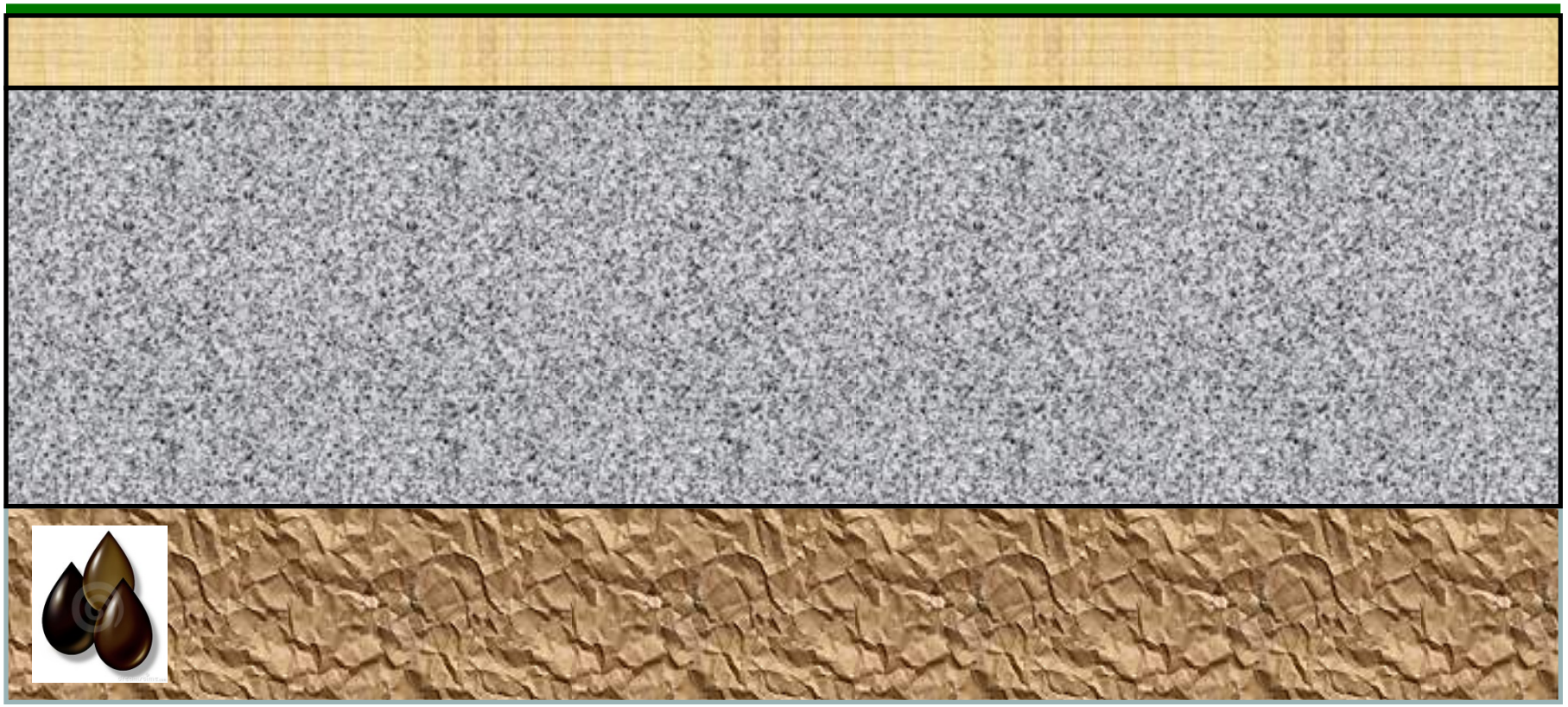
Innovating Gas-Lift for Life of Well Artificial Lift Solution

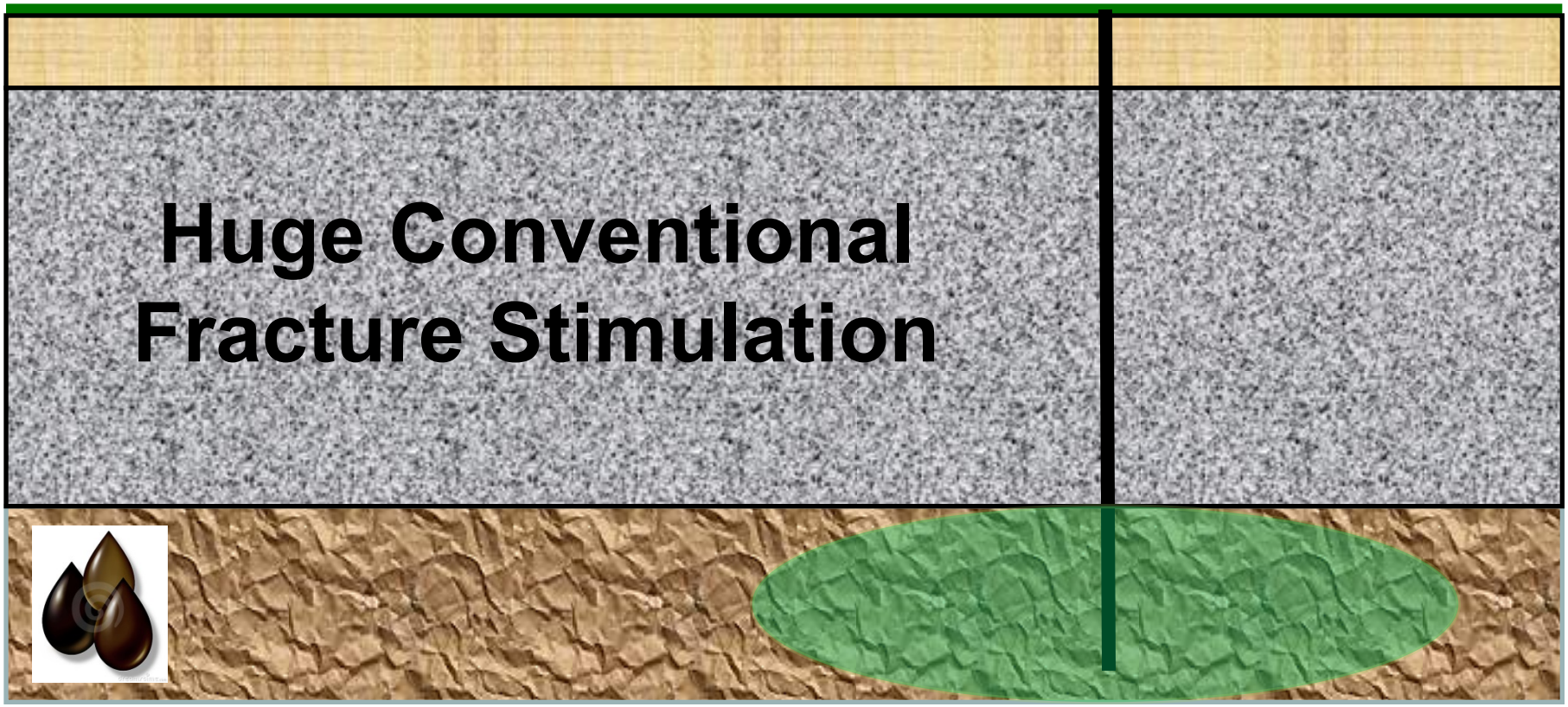
“The Unconventional Solution!”

Glenn Wilde
Optimum Production Technologies Inc.
Revive Energy Corp.

Unconventional Oil & Gas Resources



Unconventional Oil & Gas Resources



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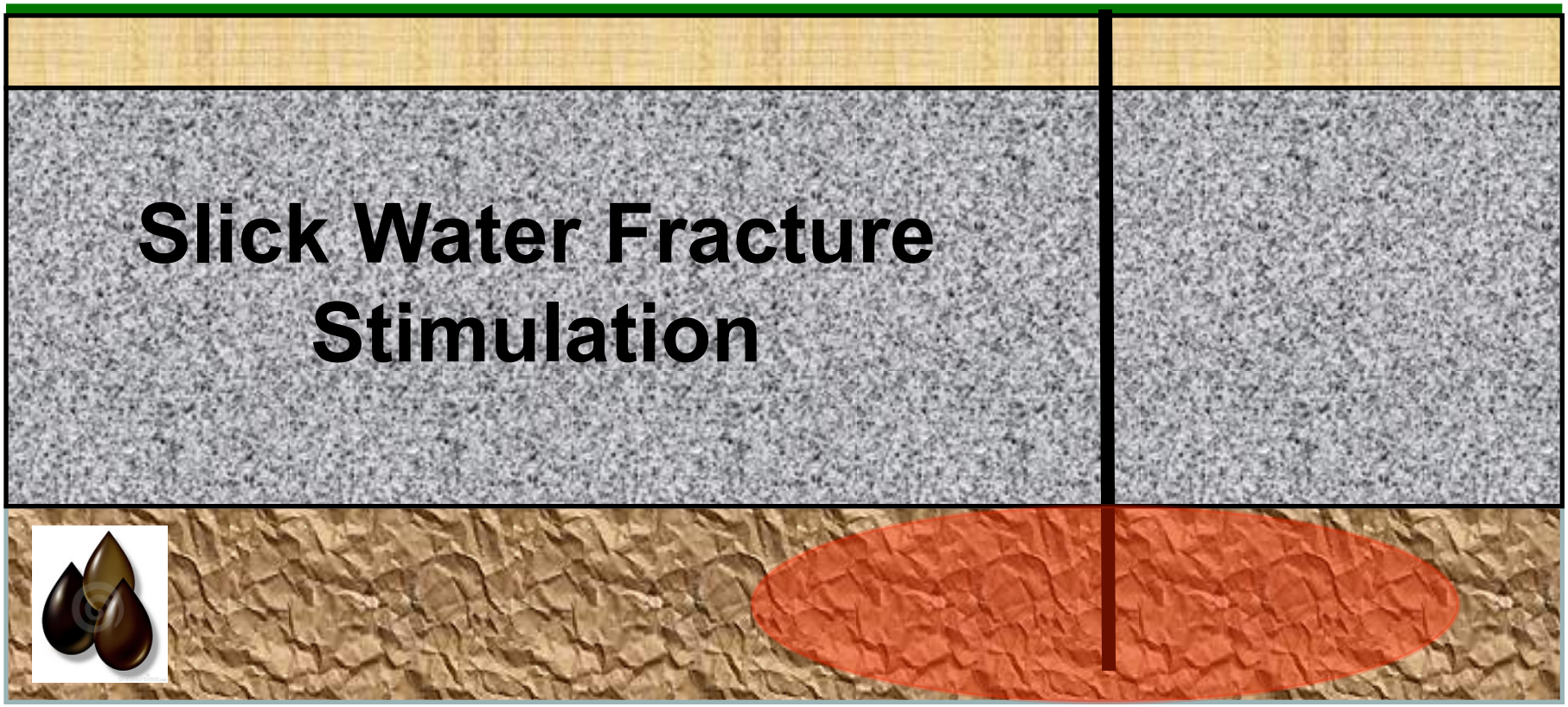

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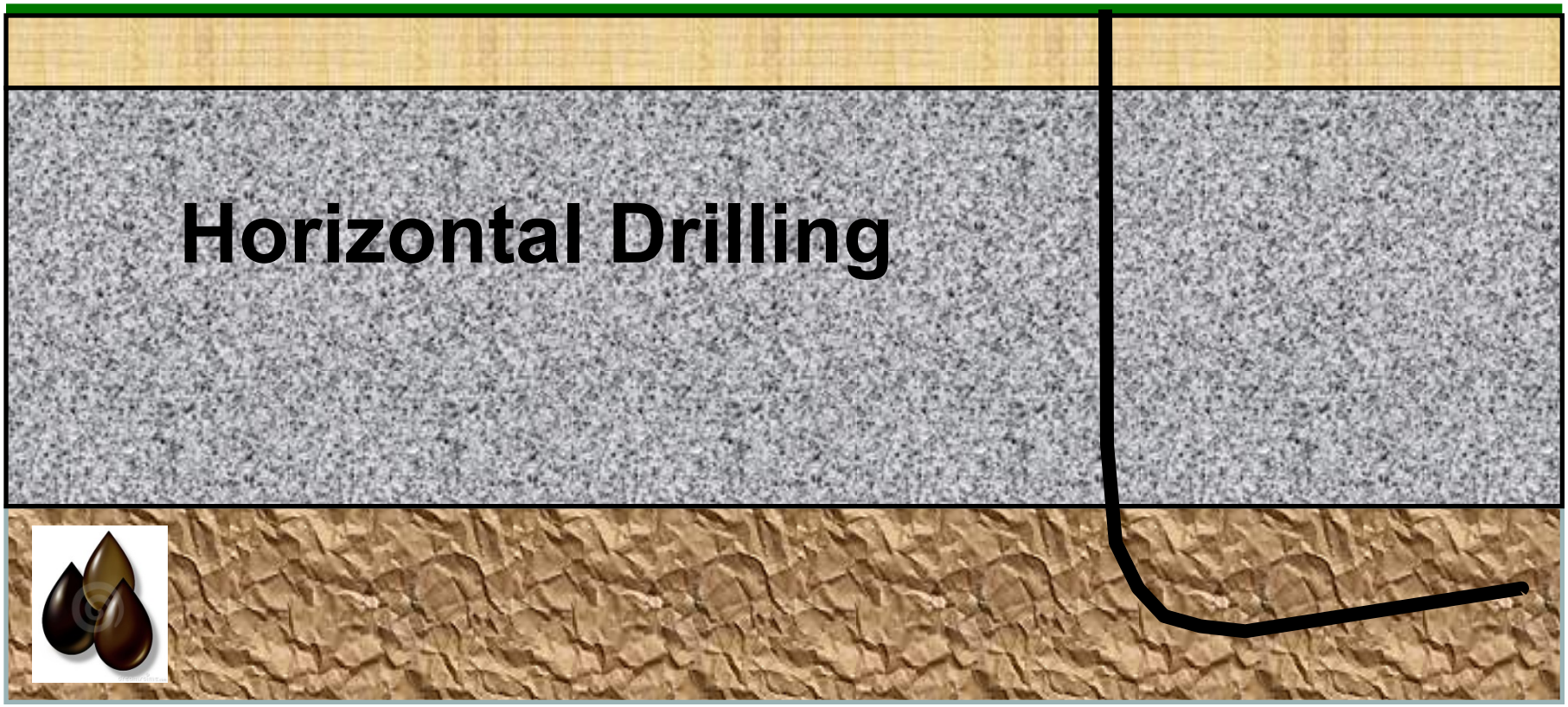

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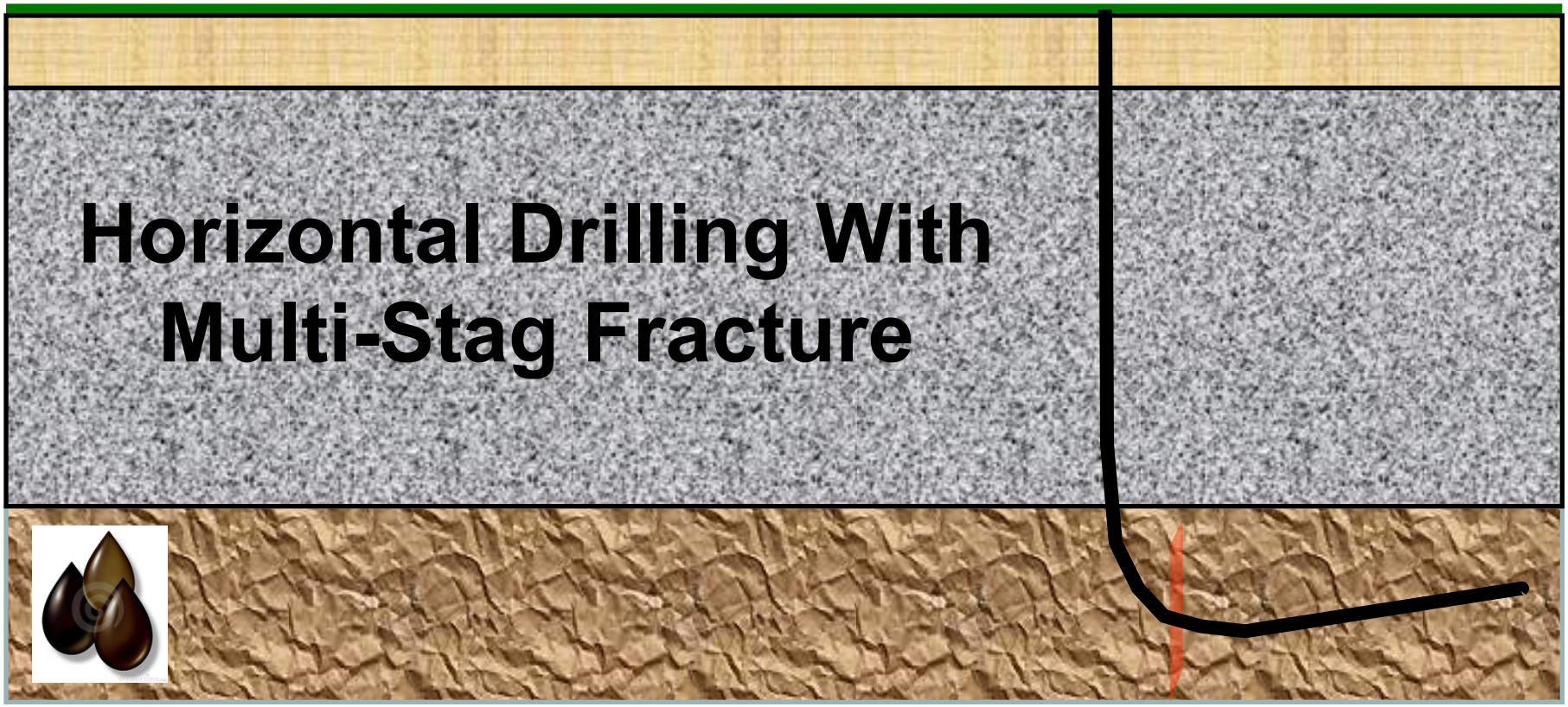

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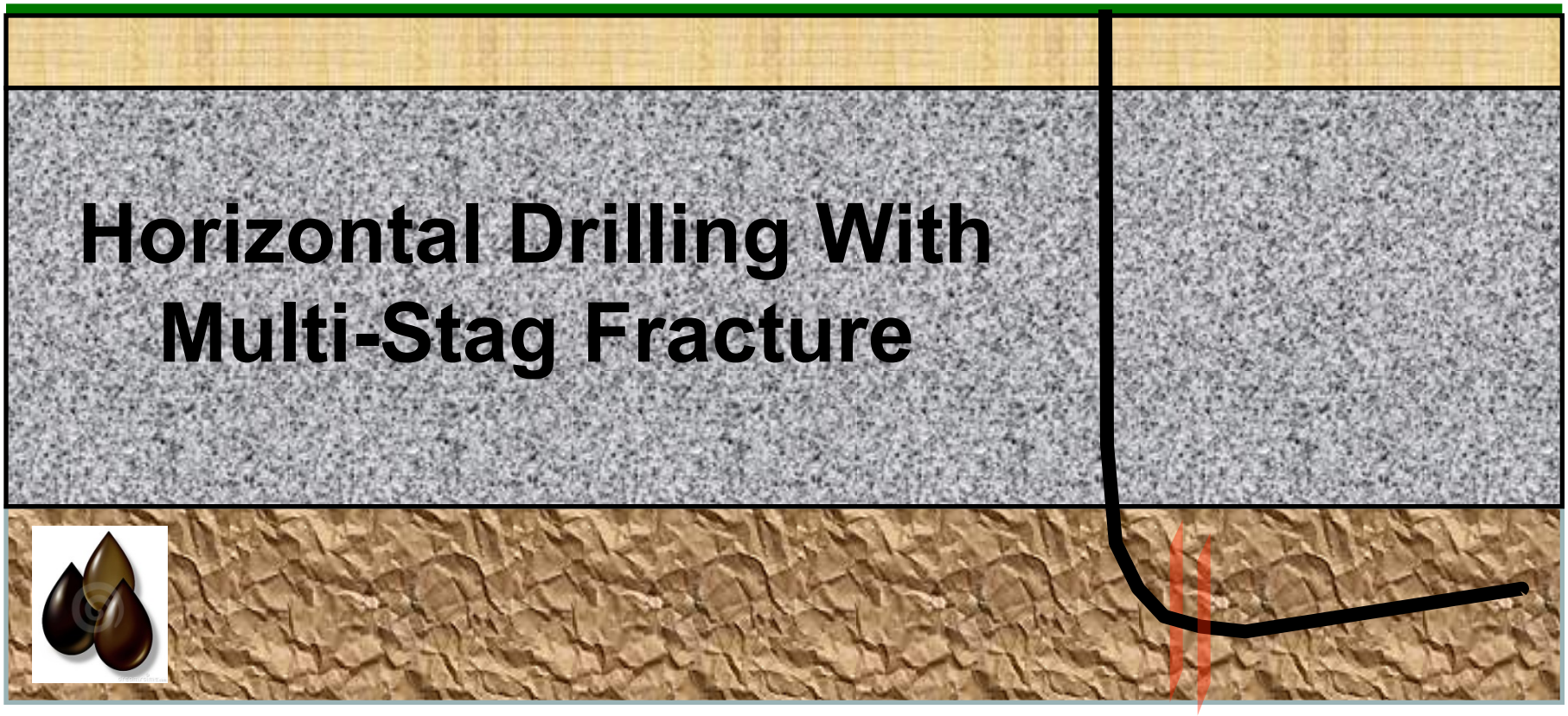

