

ESPY 1-22 Solution

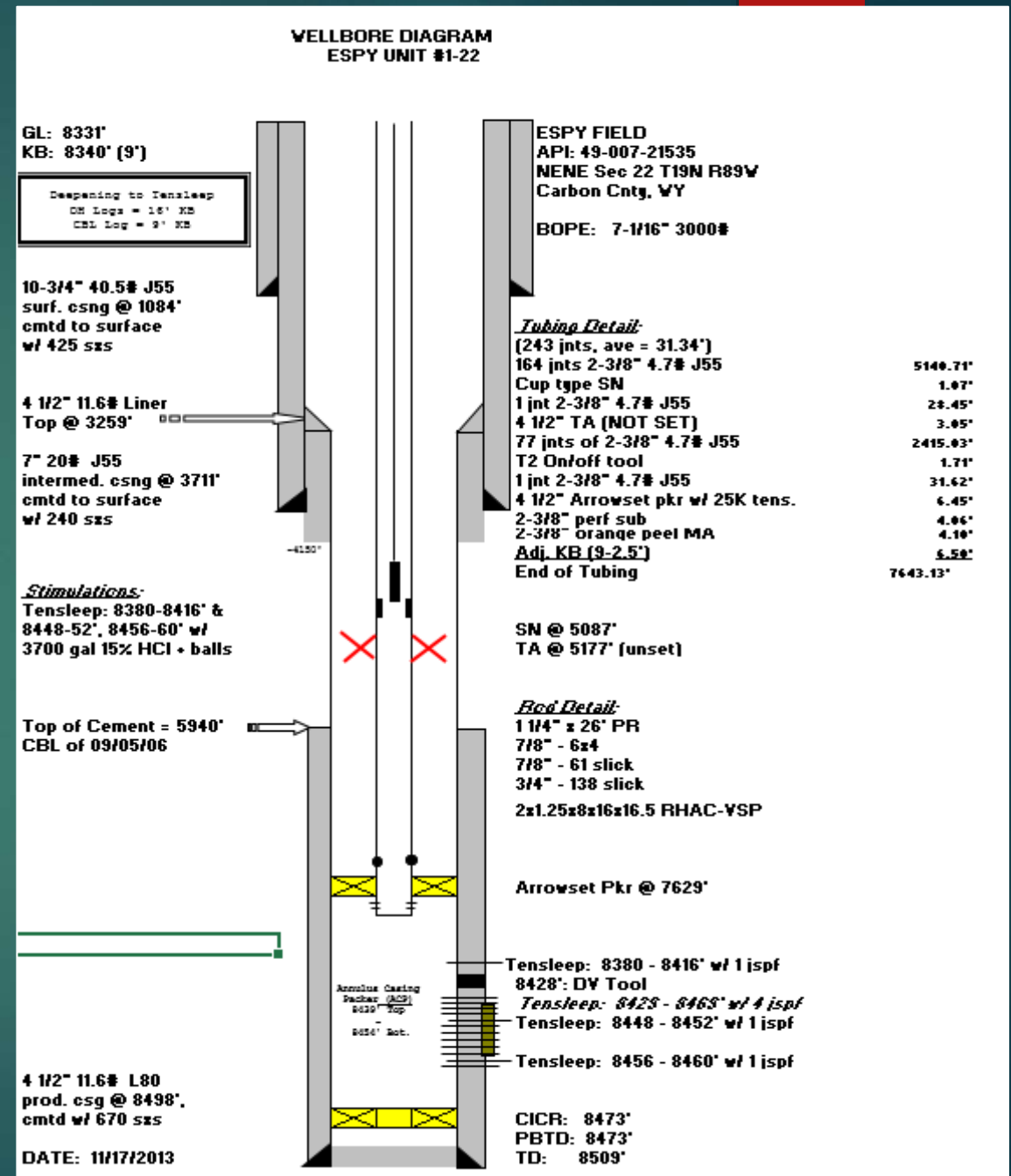


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Introduction

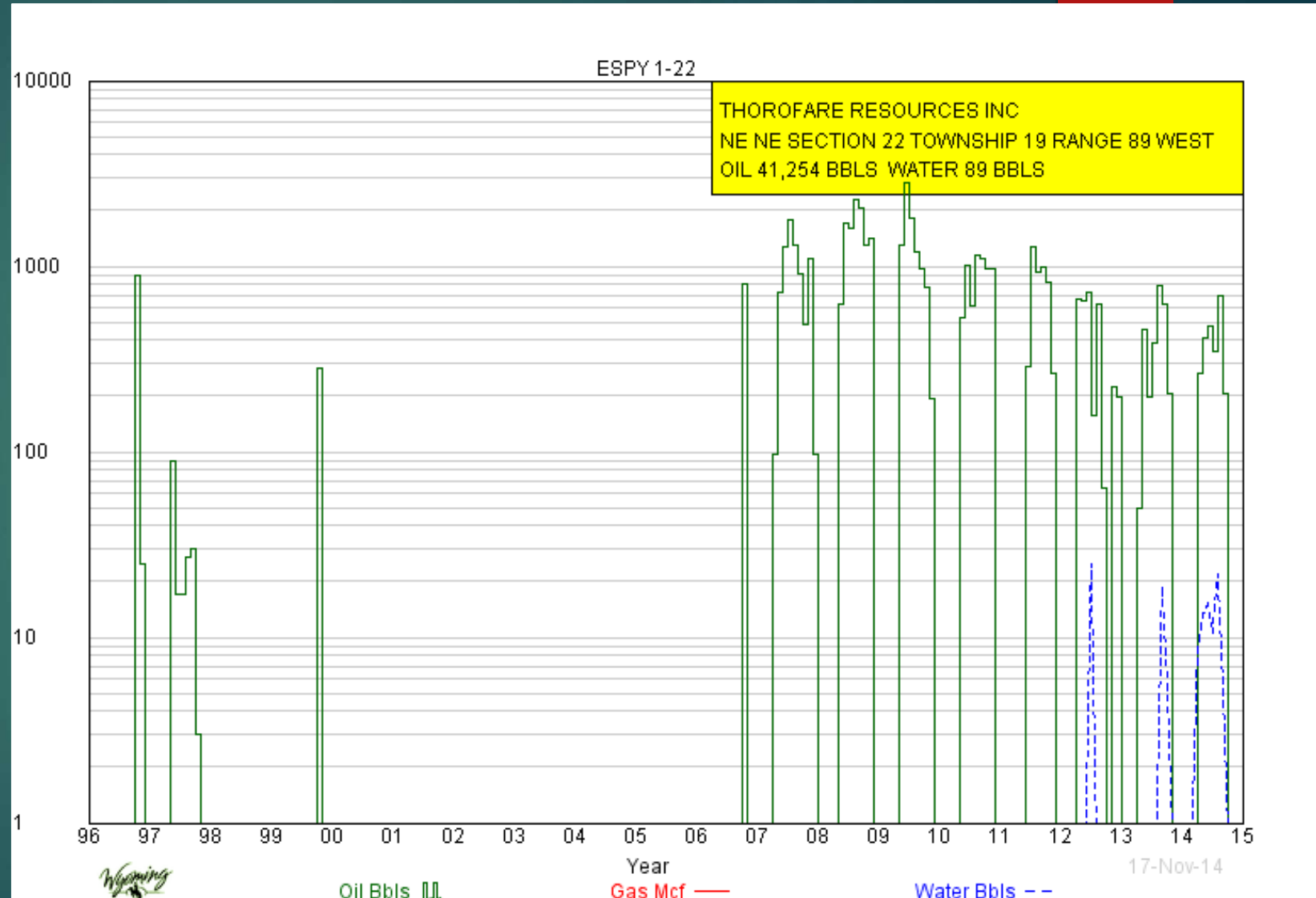
▶ ESPY 1-22

- ▶ Rod-pump well near Rawlins, WY
- ▶ Potentially a 60 BPD well
- ▶ Currently shut-in due to potential hole in liner
- ▶ Gas-pressure build-up in well
 - ▶ Currently shut-in around 2000 psi



