ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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WD-DWGB-1-5 2010

Residential Spring Well Design

The definition of a "spring" varies widely. Most authorities would describe a spring as a dug well in which the static (non-pumped) water level rises above the top of the surrounding ground level. For this reason many spring features are similar to those for dug wells. For a discussion of dug well construction, see "DWGB-1-4 Dug Well Design." For information concerning the proper abandonment of springs, see fact sheet "DWGB-1-7 Well Abandonment and Decommissioning." It is not normally possible to stop the water flow from springs.

GOVERNMENT REGULATIONS

State Regulations: A person or firm in the business of constructing any type of well must be licensed by the New Hampshire Water Well Board. The board requires the submission of a well completion report describing the spring's design, construction, soil conditions encountered and yield.

There are **statewide** design criteria rules for all well **construction** and **placement**. These rules (We 602.05 and 07), which apply to springs, were originally adopted by the board in 1983 and subsequently revised. There are no state requirements concerning minimum water **quality** or **quantity** from springs.

Finally **RSA 477:4-c** requires, when selling a home with an on-site water system, disclosure of the water system's location, malfunctions, date of installation, date of the most recent water test and whether the seller has experienced a problem such as an unsatisfactory water test.

Local Regulations: Some towns may have permit requirements relative to the placement, construction, water quantity or quality for springs. Contact your local health officer or code enforcement program for information.

EVALUATING A NEW WATER SYSTEM

There are several items to consider when planning a water system. These are described below.

Determining How Much Water You Use

A typical household requires approximately 5 gallons per minute (gpm) to meet modest domestic water needs. Factors to be considered when determining a family's demand on a water system include the number of water uses, their flow rates, how many of these uses could occur simultaneously, and for what duration.

Determining How Much Source Yield You Need

What minimum spring yield will satisfy a family's water needs is more difficult to determine. As little as 1-3 gpm of well yield could be tolerated if there is adequate water system storage. A low-yield spring (i.e., 1-3 gpm) may be acceptable if one makes use of water stored in the spring casing above the outlet pipe to the home or in large basement storage tank(s). This storage may not be available when the water table drops or the natural overflow ceases altogether in the summer or fall. Storage below the outlet within the casing may allow the use of a pump if the duration of pumping will be short. The typical 2.5-foot diameter concrete spring well tile has a storage volume of approximately 35 gallons per foot of water depth. Spring overflow capacity often varies substantially. The time to determine a spring's yield is late summer when the groundwater levels, and thus the spring's natural recharge, are at their lowest levels for the year.

Large non-pressurized storage tanks installed in the basement can serve this same function of accumulating water during periods of non-use. However, a pump will be necessary to pressurize this stored water. Taste and odor caused by stagnant water during long storage also need to be considered.

DES published a document titled "Well Yield, How Much Water is Enough?" that is available from the Public Information Center at (603) 271-2975.

Seasonal Changes in Well Yield

It should also be recognized that a spring's yield may change with time. This change can be a seasonal variation or long-term trend. A homeowner should try to develop the maximum spring capacity when the spring is first installed. Spring capacity generally can not be varied much by construction.

Spring flow can be subject to drought effects. The best time to construct a spring is in the late summer or early fall when low water tables facilitate construction. This will allow a deep spring while minimizing muddy conditions and excavation cave-in. The outlet pipe should be set as low as possible and also must be "laid to grade."

Water Quality Considerations

Spring wells experience few iron, manganese, and taste and odor conditions. Spring wells generally do not experience arsenic, fluoride and radiological problems that are seen in bedrock wells. Spring wells often experience bacteria problems caused by poor configuration, poor construction materials, vandalism, animal entry and inadequate soil filtration.

Spring Placement and Protection

Since springs can take water from the highest water level in the soil, they can be extremely sensitive to those land use activities that take place in their immediate vicinity. It should also be noted that for free flowing springs, the recharge area can be at a different location than the immediate area near the spring outlet point and also at a higher elevation. Potential spring sites located within 50 feet of surface water should not be developed unless the spring is uphill of the surface water.

Examples of chemical hazards to a spring include the application or spillage of fertilizer, pesticides, motor oil, anti-freeze, solvents, or salt brine backwash from water softeners. The use of these or other chemicals nearby or uphill may negatively affect the quality of the water in a spring.

