AZTECH
WELL CONSTRUCTION

Well Construction and Hydraulic Fracture Stimulation 101

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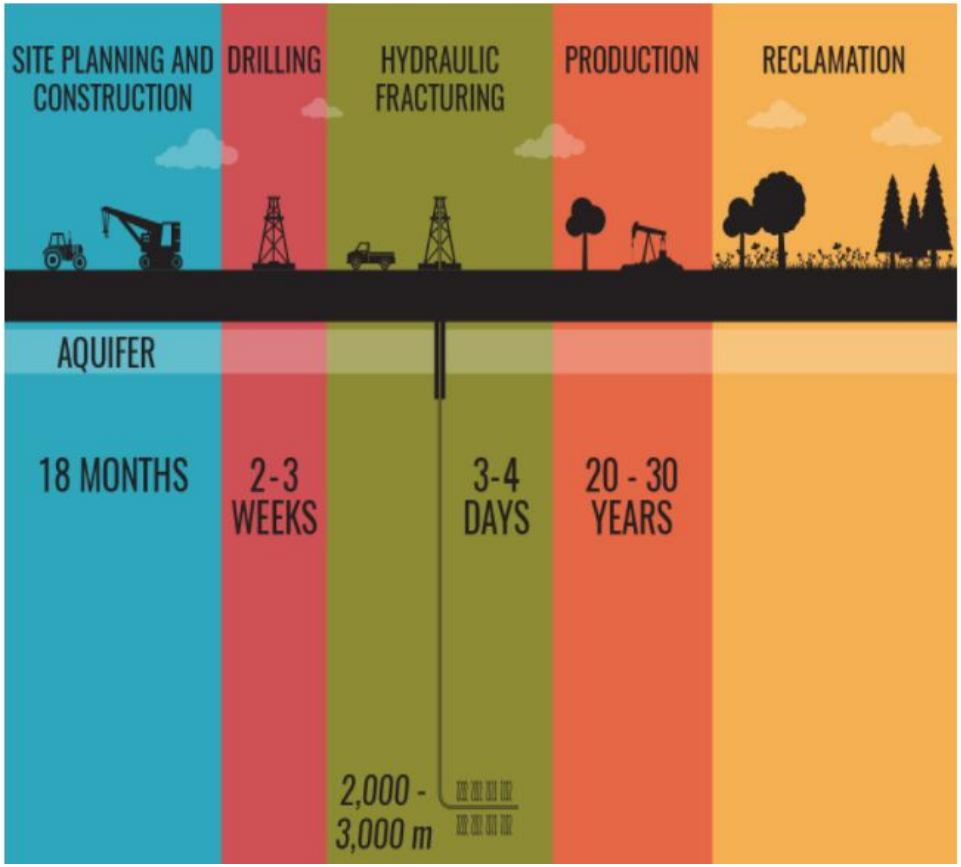
This presentation is for general educational purposes only

