

PROS & CONS of WELL CONSTRUCTION METHODS

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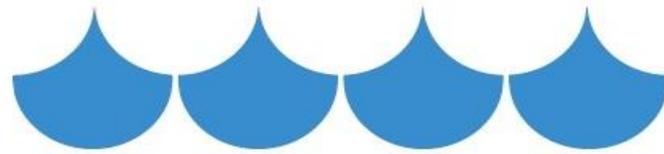
VP of Drilling Operations

Schneider Water Services

St. Paul, OR – Richland, WA

schneiderwater.com

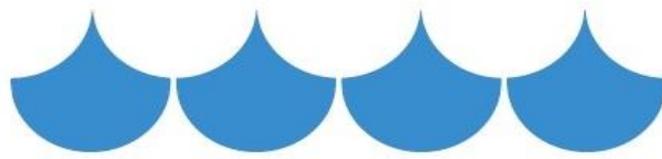
PNWS AWWA - Spokane, WA- May 10, 2013



DRILLING METHODS

Common Types for Water Supply Wells

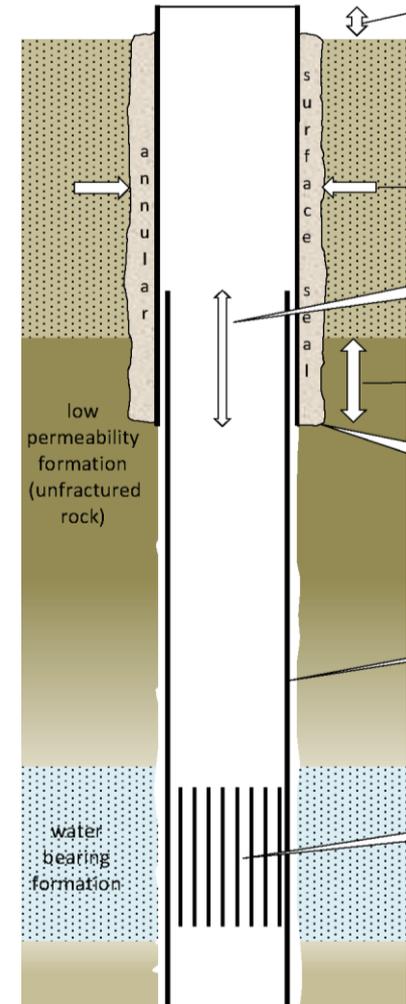
- Cable tool
- Air Rotary (direct circulation)
- Mud Rotary (direct circulation)
- Reverse Circulation (RC) Rotary



DRILL METHOD CONSIDERATIONS

- Well diameter & well depth
- Anticipated geologic formations
- Anticipated SWL (artesian?) / DD
- Site conditions
- Completion time
- Special requirements (test quality/quantity while drilling)

Consolidated Formation Well

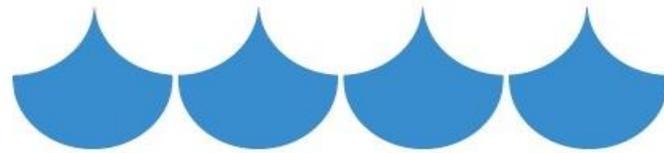




SITE CONDITIONS

ARTESIAN CONDITION

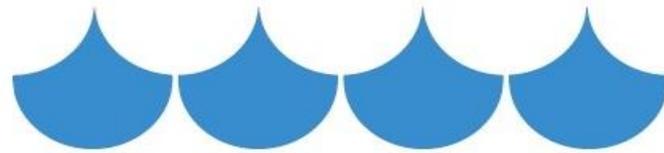




DRILLING METHODS

terminology

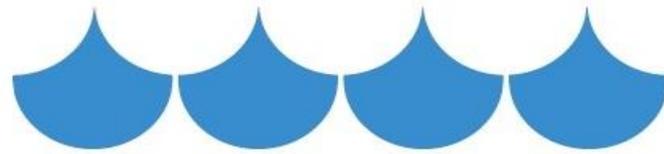
- Fluid – *n.*
 - “a substance (as a liquid or gas) tending to flow or conforming to the outline of its container” *Merriam-Webster*
 - “a substance that continually deforms (flows) under an applied shear stress. All gases are fluids, but not all liquids are fluids.” *Wikipedia*



DRILLING METHODS

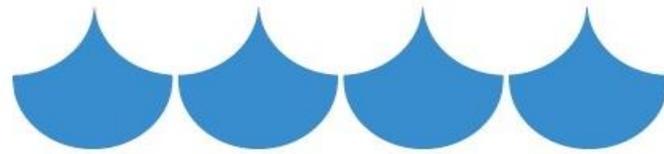
terminology

- **Under balanced drilling**
 - Pressure in the borehole is kept lower than the fluid pressure in the formation
- **Over balanced drilling**
 - Pressure in the borehole is kept higher than the fluid pressure in the formation



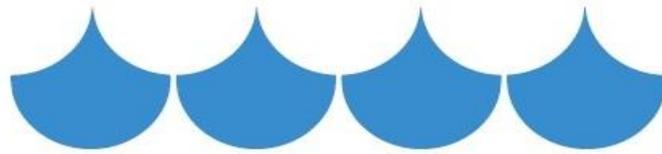
DRILLING FLUID PURPOSES

- Lift cuttings / drop at surface
- Cool & lubricate bit
- Prevent hole collapse
- Control fluid loss to formation
- Control artesian pressure
- Reduce development cost



