Keeping your Home's Feet Dry

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How to dry out existing basements and Keep new basements from ever getting wet

KEEPING YOUR HOME'S FEET DRY

By Russ Lanoie, © 2006 Conway, NH updated 1/29/08

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Water falling from the sky as rain or snow can be one of the most destructive forces in nature. Besides being destructive, it also presents one of the most elusive problems for homeowners, leading them to great frustration and expense as they seek ways to keep water from penetrating everything from their roofs to their cellar floors.

Every Do-It-Yourself magazine runs articles in the spring describing new miracle products that allegedly stop water from entering through a basement wall or floor. Some products may be effective at stopping surface water from coming through from the inside, but wouldn't it be better to keep water from getting into the wall or floor at all? I've always figured that trying to hold out groundwater is like trying to keep water from leaking through the seams of a boat. As long as any part of the boat is in the water, a certain amount is bound to leak in.

As for letting water into the basement before pumping it out, the resulting dampness can be both distasteful and dangerous, even if there is no noticeable standing water. Just as constantly wet feet would not make you comfortable or allow you to remain healthy for very long, neither can your house survive that condition for extended periods without damage.

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PART I: DRYING OUT EXISTING BASEMENTS

Many homes are built with inadequate protection from groundwater, even though conditions are well suited for the proper installation of a simple and cost effective drainage system. Unfortunately, once a water problem is discovered after a house is built it is usually very difficult and expensive to remedy the situation. And, because site and soil conditions vary so greatly, it is wise to consider your circumstances carefully before deciding on a course of action So, first things first. Before tackling a wet basement it is critical to identify the source of the water. There are essentially four ways that moisture can enter and collect in basements:

- Leaky plumbing supply or waste lines or fixtures.
- Surface (rain) water leaking through openings or flaws in the walls
- High groundwater table
- Condensation

PLEASE NOTE: There are many entries in the body of this document, such as: [PHOTO 1.3.1 CISTERN] that refer to where a diagram or photo will be inserted when time permits. There are also several headings with no text following yet. However, most of the critical issues have already been addressed and the supplemental items will be included in the future to improve clarity. Thanks for your patience and please feel free to e-mail me with your questions.

1.0 DETERMINING THE PROBLEM, HOW IS WATER GETTING IN? A TROUBLESHOOTING GUIDE

At the end of this document you'll find a Basement Drainage Checklist that you can use to review your own situation before going through the following Guide. Or you may wish to read the information below to help you know what to look for when you review the checklist for your basement.

1.1 Plumbing leaks

As with any problem, it pays to eliminate the most obvious possible causes before searching for the more complicated one(s). Note that every new electric appliance that has a troubleshooting guide always starts with the suggestion that you "Make sure it is plugged in" before calling a repair technician. Diagnosing wet basements is no different, as I've found out the hard way.

> **Wrong Culprit**… Years ago I did a job for a homeowner who insisted that her basement was wet after each rainstorm. When lots of digging and waterproofing didn't seem to get rid of the water, I was stuck with the question about its real source. When I finally started checking the house plumbing, I discovered a leak in the water heater! For some reason, she had only noticed the water after it rained in spite of the fact that it was there all the time. I've learned to more be suspicious.

Eliminate the possibility of leaks from any and all plumbing fixtures and piping inside the house and also the domestic (drinking) water supply line. This line can enter through the basement wall or through the floor and sometimes can run for some distance under the floor. A leaking water supply line will generally create a constant appearance of water, often near, but not limited to, where the water line enters the basement.

Shutting off the supply line at the street can usually stop water from leaking if it is from a public water supply. Observing increased electric use and/or running time of the well pump for a house with its own deep well system (pump in well) can often provide a tip-off to a broken water supply line as can shutting off the pump for awhile to see if the leak stops. If the house has a shallow well with a pump inside the house, the line coming from the well is a suction line, which, if it leaked, would mean you'd have no water.

Once you've eliminated possible plumbing leaks, it's time to start understanding how water can get into a basement.

1.2 Surface water entrances: how water finds its way in

If water appears during or immediately after a rain or snow melt event, especially if it is coming through the basement wall(s) well above the floor, it is likely that the problem is inadequate wall waterproofing and poor surface drainage away from the house. Roof water likely concentrates next to the wall, especially under valleys and downspouts and finds its way through flaws. If the water stops coming in shortly after the rain or snow melting stops, this generally confirms the diagnosis of surface water entering.

Water can find its way in through many different flaws or, in older foundations, almost anywhere because these walls were never intended to be watertight. Many parts of the country have many of these older foundations that are constructed of various sizes and shapes of cut granite and round fieldstone, with or without mortar, often leaving numerous passages for water to follow.

Another source of surface water can be poor surface grading that can direct water toward the lip of a bulkhead or towards basement windows where it can spill over into the basement. By not paying attention during heavy rains, a homeowner can sometimes end up blaming the wrong culprit.

Court Case: Having been called to testify in court against a builder on behalf of the owner of a new home with a wet basement, I wanted to be assured of a good presentation for my client. First examination of the problem when snow was on the ground didn't reveal much, however. It was during the final inspection on my way to court after the snow had melted that I discovered the telltale signs of water having run down the bulkhead stairs. The ground surface sloped toward the bulkhead instead of away, causing the water to pour into the basement in heavy rainstorms. Had the homeowner done some snooping during rather than after a rainstorm, she could have discovered the problem for herself. The homeowner won, and the builder was required to do the regrading.

The solution to a wet basement can sometimes be as just that easy. Regrading the surface to get water away from the foundation is about as simple as it gets while other problems require a more creative approach. See Sec. 3.1

1.3 Groundwater, the rising tide

If water appears through cracks in a basement floor and/or around its perimeter where the walls join the floor sometime after rainfall or snowmelt, and remains for some time, the problem is likely to be a high groundwater table. In some places a high water table can persist for weeks, months, and occasionally, year round, requiring the installation of a drainage system that actually lowers the water table around and under the house.

Many times an adequate de-watering system may have been installed when the house was built or sometime afterward. Because of carelessness or neglect, however, the system has failed to function simply because the outlet of the pipe has become plugged with critters building a home, roots, leaves, or other debris. Occasionally, simply locating and unplugging the end of the pipe can be all that's necessary to effect a cure. [See 3.2.1] Other times it may require replacement because of failure or because the system was never installed correctly in the first place.

Believe it or not, this was the outlet pipe for the perimeter drain at a nearly new home that had made it through only a couple of years before groundwater finally backed up into the house. This is what the pipe looked like in the fall of 2005 after I dug it up and removed the boulder that was resting directly on top of it. This was less of a failure of the system, and more a failure of the contractor to exercise reasonable care during backfilling.

1.3.1 High water table, how a basement is like a well

Wet basements are a common problem each spring in many areas because of a high water table. This simply means that the level of water in the ground has risen up to its high point for the year because of melting snows, spring rains, lack of water pickup by the trees and plants, and the absence of sun to dry the ground during the winter. Some soils hold water very tightly and, therefore, keep the water table high for a long time. Other soils (sand and gravel) pass water quickly, yet often have a high springtime water table, especially in low areas, simply because of the volume of springtime runoff.

To help understand a high ground water table, picture a pile of sand a foot deep in the middle of your bathtub with six inches of water in the tub around it. If you were to dig a hole six inches deep in the sandpile you would find water in the bottom of the hole. If you added water to the tub, the water in the hole would get deeper also (rising water table.) If we put a box into the hole it would float if it was watertight, and it would get water in it if it were not. Lots of us find ourselves in this situation, except that it's our basements that are in the hole and are getting wet because they are not watertight. DIAGRAM 1.3.1 HERE OR COMBINED BELOW

Another way to view this is to think of the similarity between a basement and a well. In the old days, a well was simply a hole dug down into the ground usually lined with fieldstone. If the well was dug deep enough into the ground, its owner might have been lucky enough to have water available from it year round. Beside the well, the house foundation was constructed in a hole in the ground and built up with fieldstone to provide support for the house, essentially just like the well but usually larger. If the homeowner was lucky enough, the groundwater that filled the well might never have risen high enough to flood the basement. PHOTO 1.3.1 CISTERN

Apparently this was not always the case, as a farmer and judge in Concord Mass, observed in the middle of the 1800's. Since many local farmers were having their food stores destroyed all too often by water in their basements, the judge published a book in 1859 entitled Farm Drainage from which the following quote is taken:

> "A trench is cut in the cellar-bottom, two feet from the wall, a foot deep at the farthest corner from the outlet and deepening towards it, round the whole cellar, following the course of the walls. In this trench, two-inch pipe tiles are laid, and carefully covered with tan-bark, and the trenches filled with the earth. This tile drain [is] connected with the outlet drain 18 inches under ground, and the earth leveled over the whole."

Incidentally, the judge's name was Henry French, and, even today, many types of subsurface drains still bear his name.

Modern basements are typically made of concrete that, by no small coincidence, is also what most modern dug well liners are made of. But the same phenomenon still occurs when the water table rises and fills the well near to the top. A nearby basement may fill up also unless some provision is made for its protection. This is one reason that it is helpful to check out a dug well near a house because the water level in the well represents the water table at that particular moment.