PROJECT LIFE CYCLE

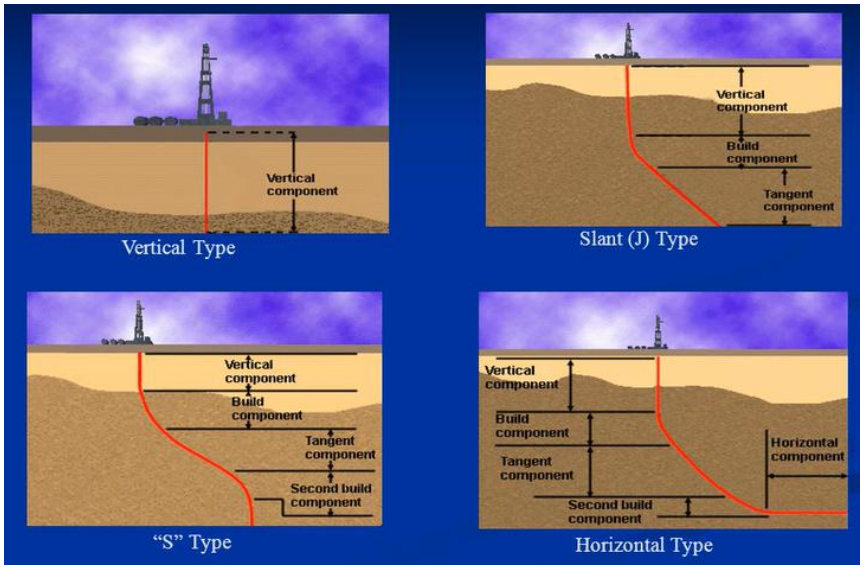


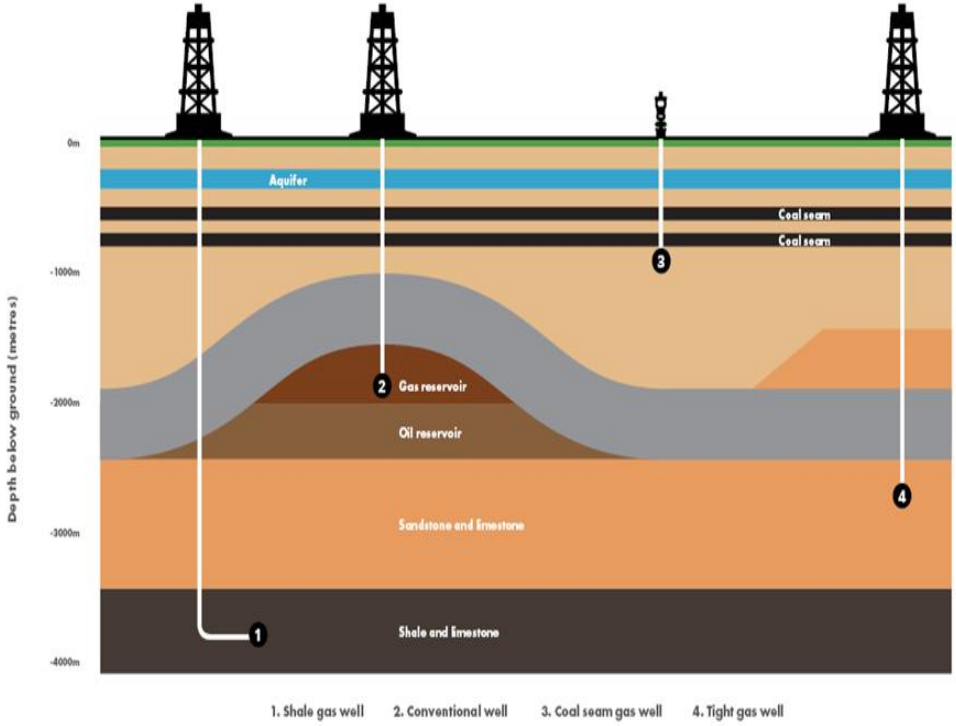
- After a drilling and hydraulic fracture stimulation activity is complete, most equipment is removed from the site. This reduces the site from around 1.5 to 2 hectares (~150m x 150m) down to 0.4 to 1.2 hectares.
- Gas can flow to a production well and into pipelines for up to 30 years.
- At the end of a well's production life, the well is sealed with a series of cement and/or mechanical plugs, decommissioned and the site is rehabilitated.

