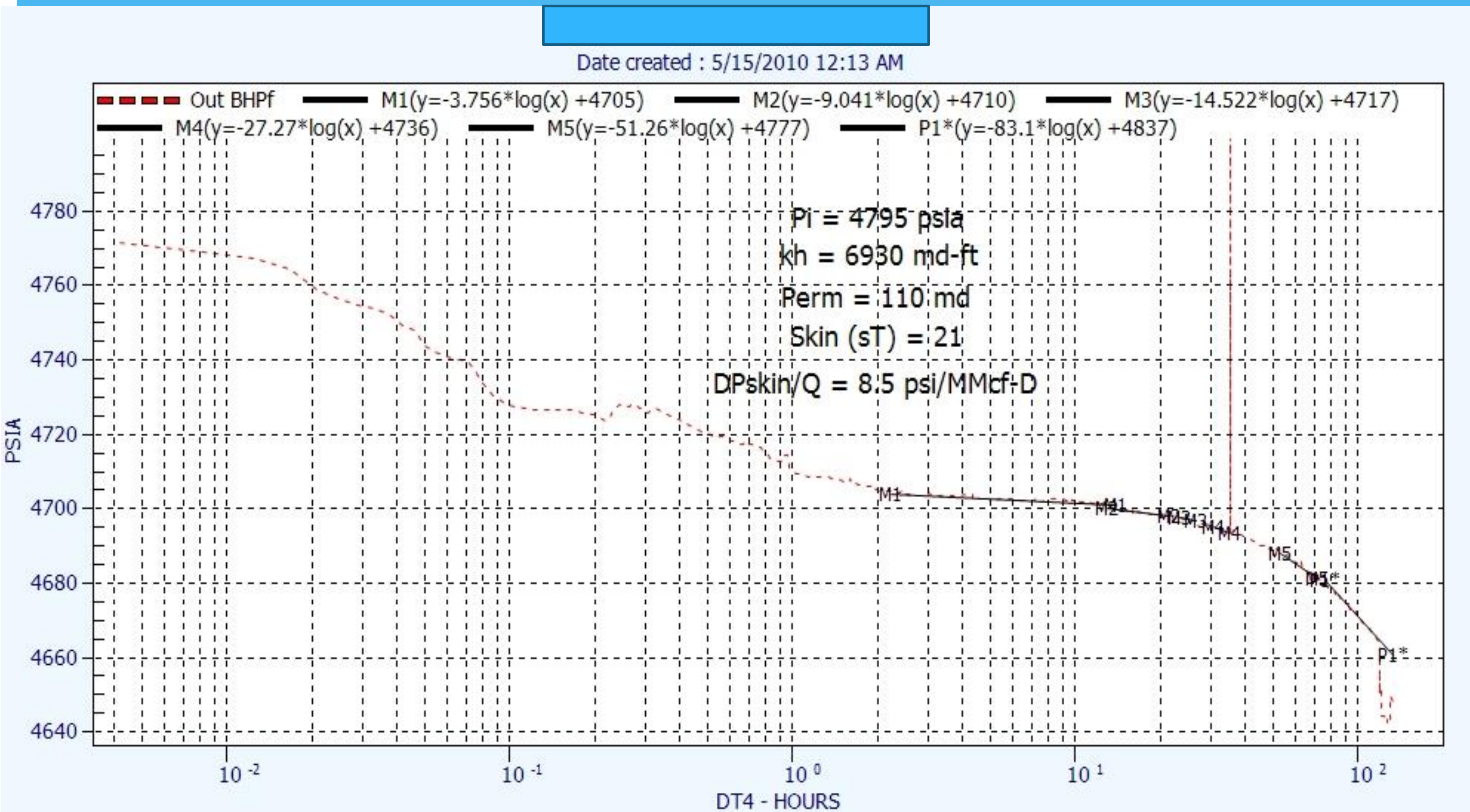
Date created : 8/14/2010 4:11 PM
B-dhg pressure
11500
11450
11400
11350
11300
PSIA
3PM
6PM
9PM
24 Thu
3AM
6AM
9AM
12PM
3PM
23 Wed Jun 2010
Date-Time - DateTime

Build-up Derivative Analysis

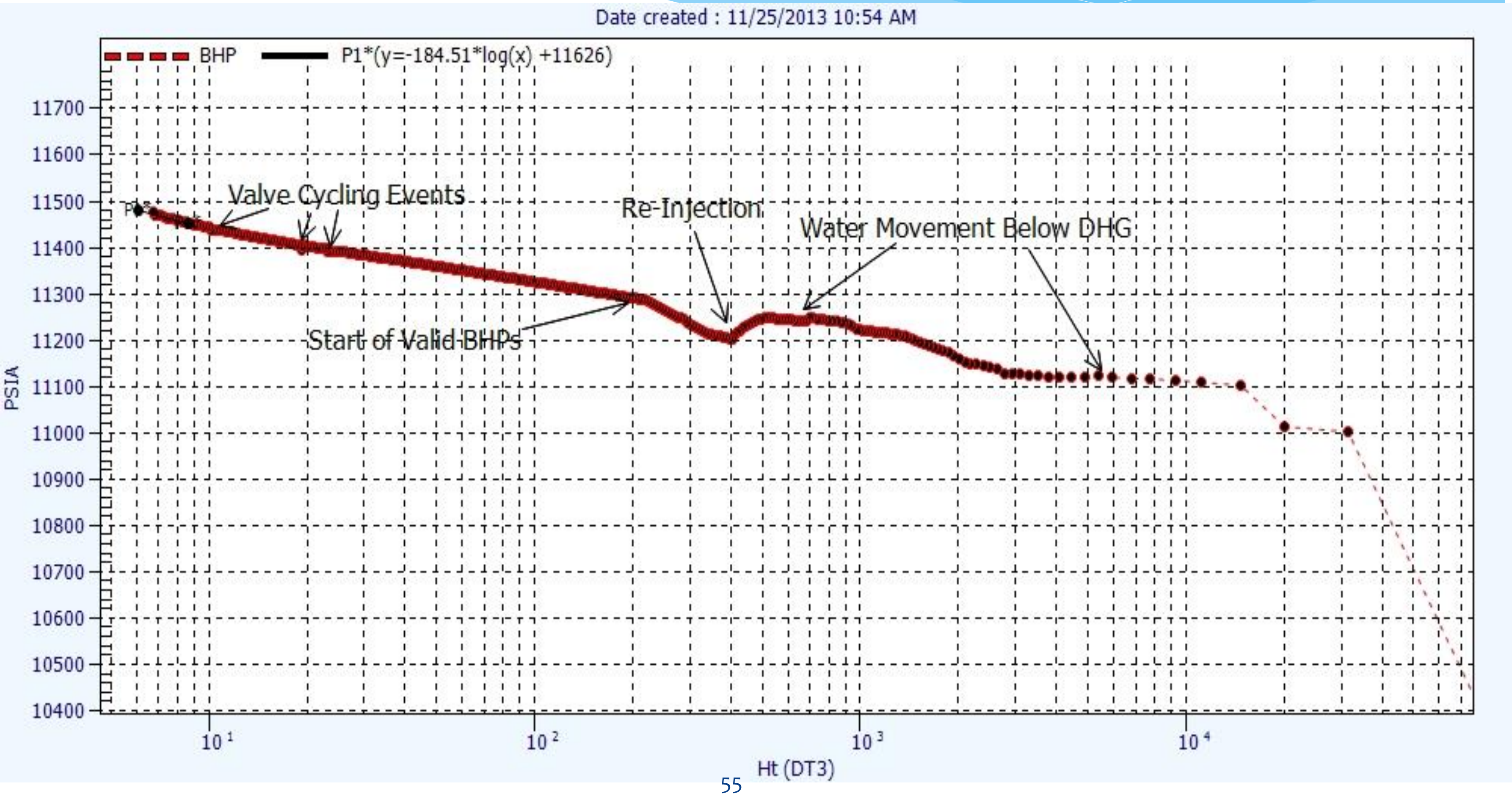


Drawdown - PTA

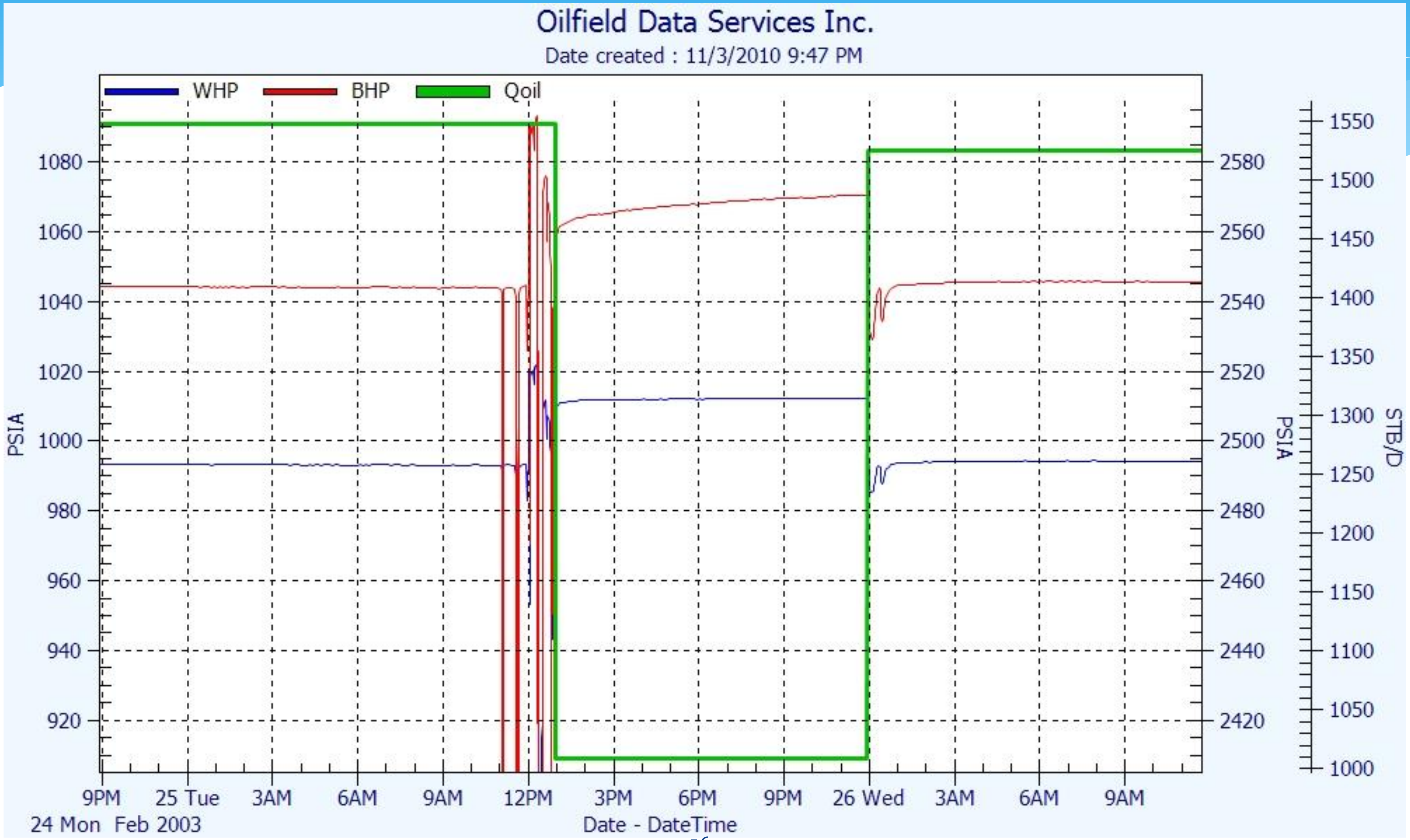
Drawdown PTA - Semilog Analysis



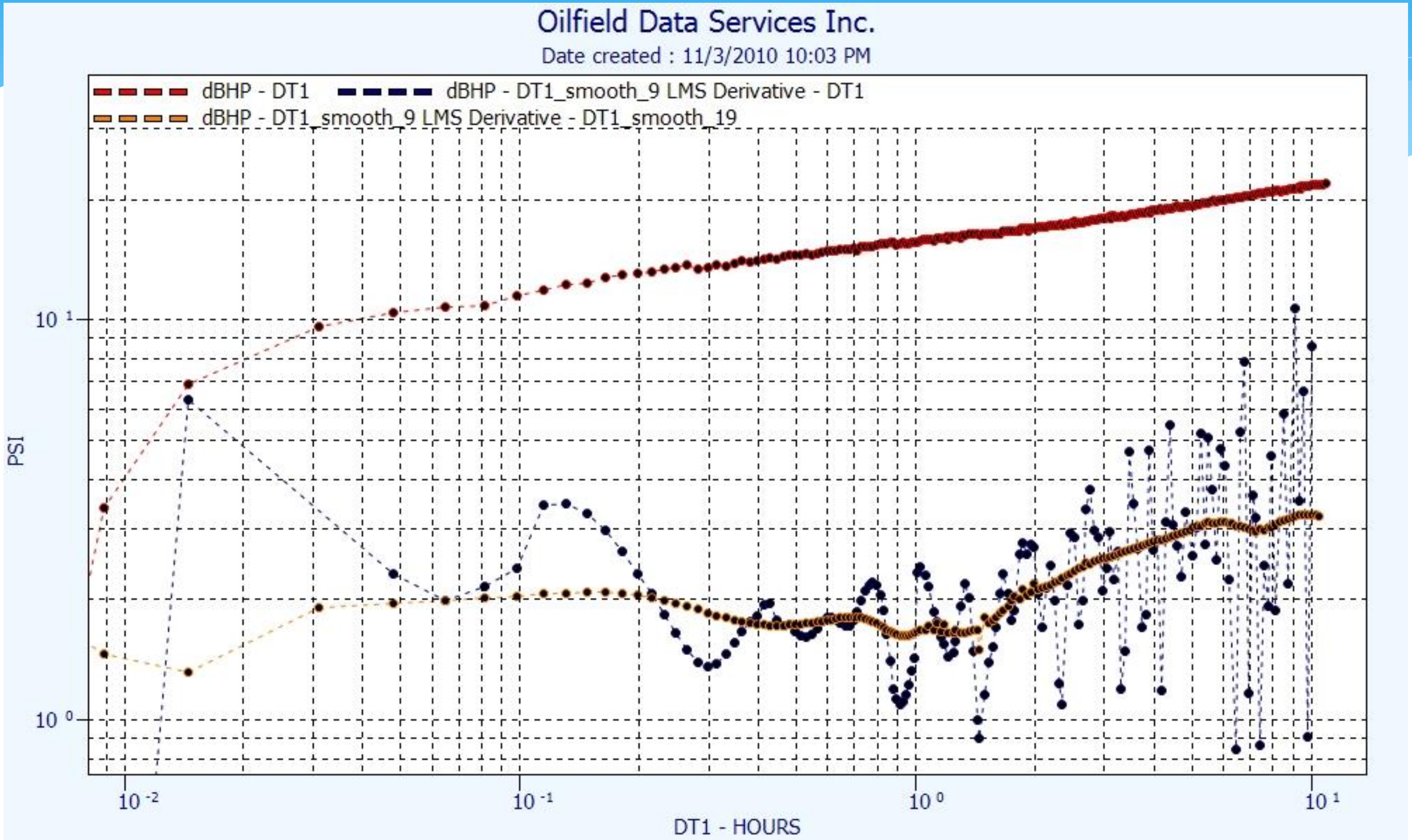
Horner Plot – P* Determination



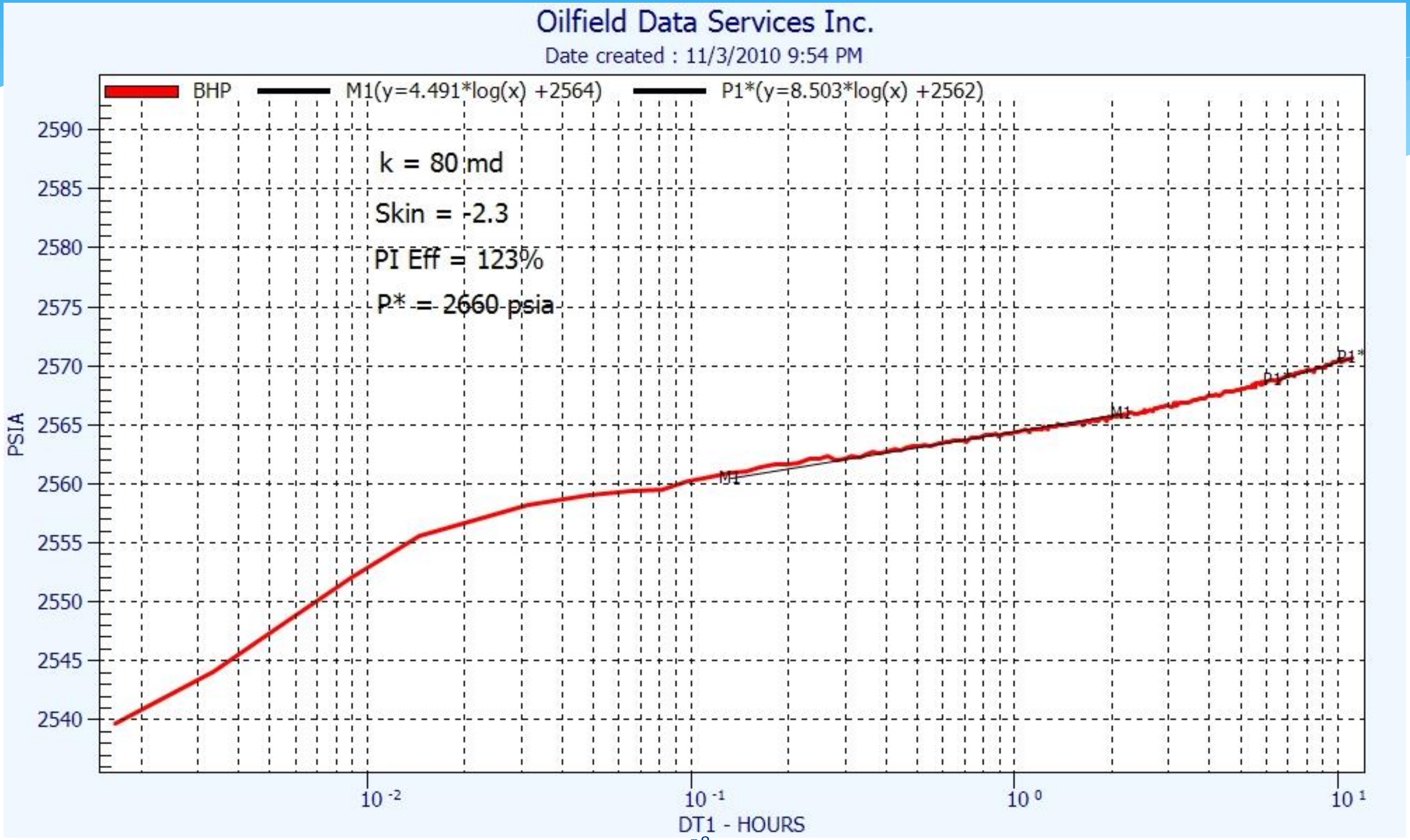
2-Rate Test (Esp. for Oil)



2-Rate Derivative (Oil)

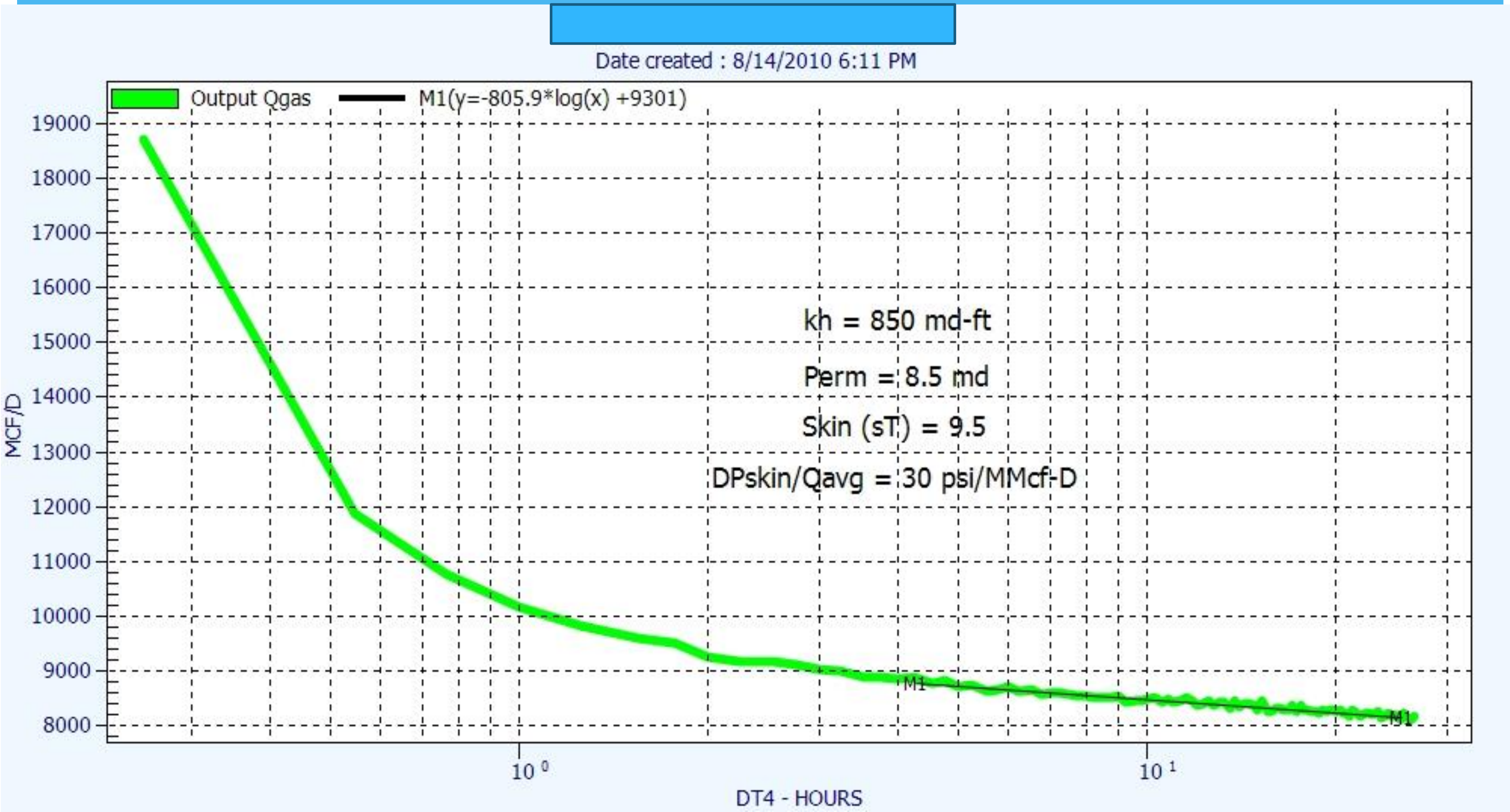


2-Rate Oil Semilog



RTA Example - Cartesian

RTA – Semi-log Analysis



Two Simple Bookends:
Applied to Static and Dynamic MBAL/EBAL

- **Expansion Drive Only (Compressibility Volume)**
  - **Vc**
- **Infinite Water Drive Only (Pushed Volume)**
  - **Vsld**

P/z & Static MBAL

- Static MBAL for Oil – Conventional & SLD
  - Conventional: N = Np * Boi/(Bo|Np – Boi)
  - SLD: N = Np*Pi/(Pi-P|Np)
- Static MBAL for Gas – Conventional & SLD
  - Conventional: G = Gp*Bgi/(Bg|Gp – Bgi)
  - SLD: G = Gp*Pi/(Pi-P|Gp)
- P/z for Gas: Plot P* vs Gp and P*/z vs Gp
  - SLD In-place = Intercept of P* slope at 15 psia
  - P*/z In-place = Intercept of P*/z slope at 15 psia

Where Bo|Np or Bg|Gp are FVFs at current Preservoir coincident with the produced hydrocarbon volume and P|Np or P|Gp are the current reservoir pressure

Conventional & TTA Decline

- **Conventional Decline Relates to Hydraulically Connected Volume**
  - **DP-DT Slope is the Conventional decline slope**

- **TTA Decline Relates to Mobile Volume**
  - **The TTA function is simply the relative inverse productivity: (P*initial*-P*wf*)/*Qspot***
  - ***Slope is the TTA-slope***

Conventional Decline Analysis

- ConVc = Qavg/(DP/DT-slope*Ct)

- $ConV_{SLD}$ = Qavg*Preservoir/(DP/DT-slope)

V_{SLD} and Vc = volume in units compatible with Qavg & DT, Qavg [=] average flow rate over the period where the DP/DT-slope is selected, DP/DT-slope is the decline in pressure per unit time [=] psi/day, and Ct is total system compressibility (1/psi).

TTA Decline Analysis

- $TTA|Vc = 1/(TTA\text{-}Slope * Ct)$

- $TTA|V_{SLD} = Preservoir/TTA\text{-}Slope$

TTA-Slope has units consistent with the stock-tank or standard condition rate units and pressures

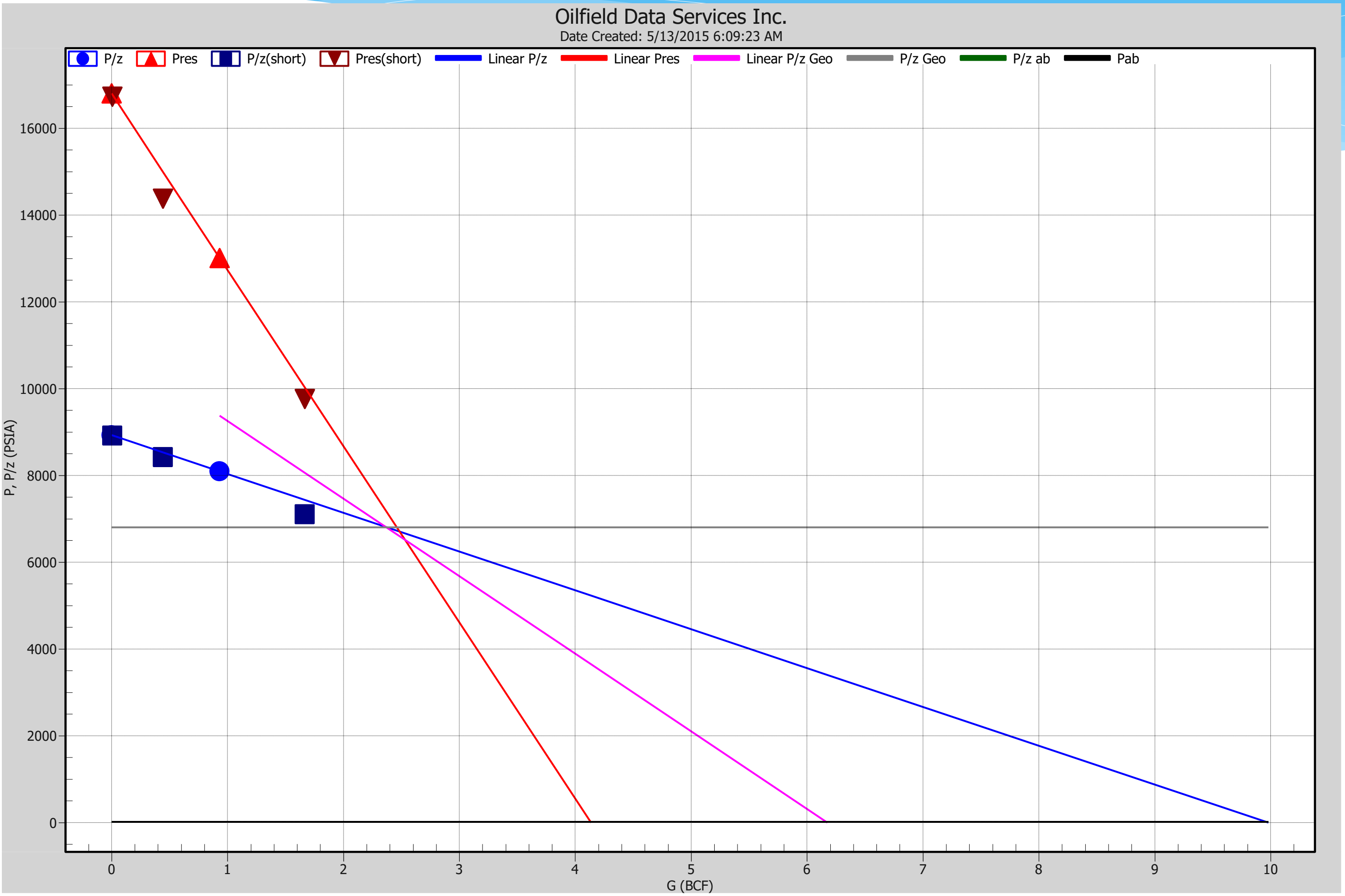
Six Values:

* Static MBAL (expansion) – In-place Energy
* Static MBAL (SLD) - Pushed In-Place Energy
* Conventional Vc – Hydraulically Connected Energy
* Conventional SLD – Pushed Hyd. Conn. NRG
* TTA Vc – Mobile Energy
* TTA SLD – Pushed Mobile Energy

Changes in these values Mean Something!!!

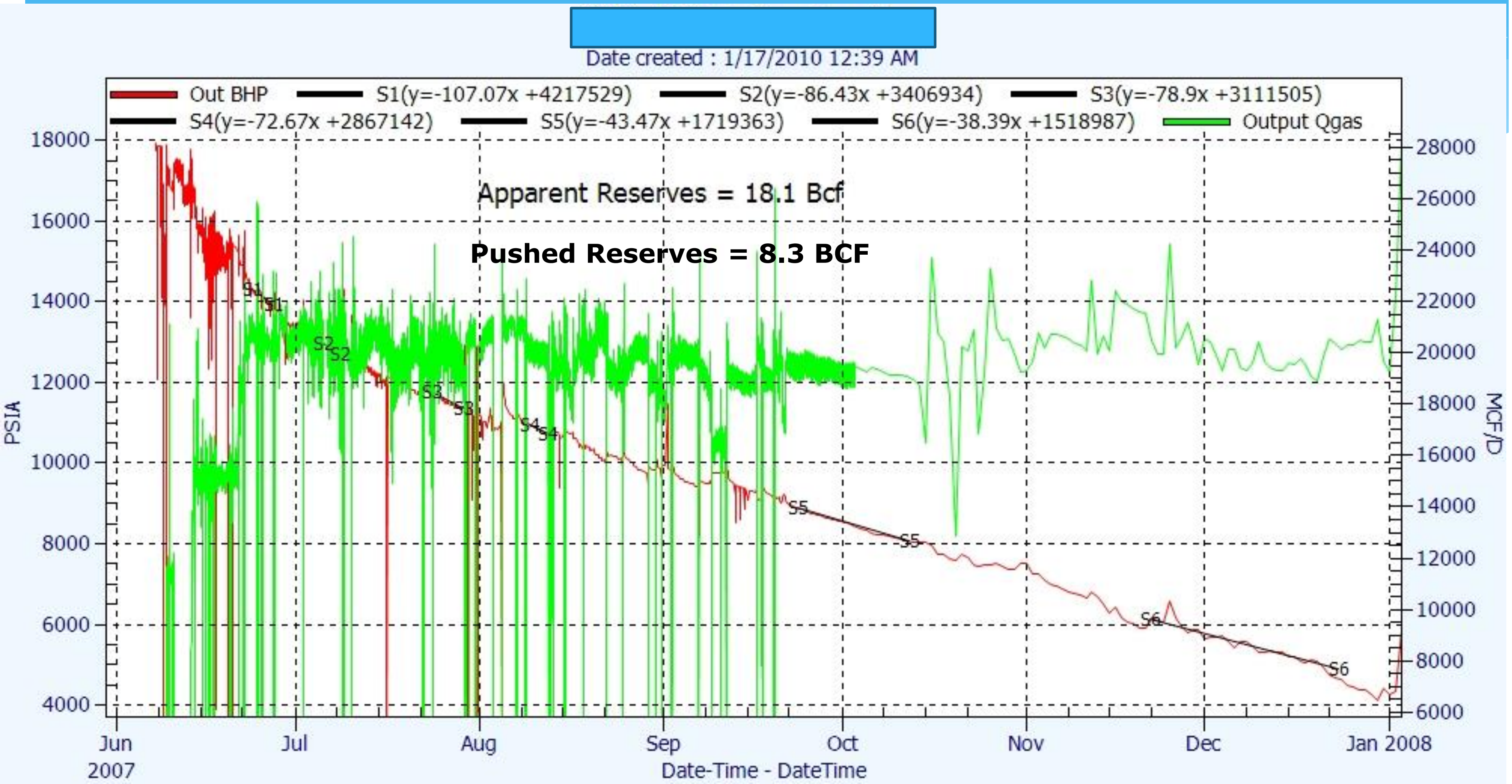
Production History for P/z

P/z Example

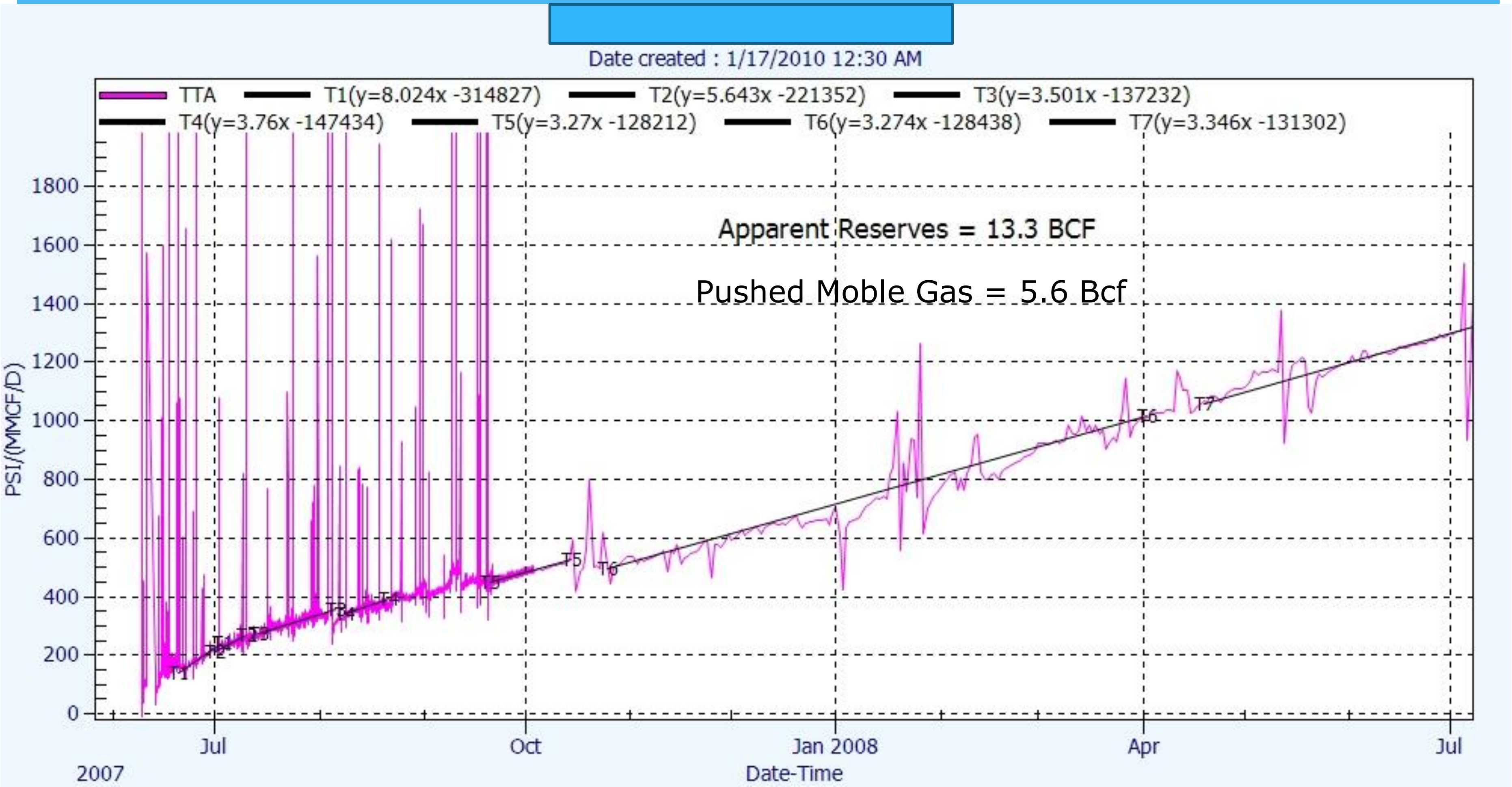


Oilfield Data Services Inc.
Date Created: 5/13/2015 6:09:23 AM
P/z
Pres
P/z(short)
Pres(short)
Linear P/z
Linear Pres
Linear P/z Geo
P/z Geo
P/z ab
Pab
P, P/z (PSIA)
16000
14000
12000
10000
8000
6000
4000
2000
0
0
1
2
3
4
5
6
7
8
9
10
G (BCF)

