Unconventional hydrocarbons exploration:

Release of hydraulic fracturing fluid or flowback waters under pressure during, between and following hydraulic fracturing

SECURe employed the Bow Tie risk assessment approach, which identifies a series of barriers that prevent a principal hazard ("top event") from occurring. This factsheet outlines recommendations, which address a single top event that can occur if control of a hazard is lost: the release of hydraulic fracturing fluid or flowback waters under pressure during, between and following hydraulic fracturing. It should be read in conjunction with the Participatory Monitoring Factsheet, which provides overall guidance on project construction.

The issue

The potential release of hydraulic fracturing fluid or flowback waters under pressure during, between and following hydraulic fracturing must be fully assessed in unconventional hydrocarbons extraction (UHE) projects. This could result in releases and/or impacts to ecosystems and people, including other subsurface users. The release of hydraulic fracturing fluid or flowback waters could occur through abandoned, monitoring or verification wells. These releases could occur via the well annulus, through cements or casing/production liners or along tubing. A range of well engineering assessments, appropriate material selection and monitoring provide effective barriers to prevent fluid release. If release were to occur, then remediation options include monitoring, operational responses, well engineering interventions, and the use of natural geological properties to slow the release. These barriers, and preventative and remedial actions are listed in detail in SECURe report BGS-01-R-11.

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Risk mitigation recommendations

Maintaining borehole integrity

- **Well integrity should be ensured** to prevent the leakage of produced waters (D3.3).
- Microannuli, or small gaps, along the well and radial fractures emanating from the casing through the cement should be considered in **leakage mitigation strategies.** Any individual fracture may dramatically increase the leakage risk, but fracture networks do not necessarily lead to a continuous, high-permeability path along the wells (D2.6).
- Under the right conditions, **re-purposing existing wells for hydraulic fracturing can be done** with minimal damage to the cement, provided the status of wells is known and properties of the cement are well-characterised (D2.6).
- Due to the high level of uncertainty in parameters associated with formation and cement behaviour, it is suggested that **a probabilistic approach in assessing well integrity, with the goal of minimising the probability of failure, is used**. However, laboratory experiments can be used to test cement integrity for realistic stress states and well materials, and to assess fracturing of the cement sheath operating limits for well pressure (D2.6).
- **Maintaining well integrity throughout the life cycle of a well** is important for UHE. Statistics on different incidents of well integrity issues indicate that the most vulnerable well components are tubing, casing and cement sheath. The loss of integrity or leakage cannot be meaningfully addressed by looking at different leakage pathways independently of the well barrier envelopes (D5.1).
- **Appropriate management of drilling wastes** is important to ensure there is no leaching of organic chemicals that could directly and/or indirectly impact shallow groundwater quality (D3.3).

Monitoring approach

- **Thresholds should be set** for hydrochemical parameters that could indicate contamination in the future. Thresholds should be calculated using the environmental baseline data to calculate concentrations of parameters that would indicate excessive natural temporal variation (D3.6).
- **Hydrochemical parameters to be used as indicators of contamination should be selected** based on the mineralogy of the aquifer, the characteristics of the potential contaminant (for example, hydraulic fracture fluid release), and the nature of any likely reaction between the two (for example, decreased pH) (D3.6).

Risk mitigation recommendations (cont.)

Establish baseline environmental conditions

- Knowledge about the waters associated with the unconventional reservoir, i.e. the **characterisation of the formation fluids**, can also be obtained from the monitoring of flowback fluids associated with borehole drilling during the development of unconventional reservoirs or from produced water when the borehole is under production (D3.4).

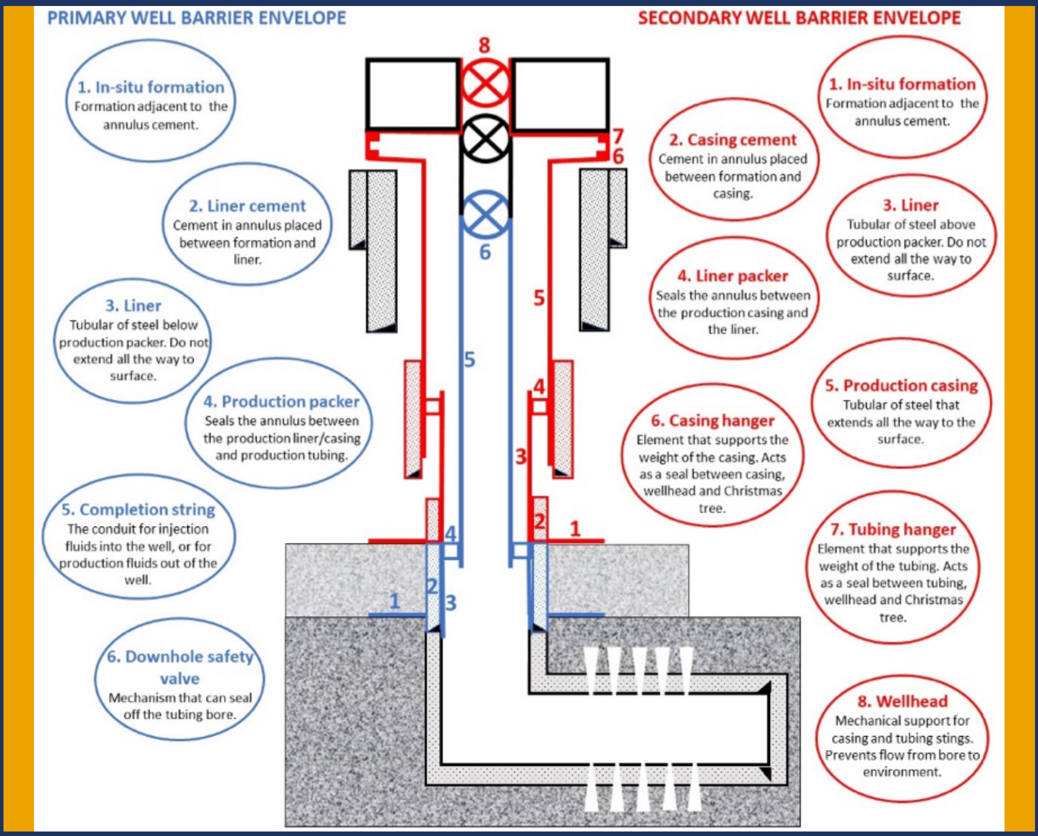

Figure 1: Simplified illustration of well barriers for a typical active shale gas well. Primary well barrier envelope in blue and secondary well barrier envelope in red (from D5.3).