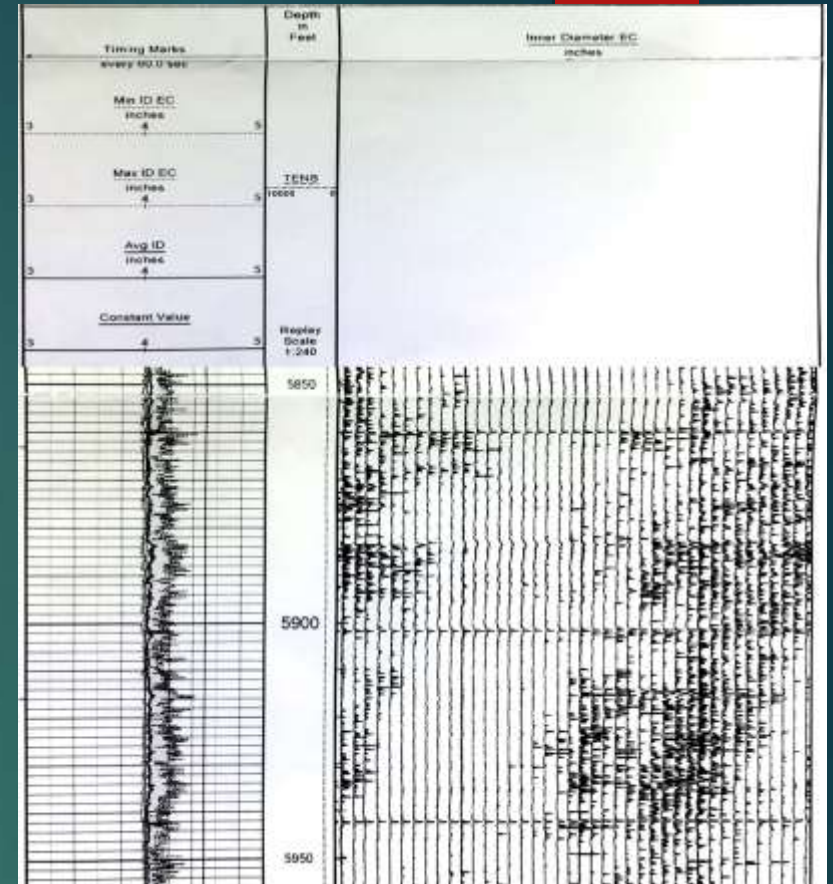
Background

- ▶ Operational History
 - ▶ Niobrara formation
 - ▶ Shut-in for winter months
 - ▶ Tensleep formation
 - ▶ Casing inspection log
 - ▶ Inconclusive



Analysis of previous casing inspection log

- ▶ Large Variation in I.D.
 - ▶ Between 5850 and 5950 feet
- ▶ No definitive hole found
 - ▶ Need to run new log for confirmation
- ▶ Potential hole could be around 5900 feet
 - ▶ 84% wall loss
 - ▶ Depth of worst defect = 5915.44 feet



JOINT TABLE											
Joint Number	Top Depth feet	Bottom Depth feet	Casing Diameter inches	Casing Weight pounds/ft	Joint Length feet	Casing Grade	Depth of Worst Defect feet	Burst Pressure psi	Defect Length inches	Defect Width inches	Percent Wall Loss
74	5776.98	5818.49	4.500	11.6	41.5		5787.89				76
75	5818.49	5859.91	4.500	11.6	41.4		5848.26				69
76	5859.91	5901.74	4.500	11.6	41.8		5889.03				76
77	5901.74	5942.34	4.500	11.6	40.6		5915.44				84
78	5942.34	5984.09	4.500	11.6	41.7		5966.78				82
79	5984.09	6026.00	4.500	11.6	41.9		5999.02				63
80	6026.00	6067.67	4.500	11.6	41.7		6047.00				72
81	6067.67	6109.42	4.500	11.6	41.7		6086.12				83
82	6109.42	6151.25	4.500	11.6	41.8		6129.10				83
83	6151.25	6193.08	4.500	11.6	41.8		6190.21				70
84	6193.08	6234.74	4.500	11.6	41.7		6226.05				79
85	6234.74	6276.25	4.500	11.6	41.5		6249.92				80

