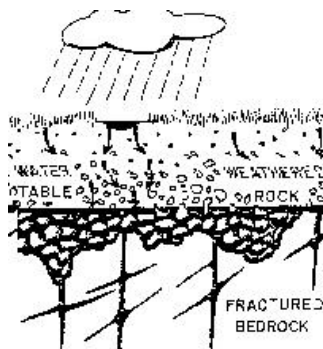


Delaware Geological Survey

Domestic Water Well Construction

By John H. Talley

BACKGROUND



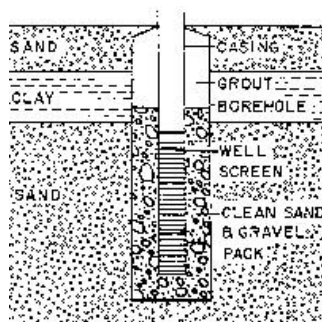
The storage and movement of ground water depends on the types of rocks and associated interconnected spaces in which the water occurs. The Piedmont Province in northernmost Delaware is underlain by crystalline rocks. Because of the massiveness and hardness of such rocks, they yield little or no interstitial water to wells. Water is stored in and moves through fractures, cracks, and solution cavities. The amount of water available depends on the number and size of openings, and the degree to which they are interconnected. Wells drilled in the Piedmont range from 100 to 400 feet in depth and yields are highly variable over very short distances.

In the Coastal Plain, the rest of the State, ground water is stored and transmitted in spaces between adjacent rock particles. As much as 30 percent of the rock mass may be saturated.

Unconsolidated rocks are analogous to a bathtub filled with sand into which water is poured. The Coastal Plain consists of sandy water-bearing units referred to as aquifers interlayered between non-water-bearing units. Wells constructed for domestic use range in depth from 15 feet to 500 feet. Yields are generally much greater than those obtained from the crystalline rocks of the Piedmont. In general, minimum well yields of 3 to 5 gallons per minute are adequate for most domestic water supply systems.



WELL DESIGN



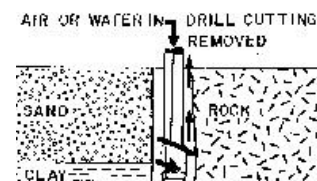
The design of wells depends on local geology and hydrology. Nevertheless, the components of most wells are very similar and include: (1) the bore hole; (2) the well casing; (3) the well screen (except in rock and other open hole wells); (4) sand/gravel pack around the screen (except in rock and other open hole wells); and (5) grout around the casing.

WELL CONSTRUCTION METHODS

Methods used in Delaware to construct domestic wells range from relatively simple ones, such as driving a pipe into the ground, to high speed drilling with sophisticated equipment. The most common wells are drilled, driven, jetted, and bored. The most suitable method depends on: (1) the type of rock being penetrated; (2) well diameter; (3) anticipated depth; (4) yield required; (5) sanitary protection; (6) intended use; and (7) cost. The method may also depend on the type of equipment available to local drillers.

Drilled Wells

Mud Rotary - In the mud or hydraulic rotary method, drilling proceeds by rotating drill pipe with a bit on the end of the pipe. As the bit and pipe are lowered in the hole, the bit cuts and breaks the rock. Rock materials are removed from the hole by a fluid (mud) which is pumped through the drill pipe and out through the bit. The drilling mud picks up the rock material and flows upward through the hole carrying

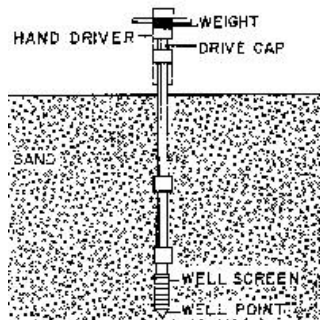


rock cuttings to the surface. After the mud comes to land surface it flows into a mud pit where the cuttings settle to the bottom. The clean mud is then recirculated through the drill pipe. The casing and screen are not introduced into the hole until drilling has been completed. This is the most commonly used method in unconsolidated formations found in the Coastal Plain.

Air Rotary - This method is similar to mud rotary except that air is used instead of mud. Cuttings are carried to the surface in the space between the drill pipe and wall of the bore hole by compressed air. Drilling commences by penetrating through soil, weathered rock, into several feet of hard rock. Steel casing with a drive shoe is then placed in the hole and driven into hard rock to form a seal, thereby preventing undesirable materials from entering the hole. After the casing has been installed, the drill pipe and rotary bit are lowered through the casing and drilling resumes. This method is usually restricted to areas underlain by crystalline rocks, such as the Piedmont in northern Delaware.