**Timeframes are indicative and would vary according to the specific site logistics, stage count, volumes, reservoir, etc*

WELL TYPES

- Well shape/depth/angle depends on:
  - Land access and surface restrictions
  - Reservoir type
  - Well engineering and cost



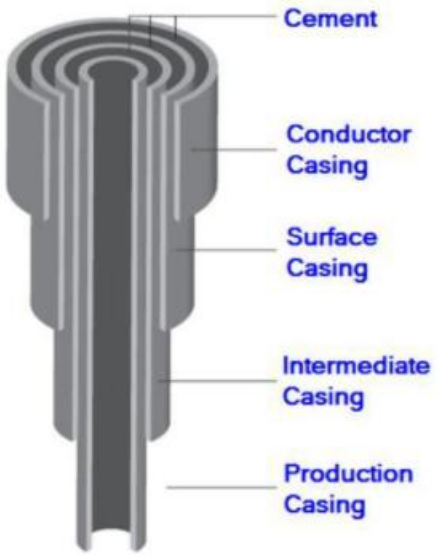


CASING & CEMENT

AZTECH WELL CONSTRUCTION

Casing functions

- Isolate porous formations with different fluid pressure
- Prevents contamination of freshwater zones
- Protects the well from caving in
- Provides a connection and support of the wellhead equipment
- Provides exact dimensions for running testing, completion and production equipment
- Aids in isolating zones with different pressure gradients to drill ahead with a certain mud density



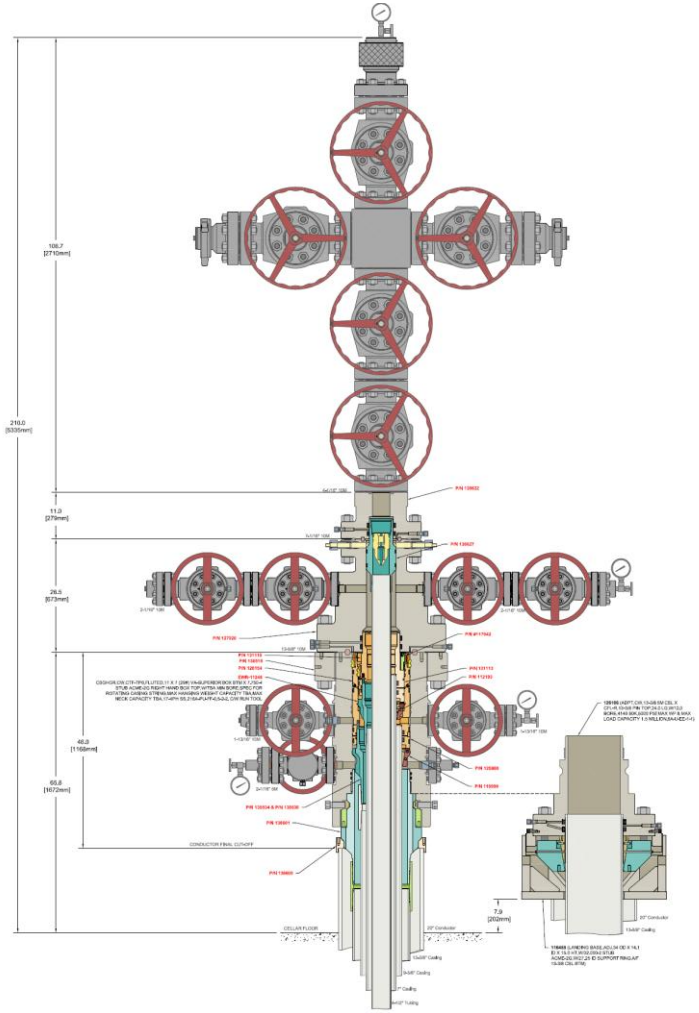
Cement functions

- Fills the annulus between the open hole and the casing
- Prevents crossflow between zones
- Protects the casing walls from corrosion
- Protects the casing from shock loads
- Provides radial support/backup to the casing

WELLHEAD

Wellhead functions:

- Provide suspension point and seals for the casing strings
- Manage the flow of oil or gas
- Provide sufficient barriers to shut-in the well
- Provide access for annulus monitoring