Location

- ▶ Located southwest of Rawlins, Wyoming
- ▶ On and off production since 1996
- ▶ It can't be accessed in the winter
 - ▶ Mountains
 - ▶ Bad roads with snow
- ▶ Rawlins area
 - ▶ 634 square miles of plains and valleys grading into relatively rugged uplifts
 - ▶ Older formations exposed in uplifts



Geology

- ▶ Greater Green River Basin
 - ▶ Intermontane desert
 - ▶ 20,000 square miles of the Central Rocky Mountains
 - ▶ Southwest Wyoming, Notheast Utah, and Northwest Colorado
 - ▶ Divided by intra basin anticlines



CRUSC. 00019. Sun Pictures of Rocky Mountain Scenery
12. Castle Rock - Green River Valley, Wyoming



Geology (con't)

- ▶ Deepened formations
- ▶ Tensleep formation
 - ▶ Producing Formation
 - ▶ Excellent oil shows
 - ▶ 13% Porosity at 8450 feet
- ▶ 2nd Frontier Formation
 - ▶ Location of the hole in casing
 - ▶ Sandstone
 - ▶ Natural gas and hydrocarbons
 - ▶ 12.3% porosity
 - ▶ Permeability = 0.22 md

Formation	Espy 1-22		TVD Difference
	Drilled Depth	TVD Subsea	
Frontier	5490	2885	-120
2nd Frontier	5666	2710	-116
3rd Frontier	6004	2375	-105
Mowry	6181	2199	-100
Muddy	6362	2019	-103
Dakota	6434	1947	-94
Lakota	6496	1886	-91
Morrison	6518	1864	-87
Sundance	6732	1652	-88
Canyon Springs	6882	1505	-84
Nugget	6926	1462	-85
Jelm	7016	1408	-95
Chugwater	7142	1250	-78
Alcova Lms	7501	898	-53
Red Peak	7511	888	-53
Goose Egg	8118	292	24
Ervay Lms	8173	238	26
Difficulty Shale	8225	186	34
Forelle Dolomite	8264	148	48
Glendo Shale	8276	136	52
Franson Dolomite	8338	75	56
Satanka Shale	8358	55	56
Tensleep	8384	29	60

Stakeholders

- ▶ Wyoming Oil and Gas Commission: permits, regulations, rules
- ▶ Thorofare Resources, Inc: Producing Company
- ▶ Future Stakeholders: Landowners, Local Community, Wyoming Department of Environment Quality

Objectives

- ▶ Gas Pressure Build-up
 - ▶ Surface piping
 - ▶ Production or Flare
- ▶ Hole in liner
 - ▶ Casing inspection log
 - ▶ Solution for hole
 - ▶ P&A, Cement Squeeze, Shallow production zone
- ▶ Final Cost
 - ▶ Analysis of well profitability
 - ▶ Addition of all costs needed for project

Gas Pressure Build-up

- ▶ Flare method chosen
 - ▶ Cost of gas production too high for profitability
 - ▶ Running production lines
 - ▶ Low natural gas prices
 - ▶ Rod-pump efficiency lowered
 - ▶ Environmentally safe according to EPA guidelines
 - ▶ Gas emissions minimal
 - ▶ Wyoming currently has no tax on flaring