If the well can be checked in spring when the water table is the highest, measure the depth from the ground surface down to the water. Compare the depth to the water to that of the basement floor below grade. If the water in the well is higher than the floor, the amount that it is higher is generally equal to the amount the basement might flood if the water were not removed. If the well cannot be observed in spring, or if it is an unusually dry spring, it may be possible to observe the high water mark (like a bathtub ring) inside the well.

Even if the house is located on sloping ground, the water table will remain pretty much the same distance down from place to place since groundwater tends to follow the original contour of the ground surface. It will, however be diverted closer to the surface if it should hit a layer of hardpan or ledge. Of course, it is not likely that there will be a dug well where the soil is shallow to ledge. [More in Sec. 2.0]

Another way to observe high water table is in side hill cuts that are often required to level a lot for a house or for road construction. Because the ground may have been dug down as deep or deeper than it might have been for a well, the water that would have been contained in the well is now free to flow out the side of the cut because the soil downhill from it has also been removed. This often makes the water that has been relieved by this excavation easy to observe, and often difficult to deal with. [Also in Sec. 2.0]

These high water table signals should serve as warnings to someone building a new home nearby, or an indicator that water in an existing basement is from a high water table rather than from surface water.

1.3.2 Springs and things
1.3.3 Looking for the signs of trouble in nearby wetlands, road cuts and hillsides
1.3.4 Check septic systems
1.3.5 Check with NRCS, neighbors, town planners etc.

1.4 Condensation/high humidity

Condensation often occurs in crawl spaces and basements with either dirt or concrete floors where there is inadequate ventilation, especially if the floor level is near the top of the water table and/or the soil is poorly drained clay or loam rather than sand. It also occurs in basements of homes that are shut up for much of the year and occupied only during hot, humid summer days when moisture laden air is suddenly allowed into the inadequately ventilated basement. The moisture carried by the hot air condenses on cool concrete, stone, metal and even wood surfaces in extreme cases, and often remains trapped because there is not enough air movement during dryer days to evaporate the condensed moisture. This is a common occurrence in vacation homes, especially when they are in heavily wooded areas with little sun and air drainage.

Condensation can also be a by-product of either a high water table or surface water entering and being trapped in the basement, then evaporating and re-condensing onto any and all basement surfaces, eventually causing severe damage to the structure.

Photo shows the results of moisture trapped in a crawl space causing rot. Note how support post has pushed up into rotted beam.

1.4.1 Moisture holding capability of air
1.4.2 Thermal mass of concrete and stone

Conclusion: It is very possible that both surface and ground water is entering the basement which will require following the recommendations in both sections 3.1 and 3.2 (see outline below) for total success. In many cases it is also likely that extremely high levels of humidity have ensued from surface or ground water flooding, and it is possible that, by controlling the unwanted water, the excessive dampness may be eliminated. Be aware that every situation is very different and requires careful examination to determine the true cause of the problem so that the best path to a solution can be chosen.

2.0 BACK TO BASICS: Understanding the interaction of soil and water

2.1 Difference between sand, silt, clay, loam and hardpan.

Soil: a mixture of any combination of sand, silt and clay, with or without organic matter which is usually limited to the upper layer or topsoil.

Sand: a loose granular material that results from the disintegration of rocks, consisting of particles smaller than gravel but coarser than silt. Soil particles range from 0.05 to 2.0 mm in diameter; individual particles are visible to the unaided eye.

Silt: soil consisting of granular material of a specific grain size smaller than sand (0.05 mm) but larger than clay. Silt particles are small enough that they can be suspended for a period of time in any surface water body before being deposited at the bottom of a lake or pond where water is reasonably still.

Clay: a naturally occurring material, composed primarily of fine-grained minerals with particles smaller than the eye can see. Wet clay is plastic or pliable to the touch while dry clay can be very hard when compacted (or fired as with pottery) or powdery when not consolidated. True clay generally exists more toward the ocean or others areas where these tiny, chemically active particles were able to settle out of waters from the melting glacier.

Loam: is a mixture of sand, silt and clay, that, depending on the percentage of each material, can often be muddy and pliable when it contains water. It can also be very hard when it is in its original state in the ground.

Hardpan: is a general term for a dense layer of soil generally located below topsoil. While hardpan can be clay, it is often a loamy mixture (sand, silt and clay mixed) that may also contain rocks and boulders of any size. Because it is a mixture of different particle sizes, the smaller particles fill in the spaces between the larger so that, like concrete (a mixture of gravel or stone, sand and cement), it is very dense and resistant to the passage of water and often very difficult to excavate, particularly when mixed with rocks that the soil tends to lock in place.

When hardpan soils are excavated, however, like the clay and very fine sand which they contain, they typically become very muddy if allowed to become saturated with water. Because of these characteristics, many people mistake loam or fine sand and silt for clay.

Regardless of what the exact soil makeup is, loamy and hardpan soils have tend to keep water from percolating down through the ground and often contribute to high water tables and wet basements.

2.2 Effect of hardpan and ledge on water movement in the ground

When soils are shallow to ledge or hardpan, it is often easy to see groundwater running out of a side hill cut for a road or a house. Water has percolated down through the ground until it hits the hardpan layer or ledge and then moves horizontally until it reaches the surface, or "daylight," in the side hill cut. Under extreme conditions, it is possible to have the soil in these wet sidehill cuts actually collapse away from the hillside due to flowing water pushing out against it and loosening it up.

2.3 Relation of water table to the ground surface

Water generally has the tendency to follow the ground surface which is why there can be a high water table even on top of a hill. In addition, hill top soils in areas where the glacier was active typically have little soil on them and the soil that is there is usually well compacted due to the weight of the glacier, helping to compound the high water table situation. So don't think that being up higher than your neighbor is going to lower your ground water table and reduce the possibility of ground water getting into your basement.

2.4 Capillary action

Capillary action is simply the wicking of water through the soil. Soils that have lots of silt and clay in them usually draw above the actual water table. That means that if you were to dig a hole into the ground down into the water table, you'll probably hit moisture above the point where water will actually puddle into your hole. Coarse sand and gravel have little capillary action which is a good reason to have a layer of porous sand or stone under a basement slab to break the capillary action.

3.0 CHOOSING AND EXECUTING A SOLUTION

There have been several instances where I've been engaged to dig around existing buildings in order to waterproof walls and/or install drainage systems only to discover that the actual problems were unrelated to groundwater.

If a foundation wall is totally watertight, there is probably little problem with letting rain water run down against it all the way to the perimeter drain. If the wall is tight, has had adequate waterproofing and/or water drains quickly through the soil, there is probably little to be concerned about. The problem is that many foundations have all sorts of defects that allow the passage of water.

If you've been able to rule out groundwater and know that all you have is surface water entering then you'll be able to do your repair near the top of basement wall.

3.1 Keeping surface water out

3.1.1 Cut stone, field stone & rubble foundations;

This house has a very porous stone foundation with a roof valley concentrating water into one area next to the foundation. Sure enough, this is where water is showing up inside in the basement next to where the valley concentrates its water.(right photo.)

Because some of the drainage jobs I've done have required me to work under the direction of an architect, I've had to follow his recommendations rather than follow my own instincts to determine the problem and come up with an appropriate solution. I'll start with this example that involved an old house with a loose stone foundation. I did this project under the direction of an architect and actually *aggravated* the wet basement problem.

Digging for a shallow perimeter drain that the architect requested allowed *more* water through the porous basement wall. This was the same mistake many folks make when they dig out next to their leaky foundation wall and replace the original backfill with crushed stone either for appearance and splash protection or to try to mitigate a water problem. Putting crushed stone below the ground surface next to a porous wall, even with the installation of a perforated drain pipe (as a sort of shallow French drain) often forces more water to enter the basement. The crushed stone becomes a dispersion system in the same way it does in a septic drain field. Usually little water enters the drain pipe, except in a deluge, and more water than ever soaks into the ground next to the foundation where it can find its way through flaws in the wall and into the basement.

What I did to solve the problem on the second try was to seal the outside of the wall with a coating of concrete that directed surface water away from the foundation as it soaked into the ground, keeping it from streaming through the loose stone foundation.

Flashing aprons for rock, block & generally lousy foundations:

The success with this project prompted me to use this technique in many other situations. Rather than using concrete, however, in most cases I rely on a layer of rubber or plastic to direct water away from the wall. Usually I excavate just a few inches below the surface next to the wall and slope the ground down and away at about a 10 to 20 degree angle to about 4 feet out from the wall, putting the bottom of the slope approximately 10" to 20" below grade. I rake the earth smooth, removing all rocks and sticks, and tamp the surface firm. Then I install a layer of rubber or a couple of layers of 6 mil (minimum) polyethylene over the slope, right up to the wall. I don't usually worry about sealing against the wall, as my primary concern is to direct the majority of the surface water away from the wall and out into the earth where it can soak harmlessly away, leaving a dry zone beneath the membrane next to the wall just like that under an umbrella..