WELL INTEGRITY

Downhole integrity

- Pressure tests, Cement bond logs (CBL), corrosion logs

Surface systems integrity

- Compatible connections, Pressure tests, Relief valves

Wellhead integrity

- Verification of well pressures, including annuli and voids
- Bleed off pressure if required
- Check for leaks
- Inspection of valves and wellhead condition
- Valve maintenance and function testing
- Pressure testing of valves and voids
- Inspection of well cellars
- Verification of wellhead and site infrastructure

FRAC HISTORY

WORLDWIDE

- July of 1947 – Pan American Oil Company (now BP)
  - 1st Job: Klepper No. 1 Gelled Kerosene / Gasoline mix
  - Hugoton Gas Field, Grant Co., KS
- Late 1948 - Patent issued, total of 23 wells fracc'ed before commercial application began
- 1st Commercial Treatment in March 1949 in Velma, OK

WESTERN AUSTRALIA

- 600+ wells have undergone hydraulic fracture stimulation in conventional reservoirs since 1958.
- The first hydraulic fracture stimulation in WA was conducted on the Goldwyer-1 well 100 km southeast of Broome.
- Fracture stimulation or re-fracturing has been conducted on 563 wells on Barrow Island since 1965.
- 12 hydraulic fracture stimulations have occurred in WA between 2004 and 2015, all conducted in vertical wells and using more contemporary hydraulic fracturing methods.

  Arrowsmith-2 (Perth Basin) - Asgard-1 and Valhalla North-1 (Canning Basin)

  Warro-3, 4, 5 & 6 (Perth Basin) - Yulleroo-2 (Canning Basin)

PROCESS AND RATIONALE

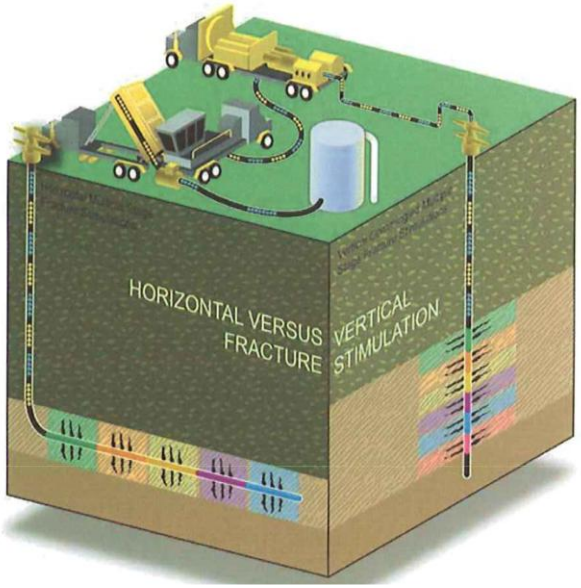
AZTECH WELL CONSTRUCTION

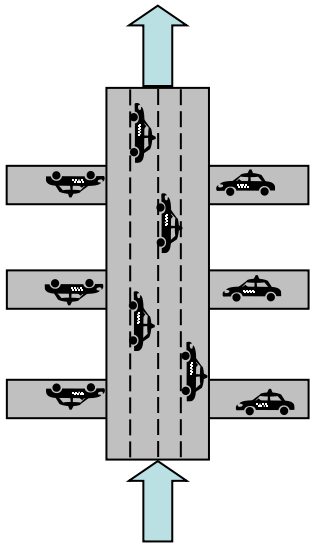
Objective

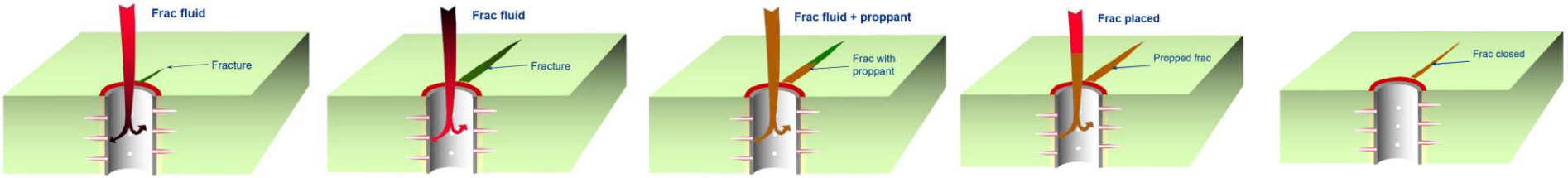
- Creation of fractures to increase the surface area available for production and provide a high-conductivity flow path for pore fluids into the wellbore