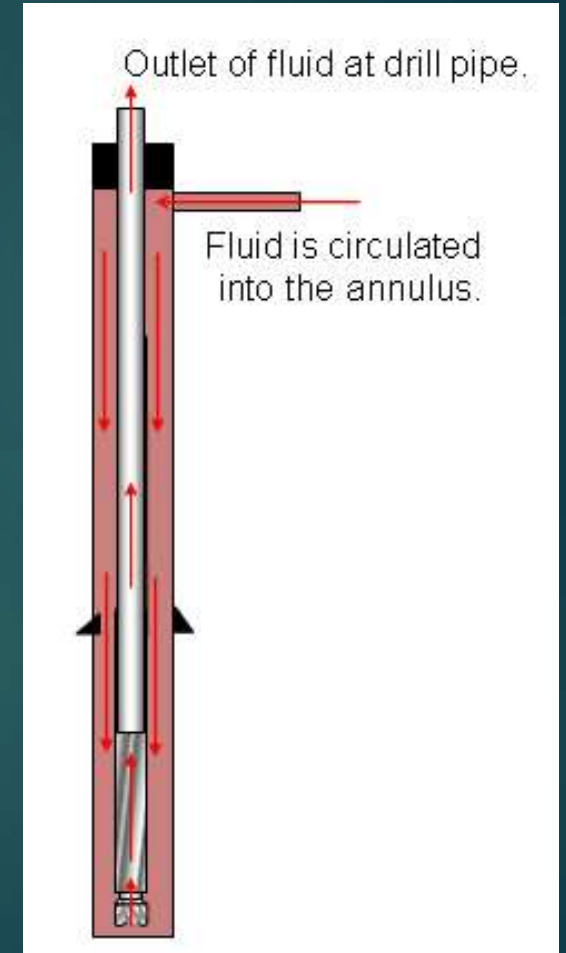
Surface Equipment

- ▶ Existing
 - ▶ Conventional Electric Pumpjack
 - ▶ 300 psi PolyPipe flow lines to Sales
- ▶ Needed
 - ▶ 1-400 bbl Production Tank
 - ▶ Wet Gas Measurement Skid
 - ▶ Flare Knockout Vessel and Flare
 - ▶ Recycle Pump from Production tanks to Sales Line
 - ▶ 3" steel flow lines with Valves



Work-over Rig Tasks

- ▶ Remove horse-head
- ▶ Use pumps to kill well
 - ▶ Circulating Method
 - ▶ Shut-in bottom-hole pressure $\sim 2000\text{psi} + (0.43273\text{psi/ft}) * 8509\text{ft} \sim 5682.1\text{psi}$
 - ▶ Kill fluid weight = $((5682.1\text{psi} + 100\text{psi}_{\text{(safety factor)}}) / 8509\text{ft}) / (0.433\text{psi/ft}) * 8.33\text{lb/gal} = 13.073\text{lb/gal}$
 - ▶ Bromines must be added to reach kill fluid weight
- ▶ Remove rods and production string
- ▶ Install BOP
- ▶ Setup for wireline truck
 - ▶ Casing inspection log
 - ▶ Set CIBP-6000ft
 - ▶ Set CICR-5903ft