This technique of installing a membrane just below the ground surface is similar to installing flashing around a chimney or other structure on a roof. One of its biggest benefits is that it can eliminate the need to completely excavate a foundation wall all the way to the footing and attempt to waterproof it, which is impossible with many fieldstone or rubble walls. It is somewhat similar to installing a full length splash block mentioned in other basement drainage articles on the Internet except that it is out of sight.

I've had success with this technique even when attempts to make the wall watertight below have failed. One case in particular involved a local public building with eighty year old granite block walls. Excavating beside them completely, steam cleaning, remortaring the joints and sealing them with some hi-tech black goo did not keep out the water as well as this flashing system that I installed just below the ground surface after the other waterproofing had failed to completely do its job.

In some cases it may be wise to seal the plastic or rubber membrane to the foundation wall if it is smooth enough, particularly if there is an excess of water falling from the roof and splashing against the wall such as is often the case here in the North Country where we tend to shy away from rain gutters. Though not always necessary, it is sometimes also helpful to bed a perforated pine in crushed stone over the plastic and runs the pipe to daylight or to a drywell away from the wall to provide water a way to exit without ponding in the stone. The stone provides double duty in this case, providing a splash guard next to the building as well as a porous media for water to get to the hidden pipe.

Left photo, poly membrane is placed over sloped soil and covered with crushed stone to protect the poly and serve as splash guard. No drain pipe was used because grade continued away at the same slope. Right photo, a rubber membrane is used in similar manner, though topsoil was replaced onto membrane. Both membranes were brought up a few inches onto the wall.

3.1.2 Block foundations: block failure, poor mortar, buckling, settling

Concrete block foundations often have cracking in the bond line between blocks. In extreme conditions where there may be freeze-thaw cycles within the walls and/or acidic ground water, these forces can actually attack the blocks and cause them to disintegrate and turn back into the aggregate they were made from. This process usually begins with the poorer blocks that are more exposed to the frost or acidic water. If it's not necessary to excavate all the way to the footing to repair the wall, it may be possible just to grout the joints, and/or coat the exposed wall to slightly below ground level and use the apron flashing trick to shed water away. In severe cases, it may be necessary to completely expose the wall, replace damaged or disintegrated blocks, and coat the entire wall with Structural Skin or a similar surface bonding cement that will both reinforce and waterproof the wall

This wall had several disintegrated blocks that were replaced and the surface coated with Structural Skin. The entire wall was coated before backfilling

3.1.3 Poured foundations: Settling cracks, honeycombing, form tie leaks; pour joints

Poured concrete can develop shrinkage or settling cracks, have water channels around form ties, or have a condition called honeycombing where the concrete aggregate became separated during the pour leaving a porous spot in the wall. In addition, poured walls sometimes have seams between different stages of the pour, or between original walls and additions where the original wall can be anything from field stone to block or poured concrete.

Above left shows the honeycombing that often occurs next to a footing or up in the wall between various stages of poured sections.
Center photo shows a typical settling crack that usually occurs at some spot in the wall where there is a break in the continuity of the concrete, such as at form ties, steps in the wall (to accommodate changing exterior grade), form seams, or window inserts as seen above.
Right photo shows a very porous connection between a poured wall segment at left of photo and the concrete blocks used to fill in the corner. Each of these defects was repaired with structural skin.

A combination of proven ingredients:

After digging up almost all the way around one house in a very sandy soil (which couldn't possibly have been holding water) I came to the conclusion that it was a combination of events that was causing water to enter the basement each spring. A deck behind the house was keeping the winter snow from insulating the ground underneath, encouraging frost to penetrate the ground. Since the ground below the deck had frozen, it would not allow the spring rains and melting snow to soak harmlessly away. Because the ground surface was sloping toward the house, water was forced to run toward it and down along the foundation wall. (The soil next to a heated basement with an un-insulated wall seldom freezes.) To top it off, there was a seam in the foundation in this spot that allowed the water to leak into the basement.

Sealing this seam and sloping the grade away from the house solved the problem. This is a place where I could have used the flashing technique also, but I had not discovered it at the time

Coincidentally, this is the same house that had a flooded basement in the spring of 2005 because of an ice dam in front of the garage as shown in photo #5 in Photo Quiz on Website.

Applying waterproofing coatings and membranes:

There are times when it is possible to apply a waterproofing/ dampproofing coating or membrane to the entire block or poured wall such as before it is backfilled in the case of a new structure, or when an existing foundation is completely excavated to replace a perimeter drain. If there is any suspicion that the wall is not watertight, or you want "belt and suspenders" protection, this is the time to do something.

Because the conventional black tar coating that most contractors use is really just damp-proofing, I often install a layer of 6 mil poly over it while it is still slightly sticky if I really want a waterproof membrane. This covering over the tar has other advantages to the installer working next to it in a narrow trench on uncertain footing! I've also used the sticky backed rubber membrane that's used as a water shield under shingles on roofs. It bonds well to an old, well hardened asphalt coating if it has been cleaned well but doesn't like to stick to bare concrete or stay in place over a fresh asphalt coating. Tacking it to the bottom of the siding with batten strips can hold it in place until the wall is backfilled. [Photo 3.1.3 F]

While a wall is exposed for perimeter drain installation or replacement, I fix obvious cracks, seams, or leaks around utility penetrations because it is far better to do this on the outside rather than the inside of a wall. Such repairs call for cleaning out any loose material and grouting with either expansive hydraulic cement or high quality caulking designed for the purpose. Usually it is best to actually widen a crack to get the best performance from the repair material. I use an electric jackhammer to chisel out a substantial opening a couple of inches wide and an inch or so deep with as rough a surface as possible to provide grip for the repair material. There are usually manufacturer's recommendations with these products.

For filling cracks I have always used a material originally designed for surface application on "dry stacked" concrete blocks. The original product was called Fiberglass Block Bond, and I've used other brand names such as Structural Skin and Fiberglass Surface Bonding Cement. Each of these products has many short pieces of fiberglass mixed in that give it tensile strength (resistance from pulling apart) that is not a characteristic of regular mortar. For filling cracks, I generally mix the stuff rather thick, more like putty than the yogurt like consistency recommended for surface spreading, and I often add concrete sand to it to give it more body for filling in holes.

I've used the stuff for foundation repairs, fixing septic tanks, building a hearth for my corn stove, and lots of applications for which it probably was not intended, with excellent results. But because one of these products is made close by in Southern New Hampshire, I contacted their sales consultants to see if this was the best product for the application. The consultant suggested that adding sand to the product would reduce its waterproofing ability, which seems sensible. When I've used it with the sand mixed in to fill major foundation flaws, however, I've also used it "full strength" as it comes from the bag, with no sand mixed in, as a skim coat over my repair after it hardened to insure the repair is waterproof. Instead of doing this, the consultant recommended using another product that appears very similar called, "Foundation Coat" for filling in cracks and voids. I've not had a chance to use it in the field as yet, but from the little testing I've done with it, it looks like it will behave admirably.   DIAGRAM

Above left photo shows a typical wall crack that opened up at a form tie. Middle photo shows crack widened out with electric jackhammer to receive masonry repair. I always wash out the crack with water to remove any dust that might interfere with the repair material bonding to concrete. Right photo shows fiberglass reinforced surface bonding cement in place, totally filling crack and opened area. It is best to keep repair material moist for a period after it is applied, though if the wall is backfilled the same day this is probably unnecessary. As always with any product of this nature, follow the manufacturer's recommendations for best results.

Another material that is often used for repairing cracks is quick-set, expansive hydraulic cement. It consists of some fast setting chemicals that produce a non-shrink, high strength, durable mass. It is considerably more expensive than the Structural Skin or Foundation Coat that I use, though its cost is well justified when its used for instant plugging of severe leaks in concrete structures, even under water. Besides the cost, the disadvantage I've found to working with it is the extremely short working time that makes it difficult to use for filling large cracks. If you do choose to use it, follow the manufacturer's directions carefully or you could end up with a mixing pot filled with useless, albeit rock hard, crack filler.

3.1.4 Utility penetrations

Another way water can get through a wall is around utility penetrations such as sewer, water or electrical conduits. This is one of those areas that may be well served by grouting with the hydraulic cement just mentioned, especially if it is the only, or one of just a few similar areas leaking, and the repair is to be made from the inside. Again, follow the directions included with the product such as opening up the area to receive the grout and place it quickly once it is mixed.

If I have had to dig outside the basement anyway to repair other areas, I generally stick with the Structural Skin or Foundation Coat type product with good results. The only time this can get tricky is if there are several pipes or wires nested together at a wall penetration. It may be difficult to work the masonry product tightly enough between the wires or pipes to get a complete seal. In this case it might be wise to use silicone or other high quality durable caulk to make a seal around the pipes or wires, and then grout the whole group with the masonry caulk.

During the 2005 season I was faced with this situation, having several wires penetrating a large opening in a basement that had several other leakage problems (LEFT PHOTO). I used a Duck Seal type flexible putty available at electrical supply houses and worked it carefully around the wires with my hands until I was satisfied that I had it tight to the wires (MIDDLE). Then I filled the opening around it with grout. (RIGHT) Note that I sloped the wires uphill toward the house as much as possible so water would run down away from the house. The only problem is that this penetration is right below a roof valley that concentrates large volumes of water in this location.

