



# The Life of a Natural Gas Well

The following is a brief overview of the people and processes involved that allow us to safely develop this natural resource and protect the environment.



*Drilling and operating a modern natural gas well involves proven technology deployed over seven primary stages – identification; site acquisition & preparation; drilling; completions & production; and reclamation. Long before the first shovel of earth is even moved, our employees and contractors are hard at work on the many technical issues to ensure the safe production of oil and natural gas. The following is a brief overview of the people and processes involved that allow us to safely develop this natural resource and protect the environment.*

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## Identifying where to drill

When our geoscientists identify the best locations to find oil and natural gas, our landmen will work with landowners to acquire the rights to drill. In some areas, companies perform 3D seismic operations on the surface land to give them a clear picture of the subsurface geological structure. Where there has been drilling over time, geologists will use existing data to create subsurface maps giving them indications of where to drill in the future. Well pads are strategically located – placing them a proper distance from water sources and designated environmental areas - to protect mutual rights, comply with regulations and maximize production.

## Reservoir Engineering

Reservoir engineers, along with geologists, study the potential amount of oil and natural gas that can be produced. They consider permitting, drilling, completion and production costs, and they assess the anticipated economic performance of the wells and whether the wells are viable to drill. Predicting the future price of oil and natural gas versus the costs to get these products to market is challenging and may involve many factors.

*Well pad locations are determined based on environmental and geological considerations.* ▶▶▶



## Permitting Process

With leases signed, the next step is to acquire the appropriate permits and surface agreements. The surface owner is influential during this process. Land not privately owned is usually controlled by State, Federal or Tribal agencies. Seneca Resources must make arrangements with the surface owner(s) and make sure Seneca has legal access onto their property. A variety of permits are required before any drilling-related activity can begin. Environmental assessments and surveys must be performed. Archeological information is reviewed to make sure there are no sensitive cultural artifacts in the area. Wildlife biologists perform field inspections to ensure that any threatened or endangered species will not be impacted. Other regulatory agencies assess streams, tributaries and wetlands. Seneca will conduct pre-drill water surveys and employ other practices to protect the landowner and the public. The entire process can be expensive and time-consuming, often requiring more than one year of pre-drilling work preparation.

## Preparing the surface

Seneca will improve and use existing roads when possible, but in many cases, we will create an access road to allow heavy equipment to reach the site. Once this is completed, we begin clearing the area where the rig will sit. The well pad is reshaped with earth, stones and protective devices to provide a wide, flat working area that will cover an average of five acres. We will also install protective liners and erosion controls to protect the surface.

*Seneca will use protective measures that often exceed state and federal requirements for well pad preparation.* ▶▶▶





## Drilling

Most modern oil and natural gas wells are drilled with a similar process. A drilling rig will drill holes of various sizes, reducing the hole's diameter with depth, and then install casing (steel pipe) to protect the integrity of the well and fresh water aquifers. Typically, "conductor casing" is installed to a relatively shallow depth, less than 50 feet, to contain the initial drilling process. Next, a wellbore will be drilled deep enough to penetrate any fresh water aquifers – anywhere from 100 to 500 feet. Then steel pipe, known as "surface casing," will be installed and cemented in place. Once this is done, a blow-out preventer is installed to protect against any type of unexpected inflow of pressure as the well is drilled deeper. A smaller diameter drill bit is run through the surface casing and utilized to continue the drilling process.

Again, casing is installed to protect the newly drilled wellbore and cemented into place and this phase is known as intermediate casing. A smaller diameter drill bit is run through the intermediate casing, and the well is deepened to the zone of interest. There are many sophisticated geophysical tools that can be run in conjunction with the drilling string, or on a separate wire line logging unit, to gather information about the strata that is penetrated during drilling. This information helps Seneca analyze the formation for reservoir and other geophysical properties. A final string of casing, called production casing, is installed through the productive zone and cemented in place. Finally, a wellhead is put in place and the drilling rig is moved off the location. The drilling phase can last for weeks or months. It is a 24-hour operation that involves lights, some noise and the movement of heavy equipment. Seneca works diligently to minimize the impact on the landowner and the community.

*Multiple layers of pipe and cement are used during the drilling process to protect the land and fresh water aquifers. >>>*





## Completion & Production

Most well completions utilize a smaller rig known as a completion unit, daylight rig or workover unit. These rigs are used to complete the wellbore and prepare the well for production. We will stimulate the well to release the natural gas or oil. This process, called hydraulic fracturing, involves pumping water, sand and chemicals at high pressure into the well to create fractures in the shale at times as small as the width of a sheet of paper. This sand, known as “proppant”, holds the fractures open and provides a pathway for the natural gas to flow through the wellbore.

The well is then cleaned out, and the rig runs smaller diameter steel pipe known as tubing, inside the casing. This allows the oil and natural gas to safely reach the surface while being completely contained inside the tubing, which can be easily replaced in the future if needed. Many engineering and safety factors dictate the specifics of well construction. Sometimes down hole pumping equipment will be installed inside the production tubing to assist in “lifting” the oil, natural gas and water to the surface.

The completion process can last for several weeks. While Seneca typically will flow gas into production, it is not uncommon to “flare” the gas well for a few days after completion. Flaring is a safe and controlled burn of natural gas. We do this to best determine the long-term production capabilities of the well. When flaring is needed, we follow all applicable regulations for landowner and stakeholder notifications. Ultimately, the well is connected to a natural gas gathering pipeline system that delivers to the interstate pipeline network where the natural gas can be sold.

The royalty payments a lease holder receives will be based on the price received at that interstate pipeline. Production varies by well and all wells decline in production over time, however, typical Marcellus and Utica natural gas wells are expected to remain active and produce for several decades.

*Completion is the process - including hydraulic fracturing >>>  
- in which the well is enabled to produce oil or gas.*



## Reclamation, Plug and Abandon

We aim to leave a site as close to the way we found it or better. And we're committed to working with the surface owner to restore their property to a level that meets or exceeds their expectations. Drilling is clearly a construction process, but it is temporary. Remediation to full satisfaction will take time and is influenced by weather conditions. It's our goal that our landowners are satisfied partners from start to finish and for many years to come.

After a well has reached its economic life, it will be scheduled for plugging and abandonment. The type of well and its original construction determines how the well is plugged. The production tubing and any related downhole equipment are removed along with any remaining surface equipment. As much casing as possible is removed and a series of cement plugs are placed throughout the wellbore to ensure surface formations are protected from the producing zones. The wellhead is cut off with a marker, typically a short piece of pipe, cemented on top of the old well bore.

The surface area is re-contoured to its original state and re-seeded in accordance with state rules and regulations and with input from the landowner. As re-vegetation of the site takes hold over time, the only thing visible is the plug and abandon marker denoting the location of the well bore.



◀◀◀ Several pieces of equipment are installed on the well pad to support safe production activities. Much of this equipment will stay on location as long as the wells are producing. The remaining surface area will be reclaimed and re-contoured to its original state and finally re-seeded in accordance with state rules and regulations.





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*Seneca Resources Corporation, the exploration and production segment of National Fuel Gas Company, develops and purchases natural gas and oil reserves throughout Pennsylvania, focusing on the Marcellus and Utica Shale Plays, and has provided Pennsylvania Energy and Pennsylvania jobs for 100 years. More information is available at **[www.YourFutureOurFuture.com](http://www.YourFutureOurFuture.com)***

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