

Industry Information

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Determination of Where to Drill Wells

Long before a well is drilled, substantial planning and work is conducted, including geological research. While every project is approached differently, the drilling, completion, and operating phases of a well are generally outlined below. If an area is being explored for exploratory wells, seismic operations or geochemistry may also occur prior to the drilling phase.

Many forms of geological data are utilized in the exploration process. Data base information is assembled and geological mapping is performed in order to identify an area as having the potential to produce crude oil and/or natural gas. Data available from previously drilled wells also provides useful information. One advantage Rockhound has is extensive archive data in most areas to evaluate.

Two of the more common types of maps used in petroleum exploration are the isopach and structure maps. An isopach map shows the thickness of a potential oil and gas producing interval. Isopach maps are often useful when exploring the main pay zone. The better wells are located in areas where the section is thicker or cleaner. A structure map shows the horizontal elevation changes in the rocks in the subsurface. Both isopach and structure maps are particularly helpful in identifying potential drillsite locations. In some areas a structure map and show map are often sufficient.

Another commonly used tool in the search for crude oil and natural gas is a cross-section of well logs. This type of data shows the lateral and vertical changes that may occur in the rocks and identifies the pay zones along with expected production. The logs utilized are often logs from previously drilled wells.

Once an area has been identified for oil and gas exploration, preliminary courthouse work is conducted to identify the oil and gas ownership of the properties in the area of interest. This work is necessary for many reasons, including the possibility that the ownership of the oil and gas is not the same as the ownership of the surface. Once the courthouse work is completed, landowners are contacted by the exploration company in an attempt to acquire oil and gas leases. An oil and gas lease is a contract between the landowner (the "Lessor") and the exploration company (the "Lessee") that grants to the Lessee the right to drill, operate and produce oil and natural gas.

Once a drillsite is identified a detailed review of the title to the property is conducted. The title work is usually performed by an attorney. This work is performed to make sure that the Lessee has the oil and gas rights properly leased and that there is no outstanding title

issues that may affect the Lessee's rights to drill and operate a well on the property. Any curative measures that may be required under the Certificate of Title are then satisfied so that the property is in drillable condition. A common title requirement is to ascertain that any oil and gas leases covering the property that are still of record are no longer in affect.

The well location is surveyed (staked) by a registered surveyor. The location is marked by placing a wooden stake in the ground at the location. The surveyor will prepare a plat map which identifies the drilling location and its applicable coordinates and the drilling unit for the drilling location. The surveyor's plat along with the well permit application information and application fee is sent to the appropriate state agency in order to acquire a permit to drill the oil and gas well. The operator applying for the drilling permit must meet specific insurance requirements and must maintain a bond with the state agency. The operator of the well will also provide notifications as required by oil and gas regulations and laws.

Once a drilling permit is granted, the actual preparation of the drilling location may begin. A meeting is held with the Lessor to discuss the location of the proposed drillsite and to establish the best means of access to the location.

Drilling of Wells

A drilling prognosis is prepared before the drilling rig starts ("spuds") the well. The geologist and petroleum engineer discuss many factors including: 1) formation depths; 2) oil, gas, and water zones to be penetrated; 3) anticipated pressures; and 4) other potential drilling conditions. Once a drilling prognosis is completed, bids are obtained from third party contractors that will be used in the drilling and completion process. Once all the bids have been acquired a cost estimated to drill and complete the well is prepared (AFE or "Authority For Expenditure").

After the site is cleared and prepared for drilling, a third party drilling contractor is employed to drill the well. The drilling rig and other equipment is transported to location by semi-trucks and moved on location into position by bull dozers. The "spuding" of the well (commencement of the drilling process) usually begins within 12-24 hours of the drilling rig moving on location.

The engineering design of the well includes several stages of drilling a hole and then inserting steel pipe ("casing") into the hole.

The cementing process involves the hiring of a third party subcontractor who transports dry bulk cement to the well site. The dry cement is mixed with water creating a slurry. The cement slurry is pumped down the middle of the casing and circulated out the bottom of the casing and back up hole in the annulus between the hole and casing. The cement slurry is pumped with water and a rubber plug which is placed at the end of the cementing procedure. The plug sets securely on the bottom of the casing so as to prevent the cement from flowing back into the casing. It can take up to 4 days to complete the drilling of the surface hole and cementing of surface casing. Once the cement is placed into the wellbore, drilling operations cease for at least 12 hours in order for the cement to cure (harden).

The drill pipe is inserted back into the hole and a 7 7/8 inch hole is drilled until reaching total depth ("TD") of the well. The geologist will evaluate rock cuttings and will monitor hydrocarbon detection equipment. A description of all the above is often recorded on a "mud log", which is a graphical presentation of rock type, penetration rate of the well, and analysis of any oil and/or gas detected in the wellbore.