Conventional Decline Evaluation



TTA "Decline" Analysis



"Static" Nodal Analysis

* Compares Reservoir Inflow (IPC) with Wellbore Performance (VLP)
  * Allows Prediction of DP to achieve a Rate (vice versa)
  * Allows Prediction of Liquid Loading Scenarios
  * Allows Optimization of Tubular Design
* Problems with Nodal
  * Infinite # of combos of skin & perm calculate the same rate (Can't use nodal to determine skin or perm)
  * User has to pick the right inflow model and right VLP correlation
  * Doesn't handle transient situations well – may match your well today, but not next month

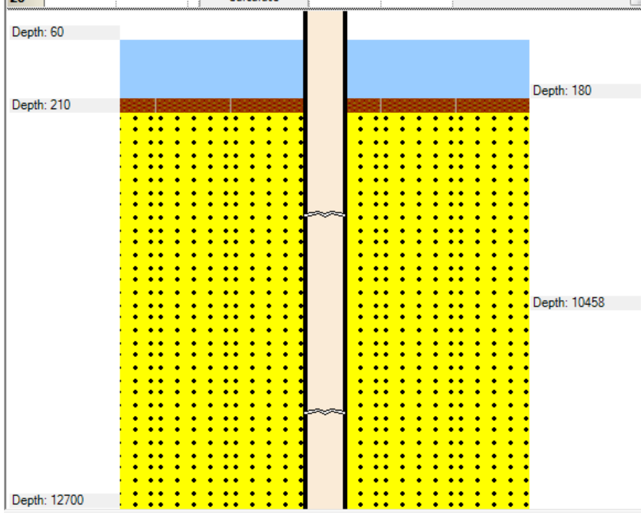
Nodal – IPC + VLP

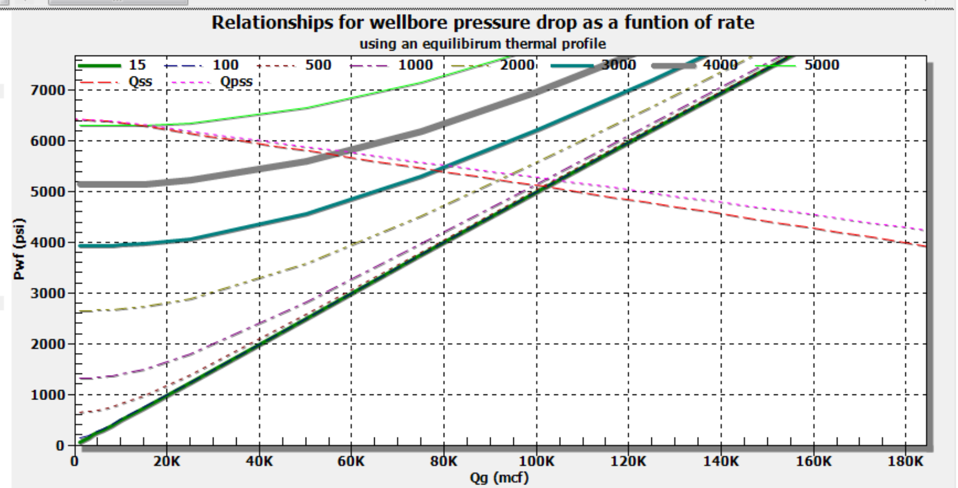
Jsers\ODSI\Desktop\April 15 2010\nodal out2.ProData - [WellboreDeliverabilityDialog]

File Memory Analysis Plot View Tools Help

	Gas Rate	WHP	C	Inflow	Inputs	Units
2	2000	100		PSTAR	6500	psi
3	3000	500		Max Pwf	6500	psi
4	4000	1000		Pwf Step	100	psi
5	5000	2000		Perm	10	md
6	6000	3000		Skin	-1.5	
7	7000	4000		D	.0000001	1/mcf
8	8000	5000		Time	24	Hours
9	10000			Radius Override	☐	
10	15000			Radius	0	ft
11	25000			rw	0.350	ft
12	50000			Net TVT Pay	120.0	ft
13	75000			Porosity	0.11	
14	100000			Sw	0.22	
15	125000			So	0.00	
16	150000			Sg	0.78	
17	175000			Cf	4.67	microsips
18	200000			Plot ?	☑ Qss	☑ Qpss
19	250000			WCD Pwf	4950	
20				Calculate		

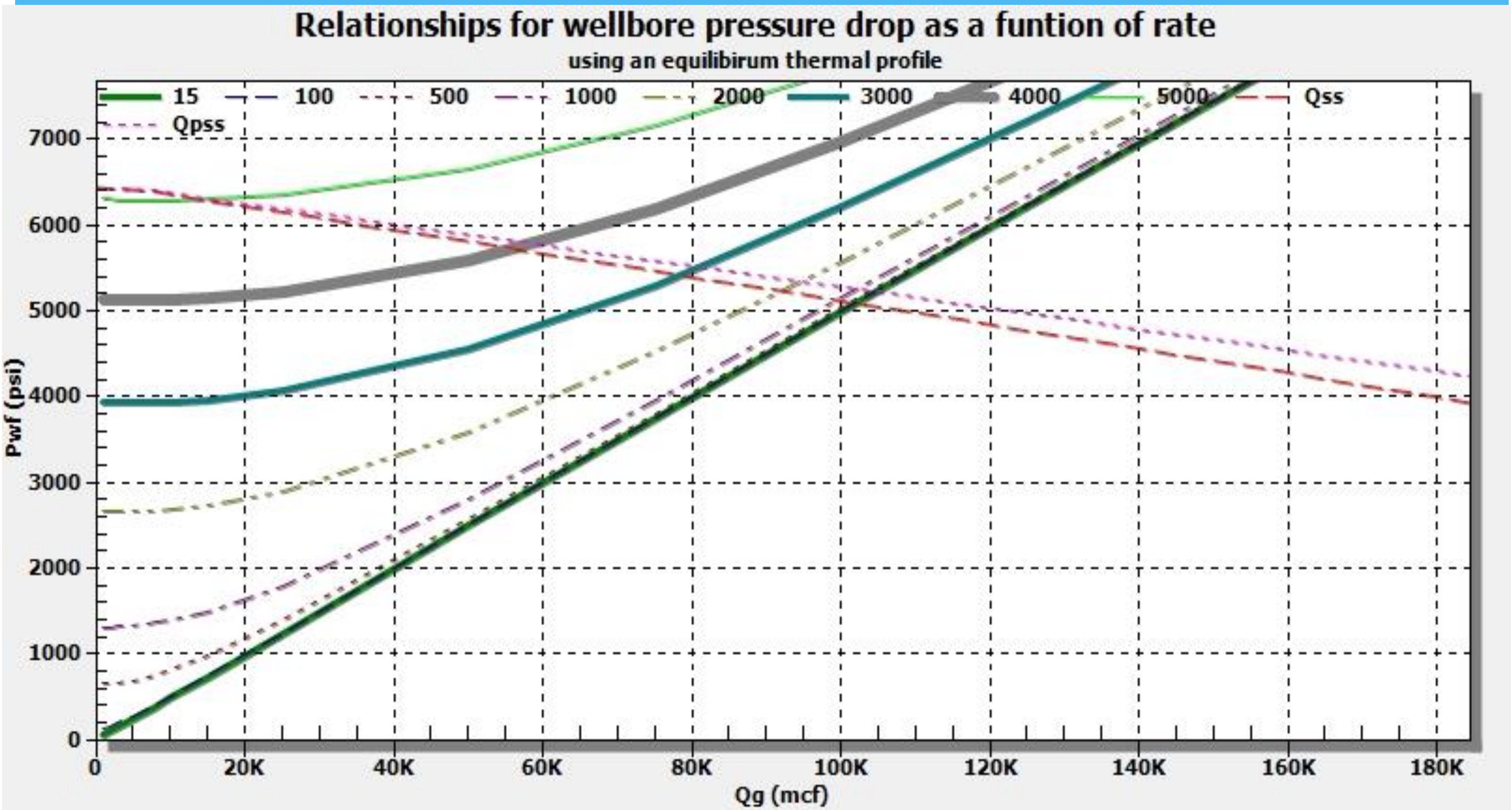
	100	500	1000	2000	3000	4000	5000	I	J	K	L	M
25000	1239.9	1393.3	1794.8	2892.1	4070.1	5230.4	6363.2					
50000	2500.0	2579.0	2812.0	3588.2	4563.2	5602.3	6658.5					
75000	3759.1	3810.6	3966.8	4530.4	5313.2	6210.0	7163.8					
100000	5000.7	5038.1	5153.0	5583.3	6217.2	6983.2	7830.9					
125000	6227.1	6256.1	6345.7	6688.4	7211.7	7867.9	8617.5					
150000	7449.3	7472.8	7545.4	7826.9	8266.8	8833.2	9496.2					
175000	8676.9	8696.4	8757.0	8993.7	9369.5	9862.5	10450.8					
200000	9862.5	9879.3	9931.5	10136.5	10465.2	10901.9	11430.0					
250000	12211.7	12224.7	12265.4	12426.1	12687.2	13039.9	13474.3					
Pwf	6400.0	6300.0	6200.0	6100.0	6000.0	5900.0	5800.0	5700.0	5600.0	5500.0	5400.0	5300.0
Qss	7294.4	14587.5	21878.7	29167.3	36452.6	43733.7	51009.9	58280.2	65543.6	72799.2	80045.8	87282.3
Qpss	8252.4	16504.2	24754.7	33003.2	41248.8	49490.7	57728.0	65959.6	74184.5	82401.6	90609.7	98807.5
Pavg	6449.9	6399.5	6348.8	6297.9	6246.7	6195.2	6143.4	6091.2	6038.8	5986.1	5933.0	5879.6
r	1008.1	1004.0	999.9	995.8	991.6	987.3	983.1	978.8	974.4	970.0	965.6	961.1
mu	0.028	0.028	0.028	0.028	0.028	0.027	0.027	0.027	0.027	0.027	0.027	0.027
B	0.642	0.645	0.648	0.652	0.655	0.658	0.662	0.665	0.669	0.673	0.677	0.681
eta	10585.865	10500.499	10414.714	10328.504	10241.863	10154.787	10067.268	9979.300	9890.876	9801.990	9712.633	9622.798





Ready

Nodal VLP-IPC Plot



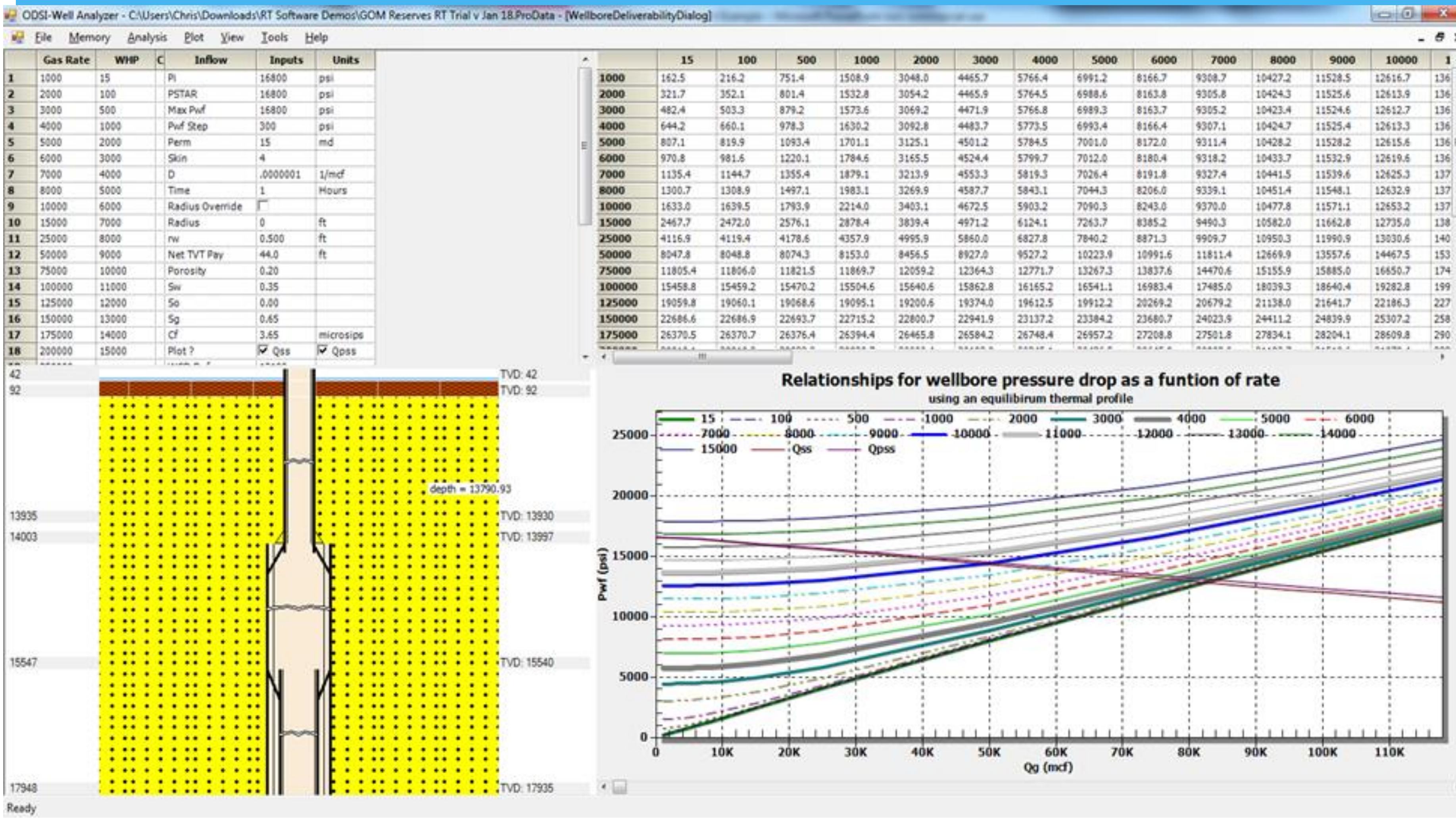
Transient Nodal Analysis Tool

* Keep track of changing produced fluid composition
* Update skin & perm from last valid PTA
* Update P* from last valid PBU
* Keep track of pressure decay during drawdown
  * Adjust Preservoir while producing
  * Use Transient Inflow model when in transient flow
  * Use Appropriate Steady State Inflow model when in SS Flow
* Link Reservoir Simulator to Wellbore Model

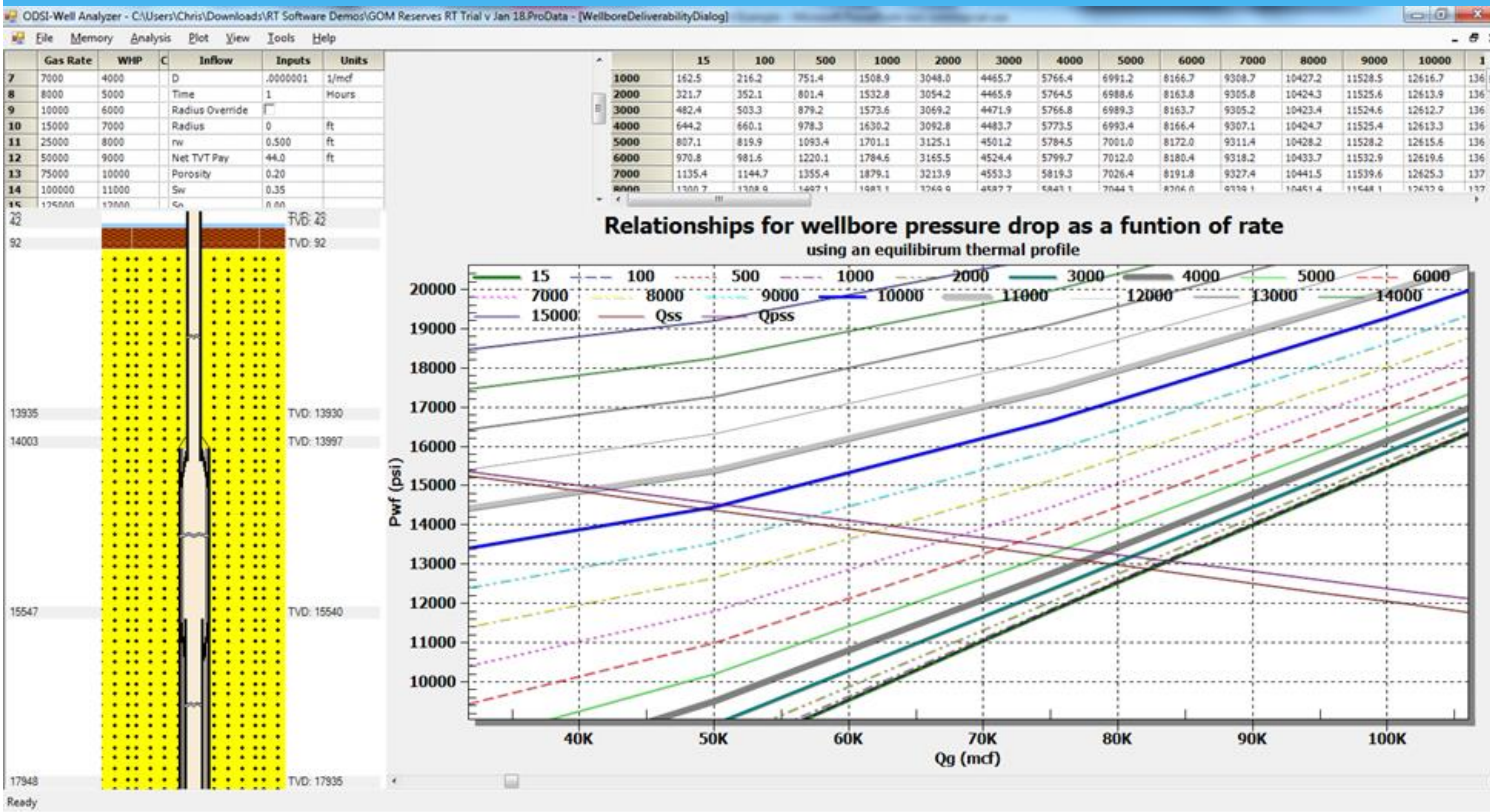
Transient Nodal Initiation

* Preservoir, Treservoir
* Skin (s & D) & Perm from Flowback PTA
* Wellbore Radius and Net TVT pay
* Fluid PVT
* Well Configuration/Geometry
* Petro-physical inputs
  * Sw, porosity, formation compressibility
* Forced Fixed Reservoir Volume or Floating Reservoir Volume
* Production Time Since last Valid P*/Pres

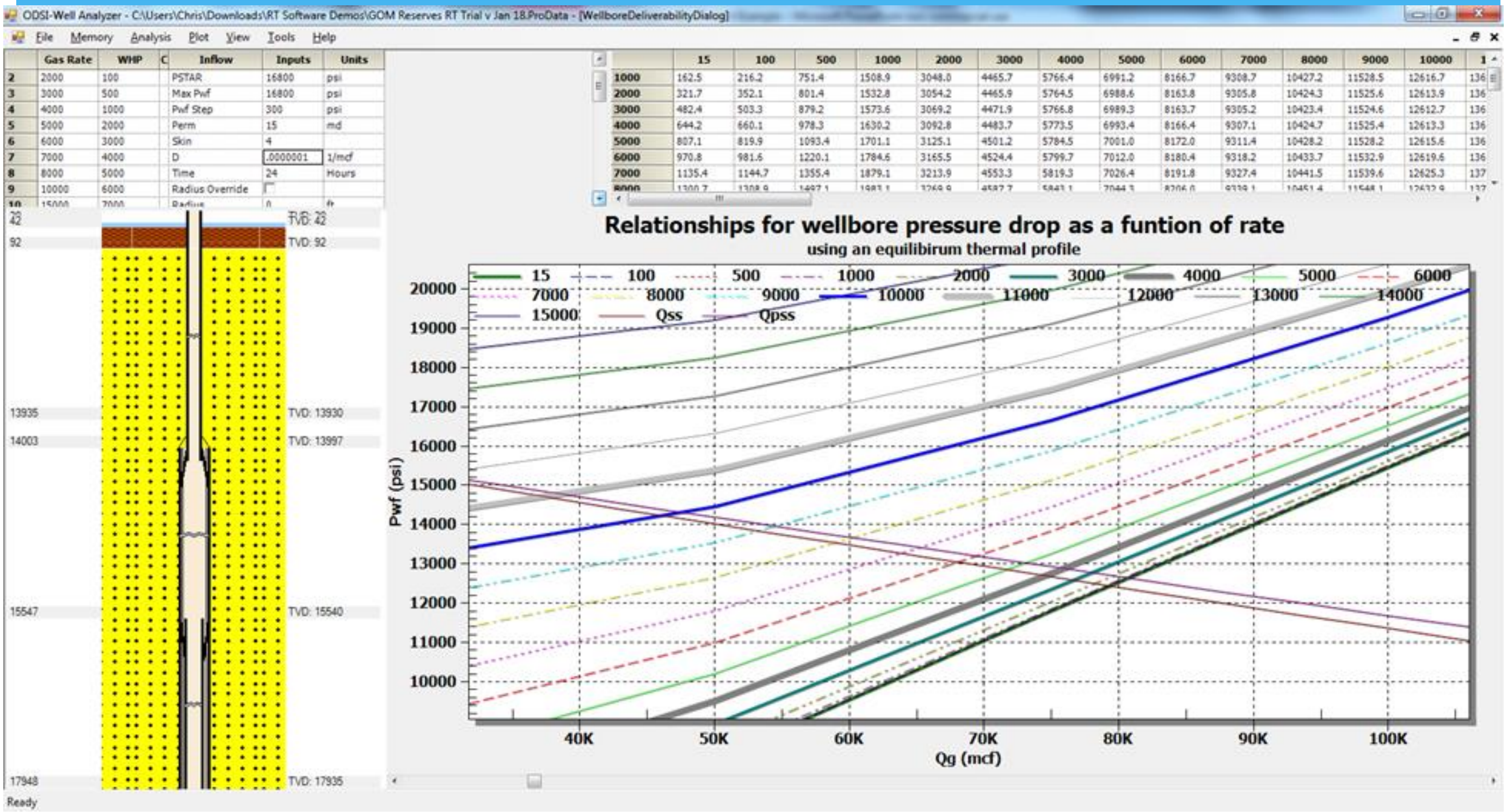
Nodal Initiation Run



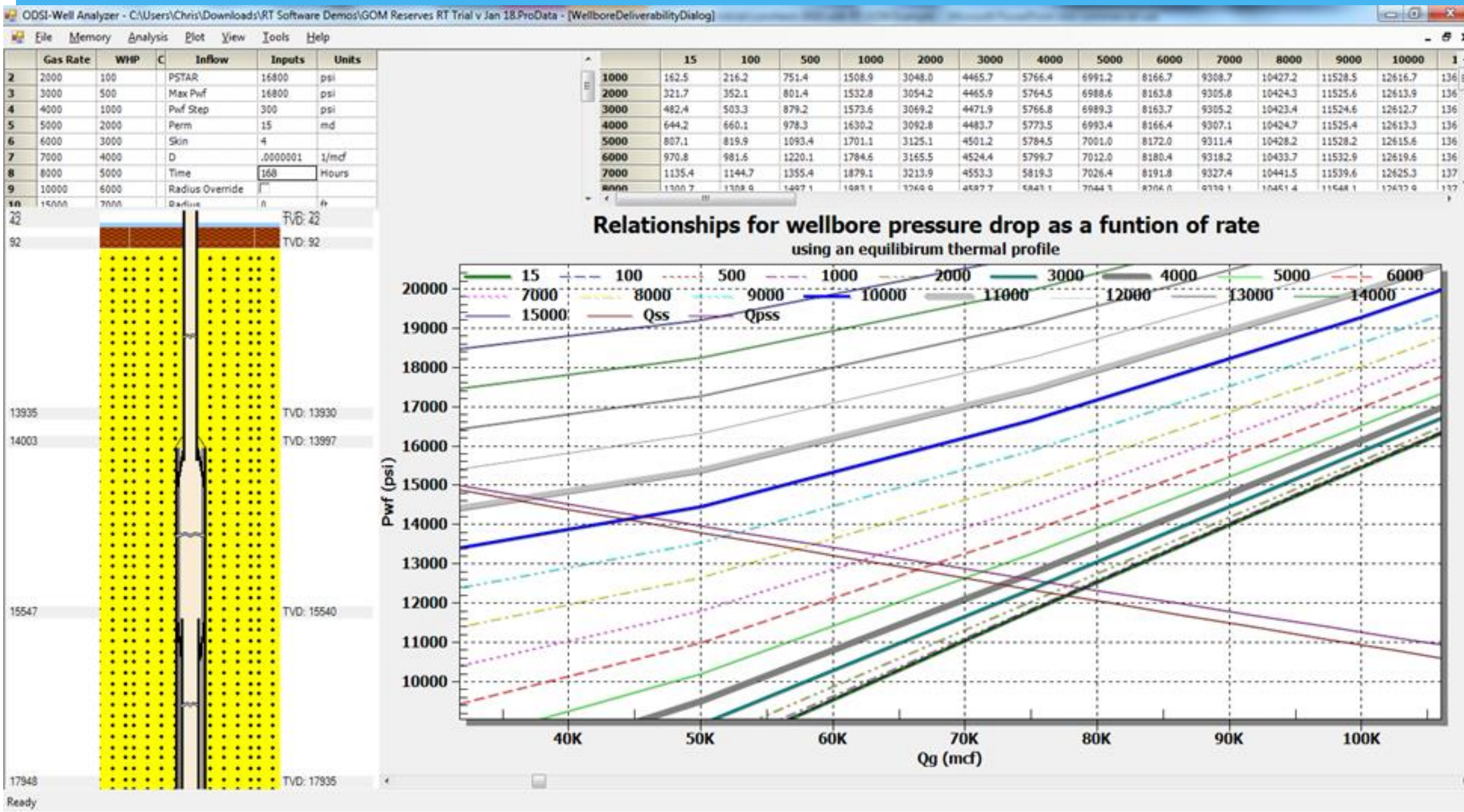
Inflow and VLP for Tp = 1 hour



Inflow and VLP for Tp = 24 hours



Inflow and VLP for Tp = 168 hours



	Gas Rate	WHP	C	Inflow	Inputs	Units
2	2000	100		PSTAR	16800	psi
3	3000	500		Max Pwf	16800	psi
4	4000	1000		Pwf Step	300	psi
5	5000	2000		Perm	15	md
6	6000	3000		Skin	4	
7	7000	4000		D	.0000001	1/mcf
8	8000	5000		Time	168	Hours
9	10000	6000		Radius Override		
10	15000	7000		Radius	0	ft

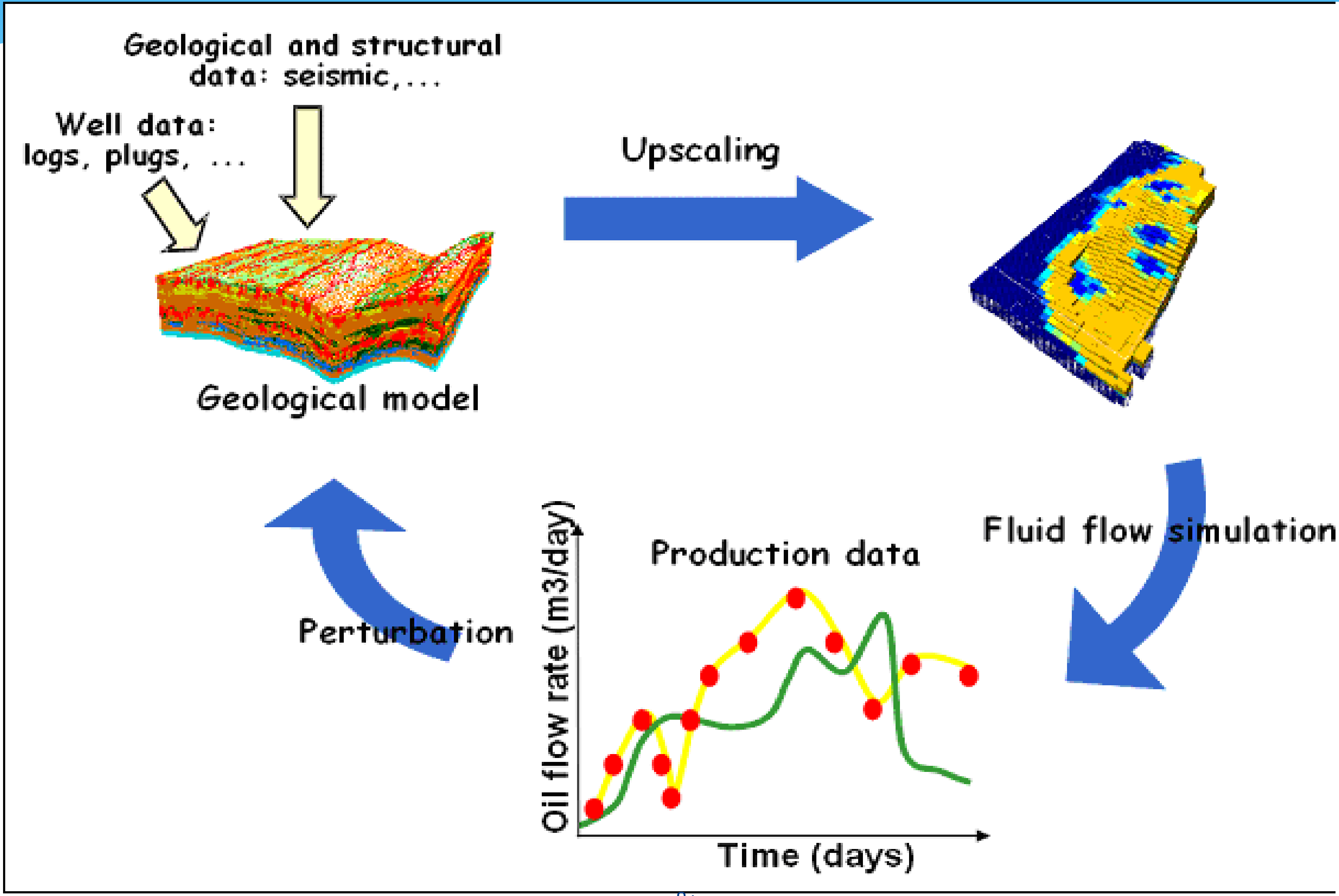
	15	100	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	1
1000	162.5	216.2	751.4	1508.9	3048.0	4465.7	5766.4	6991.2	8166.7	9308.7	10427.2	11528.5	12616.7	136
2000	321.7	352.1	801.4	1532.8	3054.2	4465.9	5764.5	6988.6	8163.8	9305.8	10424.3	11525.6	12613.9	136
3000	482.4	503.3	879.2	1573.6	3069.2	4471.9	5766.8	6989.3	8163.7	9305.2	10423.4	11524.6	12612.7	136
4000	644.2	660.1	978.3	1630.2	3092.8	4483.7	5773.5	6993.4	8166.4	9307.1	10424.7	11525.4	12613.3	136
5000	807.1	819.9	1093.4	1701.1	3125.1	4501.2	5784.5	7001.0	8172.0	9311.4	10428.2	11528.2	12615.6	136
6000	970.8	981.6	1220.1	1784.6	3165.5	4524.4	5799.7	7012.0	8180.4	9318.2	10433.7	11532.9	12619.6	136
7000	1135.4	1144.7	1355.4	1879.1	3213.9	4553.3	5819.3	7026.4	8191.8	9327.4	10441.5	11539.6	12625.3	137
8000	1300.7	1308.9	1497.1	1983.1	3269.9	4587.7	5843.1	7044.3	8206.0	9339.1	10451.4	11548.1	12632.9	137

Reservoir Simulation

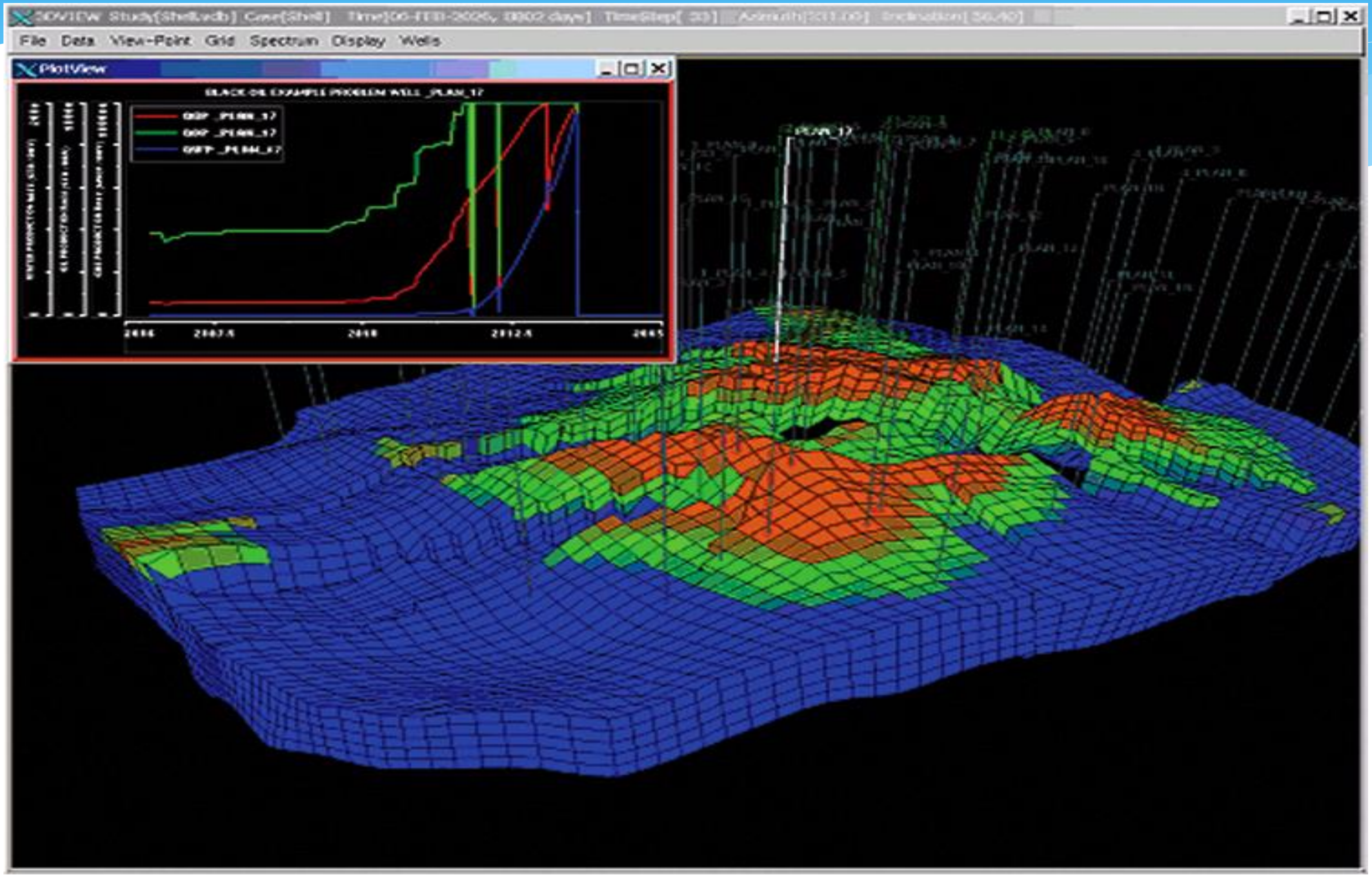
* Tracks behavior (esp Pressure and Saturation) in the reservoir
* Incorporates Multiple Wells/Multiple Zones
* Matches History and Attempts to Predict Future Performance
* Coupled with a Wellbore Simulator, can do amazing things

* Drawback: It takes a while to run… but they're getting faster

Simulation Gist…



Simulation: Well Grid



Simulator Prediction vs Actual

Simulator Prediction vs Actual - Semilog

Simulation Drawbacks

* Treats system as a tank model
  * OK for High-perm, not so good for low-perm
* Works best in SS or PSS flow (poor for transient)
* Doesn't handle discontinuities very well
* Subject to "gaming"

* Best Case Scenario: The History Match Quality is the BEST the future predictions will be…

Components of a Real-Time Well Evaluation Package

Take all the bits and Bolt them together

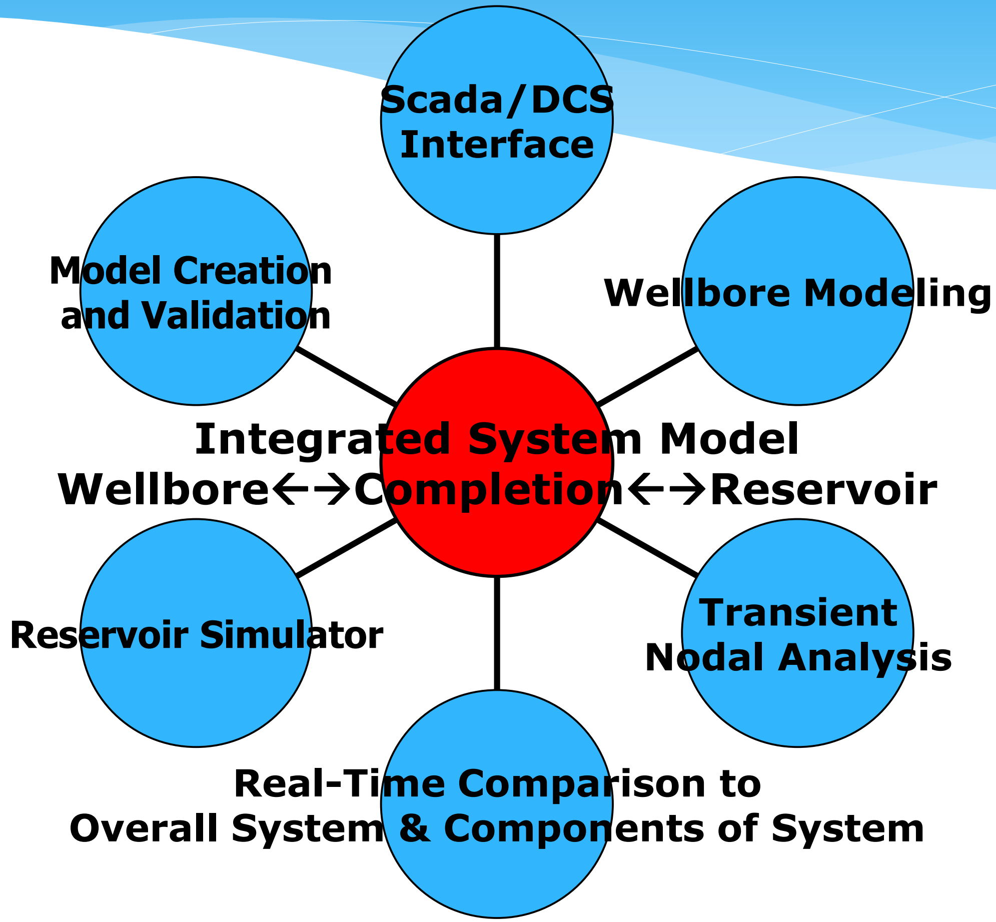
What Do We Already Have? (Batch Process)

* Hopefully… adequate data frequency and quality
* PTA/RTA Package
* "Snapshot" VLP
* "Snapshot" Inflow
* Reservoir Simulation Tool
* Wellbore Model
* Geologic/Geo-Physical Model
* Enough Well History?