Methodology

- Rock is fractured using fluid at high pressures
- The fracture is then filled with propping material such as sand or man-made materials to keep the fracture open
- The fracture fluid is returned to surface upon fracture closure on proppant material

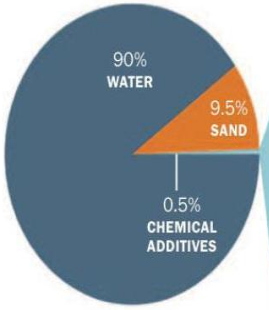


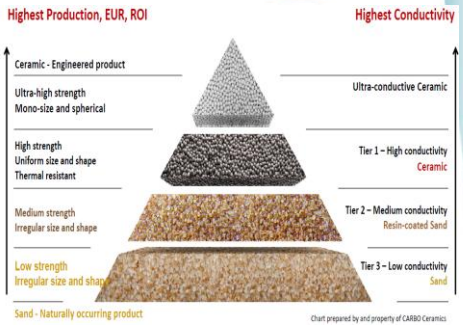




FRAC CHEMICALS

- 90%: Water
- 9.5% Sand/Proppant
- ~0.5% Chemicals:
  - Guar (thickening agent, food based)
  - Cross Linker – links guar polymer chains to form a jelly like fluid that can carry the proppant.
  - Buffers and Breakers
  - Surfactants
  - Friction reducers
- Full disclosure to authorities
- No BTEX additives permitted
- Simpler and greener fluid systems used nowadays
- None of the chemicals are classified as carcinogens or teratogens
- Chems are not persistent and do not accumulate in the environment