CABLE TOOL - VARIATIONS

- Drill-drive (alluvial)
- Pull down (alluvial)
- Over balanced (alluvial)
 - Control sand heave (esp when bailing)
 - Open hole with mud
- Under balanced (rock)



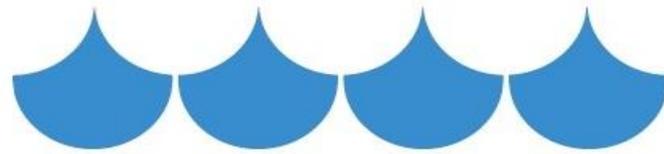
AIR ROTARY (DC) - VARIATIONS

- **Over balanced**
 - **Rarely done in WBZ (stiff foam)**

- **Under balanced**
 - **DHH conventional bit (rock)**
 - **UCAS (accommodates tough conditions)**
 - **Drill-drive (alluvial)**
 - **Dual rotary (casing rotates)**

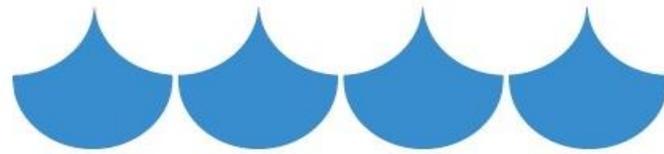
23" DHH (Down Hole Hammer)





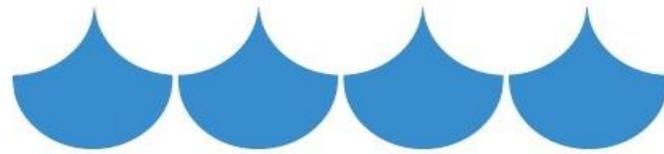
MUD ROTARY (DC) - VARIATIONS

- Over balanced
- More over balanced (e.g. barite to control high artesian pressure)
- Did I mention over balanced?
- Additives to control most any condition if you have \$



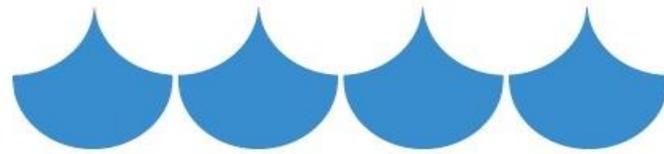
RC - VARIATIONS

- **Over balanced**
 - 'Flooded' (water or mud)
 - Usually open hole – can drill-drive/DR
- **Under balanced**
 - 'Pump & dump' (ideal in stable rock)
 - Drill-drive / DR



CABLE TOOL PROS/CONS

- Most any formation (Chinese >2000 years)
- Low equipment, fuel & maintenance cost
- Good samples
- Slow
- P & A (skilled labor - make hole)



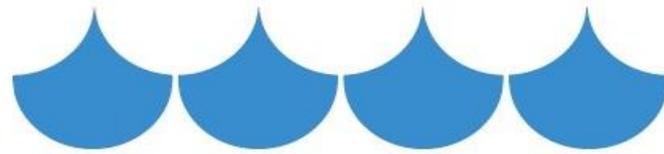
CABLE TOOL PROS/CONS

- **Adaptable to over/under balance**
 - Drill-drive in alluvial
 - Mud (increases development cost)
- **Rock (e.g. granite/basalt) = very slow**
- **'Refusal' - May need multiple casing strings**
- **Casing extraction issues / shoe cut req'd**
- **Shoe cuts oversize hole – commingling?**

CABLE TOOL

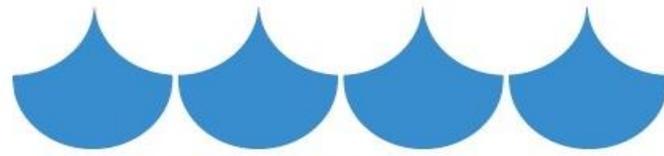
Did I say slow?





AIR ROTARY PROS/CONS

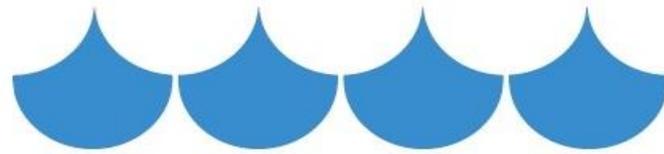
- DHH in rock – fast/ideal
- Under balanced
 - Alluvial – >\$ & hole erosion issues
 - Drill-drive
- UCAS in boulders
- Lesser quality samples
- Costly equipment, fuel & maintenance



