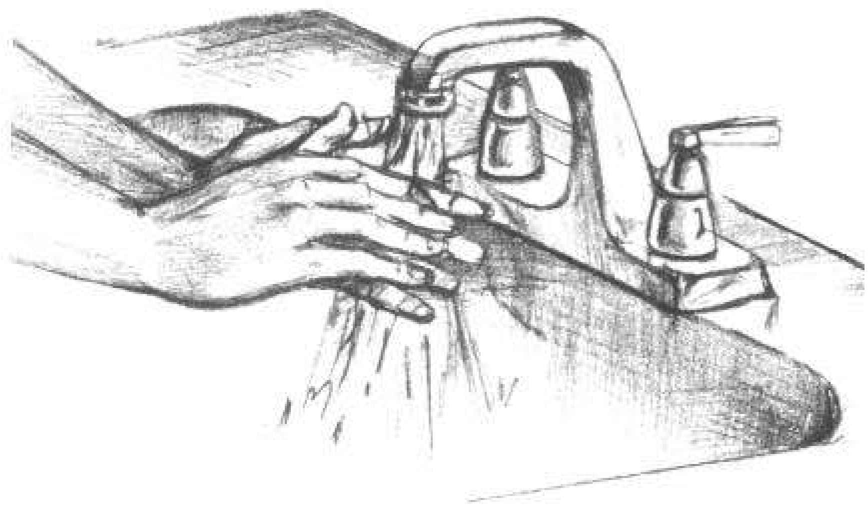
How to design and build a water system for your backwoods home

By H. Skip Thomsen



There are as many variables in the design requirements of wilderness home water systems as there are homes to design them for. Some of the circumstances determining these variables are:

- **where the water comes from**
- **the quantity of water available**
- **the quantity required**
- **how it is stored**
- **the kind of electricity that is available**
- **the amount of that electricity.**

Let's discuss each of these briefly, and then employ them in viable combinations.

Where does the water come from?

(It should be noted here that this discussion does not delve into the safety of using surface water. You must use your own discretion when selecting water sources, and if the water is to be used for domestic purposes, it should be tested first by a competent lab.)

The most common sources for water are deep wells. shallow wells, springs, creeks, and hauled water. A deep well which requires a multi-horsepower submersible pump will also require a multi-kilowatt power source. A shallow well may need only a fractional horsepower pump which can be run off an inverter. (An inverter converts 12 volt electricity stored in a battery to .110 volt electricity.)

Water can be pumped from springs and creeks in several ways, depending on their locations and the amount of water being moved. And hauled water, no matter how wonderful a system you have with which to haul it, brings with it the need for frugality. You **will** learn to conserve if you haul your water. To get hauled-in water to its points of use, you can pump the water directly from your tank-truck to storage tanks, either elevated or at ground level.

Water availability

Do you have a high- or low-production well or spring; a rationed, trucked-in supply; or an unlimited amount of water available?

If you have a well or spring which will out-produce your needs, you are indeed fortunate. Your water-storage facility will generally not need to be very big, and possibly none will be needed at all.

If your daylight-hours supply of water is smaller than your demand, but your 24-hour supply is enough or more to meet that daylight demand, you will need a storage facility that will allow the supply to catch up to the demand by slowly filling the tank 24 hours a day, thus keeping up with the loss incurred mostly in the daytime.

If you are lucky enough to have a spring on a hillside 30 feet higher than your house, you need only to run a pipe to the house. No storage, no pumps—instant pressure.

Amount of water needed

The number of gallons-per-hour or gallons-per-day your household needs will be a major factor in deciding what type of pump you will require to supply it. Will your needs be restricted to limited residential use, or will you be irrigating a small garden, or a field?

The "normally accepted" statistics show that the average American household uses 700 gallons of water per person, per day. For a family of three, that comes to about 63,000 gallons per month.

This author's family of three lived with a comfortable and dependable water system using hauled-in water for about 10 years. Total consumption rarely exceeded'1200 gallons per month. The house had all of the usual water-using conveniences: flush toilet, tub with shower (with water-saver head), fall kitchen, etc. This level of frugality required nothing more than the willing co-operation of all of the family members.

Water storage

Water can be stored in a pressure tank, a gravity-feed tank, a ground level tank, or a cistern, depending on your unique situation.

The size of the storage facility depends on a combination of factors, most notably the amount of water needed between refillings, and the amount of the refillings (as determined by pumping and/or well capacity, hauling capabilities, etc.). For example, if your water needs are about 100 gallons per day and your supply is a spring which produces at least that much, then a 100 gallon tank is the obvious choice.