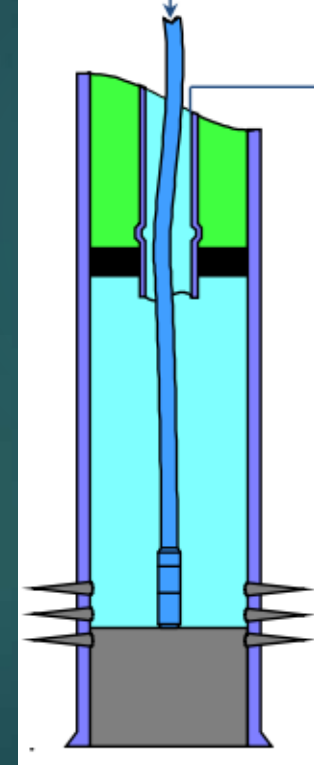
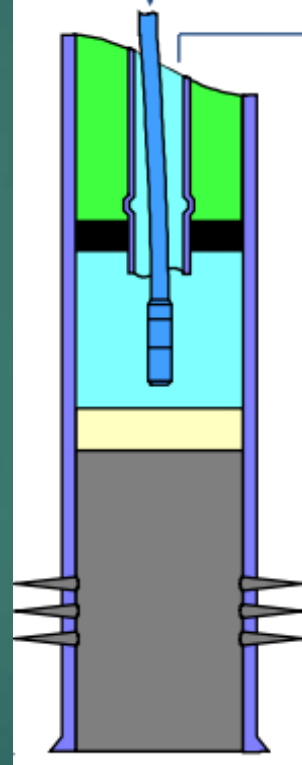
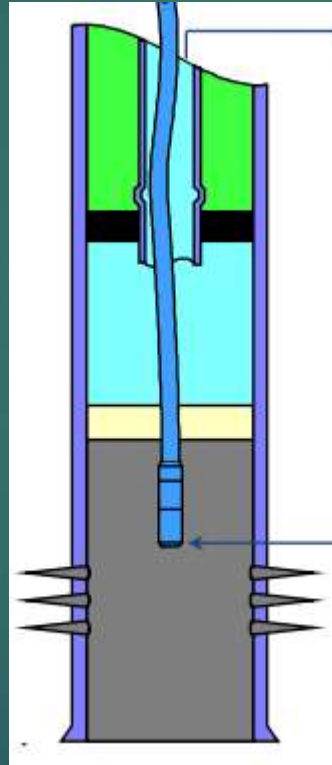
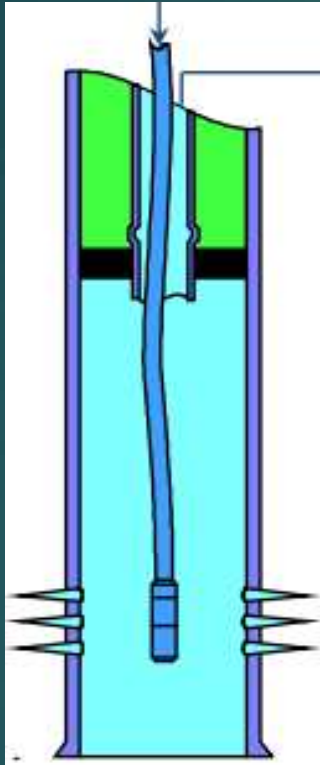


Cement Squeeze

▶ Cement Squeeze Program

- ▶ Discussed our problem with a Engineer for Magnum Cement, he created a program based on our well.
 - ▶ Type-G
 - ▶ Amount-5.2 m³
 - ▶ Cost-\$19, 700
 - ▶ Pumping Schedule
 - ▶ 1.0 m³ of fresh Water followed by 5.0 m³ of MAG G 1900 Cement.
 - ▶ Backwash tubing and casing with 1.5X tubing capacity 7.8 m³
 - ▶ WOC-24 hours minimum

Cement Squeeze Process



Cement Squeeze Process (con't)

- ▶ Drill out cement, CIBP, and CICR
- ▶ Pressure test to ensure cement squeeze success
- ▶ Run tubing and rods
- ▶ Stimulate well
- ▶ Hang horse-head
- ▶ Open to production