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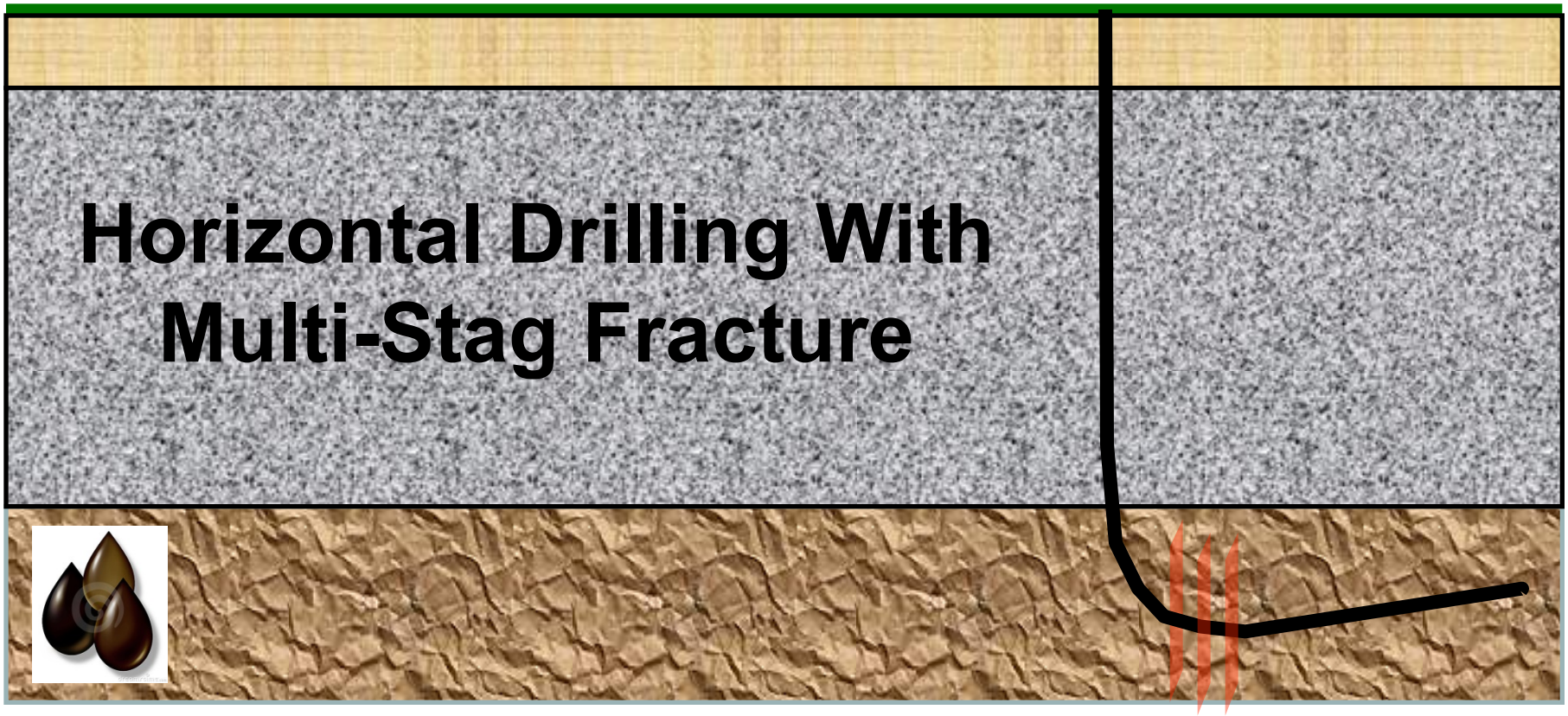

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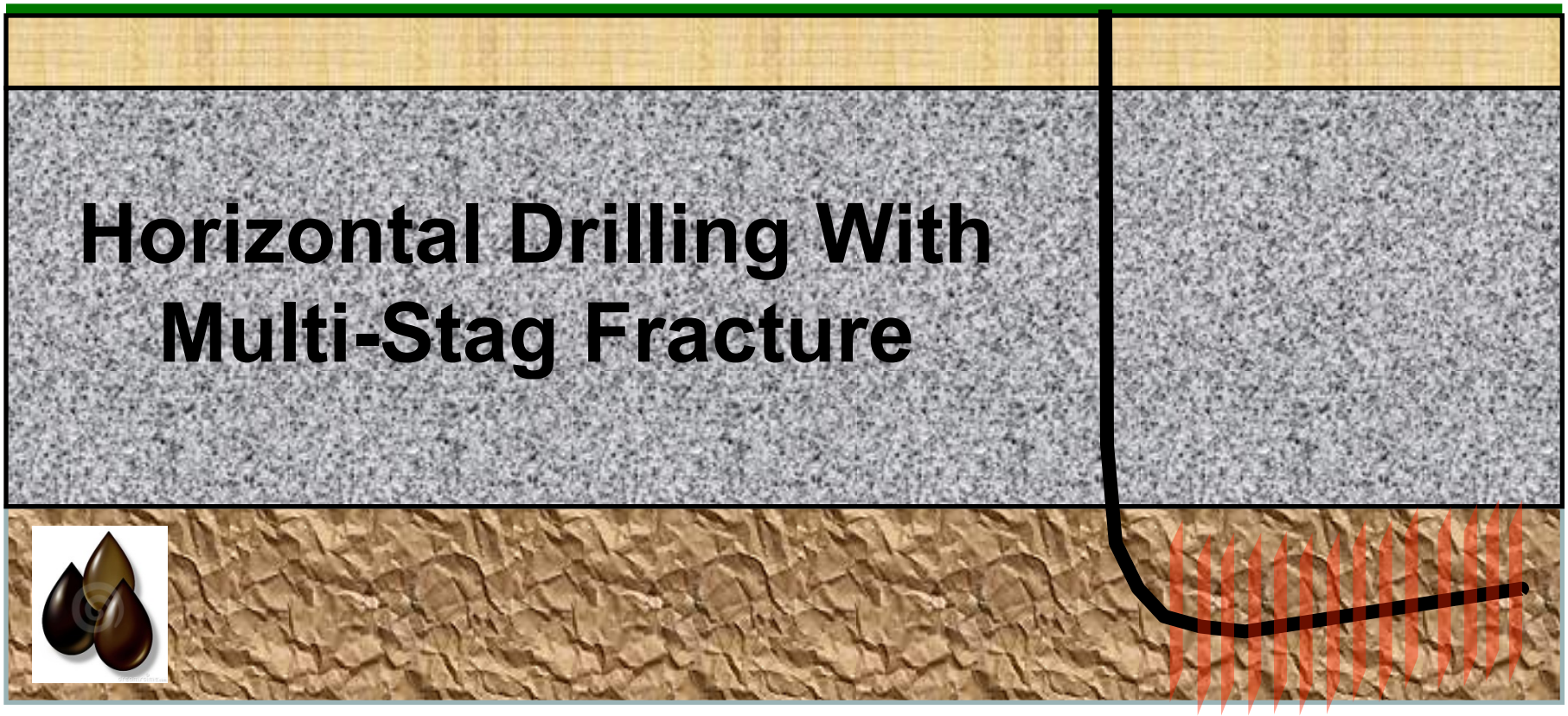

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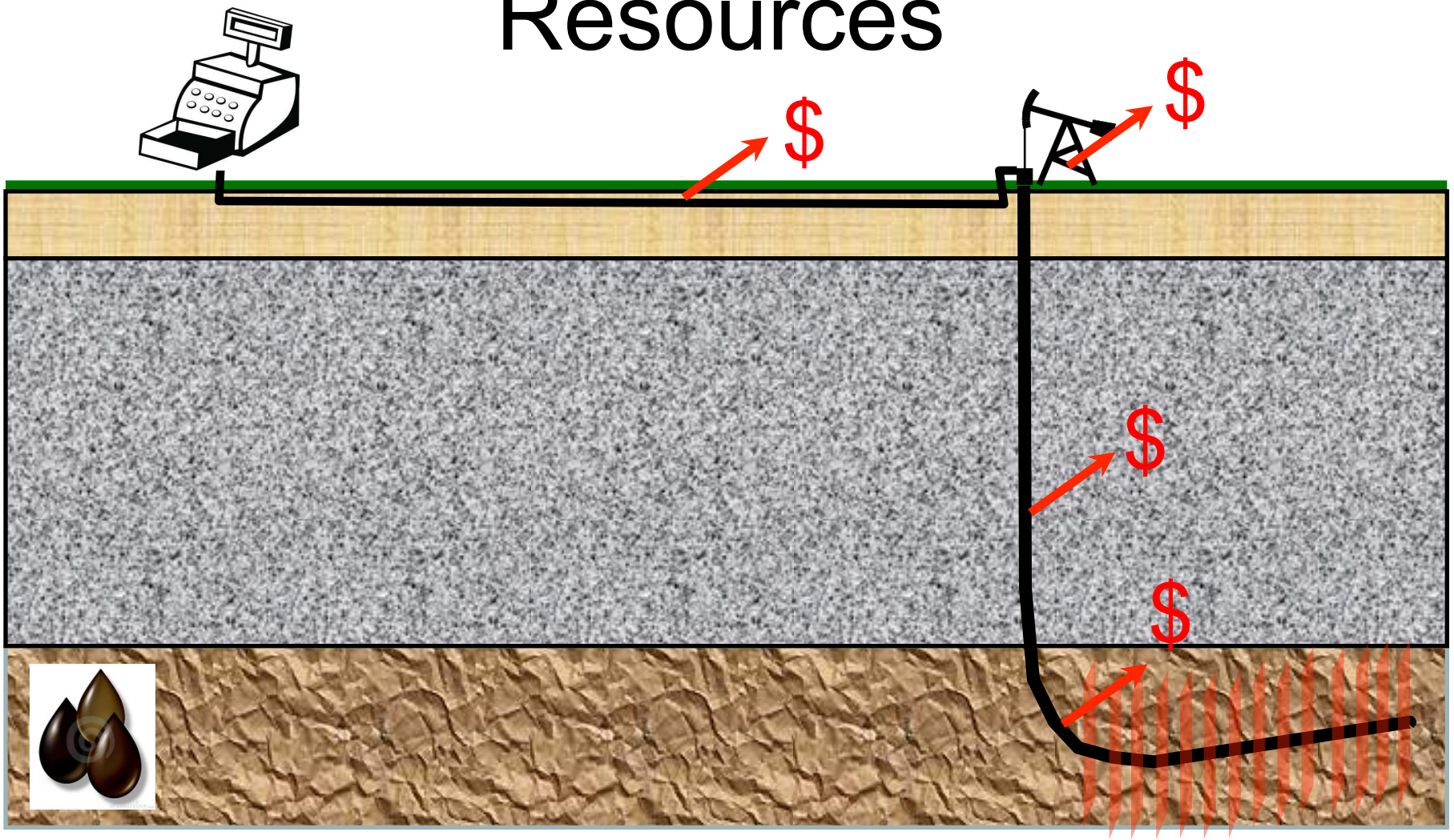

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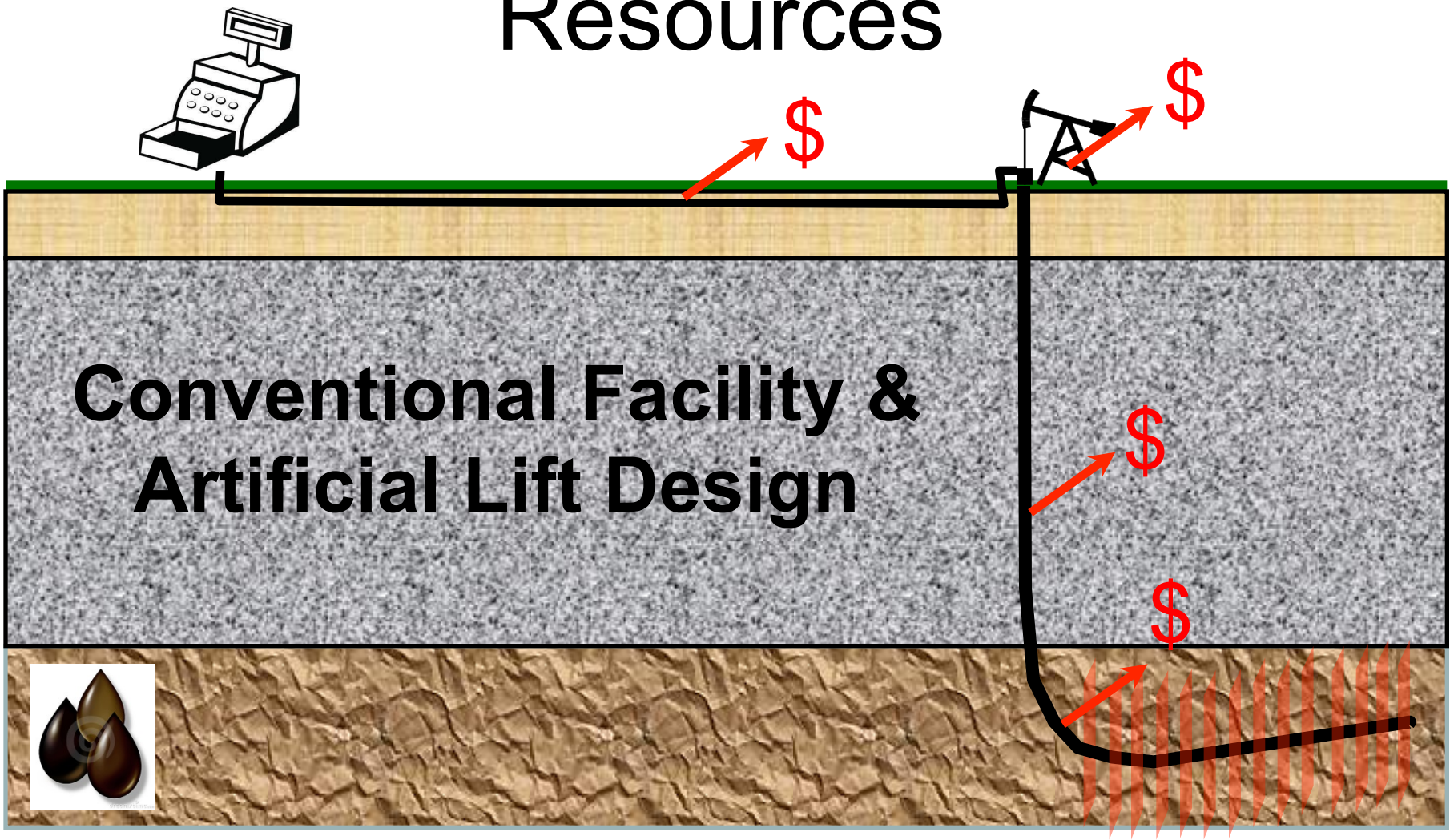

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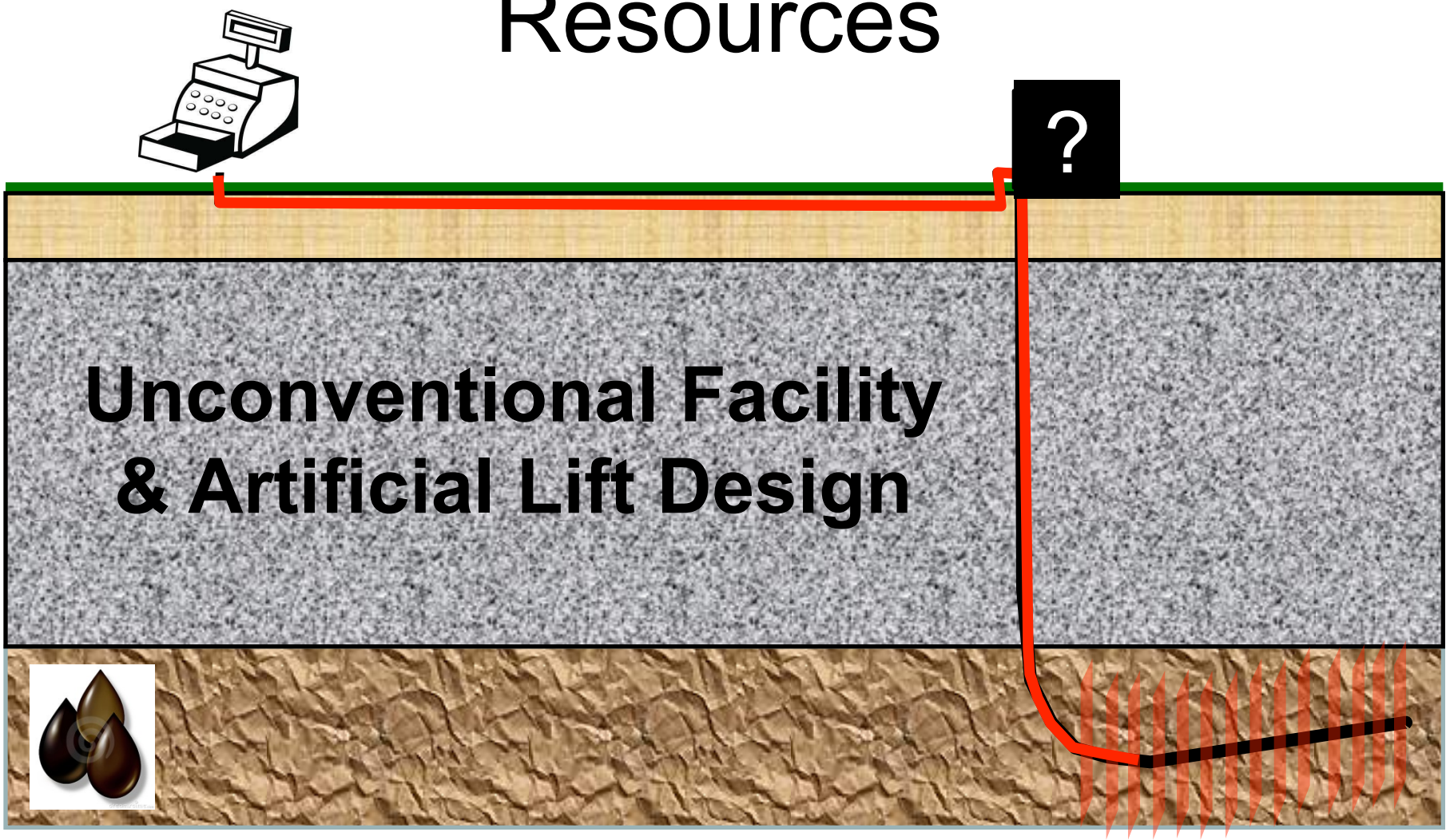
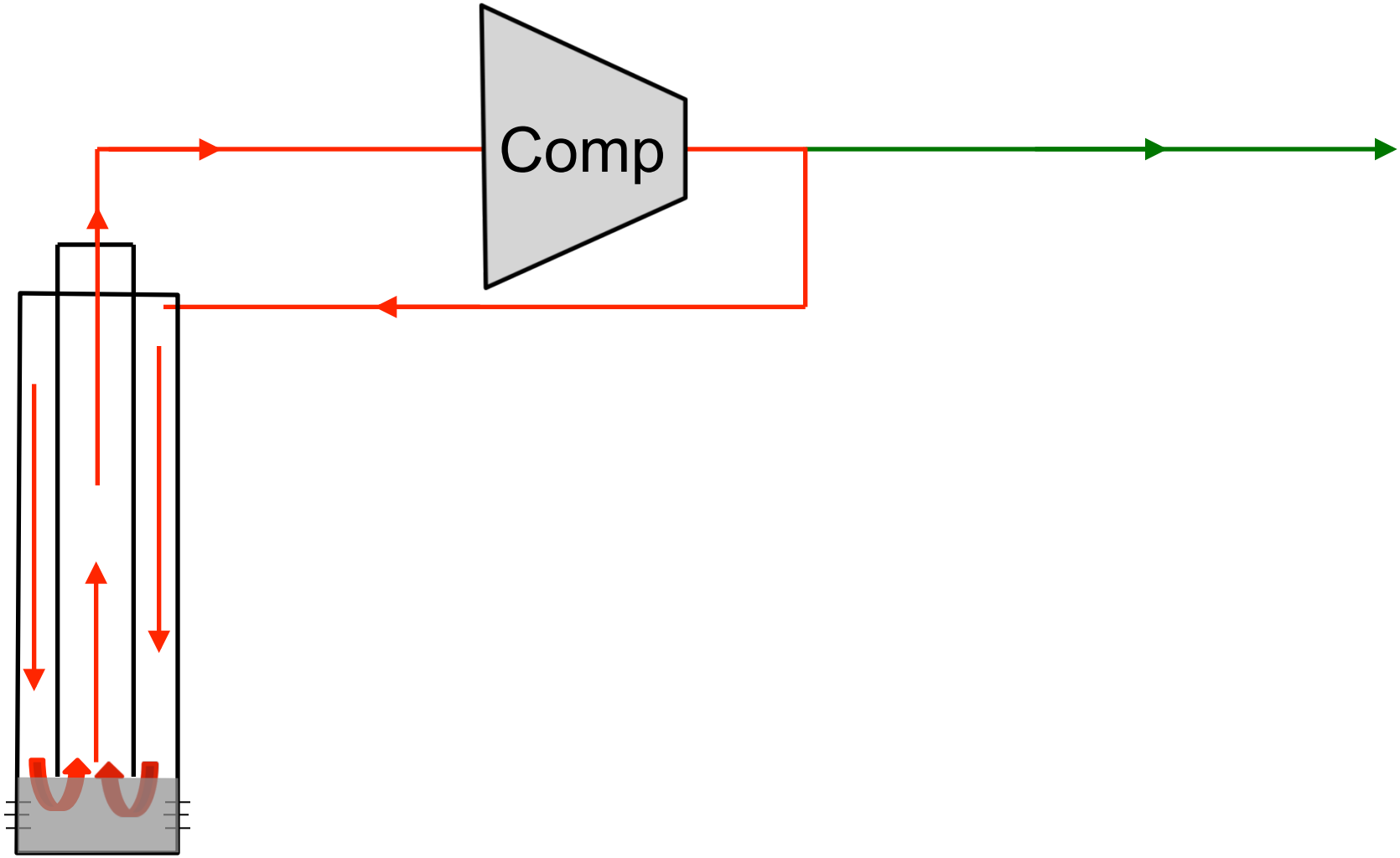


Re-circulative Gas Lift



Re-circulative Gas Lift Benefits

1. No down hole equipment other than tubing
   - Eliminates all down hole maintenance
   - Accommodates low cost cleanout

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   - Accommodates low cost cleanout
2. Accommodates all fluids
   - Liquids, Solids, High GOR
3. Provides deep depletion

An Unconventional Artificial Lift Solution For Liquids Rich Gas?

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1. Free Flowing well as long as possible!

