



## **ENGINEERING UNIT – WELLBORE INTEGRITY**

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Well integrity refers to design and construction parameters for an oil and gas well that prevent oil, gas, or water from migrating between different geologic formations penetrated by the wellbore. Designing and constructing a well so that hydrocarbons cannot migrate through or along the wellbore into fresh water formations is one of the most fundamental ways of protecting the environment, especially drinking water aquifers, during oil and gas operations.

### **Construction Requirements**

COGCC has long required operators to construct wells with multiple layers of steel pipe (casing) that are “telescoped” one inside the other, down the hole as it is deepened.

- In the water-bearing and hydrocarbon zones, the casing is cemented into place, and cement fills the void space between each layer of casing.
- At least two layers of steel casing and cement are in place from the ground surface to the lowest point of the freshwater aquifer.
- In the hydrocarbon formation, several thousand feet below the aquifer in most cases, there is at least one layer of steel and cement, and the hydrocarbons move through the inner-most casing to the surface.

These construction requirements isolate the hydrocarbon zones and the freshwater aquifers.

### **Wellbore Reviews**

COGCC Engineering staff conducts pre-construction and post-construction wellbore reviews on every single well permitted in Colorado. A pre-construction review of the casing and cement design is performed to verify that the wellbore will isolate fresh water from hydrocarbons. Field inspections are performed on a percentage of wells to monitor well drilling and completion operations, including hydraulic fracturing. After a well is completed, the engineering staff reviews documentation (well log data, service company reports, and operator daily field reports) to confirm that casings were placed and cemented in accordance with the approved permit and applicable COGCC rules and policies. COGCC requires a Cement Bond Log (CBL) to verify cement coverage behind the production casing or intermediate casing.

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## Additional Documentation and Testing

The required combination of steel and cement not only isolates fluid flow, but provides the compression, tension, collapse, and buckling strength necessary to maintain wellbore integrity in response to induced pressures applied to the well during drilling, completion and production activities. COGCC cement strength criteria are based on industry standards for compressive strength at 8 hours and 72 hours. COGCC requires production casing to be pressure tested for conditions anticipated during completion and production operations.

COGCC also requires operators to file a Completed Interval Report (Form 5A) that includes information related to completed formations, depths, perforated intervals, reporting to FracFocus and stimulation treatments.

Tests may be performed periodically during a well's productive life to monitor wellbore integrity. Bradenhead tests and MIT's are two examples.

- Bradenhead monitoring is an indirect method to verify wellbore integrity, and is defined by Rules 207.b. and 608.e.
- Wells lacking mechanical integrity or wells that are no longer capable of production are required to be abandoned per Rule 319 and Rule 326.d.

COGCC engineering staff reviews a Form 6 (Notice of Intent to Abandon) prior to plugging and abandonment to verify proper plug placement. This review is similar to a Form 2 engineering review, as discussed above, to identify all fresh water aquifers and hydrocarbon producing zones.