What Do We Need to Make it Real-Time?

* Link to RT Data (w/Validation of Data)
* Closed-Loop Wellbore Solution (w/Thermal Modeling)
* Closed-Loop Completion Solution - Can incorporate w/Reservoir Model
* Closed-Loop Reservoir Model
* Transient Recognition
* Boundary Recognition
* Regime Recognition
* Prediction vs. Actual Comparison
* Engineering by Difference (Did anything Change?)

ODSI Windows Service: The Bits…



Closed-Loop WB Components

* Wellbore Thermal Modeling (Warming/Cooling)
* Liquid Drop Out (Build-ups)
* Liquid Surge (Start-up)
* Phase Behaviour EOS Calcs
  * Use SRK or PR w/Peneloux
* Rate Modeling
  * Residence Time
  * Rate Surging & Decay
* Coupled Effects (Rate-Thermal-Phase)

Developing Thermal/PVT Models

* Run Static Temp/Pressure Survey
* Run Flowing Temp/Pressure Survey
  * Multiple Rates
* Develop Heat Transfer Model – Account for:
  * Heat Capacity of Fluids/Tubulars/Annuli/Sinks
  * Heat X-fer via Conduction
  * Heat X-fer via Convection
  * Heat X-fer via Forced Convection
* Can Tune PVT using same data… just get a good sample first

Bernoulli Solution Process

Build Parametric Models & Well Configuration

↓

Assume Continuity

↓

Solve Bernoulli (MEB)

↓

Check Continuity

Note: If Continuity Doesn't Hold, the Well is Loading–up (which is important to know)

Continuity Equation

$$\frac{\partial \rho}{\partial t} = -(\nabla \bullet \rho v)$$

* Rate of Change in Density Caused by Changes in Mass Flux

Differential Form of Bernoulli Eqn Compressible Conditions

$$\Delta \tfrac{1}{2}(v)^2 + g\Delta h + \int_{p1}^{p2} dp/\rho + Ws +$$

$$\sum_i \left(\tfrac{1}{2} v^2 \tfrac{L}{R_h} f\right)_i + \sum_i \left(\tfrac{1}{2} v^2 e_v\right)_i = 0$$

Mechanical Energy Balance (Bernoulli Equation)

* For Single-Phase Gas Flow in Pipes, the MEB reduces to:

$$dp/\rho = -(g \sin \theta/g_c + 2f_f\, u^2/g_c\, D)\, dL$$

* Basis for CS, Gray & A-C

Bernoulli for Single Phase Oil Incompressible Conditions

$$\frac{dp}{d\rho} + \frac{v\,dv}{g_c} + \frac{g}{g_c}dz + \frac{2 f_f v^2 dL}{g_c D} + dW_s = 0$$

- Basis for Hagedorn-Brown & Beggs/Brill

Simplification of Flow-in-Pipe Eqns

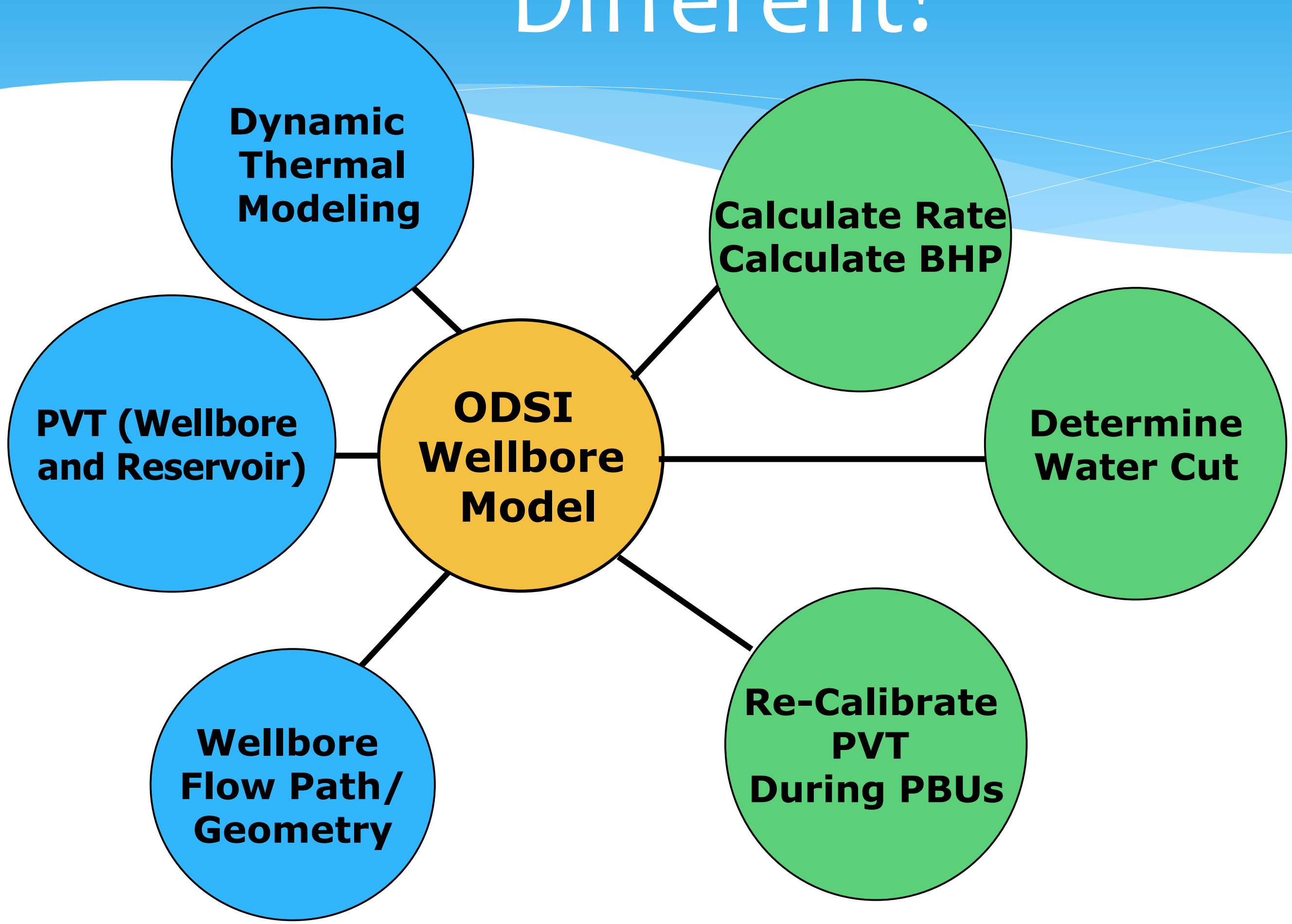
* Conceptually, these Equations are simply:

BHP = Gauge P + ΔP(gravity) + ΔP(friction)

Using a Direct Bernoulli Solution for WB

* Works for Oil, Gas or Water (Continuity)
* Gas
  * Have DP, solve for rate & BHP
  * Have Rate, solve for DP & BHP
* Oil
  * Have DP, solve for Water cut & BHP
  * Sometimes possible to solve for rate (high rate)
* Much Easier to Apply Parametric Models Continuously:
  * Thermal Transients
  * Rate Transients
  * Phase Transients
  * Coupled Rate & Thermal Transients

What Makes ODSI's Wellbore Model Different?



Completion Modeling

* Reconcile Well Geometry (frac, horizontal, etc.) with base inflow
  * Multiple Layers?
  * Build "skin" model (easiest way if it works)
* Reconcile Completion/Reservoir Interaction
  * Partial Perforation/Penetration
  * Pay Loss/Growth
  * Near Well Stresses – Elasto-Plastic Rock
* True "Afterflow" vs. Terminal Velocity Flow

Closed-Loop Reservoir Solution

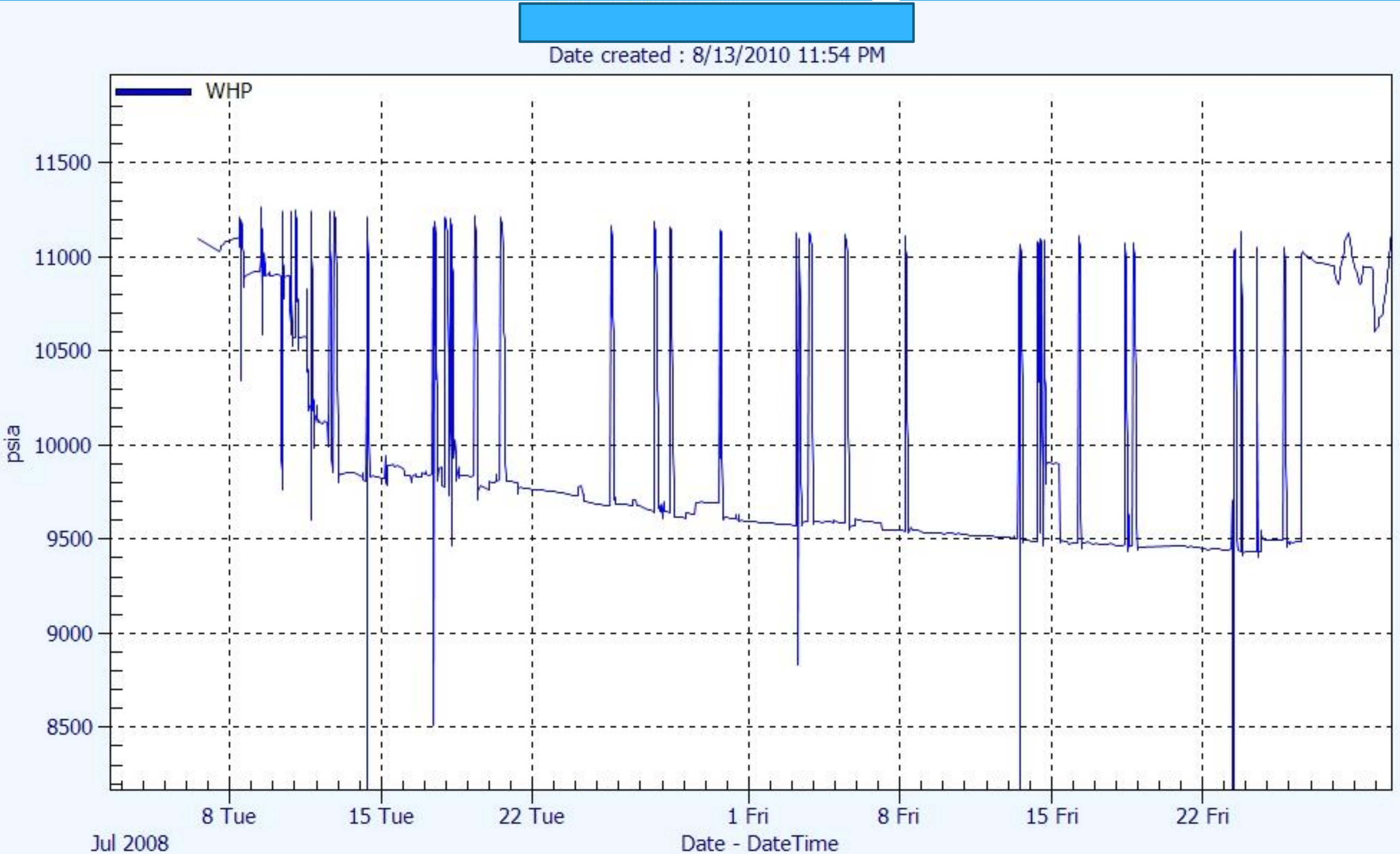
- Use "Static Reservoir Model" as input
- Use Transient Reservoir model when in transient flow
- Use Steady-State Reservoir model in SS flow
- Use Transient Recognition to "bob & weave"

- Objective: Run very quickly & get close
- Recognize if there's a problem with the "static" model

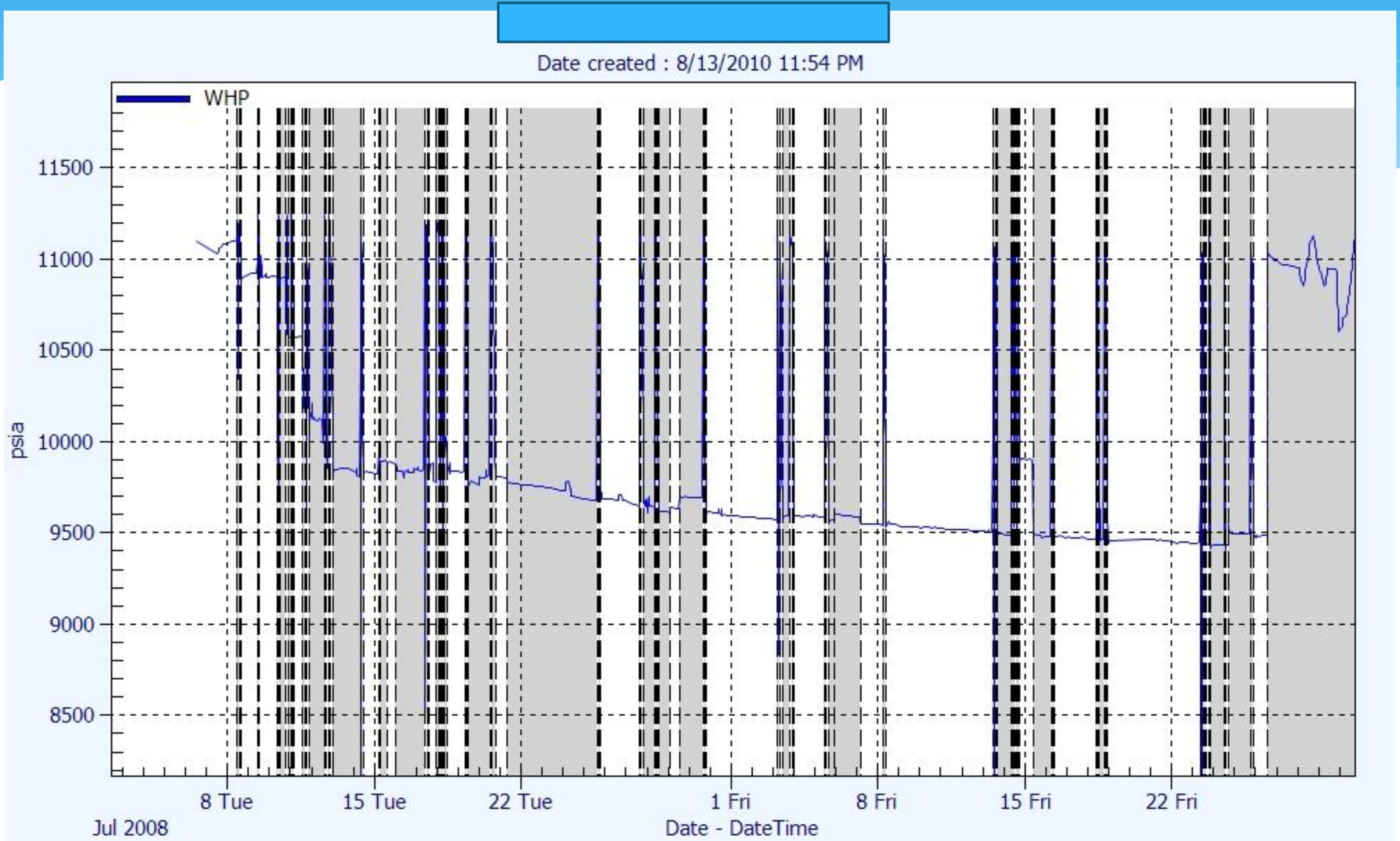
Transient and Regime Recognition

* Locate New Transients
  * Rate goes to zero, Rate stops being zero
  * Rate changes enough to start new transient
  * Pressure Methods
    * Wavelets
    * De-convolution Variance
    * DP Logic
* Banded Response Recognition
  * Transient vs. Steady-State
  * Boundary Recognition
  * Transition Recognition

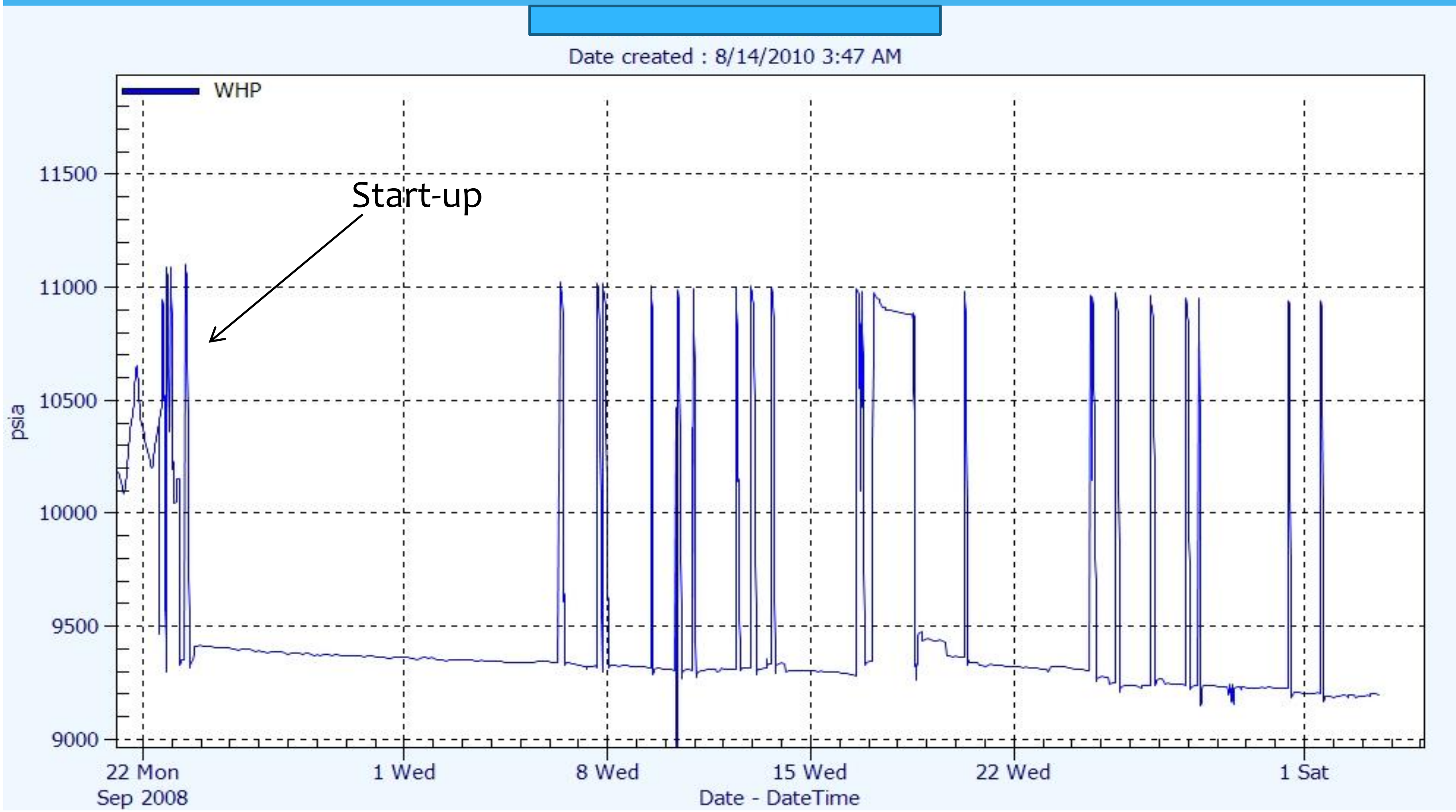
Transient Recognition



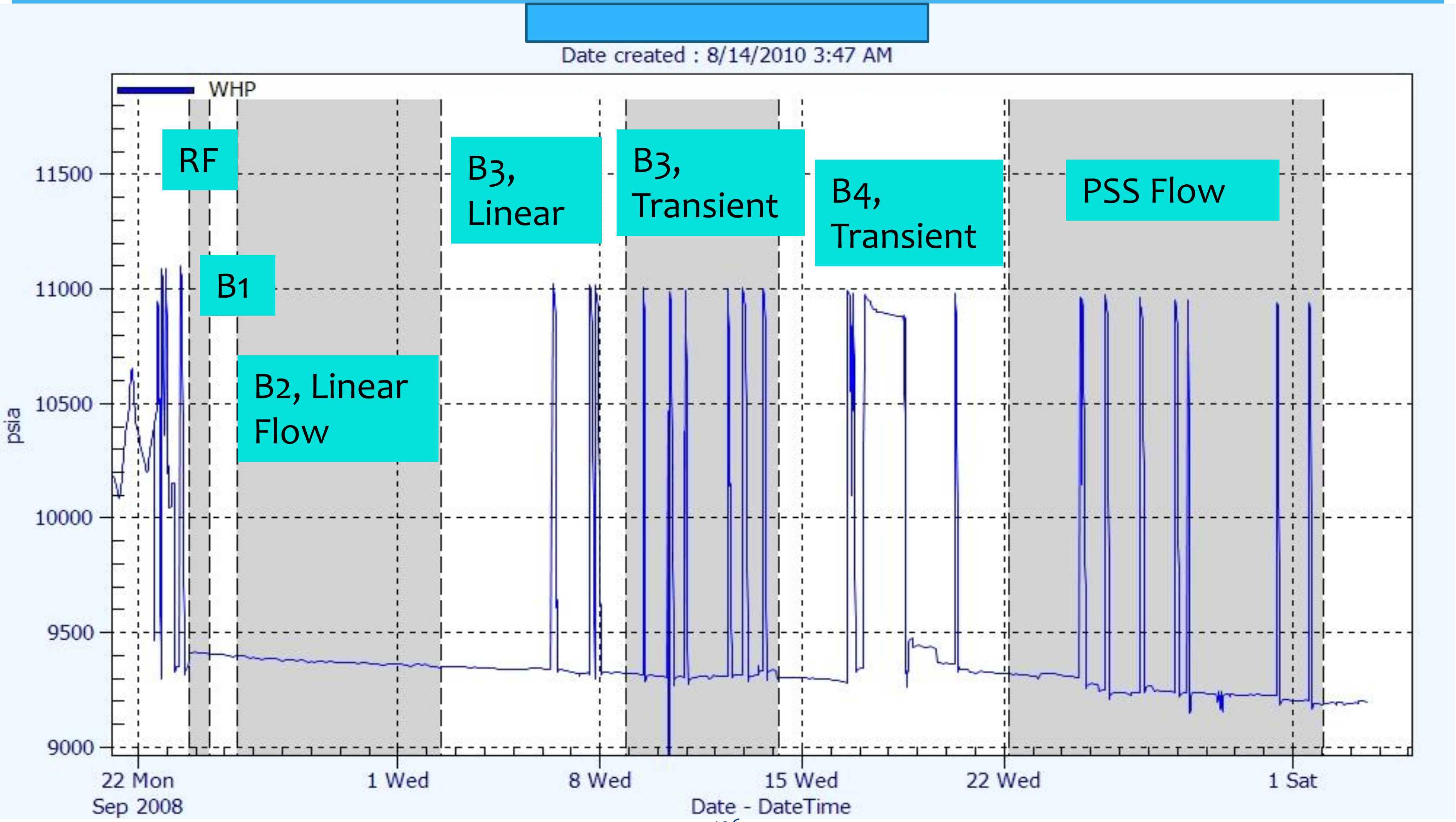
Transient Recognition



Boundary/Regime Recognition



Boundary/Regime Recognition



Methodology

* Start with most valid pressure measurement point
* Use Measured, Calculated or Inferred Rate
* Work the Mech NRG solution to WHP and mid-completion BHP
* Employ Complex Completion Model if Required
* Use Banded Energy Solution, along with Transient/Regime Recognition to determine Reservoir Inflow in both Transient and Steady-State Flow
* Bob & Weave – incorporate changes in Reservoir Model as it changes (i.e. Moving Water Contact)
* Keep track of the important stuff & Warn PE's when something goes wrong!

Translation Back to Customary Views

- Present the Results in a way that folks are used to…

  …or at least in terms they are accustomed to
- Well Test Analysis Results
- Productivity Tracking
- In-Place, Hydraulically Connected, and Mobile Hydrocarbon Volumes
- Reservoir Map (Energy Equivalent Map)
- Nodal Plots (Snapshots as function of time)
  - Includes Dynamic WBM & Res Inflow Model

Strategies for Dealing with RT Data/Analysis

* Make sure that predictions match actual well behavior
* Look for changes!
  * Perm
  * Skin
  * Apparent Volumes
* Let the well tell you – don't impose models on the well!
* Look for changes in the rate of change

Real-Time Data Strategies

* Spend time looking for results, not just digging for data
* Validate the results; only analyze manually if you disagree… or if it's important enough to spend time on
* Think about what the results mean
* Think about how this meaning affects your decisions

If you know how much money you have left in the ground and understand the well history, you'll make better decisions

Automated Processing Case Studies

Case Studies List

* North Sea #1 – Rate Calculations
* HPHT GOM Well Test Gas-Condy (DOT)
* Fizzy Oil – GOM Oil well Start-up
* NordZee – Gas Well Start-up
* Deepwater GOM Oil – Onset of Water?
  * Calculated Oil-Water Splits
* HPHT GOM Shelf Start-up

North Sea #1 – Gas Well

* Start-up of new gas field (Subsea Trees)
* Well Tests have a lot of variance
* MDTs and PVT indicate same fluid in all zones

* Objectives:
  * Explain differences in the well test analyses
  * Confirm that calculated rates match measured rates

North Sea #1 WBD

RT/T.H. : **75,4 m.**
COMPLETION DATE : MAY/20

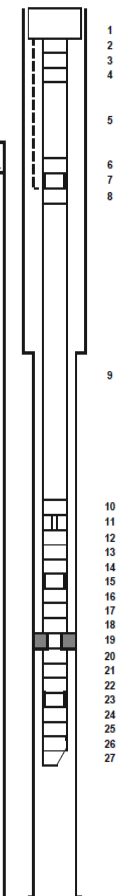
ANNULUS FLUID : CACL2 SG 1,23
INHIBITED CACL2 BRINE SG 1,23

VOLUMES		DRILLING DEPTHS / RT
TUBING VOLUME	25,87 M3	TOL 7" LINER HANGER :3333,0 mRT
LINER VOLUME	3,1 M3	
		TRSCSSV volume 9000-->0 psi = 100 cc

SUB SEA X-MAS TREE 10K API / 10,000 psi rated working pressure

TUBING HEAD	CAMERON 4"1/16 10,000 PSI
TUBING HANGER	CAMERON 13"5/8 X 4,5" VAM TOP 13% CR W/ 3,925" SRP PROFILE 10,395ACME
L MASTER VALVE	CAMERON 4"1/16 10K API HAND GATEVALVE
U MASTER VALVE	CAMERON 4"1/16 10K API ACTUATOR GATEVALVE
SWAB VALVE	CAMERON 4"1/16 10K API HAND GATEVALVE
FLOW WING VALVE	CAMERON 4"1/16 10K API ACTUATOR GATEVALVE
TOP CAP	CAMERON 6"1/2 NOMINAL STUB ACME

		STRING	length of item	To bottom of item: origin tbg. head adapter		Original
			Length	Depth	ID"	Drift SL
ITEM	QTY	DESIGNATION (all length to bottom)	m.	mTH.	inches	inches
1	1	CAMERON TBG. HANGER 13"5/8 X 4. 5" VAM TOP	0.00	0.00	**3,925"**	3,900"
		WEATHERFORD PACK-OFF STRADDLE INSTALLED		0.00	**2,500"**	
2	1	PUP JOINT PINxPIN 4"1/2 VAM TOP 12.6# L80 13%Cr	1.47	1.47	3,958"	3,900"
3	1	PUP JOINT (SPACE-OUT) 4"1/2 VAM TOP 12.6# L80 13%Cr	1.43	2.90	3,958"	3,900"
4	1	PUP JOINT (SPACE-OUT) 4"1/2 VAM TOP 12.6# L80 13%Cr	2.92	5.82	3,958"	3,900"
				5.82		3,900"
				5.82		3,900"
5	4	TUBINGS 4"1/2 VAM TOP 12.6# L80 13%CR (RANGE-3)	48.63	54.45	3,958"	3,900"
6	1	PUP JOINT 4"1/2 VAM TOP 12.6# L80 13%Cr	1.92	56.37	3,958"	3,900"
7	1	**Halliburton SP-1 TRSCSSV**	2.36	58.73	**3,81"**	
8	1	PUP JOINT 4"1/2 VAM TOP 12.6# L80 13%Cr	1.44	60.17	3,958"	3.833
				60.17		Drift
				60.17		Nylon
9	257	TUBINGS 4"1/2 VAM TOP 12.6# L80 13%CR (RANGE-3)	3134.63	3194.80	3,958"	↓
				3194.80		
				3194.80		
				3194.80		
10	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.92	3196.72	3,958"	3.833
11	1	**BAKER GAUGE CARRIER**	2.29	3199.01	3,958"	3.833
12	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.44	3200.45	3,958"	3.833
13	1	TUBING 4"1/2 VAM TOP 12.6# L80 13%CR (RANGE-3)	12.23	3212.68	3,958"	3.833
14	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.98	3214.66	3,958"	3.833
15	1	**HALLIBURTON 3.75" RPT NIPPLE**	0.47	3215.13	**3.75"**	3.833
16	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.46	3216.59	3,958"	3.833
17	1	TUBING 4"1/2 VAM TOP 12.6# L80 13%CR (RANGE-3)	12.24	3228.83	3,958"	3.833
18	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.92	3230.75	3,958"	3.833
19	1	**HALLIBURTON PACKER 32/35#**	1.95	3232.70	3,958"	3.833
20	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.44	3234.14	3,958"	3.833
21	1	TUBING 4"1/2 VAM TOP 12.6# L80 13%CR (RANGE-3)	12.24	3246.38	3,958"	3.833
22	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.92	3248.30	3,958"	3.833
23	1	**HALLIBURTON 3.68" RPT NIPPLE**	0.41	3248.71	**3,68"**	3.833
24	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.40	3250.11	3,958"	3.833
25	1	PUP JOINT (SPACE-OUT) 4"1/2 VAM TOP 12.6# L80 13%Cr	2.95	3253.06	3,958"	3.833
26	1	PUP JOINT 4"1/2 VAM TOP 12.6 # L80 13%Cr	1.92	3254.98	3,958"	3.833
27	1	SELF ALIGNING HALF MULE SHOE WIRELINE ENTRY GUIDE	2.62	3257.60	3,958"	3.833
		IN PBR	1.00			
		3"1/2 LANDING COLLAR	HUD	3923.30	mTH	



Perforations

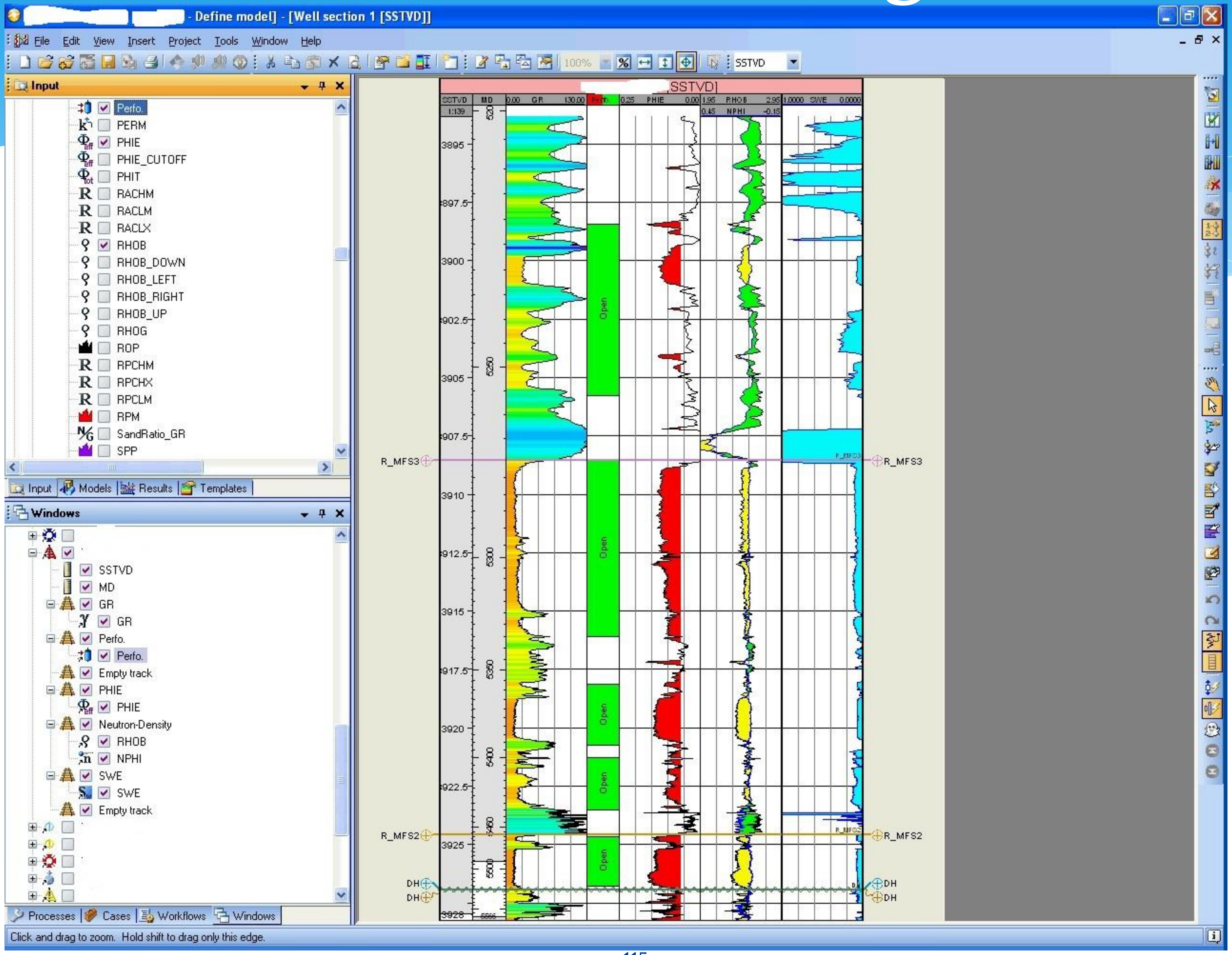
TCP 2" Omega powerjet 4.2 sh/ft 60 deg. phasing 3946.0 -- 3982.0 mRT 36 m net.

