Drilling

Fortuna Energy Inc.

Planning a Wellsite

Before deciding on the location for a well site, Fortuna Energy must consider many factors. Subsurface well log data collected while drilling nearby wells and seismic data obtained from seismic surveys allow geologists to identify the best bottomhole location. Surface conditions, environmental, safety, and regulatory guidelines, and issues identified during discussions with landowners, will all affect the selection of a surface location for the well.

Once a site is selected, the land is surveyed and the approval processes begins with the required regulatory permit applications. Upon receipt of the drilling permit, the well location is prepared for the drilling operations by constructing an access road and well site. For future reclamation and restoration of the site, Fortuna Energy strives to minimize surface disturbance and any topsoil removed is set aside for eventual restoration.

The Drilling Rig

A drilling rig and its associated equipment are then moved to the site. A small, temporary outpost quickly takes shape as the equipment is delivered on flatbed and tractor-trailer trucks. The height of the rig allows the drill crew to thread 40-foot sections of the drill string and pipe into the well as the drill bit bores deep into the earth.

The rig, its accompanying equipment, and support personnel work together as a highly specialized, extremely efficient operational team. Some of the support personnel live and work right on the site in trailers that serve as housing and offices. Site-generated electric power and satellite communications are included in the setup. Well drilling is a continuous 24 hour a day operation, so the rig is lighted for the safety of the rig hands.

Drilling Procedures

Drilling a Trenton Black River gas well deep into the earth, through multiple solid-rock layers, is a complex and expensive operation. Years of experience and scientific research stand behind our drilling procedures. Each step is taken carefully and deliberately. Since a 12,000-ft.-deep well's total drilling cost is roughly $250 per foot — or $3 million — planning is essential.

There are several progressive stages that make up the drilling operation as the wellbore is constructed deep into the earth. Each stage has special drilling tools, techniques and finishing requirements that we will briefly describe here:

Conductor Hole: Well drillers refer to starting the well hole as "spudding" the well. The well is spudded by air drilling a 20-inch diameter conductor hole through surface dirt, gravel and overburden layers into at least 15 feet of bedrock. An 18 inch steel conductor casing seals the conductor hole from the surface down to the top of the bedrock.

Surface Hole: Once bedrock is reached, the bore diameter is reduced to 17-inches and surface-hole drilling with compressed air continues to at least 600 feet from the surface, and always below the deepest underground source of drinking water. Again casing ($13\frac{3}{8}$") is run in and cemented in place.

Drilling rig

Drilling crew

Intermediate Hole: After passing below all identified sources of drinking water, the drill bit is again reduced to 12-inches for drilling the next 7,000 to 9,000 feet. The diameter of the casing reduces in stages as the bore goes deeper, and a $9^{5}/_{8}$"casing is cemented into place to the total vertical depth of the well.

Horizontal Main Hole: As the drilling operation enters the zone of interest, the bore is again reduced to approximately eight inches in diameter. For the well to be productive, the wellbore must intersect and tap as many natural fractures in the gas bearing rock formations as possible. To increase this probability, Fortuna Energy uses a unique horizontal directional drilling technology in this lower portion of the hole. From the vertical hole at about 9,600 to 12,000 feet deep, the drill bit is turned a full 90 degrees through a 600 foot radius arc and continues drilling up to another 3000 feet horizontally through the target structure to penetrate as much gas–bearing rock as possible. This horizontal section is left as an open hole, without casing, to capture all the available gas.

Well Casing: As the bit bores into the earth, long lengths of steel pipe or "casing" are fed into the well to isolate and seal the wellbore from the surrounding ground formations. This protects groundwater zones by preventing any production fluids from contaminating groundwater. The casing is also cemented into place forming vertical seals that prevent any water, air, gas, dust, etc. from flowing or seeping, up or down outside the well casing. This exterior cement barrier also prevents any surface runoff from entering the well, or water from one aquifer layer flowing into another. The casing is pressure tested to check for possible leaks, because it will eventually provide the closed system needed for production of the gas reserves that are hopefully found.

Drilling with Air: The drilling operation starts at the surface, boring past all surface dirt, gravel and overburden layers into bedrock. Eventually the hole penetrates to a point about 7,000 to 9,000 feet down, the entire length reinforced with multiple stages of steel casing pipe. Throughout this initial drilling phase compressed air is used to lift drill cuttings out of the well. Since the surface gravel and overburden layers are where the well will pass through one or more water aquifers, air drilling is preferred because it is clean and presents no new substances to potentially leak into the ground or contaminate water.

Drilling with Fluid: Once the hole is drilled into the zone of interest there is the possibility of encountering pressurized gas, so the drilling process switches from air to drilling fluid. The fluid (or "mud") consists of mostly water with water-based organic polymers and the rock cuttings that are circulated to the surface and separated into mud pits. The weight of the column of drilling mud acts as a containment cap for any gas encountered.

By the time drilling fluids are introduced, the cemented steel casing serves as a continuous high-pressure closed system from the surface to the drill bit. Casing sections continue to be placed, cemented and tested for leaks as the drilling proceeds. This protective wellbore lining serves as a leak-proof barrier between the drilling operations and the surrounding earth and water.

Surface management of the drilling fluid includes lining reserve mud pits with impermeable liners to prevent any seepage of fluids into the ground.

Water Protection When Drilling a Well

Fortuna Energy has many years of experience at drilling gas wells that do not have any impact on neighboring water. This successful record is the result of our experienced staff and the precautions we take.

Before any drilling begins we identify all private and public wells and their depths within a set perimeter of the site. We determine the deepest depths of groundwater to ensure that the groundwater aquifers are protected. The New York State Department of Environmental Conservation (NYSDEC) and Pennsylvania's Department of Environmental Protection (DEP) both have regulatory responsibility for both water and mineral resources, so we work closely with their representatives as we plan and permit a well.

When drilling is done properly, there should be no changes in water quality, water pressure or water supply. Our drilling operation does not make use of any of the underground water. The casing seals between the water aquifer, the well and any other sub-surface layers are permanent.

For further information, please access our website at www.fortunaenergy.com or contact our information desk at 607-795-2780 (Toll free 866-566-4747)