MUD ROTARY PROS/CONS

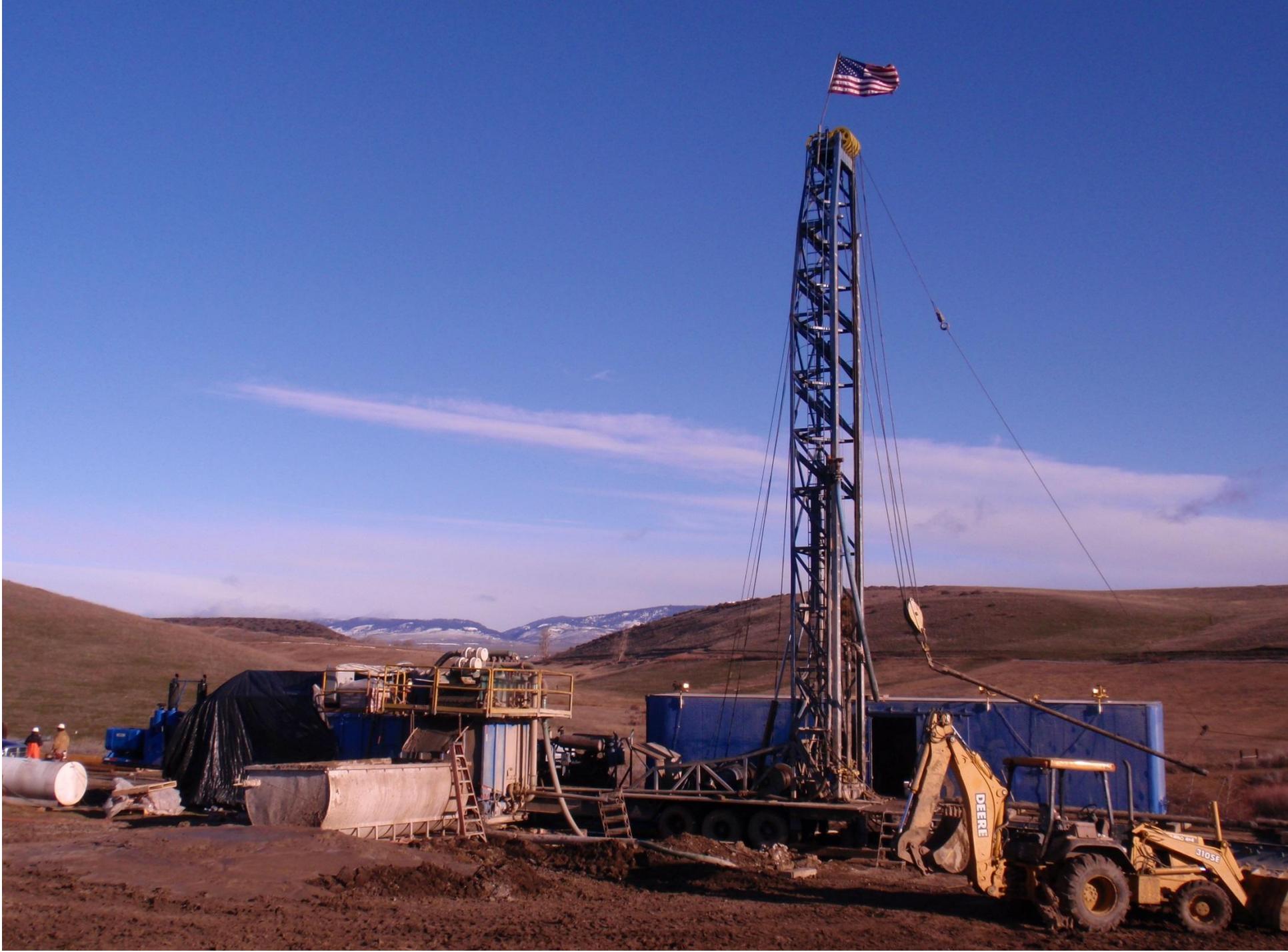
- Most any formation
- Open hole – especially deep holes
- Geophysical logging
- <sample quality (lag time, mixing)

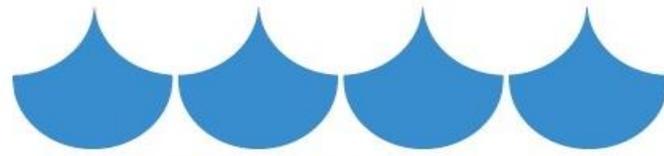




MUD ROTARY PROS/CONS

- **Control artesian**
- **Additives – LC, shale stabilizers (PAC)**
- **Costly equipment, fuel & maintenance**
- **>Development time & chemical cost**
 - **Development chemicals (e.g. PFD)**