NOT NORM CLASSIFIED

Maximum deviation 7 degrees @ 3390 mtr

Rev-02

North Sea #1 Logs



North Sea #1 - Summary

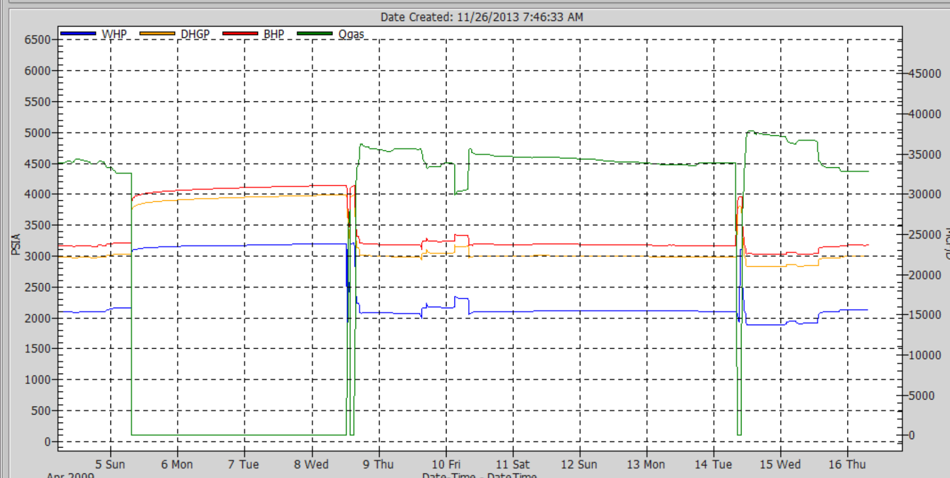
x64 Well Analyzer - C:\WORK\RT Software Demos\DER ver - North Sea #1 DHPG Calc Rate v Jan 18.ProData - [Real Time Testing]

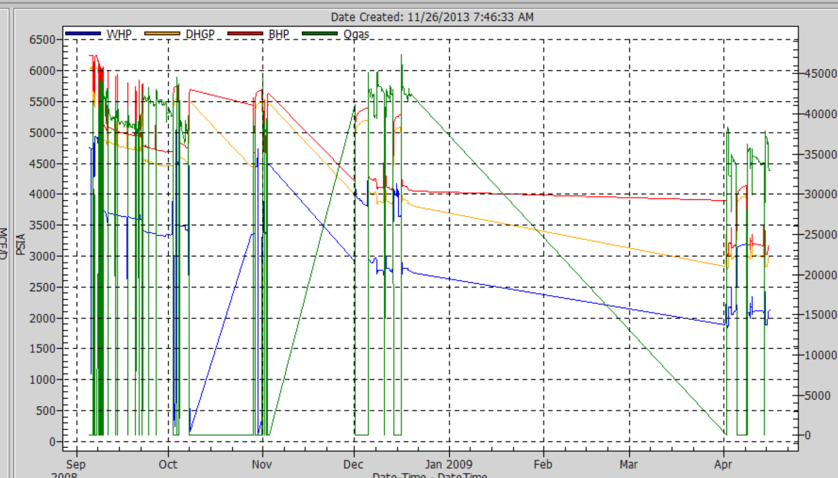
File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | P/z | Derivative | OilWaterRates | Analysis Events

	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	QGasi Mcf/D	QGas Mcf/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/MMcf	Report Link	Graph Link
1	21Sep2008 10:24:00	21Sep2008 14:42:00	4.3	PBU	3597	4231	4700	5266	4929	5457	39174	39174	NaN	NaN	NaN	5848	NaN	NaN	RTRep_2008Sep21_10240	RTRep_2008Sep21_10240
2	07Oct2008 19:06:00	28Oct2008 21:48:00	506.7	PBU	3358	4187	4469	5120	4696	5307	39746	39746	9.6	4	355	5988	60	8.93	RTRep_2008Oct07_19060	RTRep_2008Oct07_19060
3	28Oct2008 21:48:00	29Oct2008 12:36:00	14.8	DD	4519	3379	5384	4457	5577	4678	0	37972	30.5	25.4	708	4627	20	18.63	RTRep_2008Oct28_21480	RTRep_2008Oct28_21480
4	29Oct2008 12:36:00	31Oct2008 18:36:00	54	PBU	3386	389	4457	5504	4678	5701	37833	37833	9.6	4	339	5701	60	8.95	RTRep_2008Oct29_12360	RTRep_2008Oct29_12360
5	01Dec2008 07:00:00	05Dec2008 09:54:00	98.9	PBU	2912	3535	3992	4621	4217	4795	41009	41009	8.2	2.5	269	5584	70	6.55	RTRep_2008Dec01_07000	RTRep_2008Dec01_07000
6	05Dec2008 09:54:00	10Dec2008 15:48:00	125.9	DD	4190	2757	5199	3857	5388	4085	0	43293	37.4	34.2	905	3376	16	20.91	RTRep_2008Dec05_09540	RTRep_2008Dec05_09540
7	11Dec2008 05:42:00	13Dec2008 16:24:00	58.7	DD	4776	2843	5044	3899	5229	4126	0	42717	13.2	7.7	571	3824	44	13.38	RTRep_2008Dec11_05420	RTRep_2008Dec11_05420
8	13Dec2008 17:48:00	16Dec2008 11:00:00	65.2	PBU	2742	4139	3844	5102	4074	5289	42749	42749	9.7	4.5	439	5489	57	10.26	RTRep_2008Dec13_17480	RTRep_2008Dec13_17480
9	16Dec2008 11:00:00	20Dec2008 06:00:00	91	DD	3806	2728	5102	3814	5289	4041	0	43577	12	6.5	546	3723	48	12.52	RTRep_2008Dec16_11000	RTRep_2008Dec16_11000
10	05Apr2009 07:12:00	08Apr2009 12:48:00	77.6	PBU	2167	2853	3025	3654	3207	3799	32625	32625	9.7	3.6	283	4346	62	8.66	RTRep_2009Apr05_07120	RTRep_2009Apr05_07120





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North Sea #1 - PBUs

x64 Well Analyzer - C:\WORK\RT Software Demos\DER ver - North Sea #1 DHPG Calc Rate v Jan 18.ProData - [Real Time Testing]

File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | P/z | Derivative | OilWaterRates | Analysis Events

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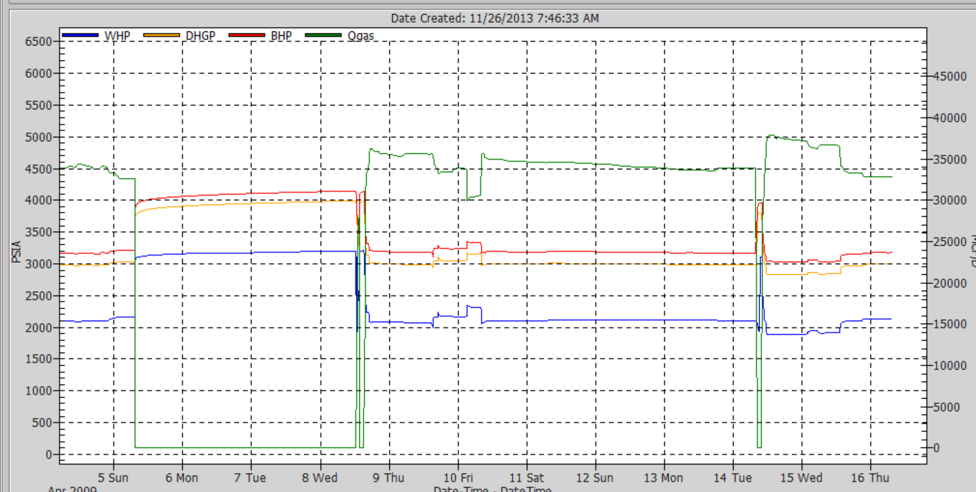
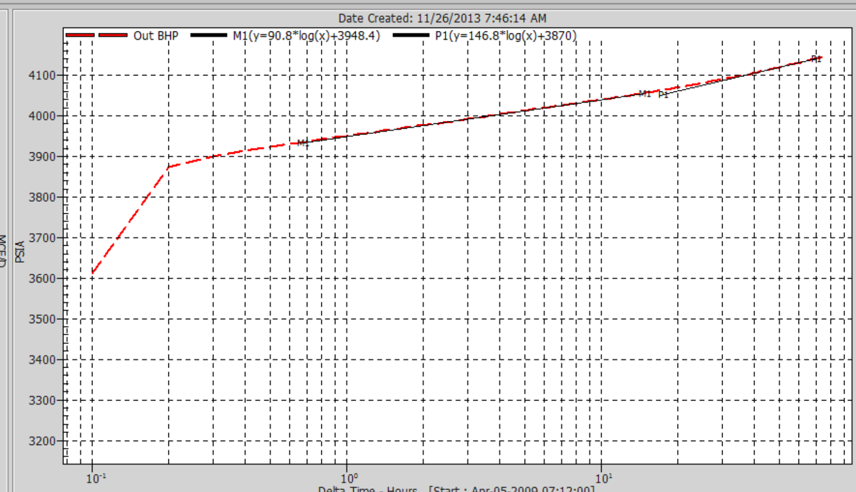
1	21Sep2008 10:24:00	21Sep2008 14:42:00	4.3	PBU	3597	4231	4700	5266	4929	5457	39174	39174	NaN	NaN	NaN	5848	NaN	NaN	RTRep_2008Sep21_10240	RTRep_2008Sep21_10240
2	07Oct2008 19:06:00	28Oct2008 21:48:00	506.7	PBU	3358	4187	4469	5120	4696	5307	39746	39746	9.6	4	355	5988	60	8.93	RTRep_2008Oct07_19060	RTRep_2008Oct07_19060
3	29Oct2008 12:36:00	31Oct2008 18:36:00	54	PBU	3386	389	4457	5504	4678	5701	37833	37833	9.6	4	339	5701	60	8.95	RTRep_2008Oct29_12360	RTRep_2008Oct29_12360
4	01Dec2008 07:00:00	05Dec2008 09:54:00	98.9	PBU	2912	3535	3992	4621	4217	4795	41009	41009	8.2	2.5	269	5584	70	6.55	RTRep_2008Dec01_07000	RTRep_2008Dec01_07000
5	13Dec2008 17:48:00	16Dec2008 11:00:00	65.2	PBU	2742	4139	3844	5102	4074	5289	42749	42749	9.7	4.5	439	5489	57	10.26	RTRep_2008Dec13_17480	RTRep_2008Dec13_17480
6	05Apr2009 07:12:00	08Apr2009 12:48:00	77.6	PBU	2167	2853	3025	3654	3207	3799	32625	32625	9.7	3.6	283	4346	62	8.66	RTRep_2009Apr05_07120	RTRep_2009Apr05_07120





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Ready

North Sea #1 - DDs

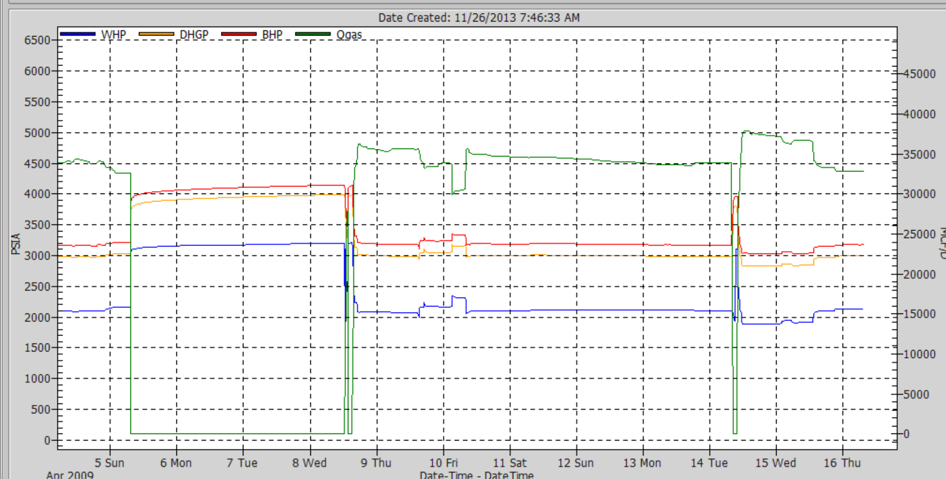
x64 Well Analyzer - C:\WORK\RT Software Demos\DER ver - North Sea #1 DHPG Calc Rate v Jan 18.ProData - [Real Time Testing]

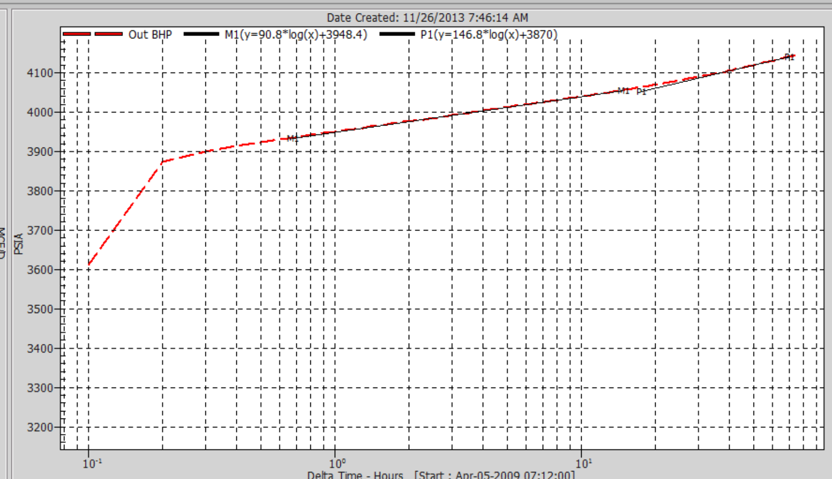
File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | P/z | Derivative | OilWaterRates | Analysis Events

	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	QGasi Mcf/D	QGas Mcf/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/MMcf	Report Link	Graph Link
1	28Oct2008 21:48:00	29Oct2008 12:36:00	14.8	DD	4519	3379	5384	4457	5577	4678	0	37972	30.5	25.4	708	4627	20	18.63	RTRep_2008Oct28_21480	RTRep_2008Oct28_21480
2	05Dec2008 09:54:00	10Dec2008 15:48:00	125.9	DD	4190	2757	5199	3857	5388	4085	0	43293	37.4	34.2	905	3376	16	20.91	RTRep_2008Dec05_09540	RTRep_2008Dec05_09540
3	11Dec2008 05:42:00	13Dec2008 16:24:00	58.7	DD	4776	2843	5044	3899	5229	4126	0	42717	13.2	7.7	571	3824	44	13.38	RTRep_2008Dec11_05420	RTRep_2008Dec11_05420
4	16Dec2008 11:00:00	20Dec2008 06:00:00	91	DD	3806	2728	5102	3814	5289	4041	0	43577	12	6.5	546	3723	48	12.52	RTRep_2008Dec16_11000	RTRep_2008Dec16_11000





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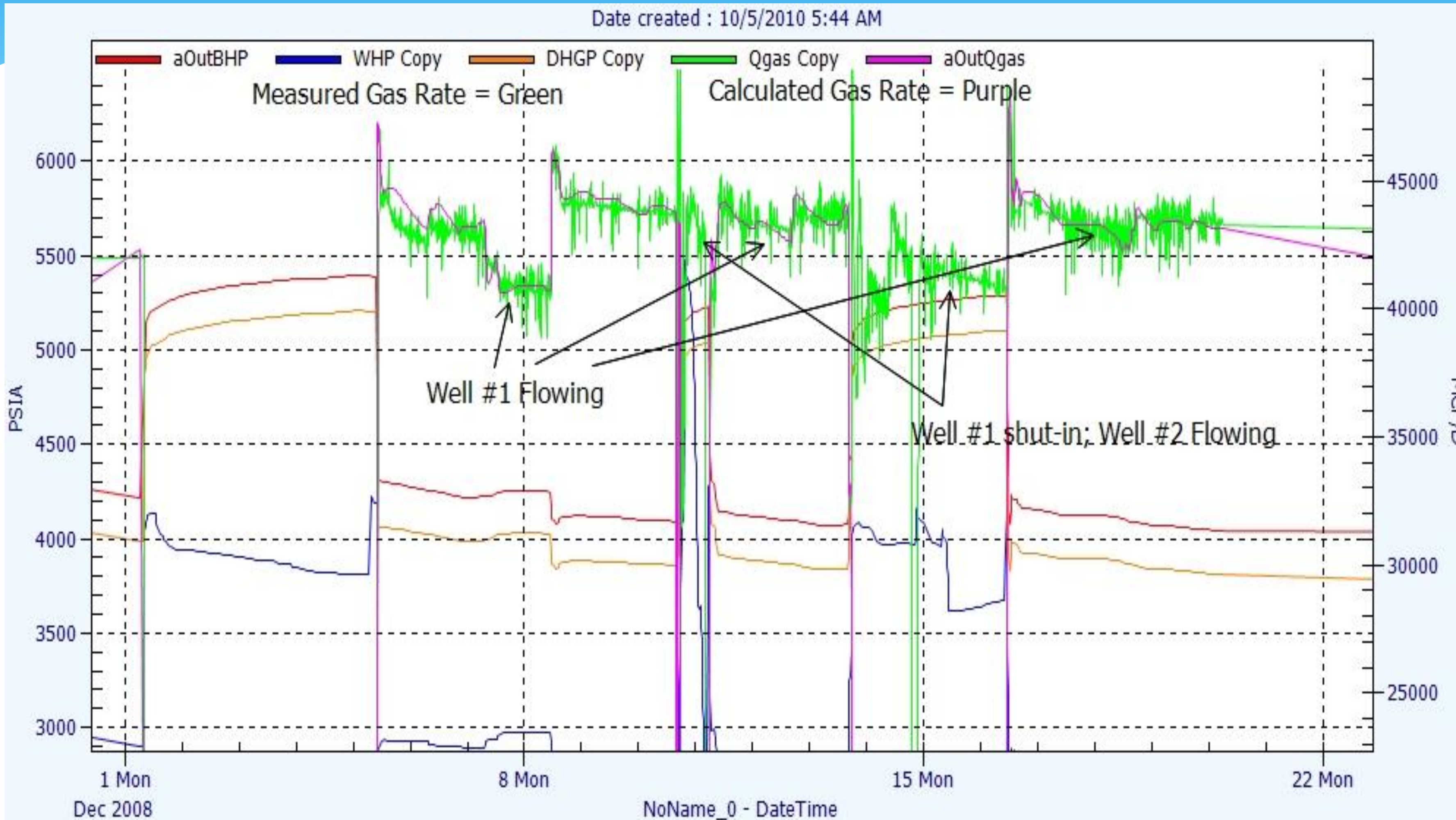
North Sea #1 Rate Check



North Sea #1 - Conclusions

* Rates (measured vs. calculated) appear valid
* Build-ups are consistent – perm of 10md, skin of 3-ish
* Drawdowns are all over the place
  * Maybe related to zonal flow?
  * No consistent explanation
* Ignore DD's – use PBUs for evaluations of change

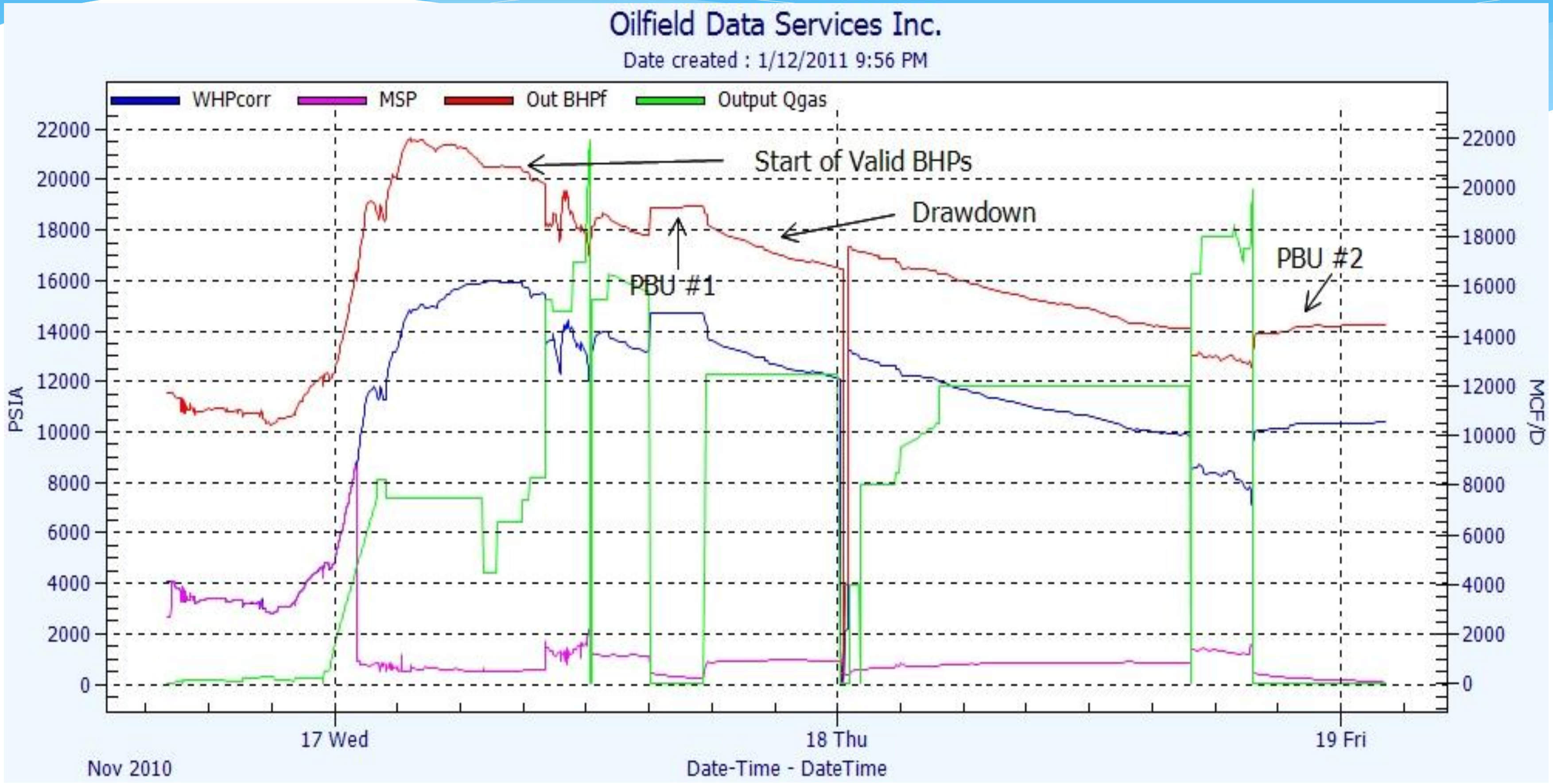
HPHT GOM Gas-Condy Extended Well Test

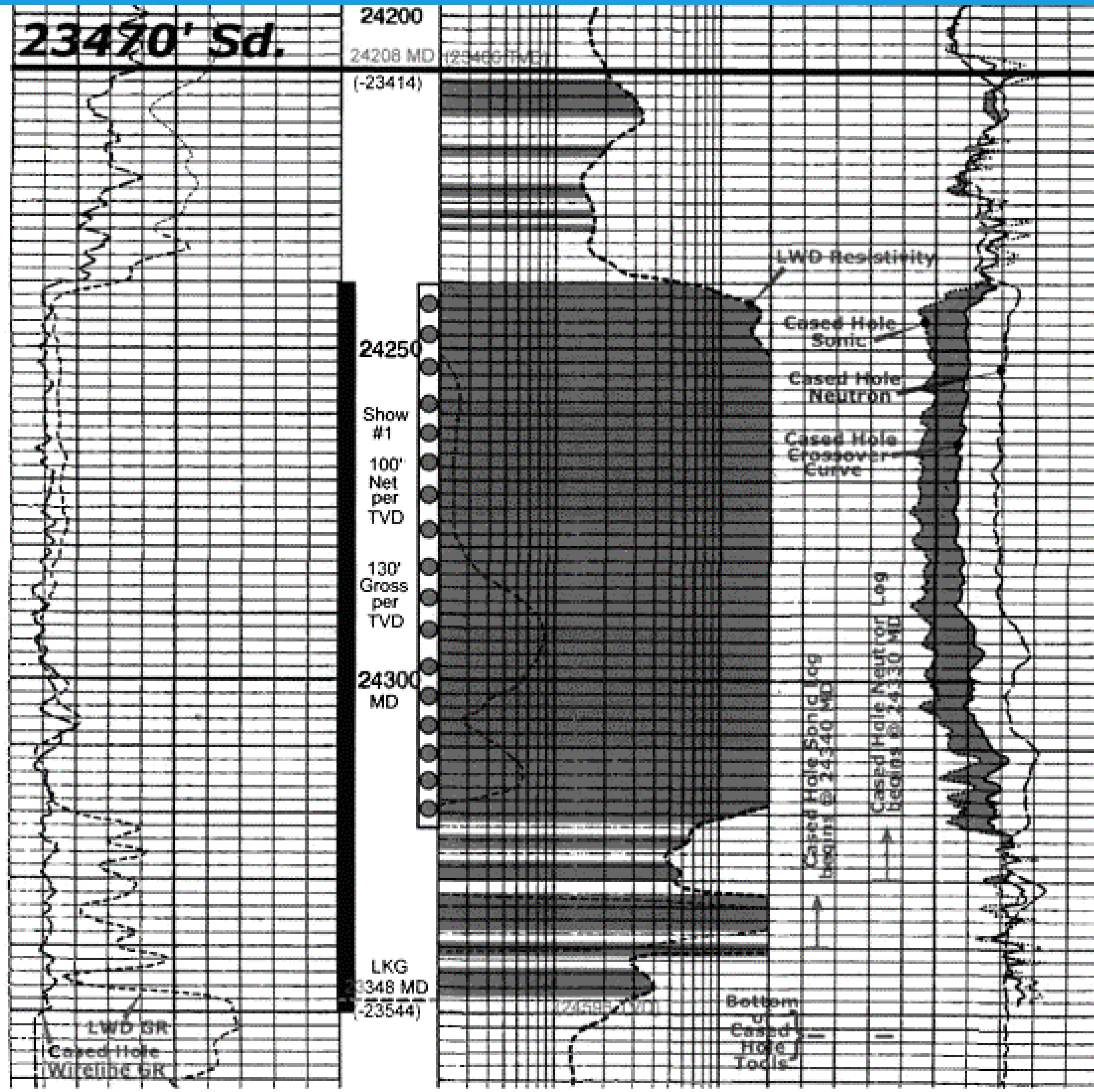
Set-up:

* Well Flowed-Back 6 months before
* "Discredited" Well Test/Reservoir Engineer said it Depleted on Test
* Supposed to be upwards of 1 TCF of reserves in field
* Temporary MOPU on location
* Rock Could Be 'Squishy'
* Good CBL
* Packer could be a weak point

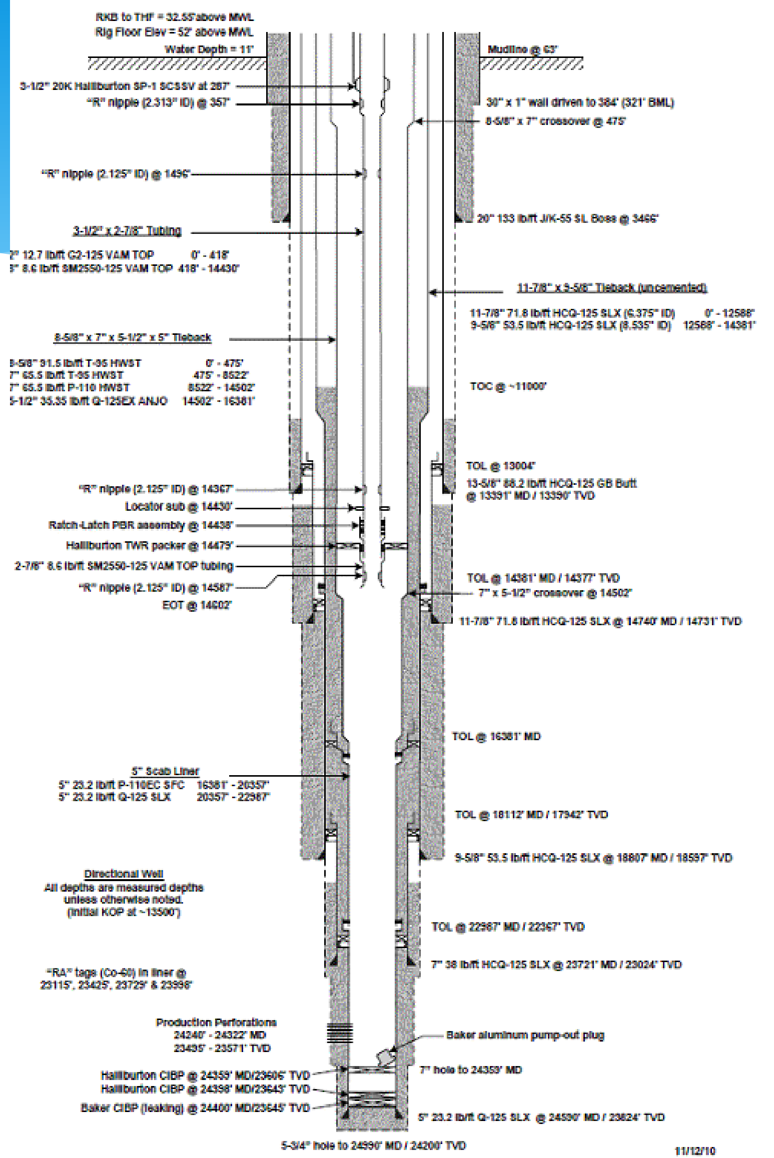
Objective: Determine if reserves justify a platform

Whaddaya Think?




23470' Sd.
24200
(-23414)
LWD Resistivity
Cased Hole Sonic
Cased Hole Neutron
Cased Hole Crossover Curve
24250
Show #1
100' Net per TVD
130' Gross per TVD
24300 MD
Cased Hole Sonic Log begins @ 24340 MD
Cased Hole Neutron Log begins @ 24330 MD
LKG
(-23544)
Bottom of Cased Hole Tools
LWD GR
Cased Hole Wireline GR

(As Run Completion Schematic)



DOT - Summary

x64 Well Analyzer - C:\WORK\RT Software Demos\DOT #1 - UHPHT GOM using outBHP.ProData - [Real Time Testing]

File Memory Analysis Plot View Tools Help

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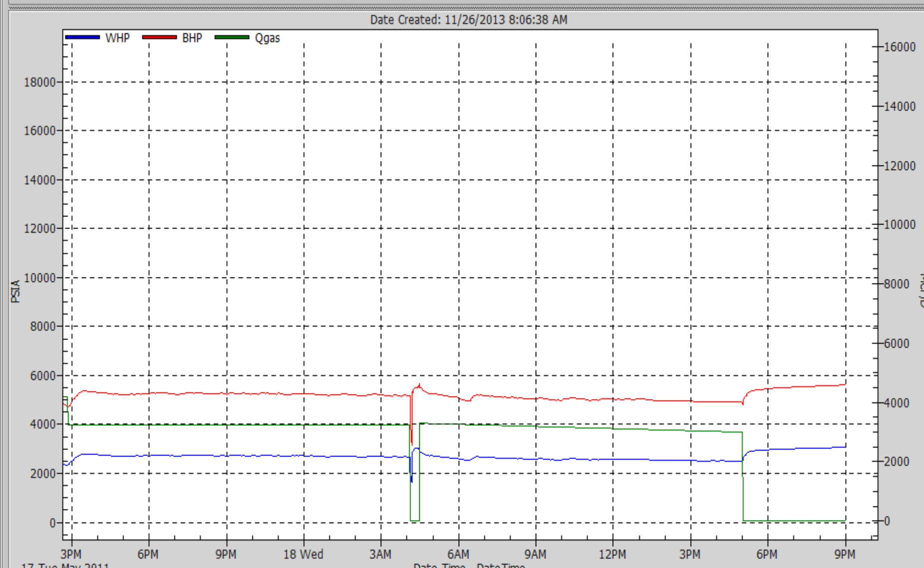
1	04May2011 10:16:19	04May2011 19:20:04	9.06	DD	14286	8946	-1	-1	18619	13553	0	13298	0.2	-2.4	-5161	9100	309	-388.0	RTRep 2011May04 1016	RTRep 2011May04 1016
2	04May2011 19:23:04	04May2011 20:23:49	1.01	PBU	9188	12061	-1	-1	13734	16149	14607	14607	11.3	70.5	2545	16540	7	174.2	RTRep 2011May04 1923	RTRep 2011May04 1923
3	04May2011 21:41:04	05May2011 18:29:49	20.81	DD	13972	7734	-1	-1	17918	11482	0	14118	0.2	-1.2	-2314	9402	149	-163.8	RTRep 2011May04 2141	RTRep 2011May04 2141
4	05May2011 18:30:04	12May2011 04:55:10	154.42	PBU	7182	3363	-1	-1	11067	6076	8016	8016	7.3	27.2	771	12629	16	96.14	RTRep 2011May05 1830	RTRep 2011May05 1830
5	12May2011 04:55:10	13May2011 03:06:25	22.19	DD	3385	5708	-1	-1	6107	9234	0	4870	0	-3.8	-2276	8117	399	-4675.	RTRep 2011May12 0455	RTRep 2011May12 0455
6	13May2011 03:06:25	13May2011 16:27:40	13.35	PBU	5746	6869	-1	-1	9279	10428	5705	5705	NaN	NaN	NaN	63218	NaN	NaN	RTRep 2011May13 0306	RTRep 2011May13 0306
7	13May2011 16:27:40	17May2011 06:05:55	85.64	DD	6941	2939	-1	-1	10511	5555	0	8000	0	-2.8	-1285	5715	33258	-1606.	RTRep 2011May13 1627	RTRep 2011May13 1627
8	17May2011 06:07:25	17May2011 13:03:40	6.94	PBU	2900	3587	-1	-1	5499	6339	3606	3606	0.8	1.3	140	6754	76	38.91	RTRep 2011May17 0607	RTRep 2011May17 0607
9	17May2011 13:03:40	18May2011 04:07:10	15.06	DD	3582	2652	-1	-1	6332	5153	0	3250	0.1	-2.1	-1466	4778	323	-451.0	RTRep 2011May17 1303	RTRep 2011May17 1303
10	18May2011 17:02:10	18May2011 21:01:25	3.99	PBU	2502	3064	-1	-1	4912	5615	3005	3005	0.4	-0.5	-89	5983	116	-29.59	RTRep 2011May18 1702	RTRep 2011May18 1702



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Ready

DOT - PBUs

x64 Well Analyzer - C:\WORK\RT Software Demos\DOT #1 - UHPHT GOM using outBHP.ProData - [Real Time Testing]