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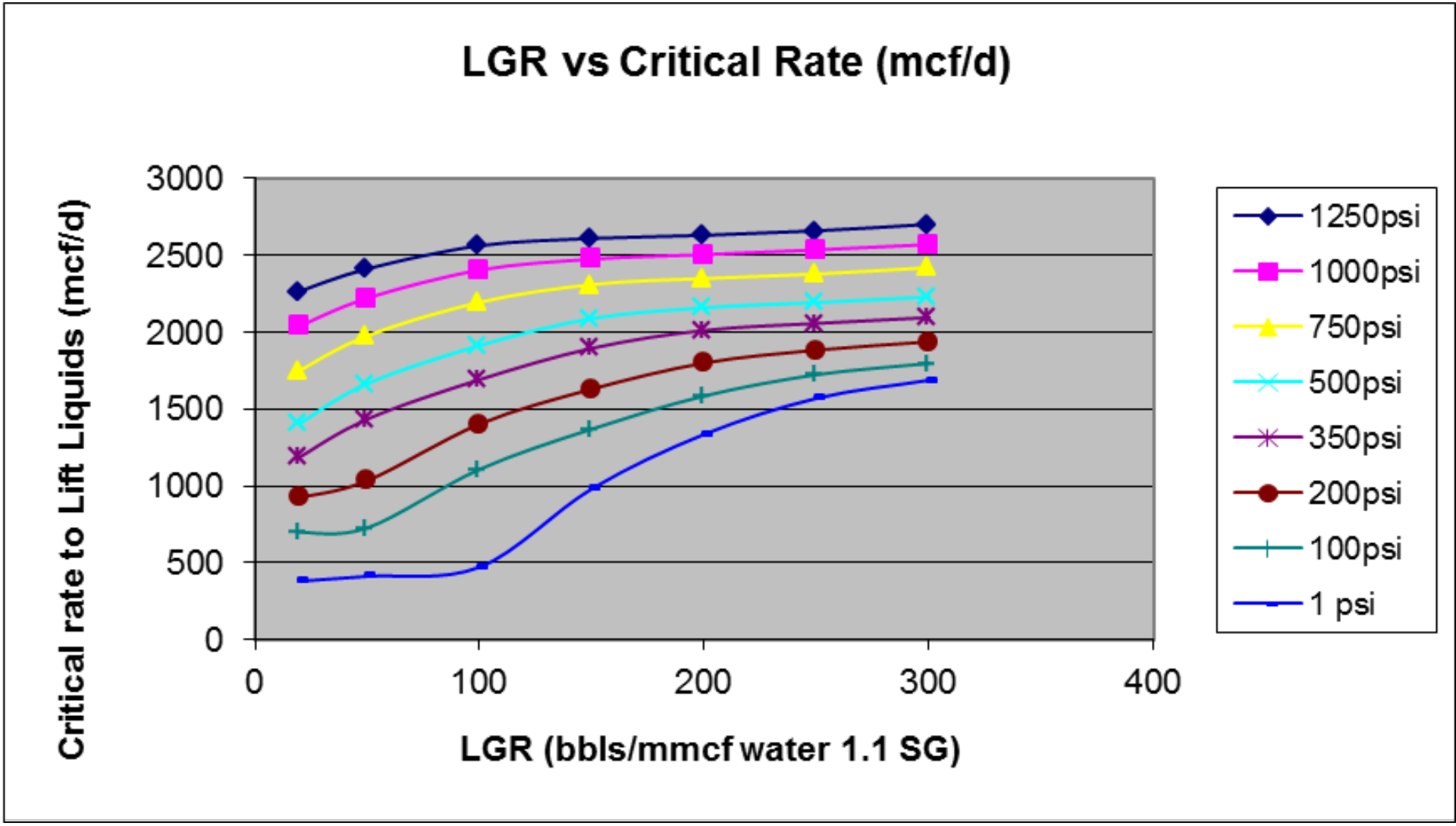
How Does Compression Impact The Critical Rate To Lift Liquids

3 1/2” Tubing 12000ft Vertical well



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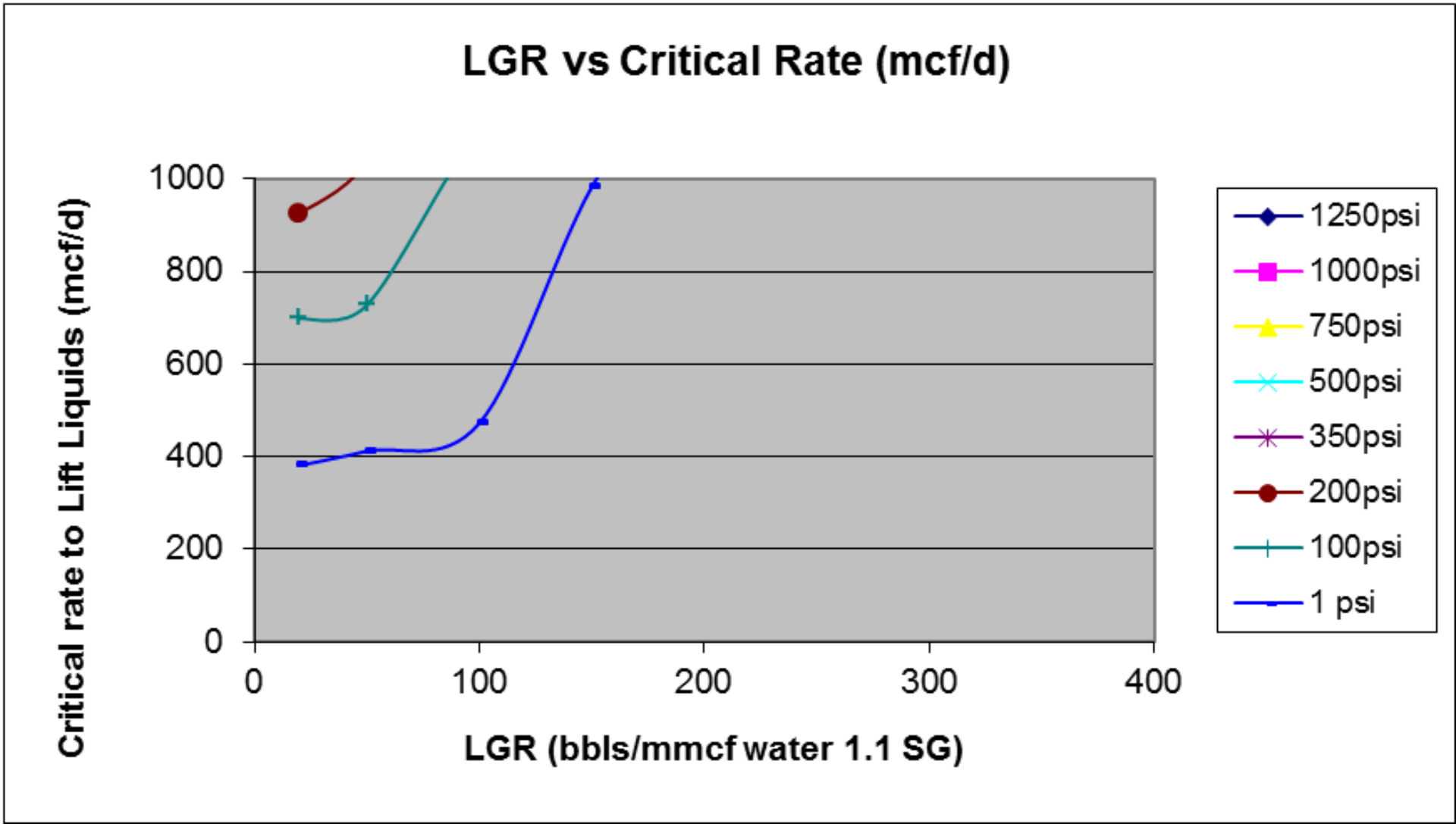
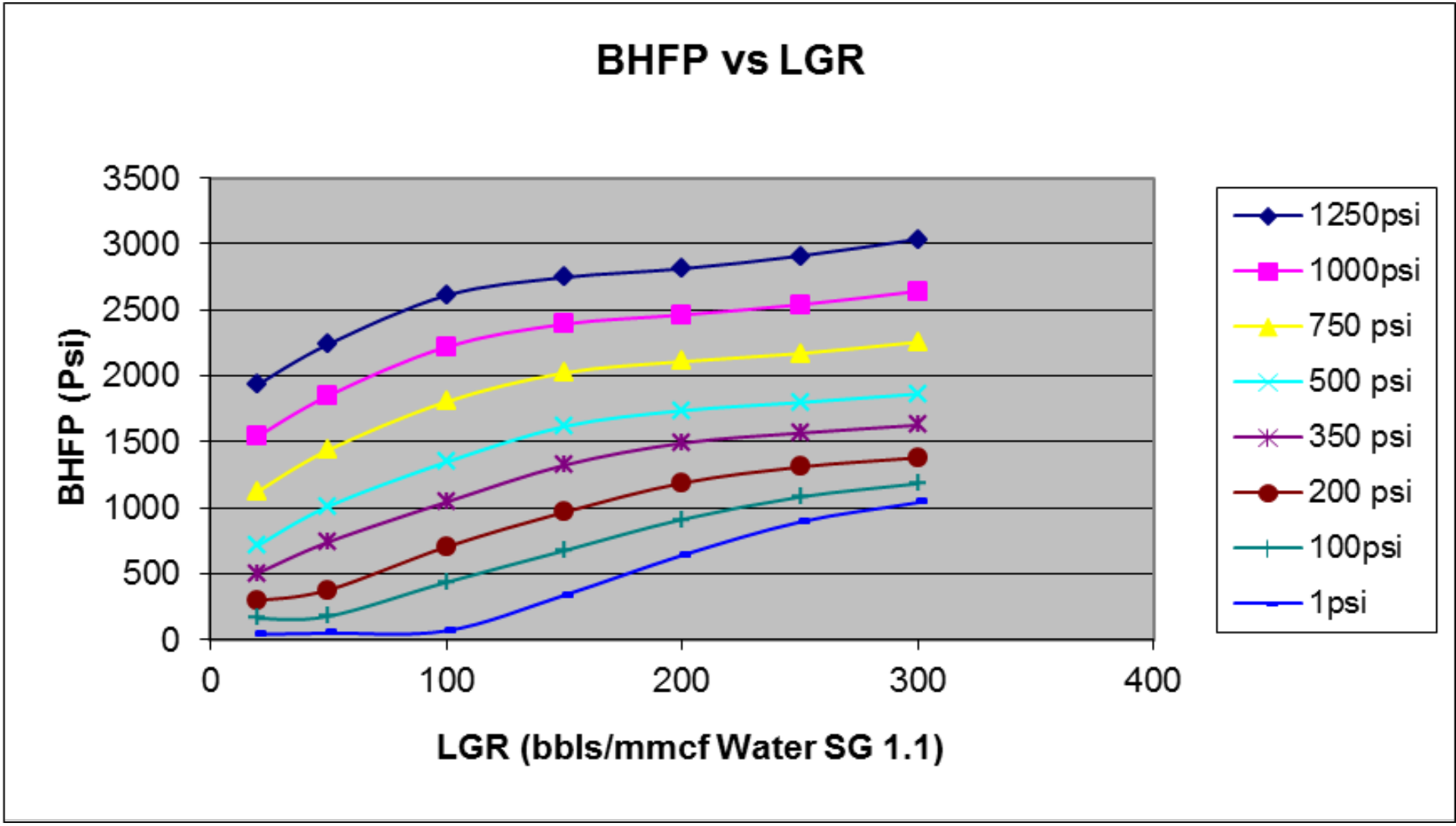


How Does Compression Impact The Bottom Hole Flowing Pressure

3 1/2” Tubing 12000ft Vertical well



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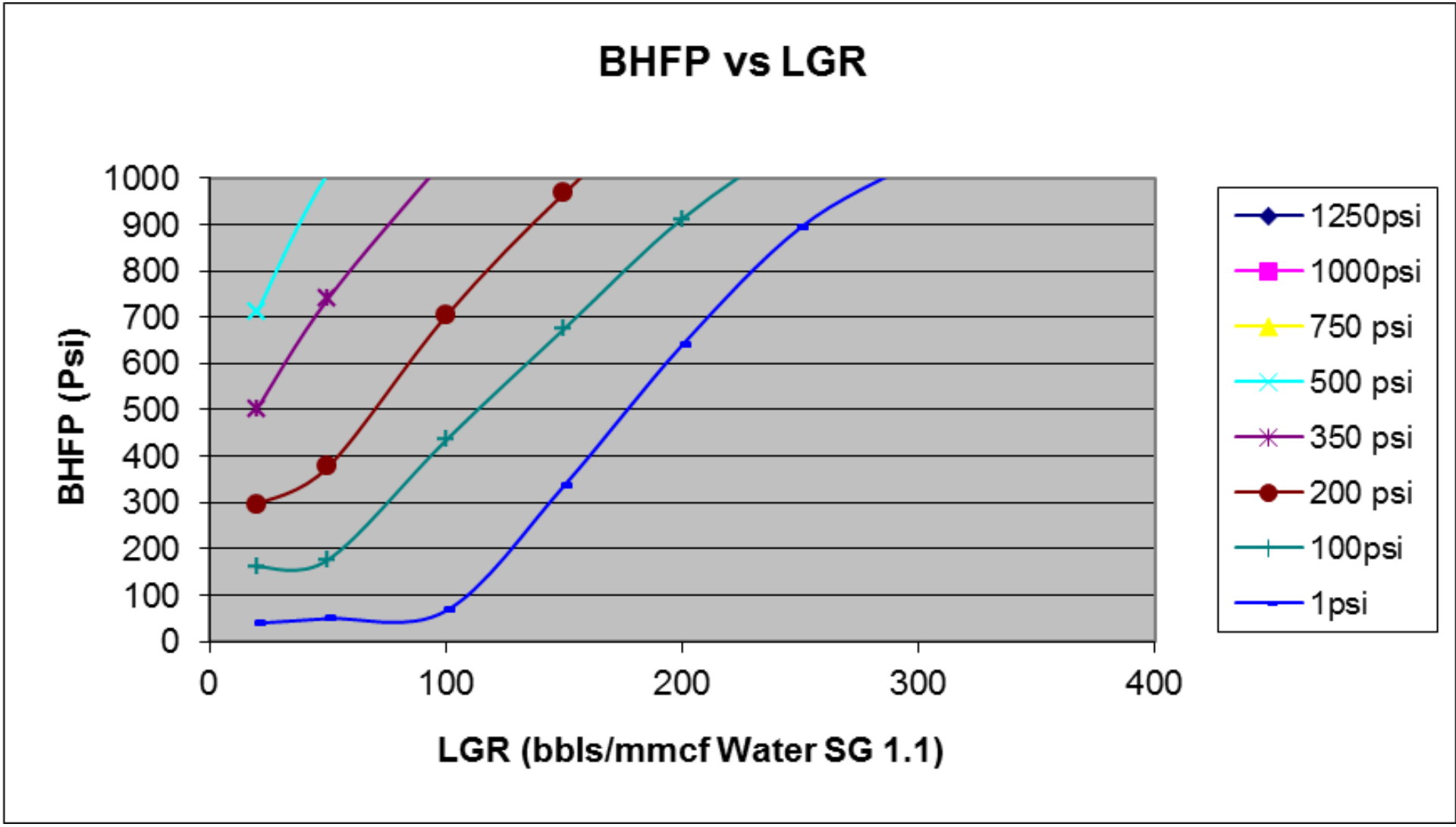
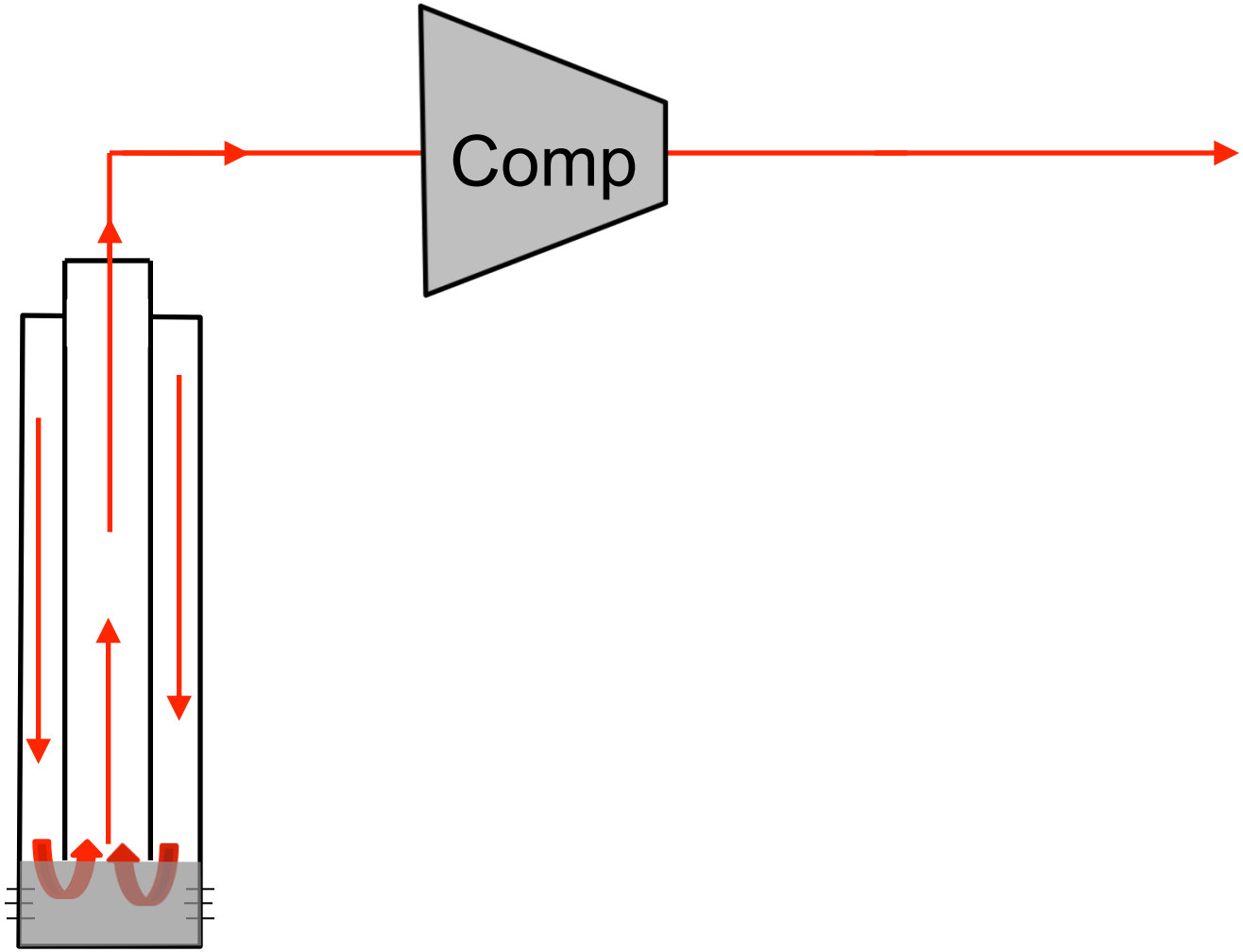
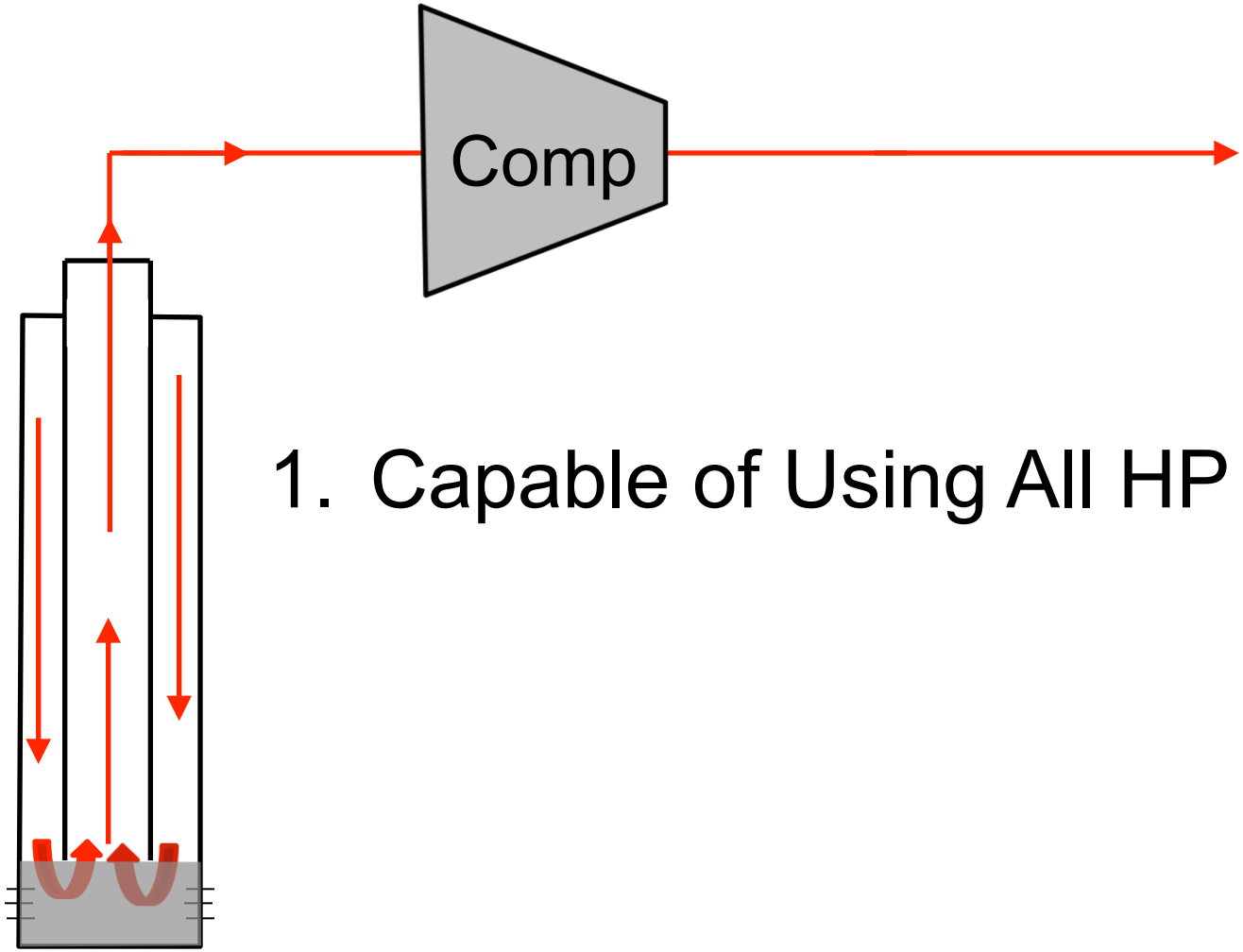