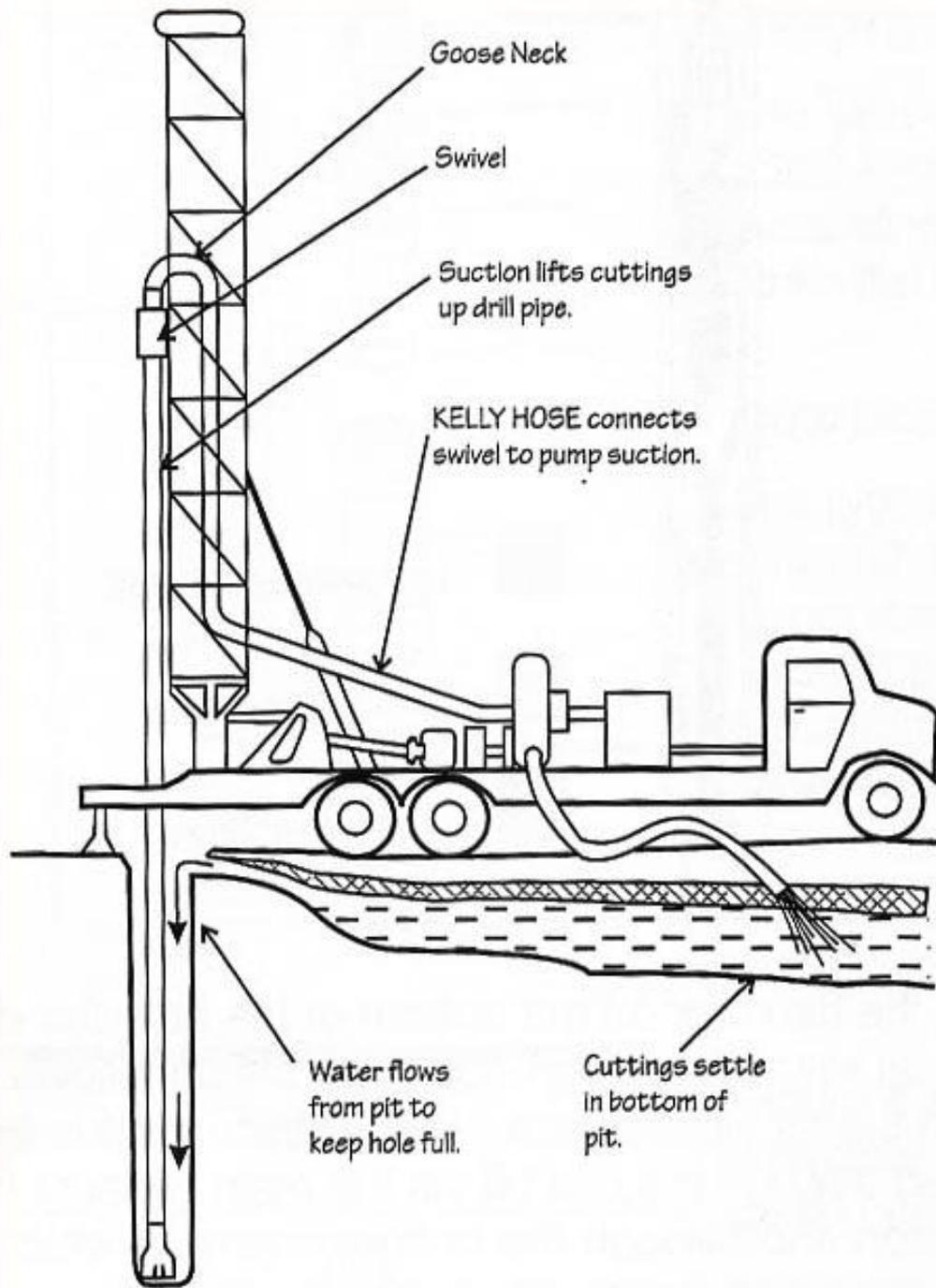
REVERSE CIRCULATION (RC) Defined

- ❖ Rotary drilling technique that uses a fluid to remove cuttings from the hole, and
- ❖ All or part of the drill fluid is directed up the drill pipe rather than totally up the annulus (hence: Reverse Circulation)

NOTE: Direction of rotation of any equipment or well components (e.g. table, THD, casing) is irrelevant

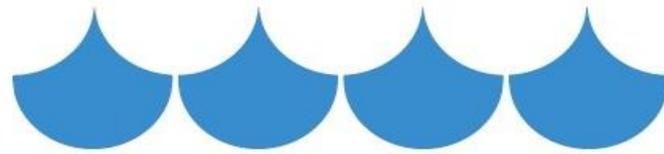
“REVERSE CIRCULATION” not “REVERSE ROTARY”

REVERSE CIRCULATION DRILLING





Flooded, alluvial formation, earthen pit, dual wall pipe:
for municipal water supply

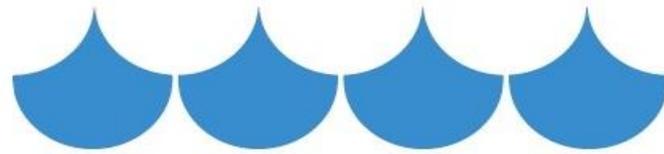


RC ROTARY PROS/CONS

- **Most formations**
- **Open hole – especially deep holes**
- **Geophysical logging**
- **Costly equipment, fuel & maintenance**
- **Adaptable to over / under balance**

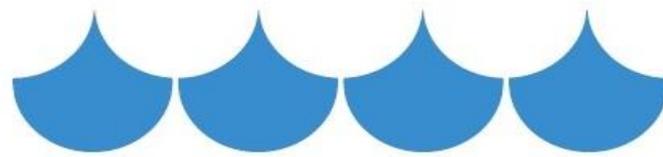
DUAL WALL





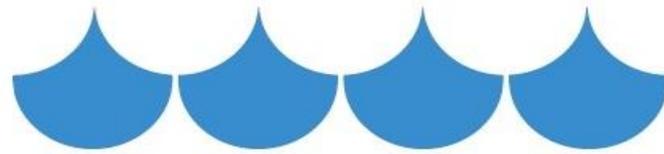
RC ROTARY PROS/CONS

- **Best samples**
 - Rapid return
 - Minimal mixing
 - mineral exploration / second only to coring
 - better than cable
 - superior to direct air/mud rotary
- **Minimized development costs**



COMPARISON (1 to 4; 1 is best)

	Cable Tool	Air Rotary	Mud Rotary	RC Rotary
Fuel \$	1	4	3	2
Equip./Maint. \$	1	2	4	3
Discharge control	1	4	3	1
Site area req'd	1	4	3	2
Boulder drilling	2	1	3	4
Sample quality	2	3	4	1
Development \$	3	2	3	1
Const. time	4	1	3	2
Hard rock	3	1	4	2
Artesian control	3	4	1	2



QUESTIONS - DISCUSSION?