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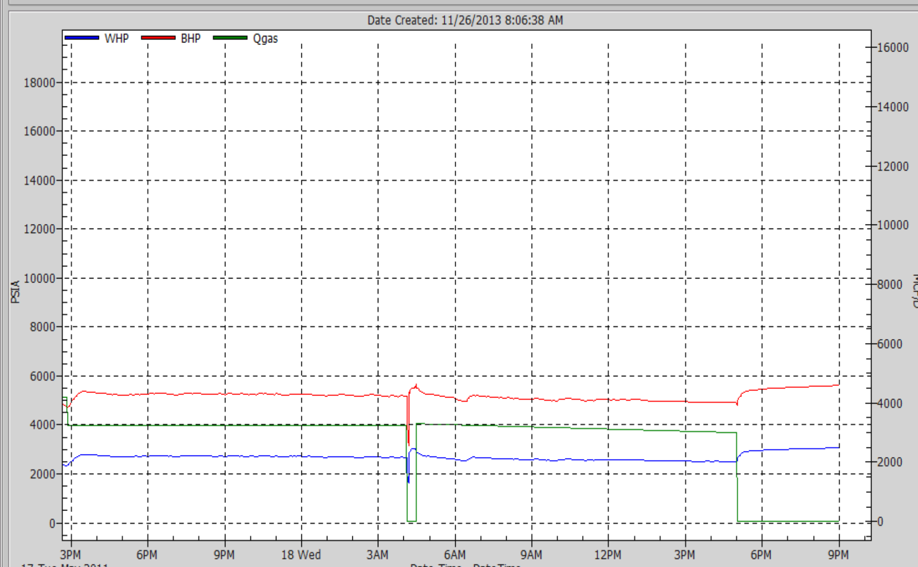
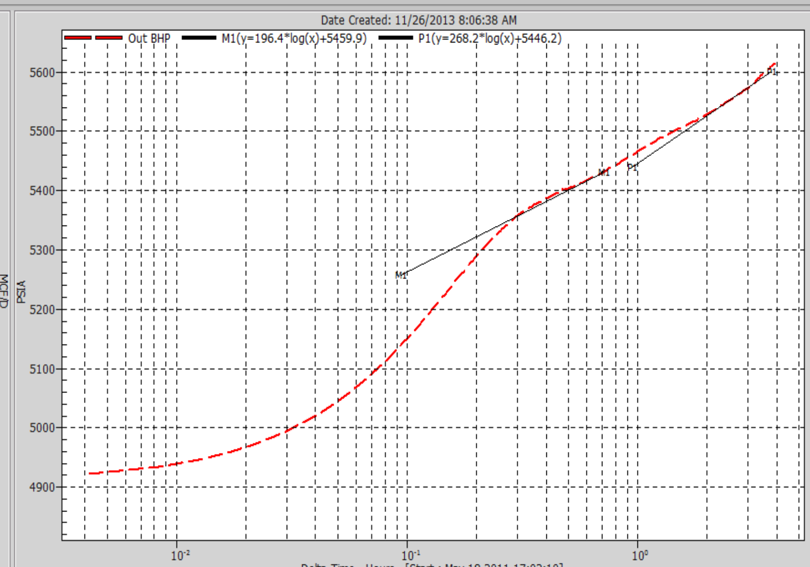
1	04May2011 19:23:04	04May2011 20:23:49	1.01	PBU	9188	12061	-1	-1	13734	16149	14607	14607	11.3	70.5	2545	16540	7	174.2	RTRep 2011May04 1923	RTRep 2011May04 1923
2	05May2011 18:30:04	12May2011 04:55:10	154.42	PBU	7182	3363	-1	-1	11067	6076	8016	8016	7.3	27.2	771	12629	16	96.14	RTRep 2011May05 1830	RTRep 2011May05 1830
3	17May2011 06:07:25	17May2011 13:03:40	6.94	PBU	2900	3587	-1	-1	5499	6339	3606	3606	0.8	1.3	140	6754	76	38.91	RTRep 2011May17 0607	RTRep 2011May17 0607
4	18May2011 17:02:10	18May2011 21:01:25	3.99	PBU	2502	3064	-1	-1	4912	5615	3005	3005	0.4	-0.5	-89	5983	116	-29.59	RTRep 2011May18 1702	RTRep 2011May18 1702





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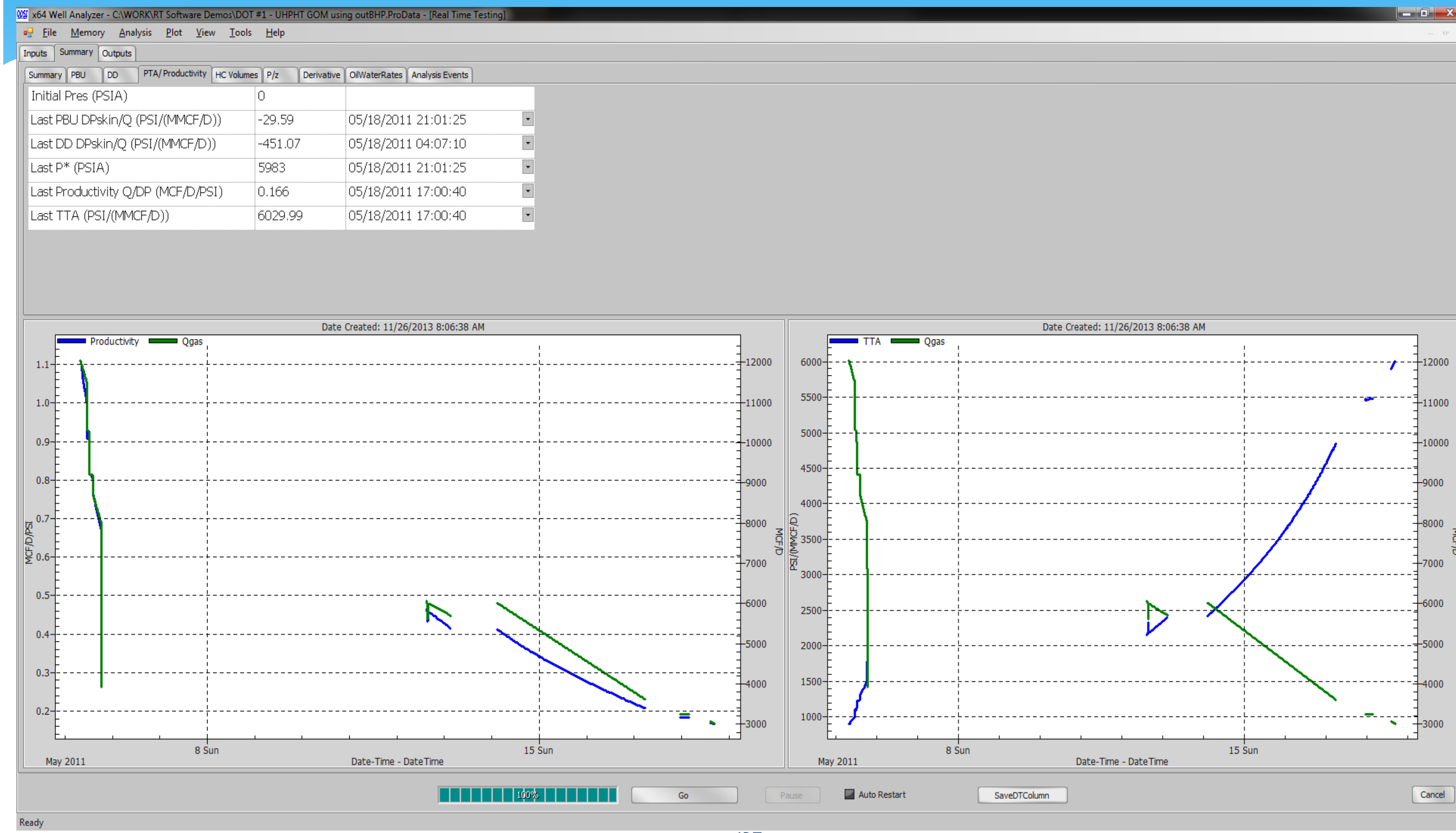
Ready

DOT - Productivity



Initial Pres (PSIA)	0	
Last PBU DPskin/Q (PSI/(MMCF/D))	-29.59	05/18/2011 21:01:25
Last DD DPskin/Q (PSI/(MMCF/D))	-451.07	05/18/2011 04:07:10
Last P* (PSIA)	5983	05/18/2011 21:01:25
Last Productivity Q/DP (MCF/D/PSI)	0.166	05/18/2011 17:00:40
Last TTA (PSI/(MMCF/D))	6029.99	05/18/2011 17:00:40

DOT – P/z and MBAL/EBAL

x64 Well Analyzer - C:\WORK\RT Software Demos\DOT #1 - UHPHT GOM using outBHP.ProData - [Real Time Testing]

File Memory Analysis Plot View Tools Help

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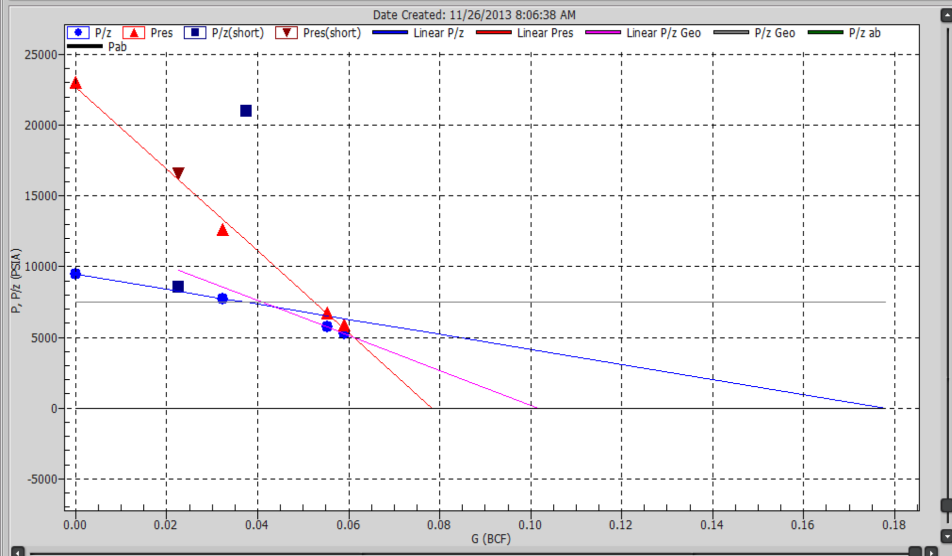
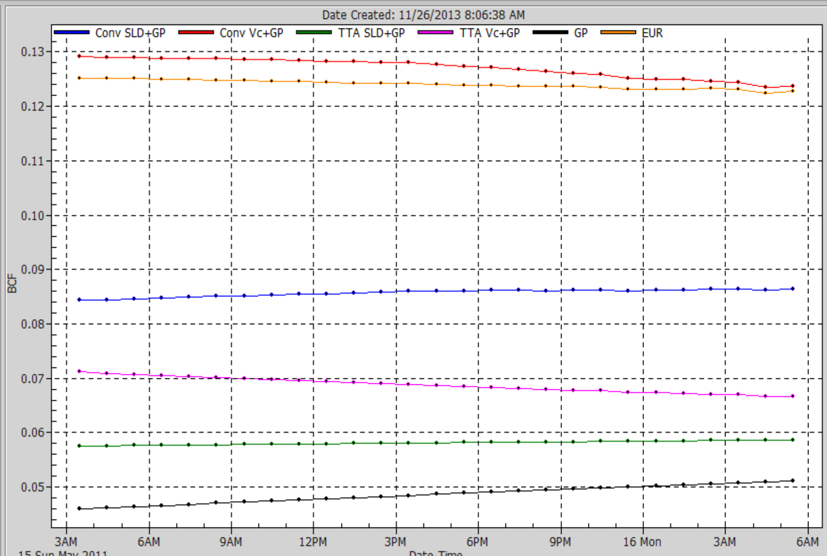
Date Time	Gas Produced	PBU Duration	Pres	z-Factor	P/z	GIP SLD @P=0	GIP SLD @P|ab=15	GIP P/z @P=0	GIP P/z @P/z|ab=15	GIP P/z geo @P=0	GIP P/z geo @P/z|ab=15	m Pres	m Pz	m Pz Geo
MM/dd/yyyy HH:mm:ss	BCF	HOURS	PSIA	dimless	PSIA	BCF	BCF	BCF	BCF	BCF	BCF	PSIA/BCF	PSIA/BCF	PSIA/BC
01/01/0001 00:00:0	0.00		23000	2.434	9449.	NaN	NaN	NaN	NaN	NaN	NaN	-99999.0	-99999.0	-99999
05/04/2011 20:23:49	0.02	1	16540	1.938	8532.2	NaN	NaN	NaN	NaN	NaN	NaN	-99999.0	-99999.0	-99999.
05/12/2011 04:55:1	0.03	154	12629	1.633	7734.	0.1	0.1	0.2	0.2	0.1	0.1	-320740.1	-53036.1	-10607
05/13/2011 16:27:40	0.04	13	632187	30.157	20963.	0.1	0.1	0.2	0.2	0.1	0.1	-320740.1	-53036.1	-106072
05/17/2011 13:03:4	0.06	7	6754	1.181	5717.	0.1	0.1	0.2	0.2	0.1	0.1	-295835.6	-53036.1	-10607
05/18/2011 19:02:2	0.06	2	5880	1.119	5254.	0.1	0.1	0.2	0.2	0.1	0.1	-290040.1	-53036.1	-12294





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Ready

DOT - Conclusions

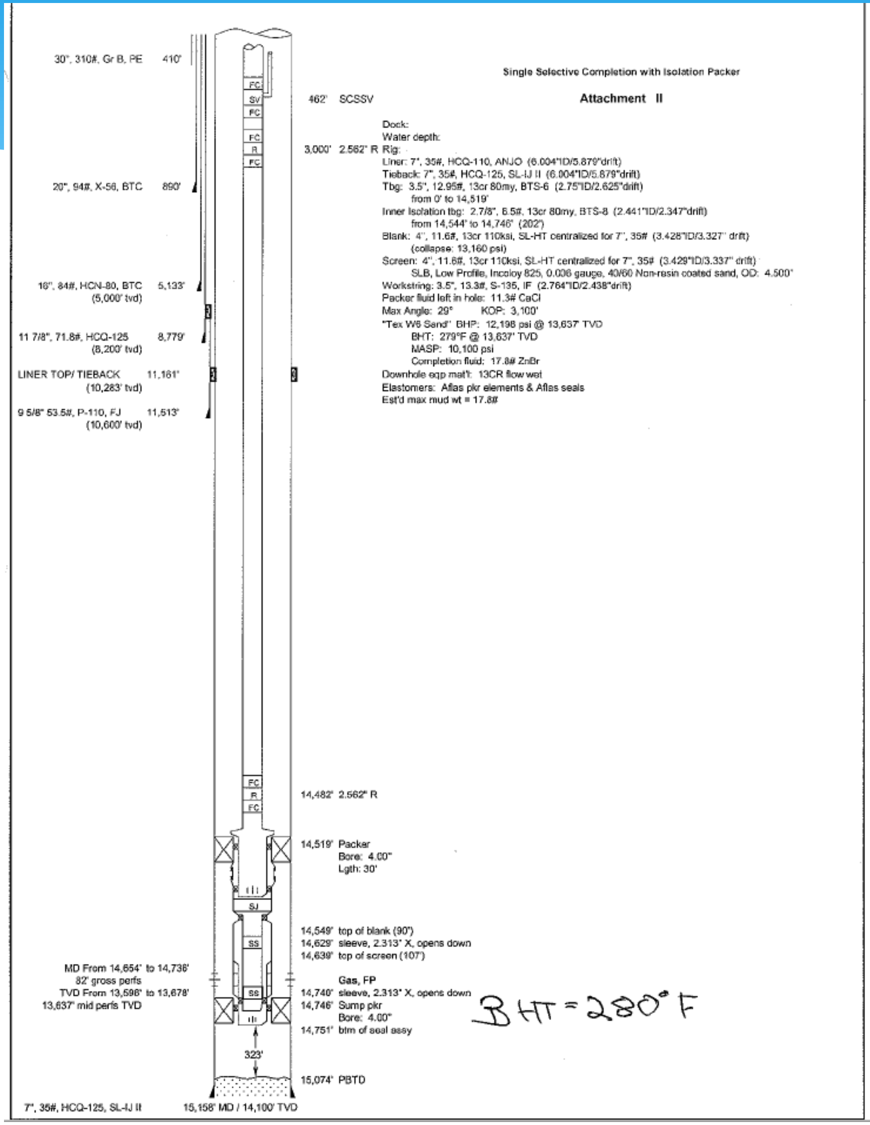
* It's WEE!
* Gosh, we wasted a lot of rig time…

GOM Volatile Oil Well

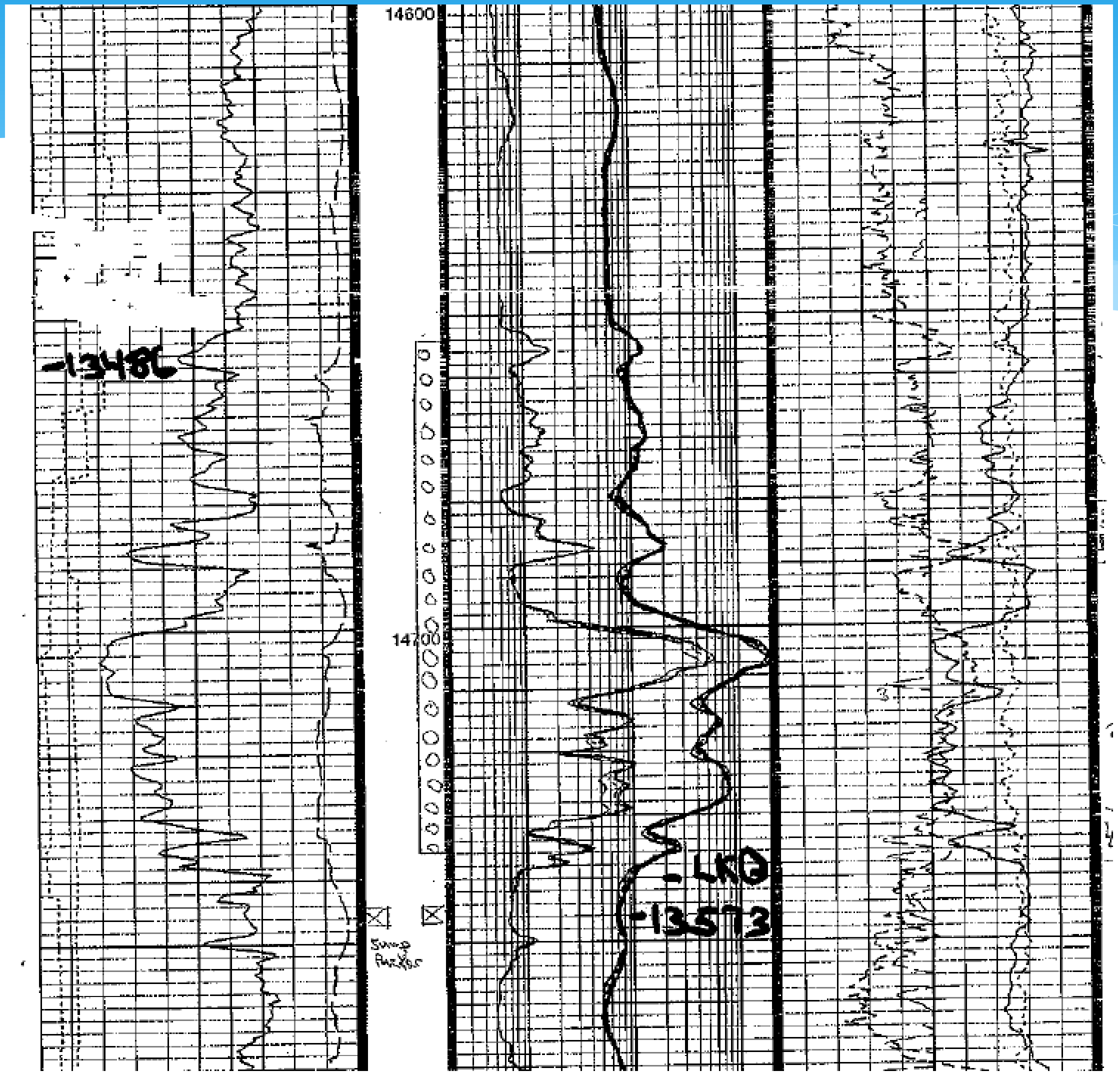
- Start-up: Objectives
  - Figure Out kh & skin
  - Determine Productivity
  - Determine Oil-in-Place
  - Estimate Recovery

Objective: Does an injection well make sense?

Fizzy - WBD


Single Selective Completion with Isolation Packer
Attachment II
30", 310#, Gr B, PE 410'
FC
SV
FC
FC
R
FC
462' SCSSV
Dock:
Water depth:
3,000' 2.562" R Rig:
Liner: 7", 35#, HCQ-110, ANJO (6.004"ID/5.879"drift)
Tieback: 7", 35#, HCQ-125, SL-IJ II (6.004"ID/5.879"drift)
Tbg: 3.5", 12.95#, 13cr 80my, BTS-6 (2.75"ID/2.625"drift)
from 0' to 14,519'
Inner Isolation tbg: 2.7/8", 6.5#, 13cr 80my, BTS-8 (2.441"ID/2.347"drift)
from 14,544' to 14,746' (202')
Blank: 4", 11.6#, 13cr 110ksi, SL-HT centralized for 7", 35# (3.428"ID/3.327" drift)
(collapse: 13,160 psi)
Screen: 4", 11.6#, 13cr 110ksi, SL-HT centralized for 7", 35# (3.429"ID/3.337" drift)
SLB, Low Profile, Incoloy 825, 0.006 gauge, 40/60 Non-resin coated sand, OD: 4.500"
Workstring: 3.5", 13.3#, S-135, IF (2.764"ID/2.438"drift)
Packer fluid left in hole: 11.3# CaCl
Max Angle: 29° KOP: 3,100'
"Tex W6 Sand" BHP: 12,198 psi @ 13,637' TVD
BHT: 279°F @ 13,637' TVD
MASP: 10,100 psi
Completion fluid: 17.8# ZnBr
Downhole eqp mat'l: 13CR flow wet
Elastomers: Aflas pkr elements & Aflas seals
Est'd max mud wt = 17.8#
20", 94#, X-56, BTC 890'
16", 84#, HCN-80, BTC 5,133'
(5,000' tvd)
11 7/8", 71.8#, HCQ-125 8,779'
(8,200' tvd)
LINER TOP/ TIEBACK 11,161'
(10,283' tvd)
9 5/8" 53.5#, P-110, FJ 11,513'
(10,600' tvd)
FC
R
FC
14,482' 2.562" R
14,519' Packer
Bore: 4.00"
Lgth: 30'
SJ
14,549' top of blank (90')
SS
14,629' sleeve, 2.313" X, opens down
14,639' top of screen (107')
MD From 14,654' to 14,736'
82' gross perfs
TVD From 13,596' to 13,678'
13,637' mid perfs TVD
Gas, FP
SS
14,740' sleeve, 2.313" X, opens down
14,746' Sump pkr
Bore: 4.00"
14,751' btm of seal assy
BHT = 280°F
323'
15,074' PBTD
7", 35#, HCQ-125, SL-IJ II
15,158' MD / 14,100' TVD

Fizzy-1 Logs



Fizzy - Summary

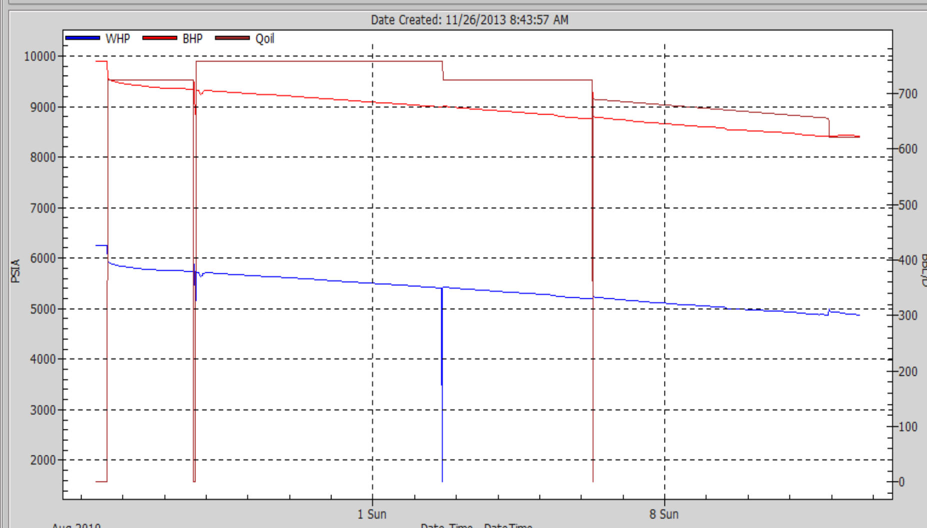
x64 Well Analyzer - C:\WORK\RT Software Demos\Fizzy-1 for SPE London.ProData - [Real Time Testing]

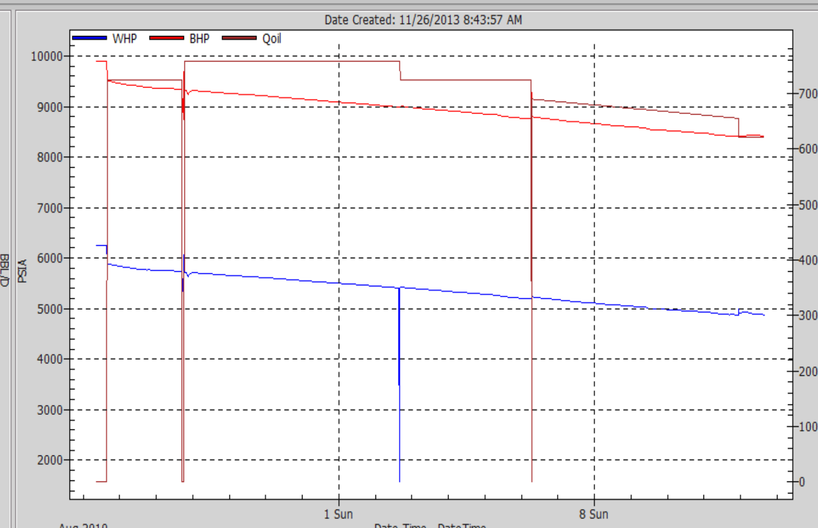
File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | 1Φ-MBAL | Derivative | OilWaterRates | Analysis Events

	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	Qoil_i BBL/D	Qoil BBL/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/BBL	Report Link	Graph Link
1	25Jul2010 15:40:35	27Jul2010 16:51:19	49.18	DD	6252	5736	-1	-1	9903	9341	0	725	39.7	3.3	134	9177	65	0.19	RTRep_2010Jul25_15403	RTRep_2010Jul25_15403





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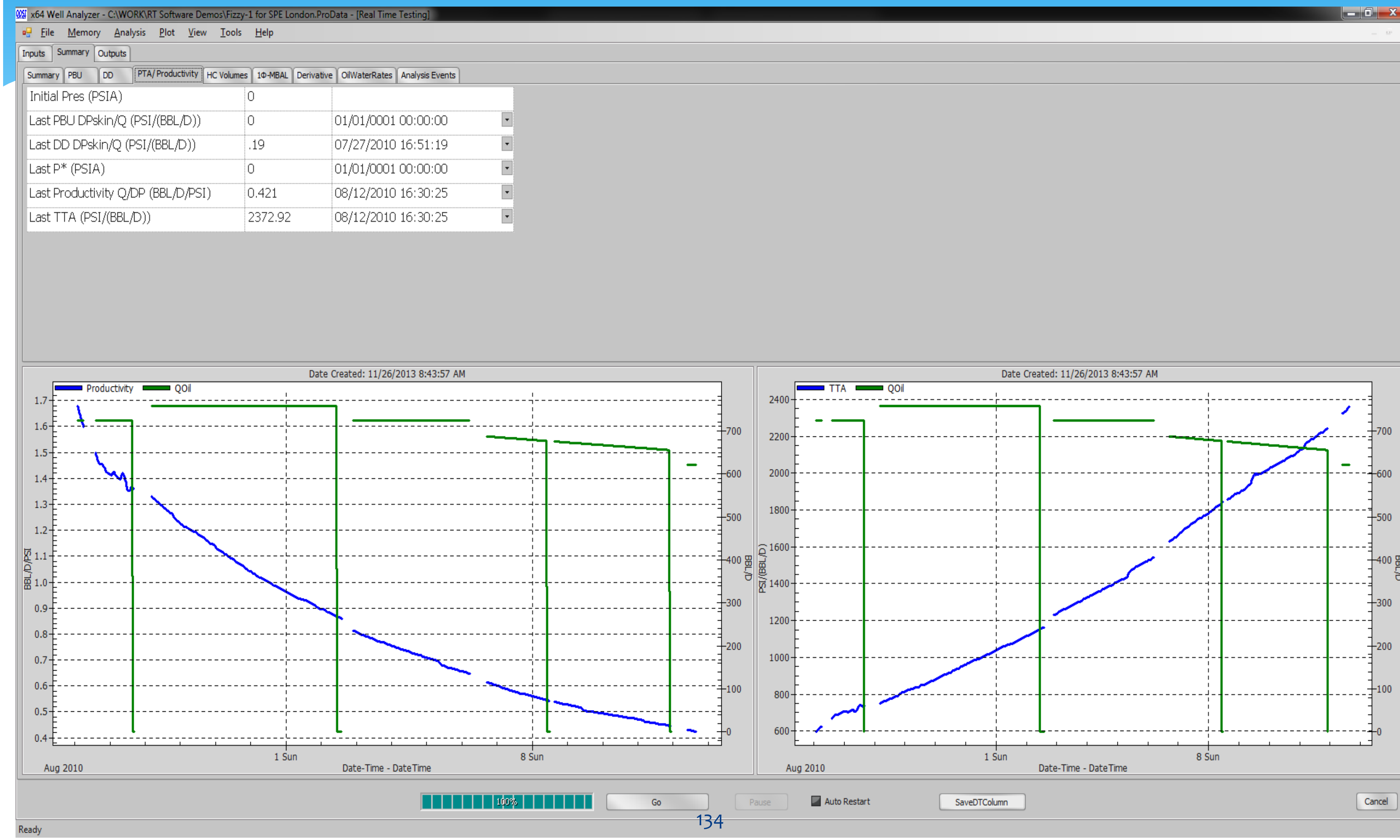
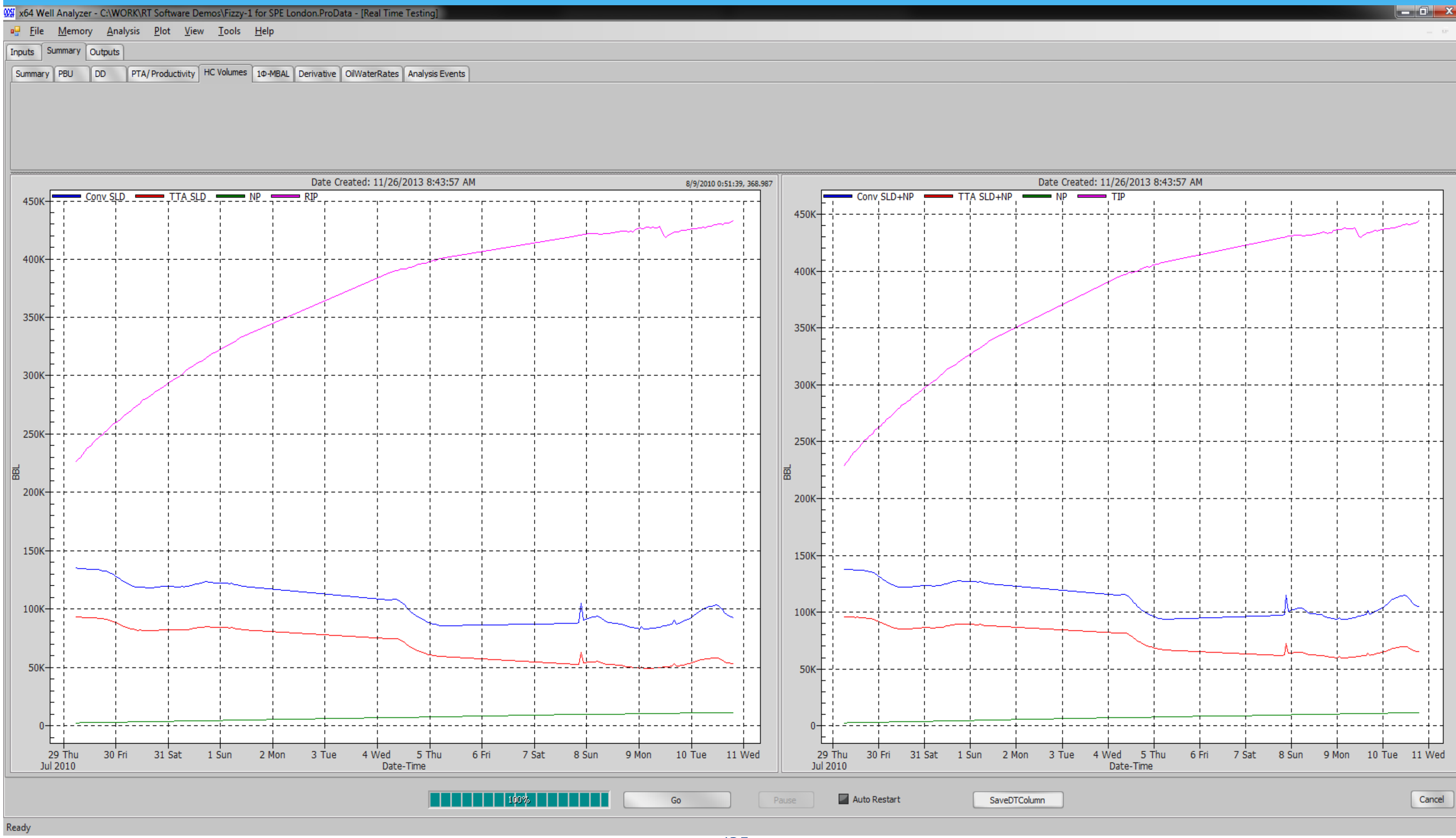
Ready

Fizzy - Productivity



Fizzy – Flowing MBAL/EBAL



Fizzy - Conclusions

* Only about 450,000 STB in place
* Around 100,000 recoverable by natural drive
* Maybe 200,000 more recoverable with water injection

* Don’t drill $30 MM injector

Nordzee #1

* Gas Well with Subsea Tree
* “Single Zone”? reservoir, but with possible baffles
  * MDTs match gas gradient
* Not fully cleaned-up during initial completion test

* Objectives:
  * Determine skin/perm
  * Determine in-place HCs
  * Estimate Recovery

Nordzee #1 WBD

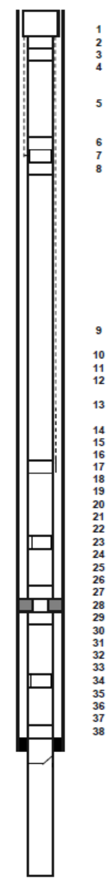
RT/TH HOP. : **73.675** m. Noble Al White (HOP=Bottom ring TH) COMPLETION DATE :	ANNULUS FLUID : INHIBITED KCl BRINE SG 1.03

VOLUMES		DRILLING DEPTHS / RT
7"Vam Top riser to RT volume	1.35 M3	
TUBING VOLUME	15.67 M3	TOP 7" LINER HANGER : 2724,54 mRT
4.5"LINER VOLUME	4.99 M3	TOP PBR 4-1/2" LINER HANGER : 3439,06 mRT
3.5"x 7"ANNULUS VOLUME till PKR	0.33 M3	TRSCSSV volume 9000-->0 psi = ~250 ml (2 reels 200m)

X-MAS TREE 510K API / 10000 psi rated working pressure

TUBING HANGER	FMC 13 5/8"x 4.5" w/ 3.925" SRP PROFILE
X-MASTREE	FMC JXT-3
PMV production master valve	5"1/8 10K
PSV production swab valve	5"1/8 10K
PMV production wing valve	5"1/8 10K
Annulus valves	2"1/16 10K

