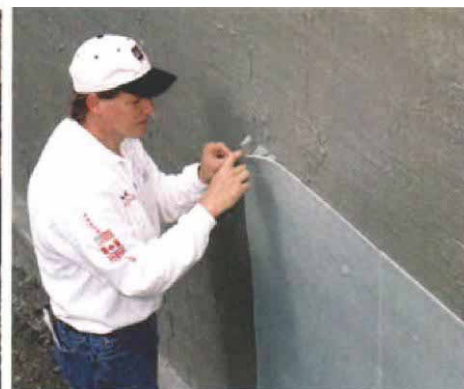


Keeping a Basement Dry

Waterproofing the foundation walls is only the first step; you also need a system of drains around the foundation that silt won't render useless

BY LARRY JANESKY



Rigid-foam protection board shields the membrane from backfill damage. Applied while the waterproofing is still tacky, the 1/4-in. foam panels also provide a thermal break between the foundation and backfill.

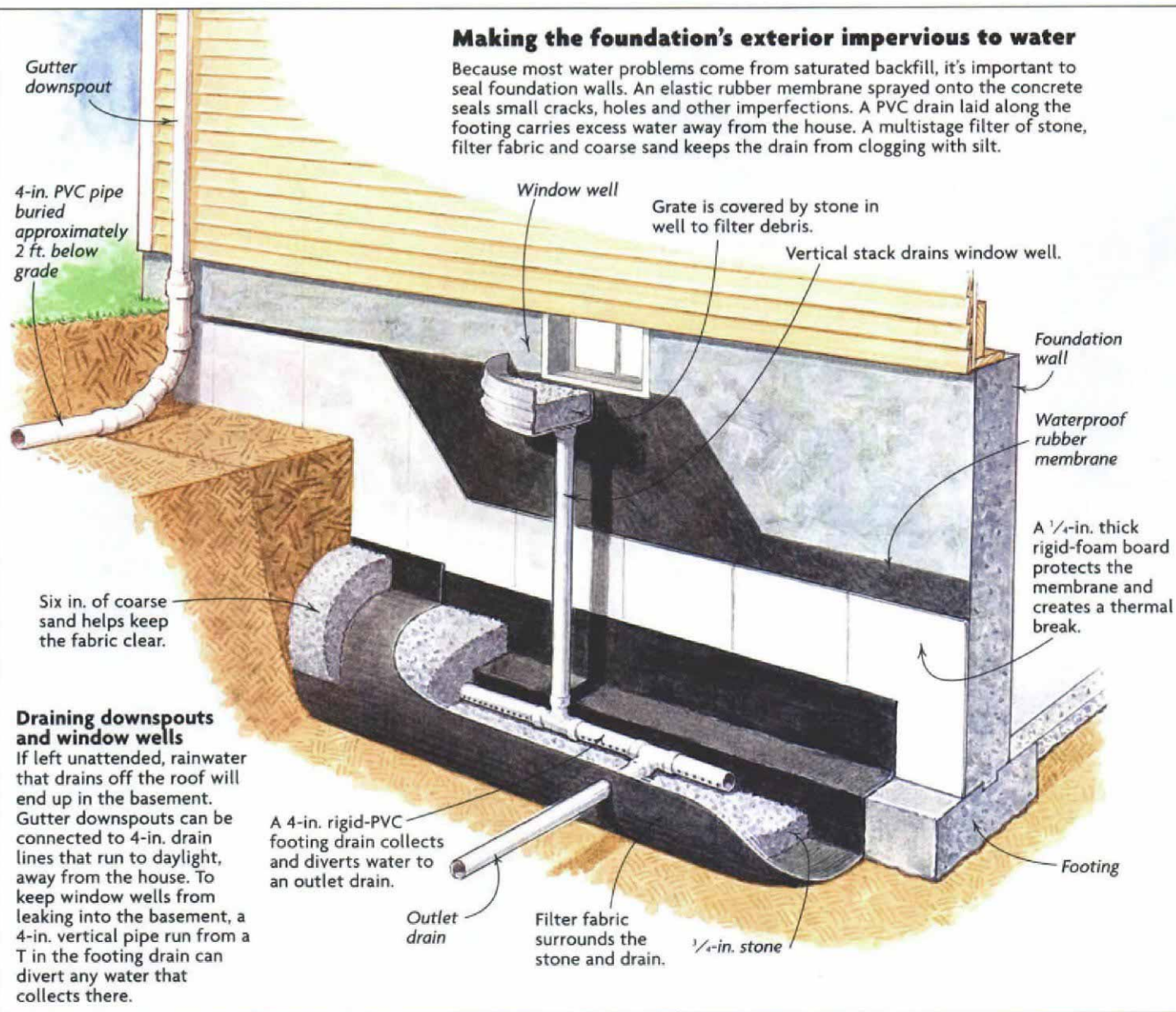
Waterproofing, not dampproofing, seals the foundation walls. More expensive than asphalt-based mixtures, a rubber-based membrane sprayed onto foundation walls remains flexible and waterproof.