Maybe that's not so obvious? Let's assume that a spring which produces 100 gallons/day is doing so at a fairly constant rate. One hundred gallons per day figures out to 4.17 gallons per hour, or 0.7 of a gallon per minute, clearly not enough of a flow-rate for even conservative household use. The reason for the 100-gallon storage tank is to allow the spring's flow to catch up with the demand.

What if it's laundry day, and you would like to do three loads of wash? Depending upon the type of machine you use, three loads of wash could easily use up a large portion of the water in a 100-gallon tank in just a couple hours. Even a small garden sprinkler uses 3 or 4 gallons per minute. At three gallons per minute, a sprinkler will drain your tank in 33 minutes. All of a sudden, that 100-gallon tank is looking pretty small.

Again, thinking in terms of 100 gallons/day usage, if you are hauling your water and your truck holds 500 gallons, a 500-gallon storage tank would moan one trip to the well every five days. Unless this poses no inconvenience, you would be better off with a 1200 or 1500-gallon storage tank. We'll get more specific on this in a later discussion.

Cisterns

Cisterns and ground-level tanks all require some sort of pumping facilities to get the water from storage to point of use. The two most basic options are either pumping the water to a smaller, elevated tank for gravity-feed to the house, or pumping directly into a pressure system. Both ways are possible even with part-time power, and each way has its advantages.

Cisterns also offer some other interesting possibilities. For the homestead located where 800-foot deep wells are the norm, and for the budget that shudders to think about multiplying that figure by the dollars-per-foot charged by your local well driller (not to mention the extravagant pump it will require to get the water out of a well of that depth), a cistern may well be the answer.

A tiny spring, a seasonal creek, a nearby watershed that carries off the snowmelt each year, or even a system that catches rainwater, can each be directed to fill a cistern. Cisterns can be constructed at or near the water source, or the water can be pumped from the source to the cistern. A cistern can be built with enough capacity to supply a household for the whole part of the year that the seasonal flow is not running. Your local library has books on the constructions of cisterns.

Availability and type of your electricity

We're assuming that you're using an alternative power system to produce your electricity. What kind of electricity do you have? Full-time 110volt AC, full-time limited 110-volt AC, part-time 110-volt AC, or 12-volt DC? Again, let's look at each.

Full-time 110 volt

"Full-time 110" is when you have a generator, or wind- or hydro-system running 24 hours a day, and your system is powerful enough to operate your highest-demand tools, appliances or pumps without having to start a bigger generator.

Full-time limited 110 volt

"Full-time limited 110" describes the system which delivers full-time 110, but is limited to the output of its inverter during those times when the generator is not running. This system would utilize a state-of-the-art, high-output inverter which draws so little power at standby that it is prudent to leave it "on" 24 hours a day. Such a system would necessarily limit pump use to the smaller 110-volt pumps in the 'round-the-clock part of the water system. Any high-horsepower : pumps in the system would be operational only when the generator was running.

Part-time 110 volt

"Part-time 110" involves a system in which everything- except major appliances, large tools, and pumps—runs off the 12-volt power supplied by a battery-bank, which is in turn recharged by a battery charger connected to a generator.

In this kind of system, the generator must be started any time 110 power is required. A modification of this system includes a low-priced, low-power (up to around 500 watts) -inverter which is used to power small 110-volt hand tools, small kitchen appliances, sewing machines, etc. As we will discuss later, these inverters are extremely inefficient.

12-volt only

Since a "part-time 110" system must rely on 12-volt power to pressurize the system, and even a "12-volt only' system must have a generator available for occasional heavy-duty jobs, the