		STRING		length of item Length	To bottom of item Depth	Depth	ID"	Original Drift
ITEM	QTY	DESIGNATION	all length to bottom	m.	mRT	mTH	inches	inches
				NAW	73.765			3,875"
1	1	**TBG. HANGER 13"5/8 X 5" VAM TOP HC**	HOP →	0.00	73.765	0.00	HOP	lock
2	1	PUP JOINT 5" VAM TOP HC 12.6# C-95 13%Cr PIN X PIN		1.84	75.61	1.84	3,958"	drift
3	1	XO 4.5" VTOP box 12.6# x 3.5" VTOP 9.2# pin13% CR L-80		0.95	76.56	2.79	3,958"	3,875"
4	2	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		6.40	82.96	9.19	3,958"	3,875"
5	7	TUBINGS 4"1/2 VAM TOP 12.6# C-95 13%CR		90.31	173.27	99.50	3,958"	3,875"
6	1	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		1.96	175.23	101.46	3,958"	3,875"
7	1	**BAKER TME 6.5 TRSCSSV W/ NIPPLE ADAPTER 3.812" BA PROFILE**		2.03	177.26	103.49	**3,812"**	n/a
8	1	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		1.43	178.69	104.92	3,958"	2.867"
								Drift
9	1	TUBING 4"1/2 VAM TOP 12.6# C-95 13%CR		13.28	191.97	118.20	3,958"	Nylon
10	1	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		1.96	193.93	120.16	3,958"	↓
11	1	XO 4.5" VTOP box 12.6# x 3.5" VTOP 9.2# pin13% CR L-80		0.54	194.47	120.70	2.992"	
12	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.48	195.95	122.18	2.992"	
13	255	TUBINGS 3.5" VAMTOP 9.2# 13% CR L-80 R-3		3171.67	3367.62	3293.85	2.992"	2.867"
14	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.96	3369.58	3295.81	2.992"	2.867"
15	1	XO 4.5" VTOP box 12.6# x 3.5" VTOP 9.2# pin13% CR L-80		0.53	3370.11	3296.34	2.992"	2.867"
16	1	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		2.96	3373.07	3299.30	2.992"	2.867"
17	1	**BAKER SS-175GAUGE CARRIER**		1.67	3374.74	3300.97	2.992"	2.867"
18	1	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		1.92	3376.66	3302.89	2.992"	2.867"
19	1	XO 4.5" VTOP box 12.6# x 3.5" VTOP 9.2# pin13% CR L-80		0.53	3377.19	3303.42	2.992"	2.867"
20	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.48	3378.67	3304.90	2.992"	2.867"
21	1	TUBING 3.5" VAMTOP 9.2# 13% CR L-80 R-3		12.50	3391.17	3317.40	2.992"	2.867"
22	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.97	3393.14	3319.37	2.992"	2.867"
23	1	**BAKER 2.812" AOF NIPPLE 9.2# VAMTOP 13%Cr L-80**		0.69	3393.83	3320.06	**2.81"**	n/a
24	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.46	3395.29	3321.52	2.992"	2.867"
25	1	TUBING 3.5" VAMTOP 9.2# 13% CR L-80 R-3		12.47	3407.76	3333.99	2.992"	2.867"
26	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.97	3409.73	3335.96	2.992"	2.867"
27	1	XO 4.5" VTOP box 12.6# x 3.5" VTOP 9.2# pin13% CR L-80		0.53	3410.26	3336.49	2.992"	2.867"
28	1	**BAKER SB-3 PACKER**		1.21	3411.47	3337.70	2.992"	2.867"
29	1	PUP JOINT 4"1/2 VAM TOP 12.6# C-95 13%Cr		1.78	3413.25	3339.48	2.992"	2.867"
30	1	XO 4.5" VTOP box 12.6# x 3.5" VTOP 9.2# pin13% CR L-80		0.53	3413.78	3340.01	2.992"	2.867"
31	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.48	3415.26	3341.49	2.992"	2.867"
32	1	TUBING 3.5" VAMTOP 9.2# 13% CR L-80 R-3		12.50	3427.76	3353.99	2.992"	2.867"
33	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.97	3429.73	3355.96	2.992"	2.867"
34	1	**BAKER 2.750" AOF NIPPLE 9.2# VAMTOP 13%Cr L-80**		0.98	3430.71	3356.94	**2.75"**	n/a
35	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.47	3432.18	3358.41	2.992"	2.867"
36	1	PUP JOINT 3.5" VAMTOP 9.2# 13% CR L-80		1.92	3434.10	3360.33	2.992"	2.867"
37	1	XO 3.5" VTOP BOX 9.2# 13% CR L-80 x 4.5" VTOP pin 12.6#		0.53	3434.63	3360.86	2.992"	2.867"
38	1	**SELF ALIGNING MULE SHOE 4"1/2 VAM TOP 12,6# L-80 13%CR 20FT**		4.56	3439.19	3365.42	2.992"	2.867"
			IN PBR	2.03	3441.22	3367.45	2.992"	2.867"
		4-1/2" LINER, 12.6#, L-80, 13%CR, VAMTOP			3439.10		3,958"	
		4-1/2" PUP joint 3852.43 m RT - 3854.38 m RT for correlation						
		4 1/2" LANDING COLLAR				4067.14	mRT	

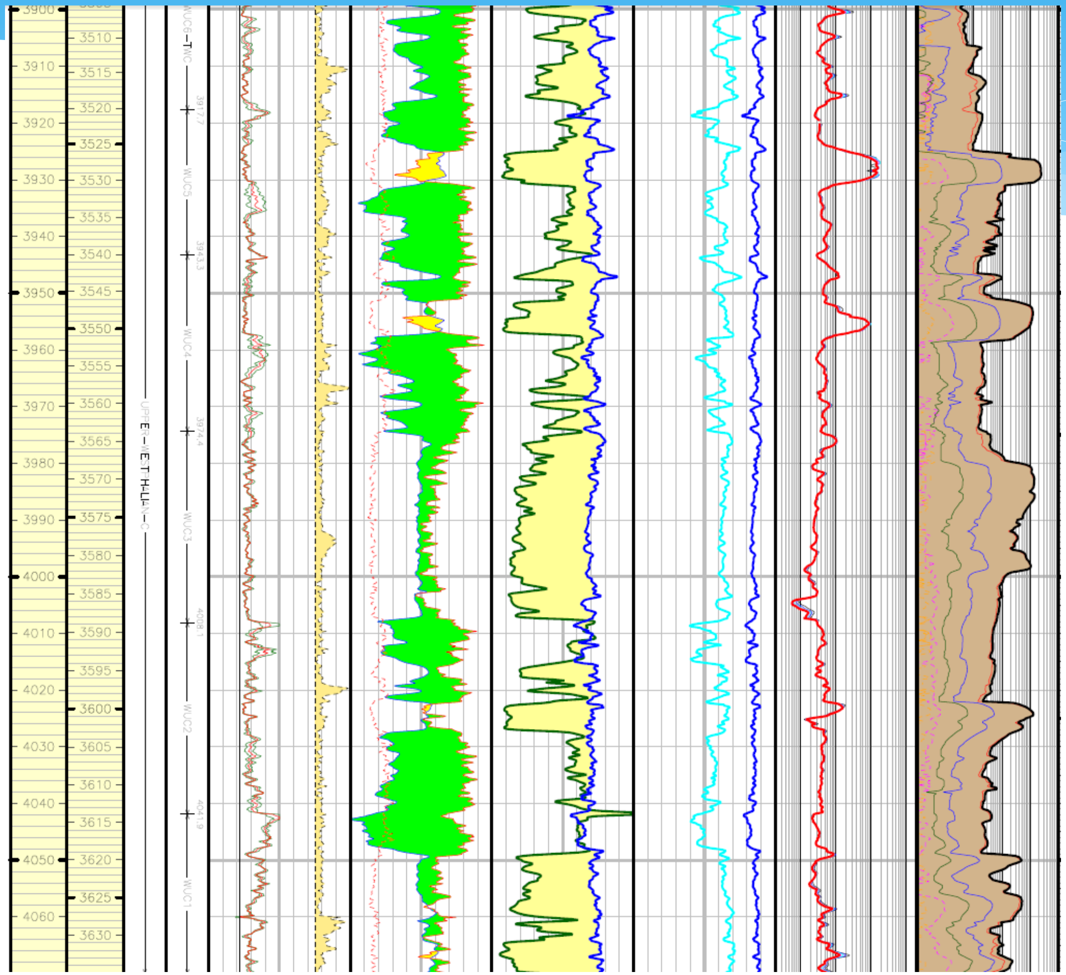


Perforations		Net Interval	
Perforated from Jan 08 till Jan 10 2013			
3879 - 3885 mRT	3805.25 - 3811.13 mTH	6m	6 spf
3923 - 3933 mRT	3849.13 - 3859.13 mTH	10m	6 spf
3949 - 3959 mRT	3875.13 - 3885.13 mTH	10m	12 spf

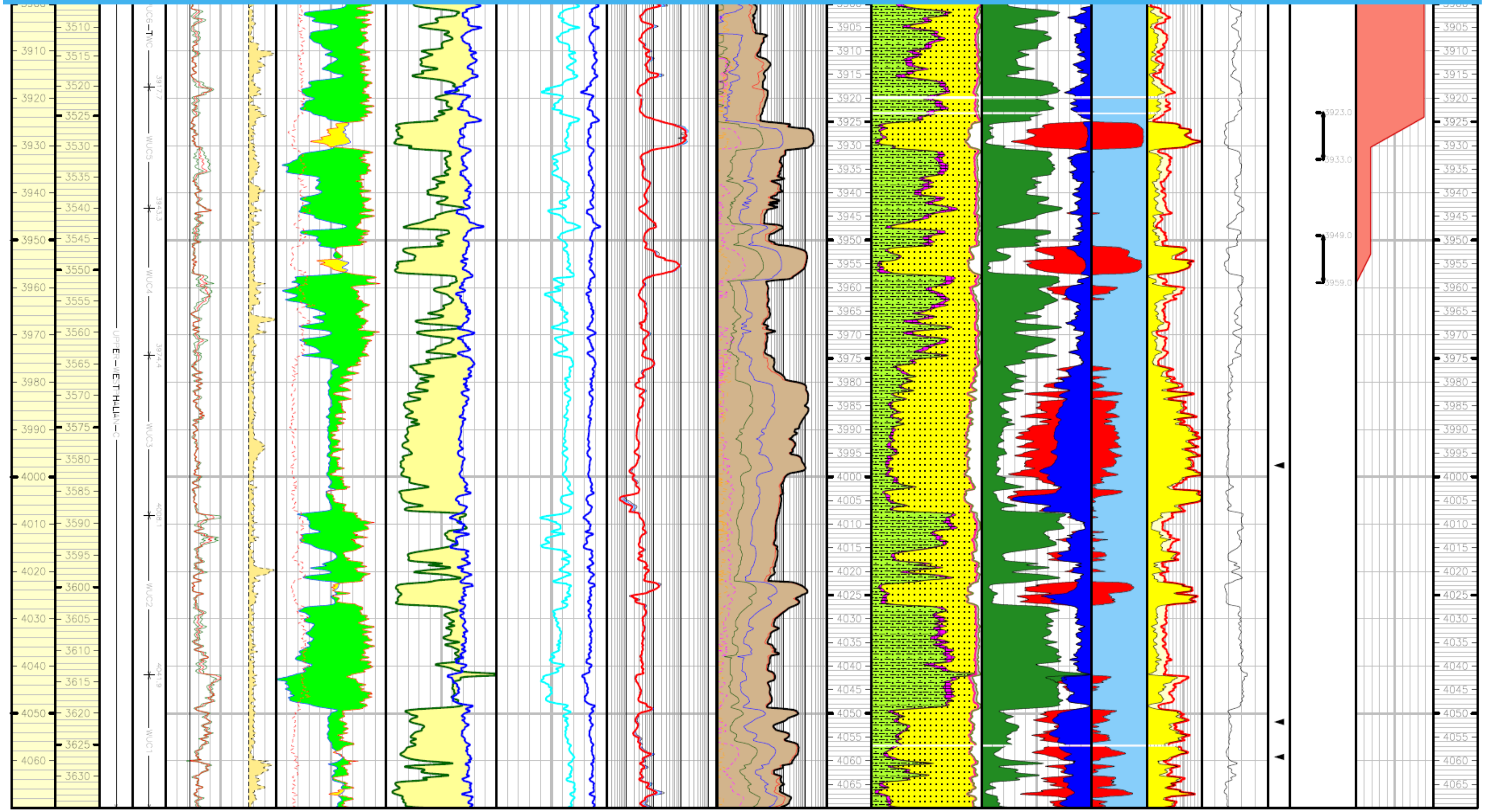
NOT NORM CLASSIFIED

Deviation @ packer depth.	34	degrees
Deviation @ reservoir	35 - 40.6	degrees

Nordzee #1 - Logs



Nordzee #1 Full Logs



Nordzee Summary

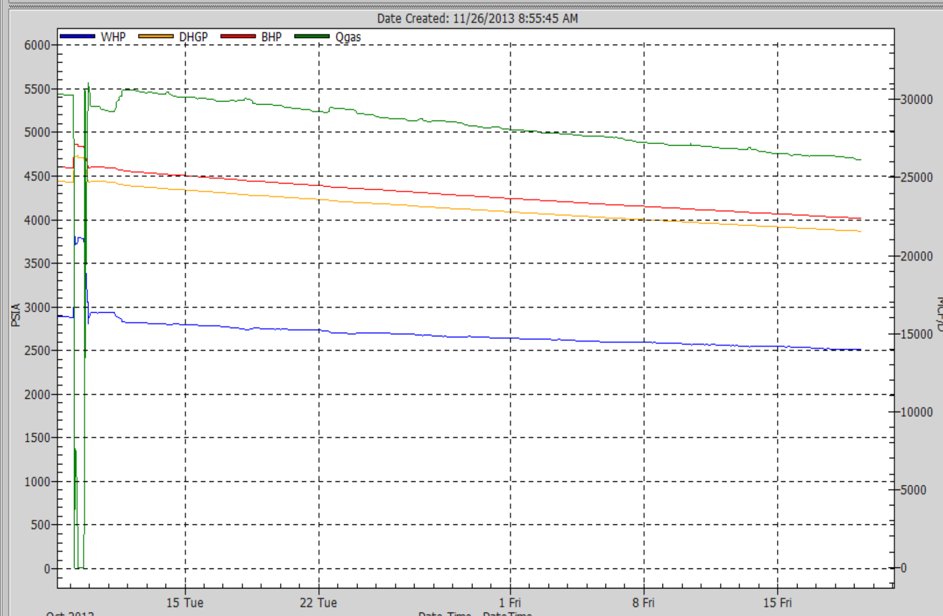
x64 Well Analyzer - C:\WORK\RT Software Demos\NordZee #1 Ex.ProData - [Real Time Testing]

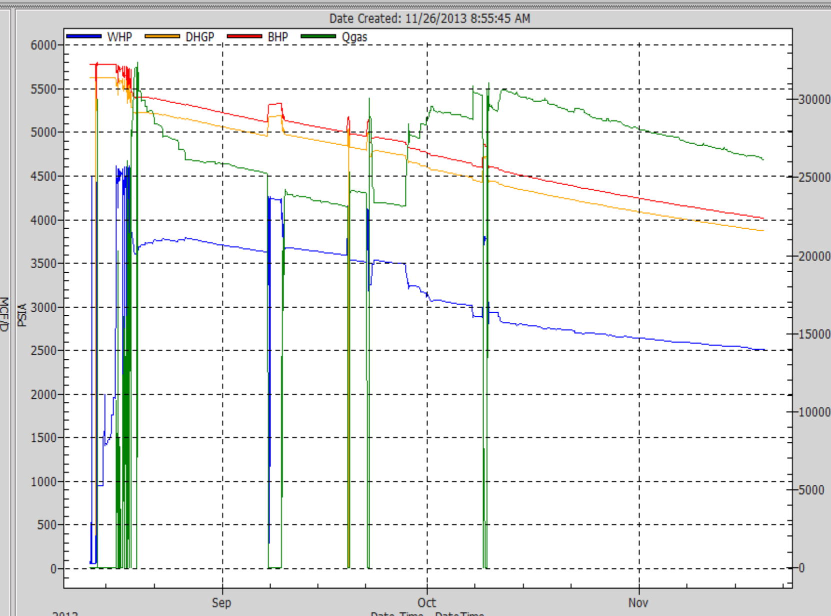
File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | P/z | Derivative | OilWaterRates | Analysis Events

	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	QGasi Mcf/D	QGas Mcf/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/MMcf	Report Link	Graph Link
1	17Aug2013 22:29:53	18Aug2013 00:17:53	1.8	PBU	4371	4587	5498	5598	5650	5745	13299	13299	119	20.3	80	5769	26	6.04	Nordzee-	Nordzee-
2	18Aug2013 03:17:53	18Aug2013 04:35:53	1.3	PBU	3991	4533	5354	5558	5519	5704	24765	24765	123.8	26.1	185	5770	22	7.46	Nordzee-	Nordzee-
3	18Aug2013 04:35:53	18Aug2013 08:47:53	4.2	DD	1699	4077	5604	5378	5751	5540	0	20196	2.2	-4.6	-1491	5536	791	-73.81	Nordzee-	Nordzee-
4	07Sep2013 17:54:53	09Sep2013 15:18:53	45.4	PBU	3624	4214	4953	5180	5113	5320	25141	25141	86	12.1	125	5361	37	4.99	Nordzee-	Nordzee-
5	19Sep2013 09:40:53	19Sep2013 13:28:53	3.8	PBU	3591	4136	4845	5028	5000	5165	23108	23108	82.7	10.5	105	5200	40	4.54	Nordzee-	Nordzee-
6	22Sep2013 03:34:53	22Sep2013 11:35:53	8.02	PBU	3514	3874	4795	4912	4951	5047	24013	24013	NaN	NaN	NaN	5166	NaN	NaN	Nordzee-	Nordzee-
7	09Oct2013 05:02:53	09Oct2013 06:29:53	1.45	PBU	2870	3709	4425	4723	4589	4855	30333	30333	86.8	14	176	4892	33	5.8	Nordzee-	Nordzee-
8	09Oct2013 09:47:53	09Oct2013 17:44:53	7.95	PBU	3735	3776	4729	4697	4863	4829	3718	3718	NaN	NaN	NaN	4852	NaN	NaN	Nordzee-	Nordzee-





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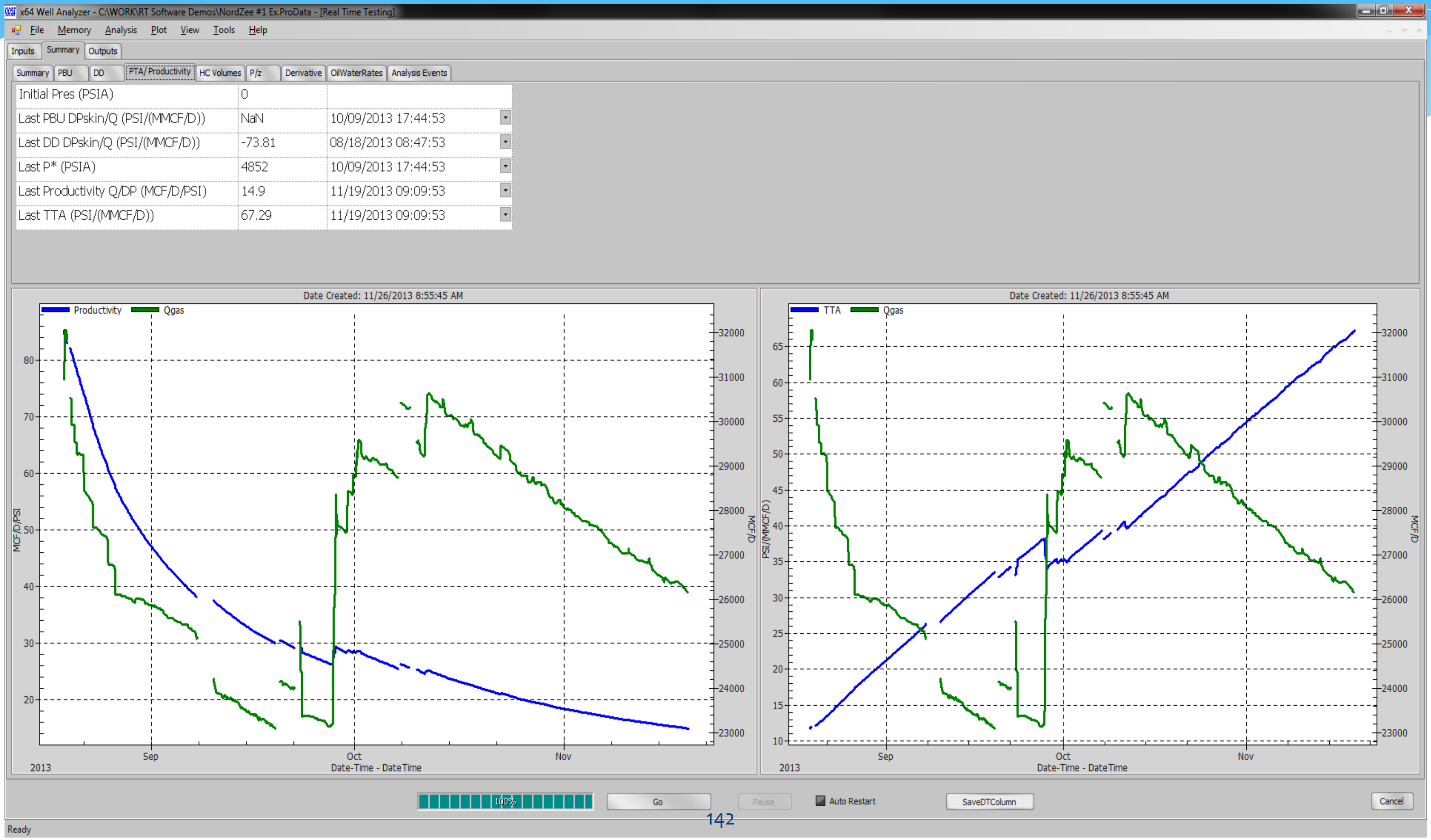
Ready

Nordzee Productivity



Nordzee – Running MBAL/EBAL

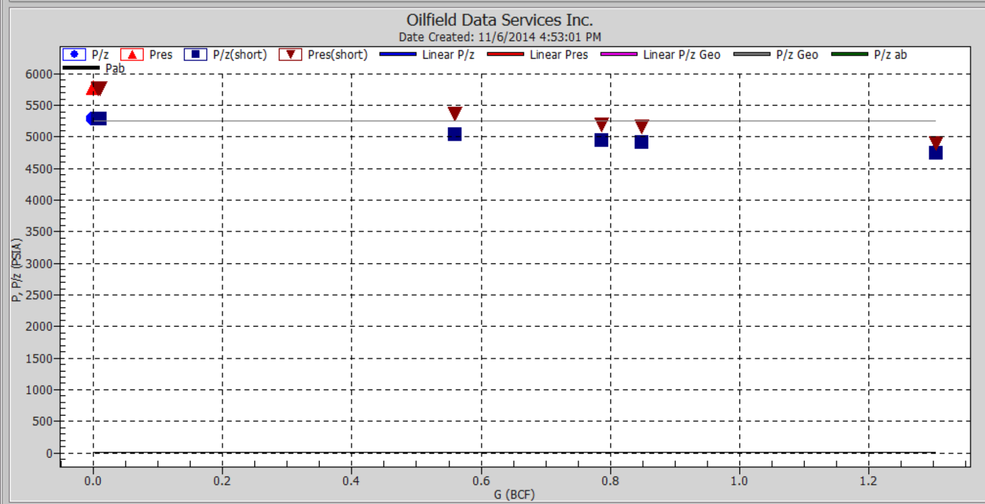
x64ODSI-Well Analyzer - C:\WORK\RT Software Demos\NordZee #1 Ex.ProData - [Real Time Testing]

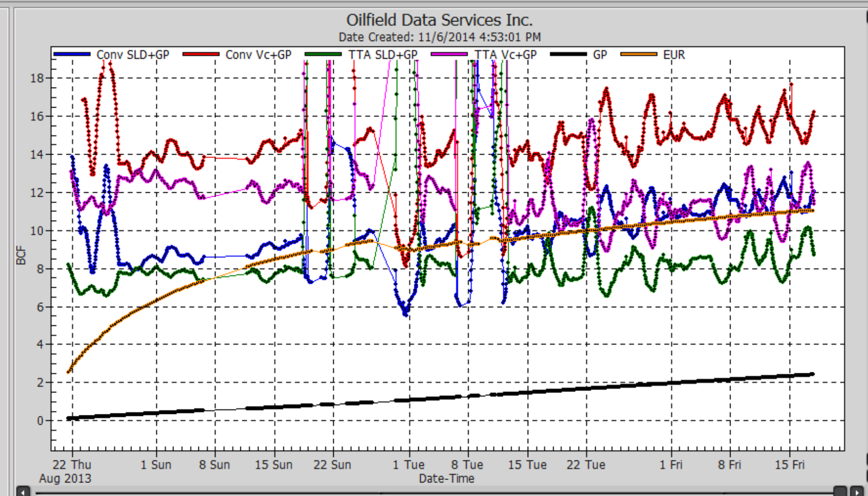
File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | P/z | Derivative | OilWaterRates | Analysis Events

Date Time	Gas Produced	PBU Duration	Pres	z-Factor	P/z	GIP SLD @P=0	GIP SLD @P|ab=15	GIP P/z @P=0	GIP P/z @P/z|ab=15	GIP P/z geo @P=0	GIP P/z geo @P/z|ab=15	m Pres	m Pz	m Pz Geo
MM/dd/yyyy HH:mm:ss	BCF	HOURS	PSIA	dimless	PSIA	BCF	BCF	BCF	BCF	BCF	BCF	PSIA/BCF	PSIA/BCF	PSIA/BC
01/01/0001 00:00:0	**0.000**		**5775**	**1.093**	**5283.2**									
08/18/2013 00:05:53	0.008	2	5770	1.093	5280.21									
08/18/2013 04:29:53	0.011	1	5770	1.093	5280.63									
09/09/2013 15:18:53	0.560	45	5361	1.063	5041.18									
09/19/2013 13:28:53	0.786	4	5200	1.052	4941.92									
09/22/2013 11:35:53	0.848	8	5166	1.050	4920.79									
10/09/2013 06:29:53	1.304	1	4892	1.031	4743.08									





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Ready

Nordzee - Conclusion

* Early PBUs occurred when well was still cleaning up – accurate for what was flowing at the time, but not whole zone
* No good drawdowns
* PBU perms around 85 md, with a skin around 13
* Apparently 15 BCF hydraulically connected
* At least 8 BCF recoverable

Deepwater Oil Well (Water?)

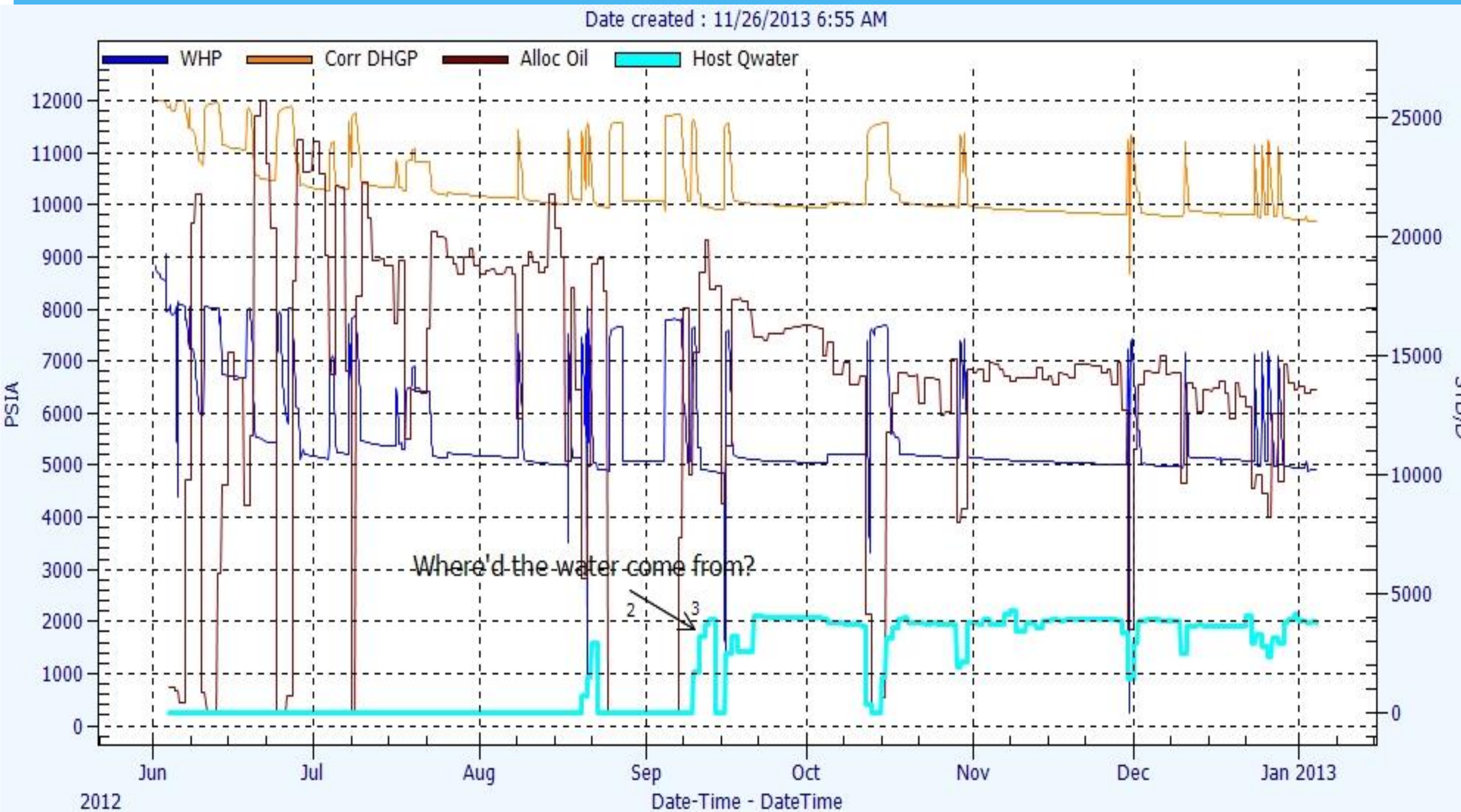
* Start-up of New Deepwater Well (subsea)

After just 3 months of Production, the well started making 4000 STB/D of WATER!

Objectives:

1) Find out where the water's coming from
2) See if it justifies a work-over

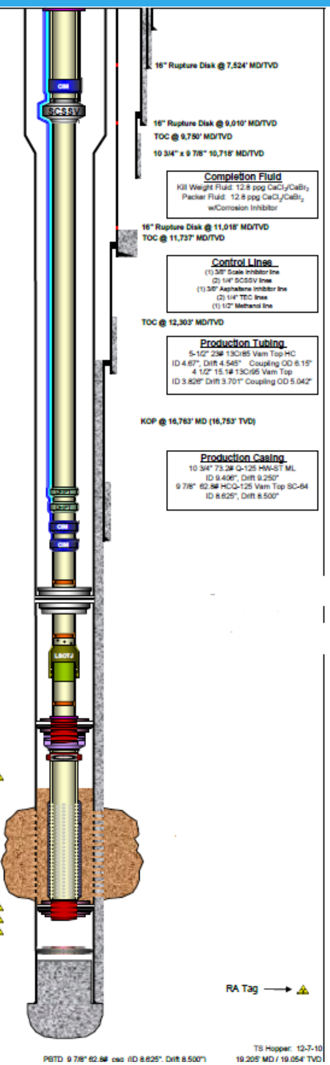
Deepwater Oil – Allocated Rates



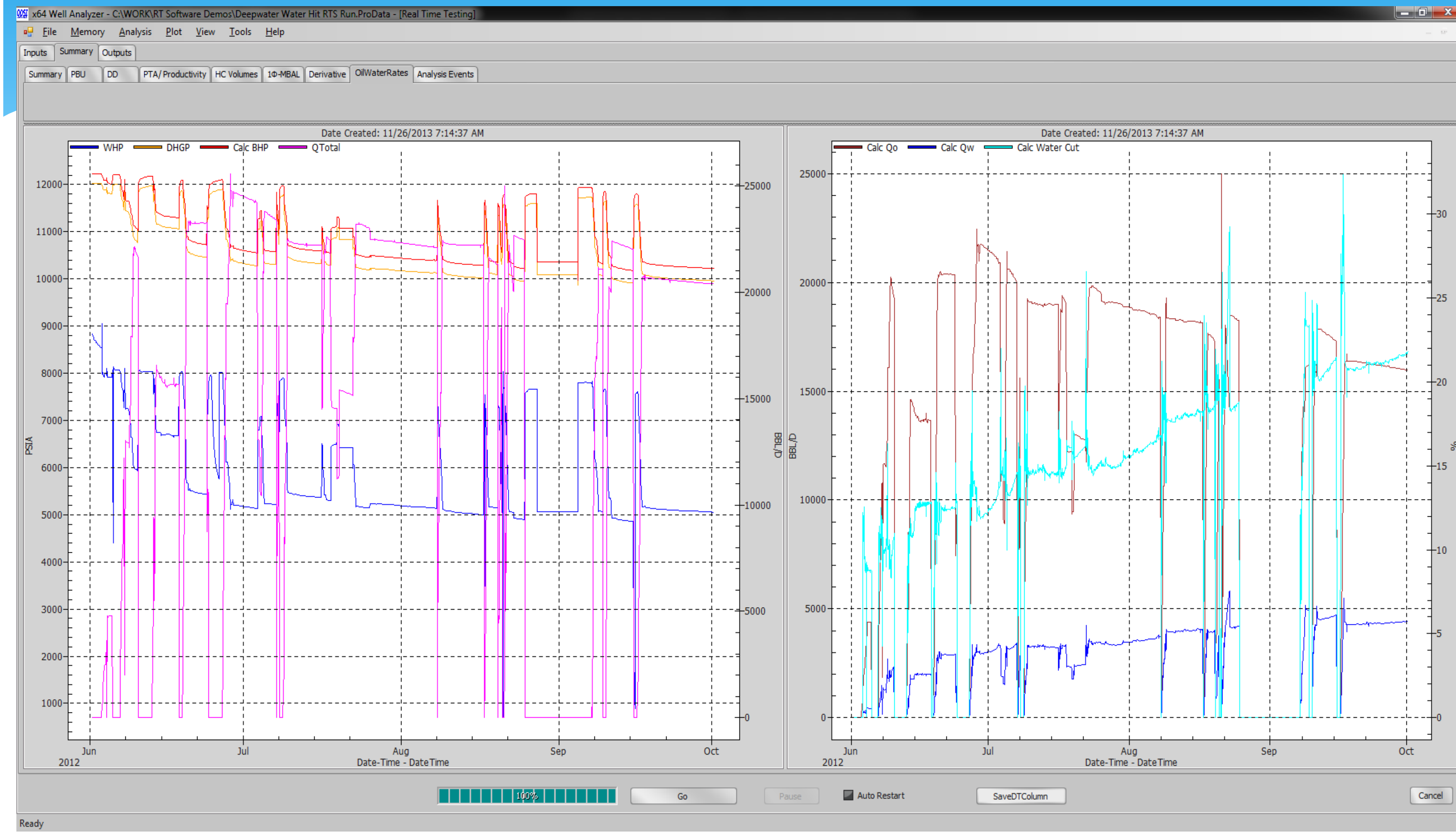
Deepwater Oil - WBS

#	Description (Datum for measurements are from top)	Depth (MD)	Depth (TVD)	Length (Pipe)	OD (Pipe)	ID (Drift)
1	Cameron 15kpsi Tubing Hanger	6,503	6,503	7.73	17.305	4.607
	Correction from E-Line to Production Tubing	6,511		-4.42		
2	5 1/2" 26.0# Vam Top HC Inc 13Cr/95 pup joint, PxP	6,506		5.52	5.500	4.670
3	5 1/2" 26.0# Vam Top HC Inc 13Cr/95 pup joint, BxP	6,512		3.41	5.500	4.670
4	5 1/2" 26.0# VTKP x 23.0# VTHC 13Cr85 Timed pup joint, BxP	6,515		8.34	5.500	4.670
5	5 1/2" 23.0# Vam Top HC 13Cr 95 ksi tubing, BxP	6,524		2,983.91	5.500	4.670
6	5 1/2" 23.0# Vam Top HC 13Cr 95 coupling, BxB	9,507		0.90	6.156	4.670
7	Methanol Inhibition mandrel 5-1/2" 23# Vam Top HC, PxP	9,508	9,508	5.94	7.588	4.560
8	5 1/2" 23.0# Vam Top HC 13Cr 95 Timed pup joint, BxP	9,514		6.43	5.500	4.670
9	X-over, 5-1/2" 23# VTHC x 4-1/2" 15.1# Vam Top, 13Cr95, BxP	9,521		2.64	5.500	4.670
10	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 95 BxB	9,523		6.52	5.042	3.798
11	SCSSV, Neptune 4-1/2" 15.1# Vam Top, w/ 3.688" R nipple PxP	9,530	9,529	14.39	7.400	3.688
12	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 95 BxP	9,544		5.89	5.063	3.809
13	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	9,550		14.55	4.500	3.826
14	4 1/2" 15.1# Vam Top 13Cr 95 tubing, BxP	9,565		8,652.77	4.500	3.826
15	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxB	18,218		10.94	4.500	3.826
16	DHPT Gauge Mandrel w/ Triple PQG gauges, PxP	18,228	18,169	8.15	7.451	3.760
17	4 1/2" 15.1# Vam Top 13Cr 95 Timed pup joint, BxB	18,237		8.92	4.500	3.789
18	DHPT Gauge Mandrel w/ Triple PQG gauges, PxP	18,246	18,185	8.15	7.451	3.760
19	4 1/2" 15.1# Vam Top 13Cr 95 Timed pup joint, BxB	18,254		6.93	4.500	3.826
20	Deep Scale Inhibition Mandrel 4 1/2" 15.1# Vam Top, PxP	18,261	18,198	5.39	6.398	3.762
21	4 1/2" 15.1# Vam Top 13Cr 95 Timed pup joint, BxB	18,266		6.84	4.500	3.826
22	Deep Asphaltene Inhibition Mandrel 4 1/2" 15.1# Vam Top, PxP	18,273	18,210	5.39	6.398	3.762
23	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,278		6.32	4.500	3.826
24	4 1/2" 15.1# Vam Top 13Cr 95 tubing, BxP (cut joint)	18,285		37.46	4.500	3.826
25	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,322		10.30	4.500	3.826
26	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 85, BxP	18,332		5.89	5.067	3.806
27	"R" Landing Nipple, 4 1/2" 15.1# Vam Top 925, BxP	18,338	18,269	1.30	5.045	3.688
28	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 85, BxP	18,340		5.90	5.067	3.806
29	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,345		6.35	4.500	3.789
30	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,352		10.21	4.500	3.789
31	HNT Production Packer, 4 1/2" 15.1# Vam Top, BxP	18,362	18,291	10.37	8.303	3.788
32	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 85, BxP	18,372		5.88	5.064	3.811
33	"R" Landing Nipple, 4 1/2" 15.1# Alloy 725/120 Vam Top, BxP	18,378	18,305	1.30	5.042	3.688
34	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 85, BxP	18,380		5.88	5.064	3.811
35	4 1/2" 15.1# Vam Top 13Cr 95 perforated pup joint, BxP	18,385		6.32	4.500	3.794
36	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,392		10.33	4.500	3.789
37	X-over, 4 1/2" 15.1# Vam Top Pin x 6 5/8" 32# VTKP SC-80 Box	18,402		2.04	6.676	3.790
38	6 5/8" 32# Vam Top KP SC-80, BxP, 13Cr85 tubing, LSOTJ	18,404		41.12	6.635	5.635
39	6 5/8" 32# Vam Top KP SC-80, BxP, 13Cr85 tubing, LSOTJ	18,445		81.53	6.635	5.635
40	6 5/8" 32# Vam Top KP SC-80, BxP, 13Cr85, pup joint, LSOTJ	18,527		10.43	6.635	5.635
41	LSOTJ metered (Outer Upper Assembly)	18,537		1.20	7.420	5.070
42	LSOTJ metered (Outer Lower Assembly)	18,538		4.10	7.420	5.070
43	End of LSOTJ Assembly	18,543			7.420	5.070
45	neck of telescoping assembly joint- Stroke begins	18,487		0.96	4.529	3.804
46	4 1/2" 15.1# Vam FJL BxP, 13Cr95 production tubing	18,489		82.19	4.529	3.804
47	4 1/2" 15.1# Vam FJL BxP, 13Cr95 production tubing	18,571		41.06	4.529	3.804
48	X-over pup, 4 1/2" 15.1# Vam FJL Box x Vam Top Pin, 13Cr95	18,612		9.88	4.529	3.804
49	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,622		10.23	4.500	3.790
50	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 85, BxP	18,632		5.89	5.042	3.798
51	"R" Landing Nipple, 4 1/2" 15.1# Alloy 725/120 Vam Top, BxP	18,638	18,541	1.29	5.060	3.688
52	Flow Coupling, 4 1/2" 15.1# Vam Top 13Cr 85, BxP	18,639		5.89	5.063	3.809
53	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,645		6.32	4.500	3.790
54	4 1/2" 15.1# Vam Top 13Cr 95 pup joint, BxP	18,651		8.31	4.500	3.793
55	PFZ Ratchet latch Locator, 4 1/2" 15.1# Vam Top, 925	18,660	18,561	2.06	6.819	3.793
56	MSH Molded HNBR Seal Unit, 5 1/2" 20# Vam Top KP SC-80, BxP, 925	18,662		6.26	6.000	4.763
57	Seal Extension, 5 1/2" 20# Vam Top KP SC-80 BxP, 925	18,668		8.04	5.980	4.763
58	MSH Molded HNBR Seal Unit, 5 1/2" 20# Vam Top KP SC-80, BxP, 925	18,676		6.26	6.000	4.763
59	Seal Extension, 5 1/2" 20# Vam Top KP SC-80 BxP, 925	18,682		8.04	5.980	4.766
60	SDG Self Aligning Mule Shoe, 5 1/2" 20# Vam Top KP SC-80, 13Cr80	18,690		3.51	5.946	4.766
61	End of Mule Shoe	18,694				
62	Completion Assembly					
63	HES VCA Versa-Trieve 12.5k GP Packer, 718, HNBR	18,659	18,561	14.64	8.305	6.000
64	HES Circ. Housing w/ MCS closure sleeve	18,674		6.46	8.300	6.000
65	X-over, 7 5/8" 42.8# AB-HDL Box x 5 1/2" 23# Vam Top HC Pin, 925	18,681		25.08	7.638	6.010
66	5 1/2" 23# Vam Top HC BxP Make-up sub, Inc 925	18,706		3.56	7.247	4.590
67	5 1/2" 23# Vam Top HC BxP pup joint, 13Cr85	18,709		4.18	5.508	4.569
68	5 1/2" 23# Vam Top HC BxP pup joint, 13Cr85	18,713		8.42	5.508	4.569
69	FS-2 Formation Isolation Valve 5 1/2" 23# Inc 718 Vam Top HC	18,722	18,617	17.00	8.010	3.870
70	5 1/2" 23# Vam Top HC BxP pup joint, 13Cr85	18,739		6.41	5.508	4.569
71	5 1/2" 23# Vam Top HC BxP pup joint, 13Cr85	18,745		8.34	5.508	4.597
72	5 1/2" 23# Vam Top HC, MJS Shear Sub, (90K shear), Inc 925 BxP	18,754		2.72	6.527	4.597
73	5 1/2" 23# Vam Top HC BxP pup joint, 13Cr85	18,756		6.35	5.508	4.612
74	5 1/2" 23# 13Cr85 Vam Top HC Blank Pipe w/ Centralizers	18,763		86.96	5.547	4.612
75	5 1/2" 23# 13Cr85 Vam Top HC Premium Screen 175 mesh	18,850		120.40	5.547	4.612
76	Top Snap, 5 1/2" 23# Vam Top HC Box x 17# Vam Top SC80 Pin	18,970	18,842	1.33	6.185	4.562
77	HMBR Seal assembly w/ self aligning shoe 13Cr80	18,971		42.84	5.950	4.675
78	End of Guide Shoe	19,014				
79						
80	Sump Packer Assembly (Wireline Set)					
81	Sump Packer, (HMBR) w/ mule shoe	18,970	18,842	6.77	8.310	6.000
82	Bottom of Packer	18,977				
83						
84	Steel Bridge Plug	19,060	18,942			
85	Top of Cement	19,097	18,957			17.000

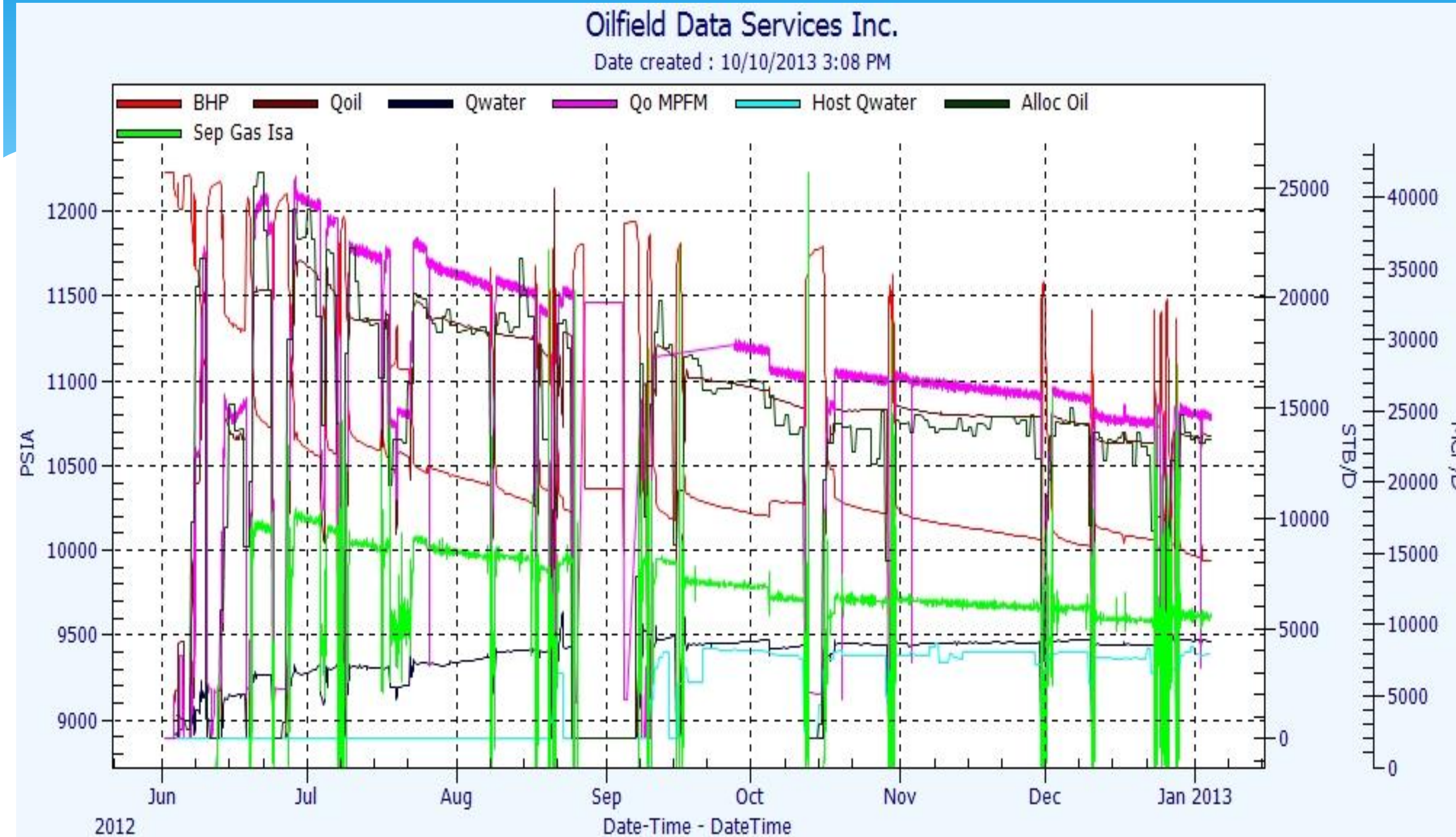
PBTD 9 7/8" 62.8# csg (ID 8.625", Drift 8.500")



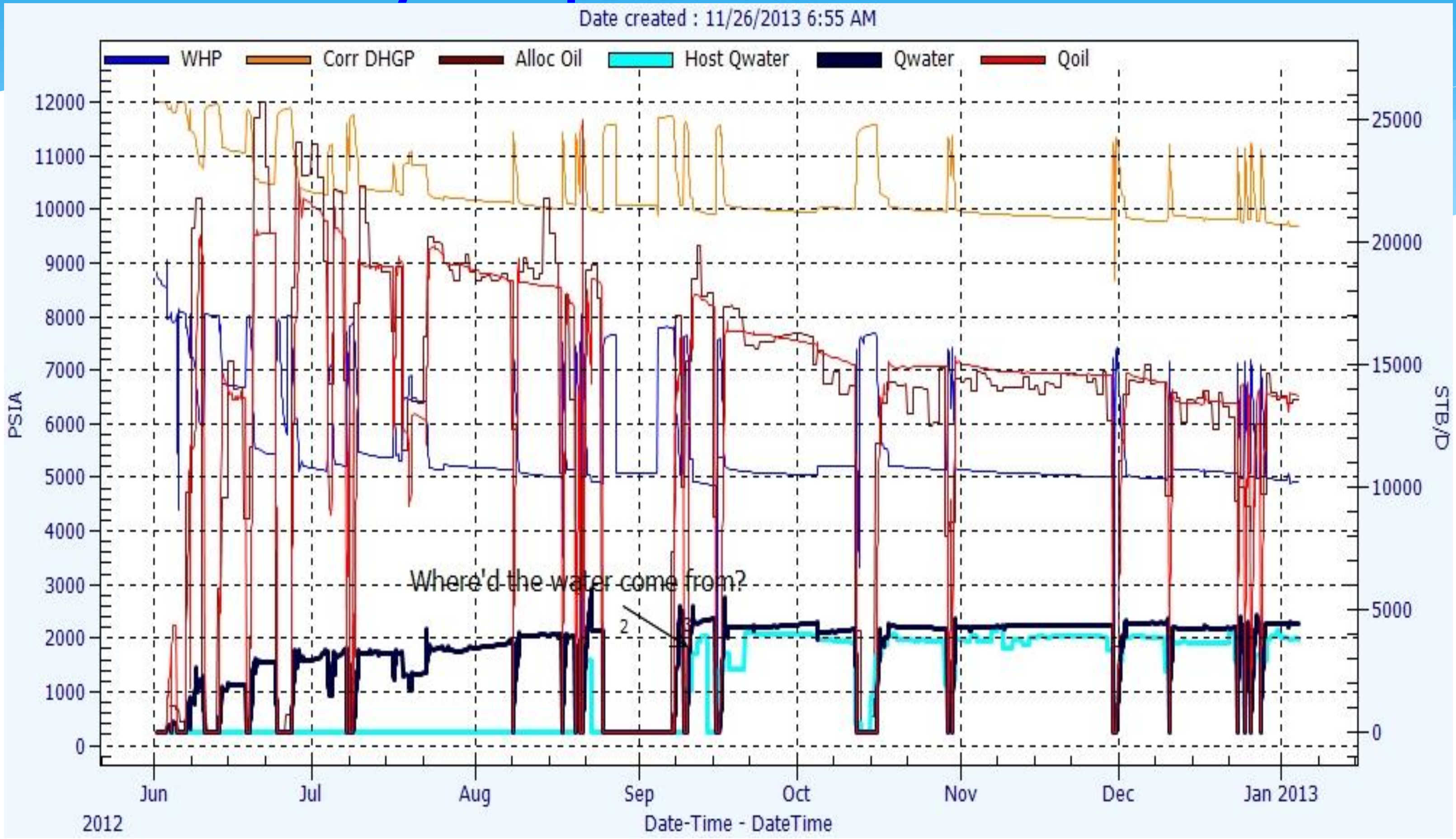
Deepwater Oil – Calc Rates Summary



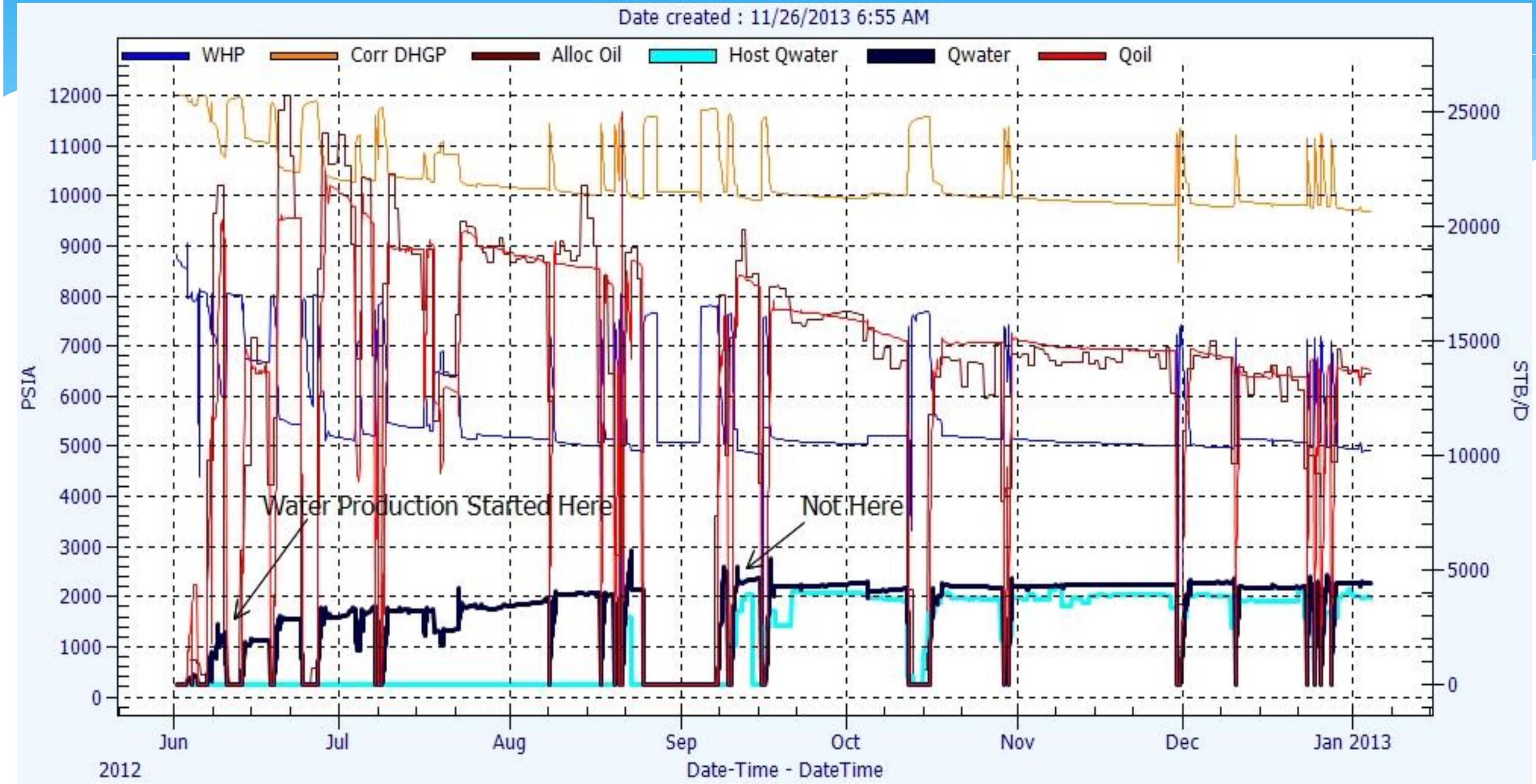
Cash Money #2 - Deepwater Rates & BHPs



Cash Money - Deepwater GOM - Calc Water Rates



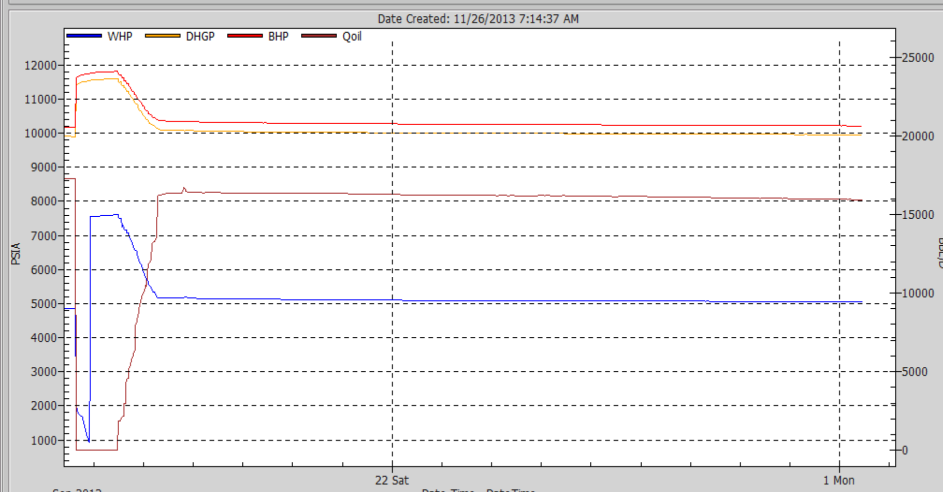
When did the Water Production Begin???

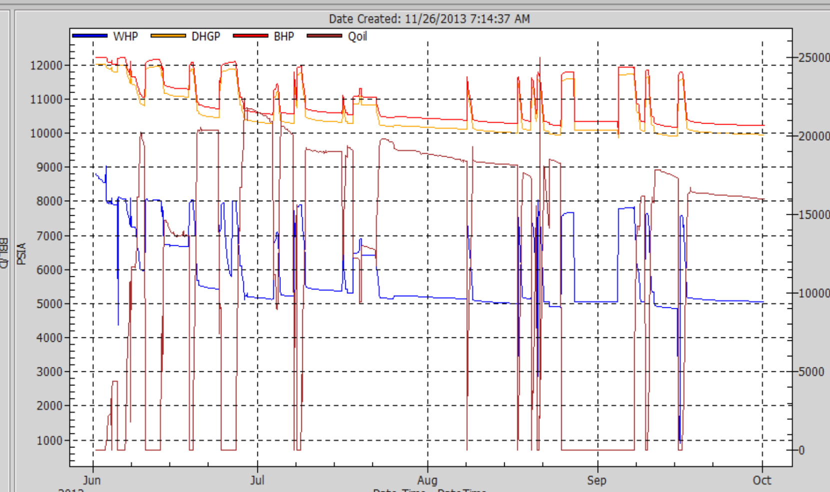


YES… ALLOCATIONS REALLY ARE THIS BAD!!

Deepwater Oil – RTS Summary

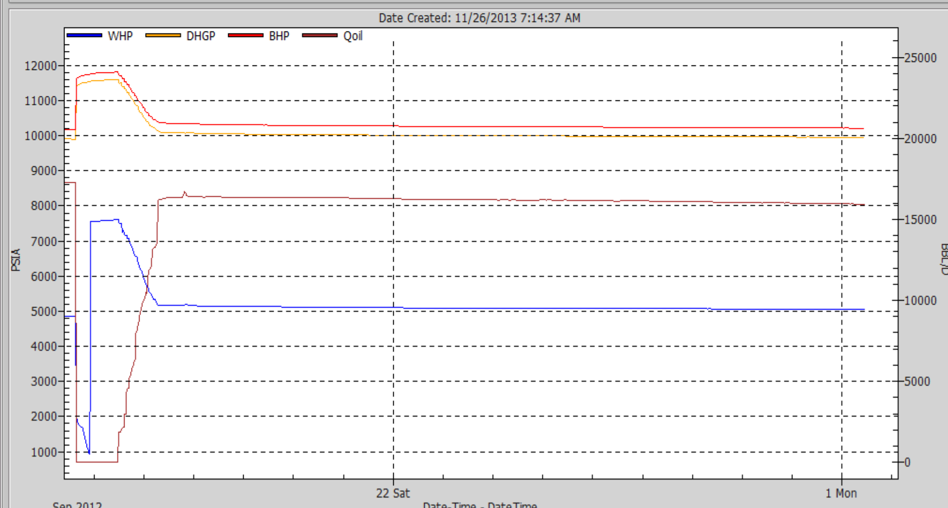
	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	Qoil_i BBL/D	Qoil BBL/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/BBL	Report Link	Graph Link
1	05Jun2012 10:24:00	06Jun2012 22:56:00	36.53	PBU	7915	8063	11803	12011	12010	12221	4380	4380	447.2	0.8	21	12241	88	0	RTRep_2012Jun05_10240	RTRep_2012Jun05_10240
2	10Jun2012 10:44:00	13Jun2012 07:11:00	68.45	PBU	5923	8032	10769	11973	11027	12183	19303	19303	486	3.3	335	12283	65	0.02	RTRep_2012Jun10_10440	RTRep_2012Jun10_10440
3	18Jun2012 13:05:00	19Jun2012 04:11:00	15.1	PBU	6665	8032	11058	11890	11293	12095	13665	13665	244.2	-1.6	-220	12271	135	-0.02	RTRep_2012Jun18_13050	RTRep_2012Jun18_13050
4	19Jun2012 04:11:00	24Jun2012 07:37:00	123.43	DD	8030	7188	11888	11290	12094	11509	0	20300	106.1	-4.6	-2191	10558	582	-0.11	RTRep_2012Jun19_04110	RTRep_2012Jun19_04110
5	24Jun2012 07:37:00	27Jun2012 00:33:00	64.93	PBU	7189	8021	11290	11898	11509	12105	9070	9070	358.4	0.6	39	12245	91	0	RTRep_2012Jun24_07370	RTRep_2012Jun24_07370
6	27Jun2012 00:33:00	03Jul2012 20:48:00	164.25	DD	8021	5126	11898	10273	12105	10547	0	17402	48.2	-5.6	-5243	10385	1389	-0.3	RTRep_2012Jun27_00330	RTRep_2012Jun27_00330
7	08Jul2012 03:20:00	08Jul2012 23:54:00	20.57	PBU	6089	7917	10711	11777	10957	11983	15631	15631	522.6	5.6	426	12145	53	0.03	RTRep_2012Jul08_03200	RTRep_2012Jul08_03200
8	08Jul2012 23:54:00	16Jul2012 10:05:00	178.18	DD	7916	5365	11776	10320	11982	10584	0	19148	311.8	0.8	125	10497	88	0.01	RTRep_2012Jul08_23540	RTRep_2012Jul08_23540
9	20Aug2012 19:59:30	21Aug2012 07:59:30	12	PBU	5533	7700	10306	11589	10560	11796	15579	15579	241.4	0.4	63	12034	94	0	RTRep_2012Aug20_19593	RTRep_2012Aug20_19593
10	21Aug2012 10:33:30	25Aug2012 06:29:30	91.93	2-Rate	7255	4891	11296	9939	11511	10208	3207	13735	231.6	0.5	77	11280	92	0.01	RTRep_2012Aug21_10333	RTRep_2012Aug21_10333
11	25Aug2012 06:29:30	07Sep2012 13:14:30	318.75	PBU	4894	7805	9940	11731	10209	11940	18213	18213	614.6	13	981	11996	33	0.05	RTRep_2012Aug25_06293	RTRep_2012Aug25_06293
12	09Sep2012 15:10:30	10Sep2012 04:08:30	12.97	PBU	5043	7635	10044	11652	10310	11867	16157	16157	589.8	14.2	1008	12028	31	0.06	RTRep_2012Sep09_15103	RTRep_2012Sep09_15103

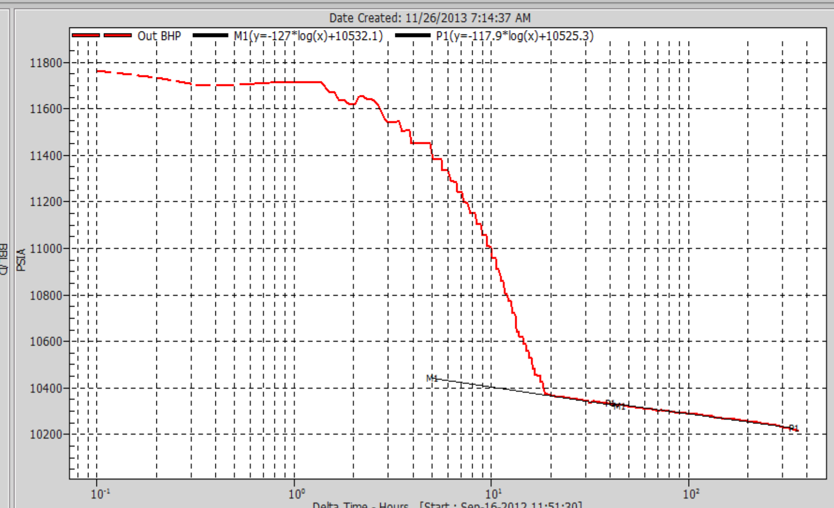




Deepwater Oil – PBU Summary

	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	Qoil_i BBL/D	Qoil BBL/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/BBL	Report Link	Graph Link
1	05Jun2012 10:24:00	06Jun2012 22:56:00	36.53	PBU	7915	8063	11803	12011	12010	12221	4380	4380	447.2	0.8	21	12241	88	0	RTRep_2012Jun05_10240	RTRep_2012Jun05_10240
2	10Jun2012 10:44:00	13Jun2012 07:11:00	68.45	PBU	5923	8032	10769	11973	11027	12183	19303	19303	486	3.3	335	12283	65	0.02	RTRep_2012Jun10_10440	RTRep_2012Jun10_10440
3	18Jun2012 13:05:00	19Jun2012 04:11:00	15.1	PBU	6665	8032	11058	11890	11293	12095	13665	13665	244.2	-1.6	-220	12271	135	-0.02	RTRep_2012Jun18_13050	RTRep_2012Jun18_13050
4	24Jun2012 07:37:00	27Jun2012 00:33:00	64.93	PBU	7189	8021	11290	11898	11509	12105	9070	9070	358.4	0.6	39	12245	91	0	RTRep_2012Jun24_07370	RTRep_2012Jun24_07370
5	08Jul2012 03:20:00	08Jul2012 23:54:00	20.57	PBU	6089	7917	10711	11777	10957	11983	15631	15631	522.6	5.6	426	12145	53	0.03	RTRep_2012Jul08_03200	RTRep_2012Jul08_03200
6	20Aug2012 19:59:30	21Aug2012 07:59:30	12	PBU	5533	7700	10306	11589	10560	11796	15579	15579	241.4	0.4	63	12034	94	0	RTRep_2012Aug20_19593	RTRep_2012Aug20_19593
7	25Aug2012 06:29:30	07Sep2012 13:14:30	318.75	PBU	4894	7805	9940	11731	10209	11940	18213	18213	614.6	13	981	11996	33	0.05	RTRep_2012Aug25_06293	RTRep_2012Aug25_06293
8	09Sep2012 15:10:30	10Sep2012 04:08:30	12.97	PBU	5043	7635	10044	11652	10310	11867	16157	16157	589.8	14.2	1008	12028	31	0.06	RTRep_2012Sep09_15103	RTRep_2012Sep09_15103
9	15Sep2012 15:23:30	16Sep2012 11:51:30	20.47	PBU	4852	7608	9903	11605	10172	11818	17270	17270	389.6	6.8	774	12005	48	0.04	RTRep_2012Sep15_15233	RTRep_2012Sep15_15233





Deepwater Oil – DD Summary

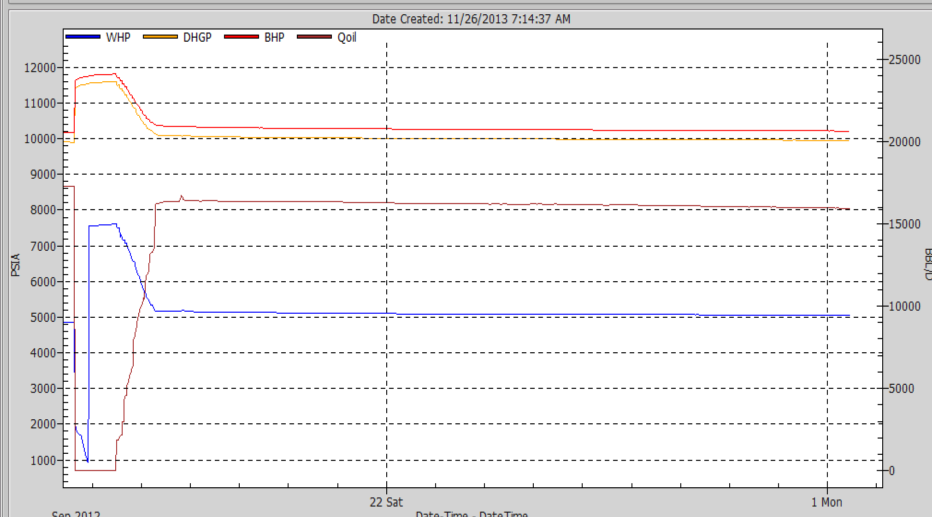
x64 Well Analyzer - C:\WORK\RT Software Demos\Deepwater Water Hit RTS Run.ProData - [Real Time Testing]

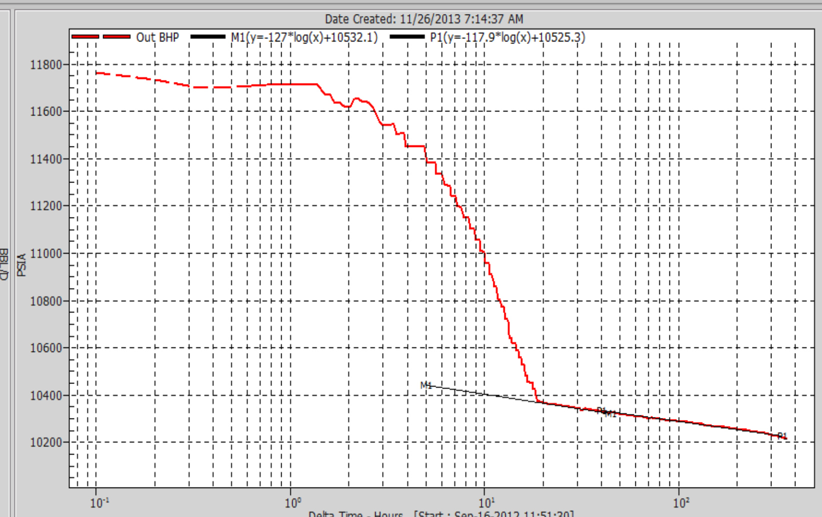
File Memory Analysis Plot View Tools Help

Inputs | Summary | Outputs

Summary | PBU | DD | PTA/ Productivity | HC Volumes | 1Φ-MBAL | Derivative | OilWaterRates | Analysis Events

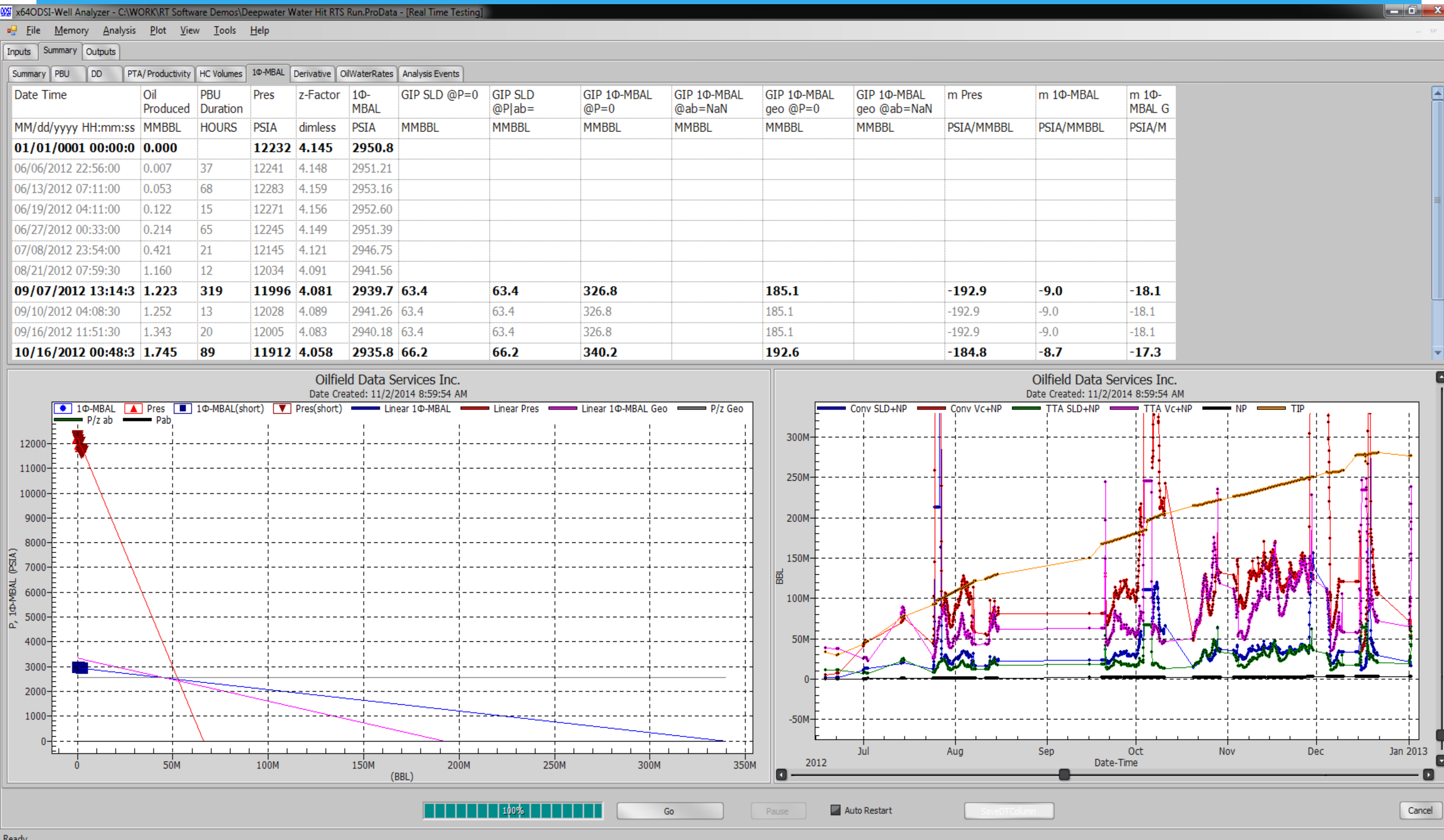
	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	Qoil_i BBL/D	Qoil BBL/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/BBL	Report Link	Graph Link
1	19Jun2012 04:11:00	24Jun2012 07:37:00	123.43	DD	8030	7188	11888	11290	12094	11509	0	20300	106.1	-4.6	-2191	10558	582	-0.11	RTRep_2012Jun19_04110	RTRep_2012Jun19_04110
2	27Jun2012 00:33:00	03Jul2012 20:48:00	164.25	DD	8021	5126	11898	10273	12105	10547	0	17402	48.2	-5.6	-5243	10385	1389	-0.3	RTRep_2012Jun27_00330	RTRep_2012Jun27_00330
3	08Jul2012 23:54:00	16Jul2012 10:05:00	178.18	DD	7916	5365	11776	10320	11982	10584	0	19148	311.8	0.8	125	10497	88	0.01	RTRep_2012Jul08_23540	RTRep_2012Jul08_23540
4	21Aug2012 10:33:30	25Aug2012 06:29:30	91.93	2-Rate	7255	4891	11296	9939	11511	10208	3207	13735	231.6	0.5	77	11280	92	0.01	RTRep_2012Aug21_10333	RTRep_2012Aug21_10333
5	10Sep2012 04:08:30	11Sep2012 07:33:30	27.42	DD	7671	5108	11652	10094	11864	10360	0	15836	129.4	-2.7	-807	9881	188	-0.05	RTRep_2012Sep10_04083	RTRep_2012Sep10_04083
6	16Sep2012 11:51:30	01Oct2012 11:18:30	359.45	DD	7608	5048	11605	9953	11818	10215	0	16325	358.8	5.4	600	10172	53	0.04	RTRep_2012Sep16_11513	RTRep_2012Sep16_11513





100%
Go
Pause
Auto Restart
SaveDTColumn
Cancel
Ready

How Much Oil Should it Produce?



