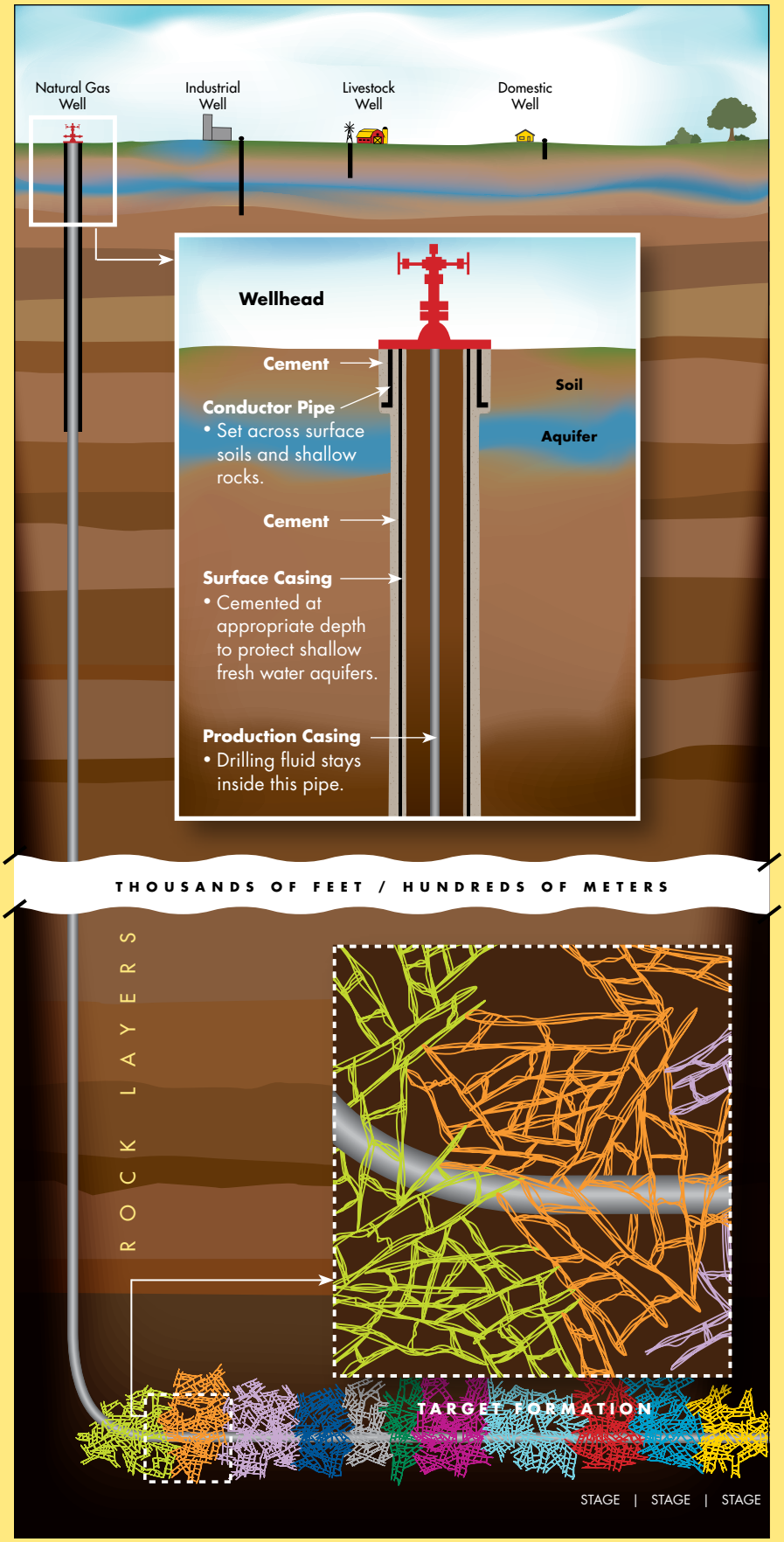
DOING THINGS RIGHT



Note: This image illustrates hydraulic fracturing used with horizontal drilling. In some formations, the well remains vertical within the tight gas formation and the fractures extend horizontally from the wellbore. For each well, casing and cementing designs are approved by applicable regulatory agencies. Illustration is not to scale.

HYDRAULIC FRACTURING: YOUR QUESTIONS ANSWERED

In formations where natural gas is trapped very tightly in tiny pores (rather than accumulated in large pools or more porous rock), if we simply drill through the rock the gas won't flow easily, making it impossible to extract enough gas to make the well economical.

After we drill a tight gas well, to complete it we stimulate the gas flow from the formation using a technique called hydraulic fracturing. This often-misunderstood technique has raised some questions that we would like to answer.

Hydraulic fracturing is a valuable technique for stimulating production from tight gas and shale gas wells.

Q What is hydraulic fracturing?

A Hydraulic fracturing is a proven technique that has been used for decades in many kinds of oil and gas wells, but is particularly valuable in tight gas and shale gas formations. A tool called a perforating gun is lowered into a newly drilled well and lined up precisely within the formation using tools such as seismic images, well logs, global positioning systems and other indicators to target the spots from which tight gas appears most likely to flow. When fired, the gun punches small holes in the well casing, cement and rock. Next, fracturing fluid is pushed out through the perforations under high pressure, creating small cracks in the formation that allow the natural gas to flow from the rock. We fracture the well in stages and set a plug between each stage. After we fracture all of the stages in the well, we drill out the plugs, which allows the gas to flow up through the well to begin production. The fracturing fluid is typically 99 percent or more water and sand, with the remainder made up of chemicals. The sand helps to keep the cracks open, and the chemical additives help reduce friction and prevent bacteria growth and scale from forming and blocking the flow of gas.