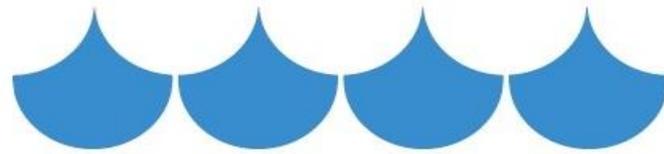
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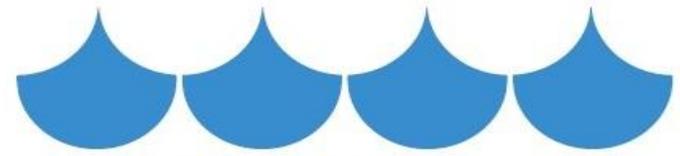
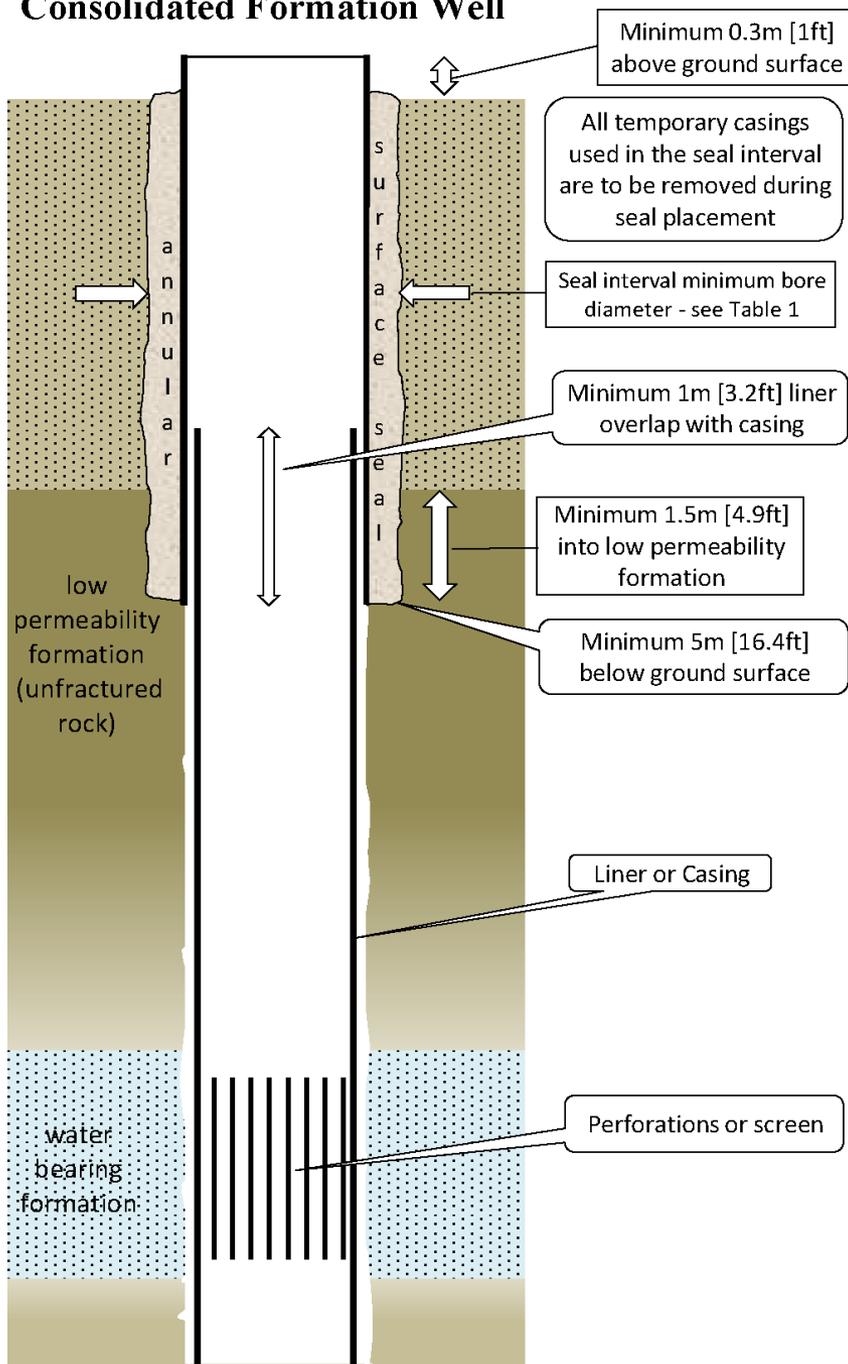
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WELL DESIGN