I've heard back from the homeowner that since my extensive repairs on their basement this is the only location where they've had some leakage during early winter rainstorms. In hindsight, I think I might have been better off with caulking rather than duct seal directly around the wires because caulk is more fluid and sticky and probably would have filled the little spaces between the wires better than the duct seal.

I revisit the job in 2007 and removed the duct seal and replaced it with a good grade of caulking which cured the leak. Then a new owner of the house had the electrical entrance re-routed up above grade where it should have been in the first place so now there's absolutely no chance of a leak!

3.1.5 Windows, window wells; low bulkheads and entrances

In the case of foundation windows, it is not always possible to shed water away because the bottoms of the windows are often too far below finish grade, requiring the installation of window wells. These often consist of corrugated galvanized steel half circles but can also be made of pressure treated wood or masonry. The goal is to make the top of the window well high enough to be able to slope the surrounding ground surface away from the house. A problem arises when the window well is directly below the roof drip, especially in a climate like ours here in the North where rain gutters are seldom used (because snow and ice fills them, making them useless, or ripping them from the building!)

The solution I've found is either to cover the window well with a clear plastic dome that also keeps out leaves and critters or to create a mini-drywell under the window well. This allows rainwater to soak away into the ground before it can rise up and find its way through the window. This can create another problem if the wall below the window well is porous, just the same as it did at that architect's job in section 3.1.1.

In this case I often use the flashing technique under the window well if there is any question about the integrity of the wall below the window. I dig out a few extra feet beyond the well and slope the soil as I explained for the surface flashing apron. Then I install the plastic membrane on the slope, place crushed stone as a mini drywell for any rainwater that may enter, install the window well structure and then backfill to the surface. DIAGRAM [Photos 3.1.5 A, B]

With regards to low bulkheads or entrances, about the only logical solution is to change the grade away from them [Note Court Case at 1.2]. This may require creating a swale, that is, a shallow and wide ditch that carries water away if the entire surface grade cannot be resloped . The wider a swale can be constructed, the easier it will be to maintain, and to walk or push a cart or wheelbarrow through it during yard maintenance.

If the entire yard area surrounding the bulkhead or entrance slopes toward it prohibiting the construction of a reasonably shaped swale (rather than a dangerous ditch) to redirect rain water, the next best solution is to install a catch basin/drywell. This can be constructed of a short piece of plastic culvert pipe standing up in a hole with a cast iron frame & grate sitting on top. Rainwater can be directed towards this structure by installing the top of the grate several inches below the lip of the bulkhead or threshold of the entrance. While the structure can be always be considered a catch basin, it can also become a dry well depending upon the disposition of the water that it collects.

Water entering this catch basin can be carried away by a pipe running slightly downhill to daylight, or it can soak away in the ground through holes drilled in sides of the culvert as well as through the open bottom. The catch basin should be surrounded by crushed stone, the more the better if the soil is poorly drained and/or the surface that drains toward it is large. Just be careful when turning the structure into a dry well that you are not inviting surface water into the ground too close to the basement, perhaps adding to an existing problem with surface water getting in through flaws in the wall.

In situations where I've not been able to run an outlet to daylight and chose not to rely on the stone surround the catch basin to get rid of the water, I've run the pipe to a drywell that I've installed some distance away, making a careful record of its location in case the need for future maintenance arises. I'm always reluctant to install a drywell within an area that's going to be paved with either asphalt, concrete, or patio blocks because I've found that, no matter how big a drywell is constructed, in time it is likely to plug up with the debris that rainwater can carry. By putting the drywell in a remote location that can be easily dug up in the future, I protect the integrity of the area that is paved.

The technique for making this culvert catch basin is identical to that used for making a pump sump pit at Section 3.3.2. I've built them for walkways, entrances and parking lots. The concept is to collect rain water and allow it to soak into the ground or carry it harmlessly away just as the catch basins and drywells located on our road and highway systems do.

Left photo shows a drywell for a separate catch basin that's located about 30' away in the middle of a concrete pool patio. The patio abuts a house and the entrance to a garage with no place to send rainwater that lands on the patio from the house and garage roofs that shed onto it.

The drywell consists of 18” smooth interior wall culvert with a 6” pipe leading into it from the catch basin and a concrete (septic tank) cover (center photo). Note the holes in the plastic culvert to let water out into crushed stone that surrounds it. The catch basin in the patio is built the same as the one in the right photo except that it does not have holes in it and crushed stone around it.

By contrast, the catch basin in the right photo doubles as a drywell because the ground surface surrounding it is not going to be paved so the catch basin/drywell can be rebuilt where it is if the soil around it ever plugs up with litter and debris. Note that it is located in the middle of a landing area just a few feet away from the step up into this house and about 7” to 8” below to provide a safe and comfortable step height into the house after the catch basin was backfilled.

An important final step before backfilling is to cover the whole catch basin and surrounding stone area with filter fabric (nonwoven preferably). I leave the grate or cover off the catch basin frame until the fabric is in place and then cut out a hole inside the that’s a couple of inches smaller than the diameter of the cover. Then I set the grate or cover into the frame which locks the fabric in place for backfilling.

Placing the filter fabric in this manner reduces the possibility of water and soil creeping down the outside of the iron frame that the grate sets into as rainwater flows to the catch basin. I believe that this soil migration is the cause of many catch basin failures because the migrating soil and water opens increasingly larger paths for more soil and water to run down into the stone below, eventually causing all the soil around the catch basin to cave in.

This seems to happen even on paved areas when pavement shrinks away from a catch basin and allows water to seep down beside the catch basin frame, starting the erosion process. This is another less I learned the hard way and have since prevented with the use of the filter fabric barrier.

3.1.6 Unique problems

Sloppy Morticians: On one job I was required to dig up an entire wall only to find that the problem occurred just a few inches below the surface of the ground.

A full basement had been added under a local church many years after it was originally built. The original foundation’s granite slabs had then been set on top of the new concrete walls and the church set back onto them to maintain the church’s original appearance above ground. When we dug up the wall, we found it to be in excellent condition in spite of the fact that water had been entering somewhere.

What we discovered was that the morticians (the guys who put in the mortar) had filled the irregular spaces between the granite and the poured concrete, they had let the mortar settle away from the granite just slightly. This tiny gap allowed rainwater (which accumulated next to the building because of the roof drip) to channel into the basement behind the finished interior wall that hid the whole process from our view on the inside.

To make matters worse, the basement window wells were filling with rainwater from the roof, so much so that it was coming in around the windows. We constructed dry wells below the windows, as I just explained above, easily relieving this problem, while the leakage between the granite and concrete was stopped by sealing the cracks with masonry and a layer of plastic.

3.1.7 Surface grading errors. [Photo 3.1.7] Surface grade, swales to lead water away

This house had water entering the basement during heavy rains. Left photo shows water line on the plastic window bubble on a basement window well. This indicates that water had been pooling in the depression shown at the left side of the level in center photo and leaking by the edge of the bubble and through the window. Rather than trying to seal the bubble completely against leakage, in this case it was much easier to reshape the grade into a gentle swale that directs roof water harmlessly away.

I use a grader blade attached to my backhoe bucket (right photo) for this type of land shaping. After the swale was shaped I topped it with a mix of 1 ½" and ¾" stone for erosion control, splash protection and appearance. There was no need for a membrane in this case because the roof overhang is about 4', typical of the houses in the old country where the builder of this house was born.

3.1.8 Gutters, downspouts and the North Country- Stone splash guards & drip edges vs. gutters & downspouts

While gutter & downspout systems have never been very popular here in the mountains of New Hampshire because of the effects of ice and snow on them, they are certainly recommended for milder areas of the country to collect and direct water away from the house.

Never connect a downspout to a perimeter drain line for fear of contaminating the perimeter drain since this interconnection would create a potential source for debris to wash into the perimeter drain. Instead, run a second line to daylight or to a drywell away from the basement. Pipe is cheap enough to avoid the risk of contaminating the perimeter drain line with debris or dead critters that can enter through a roof gutter or downspout system.

In conclusion, anyone with a water problem in an area that doesn't usually have poor soil conditions with a high water table should closely examine their situation before insisting on a course of action. It could be the problem may be solved for very little cost, without the need for equipment and the resulting mess. There are few jobs more tedious for a contractor than having to dig up around a house without destroying the landscape, the underground utilities, or his back, trying to spare the first two.

3.2 Groundwater, the rising tide:

The fact is, if it were easy to make residential basements absolutely watertight, other problems might occur. I say easy because the basements of many commercial buildings and other below ground structures such as Boston's Big Dig are built essentially watertight (or were supposed to have been). However, their construction costs are extremely high compared to typical residential basements because their walls and floor systems are built to far different specifications. This is not only to keep water out but also to keep the pressure of outside water from causing damage. Consider this situation I heard about several years ago.