Tests for many of these modern chemical contaminants can be costly. The best and least costly approach is prevention of pollution rather than installation of treatment after the fact. Be careful with respect to the use and disposal of chemicals near and uphill of a spring.

The following protective distances are required or recommended when choosing a location for a spring water supply for a private single family home.

a) Surface water and drainage culverts should not pass within 25 feet of a spring; 50 feet + is recommended.
b) Animals should not be penned or tied within 100 feet of a spring.
c) Leach fields and septic tanks must not be located within 75 feet of a spring; 100 feet is recommended.
d) Springs should not be developed if they are within 50 feet of the right-of-way line of roads. An even greater distance is preferred.
e) Springs must not be developed if they are within 75 feet of adjacent property boundary (see RSA 485-A:30-b). If placement is made necessary within 75 feet, a standard release form is required to be signed by the spring owner and given to DES, the town health officer, and the county registry of deeds. Since most zoning

codes require a 10-foot setback from adjoining property lines, this distance is effectively 65 feet. Visit the fact sheets webpage (listed above) and scroll to DWGB-21-4, “Best Management Practices for Well Drilling Operations.”

f) A spring should not be developed in locations subject to any flooding unless the immediate 25-feet radius of the spring is built up above the highest flood level possible.

Springs on Other Properties

Many springs are located on property adjacent to that of the user’s. At best, the user’s right to the spring is based on an easement that gives very little detail. Such easements are often deficient in the following areas.

a) Lack of restriction of hazardous activity uphill or otherwise near the spring.
b) Lack of sufficient room or approval for maintenance around the spring or connecting piping.
c) Approval or access to the spring or delivery piping.
d) Comments on the amount of water allowed to be taken.

DES recommends that these shortcomings be corrected before the spring is developed or, if the spring already exists, as soon as possible.

Choosing the Type of Well to Construct

Based on the considerations above, such as water needs, available water yield, and existing pollution, a well type can be chosen. In many cases there is relatively little choice since the choice of well types is largely influenced by the type of soil and the water availability on the property.

Contracting With a Spring Well Contractor

After determining that a spring location is viable, a contractor will need to be selected. The contractor will need guidance to govern the amount of work to be done in developing the spring. Normally, spring wells are installed on a lump sum contract basis. The nature of the contract is between the homeowner and the spring well contractor. DES suggests that the finished configuration, dimensions and elevation of the top and bottom of the spring be discussed in advanced before work begins.

CONSTRUCTION OF NEW SPRINGS

In choosing which spring location to develop, it is important to ensure that the spring has year-round flow capacity. If the spring goes dry during the summer, this location should be either bypassed or the location should be developed as a dug well with a pump. Refer to "DWGB-1-4 Dug Well Design” for information relative to addressing the seasonal overflow condition.

Excavation and Backfill

When beginning excavation, place different soil types in different piles so that they may be replaced in the same sequences as removed. Upper soil layers may be high in bacteria, organic material and readily soluble iron and manganese. If these poor quality soils are placed below the water table during backfilling, water quality problems may occur.

Try to prevent an accumulation of fine silt in the bottom of the excavation. An accumulation of silt may form an impervious layer reducing the entry of water into the completed excavation. When placing the crushed stone base and spring well casing, break up this fine sediment layer. At least 5 feet of soil backfill should cover the highest level of crushed stone, if crushed stone is used.

Depth

In dug wells, one usually excavates as deep as possible in order to have the well as resistant to drought effects as possible. In spring wells the excavation depth would be governed by the direction and origin of the upwelling water. The water service line to the home should have at least 5 feet of cover to prevent freezing in winter.

Stone Bed

A one-foot layer of 1- to 2-inch crushed stone is often used at the bottom of a spring. This allows convenient leveling of the spring well tile. Where such stone is used, place multiple layers of progressively graded pea stone (course to fine at top) above the larger crushed stone to act as a transition zone. This will prevent the backfill soil from settling into the crushed stone in the future. DES does not recommend the use of straw, tar paper or other degradable materials on top of crush stone as they may potentially cause bacteria and taste problems and also disintegrate with time. Many springs do not use crushed stone.

Pipe or Concrete Tile Sections

Pipe sections should be joined by bell-and-spigot or tongue-and-groove connections. This is critical since frost heaves or pressure from uphill soil on a sloped site will often displace tiles that are not locked into one another. If pipe sections can slide sideways, soil will fall into the spring casing. This will cause settlement of the exterior backfill soils leading eventually to direct pathways for bacteria to enter the well. Joints should be oriented with the outside tongue facing down as shown in the diagram on page 8. Water should enter the spring at the bottom of the well casing. Wire-reinforced concrete is suggested for spring well casing rings and the top cover. The joints between the top two well casings should be cement-mortared or otherwise sealed to achieve a water tight condition at the joint.