Unconventional Compressor Design

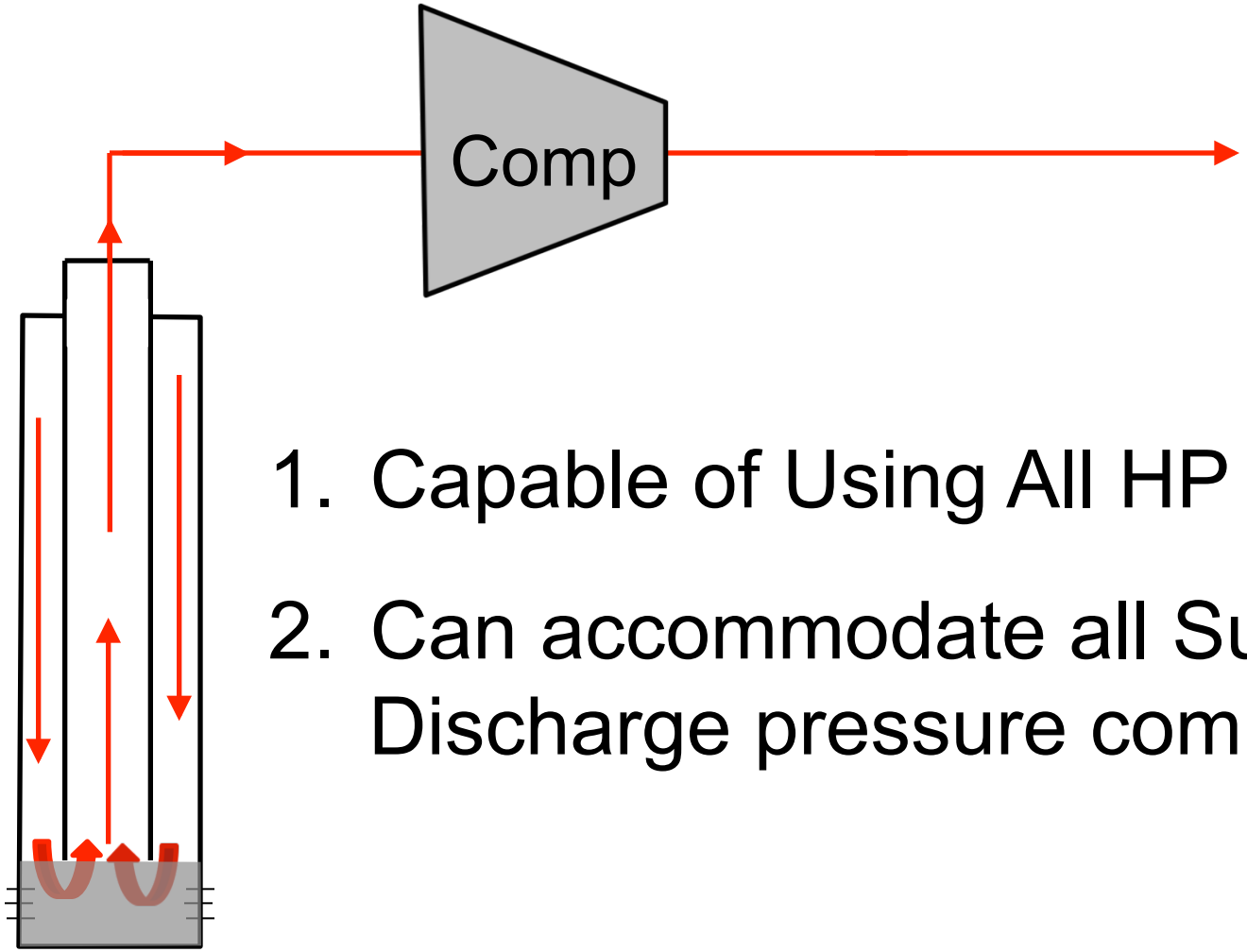


Unconventional Compressor Design

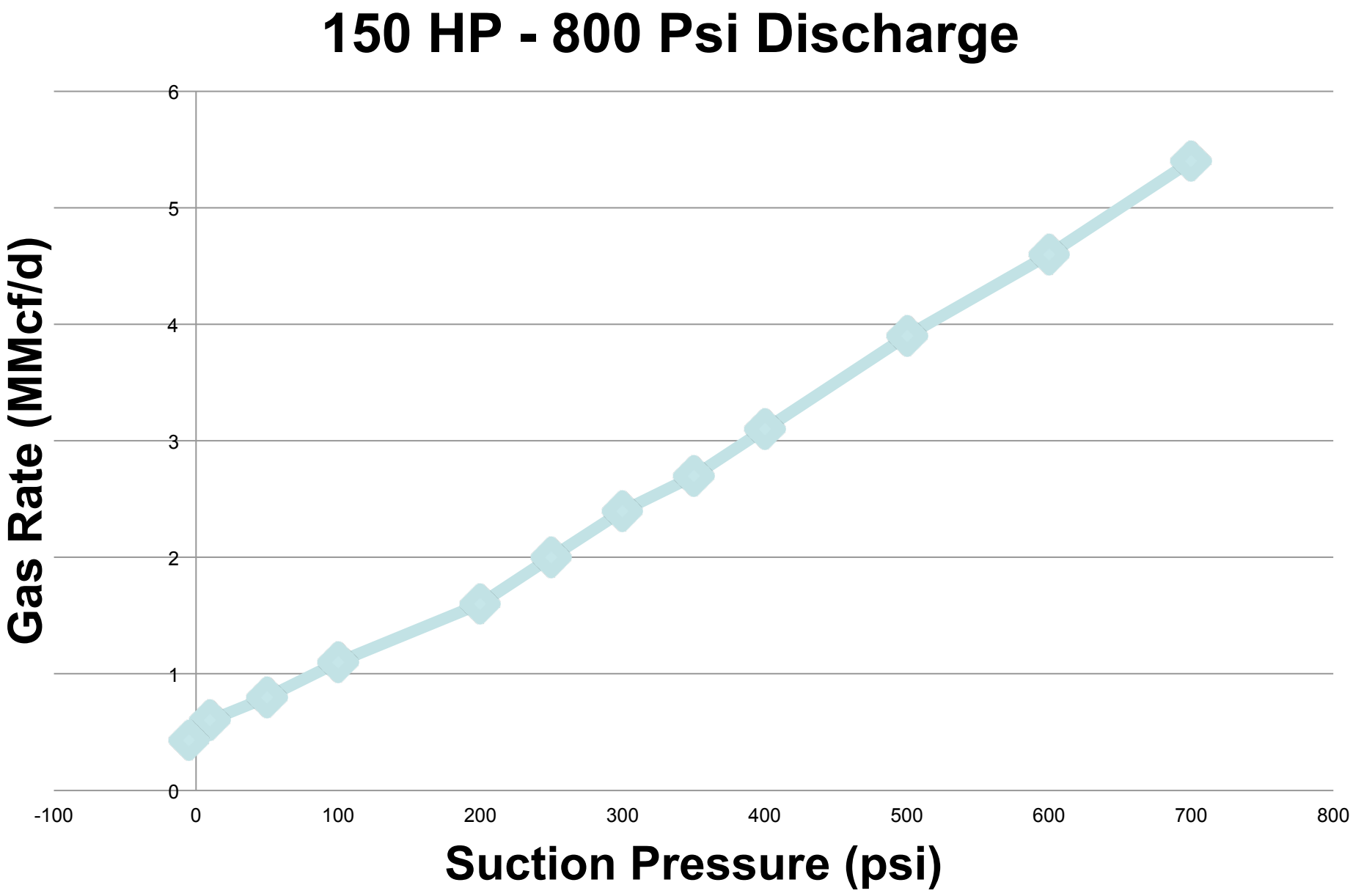


1. Capable of Using All HP

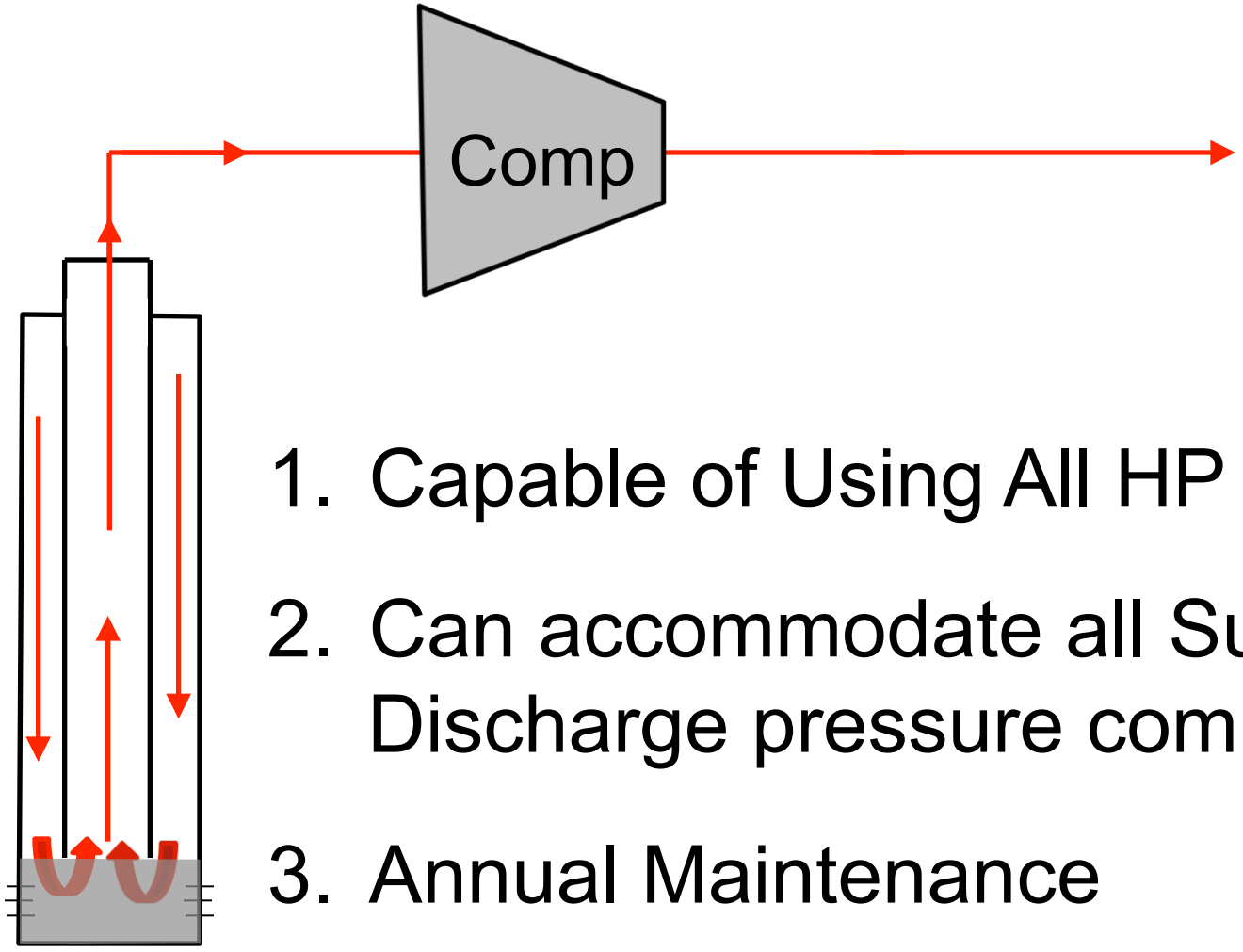
Unconventional Compressor Design



1. Capable of Using All HP
2. Can accommodate all Suction / Discharge pressure combinations


150 HP - 800 Psi Discharge
Gas Rate (MMcf/d)
0
1
2
3
4
5
6
-100
0
100
200
300
400
500
600
700
800
Suction Pressure (psi)

Unconventional Compressor Design



1. Capable of Using All HP
2. Can accommodate all Suction / Discharge pressure combinations
3. Annual Maintenance

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Unconventional Wellbore Design

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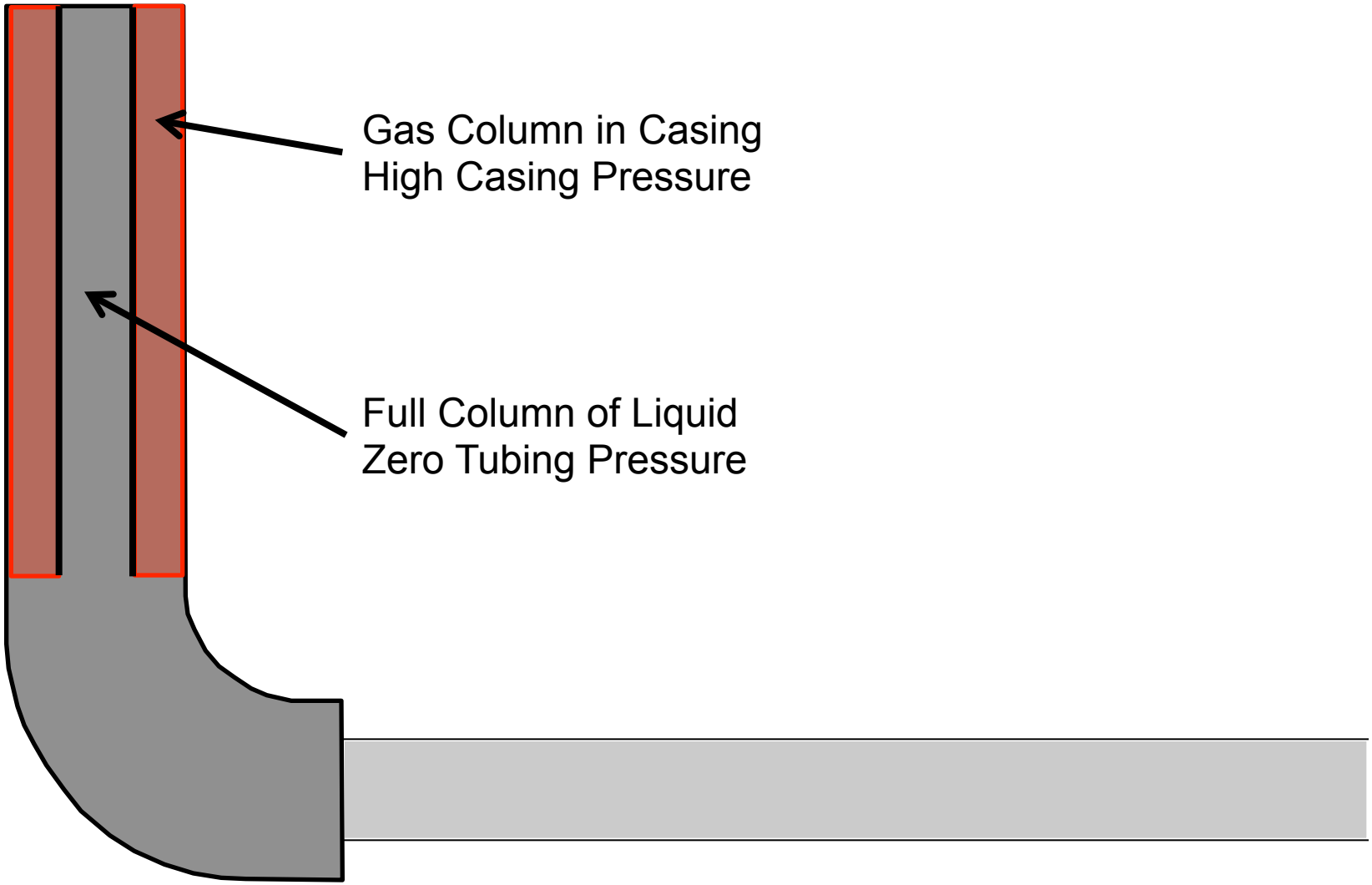
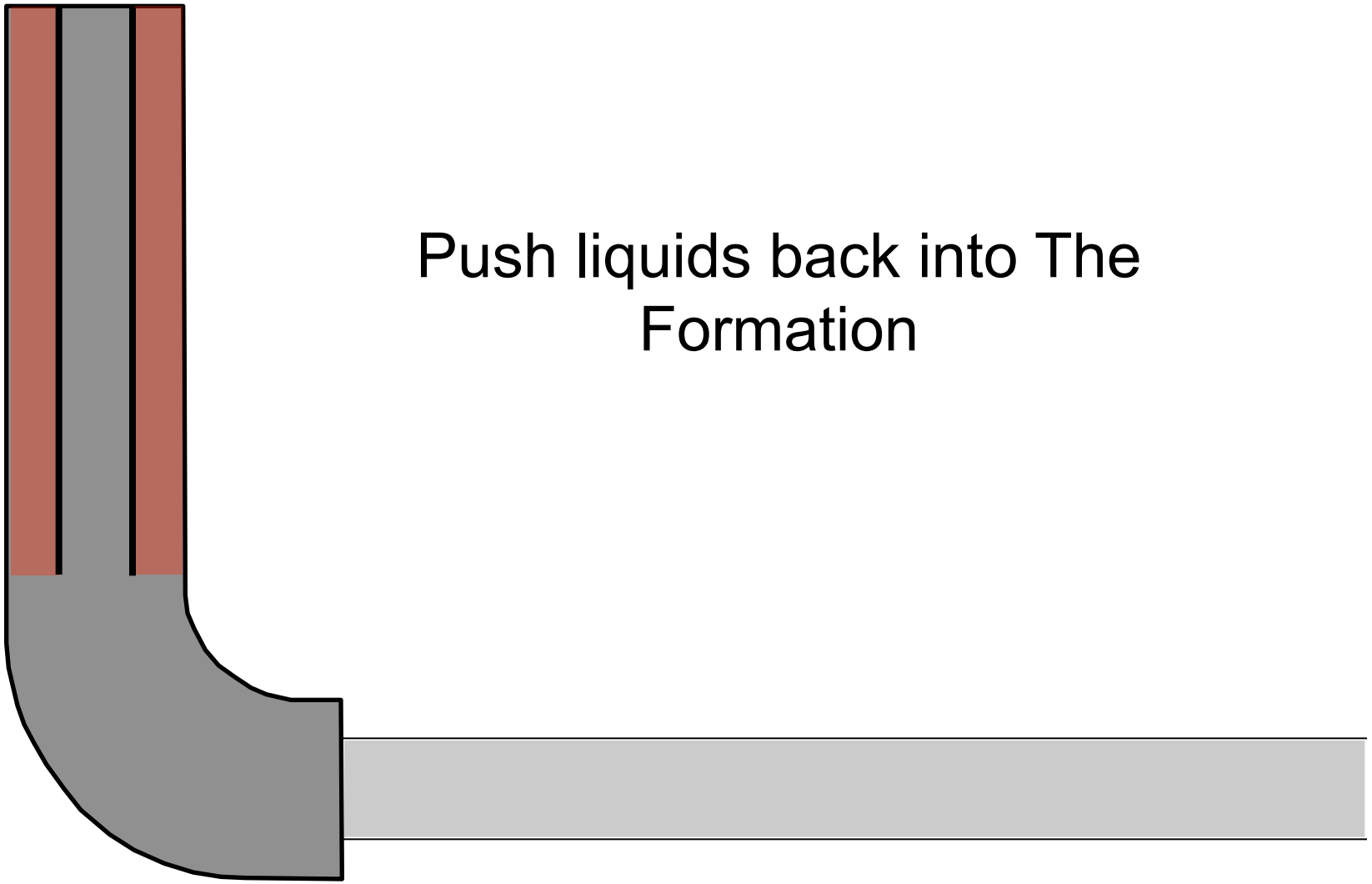
3. Eliminate all downhole equipment!