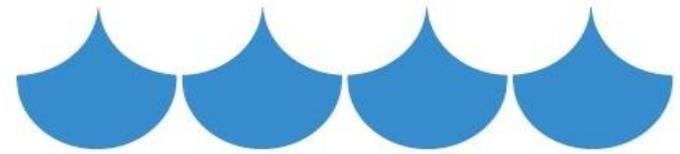
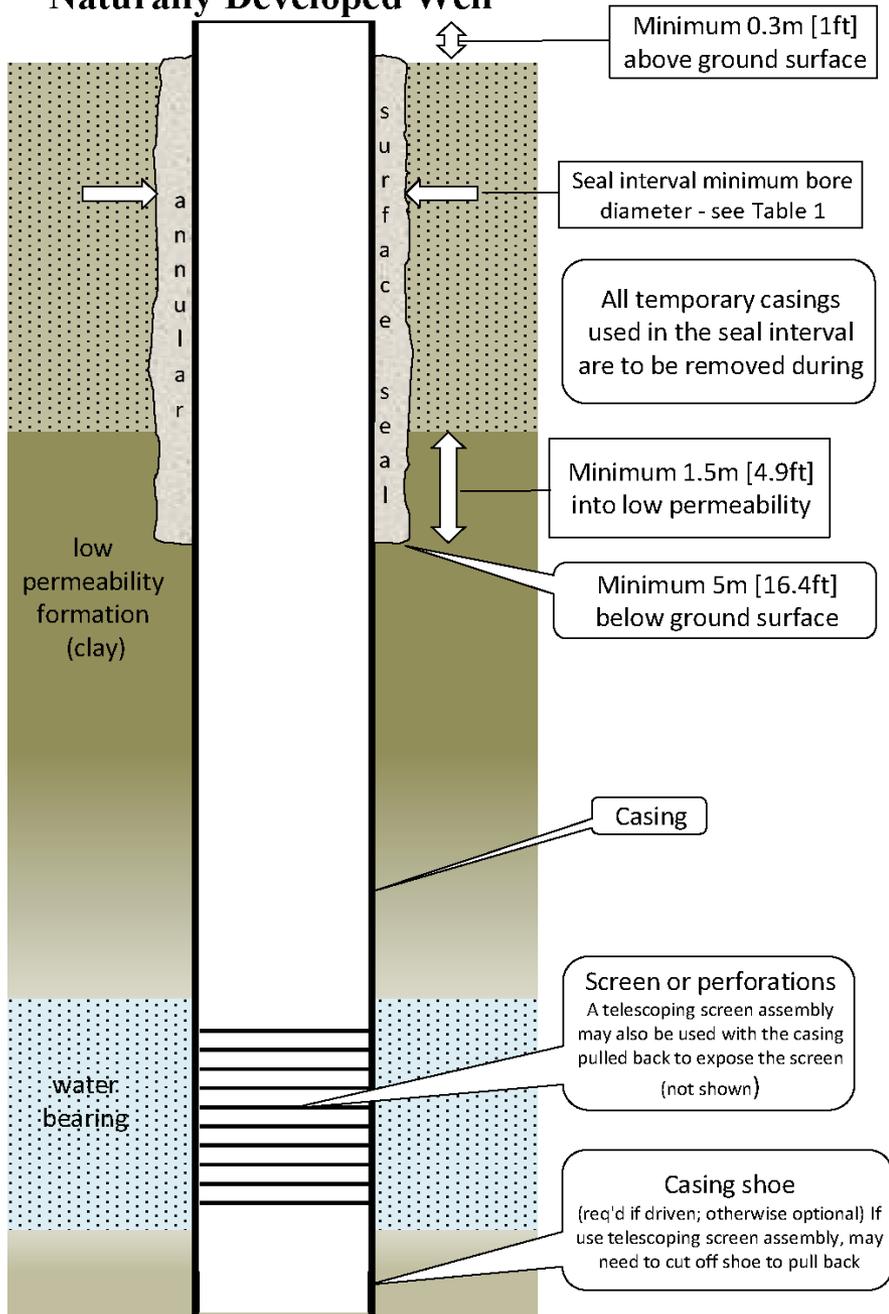
- Permit conditions/restrictions
- Geology dictates design
 - Consolidated v Unconsolidated
- May use multiple drill methods
 - Geology
 - Site conditions
- Desired/expected yield
- Pump chamber – diameter & depth

Consolidated Formation Well



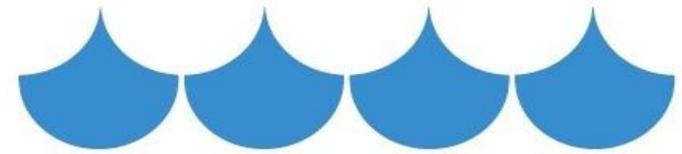
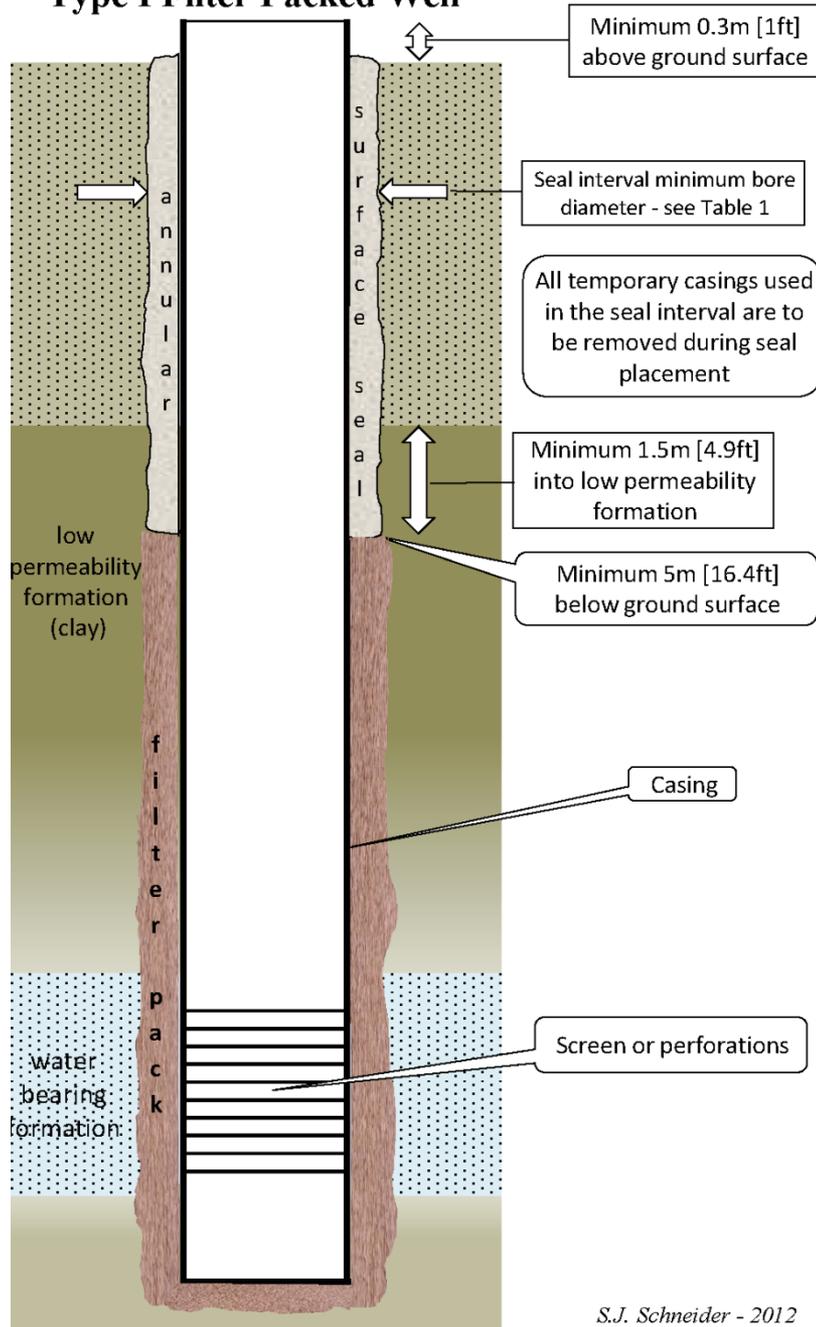
- Seal into rock, plus no commingling
- Temp casing or over balanced for seal
- Pump chamber depth
- Instability in rock
 - Overbalance
 - Cement / redrill
 - Case off
- Liner recommended
- Screen v perforations