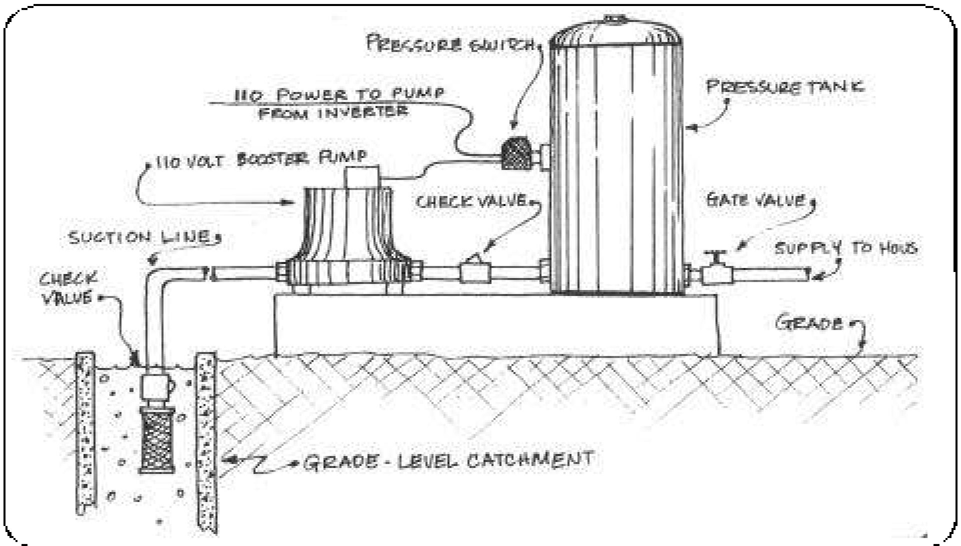


Figure 1.

above section "Part-time 110" applies here as well.

The combinations of circumstances are endless, and each combination requires different equipment.

Pumps

Regardless of which system you elect to install in your home, you will probably want to have a high water pressure capability available at least occasionally, for uses such as moving water from one storage facility to another, watering a garden, washing equipment, construction uses, and so on. The options are many, but the simplest are either a light-weight electric transfer pump which you can plug into a generator (while you are charging your batteries), or a gas-engine pump.

Gas-engine pumps come in many performance ranges. Some move thousands of gallons per hour at very low pressure, and others move very little water at extremely high pressures. You must first determine what your exact needs are, and then shop for the pump to do that job best.

A deep well which requires a multi-horsepower submersible pump will also require a several-kilowatt power source. These pumps can be made to work well on even a part-time electrical system, but you can't get around the need for ample power.

A fractional-horsepower jet-pump will usually do the job on a shallow well, and these pumps will run with power supplied by a heavy-duty inverter, making 24-hour-a-day pump operation possible with part-time use of a generator.

Pumping water from a spring can be done in several ways. Gravity-feed to a storage tank is ideal, but assumes that the tank can be placed below the level of -the spring. When this isn't feasible, an additional pump must be used. The size of this pump depends entirely on the amount of water which must be moved and the height to which it must be lifted.

Creek-supplied water must almost always be pumped uphill, and the requirements for pumps are the same as for springs.

A typical home system

So let's get down to a specific typical system. Let's say you have a homestead with full-time limited 110 power and a ground-level water-source: a creek, pond, spring, cistern or other storage tank. Remember, full-time limited 110 means 24 hour-a-day 110, but the amount of 110 is limited to the rating of the inverter whenever the generator is off- line; and the inverter is one of those hi-tech, super-efficient models.

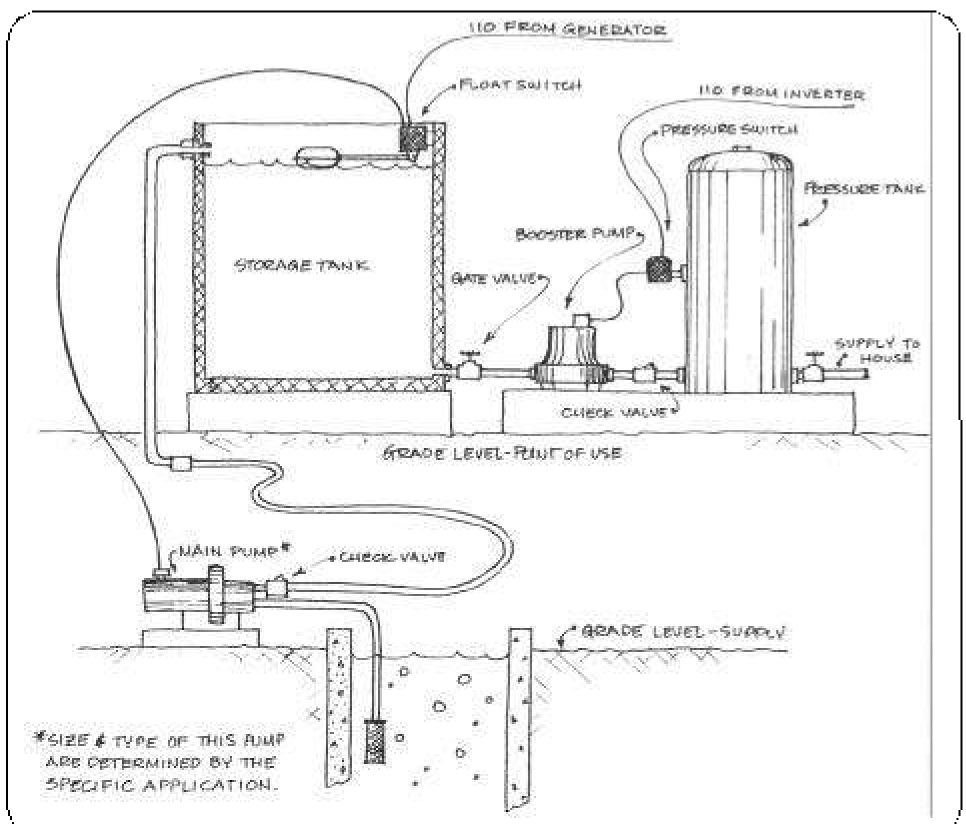


Figure 1.