The Difficulties of Well Startup

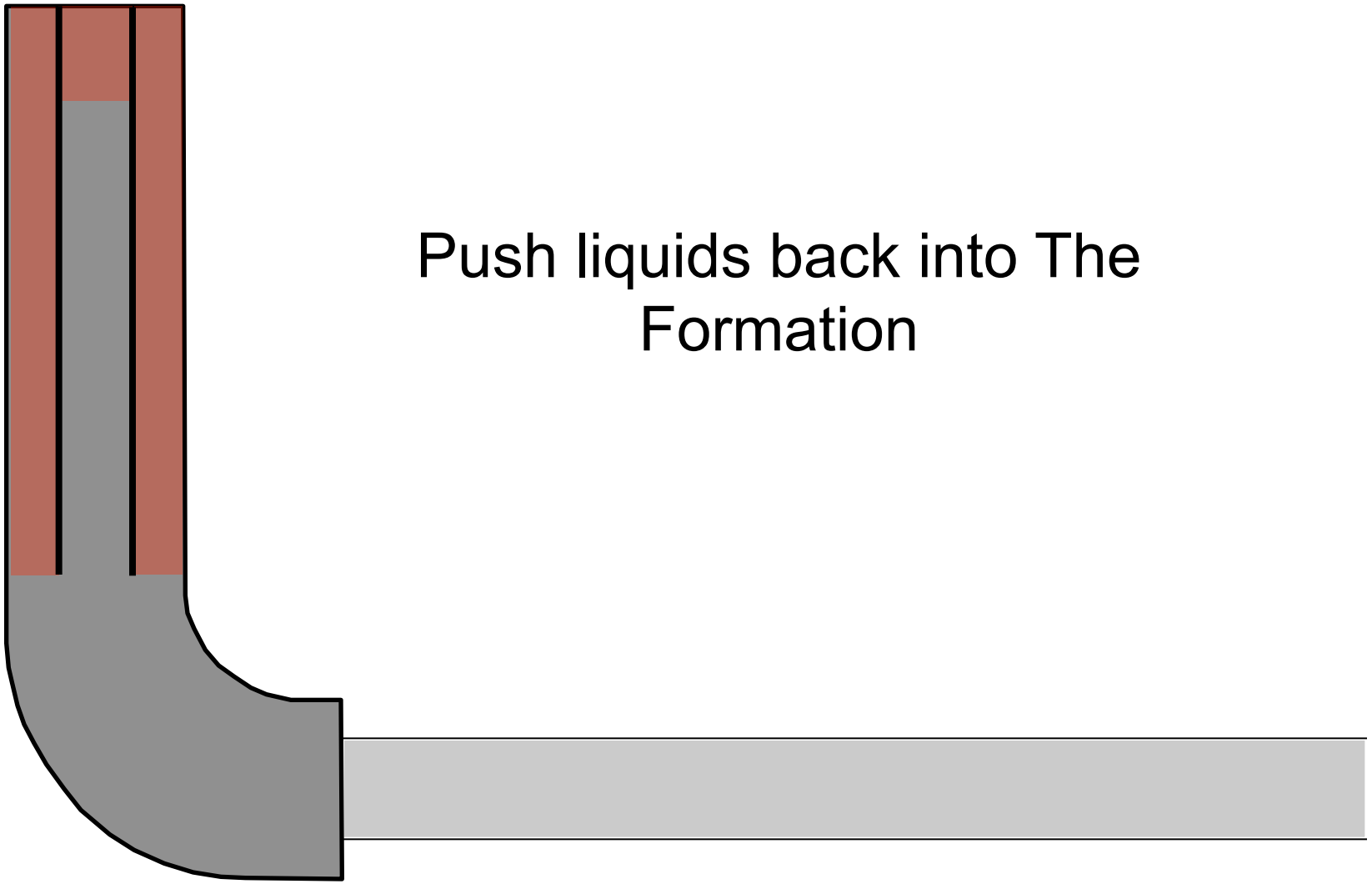


Well Startup Without GL Valves



Push liquids back into The Formation

Well Startup Without GL Valves



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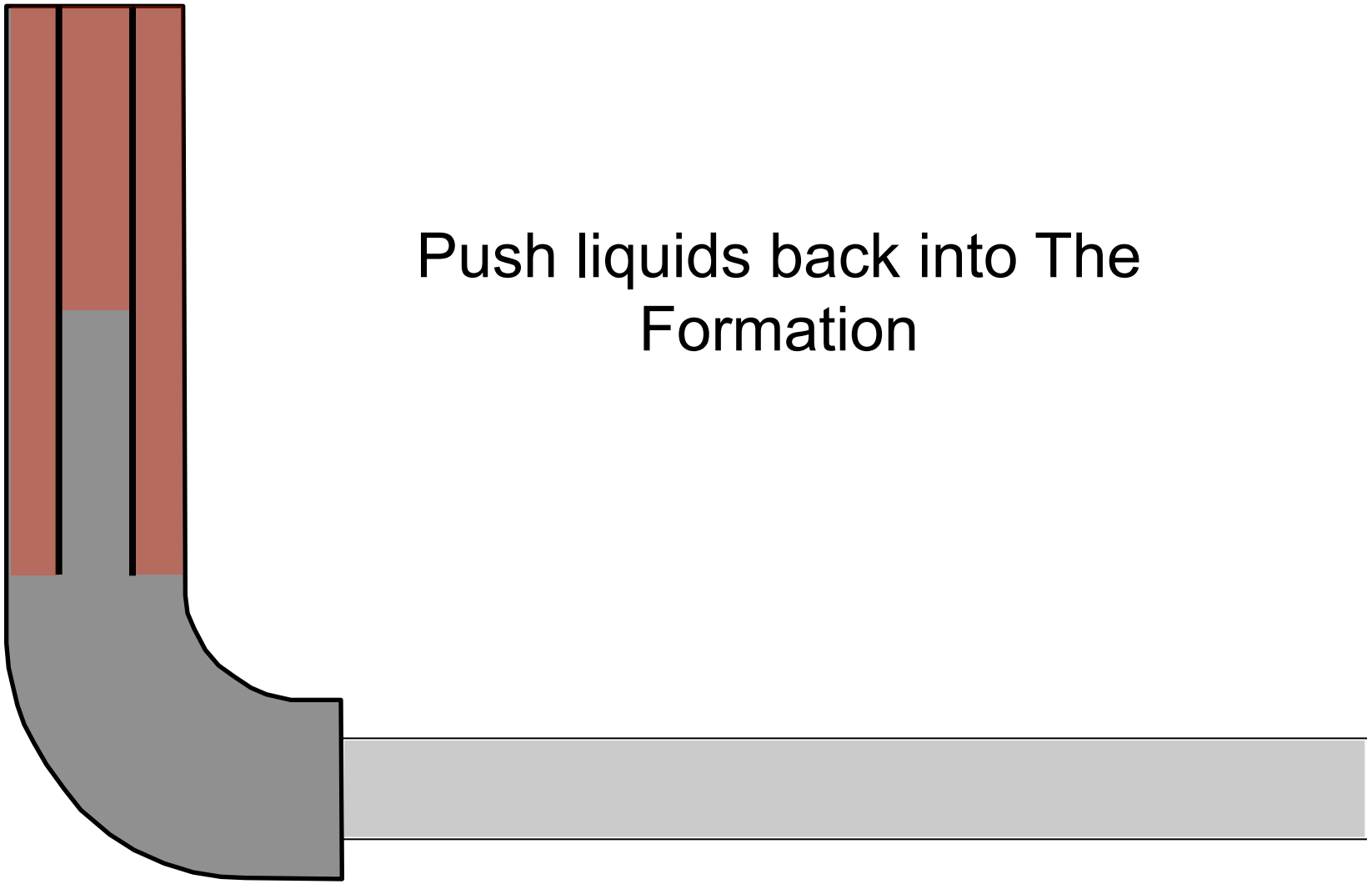

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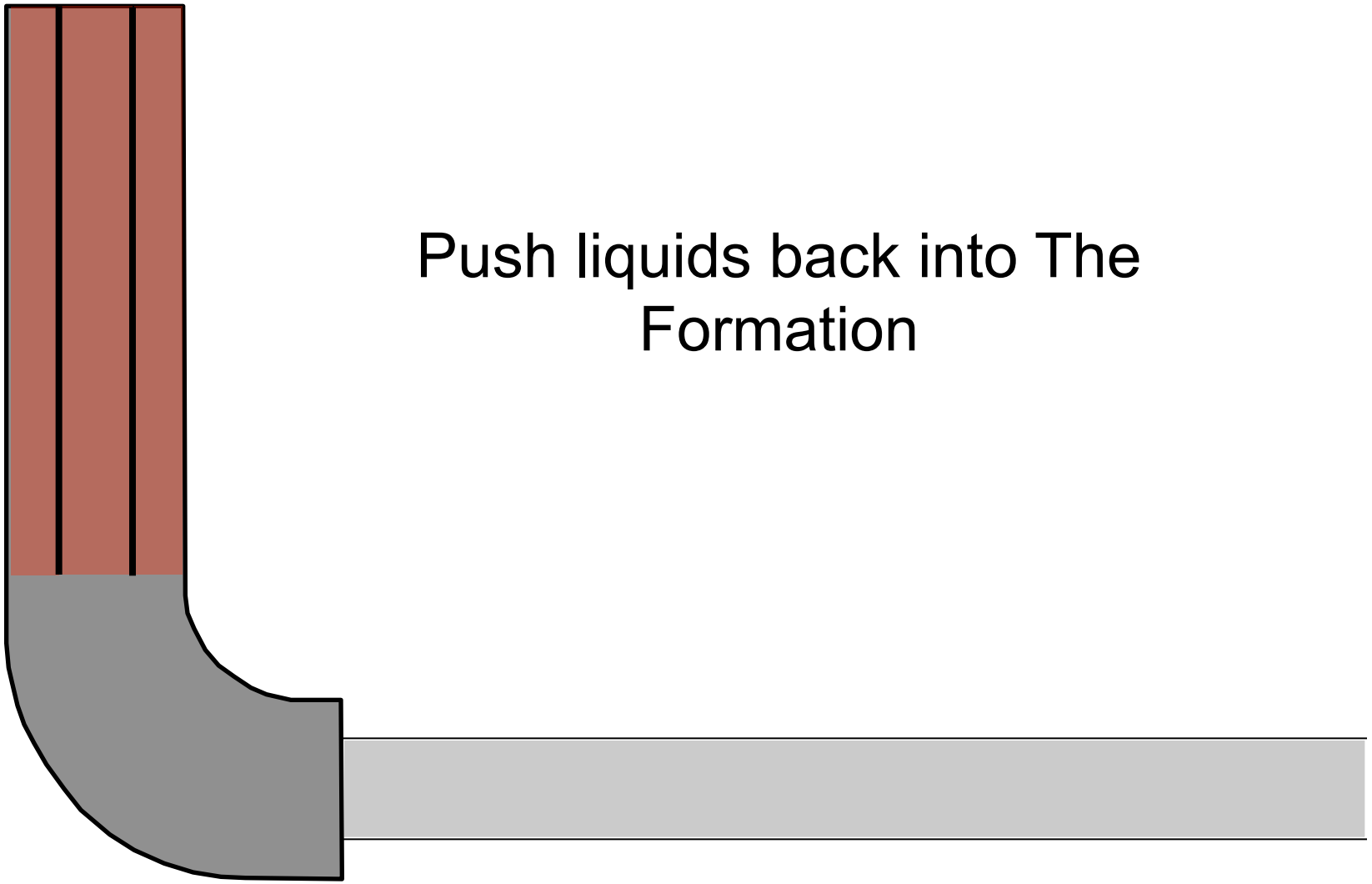

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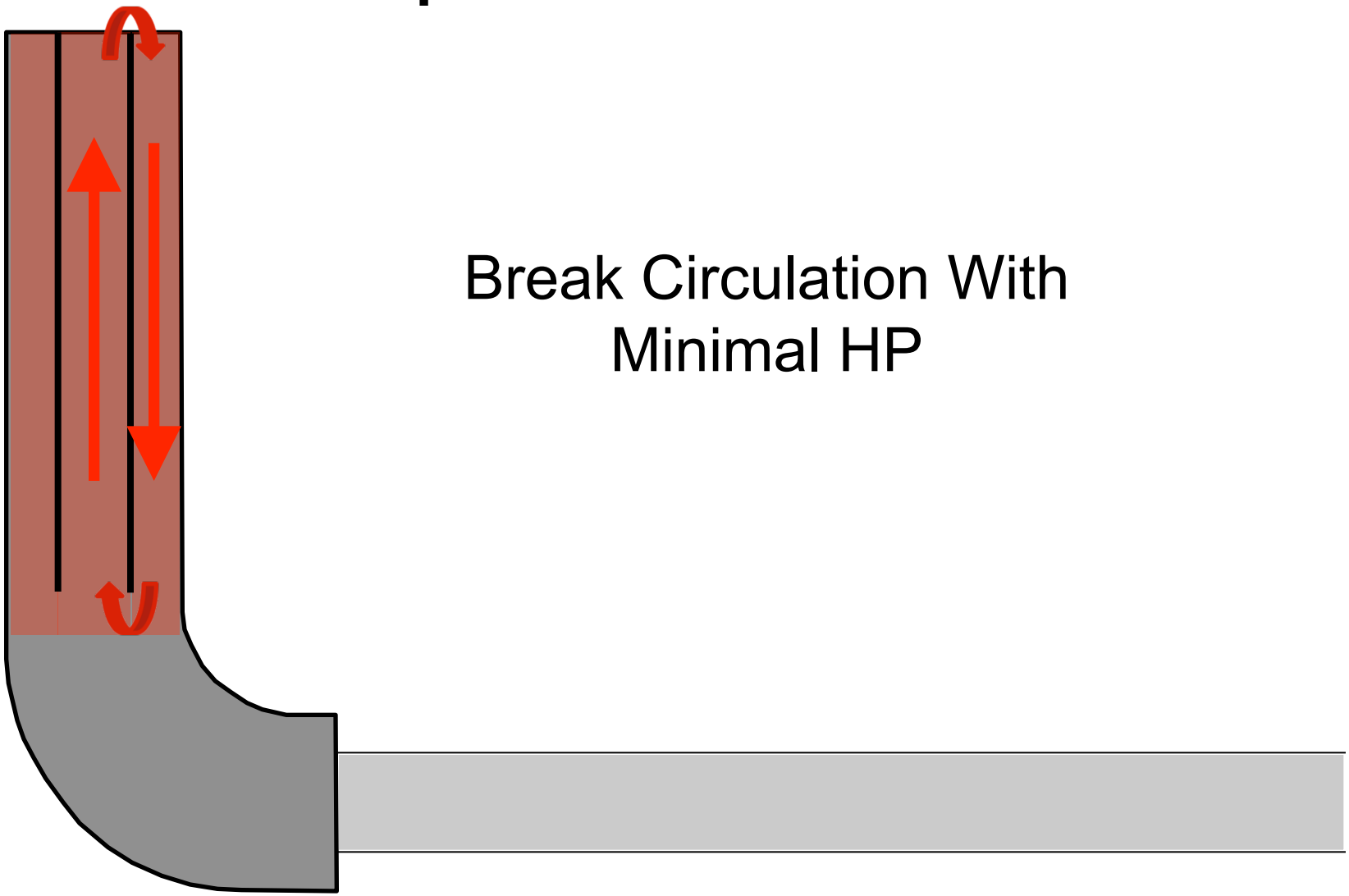
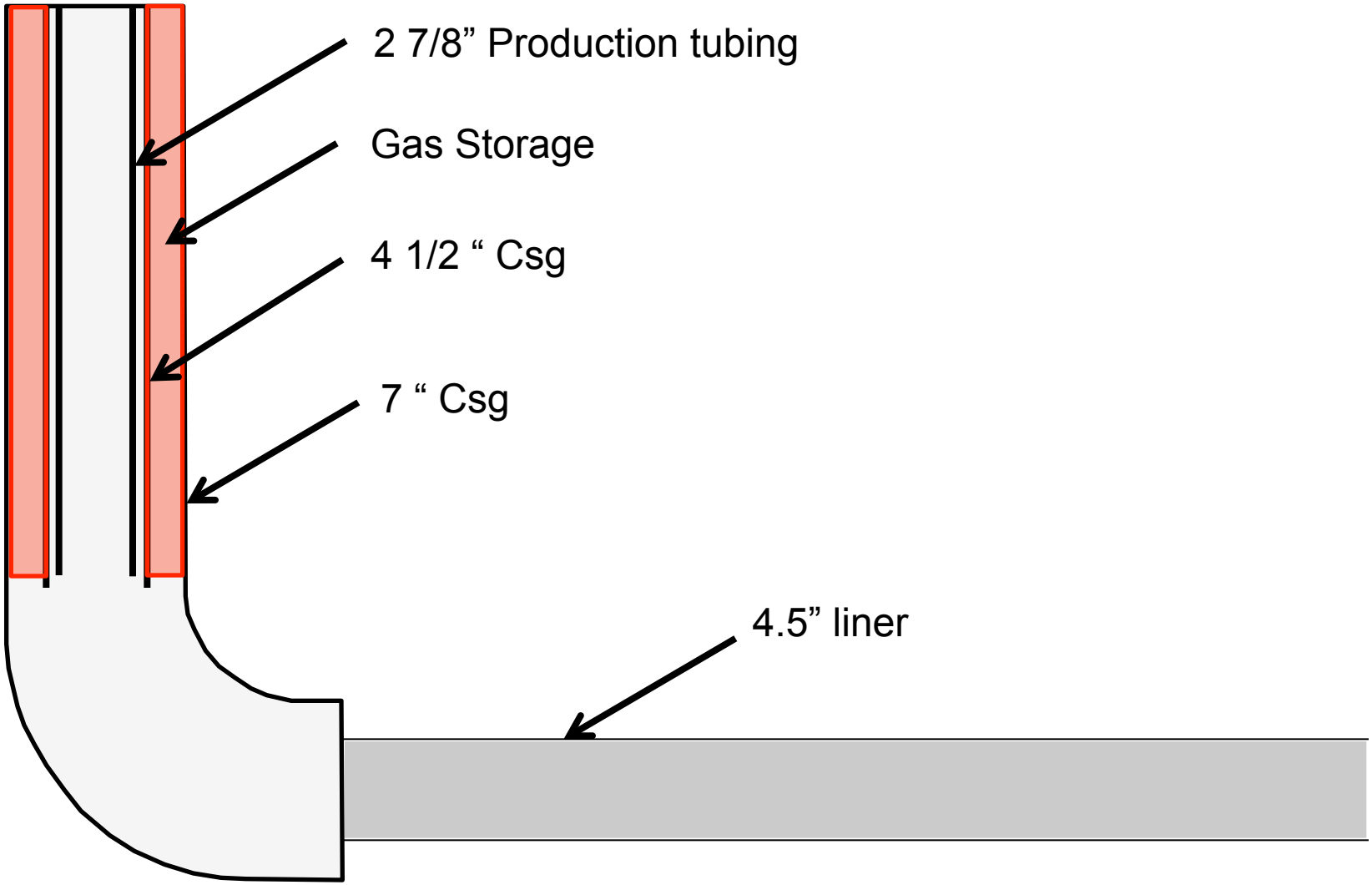


Break Circulation With
Minimal HP

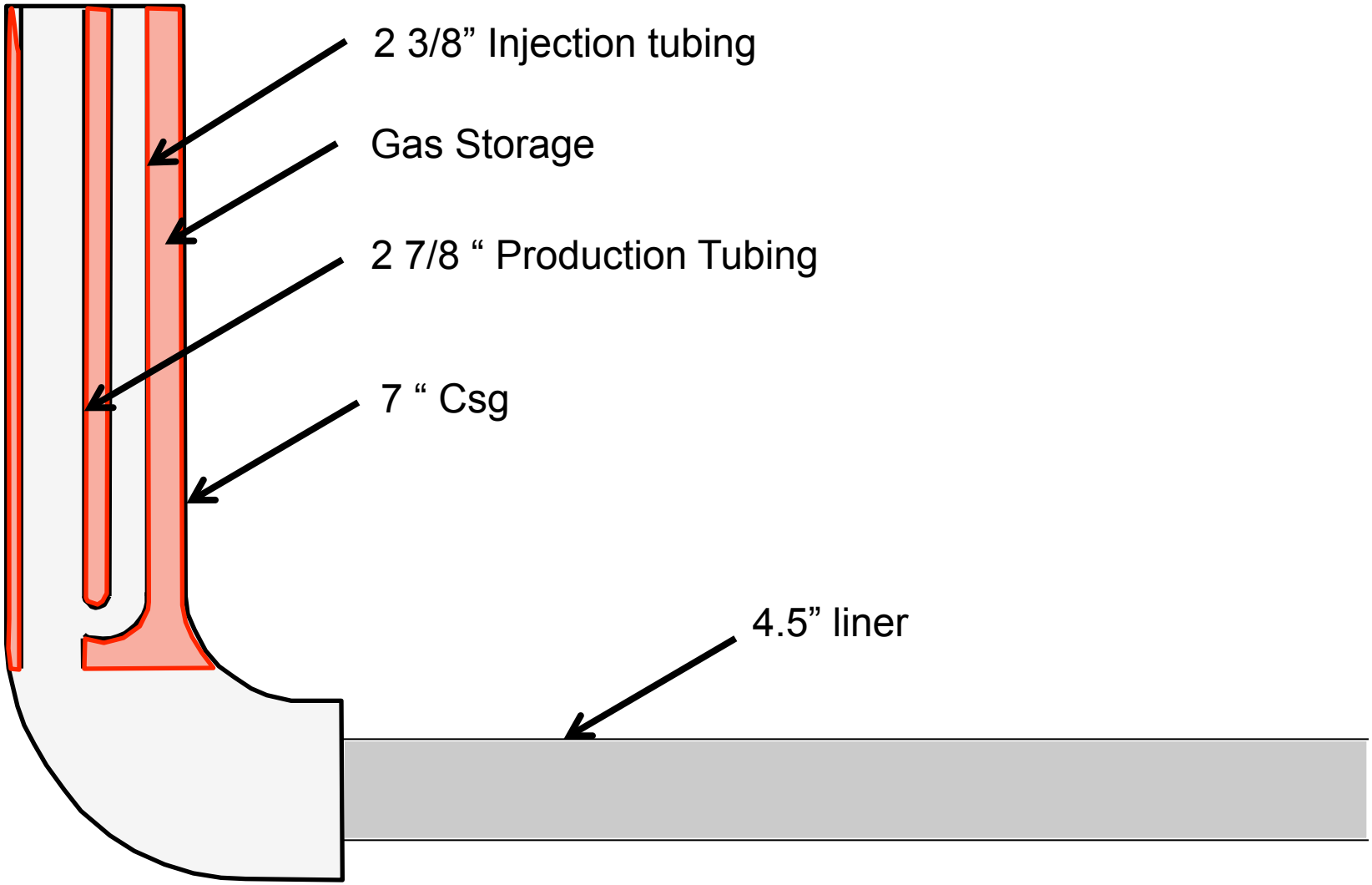
Unconventional Wellbore Design

1. Design Tubing for optimum depletion
   - The larger the better!
   - Install friction reducing coatings
   - Eliminate upsets to reduce turbulence
2. Install Surface Flow control valve to allow annular production
3. Eliminate all downhole equipment!
4. If necessary provide capability to store gas in the wellbore

Concentric Tubing Gas Storage



Parallel Tubing Gas Storage



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2. Installation of re-circulative Gas lift system.

Unconventional Gas Lift Design

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1. Re-Circulative Gas Lift Control System

Unconventional Gas Lift Design

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   - Well site intelligence

Unconventional Gas Lift Design

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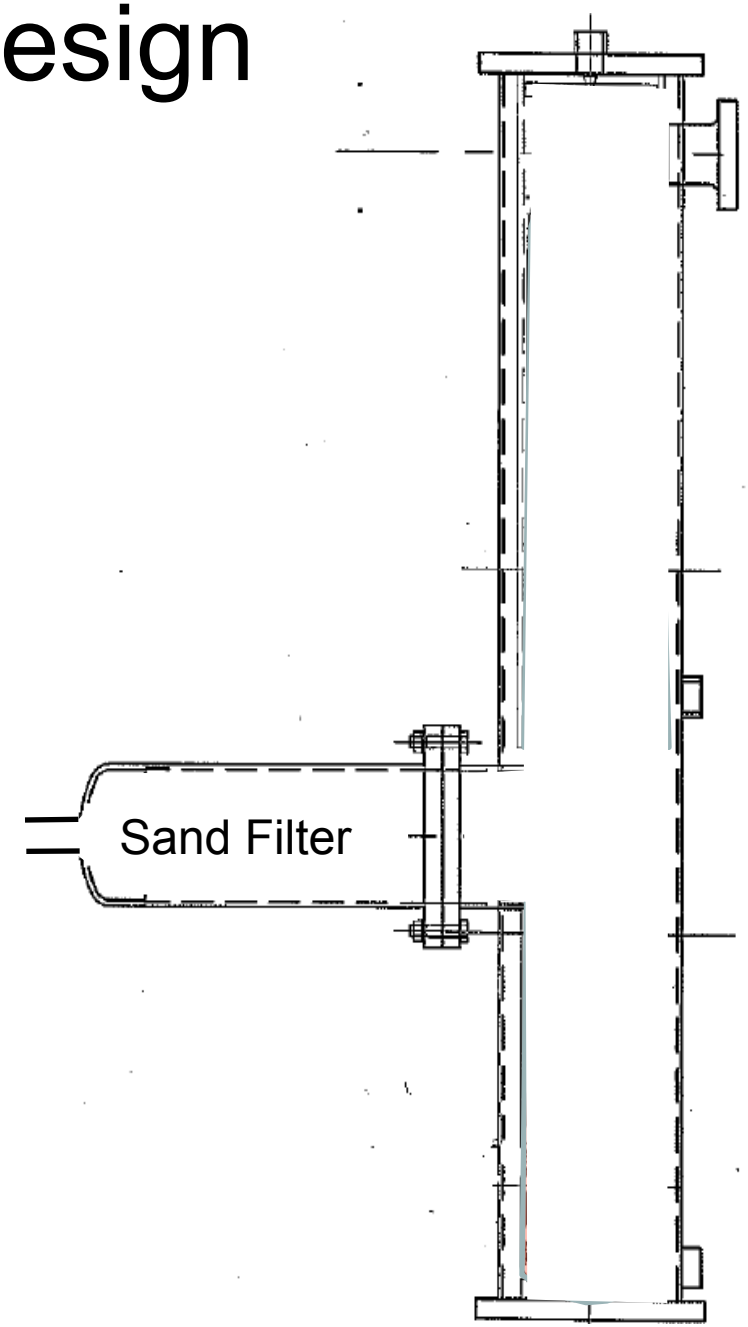
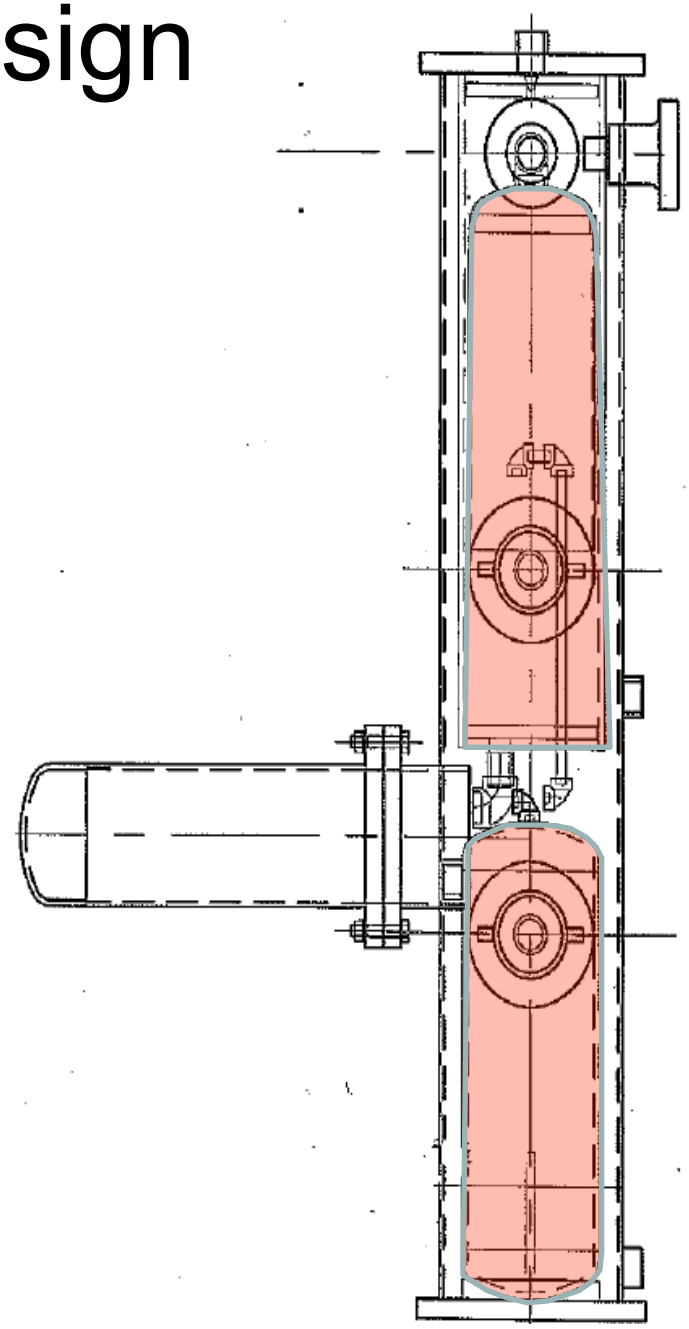
1. Re-Circulative Gas Lift Control System
   - Well site intelligence
   - Real time Critical rate determination
   - Real time production optimization
2. Low Maintenance control valve design
3. Blanketed Blow Case providing safe depletion into a deep vacuum.