> **Foundation disaster**: I happened to be talking with a couple who I had done a small job for some years before and asked them how it had worked out. They said that what I had done was fine but an unrelated misfortune had befallen the house. During one extremely rainy night they awakened to a strange sound that seemed like wind at first until they realized it was coming from their basement.
>
> It seems that excess rainwater had soaked into the ground around their home because the home was located in the lowest section of their development. The extreme pressure from this accumulating ground water around and under their house actually buckled up their basement floor, causing the soil from under the floor to erupt six feet in the air and bury their washer and dryer. In the process of this soil displacement, the foundation was undermined and parts of the wall dropped more than a foot. They abandoned the house.

I know of a similar catastrophe that befell a new house here in the mountains one spring when the nearby river rose unusually high, saturating the ground surrounding the house without actually flooding the area. Because the basement floor had not yet been poured, the water rushed under the wall and up into the basement with such force that it undermined the wall and caused the foundation to collapse.

Although these are extreme examples, they do demonstrate the destructive power of water. These foundations were likely built in a manner similar to most residential basements. What destroyed them was having groundwater flow under the walls so fast that it undermined them. In the first case, the pressure had to lift and open cracks in the floor before it could rush in and cause it to fail. As for the second, I'll bet that even if it already had a typical poured floor, it probably would have failed anyway because of the extreme pressure and volume of water.
Had either basement filled with water through a bulkhead or other opening as happened to other houses in the same spring event that destroyed the second foundation, the water would have equalized the pressure and the foundations probably would not have failed. Or, had the outside water risen slowly and the basements leaked it in fast enough to equalize the pressure, like waiting until the car in the lake fills up before trying to open the door, they would not have collapsed. It was the rapid rise of the water outside the buildings with no place to go but under and inside that doomed these two structures.

I've seen less dramatic results of hydrostatic (water) pressure in countless other basements that have developed pressure cracks in the floor, cracks that often yield water during the spring each year. If it were not for these leaky cracks and seams around the edge of the floor, even slowly rising groundwater might force pressure to build up to a point greater than the ability of the walls, and particularly the floor, to withstand it. Also, if basements were absolutely watertight and strong enough, they might even float like our box in the bathtub.

If that sounds unlikely, ask someone about the concrete ships that were built years ago. Or, just consider that few of today's boats are made out of a material that would float by itself such as wood, but rather are made out of something like fiberglass or steel that will float fine only if the water is kept outside its shell. Like most ships that have pumps to keep out any water that might leak in, many houses have sump pumps to discharge water that could otherwise damage the basement. Fortunately, when water is pumped out of the basement, the water table around the house is lowered, (like pulling the plug on the bathtub's drain) relieving the hydrostatic pressure. This is likely the reason we see few floating houses or erupting floors. On the other hand, there have been many concrete structures, specifically watertight septic tanks, which have floated out of extremely wet ground just after they've been pumped out.

Perimeter drains: creating a dry island- the most effective solution

The traditional manner of keeping a basement dry is to install a perimeter drain around the outside of a building during its construction. In many cases it's still possible to install a perimeter drain around an existing house that's found to have a problem with a high water table. The advantage of installing the drainage system outside the foundation is that it will intercept groundwater before it ever reaches the foundation. Because of the severe conditions I encountered when building my own home several years ago, I'll use my experience as an example to illustrate my point.

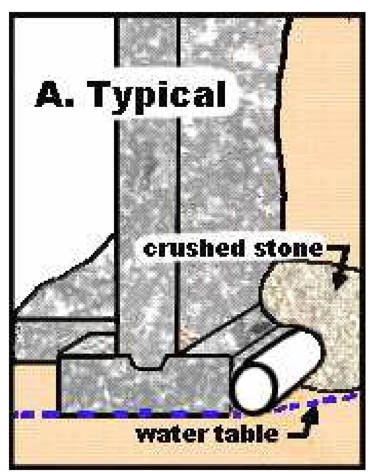
> **An extreme case**... Just as we started sitework for my new house in the fall of 1976, we were deluged with rain. This untimely rain aggravated an already difficult groundwater situation and made me strongly consider forgetting the idea of building that year. However, with patience (and a good pair of rubber boots) I was able to get the perimeter drains installed four feet outside of where the house was to be located before I started digging the cellar hole. Within days of installing the drains I was able to excavate as if it were a dry summer in spite of the fact that it was mid fall when the water table usually rises.
>
> Thirty years have passed and we have never been bothered by moisture in the basement. This is in spite of the fact that our original springtime water table was just two feet below the surface of the ground, and we are built into the ground about six feet on a gently sloping side hill.

3.2.1 Locating and restoring a lost drainpipe

Several times in the last few years I've discovered drain outlets for perimeter drains that homeowners were not aware they had. When they've called me to troubleshoot a wet basement, I've looked for existing drain outlets where clues have pointed me, uncovered the existing outlet that had been buried, perhaps for many years, and eliminated their water problems with five minutes of hand shovel work. [Photo 3.2.1 A, B]

3.2.2 Location and depth for new and retrofit installation when possible

Conventional perimeter drains are usually constructed as shown in Figure A with 4" pipe laid at the base of the footing and bedded in porous material to encourage water to flow into it. Usually this scenario is entirely satisfactory, though in some cases capillary action within poorly drained soils can still make the cellar floor damp even though it is above the water table that is kept from rising any higher by the perimeter drain.

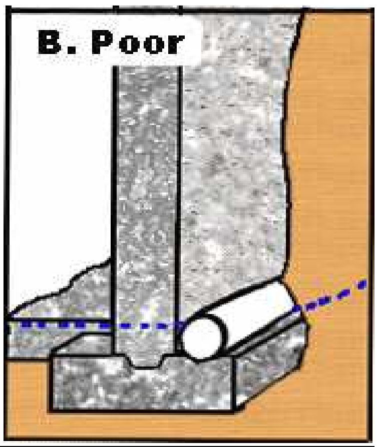


One way to reduce water's capillary action under a floor is to install a layer of crushed stone entirely under it, as water cannot wick through this coarse aggregate. Although this can be costly and is limited to new construction, it is required by some building codes.

A layer of crushed stone does help to assure a dry basement as long as it is connected to an outlet that carries water away, and it has a secondary use for radon mitigation in areas where radon can be a problem.

When drains are properly installed, they keep water away from the basement by lowering the water table around the house, preventing water from ever reaching the cellar. This is, truly, like creating a dry island or like taking our boat completely out of the water so no water can possibly leak in.

-



3.2.2 a Installation errors:

In many instances where I've been asked to troubleshoot and resolve wet basement problems, I've uncovered drain pipes that were installed above the footing, allowing water to rise to the level of the floor. If the builder made the additional mistake of installing the drain pipe with the holes facing up, then the water level is forced to rise to the top of the pipe before it can get into the holes in the pipe. Other times there is little or no porous bedding material and pipe inlet holes are plugged with soil. Oftentimes I find both errors on the same job. [Photo 3.2.2 A, B]

3.2.2 b Locating the pipe for optimum performance:

The first thing to consider when placing a new or retrofit drain pipe is getting it deep enough to lower the water table far enough below the floor to reduce the effects of capillary action, especially if stone is not or cannot be used under the floor. This is an obvious choice for a retrofit situation where it may be impractical to tear up a floor to run interior drains but is possible to dig on the outside, and it just may be that installing the outside drainpipe lower is a cost-effective alternative. For new construction and retrofit situations I try to place the drain pipe a foot or more lower than the bottom of the footing whenever possible and far enough away to avoid undermining the foundation. This usually means 2' to 4' or even more if necessary to protect landscaping or porches and similar structures. (see curtain drains below)

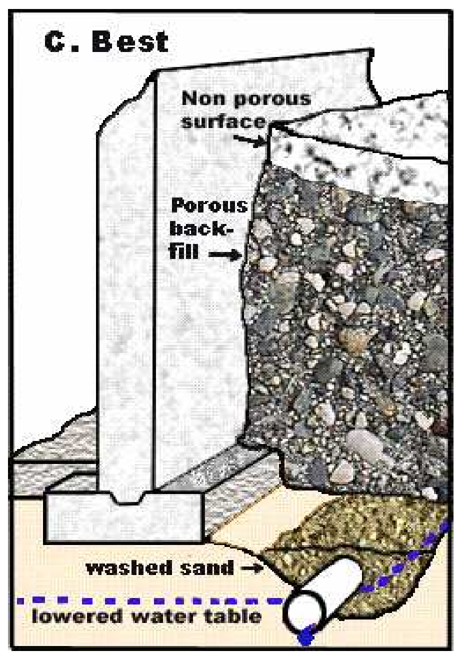
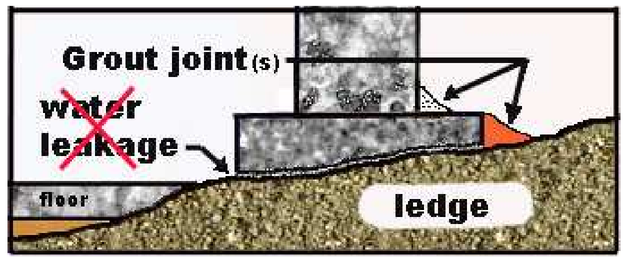


Figure C shows how I installed the drains for my house, which is the same procedure I use for drying out existing wet basements wherever conditions permit.