I was standing in water a quarter-inch deep that covered an entire basement floor. The homeowner asked me in a surprisingly calm voice, "Is there any reason the basement of a brand-new million-dollar home should leak?" "Even if your house cost \$100,000, it still shouldn't leak," I answered. I also told her that she had lots of company in her misery: A recent survey of 33,000 new-home owners revealed that 44% had leaky, wet basements. It was my guess that most of the basement problems were the result of a builder's neglect or efforts to cut costs.

As a basement-waterproofing contractor, I fix the mistakes of others. Having been a builder myself, I can empathize with the emotional struggle to "spend more and be safe" vs. "spend less, make a profit, we should

Making the foundation's exterior impervious to water

Because most water problems come from saturated backfill, it's important to seal foundation walls. An elastic rubber membrane sprayed onto the concrete seals small cracks, holes and other imperfections. A PVC drain laid along the footing carries excess water away from the house. A multistage filter of stone, filter fabric and coarse sand keeps the drain from clogging with silt.



be okay." However, no matter how much you spend, you shouldn't end up with a basement that seeps water like a cave; it's not good for the house or its occupants. Remember that it's much easier (and cheaper) to build it right the first time than to dig it up later with a jackhammer. To that end, I like to seal foundation walls, drain water away from the foundation's exterior and expel the water that does manage to leak into a house's basement.

Sealing foundation walls

When water saturates the soil surrounding a foundation, it essentially creates a column of water whose cumulative weight increases as it rises in the backfill. This force pressing down is known as hydrostatic pressure; it drives water through joints, cracks, form ties and other foundation imperfections. The

first line of defense is some sort of exterior coating on the foundation walls.

These sealants are categorized into two groups: dampproof and waterproof coatings. Dampproof coatings are typically thin asphalt-based solutions that are sprayed or painted onto the foundation's exterior. The asphalt reduces the porosity of the concrete, but over time, it emulsifies in water and won't seal cracks. Some contractors mix fiberglass fibers with the asphalt to strengthen the mix but still offer only a one-year warranty. The low cost of dampproofing (about 30¢ per sq. ft.) makes it attractive to many builders, but the brief or nonexistent warranties (usually only a year) should make consumers wary.

Waterproof coatings, on the other hand, are a mixture of rubber and asphalt or all



Clogged footing drains can't do the job. Water draining into the pipe carries silt that eventually fills the pipe. To avoid replacing a clogged footing drain, the author surrounds the pipe with a layered filter that stops sediment.



Interior perimeter drains are good insurance in new construction or retrofits. Plastic drains on top of the footing collect water that leaks in through the walls and channel it to the sump pump. The entire drain is to be covered with concrete, except the opening facing the wall.

rubber (sometimes called *elastomeric*) and can cost three times as much. Like damp-proof coatings, waterproof coatings are sprayed onto the foundation (photo left, p. 64), but the material must be heated before application; it's also applied in a thicker coat and is elastic enough to bridge $\frac{1}{16}$ -in. wide cracks and small holes. The key to the waterproofing's performance is the amount of rubber in the mixture; more rubber means better performance and higher costs.

To protect any coatings' integrity when the foundation is backfilled, many contractors cover the sealed concrete with what is known as protection board: sheets of fiberglass, rock wool or extruded polystyrene foam. I use a $\frac{1}{4}$ -in. thick foam board that adheres to the fresh layer of waterproofing (photo right, p. 64); at the very least, it provides a thermal break between the backfill and the foundation. Typical costs for a combination of wa-

terproofing and rigid board can run from \$1.10 to \$1.50 per sq. ft.; 20-year warranties are common. Recently, a number of waterproofing manufacturers such as Rub-R-Wall (614-889-6616) and Wall Guard Corp. (800-992-1053) came out with an extremely resilient coating that doesn't need protection board. But I still like to have the extra insulation provided by the foam.