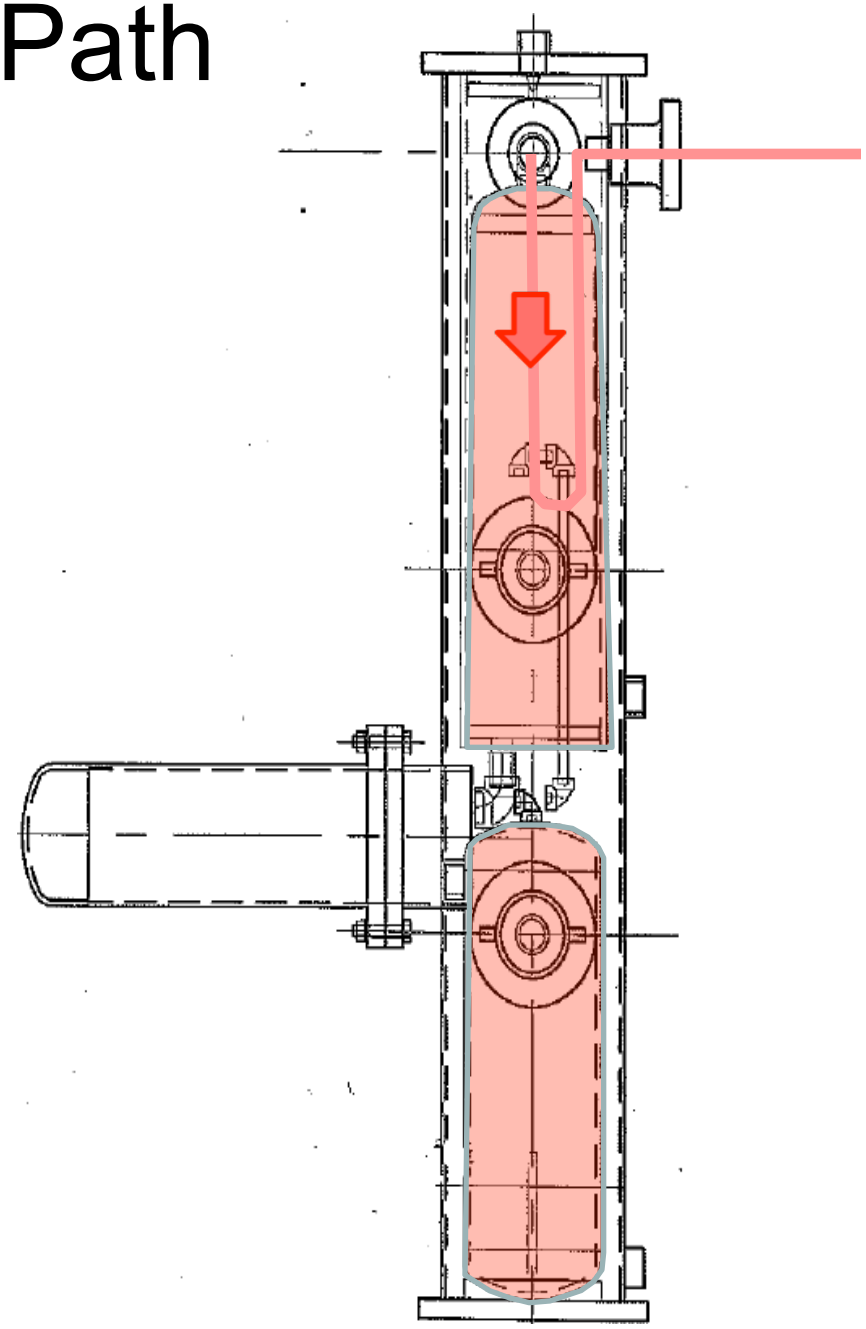
Vessel Design



Vessel Design



Gas Flow Path



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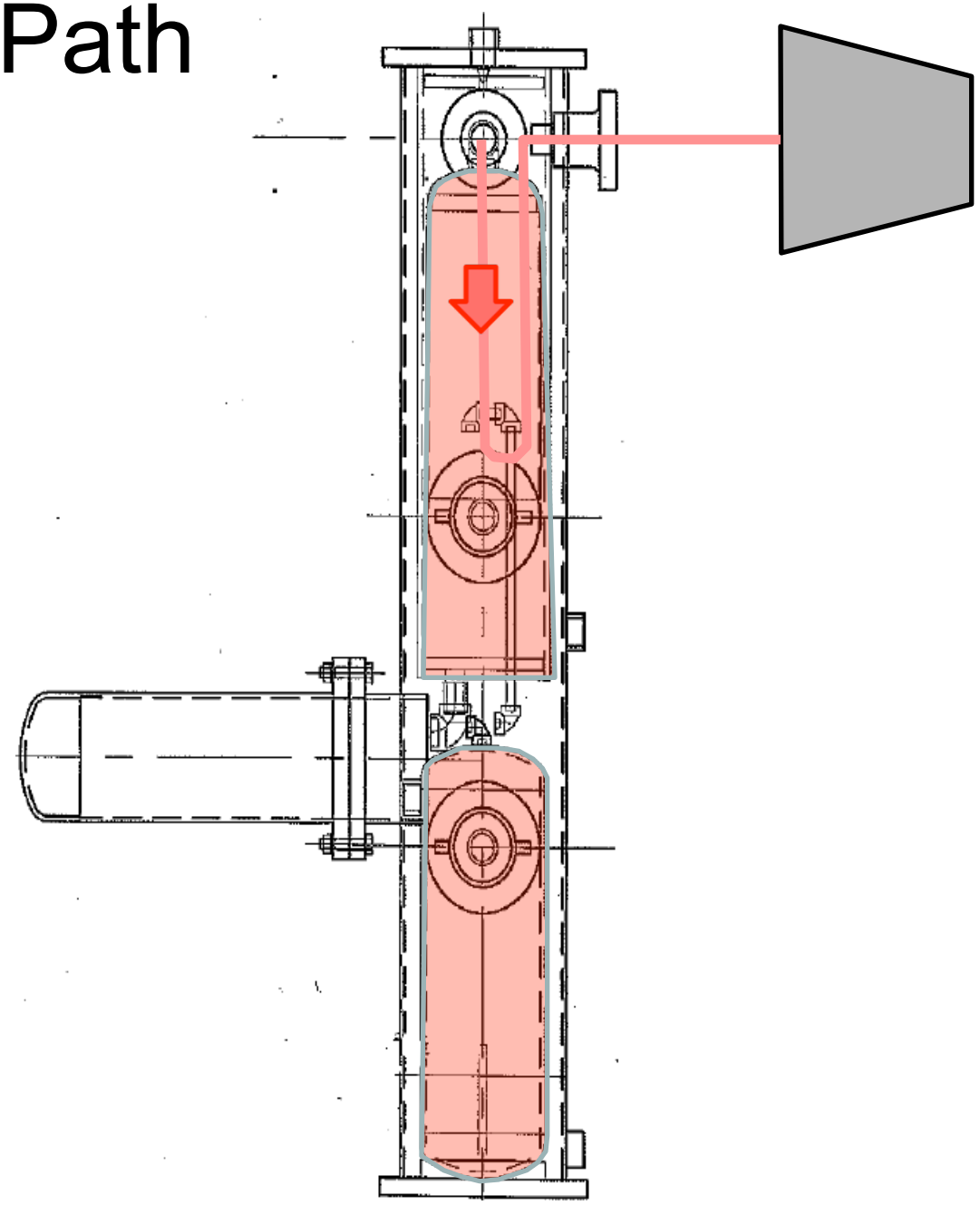

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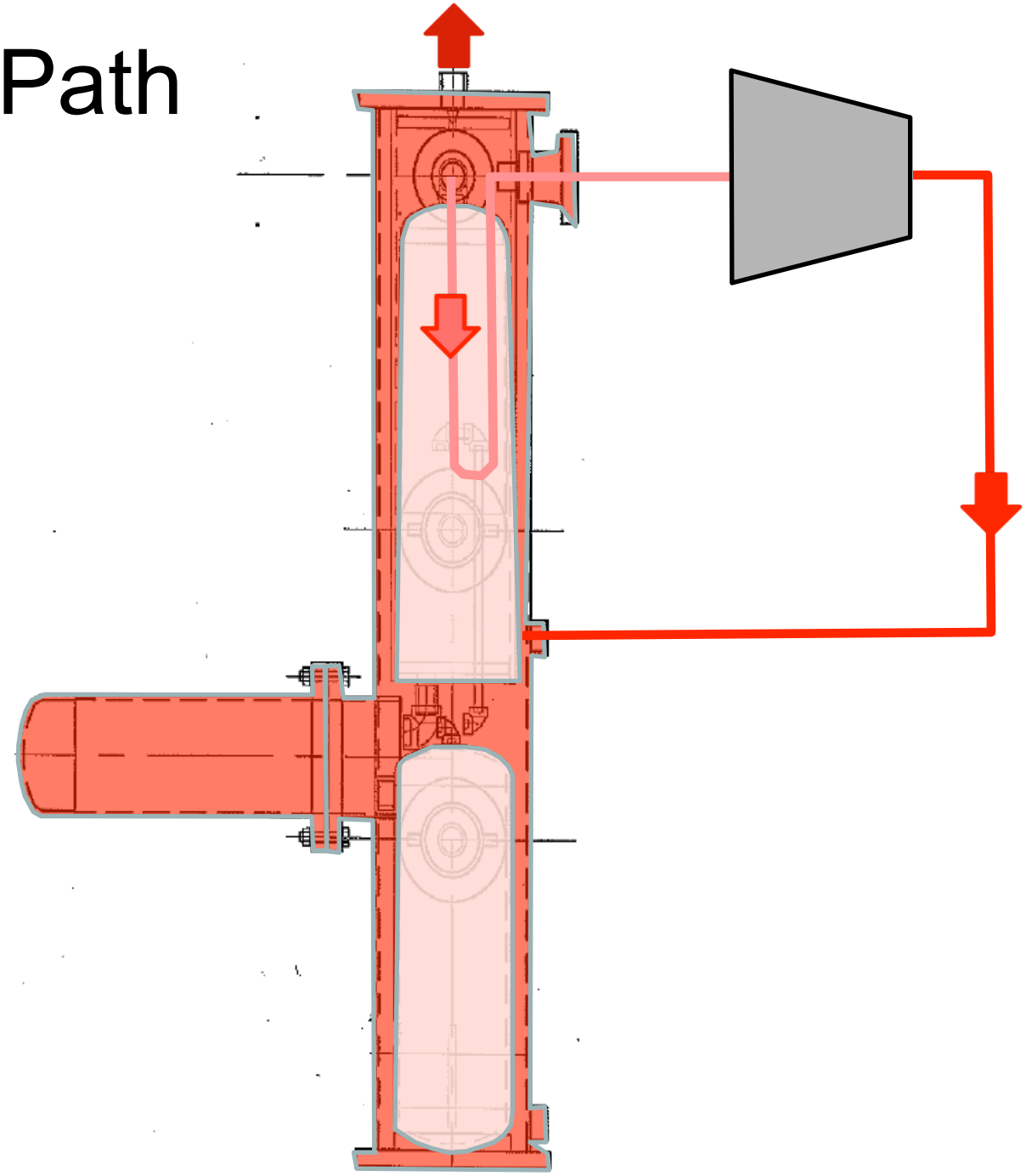
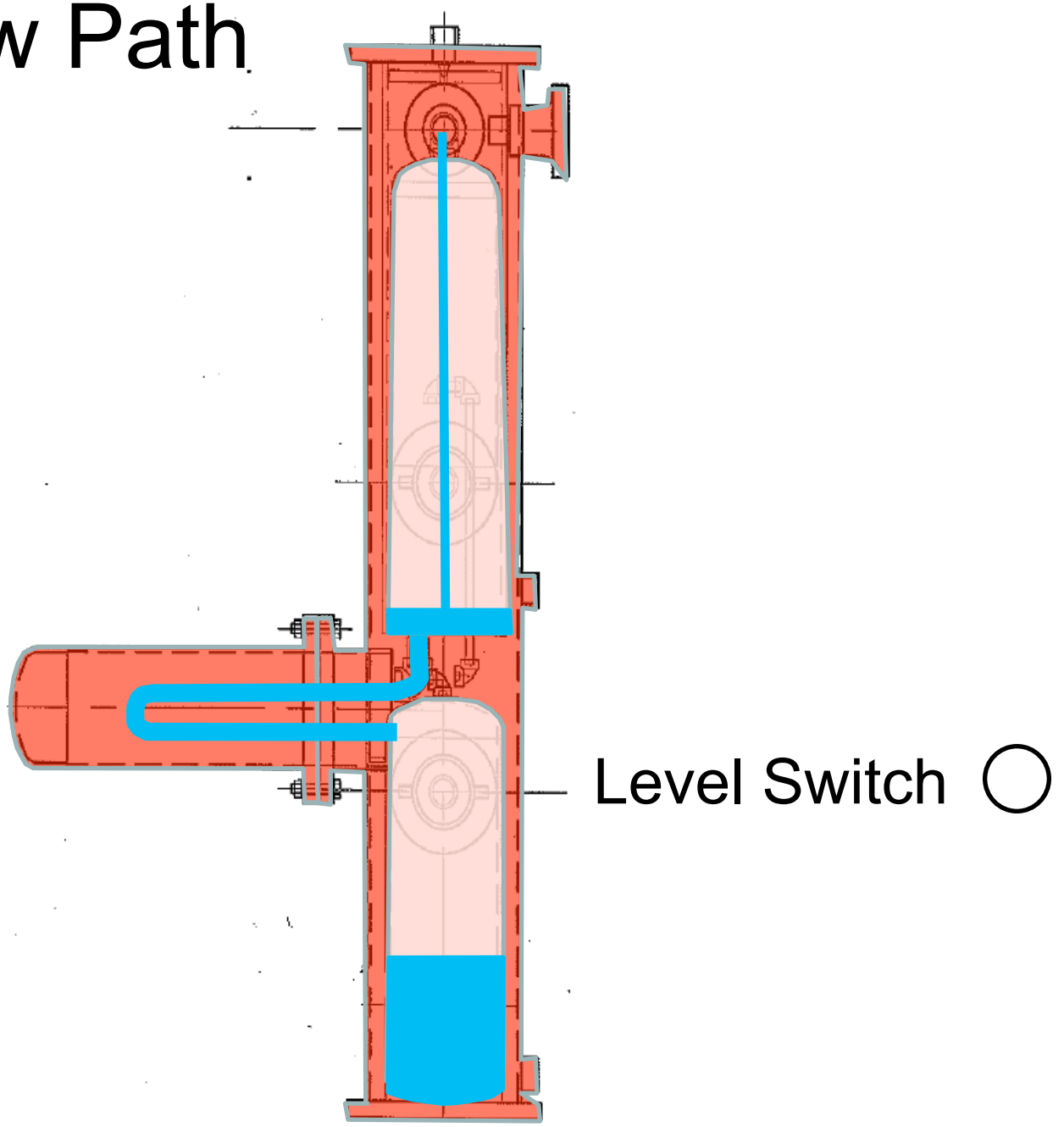


Liquid Flow Path



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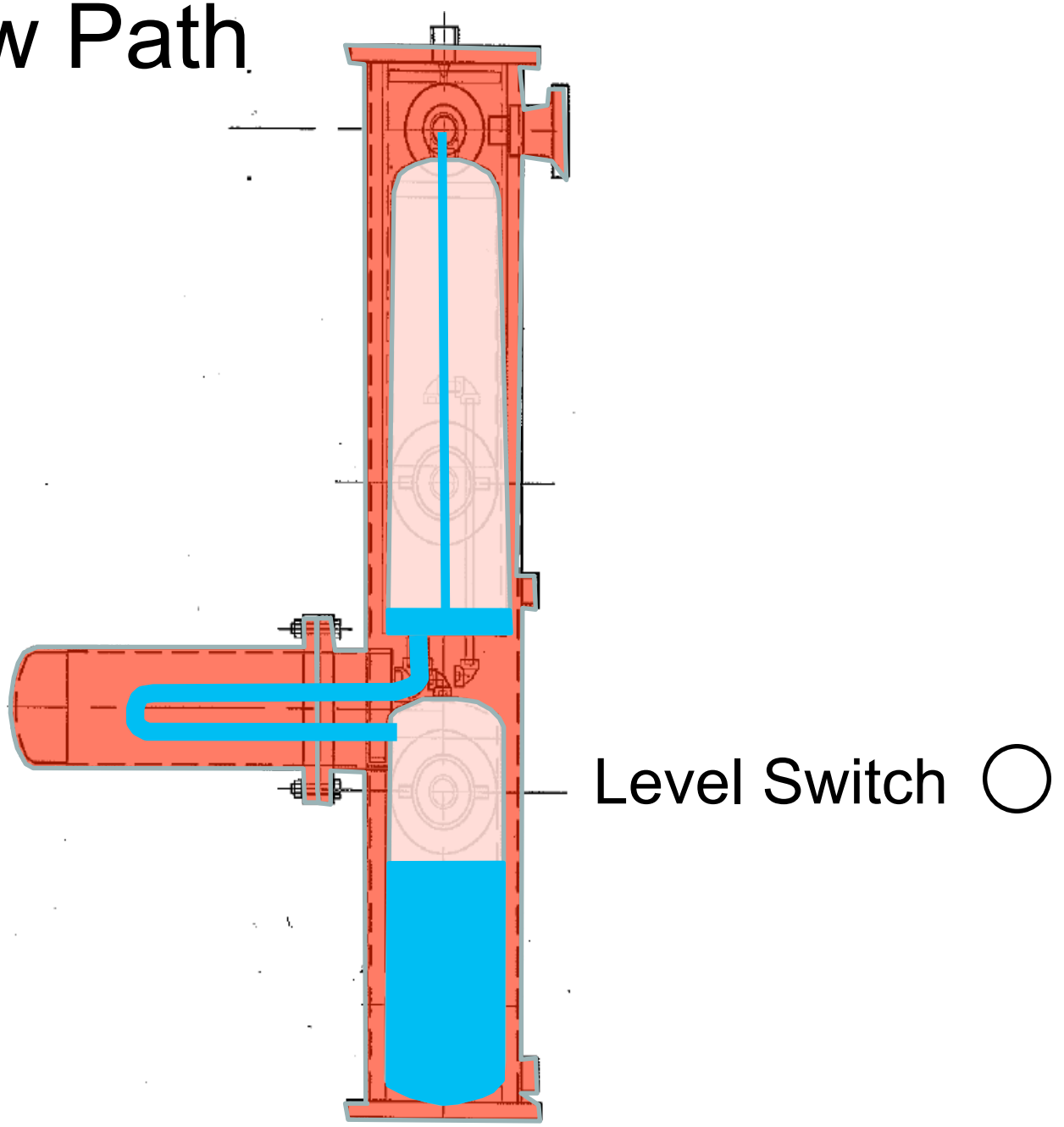