Unconsolidated Formation Naturally Developed Well



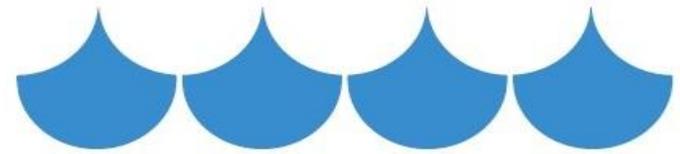
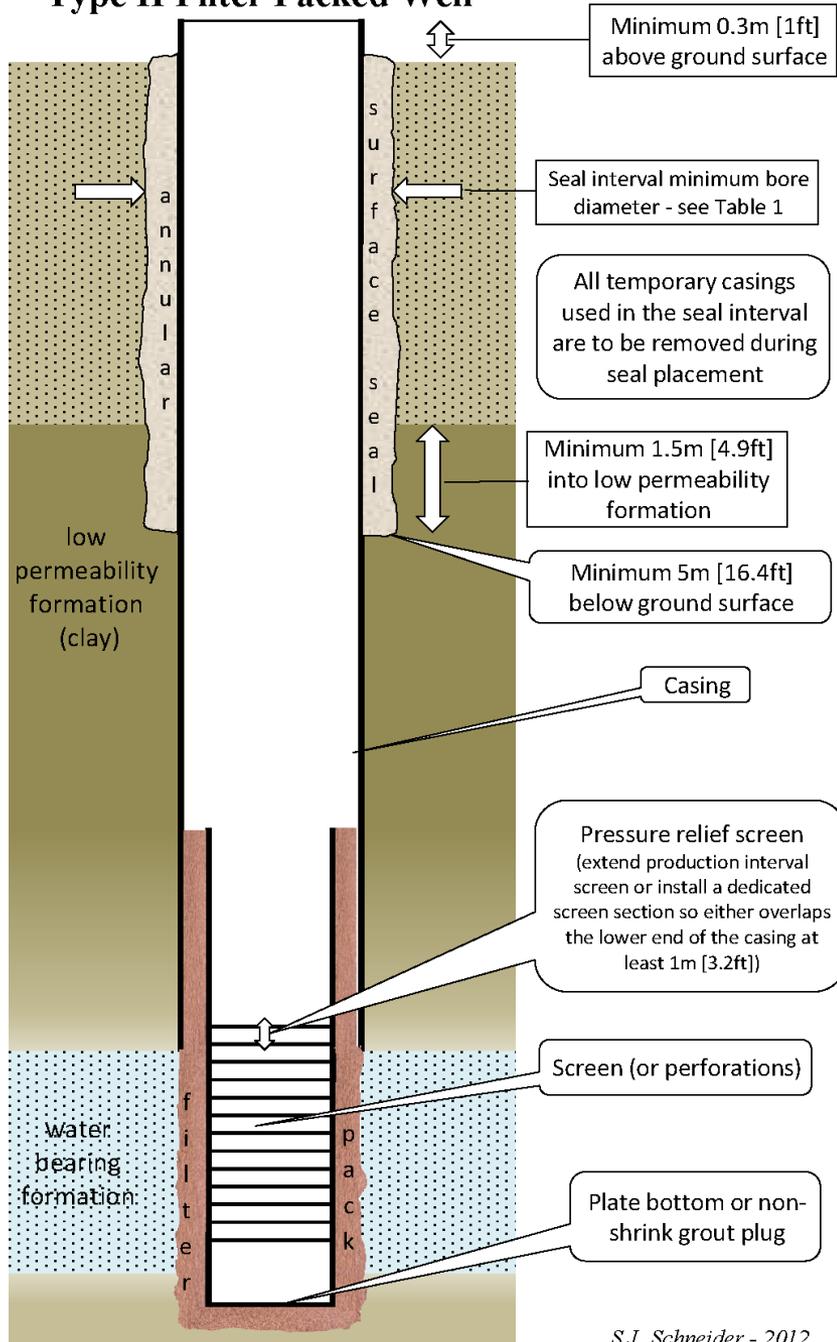
- Seal into clay, plus no commingling
- Temp casing or over balanced for seal
- Screen slot selection is critical
 - Sand/silt stringers
 - Variations in grain size (fine overlying coarser)
- Screen v perforations