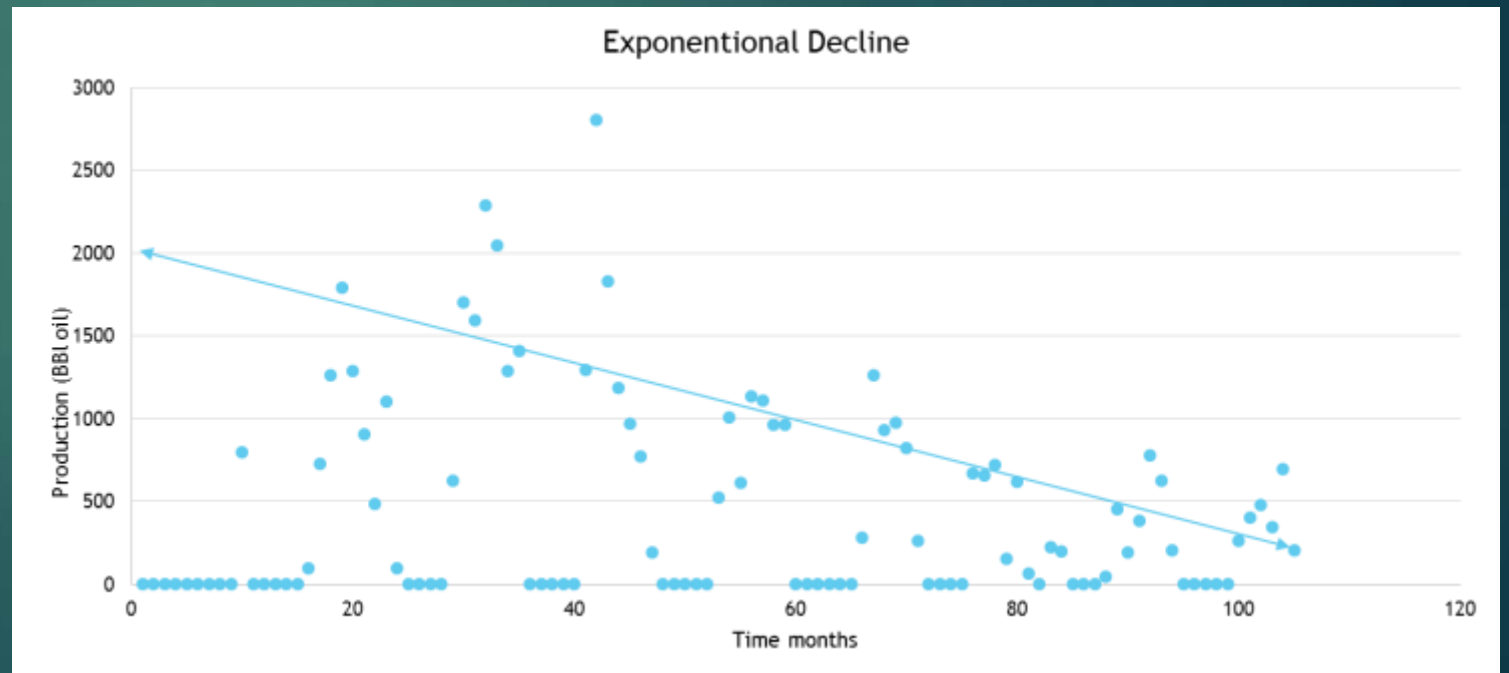
Problems

- ▶ Oil prices
 - ▶ \$/bbl is still very low compared to when we started the project
 - ▶ Caused changes in economics
 - ▶ Reduced profitability by around \$5MM
- ▶ Loss of group member
 - ▶ More tasks to take on



Economic Analysis

- ▶ Used Production data from Jan 2006-Sept 2014
- ▶ Created a exponential decline analysis using:
$$q(t) = q_i * e^{(-D_i * t)}$$
- ▶ Where $q(t)$ is predicted production for that month
- ▶ q_i = Initial Production (2000 BBI)
- ▶ $D_i = -(dq/dt) * 1/q$ (0.020886911)
- ▶ t = month (total 120 months)



Economics

- ▶ Well on average produces for seven months a year, based on exponential decline analysis this well will stop being profitable in Oct 2031.
- ▶ Taking into account that it only produces for 7 months a year.
- ▶ Based on \$4000/month operating costs.
- ▶ Average price per barrel of oil at \$56.63
- ▶ From Sept 2014-Oct 2031 well will generate \$3.3MM and cost 480K to keep running.
- ▶ Given us a profit margin of \$2.8MM before any work-overs are completed

Economics (con't)

- ▶ Surface Equipment Costs (including transportation)
 - ▶ Flare (\$2500)
- ▶ Work-over Costs
 - ▶ Rig (\$6000/day) (7 days)
 - ▶ Trucking pump, tank, water (\$2000)
 - ▶ Wireline (\$16,000)
 - ▶ Cement Squeeze (\$20,000)
 - ▶ Hydrotest (\$3,500)
- ▶ Estimated Total Cost of Project: (~\$86,000)

Questions?