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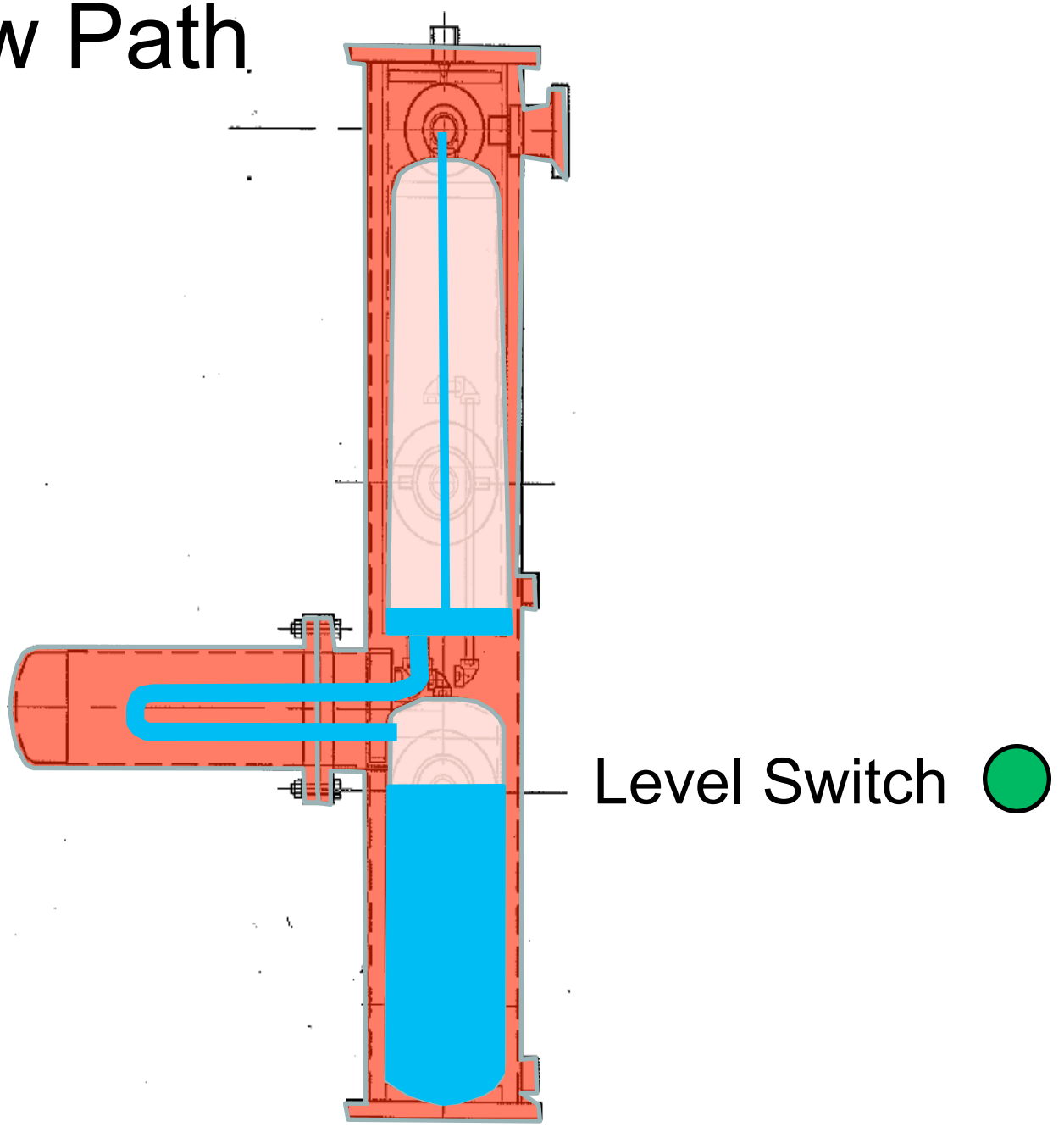

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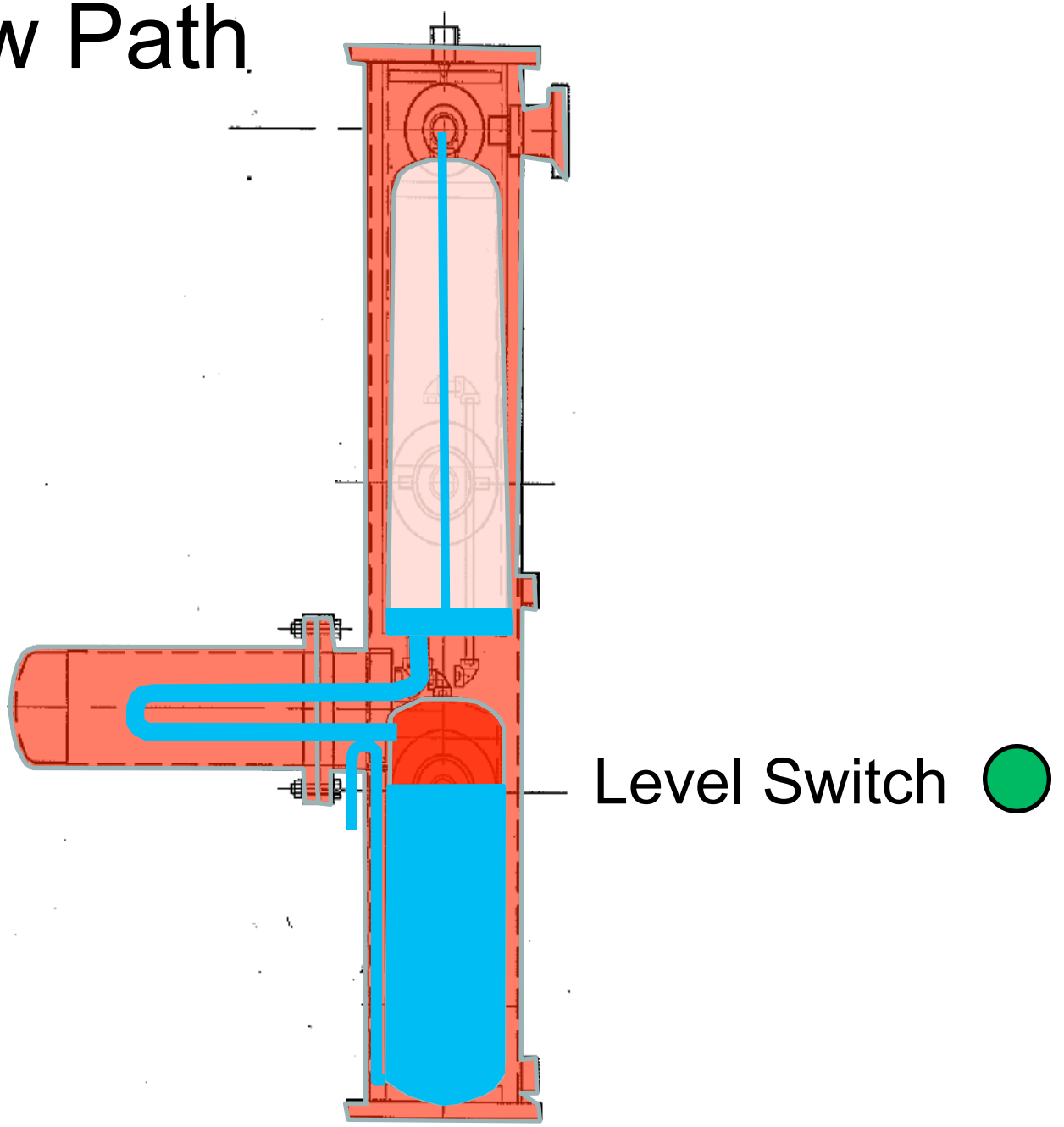

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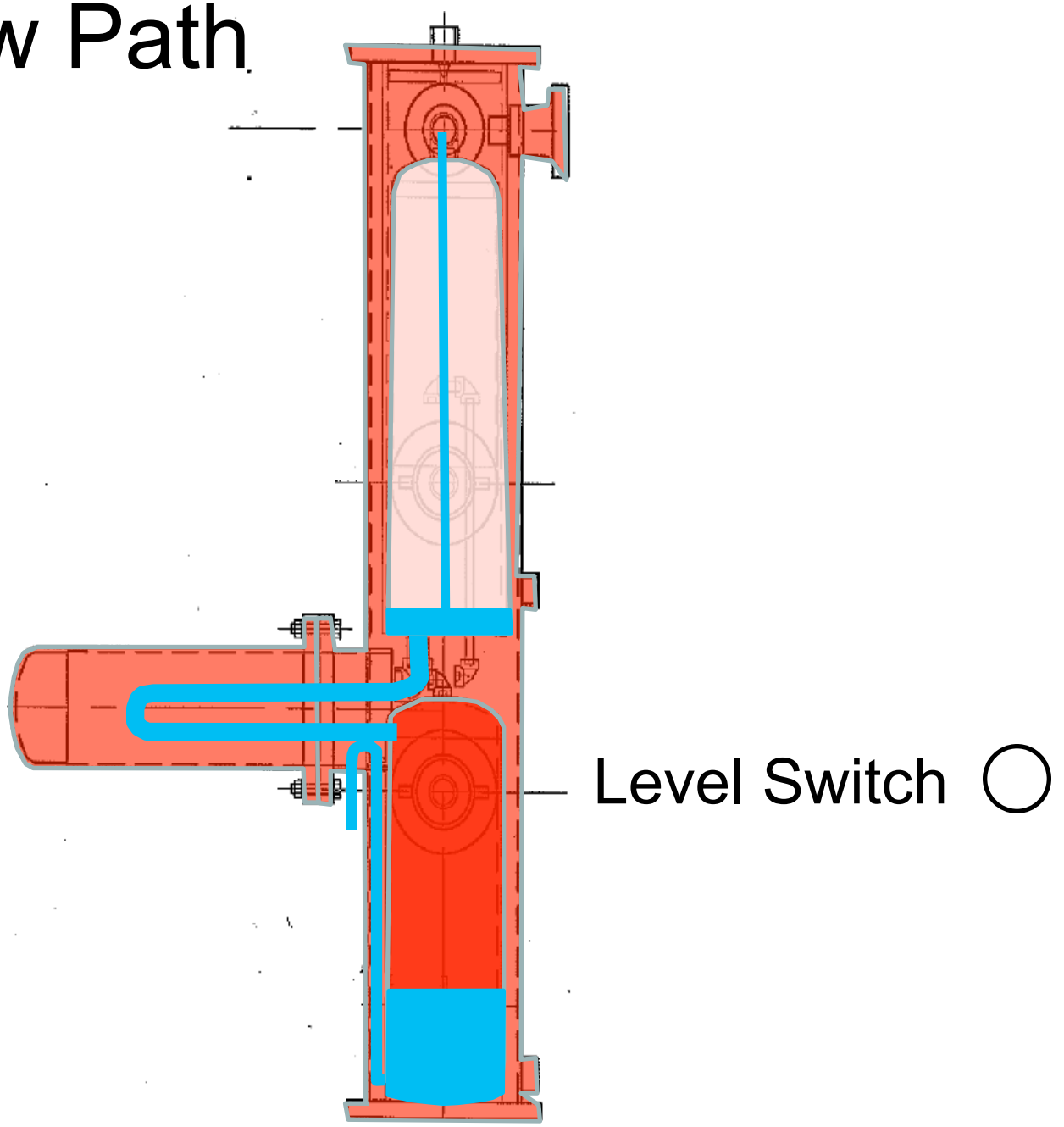

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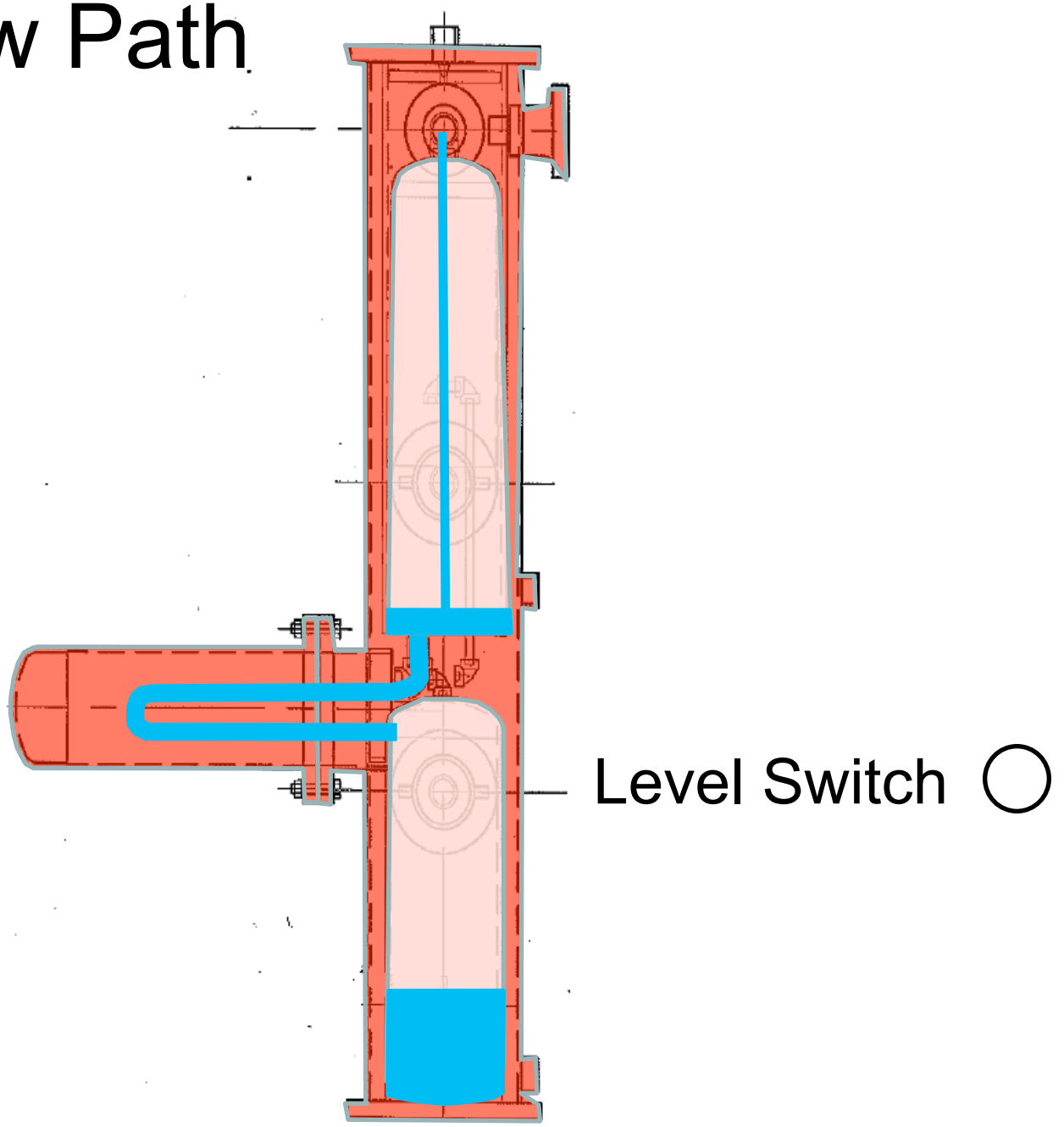

3rd Generation PROTOTYPE

Gas Lift Case Study

Gas Lift Case Study

- Vertical Gas Well

Gas Lift Case Study

- Vertical Gas Well
- Perforations 1799m – 1819m

Gas Lift Case Study

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- 3 ½” tubing landed @ 1800 m

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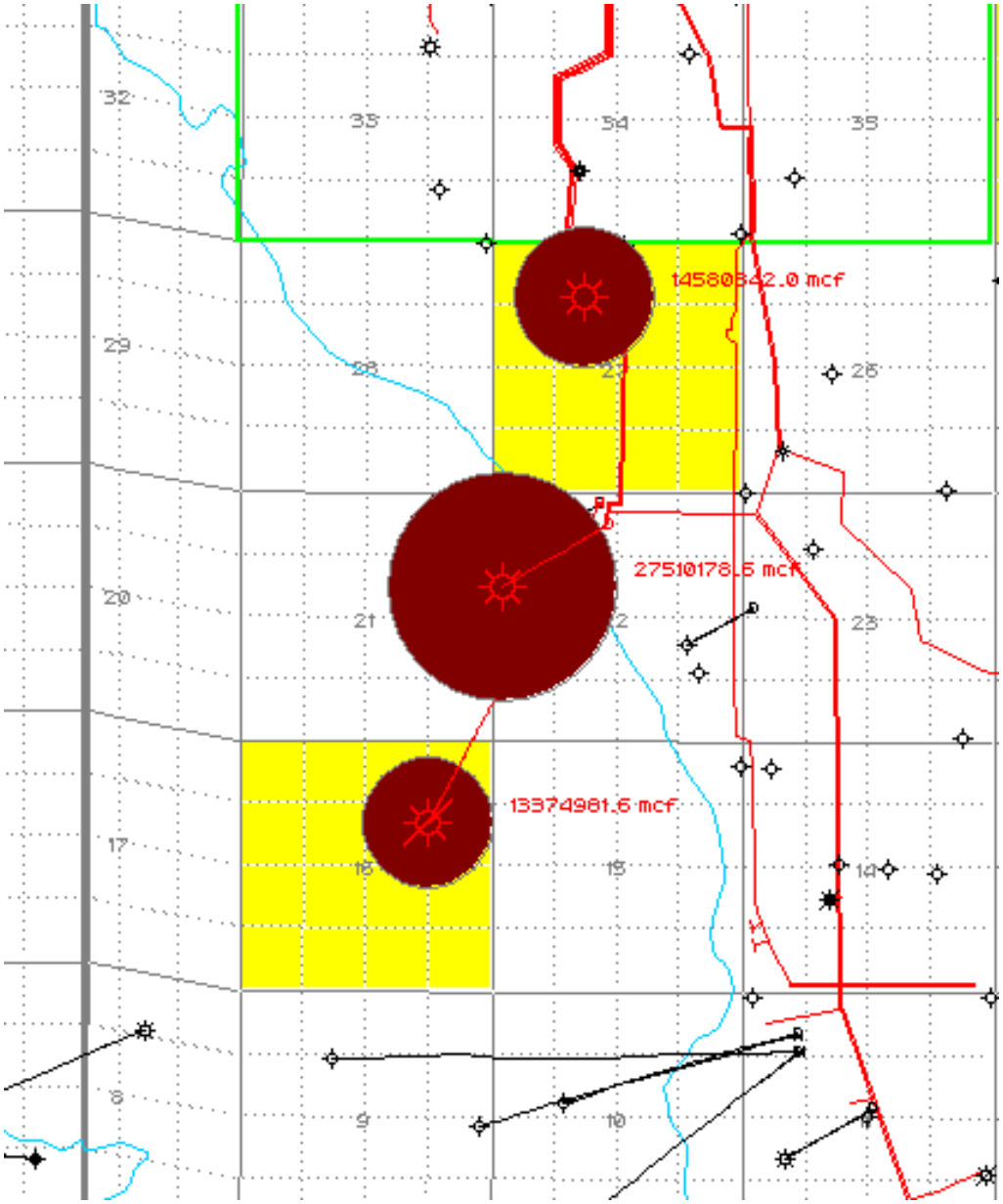
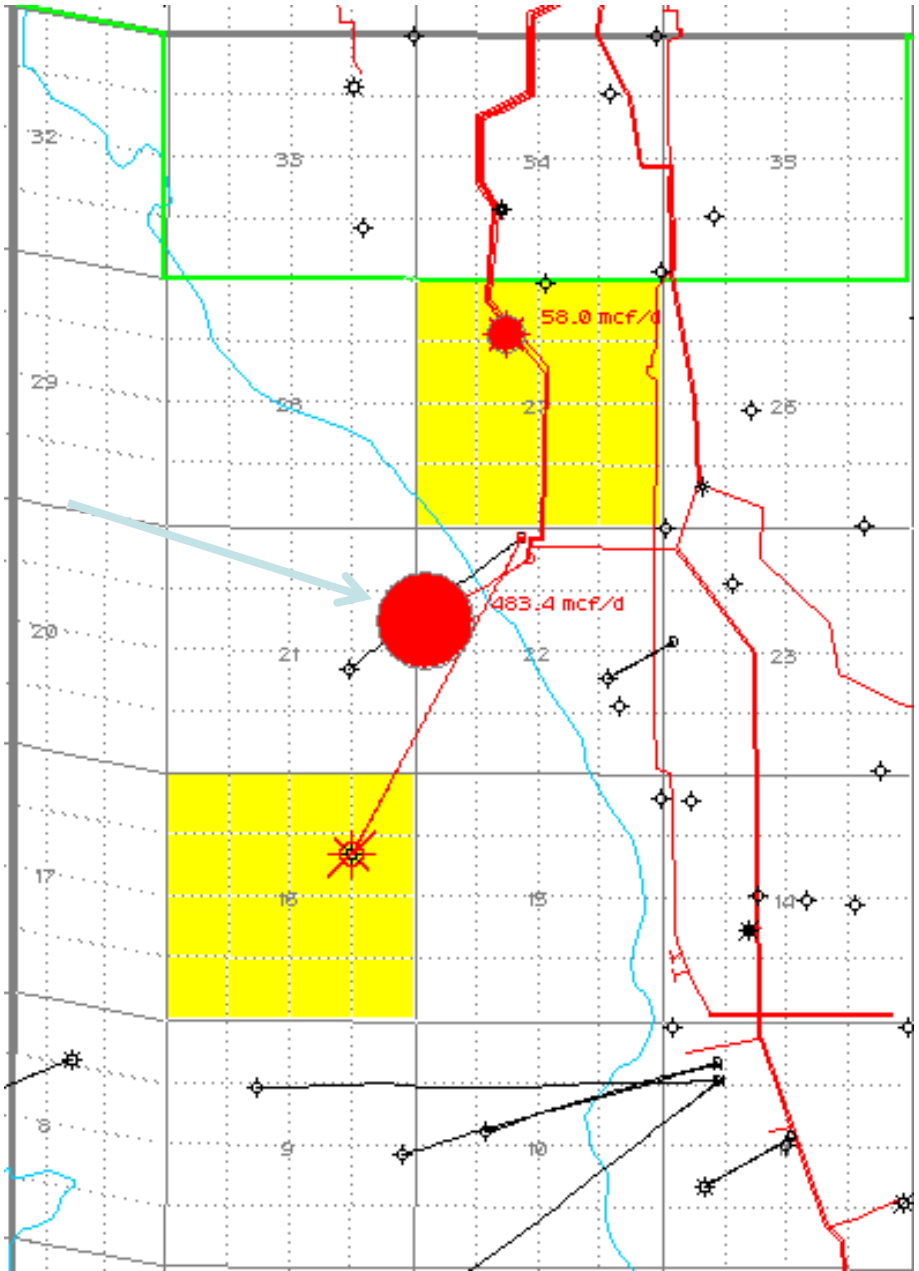
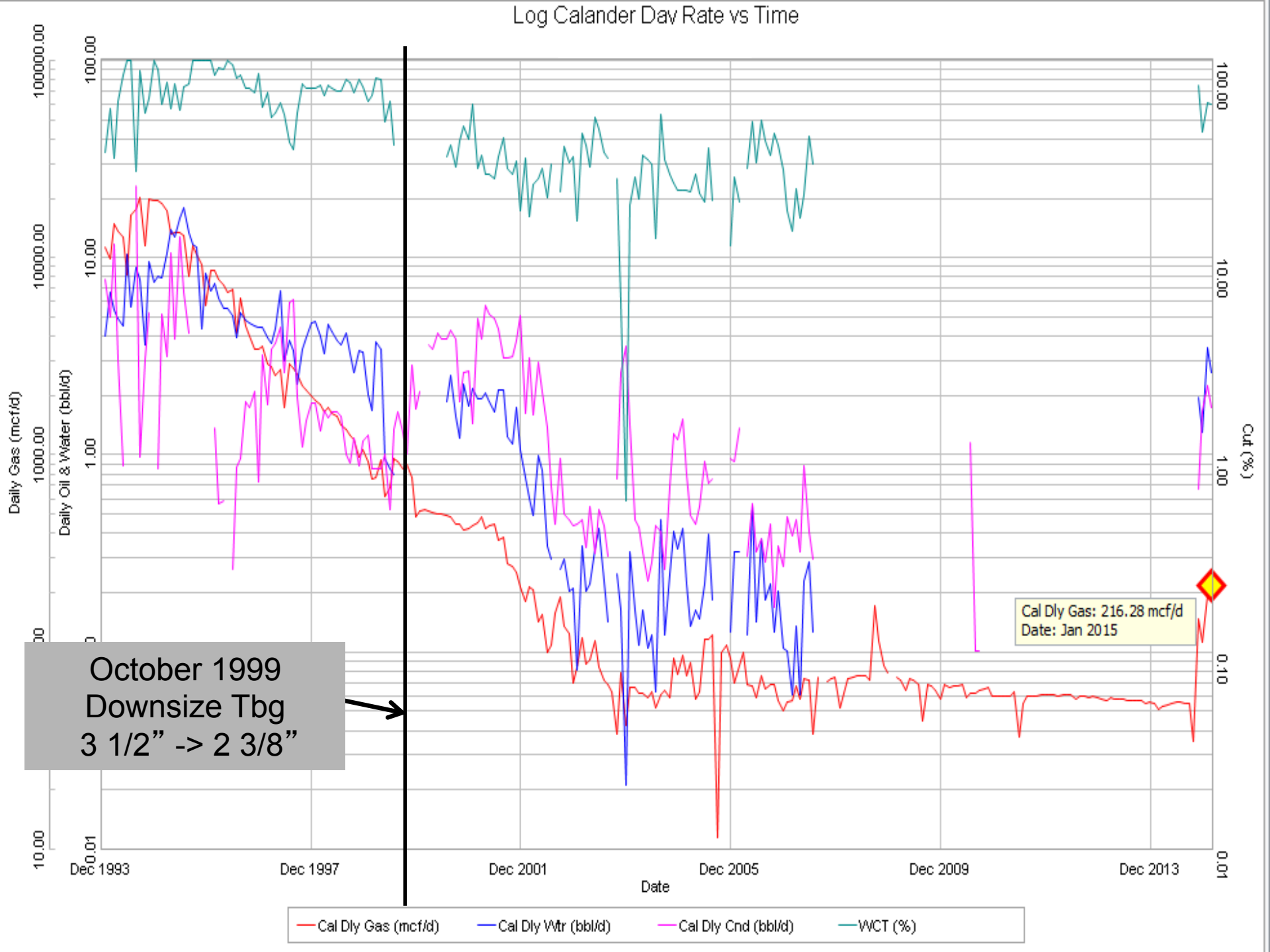
- Vertical Gas Well
- Perforations 1799m – 1819m
- 3 ½” tubing landed @ 1800 m
- Gas relative density – 0.8
- Condensate Gravity – 54 deg API
- Cum Gas 14.6 BCF
- Reservoir pressure – 100 psi