Casing Joint Sealing Material

Sealing the top two joints in concrete well casings, along with the space between the under side of the cover and the top of the casing will help to ensure that all water in the well has been filtered through soil. The material used for this seal should be appropriate for contact with potable water, meeting NSF/ANSI Standard 61. Sealing is critical at only the top few joints. Joints near the bottom of the well would not have bacteria present due to soil filtration.

Apron

To ensure against the possibility of unfiltered surface water entering the spring structure, an impervious apron of hardpan, clay or fine silt soils should be placed on the top of the mounded backfill entirely around the spring. This apron should be approximately 10 feet wide or as wide as the excavation that was made to install the spring. The apron should be at least 2 feet thick and sloped away from the well by 2 inches per foot. A greater slope should be considered if substantial settlement of the backfill is expected. Finally, the apron should be loamed and seeded to ensure a stable condition. Without sloped backfill, puddles of contaminated water will form in contact with the spring casing and potentially leak into the spring. This condition often results in bacterial contamination.

Cover

A center observation hole in the cover is not recommended. If one exists on an existing spring, it should be sealed tightly and permanently to prevent the leakage of rain water that may be contaminated with bacteria into the spring from above. If the observation hole is subsequently opened, the seal must be re-established. Acceptable substances for sealing the observation hole include cement mortar or products which meet NSF/ANSI Standard 61. The cover should overhang the well and should ideally have a rain drip on the underside to prevent contaminated rain water from running into the spring on the underside of the cover.

The cover shape shown in the diagram on page 8 is not regularly available in New Hampshire. However, DES urges concrete precasters to adopt this shape in order to solve the "underside" leakage problem. The underside of the cover may not be totally flat. It is suggested that reference marks be placed on both the cover and the casing to ensure the same alignment each time the cover is replaced. Cement mortar or sealants can then be placed on the vertical sidewall to match cover irregularities on the underside. This filler material however, tends to break off.

Another approach to minimize the space between the underside of the cover and the top of the casing is to grind or chip the top edge of the vertical casing to achieve a more precise fit with the under side of the cover. Drag a pencil along the underside of the cover so that it indicates the amount of grinding that needs to be done on the top edge of the casing. Use a rotary saw or abrasive wheel and breathing protection. DES suggests that the cover overhang the casing by at least 3 inches. This may help keep the soils next to the well casing dry which in turn may reduce the incidents of lifting of the top casing.

If there is a need for an inspection port in the cover DES recommends the fabrication of a second lightweight, easily removable shield to fit over the entire concrete cover. This shield should be lockable to prevent vandalism and could be made from welded steel, aluminum or sheet metal. Plastic sheeting will deteriorate in sunlight and thus is not recommended. This rain shield can be locked in place onto the side of the concrete cover.

Overflow Pipe

Springs typically have an enormous range in flow from the highest in the spring to the lowest in the early fall. If the outlet pipe is insufficiently sized the casing can be lifted out of position, and the excess flow will "punch out" beneath the casing at peak condition. To gauge the extreme of flow, DES recommends that the spring be observed during the snow melt season before the design and sizing of the spring construction components are determined. DES recommends that the design of the spring include all the flow capacity and that the overflow pipe have capacity to then release all water captured. If excess flow is not accommodated within the casing, it will rise out of the ground, loosening the soil and destroying the filtration that prevents bacterial occurrence.

Excess flow will have such volume as to flow continuously. As a result, excess water must have an escape pathway to exit from the interior of the spring well casing. This pipe is called an "overflow" pipe and is shown in the diagram on page 8. Key components of good overflow pipe design include.

- Resistant to vandalism.
- Have the elevation of the spring casing sufficiently high to achieve an approximate 1-foot "free fall" of the excess water from the overflow pipe to the ground.
- Have ½-inch or finer hardware wire screen at the end of the overflow pipe covered by typical household mosquito screening to prevent entry of animals or insects back into the spring.
- Place stones below the overflow spill point to prevent soil erosion.

A spring's overflow pipe is typically the cause of most bacterial contamination. Typical problems include.