If the water supply and the point of use are at the same elevation, the water can be pumped directly from the source into a conventional pressure system with a little (one that will run off an inverter) 110-volt booster pump (figure 1).

If the source is more than a foot or two lower than the point of use, the water will have to be moved by a main (larger) pump, into a storage tank at or above the level of point of use which will supply gravity-fed water to the booster pump. The booster pump then pressurizes the system.

The size of the larger pump is determined by the vertical distance the water must be moved, and the capacity of the tank is determined by the needs of the household and by how often you will want to refill the tank.

The easiest way to hook it all up is to wire the main pump directly to your generator's output, so that each time the generator comes on-line, it will automatically top off the tank as required. A float switch in the tank will shut off the pump when the tank is full (figure 2).

Please note that it is important to insure that the pump doesn't get power until the generator comes up to speed. Trying to start a motor with a generator coming on-line from a dead stop is not good for the motor or the generator.

There are automatic ways to do this, too, but the simplest is make sure that the main switch on the output of your generator is OFF while you are starting the generator, and stays off until the generator is happily running at its normal speed. A future article will Cover a circuit to do this automatically in remote-start generator systems.

A catchment of some sort will be required from which the booster pump can draw its water. The only instance in which this catchment need be bigger than just enough to draw water out of, is if the source is a spring or stream which won't keep up with the pump. And that would have to be a very small stream. More on this in a moment.

If the source is very clean running water, the catchment can be nothing more than a five-gallon plastic pail. If there is a possibility of sediment or other debris in the water supply, the catchment must have some means of filtering the water or at the very least be large enough to allow the impurities to settle out. Ordinary clean sand makes an excellent filtering medium.

Don!t run pump dry

No matter what your water source is, if there is any chance that you might be able to, pump it out faster than it can replenish itself, you must install a means to prevent pumping it dry. One of the surest ways to ruin almost any water pump is to run it dry.

Here's an easy way to prevent it. Install a gate valve on the output of the pump and carefully adjust it so that the pump moves a slightly lower volume of water per minute than the source is capable of producing.

For example, if you **know** that your well will produce six gallons per minute (GPM) in the worst of times, adjust the valve so that the pump cannot deliver more than five GPM. To determine the flow, use a five gallon bucket and time the fill.

Determining flow rate

If your water source is a well, you probably already know what its production rate is, in gallons per minute. With any other source, such as a spring or small stream, you will have to do some experimenting to determine the flow rate. Here's how.

With the suction line placed where it will normally be picking up its water, turn on the pump and carefully watch the level of water in your catchment. If the pump, is capable of drawing the level down, close the valve until the source is slightly, but positively, gaining on the pump. If your water source fluctuates seasonally (as most do), you will have to monitor the situation periodically.

If you can get by year 'round on the amount of water available in the leanest time of year, just set the pump's output valve at that rate and forget it. A gate valve is capable of very fine adjustments and is the only type of valve I recommend for this application.

Speaking of recommendations, I heartily recommend that you use only ficaptive-air" pressure tanks in your water system. These tanks contain a bladder which keeps the pressurized air separate from the water. This prevents the absorption of the air into the water over a period of time, which causes the "waterlogging" problem of ordinary tanks and the necessity of periodic recharging.

Captive-air tanks are well worth the extra price.

In the next issue of *Backwoods Home Magazine*, I'll have a discussion of some of the different types of pumps, their power requirements, and applications; and another example of a typical installation.

(Skip Thomsen is the author of *More Power to You!* which provides step-by-step instructions for building a time-tested "full-time limited 110" electrical power system. It is available, for $8.95 (plus $2 S&H) from *Backwoods Home Magazine* or from the author at Oregon Wordworks, P.O. Box D-SG, Manzanita, OR 97130.) Δ

"That's the sound
Of fall,"
My son said,
At the sound of dry leaves,
Being crushed beneath the wheels,
As we turned onto Hermosa.
Yet,
The feel of summer
Was still on the air.
He is just eight
But already learning
To mark the passage of time.

John Earl Silveira
Ojai, CA