3.2.2 c Obstructions:

Once in a while it is impossible to place a pipe at or below the bottom of a footing because of obstructions such as immovable boulders or ledge. At times the footing may be poured around or right on top of the obstruction. I've encountered this situation several times and have attacked the problem by washing the rock surface clean (pressure washing would be ideal) and grouting (sealing) the rock to the wall with a strong, well bonding masonry product such as Structural Skin or Foundation Coat. This masonry seal keeps water from entering under the footing, and is formed into a "cove" shape that can be gradually sloped away to divert water from the rock or ledge to a point where it can be picked up by a conventional perimeter drain system if possible or necessary. This technique requires a lot of patience and a little luck to be entirely successful, but it is often easier than trying to dig a ditch through solid granite.

When a wall or footing is poured directly on ledge it is often not well bonded to the ledge to make a watertight seal. Cleaning the ledge and grouting the seam can keep water from seeping through regardless of whether a drainpipe is installed. It can be prudent to also seal the seam between the wall and footing while the area is exposed, just in case...



On the other hand, if the ledge is soft and/or fractured enough, it may be possible to slot through the rock with a jackhammer to install the pipe below the footing. A few hours work with an electric or pneumatic hammer can make all the difference between success and failure of a drainage project.



Left photo shows a partially disintegrating block foundation sitting on ledge. This is the wall shown on the photo quiz on the Website where the previous owner told the present owner that there was "moisture in the basement when it rains." In fact the ledge and the porous blocks created a small river whenever it rained. Neither was the footing sealed to the ledge, nor were the blocks sealed to the footing or to each other very well. The elbow on the near end of the drainpipe in the ditch bottom and the pipe sloping up to the left of the photo are there simply to protect the end of the drainpipe until the ground is prepared for the next section of pipe.

Fortunately the ledge was soft enough that it was able to be slotted with an electric jackhammer (center) enough to fit in a 4" drainpipe (right) through the high spots in the ledge. Before backfilling, the entire wall was covered with Structural Skin inside and out to reinforce the deteriorating blocks and waterproof the surface.

Rule of thumb: If the ledge or boulder is smooth and hard, grouting or coving might be the only practical alternative. If the ledge is soft and breakable, cut a slot in it to assure lowering the water table below the floor.

3.2.2 d Providing a cleanout: Whenever possible, I install a tee or an elbow on the drain line at the origin of the pipe (the opposite end from the outlet) which is usually the high point, and extend a riser pipe to the surface of the ground next to the house. This riser serves as both an inspection point and an emergency cleanout if ever necessary. I cover the end with a 4" plastic cap and mark the location. Often it's possible to make the cap flush with the surface of the crushed stone that I usually use as a splash guard next to the foundation, leaving the end of the pipe nearly invisible but easily accessible. It is helpful to make diagrams or take photos to record all such locations. [Photo 3.2.2 D]

3.2.2 e Curtain drain:

There are many retrofit situations where it's impossible to dig right next to the house because of landscaping, paving or a deck or porch. Here I might install a drain only on the upgrade side of the house as it is often only necessary to intercept water moving through the ground downhill toward the house to eliminate a moisture problem. This type of drain is considered a curtain drain rather than a footing or perimeter drain, especially if it is several feet from the house. Its effect remains to lower the water table on the downhill side in order to protect the house.

This is an important consideration particularly for retrofit installations as it can greatly reduce site disruption and the cost of excavation. The disadvantage is that the drain might have to be extremely deep into the hillside in order to intercept water deep enough to be totally effective. With today's excavators, however, this is less of a problem than in years past, as long as there is enough room to work. DIAGRAM

3.2.3 Bedding material: <u>CONCRETE SAND VS. STONE</u>

In order for the perimeter drain pipe to pick up water successfully, it needs to be surrounded, or bedded in a porous material that allows water to pass easily through it and into the pipe. The traditional material specified for this use by architects, engineers, builders and basement drainage companies consists of small stones that have been washed and graded. They are produced by screening either bank run gravel (the stuff that comes from the ground just as nature left it, generally yielding rounded stones), or crushed bank run gravel or blasted ledge (yielding angular, sharp pieces). Screening gets out the pieces that are both larger and smaller than what the specification calls for, while washing removes the dust that can contaminate the stone for drainage purposes. It is this dust size material, much of it almost invisible to the naked eye, which is what we referred to as "fines" in Section: 2.1.

> **Here is a warning** to those who may be unfamiliar with these materials. There seems to be a bit of confusion in the terminology used by architects and engineers and those of us who handle these materials in the field regarding their correct names, at least in my area of the country. The professionals tend to call gravel what us practitioners refer to as stone, since we use the term gravel to mean material that contains everything from larger pieces of rock down to sand, silt and clay. This is the stuff that is used for road construction rather than drainage. It can be bank run gravel, just as nature left it, or crushed bank run gravel, meaning that bank run gravel has been run through a stone crusher so that none of the stones exceed a certain size.
>
> To us who work with the stuff, crushed stone refers to stone only, without the fines between the stones to hold it together for surfacing gravel roads. In New Hampshire, we refer to 1½" washed crushed stone as "septic stone" because of its use in septic leaching fields. In

addition, it is also widely used as "drainage stone" as it is called in the April 05 issue of This Old House magazine, though the article does not assign a size to the stone. Smaller stone, crushed and screened to ¾," can also be used for drainage purposes, and, although it is typically somewhat more expensive than 1½"stone, it is much easier to shovel by hand than the larger stone. It still does a super job of allowing water to pass through. Peastone is smaller still and much more expensive. Although it passes water very rapidly, I have little experience using it for drain pipe bedding, except to say that my local aggregate supplier offers a ¾ stone product that has smaller stone mixed in for use as concrete aggregate.

While the use of these terms seems academic, it can, in fact, lead to a real miscommunication between a customer and his local sand and gravel supplier. My local supplier tells me that there have been times when he's had to send an empty truck back to a customer's house along with a loader to bring back a material that turned out to be something different than what the customer thought he'd ordered. Be aware of what you are ordering.

3.2.3 a The problem with stone…

Many years ago I heard a civil engineer speak at a construction seminar about troubleshooting foundation drainage systems. He claimed to have found that one of the most common reasons for drainage system failure is fines migrating (washing) into and plugging up the bedding stone.

Because "drainage stone" is so porous, in some cases it cannot hold back the original soil when it's used as bedding for drainage pipe. Forty percent of the volume of 1 ½" crushed stone is "voids," or openings that, because they allow water to pass readily, can also permit silt from the original soil to wash into the bedding as well as into the pipe, plugging up both and leading to failure. [Photo 3.2.3 A]

To prohibit stone from silting up, it should be wrapped in filter fabric to hold back the original soil. Water still passes through the fabric but the soil stays in place.

Filter Fabric is synthetic cloth-like material that is used for several types of construction related applications such as erosion control, road stabilization and soil separation. It can consist of either woven or non-woven fibers in varying thicknesses or weights. It is available in 12 to 15 foot wide rolls several hundred feet in length. Woven fabrics (usually black) resemble the stuff that modern day grain bags, silt fence, and some weed control barriers are made from. Non-woven fabrics can resemble a range of materials from soft felts to the stiff shiny house wrap (to which they are closely related) usually seen enveloping homes under construction. It is the non-woven fabric that is generally used for wrapping stone.

I've used this technique when dealing with a very high water table in a very tight (fine, heavy, silty) soil where I had to guarantee effective drainage for a local church building in my town. We actually had to dewater the site with sump pumps installed about 7' below grade in several stations around the site before we excavated. After excavating the cellar hole we placed 4" septic system pipe bedded in ¾" stone and completely wrapped in filter fabric. We ran these pipes around the perimeter of the footings and from one footing across to the other in several places to assure effective results. Because the church is located on flat ground with no way to provide a gravity outlet, the pipes lead to a sump under the front stairs of the building where a pump ejects the water out to the storm drain in the street. The system has worked without a glitch for over 15 years except when the pump plug corroded enough to cause the plug to short out several years ago. [Photo 3.2.3 B]

3.2.3.b The alternative to stone

With all of that said, I'm now about to suggest an alternative to using "washed, crushed, graded, septic, drainage stone" as bedding for drainage pipe. I started using this approach about 1970 when working on agricultural drainage systems under the direction of our local branch of the Soil Conservation Service, now known as the Natural Resources Conservation Service (NRCS). Our local District Conservationist, Jim Haine, used to do battle with contractors hired to install agricultural drains, as most of them felt that they had to use 1½" stone around the pipes to be effective. Jim had a different approach that not only worked, but actually had some government research behind it done by the Army Corps of Engineers.

Jim struggled to get contractors to use "clean, sharp sand" as I can still hear his ghost saying. It seems that sand, the cleaner and coarser the better, passes water readily yet keeps the trench more stable than stone and allows less silt (fines) to pass into the system. As a result, the sand has come to be known as a "filter material" for underground drainage systems.