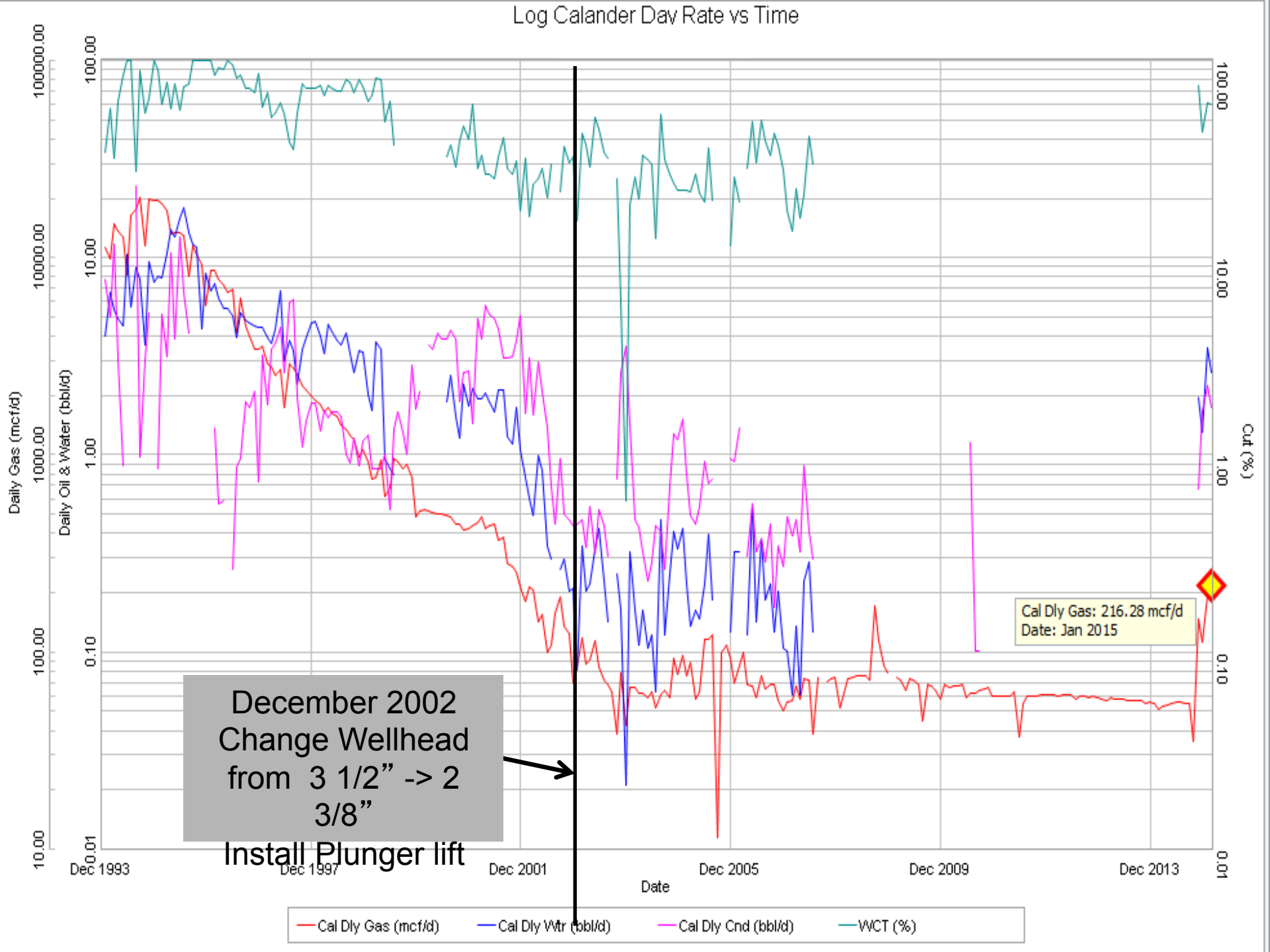
Pool Cumulative Gas

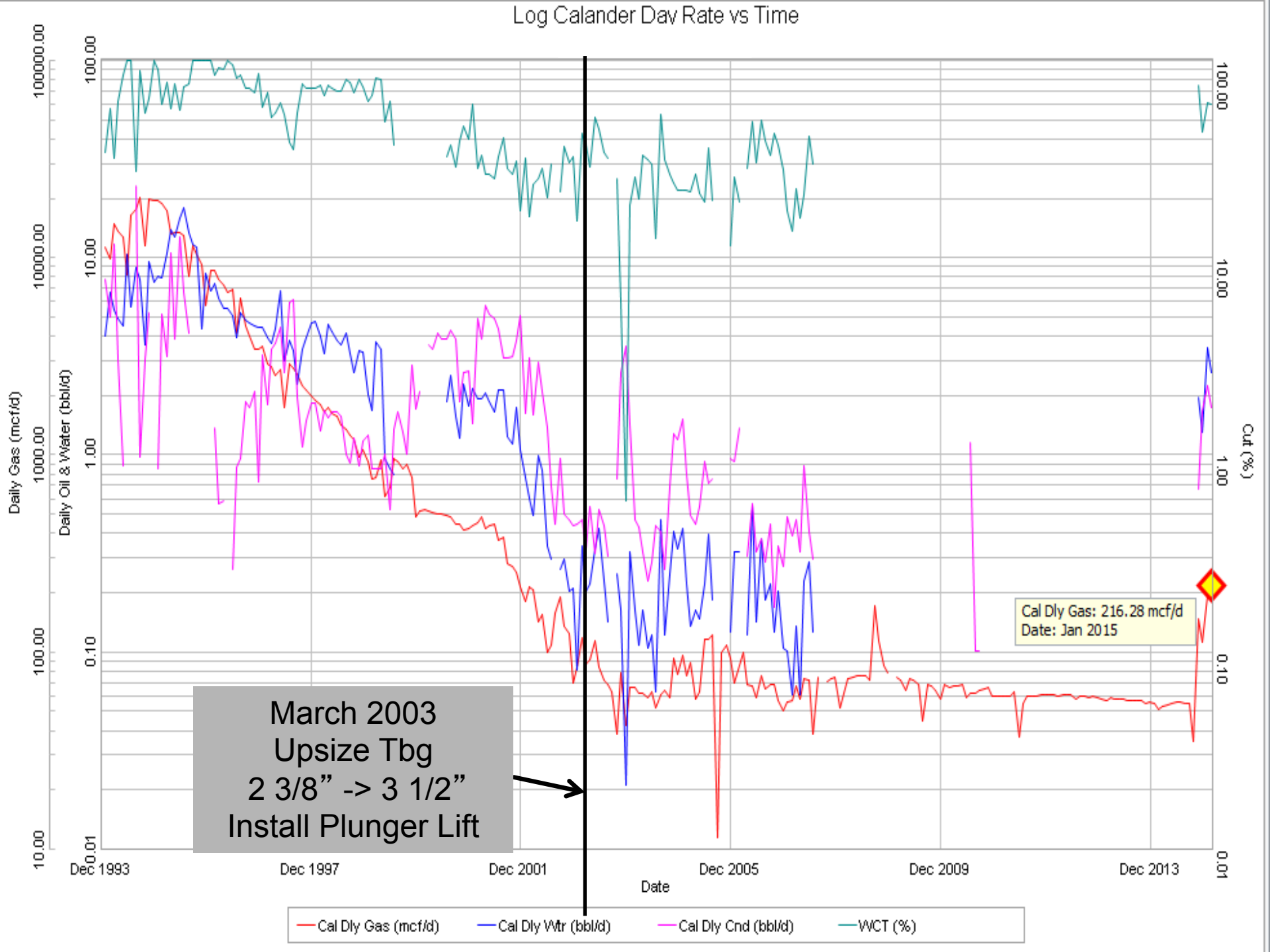


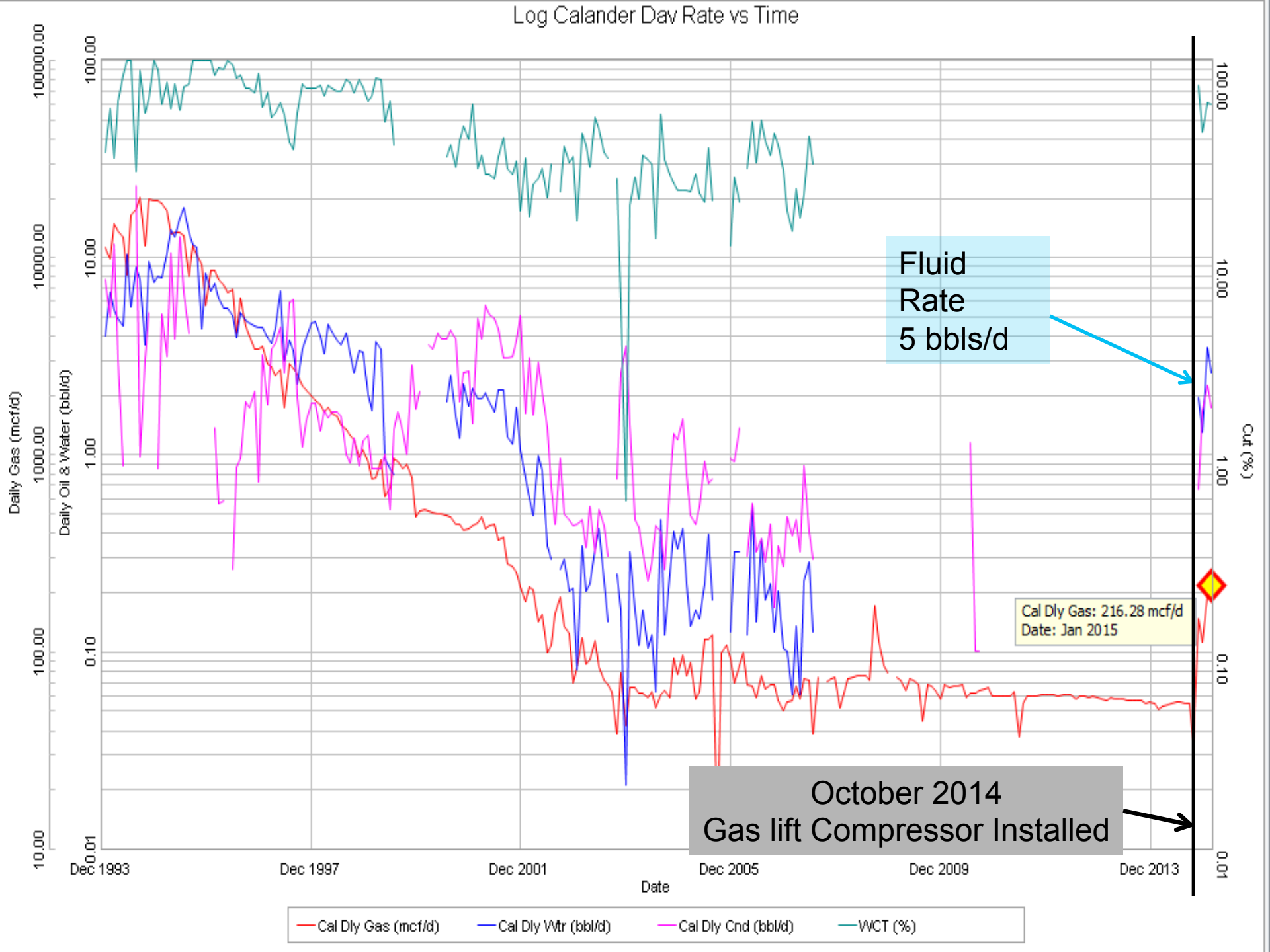
Pre Gas Lift Production Rates

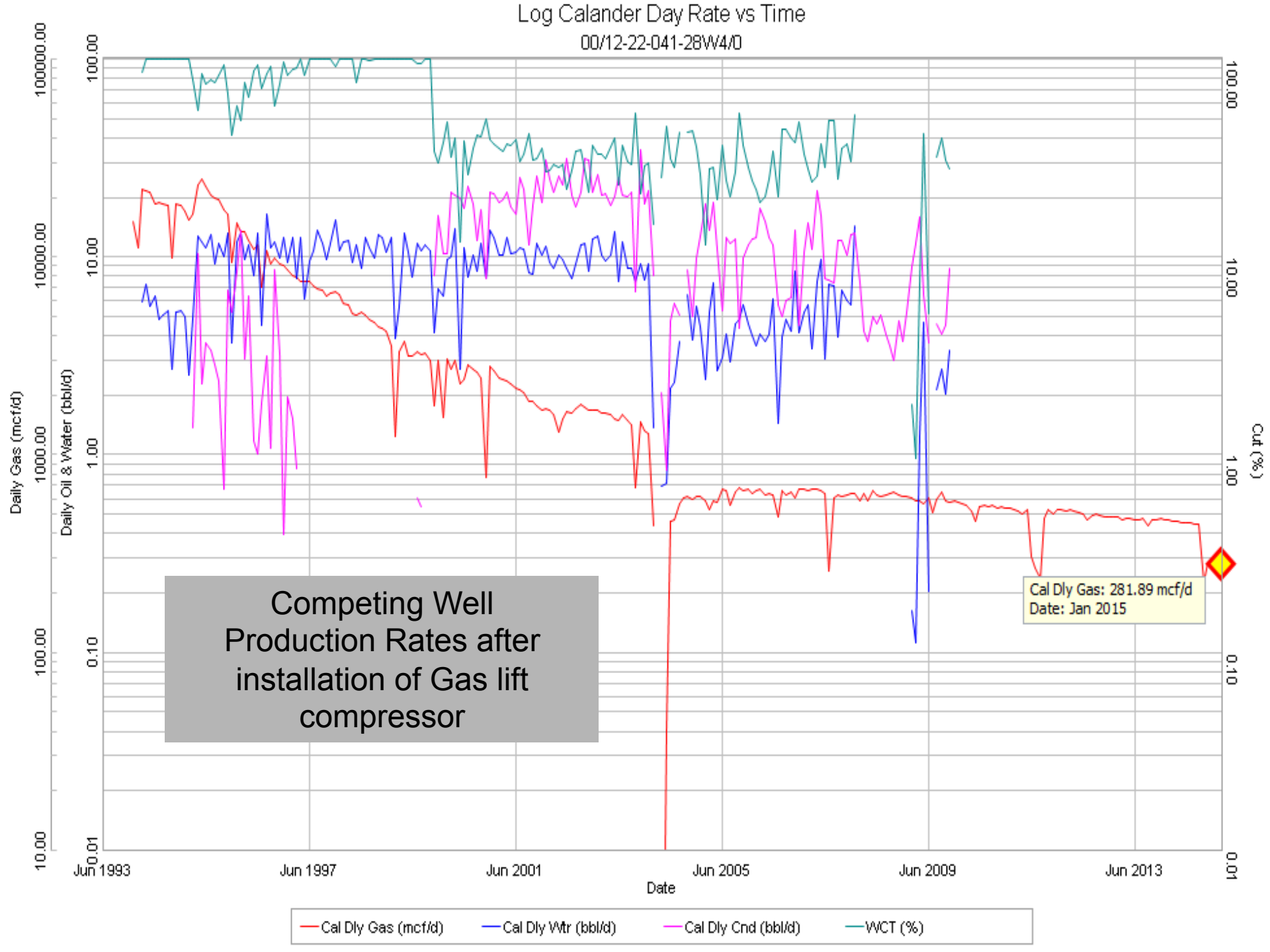



Log Calander Dav Rate vs Time
Daily Gas (mcf/d)
Daily Oil & Water (bbl/d)
Cut (%)
100000.00
10000.00
1000.00
100.00
10.00
1.00
0.10
0.01
Dec 1993
Dec 1997
Dec 2001
Dec 2005
Dec 2009
Dec 2013
Date
Cal Dly Gas: 216.28 mcf/d
Date: Jan 2015
October 1999
Downsize Tbg
3 1/2” -> 2 3/8”
Cal Dly Gas (mcf/d)
Cal Dly Wtr (bbl/d)
Cal Dly Cnd (bbl/d)
WCT (%)


Log Calander Day Rate vs Time
Daily Gas (mcf/d)
Daily Oil & Water (bbl/d)
Cut (%)
Date
Dec 1993
Dec 1997
Dec 2001
Dec 2005
Dec 2009
Dec 2013
Cal Dly Gas: 216.28 mcf/d
Date: Jan 2015
December 2002
Change Wellhead
from 3 1/2" -> 2
3/8"
Install Plunger lift
Cal Dly Gas (mcf/d)
Cal Dly Wtr (bbl/d)
Cal Dly Cnd (bbl/d)
WCT (%)


Log Calander Dav Rate vs Time
Daily Gas (mcf/d)
Daily Oil & Water (bbl/d)
Cut (%)
100000.00
10000.00
1000.00
100.00
10.00
100.00
10.00
1.00
0.10
0.01
Dec 1993
Dec 1997
Dec 2001
Dec 2005
Dec 2009
Dec 2013
Date
Cal Dly Gas: 216.28 mcf/d
Date: Jan 2015
March 2003
Upsize Tbg
2 3/8” -> 3 1/2”
Install Plunger Lift
Cal Dly Gas (mcf/d)
Cal Dly Wtr (bbl/d)
Cal Dly Cnd (bbl/d)
WCT (%)


Log Calander Day Rate vs Time
Daily Gas (mcf/d)
Daily Oil & Water (bbl/d)
Cut (%)
Date
Dec 1993
Dec 1997
Dec 2001
Dec 2005
Dec 2009
Dec 2013
Fluid
Rate
5 bbls/d
Cal Dly Gas: 216.28 mcf/d
Date: Jan 2015
October 2014
Gas lift Compressor Installed
Cal Dly Gas (mcf/d)
Cal Dly Wtr (bbl/d)
Cal Dly Cnd (bbl/d)
WCT (%)


Log Calander Day Rate vs Time
00/12-22-041-28W4/0
Daily Gas (mcf/d)
Daily Oil & Water (bbl/d)
Cut (%)
100000.00
10000.00
1000.00
100.00
10.00
100.00
10.00
1.00
0.10
0.01
Jun 1993
Jun 1997
Jun 2001
Jun 2005
Jun 2009
Jun 2013
Date
Competing Well Production Rates after installation of Gas lift compressor
Cal Dly Gas: 281.89 mcf/d
Date: Jan 2015
Cal Dly Gas (mcf/d)
Cal Dly Wtr (bbl/d)
Cal Dly Cnd (bbl/d)
WCT (%)

Critical Rate
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted

Critical Rate
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted
  - Hagedorn Brown 310 mcf/d

Critical Rate
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted
  - Hagedorn Brown 310 mcf/d
  - Beggs & Brill 466 mcf/d

Critical Rate
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted
  - Hagedorn Brown 310 mcf/d
  - Beggs & Brill 466 mcf/d
- Actual 350 mcf/d

Bottom Hole Pressure
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted

Bottom Hole Pressure
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted
  - Hagedorn Brown 93 kPa

Bottom Hole Pressure
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted
  - Hagedorn Brown 93 kPa
  - Beggs & Brill 241 kPa

Bottom Hole Pressure
1 psi Tbg – 25 bbls/mmcf liquids

- Predicted
  - Hagedorn Brown 93 kPa
  - Beggs & Brill 241 kPa
- Actual 320 Kpa

Questions….