Delaware Geological Survey

Domestic Water Systems

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Introduction

Thousands of homeowners in Delaware currently rely on individual wells and water systems to provide water. In addition, hundreds of new wells and systems are constructed each year to provide water for those not served by public water systems. Methods used to construct water wells in Delaware are discussed in DGS Information Series No. 2 (Domestic Water Well Construction). Domestic water systems are described herein.

Proper water system selection and design are essential to ensure that the water requirements of the user are met with respect to reliability, reserve capacity, system cost, and operating efficiency. The primary requirements of all systems are: (1) to produce an adequate supply, (2) to deliver water at required pressures, and (3) to yield water quality meeting public health standards. In addition, a system is not ready for use until it has been disinfected following the procedures described in "Regulations Governing the Construction of Water Wells" (Delaware Department of Natural Resources and Environmental Control).

SYSTEM COMPONENTS

A domestic water system consists of a pump, a storage tank, distribution lines, and other devices, such as pressure gages and electrical switches, which allow the system to operate automatically.

SYSTEM OPERATION

Water is pumped under pressure from the well to a storage tank. The tank contains water and air. As the tank fills with water, the air over the water becomes compressed. Water continues to enter the tank until a predetermined pressure is reached, generally between 40 and 60 psi (pounds per square inch) at which time a pressure switch opens the electrical circuit to the pump motor and the pump stops.

When a valve (spigot, shower, etc.) is opened, pressurized air in the upper part of the storage tank forces the water to flow out of the tank and into the distribution system. Water will continue to flow from the tank, without the use of the pump, until the pressure drops to a predetermined setting, usually 20 to 40 psi. At this point, a pressure switch closes the electrical circuit and starts another pumping cycle. Proper design ensures that the system functions efficiently and effectively.

PUMPS

The primary types of pumps used in private water systems include: (1) submersible, (2) shallow well jet, and (3) deep well jet. The selection of a pump depends on many factors including: (1) well diameter, (2) well yield, (3) water levels in the well,(4) peak flow rate (gallons per minute) required in the home, (5) the vertical distance (total operating head) in feet that the water must be pumped, (6) pump reliability, and (7) availability of parts and repair service.

Submersible pumps are commonly used in wells with 4" or larger diameters and where the pumping water level is greater than 25 feet below land surface. The entire pump is submerged in the well. Such pumps are cooled by well water passing by the motor casing and into the pump intake. Water enters the pump through an intake screen between the motor and the pump assembly, passes through the impellers and diffusers, and is pumped to the surface. Some advantages of submersible pumps are: (1) the motor is easily cooled, (2) surface noise is eliminated, (3) high system efficiency occurs as all water pumped from the well is delivered to service outlets, (4) the pump can be mounted in casings that are not entirely straight, and (5) a variety of such pumps is available to meet a wide range of pumping water levels and pumping capacities. Disadvantages include: (1) problems are generally electrical in nature and often require removal from the well for repair, (2) susceptibility to damage from sand and other rock particles in the water being pumped from the well, and (3) susceptibility to damage from fluctuations in voltage.

Jet pumps are classified as "shallow well" and "deep well" pumps. Both shallow and deep well jet pumps are a combination of a centrifugal pump and a jet (ejector) or nozzle venturi arrangement. The centrifugal pump provides the "drive water" necessary to operate the system. The jet consists of pipe, a nozzle, and a venturi tube or throat. The pump forces some water through the nozzle and venturi tube, and the rest of the water to the water storage or distribution system.

In shallow well jet pumps all working components (motor, centrifugal pump and ejector) are mounted in or attached to the pump housing entirely above ground. Water is lifted out of the well through a suction line (a separate pipe placed in the well casing or the casing itself) which is connected to the pump and extends to below the water level in the well. For all practical purposes the normal limit of suction lift is 25 feet; such pumps will not operate when the head (difference in elevation between the pump and water in the well) is greater than approximately 25 feet.

In deep well jet pumps the ejector system is submerged down in the well. A centrifugal pump at the surface pumps "drive water" down to the ejector assembly creating suction which picks up additional water and forces it to the surface. Because deep well pumps force water to the surface from the nozzle venturi, they are not restricted by suction lift limitations (25 feet) as are shallow well jet pumps. Several different ejectors are available for deep well jets. The design used depends upon the distance to the water, well capacity, and pressure required at the surface.

The advantages of jet pumps are: (1) the design is fairly simple and maintenance and operating costs are generally low, (2) they operate relatively quietly, (3) the submerged ejector has no moving parts; all moving parts are accessible at the surface, (4) pumping action is smooth and uniform, (5) they can be used in small diameter wells, and (6) pumps can be located away from the wells. Disadvantages include: (1) practical lift, in feet, for shallow and deep jets is 22 feet and 85 feet, respectively, (2) repair of the jet or foot valve in deep well jets requires removal from the well, and (3) pumps are easily damaged by water containing sand or rock particles.

STORAGE TANKS

Pressurized storage tanks are integral parts of water systems. Their function is to: (1) enhance the life of the pump by reducing the number of times the pump cycles on and off, (2) provide water under pressure for distribution throughout the system, and (3) provide additional water storage. A typical pressure tank has a total volume of about 40 gallons with total usable storage of about 10 gallons. Tank sizes may be larger or smaller depending upon water requirements.

There are three basic types of pressure (hydropneumatic) tanks in use today and all three function the same way. The diaphragm or bladder tank is the most common type. It is precharged at the factory. However, the installer can change the pressure to meet system design. The air is kept separate from the water with a flexible separator, usually made of rubber. The diaphragm or bladder prevents air from being dissolved in the water of the pressure tank. Without maintaining a physical barrier between air and water, air in the tank can dissolve in the water resulting in a condition referred to as "water logging." When this condition occurs, no air is left in the tank to provide pressure and usable storage is reduced to zero.

Another type of tank used is a plain steel tank with a floating wafer to reduce the contact of air with water. The wafer rides on the surface of the water; however, because it doesn't completely separate air and water, periodic recharging with air is necessary.

Plain steel storage tanks can also be used. Because such tanks have no barrier separating the air from the water, an air volume control is provided for periodic recharging.

SELECTING A CONTRACTOR

The design and construction of domestic water systems is normally a job for professionals. In addition to being able to design and install such systems, licensed contractors must be thoroughly familiar with the State "Regulations Governing the Construction of Water Wells," local and county plumbing codes, and State Division of Public Health regulations. In most cases, the licensed water well contractor is also qualified to design and install water systems. In other cases, licensed pump installers and plumbing contractors design, install, and disinfect systems.

COSTS OF A WATER SYSTEM

Costs of water systems vary widely and depend on: (1) well diameter and depth, (2) pumping water level and well yield, (3) types of materials used, (4) storage requirements, (5) and peak water demand required in the home.

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