> Filter material: According to the American Iron and Steel Institute's Handbook of Steel Drainage and Highway Construction Products, New York ,NY 1967:
> "Early subdrains consisted of a trench filled with coarse rock ("french" drains) which quickly silted up. Extensive research by the U.S.Waterways Experiment Station at Vicksburg, Mississippi, shows that **a graded material roughly equal to concrete sand** (AASHO Specs) **has been found most suitable. Such material gives better support to the sidewall of the trench and thereby reduces erosion and silting.** Filter material should be placed in layers and tamped."
> (Notice the reference to our friend, Judge French)

One of the advantages of the concrete sand recommended by the Corps is that it should be universally available at a fairly constant specification anywhere that concrete is supplied, since it is one of concrete's key ingredients along with crushed stone and cement. Sand is considerably less expensive than stone, although this should not be a major consideration when drying out an existing wet basement or preventing a new basement from getting wet is at stake. It's certainly much easier to shovel than stone which is a big plus to the installer, considering that there always is a certain amount of hand work when placing the bedding and leveling the pipe.

I've used sand as bedding ever since in all but the wettest conditions, such as the church mentioned above, with outstanding results. [3.2.3 C]

3.2.4 Pipe choices: A holy (but not divine) dilemma:

The only drawback to using sand is that the perforated drain pipe that is available today for septic system applications has holes that are too large to hold back sand adequately. Most perforated schedule 20 "thinwall" Sewer and Drain pipe (SDR) comes with ½" or, more often, with 5/8" holes.

Until the early 1970's, there were a couple of manufacturers of 4" black fiber pipe, called Bermico and Orangeburg Land Dry tile, with 5/16" holes designed primarily for land drainage applications. Although these holes were still a little large for sand, the bedding we most often used at the time was clean bank run gravel that contained lots of sharp sand and larger stones. This was because another of Jim Haine's rules was that 25% of the bedding material should be larger than the holes in the pipe. [Photo 3.2.4]

We could use modern, large holed perforated pipe and still meet that criteria by bedding with clean bank run gravel. Or we could use concrete sand and then add ¾" stone just under the pipe, on top of the sand bedding filter material. This would allow ditch stabilization with the sand, and keep the sand from washing into the pipe because of the stone in immediate contact with the pipe. The sand holds back the original soil, while the stone holds back the sand.

DIAGRAM

While this approach of using sand and stone to properly bed the large holed pipe creates an extra step beyond just using clean bank run gravel, it is often still easier to install. Typical bank run gravel, unless screened, can have stones of any size making working with it by hand much more difficult than with graded sand and stone.

ANECDOTE: The truckload of hand drilled 5/16 hole PVC pipe

An alternative to this labor intensive bedding approach that I developed in the 1970's is to buy solid pvc or polyethylene SDR (Sewer & DRain) pipe (thinwall, schedule 20) and cut slots in it rather than buy the same pipe with large holes. I use my radial arm saw to cut the slots by setting the blade up about 3" above the table and slicing through about ¼ the depth of the pipe every two to three inches or so, just like a butcher slicing meat. I wear goggles because the resulting pipe chips are very sharp, and I count my fingers before and after each session. It only takes a minute or two to slot each pipe. Rigid polyethylene or modern, good quality PVC pipe generally resists shattering when the sawblade passes through unlike early PVC pipe that was quite brittle.

The 1/8" slots that result seem to let in water just fine and yet keep the concrete sand from entering the pipe. The pipe is installed with the slots facing down or turned slightly toward the direction of incoming water. Occasionally I'll use the heavier grade 4" SDR 35 sewer pipe, but I've only used Schedule 40, the heavy stuff used for drains inside a house, for outlet lines if there is a possibility the pipe may be driven over, or at the outlet to offer greater protection.

Left photo is modern polyethylene pipe slotted for use as perimeter drain to be bedded in sand. Right photo shows a similar slotted pipe that I installed as a drain in 1984. I connected a new pipe for a spur line into the nearby basement by drilling into this pipe with a 4 ¼" hole saw during summer of 2005.. Note the minimum of silt collected in the bottom of the pipe in 20 years

Why don't I just use the readily available 4" corrugated rolled black pipe that has the narrow slots every so often all the way around its circumference? Our local NRCS soil conservation district recommends against using this pipe in our area because of the amount of iron in our water that stimulates an iron bacteria. Also often seen in wells, this iron ochre as it's called is caused when iron carried by ground water reaches the air in an open pipe (or well), turning it into the red goo seen in the photo below. This goo can plug up slots that are too narrow, causing failure of the drainage system.

I have had at least one e-mail from a reader of this site who related such a problem with this thinly slotted pipe plugging up with something that sounded like iron bacteria. During a recent basement drainage project that I did myself, I uncovered the pipe shown below next to a foundation. The pipe was filled with iron bacteria and accumulated silt that had just about stopped any water from entering the pipe. I've also seen evidence of this red slime around many perimeter drain outlets in our area because of the high iron content in many of our soils.

This pipe that I dug up during the summer of 2005 was partially blocked with silt. The rust color is apparently due to so called *iron ochre* which is a slimy yellow-tan or red jelly-like substance made up of iron deposits mixed with bacterial slime. By itself it can cause failure of subsurface drains by clogging up the filter material.

Much of the collected silt washed out when the end of the pipe was uncovered and water started to flow. Although the pipe had been correctly placed at the bottom of the footing (to immediate left of pipe), the stone bedding was almost totally filled with silt and the red slime.

It is for these reasons that I prefer to slot my own pipe with the larger 1/8" slots, and also because rigid pipe is easier to keep on grade during installation. Also, most rigid pipe has a smoother inner surface than the corrugated pipe allowing silt (often picked up in the pipe during construction, especially if it is installed when the water table is high) or algae buildup to pass more easily, helping the pipe keep itself clean. This can also help keep the pipe clean if a small critter makes his way up into the pipe to store goodies for winter snacking. Springtime water flow has a better chance of washing out his leftovers (and perhaps him if he didn't make it through the winter) through smooth pipe. See Rodent Guards 3.3.1 [3.2.4 D]

3.2.4 a Exceptions: As with anything, there are exceptions to the conditions that require such fine bedding as sand. High water tables can exist in coarse sandy or gravelly soils just as they can in tight hardpan soils, especially in low lying areas. The big difference with these soils is that they are more porous, that is, they allow water to pass through much more quickly than tighter soils do because the relatively large size of the smallest particles in the soil creates larger pores. This means that the drain pipe may be expected to carry much more water when the water table is high, so the pipe should be allowed to pick up as much water as quickly as possible from the surrounding soil.

In these instances, I generally return to the practice of using stone as bedding. If the soil bears water rapidly yet is very fine sand or silt, like the church I mentioned, it may still be best to wrap the stone with filter fabric as discussed. If the soil is coarse sand or gravel with few fines, either ¾" or 1½" stone may provide adequate bedding itself without any fabric. The relatively "large" size of the smallest soil particles is probably substantial enough to keep them from being carried by the groundwater into the stone and plugging it up. Remember, though, that the smaller ¾" stone is easier to place and it may, in fact, provide somewhat more of a filter than the coarser 1½"stone. I know of one town here in New Hampshire that prefers to use ¾ stone as filter material for road underdrains because the road foreman believes that the smaller stone can help hold back the original soil to prevent the failure of the bedding without using filter fabric. I suspect he's right when he's in coarser soils, but I think it may be a recipe for failure in fine, silty soil.

Over the years I have dug up many poorly functioning basement drainage systems and often found them to be 4" pipe with the larger holes bedded in 1½" stone, if anything. In many cases the stone was not plugged with silt, but was surprisingly clean. The reason for failure was not that the pipe or stone had plugged with silt, but rather that the pipe was installed too high (above the footing) to lower the water table adequately to protect the basement floor. It's possible that the stone remained clean because groundwater never made its way up into it because it found its way into the basement first!

3.2.4b Pitch: The pipe around the house can virtually be laid level as it needs only the slightest pitch to carry water successfully, unlike a sewer line that is designed to carry floating solids. 1/16" to 1/8" per foot (.5 to 1%) is more than enough pitch, though a steeper pitch is perfectly okay if enough elevation is available

Porous (perforated or slotted pipe) should be used only in the area that needs to be kept dry, especially if the outlet pipe runs near a septic system (see local codes) or if there are trees anywhere near its path. As soon as the pipe has passed the area that needs to be kept dry it is essential to switch to solid pipe with watertight joints where possible to discourage tree roots from entering and plugging the pipe. I prefer to use SDR 35 pipe that is heavier than the thinwall that I use next to the foundation. SDR 35 is available with tapered joints that should tighten up beyond what a root could ever get through when tapped solidly together during installation. More at Section. 3.3.1: Outlets

I tend to be cautious and recommend providing the greatest degree of protection possible, especially when it really is so easy to accomplish. Consequently, I try to use a stabilizing filter material such as sand whenever in doubt about the original material's ability to remain in place when water runs through it. If it is a high water yield situation due to porous granular soil (coarse sand), I'll bed in stone, with or without the fabric depending on the porosity of the soil.