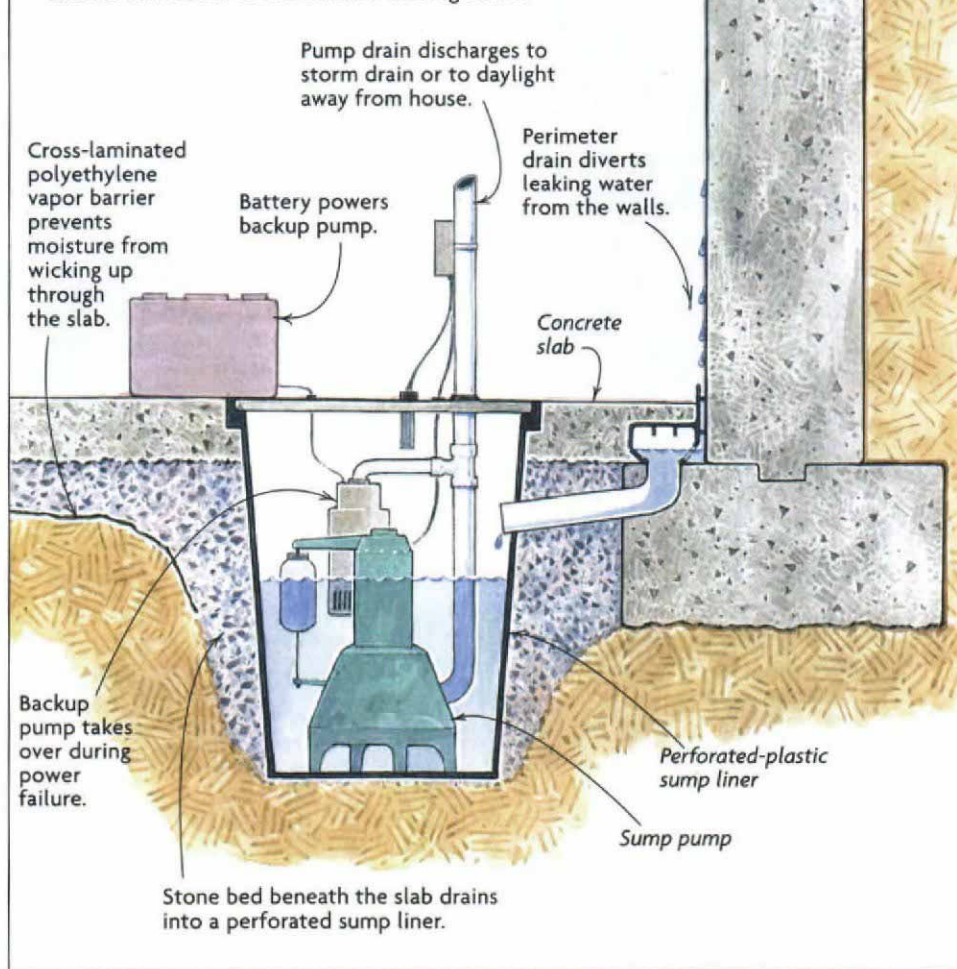
When applying waterproofing, I make sure the joint between the footing and the wall is sealed. This means the top of the footing has to be clean before the wall is sprayed. Form ties should be knocked off both inside and out before spraying. It's also a good idea to determine the finish-grade height and spray to that line. If this elevation is miscalculated, 6 in. or more of untreated wall can end up beneath the backfill, causing leaks when the inevitable shrinkage cracks begin to appear in the foundation.

Recently, a popular alternative to waterproofing has been waterproof drainage mats. The dimpled polyethylene sheets are unrolled and nailed onto the foundation wall, caulked at the top and left open at the bottom. The mat's dimpled shape creates an air-space between the wall and the soil, so if water does leak in at the top or through a joint, it can drain to the bottom.

The problem with these drainage mats is that they must have an open footing drain below. If (or when) the footing drain clogs, hydrostatic pressure forces water up between the matting and the wall. Because the wall was never waterproofed, every crack and form-tie hole is vulnerable to easy water entry. In contrast, if a footing drain fails along a wall that was waterproofed, the form ties, wall cracks and footing/wall joint are sealed and protected. However, even the best waterproofing guarantees only that water won't

Keeping the interior dry with a system of drains and pumps

To handle any leakage through foundation walls and to ensure a dry floor, an interior perimeter drain collects water from the walls and channels it to the sump pump. On sites where exterior drainage is poor, the pump can also be connected to the exterior footing drains.



penetrate walls and doesn't prevent water from coming up around the footings and floor.

