Well Integrity, the Key to Well Re-Use

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Abstract

This presentation reviews the principles of well integrity including barrier philosophy and the use of barrier elements and envelopes. This, in turn, provides an insight into barrier deterioration in legacy wells and risks associated with re-use of these wellbores for future usage. These uses include hydrocarbon production from bypassed (unperforated) intervals, saltwater disposal, storage of various fluids including natural gas, CO_2, hydrogen, and other fluids, geothermal energy recovery, and other similar uses. The integrity of legacy wells limits their utility while still providing a means to recycle old wellbores for future use.

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What is well integrity (WI)?

Properties or conditions of a well that provide containment and prevent the escape of fluids to subterranean formations or surface (ISO 16530-1, 2017)

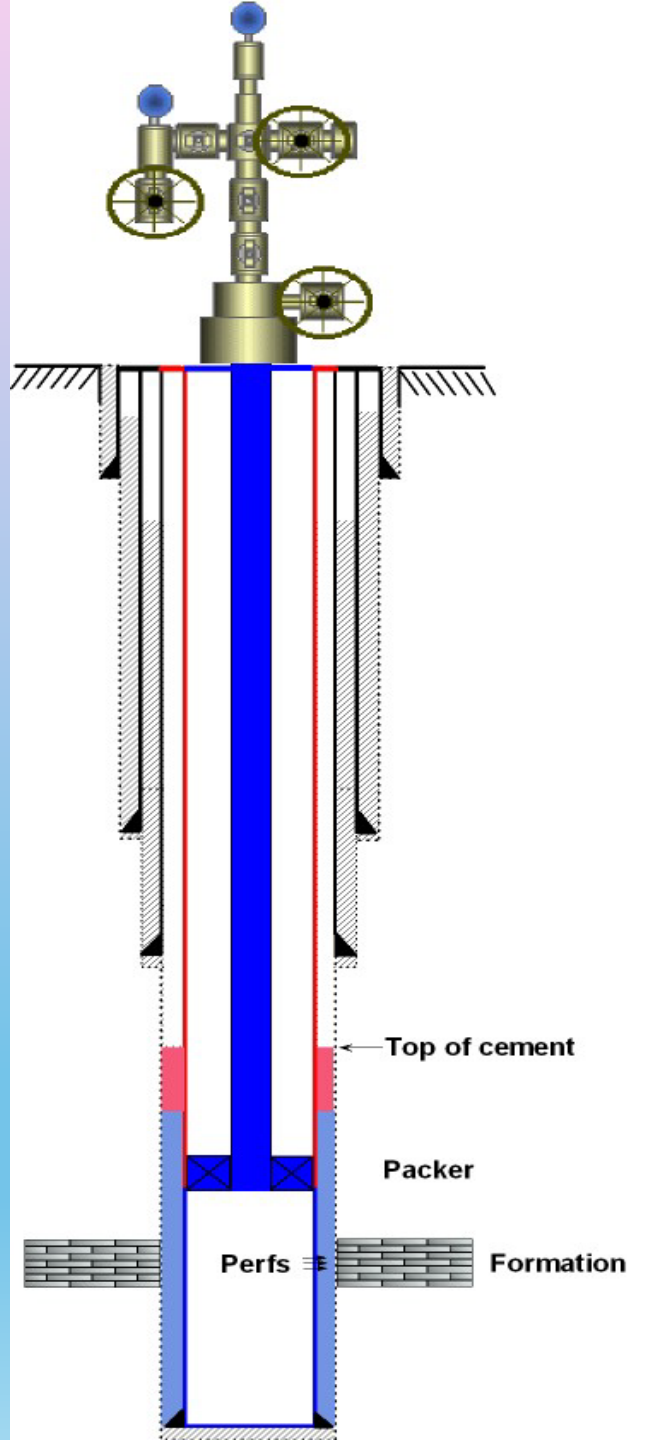
How is WI achieved?

Through the use of **barriers**:

1. Barrier elements (casing, cement, wellhead)
2. Barrier envelopes (casing + cement + wellhead)

Primary Barrier Envelope – Blue

Secondary Barrier Envelope – Red

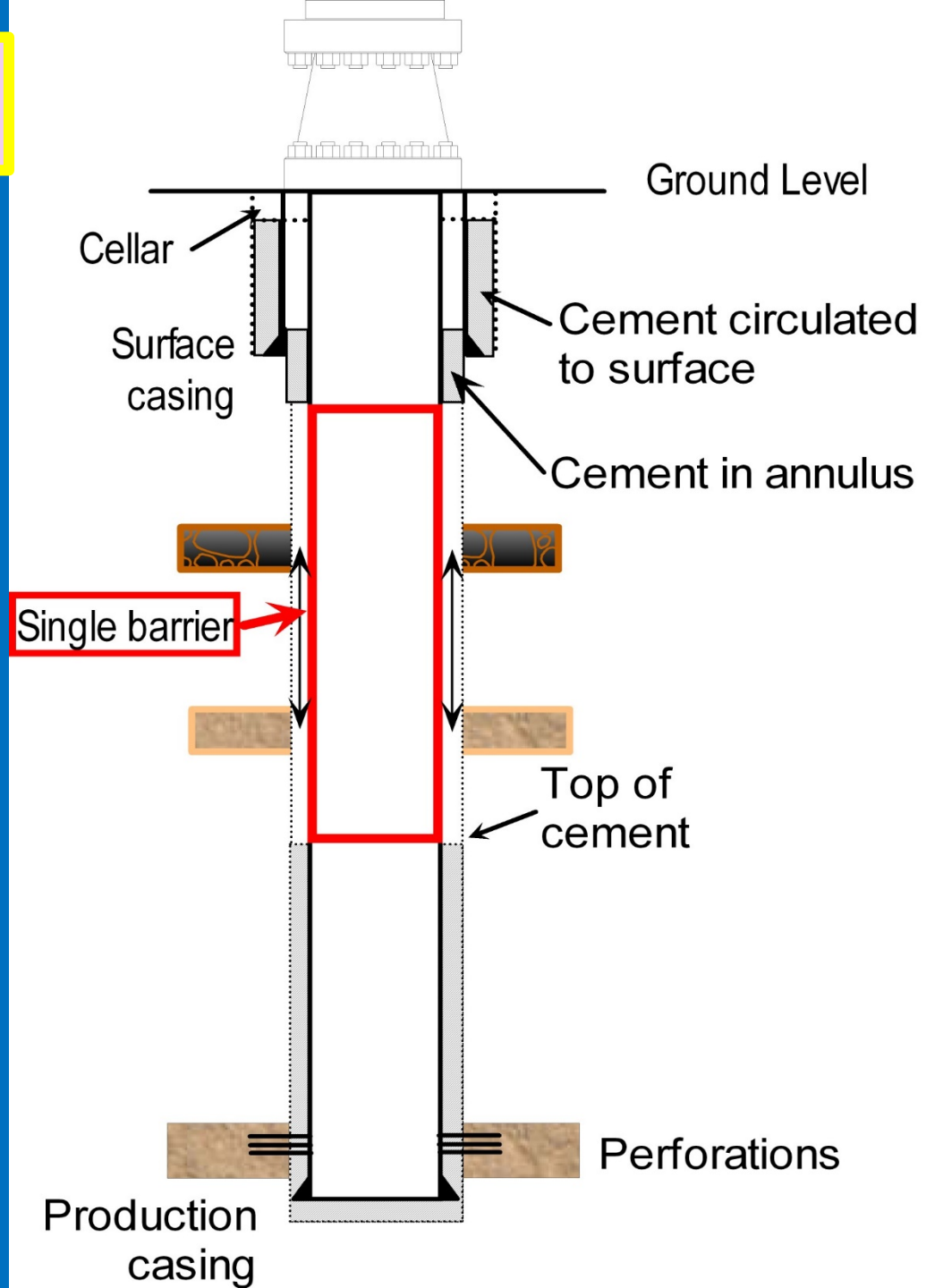


PAST WELL DESIGN PHILOSOPHY

1. Predicated on CAPEX conservation
2. 25- to 30- year life only
3. Minimal casing and cement designs
4. Just meet regulatory requirements
5. Did not address barriers remaining after P&A (long-term)