Unconsolidated Formation Type I Filter Packed Well



- Seal into clay, plus no commingling
- Temp casing or over balanced for seal
- FP thickness <4"
- Screen slot for finest & based on uniformity
- Reduced risk of sand pumping v nat. dev.
- Cannot add FP
- 1 diameter full depth

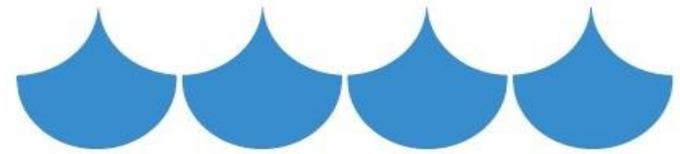
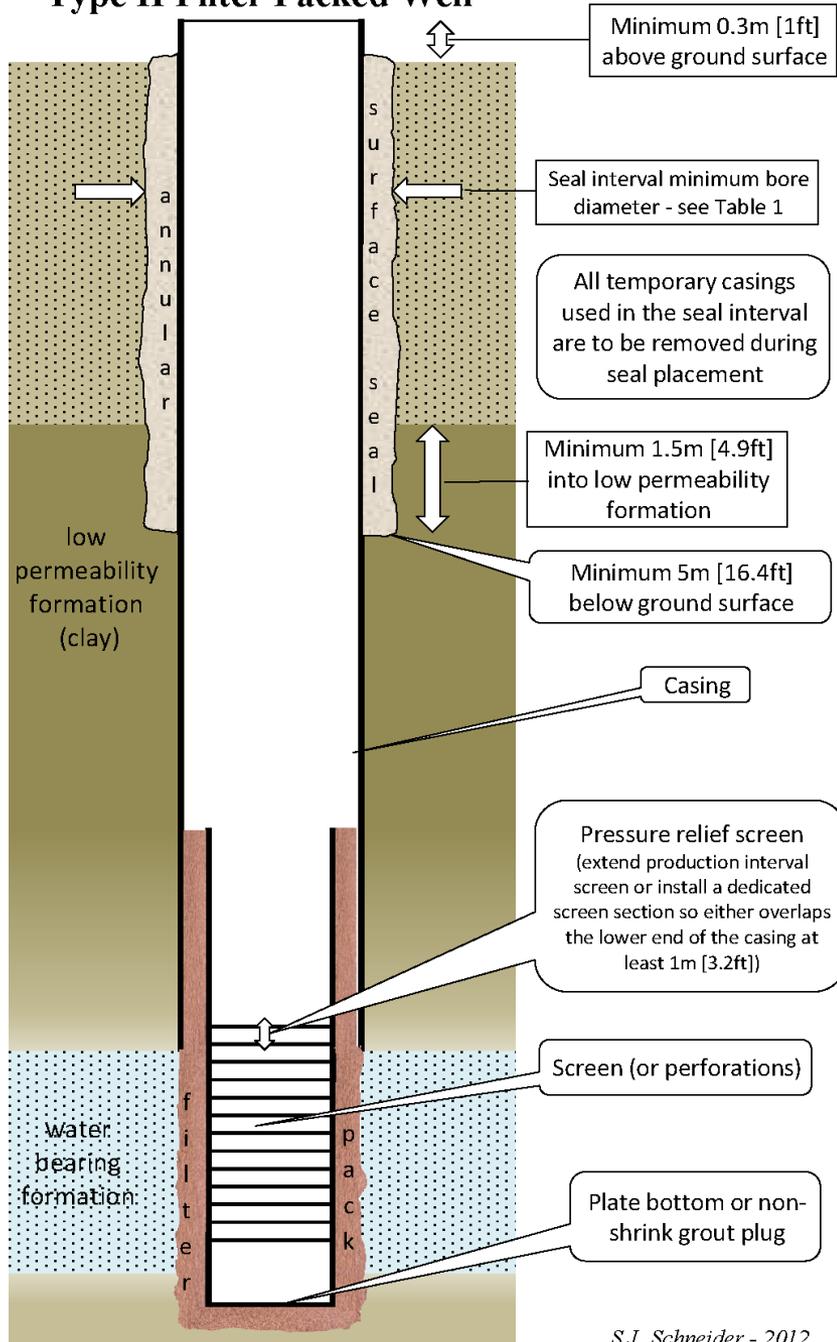
Unconsolidated Formation Type II Filter Packed Well



Same as Type I except:

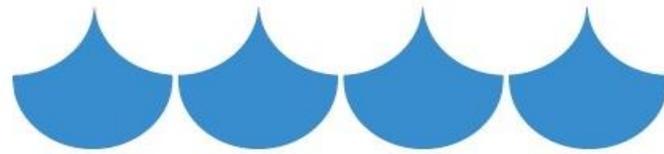
- Can add FP in future
- Difficult to check pack depth w/pump in well
- Reduction in diameter
 - Development \$
 - Rehabilitation \$
- < Pump chamber depth
- More \$ than Type I

Unconsolidated Formation Type II Filter Packed Well



Telescoping screens:

- Relief screen
 - Extend from production interval
 - Separate screen
 - 3'-5'
- No K packer
- Applies whether filter packed or not (e.g. naturally developed)



QUESTIONS - DISCUSSION?



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