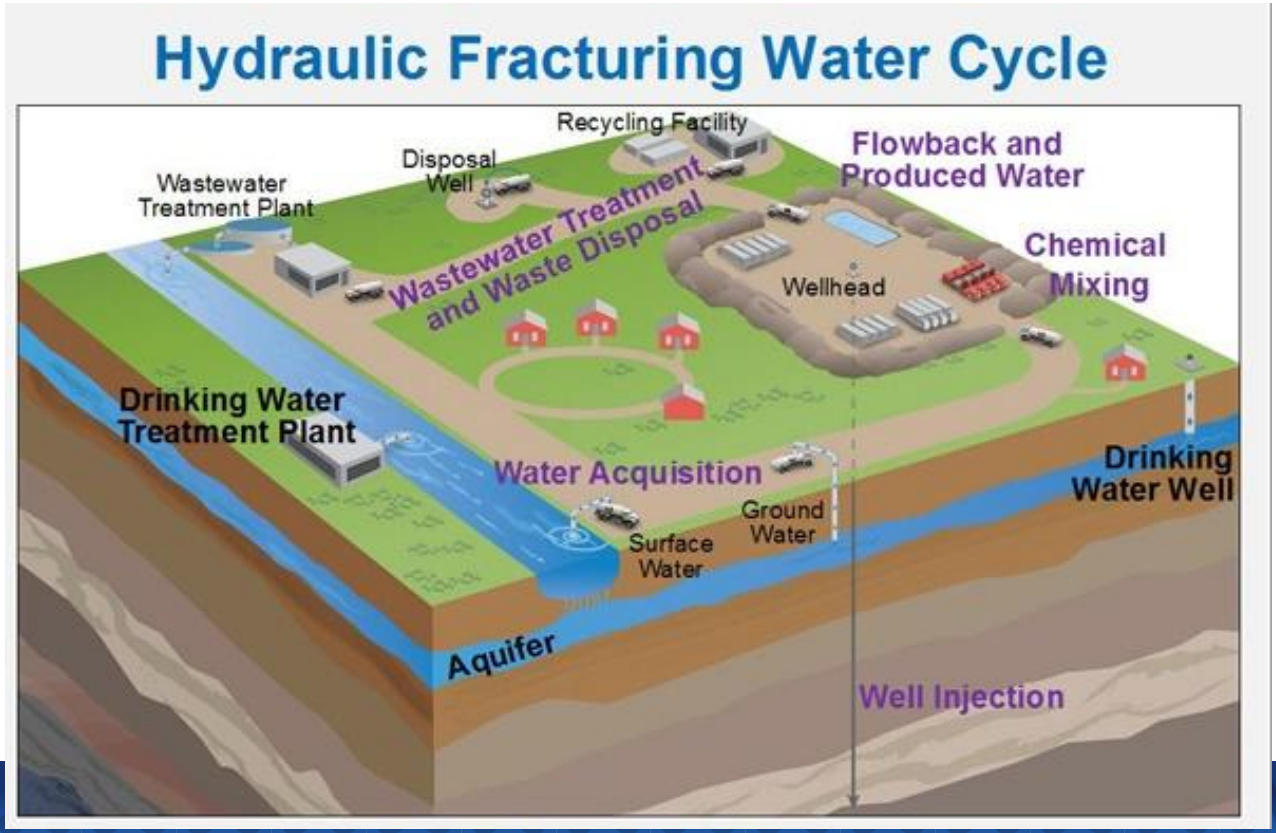


Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

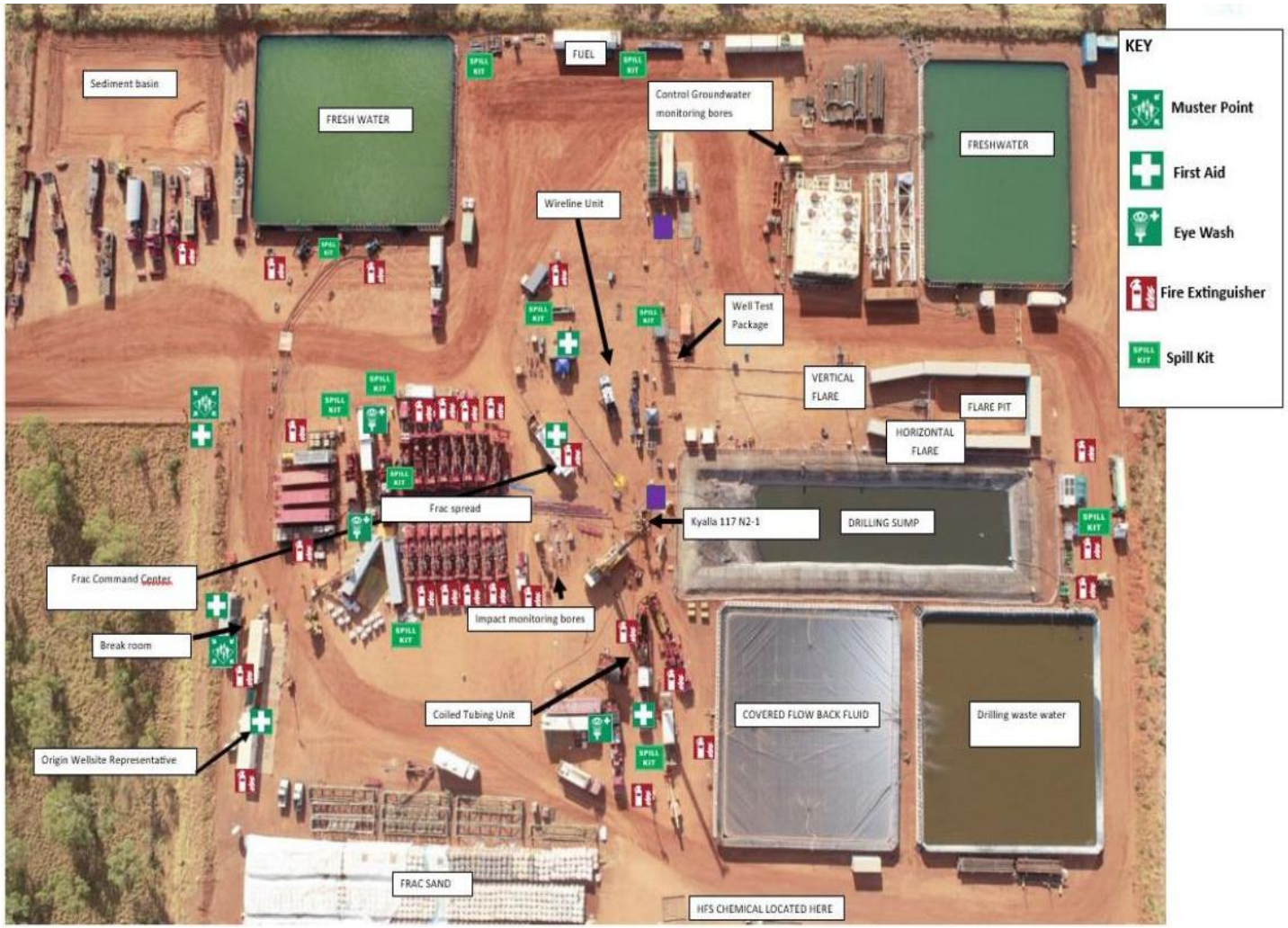
Modern Gas Shale Development in the United States: A Primer (2009).

