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# ENVIRONMENTAL Fact Sheet

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## Well Development by Hydro-fracturing

Hydro-fracturing, commonly referred to as hydro-fracking, is a well development process that involves injecting water under high pressure into a bedrock formation via the well. This process is intended to flush and remove fine particles and rock fragments from existing bedrock fractures and/or increase the size and extent of existing fractures, resulting in an increased flow of water, and a larger network of water bearing fractures supplying water to the well.

The procedure is often used to increase well yields of new deep drilled wells with marginal or inadequate production rates. It may also be applied to older existing wells that have progressively diminished recovery rates over time, which is usually caused by mineralization and incrustation of rock fractures.

### **History**

Hydro-fracturing was originally developed in the oil fields to increase production volumes and is a relative newcomer to the drinking water well industry. It is now the method preferred by most contractors for developing bedrock wells because it is a controlled process. Older methods included blasting with dynamite and, more recently, the application of dry ice to a capped well. These methods were somewhat uncontrolled and sometimes resulted in well failure.

The use of dynamite frequently caused wells to collapse from the force of the blast, rendering the well useless. The use of dry ice was common only a few years ago and was a much less violent approach to applying high pressure to the bedrock formation. The resulting phase change of water to ice from melting of solid carbon dioxide (CO<sub>2</sub>) to gaseous CO<sub>2</sub> resulted in a 5 percent increase in volume of the water/ice and an increase in the volume of CO<sub>2</sub> gas. The well was capped immediately after the introduction of dry ice into the well. The CO<sub>2</sub> gas was trapped in the well as it expanded, resulting in a significant increase in pressure. The pressure generated theoretically had the same effect on bedrock fractures as the hydro-fracturing process does today.

Unfortunately, in some wells the increased pressure on the well casing forced the casing in the upward direction causing the drive shoe seal to lift, consequently breaking the seal and allowing surface water, or near-surface groundwater, to enter the well. In one reported instance the well casing actually shot out of the ground into the air. The hydro-fracturing process eliminates this problem by controlling the pressure with packers below the well casing.

### **The Hydro-fracturing Process**

The procedure involves the installation of an inflatable or mechanical packer that is placed in the

well bore at least 40 feet below the well casing and drive shoe seal, and at least 60 feet below the ground surface to ensure that the process does not “break” the seal or allow surface water contaminants to enter the well. The packer is inflated or locked into position and water is pumped through the packer under pressure. Most applications require between 500 and 2,000 pounds per square inch (psi) pressure and in some cases 3,000 psi pressure may be needed in tight rock formations.

If successful, pressure will steadily rise to a maximum level as the rock formation resists flow, then pressure will suddenly drop off and stabilize at a lower level. The drop in pressure indicates that the formation is accepting water and the resistance to flow is diminished. Water is then pumped into the formation for 5 to 30 minutes. Injection pump delivery rates of 50 to 75 gallons per minute (gpm) have proven successful. Generally, 1,500 to 2,000 gallons of water or more are pumped into the bedrock formation.

It is extremely important that only potable water, or clear disinfected water, is used for injection water because of the high pressures involved and potential for forcing contaminants deep into the bedrock fractures.

One or two packers may be used for hydro-fracturing. When utilizing one packer, the packer is set near the top of the well but at a safe distance below the drive shoe seal. After the initial pressurization sequence, the packer is released and lowered further into the hole, and the process is repeated as many times as necessary. Commonly, two pressure sequences are performed.

Zone isolation hydro-fracturing uses a two-packer system where the packers are placed in series and water is pumped into the isolated zone between the packers. This system can be more effective because it concentrates hydraulic pressure within a small area, typically 30- to 60-foot intervals, and individual fractures can be isolated and hydraulically developed. With this method, approximately eight zones are isolated within the well starting within a specified section of the well targeted by the water well contractor. Each successive pressure sequence stresses one interval higher than the last. In this way, all potential water bearing fractures, or fracture zones, are worked independently within the section of the well bore being developed. This differs from, the single-packer, one- or two-sequence method, which probably only affects the weakest, least resistant point(s) in the well.

The single-packer method is generally used for private wells serving individual households and commonly produces adequate results. Zone isolation hydro-fracturing is a much more expensive and time consuming procedure, and is generally used only on very difficult wells or public supply wells where a larger flow of water is desired.

### **Yield Testing**

Well yield increases, if successful, are generally modest but may constitute a significant increase if the original well yield was very low. Occasionally, large increases in well recovery rates are realized.

A typical well yield after hydro-fracturing is 0.5 to 5 gpm. Water well contractors report a high success rate. However, in some instances due to geologic conditions hydro-fracturing will not increase well yield. If initial pressure continues to build and reaches the operator's maximum equipment capacity, the formation will not accept water and the procedure may not be successful.

Many water well contractors do not include yield testing as part of their hydro-fracturing contract because injection water volumes are large enough that it may require an extended period of time to allow the bedrock aquifer to reach equilibrium. If the yield test is conducted immediately after the well is hydro-fractured, the amount of water injected into the bedrock formation must be a consideration to avoid an over-estimation of the increased well yield.

### **Development by Surging**

Surging is another, less common method used for developing well yields in bedrock wells. This development method uses a cable tool drill machine. Cable tool machines were commonly used for drilling water wells up until the 1960s, when rotary drill machines replaced them. The cable tool method of drilling employs the principal of free falling weight to deliver rhythmic blows against the bottom of a drill hole. A drill bit is attached at the bottom of a string of tools, which is suspended by a cable and systematically raised and dropped within the well. When used for well development, the drill operator surges the well using the same method of raising and dropping the drill string, either with the standard drill bit, or by attaching a surge block in place of the bit. The rhythmic action of the drill string pushes water into bedrock fractures and then pulls water out of the fractures. This surging action flushes and removes fine particles and rock fragments from existing bedrock fractures, resulting in an increased flow of water to the well.

### **Contractors Must Be Licensed**

Only licensed water well contractors are authorized to hydro-fracture wells in New Hampshire. If you are thinking about having your well hydro-fractured, it is generally advisable to first consult with several water well contractors. These professionals will help you evaluate your water supply needs and the probability of success in your geographic area to help you determine whether hydro-fracturing is a viable choice for your well. The equipment capabilities of different contractors and the types of contracts offered are other considerations.

### **For Additional Information**

For further information about well development you may call the Water Well Board at (603) 271-1974 or the DES Drinking Water and Groundwater Bureau at (603) 271-2513. Visit their websites located at <http://des.nh.gov/organization/divisions/water/dwgb/wwb/index.htm> and <http://des.nh.gov/organization/divisions/water/dwgb/index.htm>, respectively.

Note: This fact sheet is accurate as of August 2010. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.