Down-the-Hole Hammer - This is a version of the air rotary method. The method of casing emplacement is the same as that used in air rotary. Down-the-hole-hammer utilizes a drill bit which is attached to a pneumatically operated device similar to a jack-hammer. The hammer action of the bit breaks the rock into small fragments which are removed by the air used to operate the hammer. The hole is continuously cleaned and a small amount of water is used to control dust and cool the bit. As with air rotary, this method is most commonly used in areas underlain by hard, crystalline rock (Piedmont).

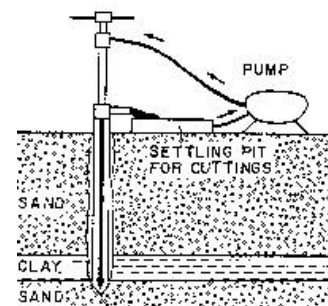
Driven Wells



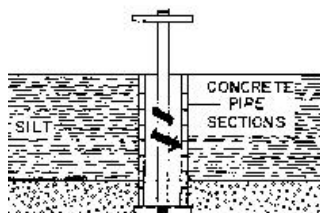
The well is constructed by driving a pipe, either manually or by machine, at the end of which there is a drive point and screen. Installation is limited to loose silt, sand, and fine gravel. Driven wells, commonly referred to as drive points, are usually less than 50 feet deep, very small in diameter (less than 2 inches), and yield comparatively small quantities of water.

Jetted Wells

A jetted well is constructed by using high-velocity streams of water pumped through drill pipe having a "jetting" nozzle, bit, or chisel attached to the bottom section. As the pipe is lifted and dropped, the bit loosens or breaks the rocks. The material cut or washed from the hole is carried to the surface in the annular space around the drill pipe. As with the mud rotary method, cuttings are removed in a pit by gravity settling and the fluid is recirculated through the drill pipe. Well casing is usually installed as drilling proceeds. This method is most efficient in loose sand, silt, and fine gravel. Wells may be drilled to several hundred feet. Screens are usually installed in jetted wells by the pull-back method: the casing is placed to the full depth of the well, the well screen is lowered inside the casing, and the casing is pulled back (up) to expose the screen to the aquifer.



Bored Wells



"Bored" refers to the method in which earth materials are cut and removed from the hole with an auger or bucket auger. This method is usually restricted to water-poor areas where sufficient quantities of water cannot be obtained from other types of wells. Wells are usually less than 25 feet deep and are typically cased with 24 inch diameter concrete rings. The annular space between the concrete rings and the bore hole is grouted with cement or concrete. Water enters the well through the open bottom of the well. These large diameter borings function not only as wells, but also

as storage reser-voirs. Because they are usually finished several feet into the water table, the quantity of water available may vary depending upon the position of the water table which fluctuates throughout the year.

SELECTING A WATER WELL CONTRACTOR

The responsibility for constructing water wells rests principally with water well contractors licensed to practice in the State of Delaware. Prior to constructing a water well, a permit must be obtained from the Water Supply Branch of the Department of Natural Resources and Environmental Control (DNREC). Permits are available to licensed Water Well Contractors and to those who desire to construct their own domestic or agricultural well on their own land or land leased to them for their own use.

The construction of water wells is normally a job for professionals. In addition to being able to construct wells, the licensed contractor must be thoroughly familiar with State "Regulations Governing the Construction of Water Wells." A list of licensed water well contractors is available from the Delaware Geological Survey (University of Delaware, Newark, Delaware 19716) and from the Water Supply Branch of DNREC (P. O. Box 1401, Dover, Delaware 19903). The Delaware Geological Survey also conducts exploration and research of the water resources of the State and presents its findings in reports and maps. Questions pertaining to wells and water resources can be addressed to the Delaware Geological Survey.

COSTS OF A WATER WELL

Costs of water wells vary and depend upon: (1) rock type, (2) well depth, (3) well diameter, (4) site accessibility, (5) distance to job site, and (6) types of materials used. In many areas of Delaware, water well contractors can provide a very close estimate of well depth, water yield, and water quality. However, in other areas, it can be very difficult to predict how deep a well will be and the amount of water it will yield because of the complexity of subsurface geology. In addition, costs may vary for a particular location based on the type of well to be constructed. The consumer will have to evaluate the type of well required based not only on cost, but also on desired quantity and quality of water, dependability of supply, and susceptibility to contamination by undesirable fluids.

Some contractors quote price estimates based on cost per foot of drilling. Others provide an itemized breakdown which includes drilling per foot, casing per foot, grouting, and costs of other materials.

WELL COMPLETION REPORTS

Following well construction, the water well contractor is required to submit a Well Completion Report to DNREC within 30 days of completion of the well. This report contains well construction details such as depth, diameter, water level, and well yield. The owner of the well should obtain a copy of the report for future reference.

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