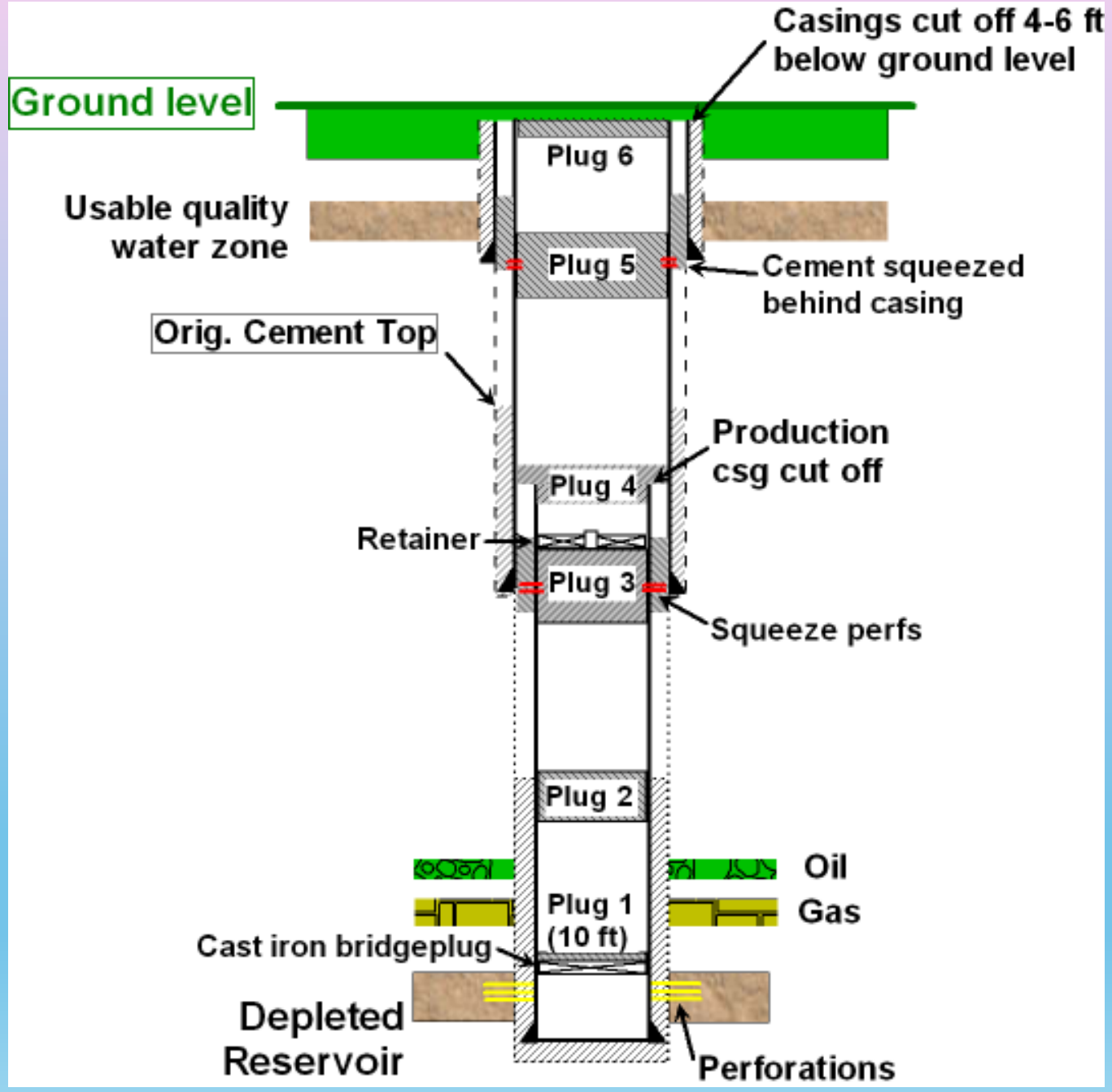
Single-Barrier Wells

- No cement behind portions of the casing,
- Few centralizers,
- Crossflow likely,
- Formation fluid exposure to exterior casing surface.



Well Characteristics

Idle	Orphaned	P&A
• Tubing in place	• No tubing (65%)	• No tubing/csg cut
• Artif. lift in place	• May be obstructed	• Plugs in place
• May be TAd	• May be TAd	• May be obstructed
• Can enter	• Can enter	• Re-entry difficult
• Measure WI	• Measure WI	• Can infer WI only


Casings cut off 4-6 ft below ground level
Ground level
Plug 6
Usable quality water zone
Plug 5
Cement squeezed behind casing
Orig. Cement Top
Production csg cut off
Plug 4
Retainer
Plug 3
Squeeze perfs
Plug 2
Oil
Gas
Plug 1 (10 ft)
Cast iron bridgeplug
Depleted Reservoir
Perforations

Inferring Well Integrity *Pre-job*

Well History		External Indications
• Age	• Design	• Sustained casing pressure
• Constructio n	• Use	• Leaks/flows – fluid type(s)
• Workovers	• Deepen’ g	• Subsidence/Heave
• Repairs	• Owners	• Offset well behavior
• WI problems in vicinity		• Environmental issues
• Regulatory problems		• The public

Wrap-up

1. Start with good well control capability (BOP)
2. If well is not accessible for a complete WI determination, establish it going down
3. Do not assume WI is acceptable anywhere in the well
4. Well integrity must be sufficient to survive the procedure and then for some time in the future
5. Never fall in love with your own deals