Building a gravel and sand burrito that keeps footing drains clear

To keep a basement dry, you need to channel water away from the house with footing drains. Although most building codes say that foundations must have a drainage system of drainage tile, gravel or perforated pipe, I always use 4-in. dia. rigid-PVC pipe. (I've found that the black coiled, slotted pipe often used is difficult to keep straight; any dips in the pipe cause poor flow and clogs.) Two rows of 1/2-in. holes drilled at 4 and 8 o'clock positions keep the pipe's sediment intake to a minimum; slots will clog much faster than holes in most soil conditions. To make sure the pipe doesn't become clogged (photo p. 65), I wrap the pipe with a succession of filters that resembles a giant burrito.

I start by cleaning the excavation to the bottom of the footing, usually with a shovel; a half-buried footing causes poor drainage. Next I unroll 6-ft. wide filter fabric along the footing, spreading excess on the ground away from the foundation and up the sidewalls of the excavation (drawing p. 65). I then dump 3 in. of 3/4-in. stone on top of the fabric, level it off by hand, then set the PVC pipe so that at worst, it's level around the entire foundation. Because the footings are mostly level, I'm happy if I can gain a few inches of pitch to the outlet. During this stage of the project, it's convenient to tie the drains below each window well to the footing drains. Vertical risers made of solid 4-in. dia. pipe run up from the footing drains under the window wells and terminate with a grate about 4 in. below the windowsill. The well can be filled later with stone so that leaves won't clog the grate.

I backfill over the footing pipe with more 3/4-in. stone to an elevation of 8 in. above the top of the footing. As a rule of thumb, 1 yd. of aggregate will cover 12 lin. ft. of exterior footing drain; therefore, a house with 150 ft. of foundation will require a little more than 12.5 yd. of aggregate. I pull the filter fabric up over the top of the stone and against the wall, using shovelfuls of sand or stones to hold it in place. If the fabric is not long enough to reach the wall, I add another course, overlapping by least 12 in. Now the burrito is nearly complete. Because the filter fabric will eventually clog, I put about 6 in. of coarse sand on top of the filter fabric. This progression of materials will keep the drain clear longer than any other practical way I know. The fabric protects the stone, the sand protects the fabric, and the soil won't wash into the sand.

As long as the lot's grade allows it, the exterior footing drains should always be run to daylight, pitched at 1/4 in. per ft. or more, if possible. If the drains are servicing more than 200 lin. ft. of foundation, you might want to consider added measures. For example, you could put two outlets to daylight or increase the diameter of the outlet pipe from 4 in. to 6 in.

If there isn't considerable pitch on the lot or a storm sewer handy, the footing drains must run inside to a sump pump. A single 6-in. pipe that connects the exterior drain to the pump should be cast through the footing at the sump location and gives the drain as short a run as possible.

It's worth mentioning that it's never a good idea to connect an interior footing drain with a crossover pipe in the footing to an exterior footing drain that drains outside the house. The probability of failure on an exterior component of the system is high, while the probability of a failure to the interior system is low. If and when the exterior footing drain fails, the water will back up into the interior footing drain and flood the basement.

Drain the gutters far away from the house

It may seem obvious, but many houses don't have adequate drainage for gutters and downspouts. Rather than carry water away with splash blocks, it's more efficient to connect the downspouts to a 4-in. dia. PVC pipe (drawing p. 65). Starting at about a 2-ft. depth at the house, the pipe should be pitched toward daylight as steeply as possible so that it can flush out the dead leaves and sticks that always accumulate.

Because gutters collect debris, it's a good idea to enlarge the downspouts to 3 in. by



Tough vapor barrier keeps basement slab dry. Made of 2-ply high-density polyethylene, the vapor barrier can be installed under or over the gravel base and keeps moisture from wicking up through the slab.

4 in. instead of the usual 2 in. by 3 in.; this will also drain the gutter twice as fast in a heavy rain. The underground drain itself can be enlarged to a 6-in. dia. if necessary. In the drain, it's best to avoid 90° bends, which trap leaves and gunk, and use 45° bends instead. If there's a long run of gutter, give it two outlets. Finally, never connect the gutter drains to the footing drains, no matter how far downstream. Gutter drains are always voted "most likely to clog" and will back up the footing drains, too.