Date Time	Oil Produced	PBU Duration	Pres	z-Factor	1Φ-MBAL	GIP SLD @P=0	GIP SLD @P|ab=	GIP 1Φ-MBAL @P=0	GIP 1Φ-MBAL @ab=NaN	GIP 1Φ-MBAL geo @P=0	GIP 1Φ-MBAL geo @ab=NaN	m Pres	m 1Φ-MBAL	m 1Φ-MBAL G
MM/dd/yyyy HH:mm:ss	MMBBL	HOURS	PSIA	dimless	PSIA	MMBBL	MMBBL	MMBBL	MMBBL	MMBBL	MMBBL	PSIA/MMBBL	PSIA/MMBBL	PSIA/M
01/01/0001 00:00:0	**0.000**		**12232**	**4.145**	**2950.8**									
06/06/2012 22:56:00	0.007	37	12241	4.148	2951.21									
06/13/2012 07:11:00	0.053	68	12283	4.159	2953.16									
06/19/2012 04:11:00	0.122	15	12271	4.156	2952.60									
06/27/2012 00:33:00	0.214	65	12245	4.149	2951.39									
07/08/2012 23:54:00	0.421	21	12145	4.121	2946.75									
08/21/2012 07:59:30	1.160	12	12034	4.091	2941.56									
09/07/2012 13:14:3	**1.223**	**319**	**11996**	**4.081**	**2939.7**	**63.4**	**63.4**	**326.8**		**185.1**		**-192.9**	**-9.0**	**-18.1**
09/10/2012 04:08:30	1.252	13	12028	4.089	2941.26	63.4	63.4	326.8		185.1		-192.9	-9.0	-18.1
09/16/2012 11:51:30	1.343	20	12005	4.083	2940.18	63.4	63.4	326.8		185.1		-192.9	-9.0	-18.1
10/16/2012 00:48:3	**1.745**	**89**	**11912**	**4.058**	**2935.8**	**66.2**	**66.2**	**340.2**		**192.6**		**-184.8**	**-8.7**	**-17.3**

Deepwater Oil - Conclusions

- Err… no need to panic, it's been making water since Day One
- Min In-place oil = 65 MM STB
- Max In-place oil = 260 MM STB
- Min recoverable oil = 40-ish MM STB

- Enough Oil to justify work-over… but, the well doesn't need a work-over

Deep GOM Shelf – Gas/Condensate

- 18,000 psia Pinitial; 330 degF
- Initial Flowback – 20 MMscf/D; 400 BOPD

- Objectives:
  - Can we pull it harder?
  - How big is it?
  - No, really… how big is it? How much is water?
  - What's up with the perms being all over the place?

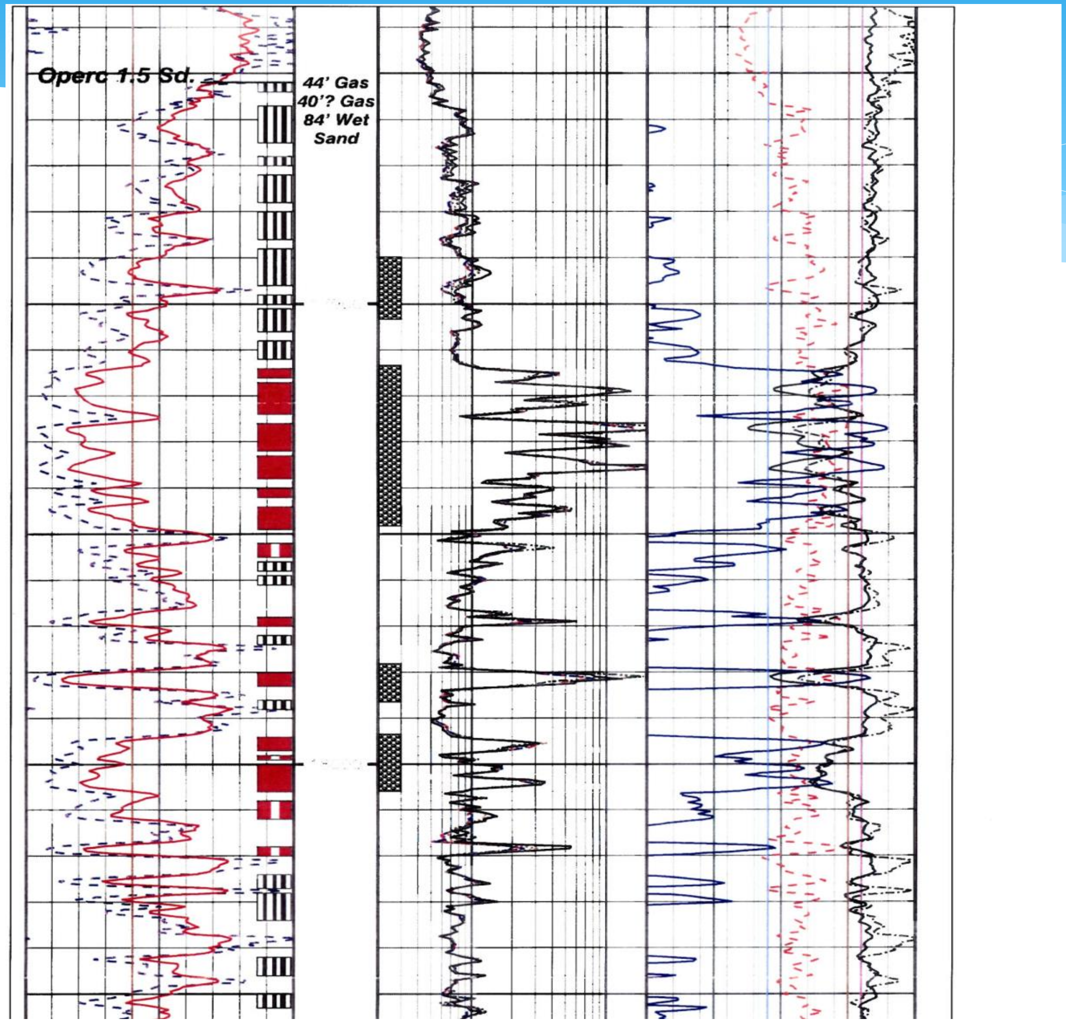
GOM Shelf IPT

- Gulf Of Mexico Gas Condensate Well
- Has SCADA WHP Gauge + Instant Seperator Gas and Periodic Liquid Rates
- Have To Apply Liquid Residence Time

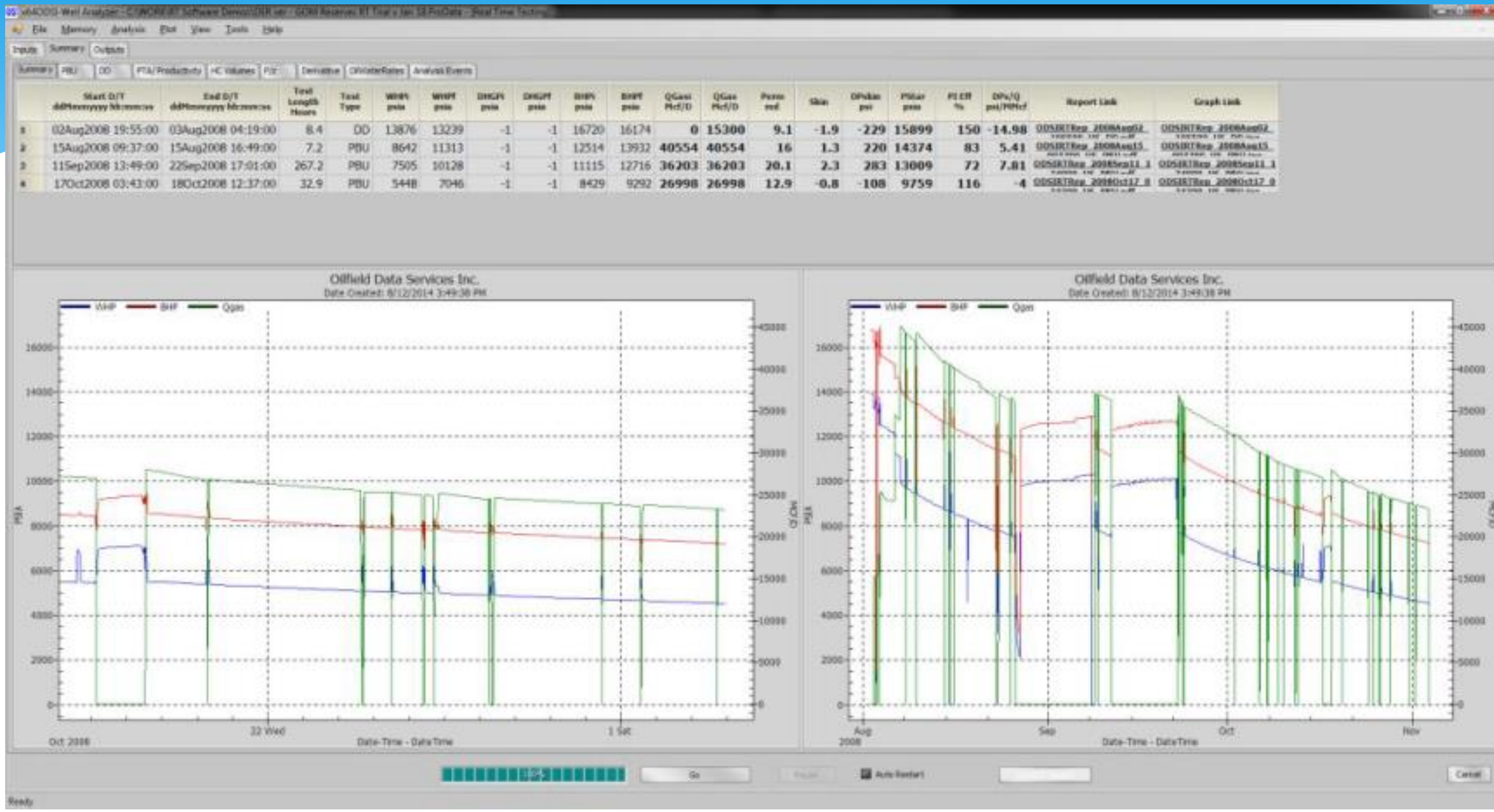
(Else Turbine Meter Data Would Result In High Or Low Rates Due To Separator Dumps)

- **Objectives:**
  - Calculate Liquid Rates
  - Analyze Build-up Tests
  - Split Apparent Reserves into Components

Logs – GOM Shelf



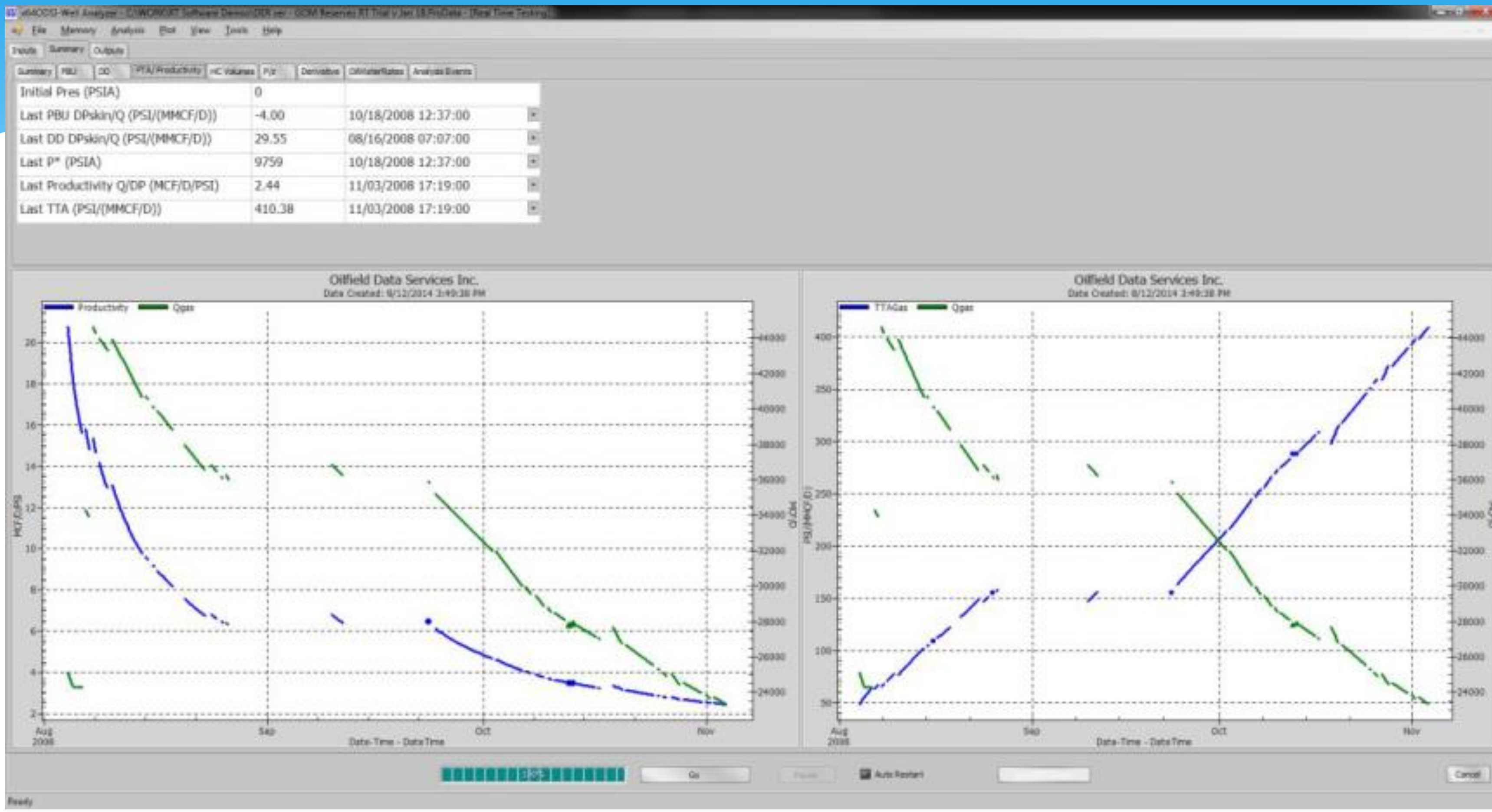
GOM Shelf IPT



	Start D/T ddMmmyyyy hh:mm:ss	End D/T ddMmmyyyy hh:mm:ss	Test Length Hours	Test Type	WHPi psia	WHPf psia	DHGPi psia	DHGPf psia	BHPi psia	BHPf psia	QGasi Mcf/D	QGas Mcf/D	Perm md	Skin	DPskin psi	PStar psia	PI Eff %	DPs/Q psi/MMcf	Report Link	Graph Link
1	02Aug2008 19:55:00	03Aug2008 04:19:00	8.4	DD	13876	13239	-1	-1	16720	16174	0	15300	9.1	-1.9	-229	15899	150	-14.98	[illegible]	[illegible]
2	15Aug2008 09:37:00	15Aug2008 16:49:00	7.2	PBU	8642	11313	-1	-1	12514	13932	40554	40554	16	1.3	220	14374	83	5.41	[illegible]	[illegible]
3	11Sep2008 13:49:00	22Sep2008 17:01:00	267.2	PBU	7505	10128	-1	-1	11115	12716	36203	36203	20.1	2.3	283	13009	72	7.81	[illegible]	[illegible]
4	17Oct2008 03:43:00	18Oct2008 12:37:00	32.9	PBU	5448	7046	-1	-1	8429	9292	26998	26998	12.9	-0.8	-108	9759	116	-4	[illegible]	[illegible]

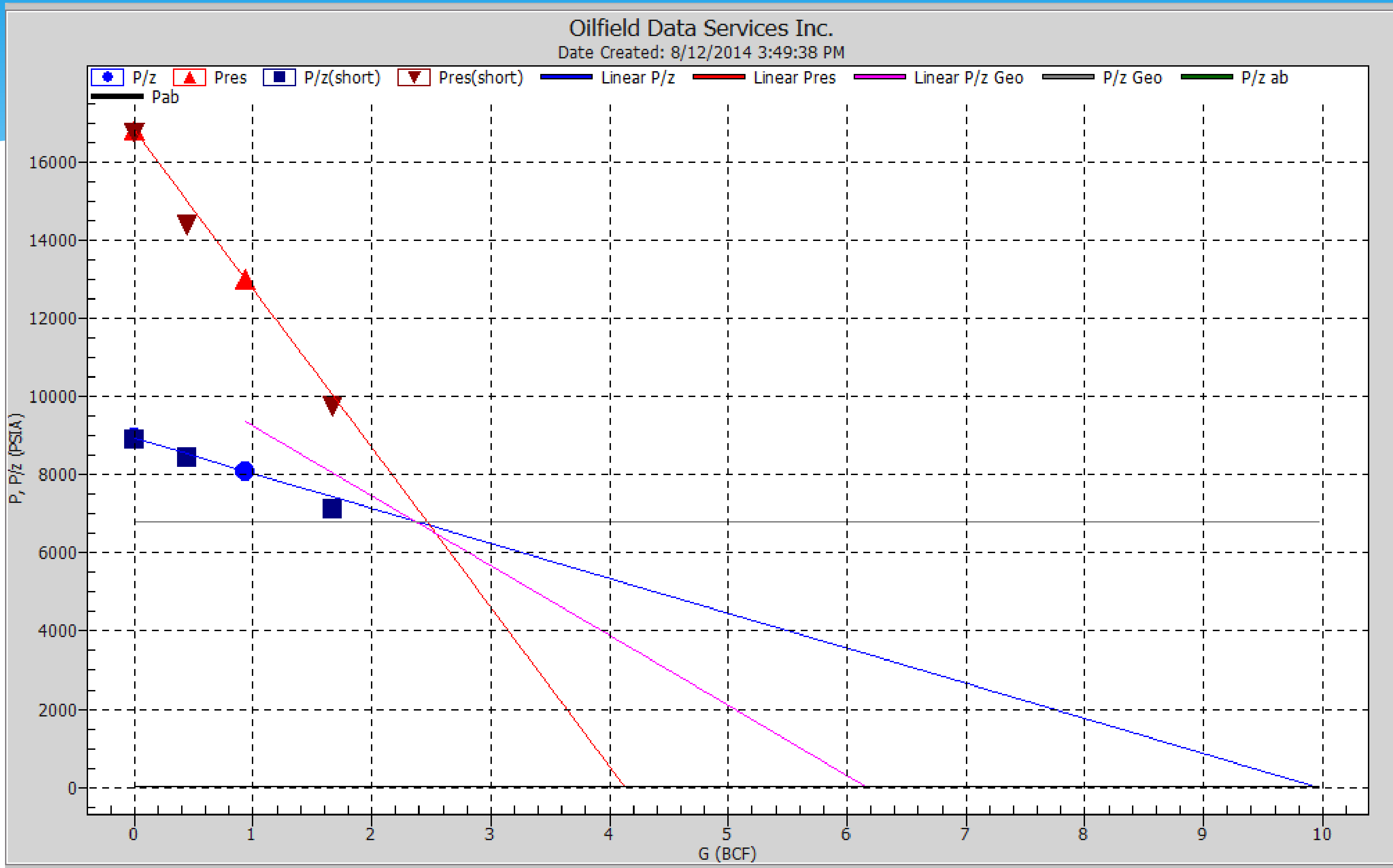
- Permeability ~ 15 md, Skin Is Low And Remains Constant
- Reservoir Pressure Drops 6000 psia
- Reservoir Appears To Be In Depletion Drive

GOM Shelf



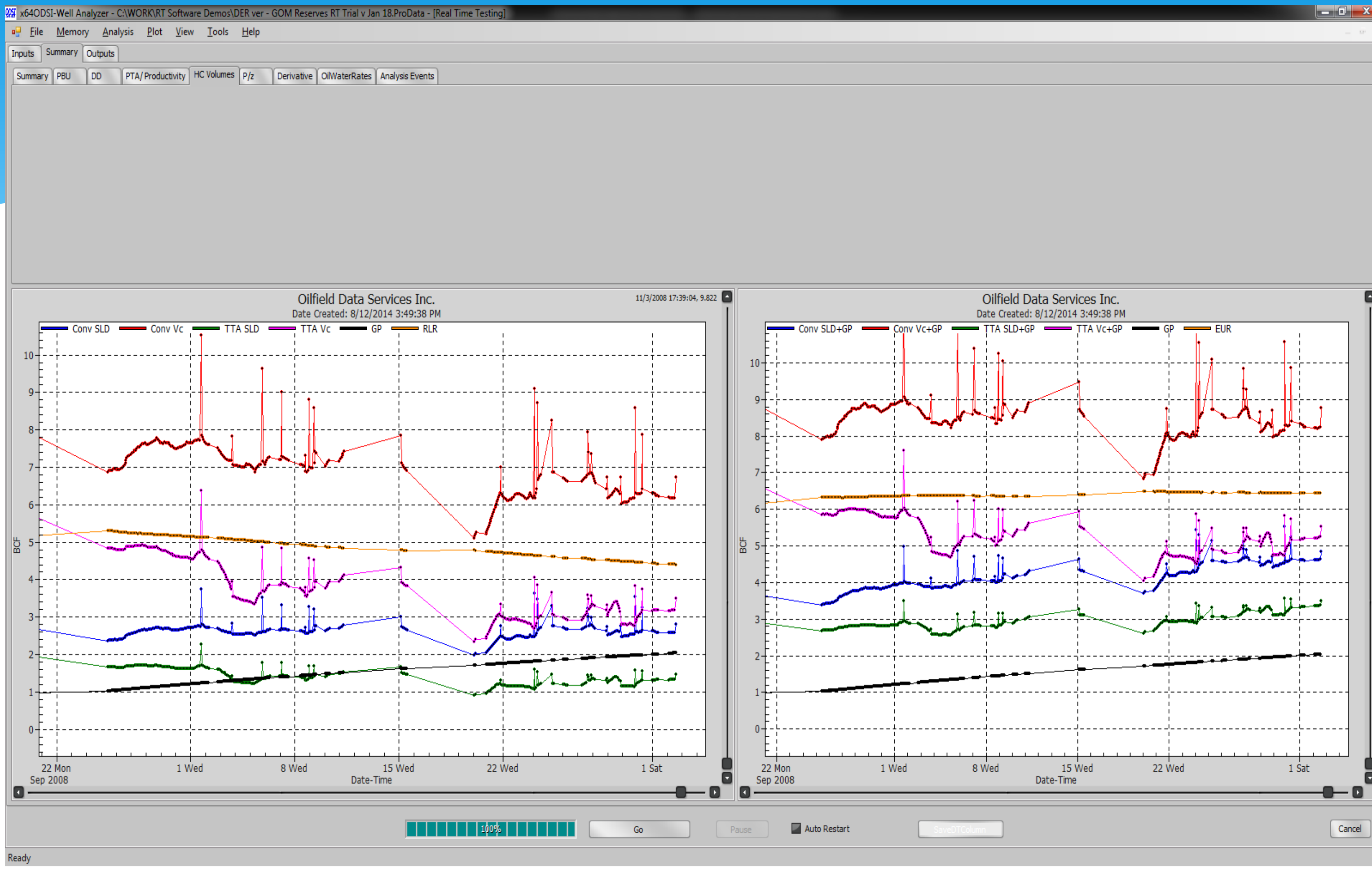
- No Major Shifts In Productivity (No Shifts In Scalar Value Or Slope)
- Inverse Productivity indicates Pseudo Steady-State Response

GOM Shelf



- P/Z Calculation and SLD-P Calculation Gives Us 4-10 BCF

GOM Shelf



- Running Energy And Material Balances
- LHS: Remaining Apparent Gas Volume
- RHS: Total Gas Volume
- This can be Compared With P/Z Results

GOM Shelf – Static and Flowing MBALS

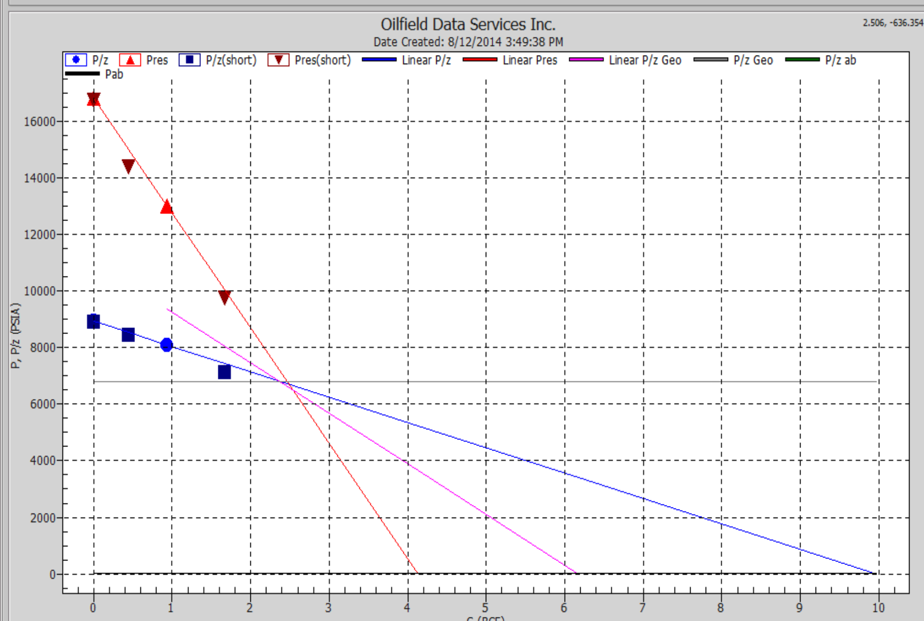
x64ODSI-Well Analyzer - C:\WORK\RT Software Demos\DER ver - GOM Reserves RT Trial v Jan 18.ProData - [Real Time Testing]

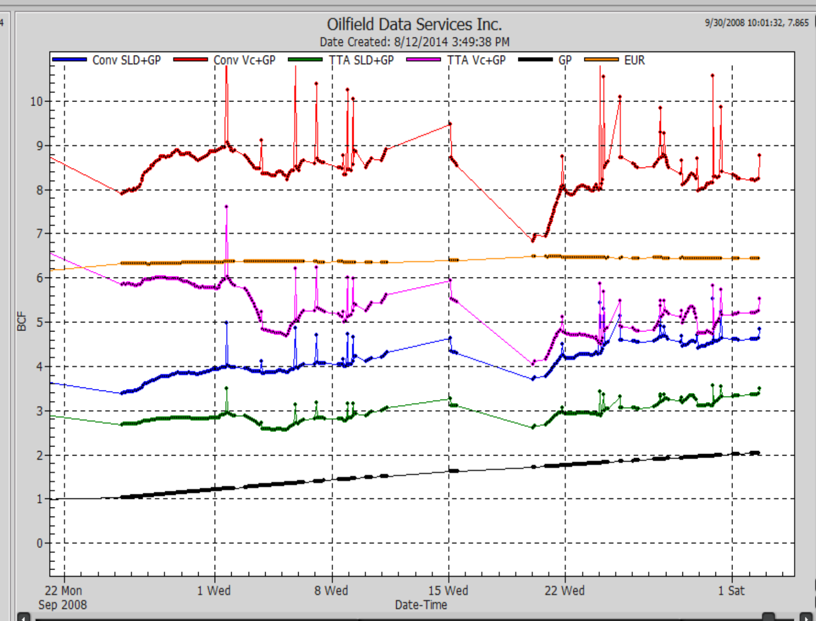
File Memory Analysis Plot View Tools Help

Inputs Summary Outputs

Summary PBU DD PTA/Productivity HC Volumes P/z Derivative OilWaterRates Analysis Events

Date Time	Gas Produced	PBU Duration	Pres	z-Factor	P/z	GIP SLD @P=0	GIP SLD @P|ab=15	GIP P/z @P=0	GIP P/z @P/z|ab=15	GIP P/z geo @P=0	GIP P/z geo @P/z|ab=15	m Pres	m Pz	m Pz Geo
MM/dd/yyyy HH:mm:ss	BCF	HOURS	PSIA	dimless	PSIA	BCF	BCF	BCF	BCF	BCF	BCF	PSIA/BCF	PSIA/BCF	PSIA/BC
01/01/0001 00:00:0	**0.000**		**16800**	**1.883**	**8922.6**									
08/03/2008 09:55:00	0.005	6	16728	1.878	8908.94									
08/15/2008 16:49:00	0.445	7	14374	1.707	8419.16									
09/22/2008 17:01:0	**0.933**	**267**	**13009**	**1.608**	**8088.4**	**4.1**	**4.1**	**10.0**	**10.0**	**6.2**	**6.2**	**-4062.3**	**-893.9**	**-1787.**
10/18/2008 12:37:00	1.667	33	9759	1.374	7101.35	4.1	4.1	10.0	10.0	6.2	6.2	-4062.3	-893.9	-1787.9



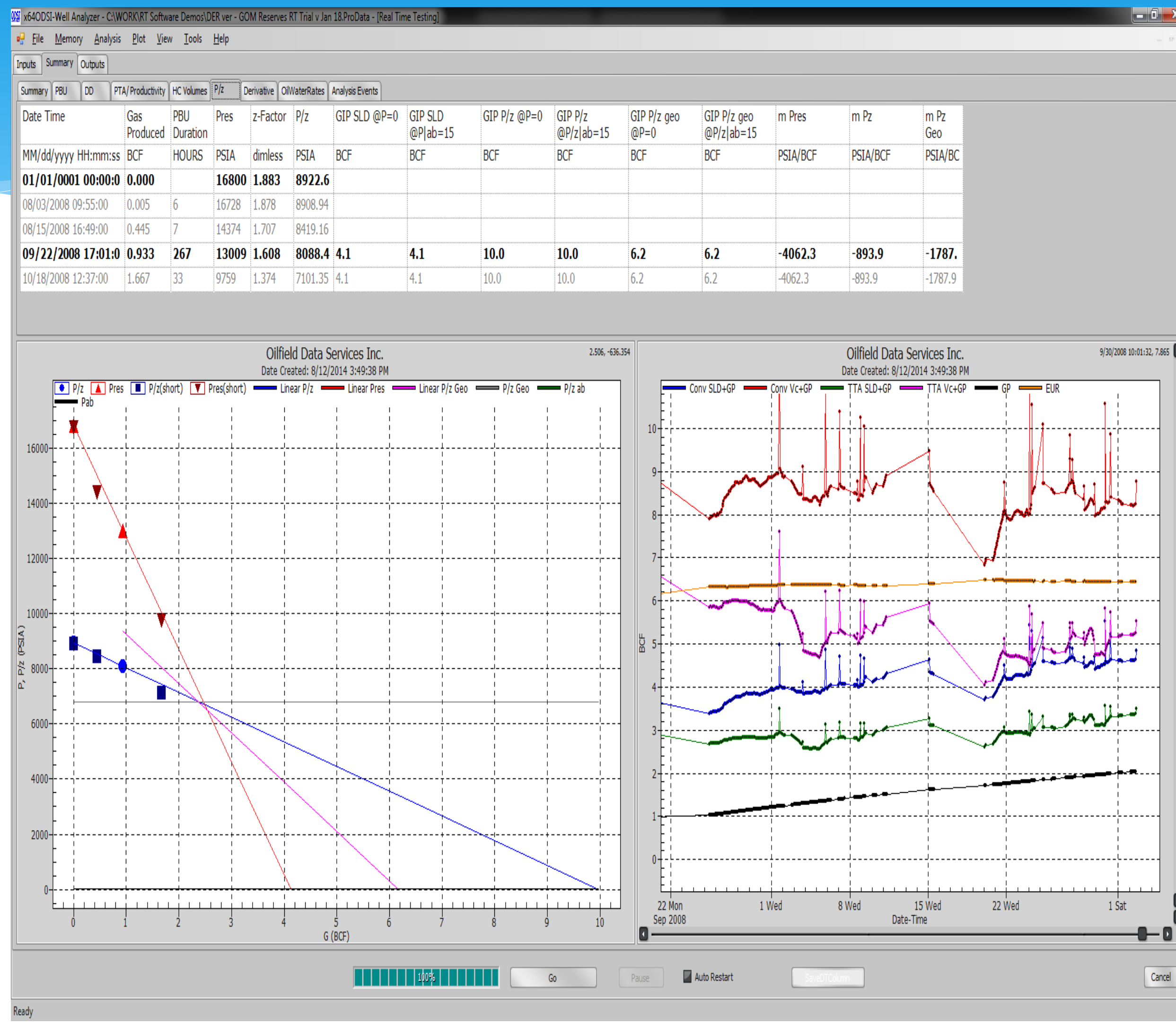


100% Go Pause Auto Restart Cancel

Ready

GOM Shelf

- **LHS:**
  - SLD/Straight Line Depletion **(Red)**
  - P/Z Expansion/Depletion: **(Blue)**
- **RHS:**
  - Conventional Expansion: **(Red)**
  - Conventional SLD: **(Blue)**
  - TTA Compressibility: **(Purple)**
  - TTA SLD: (**Green**)
  - Gp: Black
  - Static MBAL To The Gas/Water Contact: (Orange)



GOM Shelf HP-HT Conclusions

* Skin & Perm are fluctuating due to crossflow and differential depletion in high-perm zones
* Moderate Perm with Low Skin
* Gas on top of dead-leg water

Reservoir Volume: 10 BCF of potential elastic energy

* 3 BCF of water (dead leg)
* 1.5 BCF of rock compaction
* 5.5 BCF of Mobile Gas
* 1.0 BCF of "Tight" Gas

Notes on the Case Studies:

At no time was the pressure data "smoothed"

At no time was the data forced to fit a model

At no time was the "answer" provided ahead of time

If you let it, the well will tell you what it's volume is made of and what it can produce

Analyze the Data Without Imposing Bias!

Thoughts, Musings & Conclusions

What is Good Oilfield Management?

* Maximize NPV
* Maximize Recoverable Reserves
* Avoid waste (time/money/resources)
* Mitigate/minimize risk (Ops/Reserves/HSE)
* Learn from your mistakes (and successes)

- MAKE BETTER DECISIONS IN A TIMELY FASHION

What is BAD Oilfield Management?

* Maximize bonus
* Maximize ‘booked’ reserves
* The INSIDE View – eliminate/ignore contrary data
* Falling in love with a rate
* Wait until a problem is obvious (and expensive to fix)
* Hope no one notices (until you’ve moved on) – make sure no one takes ownership
* Shoot the messenger

- Make the decision that’s best for you, not the company

What are the Consequences of Automated Monitoring/Surveillance?

* Democratized information/results
  * Can spend time discussing what it means
  * Easier to translate to other departments/silos
  * Less finger pointing and more inclusive work processes
* Quicker Decisions
  * Reach conclusions on what it means
  * Easier to focus on NPV of Decisions
* Quicker Actions/Inactions

Conclusions: RT Well Evaluation

* Proper Instrumentation and Visualization Software are the 1st Step (Don't Drop Bits!)
* Closed-Loop Solutions for the Wellbore and Reservoir make it possible to quickly check system model
* Do NOT impose a "static" model on the well
* Warning an Engineer when (or before) something bad happens is more important than being accurate to the 9th decimal place
* Checking the results of an Automated Calculation is a lot easier and more timely than doing it yourself

Final Thoughts

- This technology is already here!
- Understand the physics – not just the software package
- Always know:
  - How much MONEY is left in the ground?
  - How fast can I get it out (safely)
  - Is the performance changing?
- Compare NPV remaining vs. Cost of a “fix”
- Seek out non-biased results

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Total - Pau