Q Can the fractures allow natural gas to seep up into the water table?

A Typically, North American gas formations that require fracturing are located a mile (1.6 kilometers) or more below the water table, trapped below many layers of impermeable rock. These thousands of feet of rock overlying the tight gas formations, combined with the low permeability of the tight gas formations themselves, keep the natural gas and other hydrocarbons contained within the target formation, and also help prevent migration of any hydraulic fracturing fluids that may be pumped into such formations.

Q Are the chemicals used in hydraulic fracturing dangerous?

A Most of the fluid used in hydraulic fracturing is water. We add chemicals, typically around 1 percent of fracturing fluids, to keep the pipes cool by reducing friction and to prevent scale build-up and bacterial growth. Many of these additives are compounds that are used in other applications you encounter in your daily life, from citric acid and guar gum, commonly used as food additives, to ethylene glycol, commonly used in household cleansers and automotive antifreeze. Some of the chemical additives can be hazardous if not handled carefully. We take great care when using all the compounds added to fracturing fluid, and meet or exceed all regulatory requirements related to handling hazardous materials.

The formulas for fracturing fluids vary, partly depending on the composition of the gas field and partly on the expert opinion of the operator or fluid supplier as to what works best. These formulas are owned by the supplier

Drilling, casing and cementing procedures are designed to isolate the well from the potable groundwater zone.

and some are considered proprietary. Shell is transparent about our operational methods and the products used in our hydraulic fracturing operations. This includes releasing information about the chemicals we use in our hydraulic fracturing operations to the extent we are permitted by our suppliers to release their proprietary information. We support regulatory efforts that require our suppliers to release such information.

Q Can fracturing fluid seep from the gas formation into the groundwater supply?

A Shell's drilling, casing, and cementing procedures, which meet or exceed regulatory requirements, are designed to protect groundwater by isolating the well from any groundwater supplies. We pump the fracturing fluid through the well into the rock or shale zone containing the gas, which has very low porosity and is typically trapped far below the deepest source of potable water and underneath many layers of impermeable rock. Consequently, the fracturing fluid should either stay within the target formation or be forced back out through the well, but in either case it should remain isolated from groundwater supplies.

Q Can fracturing fluid get into the water supply?

A We design and test the integrity of our wells to meet strict specifications based on the local environment. The upper portions of the well, where the wellbore passes through the water table, are extensively reinforced to help prevent either gas or fluids from escaping into the surrounding ground. Wells are made of steel pipes and sealed in place with cement from the surface to below the level of drinking water supplies, typically to a depth of 1,000 feet (about 300 meters) or more. These barriers help to contain the fracturing fluid and, along with the depth at which fracturing takes place, prevent the fluid from mingling with drinking water close to the surface.

During and after hydraulic fracturing, wells are monitored with pressure sensors to check that they are firmly sealed. Shell also periodically monitors the fractures and the fluids using micro-seismic technology to map the formation, which helps to make production as efficient as possible and protects the environment.

Q Can the chemicals stored on the site affect groundwater?

A Safe handling of all water and fluids on site, including chemicals used for hydraulic fracturing, is a high priority for Shell. We comply with all regulations regarding containment, transport and the handling of any spills, should one occur. To protect groundwater, we keep chemical containers and all fluid handling equipment located on site within secondary containment barriers that could capture a spill in the unlikely event that one were to occur. The containers must pass regular integrity checks and certification. We check water storage tanks for integrity before we use them and check them visually each day. Single-use containers that are used to transport small volumes of chemicals are returned and disposed of offsite. Any spill that were to occur on a well pad would be promptly cleaned up, reported and documented according to both our own and regulatory requirements.

Q What happens to the fracturing fluid after it is used?

A We take multiple steps to properly handle hydraulic fracturing fluid. First, when possible,

we reuse it for additional wells in a single field. This both reduces our overall use of fresh water and reduces the amount of recovered water and chemicals that must be disposed of. Second, we keep the recovered water in storage tanks or lined storage pits until it is disposed of in a permitted salt-water disposal well or other approved disposal site. All disposal facilities used by Shell undergo extensive onsite environmental assessments to determine if they meet regulatory standards and Shell specifications prior to use.

Q How do the disposal wells hold the fluids?

A All of our Shell-operated injection wells are designed to meet regulations to protect groundwater. Our geologists and engineers work together to design, drill and test injection wells for integrity and compliance. We isolate the wells in three ways:

- We choose zones that have multiple confining layers above the zone to keep the injected fluids within the target formation.
- We use multiple layers of well casing and cement (similar to our production wells) and periodically run mechanical integrity tests to verify that the casing and cement are holding the liquids.
- We control how much fluid we inject and at what pressure (specified in each well permit) to help keep the fluids in the target zone, and we monitor the pressure in the injection well and the spaces between the casing layers (also called the annuluses) to check and verify the integrity of the injection well.

We also screen any non-Shell-operated injection wells that we use to verify that they comply with all regulatory requirements.

"We have a fundamental belief that we have more success if we work with people in ways that are inclusive and try to find the solution that works best for everyone."

– Jeff Wahleithner,
Vice President, Drilling –
Shell Upstream Americas