Getting rid of water in basements

Although installing interior basement drains in new construction is a good idea, they're usually installed to fix problems in existing construction. Typical strategies include the use of interior perimeter drains that collect water from foundation walls, a vapor barrier below the slab that prevents water and vapor from wicking up through the concrete and a good sump pump that will eject any water that collects in the drains and under the slab. In new construction, these methods all start with a new basement floor.

Under the slab, I like to lay 8 in. to 10 in. of clean ½-in. to ¾-in. stone. This stone allows the entire subslab area to drain and makes a good base for the slab. Once the gravel is laid, I always like to install a puncture-resistant vapor barrier (photo above). The strongest material is a 4-mil cross-laminated high-density polyethylene such as Tu-Tuff (Sto-Cote; 888-786-2683). It comes in 20-ft. by 100-ft. rolls that cost about 4¢ per sq. ft. I overlap adjoining pieces at least 18 in. and seal the lap with housewrap tape. The concrete guys aren't crazy about the barrier because it doesn't allow the water in the mix to settle out, making the finishing process longer, but a 3-in. bed of sand laid over the barrier will alleviate the problem. (You can also lay down the barrier before the gravel is brought in.) Either way, the long-term benefits of an unbroken barrier under the floor are well worth the temporary inconvenience of installation.

Because water usually comes into the basement through the walls and the footing/wall joint, the best place to capture and channel the water is at the junction of the floor and

wall (drawing p. 67). The most efficient method is to install a plastic perimeter drain (photo p. 66) that sits on top of the footing and below the slab; this perimeter drain collects any water that seeps in through the walls. In retrofit jobs, the first 6 in. of slab perimeter is cut away to expose the footing; once the drain is installed, the slab is patched. There are many manufacturers' variations on this theme; I use a drain that I designed and now manufacture. Rectangular in cross section, it has a slotted opening facing the wall that channels water down and out toward the pump. The interior footing drain costs about \$30 to \$40 per ft. in a retrofit. A less expensive version of this system for new construction is known generically as a draining floor edging (photo left, facing page). It's a 6-in. by 4-in. L-shaped plastic flashing with a dimpled design. The dimples are laid against the wall and footing side and allow water to pass into the gravel below the slab, where it can be pumped out. The flashing material costs about \$1.50 per ft. You can find versions of these products through your local waterproofing contractor,



Drainage flashing is a simpler, less expensive interior drain. Installed at the junction of wall and footing, this flashing has a dimpled profile that allows any water from the walls to flow beneath the slab and into the sump pump. Obviously, it's important to keep the top of the flashing clear when pouring the slab (photo right).



or you can contact my company, Basement Systems, at (800) 541-0487.

Sump pumps for interior drainage

Any drainage technique I've mentioned is dependent on one thing: a good sump pump. After installing more than 10,000 pumps myself, I have some criteria for choosing a pump. First, it should have a cast-iron body; second, it should be able to pump $\frac{1}{2}$ -in. dia. solids; and third, it should have a mechanical float switch (a float riding up and down on a rod), not a pressure switch or a "ball on a wire" design that often hangs up. A Zoeller M-53 (Zoeller Pump Co.; 800-928-7867; www.zoeller.com) fits the bill perfectly, costs about \$150 and pumps 2600 gal. per hr.

The pump sits inside a plastic bucket called a liner that collects water and separates it from the surrounding dirt so that the pump can push it out. The liner should be perforated and set in a bed of aggregate. Any drainage system that feeds water to the sump should have a pipe cut through the sidewall of the liner. The liner should have an airtight lid that will keep moisture from evaporating in-

to the basement; it also keeps objects from falling into the sump hole that could interfere with the switch operation.

Relying on a lone sump pump to keep the basement dry is risky. It's all too common for a storm to knock out the power and flood the basement all in one night. A battery-operated backup pump provides insurance and often is equipped with an alarm that announces a pump failure. The backup can usually be installed in the same sump hole as the primary pump and use the same discharge line. The best backup systems use pumps that sit up off the sump floor, have float switches and use matched chargers and

batteries made specifically for long-term standby use. This last item is critical. Many backup units don't provide a battery; if the battery and charger aren't matched, the system won't charge properly. Backup-system equipment can cost from \$300 to \$1,000.

Discharge from the sump pump should be piped to a storm drain if one is available or to the exterior, where it will flow away. The discharge line should be installed so that it doesn't freeze during the winter. □

Larry Janesky is president of Basement Systems in Seymour, Connecticut. Photos by Tom O'Brien, except where noted.