When the well has reached TD, the hole is loaded with fluid, circulation is established, and the drill pipe is removed from the hole. A third party subcontractor is hired to lower instruments on a wireline into the wellbore to take various readings. This process is called "logging the well". The logging tools determine physical parameters of the individual rock formations including the actual depth, porosity, and likelihood that the interval contains oil and/or natural gas. Once this information is acquired, the decision will be made to either plug the well or "complete" the well and place it into production. The completion phase of operations is the time from when the drilling is finished and the well is prepared to be placed into production. There is no guarantee that if the well is completed and placed into production that it will be an economical producer of hydrocarbons.

Once the decision is made to proceed with the completion of the well, usually 4 1/2 inch production casing is lowered into the hole and cemented in place with at least 500 feet of cement above the point where oil and gas is thought to be present. Once the production casing is cemented in place, the drilling operations are finished.

Completion of Wells

After the well has been drilled and production casing cemented in place, the well is ready to be "completed". Completion of the well refers to the procedures that occur in order to place the well into production. The completion phase is restricted to day light hours. The process starts with the studying of the information gained from the drilling and logging of the well. Based upon interpretation of that information, an engineering plan is devised on how to proceed with the completion of the well.

The first phase of completion involves the moving in of a service rig. This rig is smaller than the drilling rig. It is used to raise and lower pipe and casing in and out of the hole. Once the service rig is set up, a third party subcontractor is hired to obtain a cement bond log and to perforate the well. A cement bond log is an acoustic measurement that is used to determine if the cement around the 4 1/2 inch production casing is properly in place. Once the cement quality is evaluated, the well is perforated at the exact depths where the oil and gas is expected to be found. The perforating tools are lowered by wireline into the well and placed at the exact depth of the anticipated oil and gas. The perforating gun is fired sending 3-4 inch long bullet-like charges through the steel casing and into the formation thought to contain crude oil and/or natural gas. The penetration distance of the perforations into the formation is between 12 - 24 inches. This procedure communicates the wellbore with a specific interval in which oil and gas is expected to be produced. Logging and perforating usually takes 1 day.

Once the well is perforated, the next procedure can be for the well to be “fraced”. The procedure is designed to create a vertical crack in the rock and the sand fills the crack thus providing an avenue for migration of the oil and gas to the wellbore. Acidizing a well is another method of stimulating the formation to enable oil and gas to flow.

Once tubing is run into the well, the construction of the surface production facilities begins. The production facilities needed to produce a well include a separator, oil and salt water holding tanks, and a natural gas measurement meter. The location of the tank batteries and separator must be a specified distance from the well and also must have a dike surrounding the facilities. The tank batteries generally consist of 1 or 2 tanks to hold the oil and a smaller tank to hold formation salt water. The tanks will be various sizes depending upon the amount of oil and/or saltwater that is anticipated to be produced from the well.

The separator differentiates wellbore fluids from natural gas. The natural gas is metered and placed into a sales line, which delivers the natural gas to the utility’s pipeline. Natural gas is metered at the well and by a meter where the gas enters the pipeline. Natural gas is sold by “Mcf” which is an abbreviation for thousand cubic feet. The metering of natural gas involves a process whereby pressure is recorded as the gas flows through a specific size diameter orifice in the gas line. Based upon this information, a calculation of the amount of natural gas that is sold can be made.

The wellbore fluids may consist of both formation salt water (brine) and crude oil. The fluids are stored in a tank. Because of the density differences between oil and brine, the oil floats on top of brine. The bottom of the tank is drained to a separate tank thus removing the saltwater from the oil. Crude oil is sold by the barrel with 1 barrel containing 42 gallons.

Operation of Wells

Natural gas and crude oil wells are “tended” by a well pumper. The pumper visits the well on a regular basis to ensure that it is producing at its maximum efficiency and to make sure that the well meets regulatory standards. The pumper monitors and records pressures, fluid levels in tank batteries, inspects equipment to be sure all is functioning properly and checks the gas measuring device to be sure that it is functioning properly. The pumper is also responsible for the physical presence of the well and will paint, mow, and trim weeds as necessary.

Glossary of Terms

“Acidizing” means a well completion technique wherein acid is pumped under pressure into an oil and gas reservoir.

“Ad Valorem Tax” means a form of production tax charged usually by counties based on an evaluation of oil and gas as real property.

“Bottom Hole Pressure” (“BHP”) means the actual pressure at the bottom of a well determined by lowering in a well a bottom hole pressure gauge on a cable.

“Developmental Oil and Gas Well” or “Developmental Wells” means a natural gas or oil well drilled in a previously discovered formation known or believed to be productive.

“Directional Drilling” means intentionally drilling a deviated hole for the purpose of encountering an oil and gas reservoir some predetermined horizontal distance from the surface well site.

“Disposal Well” means a well either drilled or converted for the purpose of disposing salt water.

“Division Order” means the document provided by a purchaser defining to whom income from oil or gas sales is to be paid and setting out the terms of purchase.

“Drilling Rig” means either rotary or cable tool equipment used to drill wells.

“Dry Hole” means a well that cannot produce economical amount of oil and gas and must be plugged and abandoned.