- The reverse flow of contaminated surface water back into the spring.
- The use of the overflow pipe by small animals as a nesting area or walkway.

The high end of the overflow pipe is typically placed approximately 12 inches or more down from the top edge of the spring casing. The free fall discharge point should be approximately 3 or more feet away from the spring casing. The overflow pipe should slope away from the spring. Use an appropriate sized single piece of steel pipe supported at the outer end.

Water Supply Line to the Home

Provide at least 1 foot of clearance between the pipe intake and the bottom of the spring. Provide a minimum of 4 to 5 feet of cover over the water line to the home for frost protection. Before backfilling, first take field measurements and then draw an accurate sketch of the precise route of the water line from the spring to the home. Place the sketch in a water proof envelope such as a sealed plastic freezer bag and attach it to your pressure tank or inlet pipe. It is suggested that the pipe from the spring to the home be plastic. Seal this line as it passes through the foundation to reduce radon or groundwater entry into the basement. For old springs ensure that this piping is not made of lead. Where there is any doubt of the spring's year-round flow, the water service line should be installed as deep as possible at the spring and sloped continuously downhill.

AFTER CONSTRUCTION ACTIVITIES

Determining the Spring's Safe Yield

The homeowner should know the spring's safe yield. Once the spring construction is completed, a flow measurement can be performed. The safe yield of a newly completed spring can be determined (and the spring flushed) by allowing water to run continuously over a sustained period of time at both the home and any excess water discharging from the overflow pipe. Measure all flows using a 20- or 32-gallon trash can. This evaluation should be done in the late summer. If the water is initially muddy immediately after construction or reconstruction, do not run the water through the home's plumbing. For older springs, if the water is muddy at any time, inspect the spring construction immediately. A rapid change in the visual quality of the water is a clear sign that the spring construction is not safe.

Conduct at least an annual maintenance inspection of the spring. Remove leaves, repair aging materials and replace damage caused by winter weather or vandalism.

Disinfection - Chlorination

It is difficult to disinfect a spring since the upwelling water will resist penetration of the chlorine into the well. For new springs, it is most important to flush the spring of silt, mud and debris before chlorinating or testing for bacteria. The spring may have to be allowed to flow continuously for days (or weeks, in a few cases) before this cleaning process is complete. Chlorine, regardless of its concentration, is not able to reach bacteria trapped inside accumulations of mud. DES strongly advises that a bacterial test not be taken until the spring has been thoroughly flushed.

The spring can be disinfected by adding liquid chlorine. One gallon of 5.25 percent sodium hypochlorite (common household bleach) in 1,000 gallons of water will provide a good disinfecting solution of 50 parts per million (ppm). The quantity of water stored inside a spring well casing is shown below.

Volume in Wells (Gallons)

Water Depth (feet)	**Well Casing Diameter** (feet)			
	1	**2**	**3**	**4**
2.5	15	60	130	230
5	30	120	260	460
10	60	240	520	930
20	120	470	1060	1880

The volume of water inside the spring casing does not include the volume of water readily available in the crushed stone that normally surrounds the base of the spring casing. As a rough rule of thumb, DES suggests doubling the calculated volume inside the casing when determining the amount of bleach needed.

The procedure outlined below should be followed when disinfecting a spring. Add the chlorine directly to the spring. Run each faucet in the home until a chlorine smell is detectable. Close the faucets and allow the chlorine to stay in the water service pipe and the plumbing for 12 to 24 hours. If the spring is flowing, much of the chlorine will naturally wash out through the overflow pipe. After 12 to 24 hours, flush chlorine from the plumbing system. Do not flush into a septic system. Flush the chlorinated water onto the ground but not into a stream or pond. For more information on disinfection, visit the fact sheets webpage (listed above) and scroll to DWGB-4-11, "Disinfecting a Private Well."

Testing New Springs for Water Quality

After all chlorine is flushed from the spring and plumbing system, a sample can be taken for bacterial and chemical quality. Water quality samples with any chlorine residual can not be tested for bacteria or nitrate/nitrite. The presence of chlorine can be checked by using a chlorine test kit, available from swimming pool supply stores.

The DES laboratory and many private laboratories can conduct bacterial tests and tests for other contaminants in drinking water. Different containers are required for testing radon gas, industrial solvents and hydrogen sulfide odor. See the brochure “Water Quality Testing for Private Wells” at www.des.nh.gov/organization/divisions/water/dwgb/well_testing/documents/well_testing.pdf for a discussion of which water quality factors to test for in a private spring. DES recommends that a bacteria sample be taken on an annual basis for springs in view of their shallow construction and imprecise building materials.