WATER USAGE

- There isn't really a "typical" fractured well because the amount of water used depends on the rock formation, the operator, whether the well is vertical or horizontal, and the number of stages of the well that are fractured.
- Some water may be recycled from fluids produced by the well, so the net consumption might be smaller at sites that recycle.
- Water use per well can be anywhere from about 3 million liters to about 30 million liters.



EQUIPMENT

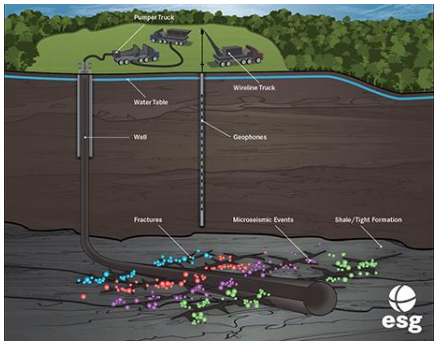

Sediment basin
FRESH WATER
FUEL
Control Groundwater monitoring bores
FRESHWATER
Wireline Unit
Well Test Package
VERTICAL FLARE
FLARE PIT
HORIZONTAL FLARE
Frac spread
Kyalla 117 N2-1
DRILLING SUMP
Frac Command Center
Break room
Impact monitoring bores
Coiled Tubing Unit
COVERED FLOW BACK FLUID
Drilling waste water
Origin Wellsite Representative
FRAC SAND
HFS CHEMICAL LOCATED HERE
KEY
Muster Point
First Aid
Eye Wash
Fire Extinguisher
Spill Kit

MONITORING

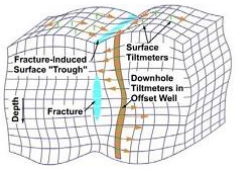
Impact Monitoring Bores

- Water levels and quality

Micro-seismic



- Measures the location of micro-earthquakes or microseisms, resulting from hydraulic fracturing. These are detected by an array of geophones or accelerometers, placed in an offsetting wellbore or surface.
- As the treatment proceeds, a map of the event locations develops which provides time-based measurements of the fracture azimuth and dimensions.