“Electric Logs” (“E-logs”) means any of the tools that are lowered into a well on a cable that are used to make various evaluations of a reservoir or well.

“Exploratory Well” means a well drilled either in search of a new and as yet undiscovered pool of oil or gas, or with the hope of greatly expanding the limits of a pool already partly developed.

“Farmout and Farmin” refers to the practice of giving or getting interest in oil and gas leases.

“Flow Line” means a small pipeline that transports gas to a gas processing unit and on to a gas meter or, in the case of oil, the pipeline that transports oil to a separator and on to a tank battery.

“Gas Meter” means a device used to measure volumes of natural gas.

“Hydrofracturing” (“fracing”) means a well completion technique wherein treated water and fine sand are pumped under high pressure into an oil and gas reservoir until the rocks actually fracture.

“Initial Production” (“IP”) means the rate of oil or gas production when a well is first put into production.

“Intangible Drilling and Development Costs” or “IDCs” shall mean expenditures made with respect to any well including, but not limited to, wages, fuel, repairs, hauling, supplies and

other costs and expenses incident to and necessary for the drilling of such well and the preparation thereof for the production of oil and gas which are currently deductible pursuant to the IRC, including the expense of plugging and abandoning any well, but not including equipment or other tangible drilling costs.

“Landowner’s Royalty Interest” means the ownership right in the oil and gas production, or the proceeds therefrom, to be received free and clear of all costs of development, operation or maintenance, reserved by the owner of the oil and gas rights.

“Lease” means an agreement with an owner of oil and gas rights authorizing the lessee thereof to explore for and produce oil and gas.

“Leased Premises” means the area of land covered by an oil and gas lease.

“Lessee” means the person or entity that acquires an oil and gas lease.

“Lessor” means the owner of the land or mineral rights that grants an oil and gas lease.

“Lifting Cost” means the amount of money it requires to produce a barrel of oil and an mcf of gas.

“Location” means a well site.

“Mcf” means one cubic foot of gas measured under standard conditions.

“Net Revenue Interest” (“Income Interest”) means the percentage of interest upon which a well owner shares in the income of the sale of oil and gas.

“Oil and Gas Traps” means conditions in rock formations that preclude oil and gas from upward migrating and hold or trap them in a reservoir.

“Overriding Royalty Interest” means an ownership right in the oil and gas produced, or the proceeds from the sale thereof, to be received free and clear of all costs of development, operation or maintenance.

“Permeability” means that characteristic in rocks that allows the passage of fluid.

“Porosity” means pores or tiny open spaces in rocks that can hold oil, gas or water.

“Primary Term” means the initial term or length of time an oil and gas lease remains in effect providing all other terms and conditions of the lease are fulfilled.

“Production Casing”, is a casing run just above or through a reservoir through which a well is produced.

“Recoverable Reserves” means the amount of total production that can be produced from an oil and gas reservoir.

“Reservoir” means porous rocks that contain oil and/or gas.

“Rig Hand”, “Roughneck” or “Roustabout” means a laborer on an oil and gas rig.

“Rock Hound” or “Rock Buster” are slang terms for a geologist.

“Seismic Survey” is the method of mapping rock structures by creating energy at the surface and detecting the energy reflected back to the surface from rock formations.

“Severance Tax” is an oil and gas production tax usually charged by the state and due when the production is removed (severed) from the ground.

“Service Rig” means a small rig that is used to complete, service or rework wells.

“Shooting a Well” means the process of stimulating the production potential of a well by shooting or nitroglycerin in the bore hole next to the reservoir.

“Shut-in” (“SI”) is the term to describe that a well’s valves are closed rendering the well incapable of producing.

“Shut-in Casing Pressure” (“SICP”) is recorded casing pressure when a well is shut-in.

“Surface Casing” means the large casing run from the surface through unconsolidated surface material.

“Tangible Drilling and Completion Costs” or “TDCs” means all costs of equipment, parts and items of hardware used in drilling and completing a well, and those items necessary to deliver acceptable oil and gas production to purchasers to the extent installed downstream from the wellhead of any well and related costs which are required to be capitalized pursuant to applicable provisions of the Internal Revenue Code.

“Tank Battery” means one or more oil storage tanks, usually 100 or 300-barrel capacity.

“Total Depth” (“TD”) means the deepest depth reached in the drilling of a well.

“Turnkey” is a drilling term where the drilling contractor or operator drills and completes a well for a given price and assumes all risks.

“Wellhead” means the mechanical equipment used on a producing well installed on the casing to control and regulate production.

“Wellhead Price” is the current price paid by a purchaser for crude and/or natural gas.

“Work Over” is a term used to describe moving a service rig onto a producing well for the purpose of repairing or reconditioning a well.

“Working Interest” means an ownership interest in an oil and gas lease giving the owner certain rights which may include the right to develop and receive oil and/or gas produced from a well and/or the revenues from the sales thereof after the costs of development, production, operation and marketing and subject to the rights and interests of the holders of the Landowner’s and Overriding Royalty Interests.