INSPECTING EXISTING SPRINGS

When inspecting an existing spring, look for any defects or openings in the casing which will allow foreign substances or small animals to enter the spring. Also look for points where surface runoff can enter the spring casing directly from above.

Existing springs, especially those built of field-stone, are frequently subject to surface water runoff, carrying bacteria and viruses into the spring. To prevent this problem, all joints between the field stone should be mortared and the entire outside surface of the spring should be uniformly coated with cement mortar and wire mesh to provide a smooth, one-piece exterior surface. This should extend down below the ground surface to the extent that conditions permit. Where concrete or vitrified clay tile is used, the top two joints between pipe sections should be sealed if possible.

Typically in older wells, the backfill around the well casing has settled. Once structural improvements to the casing are completed the backfill should be mounded up around the outside of the spring as shown in the diagram on page 8. This backfill should be fine-grained material free of organic matter. Finally, the finished slope should be loamed and seeded to ensure a stable condition.

Wood covers are another common deficiency of older springs in that they are susceptible to rotting. In addition, rain water and debris can fall between the wood slats and into the spring. We recommend a solid one-piece concrete cover that extends beyond the well casing. To achieve reliable bacterial quality, the spring construction must exclude all dust, dirt, surface water and animals. If the spring construction is not tight or if there is not effective filtration of every drop of water entering the spring, the spring is not a safe water supply source.

The overflow pipe of most springs can be a major passageway for bacteria. Typical problems include the reverse flow of contaminated surface water back into the spring, or use of the overflow pipe as a walkway for small animals such as mice and chipmunks. This pipe must be screened and have a free fall at the end of the pipe to the ground below.

FOR MORE INFORMATION

Please contact the Drinking Water and Groundwater Bureau and the New Hampshire Water Well Board at (603) 271-2513 or dwgbinfo@des.nh.gov or visit our website at http://www.des.nh.gov/organization/divisions/water/dwgb/index.htm. All of the bureau’s fact sheets are on-line at http://www.des.nh.gov/organization/commissioner/pip/factsheets/dwgb/index.htm.

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.”

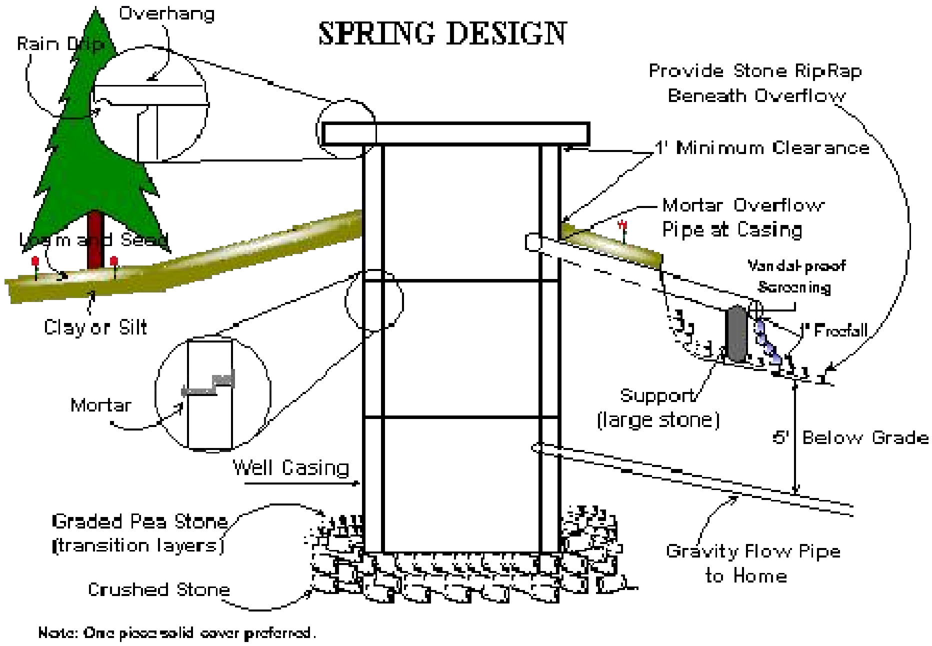

Figure 1. Spring Well Design Components.