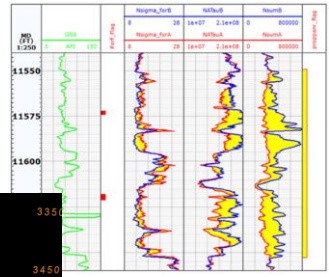


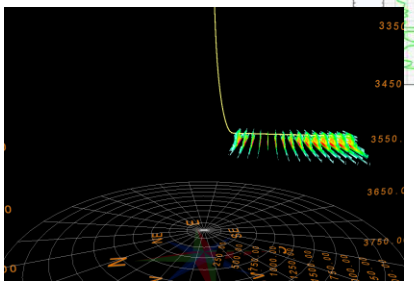
Tiltmeters

- Measures and maps surface deformation caused by hydraulic fractures. The tiltmeter is a very sensitive device, that can sense changes as little as one part per billion in the displacement gradient (or tilt).

Non-radioactive tracers

- Environmentally friendly traceable proppant (Tracer incorporated into every grain)





Temperature logs

- Fracture height evaluation

MYTHS & FACTS

Myth: Hydraulic fracturing is a new technique

Facts:

- Hydraulic fracturing has been used since the 1950s. So, this technology has been around for a long time and more than 2.5 million fracture stimulation jobs have been completed so far.
- It has been improved significantly over the past 2 decades (tools, fluids, application to horizontal wells).
- It has found a perfect application in tight/shale gas reservoirs.

Myth: Hydraulic fracturing causes earthquakes

Facts:

- It produces micro-seismic events.
- We can measure these seismic event on surface or downhole caused by fracturing and thousands of such data sets are available.
- This technique is called “micro-seismic monitoring” and it has been used to detect where the fracture is going.
- The magnitude of these “earthquakes” are typically smaller than the “quakes” a truck passing by would cause on the earth’s surface.
- On a Richter scale they would register a negative number, or about 1 million times smaller than a typical tremor.
- Fracturing does not penetrate deep enough to reach major faults and tectonically active plate boundaries, which are 3 to more than 8 kilometers beneath the Earth’s crust

MYTHS & FACTS

Myth: Hydraulic fracturing contaminates groundwater

Facts

- It could potentially happen if not properly managed
- There have been over 1 million wells hydraulically stimulated in the US and thousands in Australia.
- To date there have been no documented cases of groundwater contamination due to fracturing.
- There is a very small probability that hydraulic fracturing can lead to groundwater contamination if: – The chemicals used are toxic – The fracture connects to sources of potable water – Fracture growth is uncontrolled.
- Most shale gas fracs use only water and a small concentration of non-toxic polymer
- Service companies should disclose these chemicals to regulators.

Myth: Hydraulic fracturing causes gas to come up into our home water supply

Facts

- This notion was popularized by the dramatic footage in the movie Gasland.
- Gas in home water supplies have been known to occur in water wells due to natural gas seeps much earlier than hydraulic fracturing was ever used and there is no proved connection between hydraulic fracturing and gas in a home water supply.
- There are famous examples of natural gas seeps around the globe that burn naturally or can be ignited on the surface.

MYTHS & FACTS

Myth: Salt water produced from natural gas wells will contaminate the surface

Facts

- The volume of water produced from shale gas wells is relatively small.
- The chances of a surface spill are quite low and the consequences are not catastrophic.
- Fluids flowback management includes surface lined ponds and tanks.
- Water is either treated and disposed at an approved facility of evaporated.

Myth: Hydraulic fracturing is a big drain on our groundwater resources

Facts

- Water sources include lakes, aquifers, desalinated water, recycled water.
- The water used in hydraulic fracturing is less than 1% of the municipal water use once on large scale development phase. Water consumption occurs only during drilling and fracturing (it is not a continuous process)
- There is more water used to water golf courses in than is used in hydraulic fracturing.
- Under extreme drought conditions water is a very precious commodity and should be used with extreme care.
- Perth daily usage ~900 million liters/day.