If you are faced with a situation that requires a judgment call, you might talk with an engineer, a soil scientist, or a septic system designer who is required to know local soils when designing systems. Also look to your local NRCS folks who can help you identify soil conditions either on site or from the extensive systems of soil maps that they have at each rural county office.

WHEN IN DOUBT, ASK!

3.2.5 Adding insulation to the wall when the hole is open

3.2.6 Commercial drainage products: Mirafi. Dow Corning, etc

3.2.7 Interior drains: When to choose this alternative, why do most commercial outfits do it

There are two reasons for the installation of interior drains.

<u>First</u>: because the area within the basement may be victim of extreme capillary action or springs that may cause extreme wetness even under the middle of a slab in spite of exterior drains. If installed during original construction it is possible to install interior and exterior drains together or add a bed of stone under the complete slab as discussed.

<u>Second</u>: Interior drains are often much easier and sometimes the only choice for a "retrofit" situation. Their installation is often an afterthought because of a lack of adequate external drainage when the house was built. This is why most "professional" drainage outfits use this method. EXPAND……….

3.2.7 a How to do it
3.2.7 b Double duty for drainage and for radon mitigation
Weeping tiles, local term

3.2.8 Combining interior and exterior in extreme conditions such as the church

3.2.9 Backfilling and backfill material:

Proper backfilling is also important to help keep moisture away from the wall. Good porous sandy backfill against the wall will keep water from lingering and finding its way through imperfections. To conserve the amount of sandy material that may need to be purchased and brought on site it is possible to add sand directly against the wall and original material (with the larger rocks removed) towards the outside of the excavation. I often alternating buckets of sand and original material, and compact these layers as the excavation hole is filled. The backfill should be topped off with nonporous material (clay or loam) and sloped away from the foundation to prevent surface water from entering the ground next to the wall.

DIAGRAM

Conclusion: A properly installed perimeter drain creates an island for a house above the water table by lowering the ground water completely around it. It keeps water from entering under the footings as it did in our beginning examples of foundation failures, and, in my experience, provides the surest protection against any type of dampness in a basement resulting from groundwater.

In fact, every time that I've been able to accomplish the criteria of installing the drain pipe well below the footing, it appears that the drainage job has been successful, whether for new construction or for drying out an existing wet basement.

3.3 Getting rid of the water

When possible, it's best to run the outlet pipe downhill away from the house until it intersects the surface of the ground, allowing the water to run to daylight, as it's called. If it is impossible to run the outlet to daylight, even by using an absolute minimum pitch, it may be possible to relocate water under the ground by sending it to a drywell. Or the drainpipes can lead to a sump that is located either inside or outside of the house. This sump contains a pump, or occasionally, two pumps, that discharge the water out of the sump to a location as far as possible away from the house.

3.3.1 Gravity drain to daylight

3.1.1 a Choosing pipe: In many situations, particularly here in the mountains where the land is seldom flat, it is possible to drain water away from most basements by gravity rather than by pumping. This means running the pipe slightly downhill until it is able to intersect the surface of the ground to daylight. As with the pipes around the house, the outlet pipe need only be barely off the level for water to flow, with 1/16" to 1/8" per foot (.5 to 1%) adequate. This is critical in some locations in order to reach daylight on a gently sloping hillside without having to run onto the neighbor's property.

Watch out for roots! Water flowing through a porous pipe towards a daylight outlet provides an invitation for tree roots to enter and eventually, to block it completely. Therefore it is best to use solid pipe with root proof joints to prevent root penetration whenever possible beyond the area to be drained, as explained in Section 3.2.4

Tree roots do not have the tendency to enter a drainage pipe when the pipe is set down into the water table as most tree roots do not grow in soil that is saturated with water. When a drainage pipe leaves the saturated soil on its way to a “daylight” outlet, however, it is likely to pass through unsaturated soil above the water table. If the drain pipe is porous rather than rootproof, it can invite roots to come inside to soak up moisture after the water table in this area of the pipe has dropped below the pipe. The roots are responding to the stimulus called “hydrotropism” that makes them seek out water just as they should. While they are probably not active at the bottom of the pipe where the water is flowing, they seem to thrive in the moist environment above the flowing water. When the water flow diminishes as spring turns to summer and the water table drops, roots will creep to the bottom of the pipe and can effectively choke it off.

This photo shows the old agricultural style paper fiber drain pipes (Bermico or Orangeburg Land Dry) that I installed to lower the water table throughout my own property in 1972. At this location the pipe is 5’ below grade where roots seldom travel, especially because the water table usually remains high. It’s not here, but where the pipes get closer to the surface that I’ve had the trouble with root intrusion.

Note that this drainpipe was installed in the same trench as my waterline and the utilities that run to my home. While doing a water line repair in 2003 I removed a short section of this pipe to check its condition. It was clear of roots and silt. (The rope inside the pipe was for pulling new lines if needed.)

While I have yet to see a perimeter drain pipe completely stopped up with roots, I have pulled 40’ root masses from the land drainage lines on my own property 15 or 20 years ago. I also had a near backup into my cellar during a time of heavy rain in Spring of 2007 when the outlet pipe to my drainage system could not handle the flow because of the root clogging. I can only guess what my drain pipes that are near the surface and closer to trees look like now that almost 35 years has passed since their installation.

Schedule 40 pipe (the heavy stuff) with glued, root-tight joints should be used wherever there is a possibility of any type of vehicle hitting or crushing it.

The outlet must be located in accordance with regulations regarding distances from septic systems (formerly 75’, now 35’ in NH) and neighbor’s lot lines where required. The end of the pipe should have a rodent guard to keep critters from nesting in this ready-made hotel during the dry season. I use 4 to 6 pieces of brass wire so it won’t rust or corrode, spaced about ½” to ¾” apart to discourage the critters. Anything finer can plug up with algae and silt that might occasionally wash through the line and anything wider might let the little buggers pass, since they can fit through tiny openings seemingly half their size.

The end of the outlet pipe should be placed high enough in the outlet ditch or in a sidehill to let water freefall several inches to keep small amounts of buildup, especially leaves, and other debris, from blocking the pipe. It is helpful to make a header of stone around the outlet for protection. In many cases it is also helpful to place a tall stake next to the outlet (particularly in snow country) in the event it may need to be checked during winter. [Photo 3.3.1 B, C]

3.1.1 b Maintaining the drain outlet: It is essential to keep the drain outlet running freely. The rodent guard must be kept clear of any debris that may have gotten caught onto it from within. The area below the outlet must be kept cleared of leaves and debris, especially if the drain empties into a ditch.

Sometimes drains that have clogged up internally can be cleared by the use of a pressure washer (or even a garden hose taped to a plumber's snake) to break up the clog. I've cleared obstructions from perimeter drains and had water drain out of a basement just like water leaving a bathtub.

Outlet at left is for my own house perimeter drain plus several hundred feet of subsurface land drainage that daylight into a ditch. Note stone header and brass wire rodent guard in place for 25 years.

Right photo is an extremely heavy schedule 80 pipe that was installed under a state road by directional boring. Note the commercial rodent guard.

3.3.2 Relocating water underground: drywells & soakaways

If the drain pipe can not be run to a safe outlet area it may be possible to run the outlet to a dry well [explain] on the property that is downhill from the house but high enough above the water table to "relocate" the water on site without it ever being brought to the surface.
[Photo 3.3.2]

3.3.3 Alternatives to gravity venting: Sump pump systems

If it's not possible to relocate the water underground or run it by gravity to daylight, it may be necessary to connect the perimeter drains to a collection basin, or sump, inside or outside of the house. From there a sump pump can push water away from the house. It is helpful to find a place to send the water that is far enough away so that it does not just short circuit into the ground and back into the basement. The disadvantage of using a pump is dependence on the longevity of the pump and the supply of electricity.

Sump pump saga: I can remember receiving letters from home years ago telling of the recurring disasters to my aunt's house caused by excess water in her basement when her sump pump failed. Freezers full of spoiled food, ruined furniture and the general nuisance of a flooded basement were becoming too much to bear.

On one trip home I did some grade checking and told the folks that a gravity drain could probably solve the problem. They went ahead and had one installed and have had no more trouble with unexpected flooding or pump maintenance since. It still makes me wonder why it took so long for anyone to make that obvious recommendation. Yet I know of similar situations that exist today, and house that are being built where sump pumps are expected to do what could be done with a few pieces of pipe and some planning.

Many basement drainage companies still rely on sump pumps for all installations, regardless of whether or not gravity could be used to vent the water. This creates a long-term dependence on a mechanical device.

Sump pumps can get plugged up, wear out, fail to come on after months of non-use, or stop because of a power failure. Unfortunately, it is often during the worst weather conditions that power is lost in rural areas while, at the same time, excessive rainfall is causing the water table to rise. About the only assured way to protect a basement is to have a battery-powered back-up system set to come on automatically when all else fails. Such systems are now on the market but represent additional investment and occasional maintenance to keep them in working order. They use an automotive-type battery for power, as do the safety lights in public buildings.

There is also a new style pump available that uses water from a garden hose to power it, but this is only effective when powered by a community or municipal water supply that does not require electricity to the house to keep it operating. And, from what I've seen, it requires someone to set it up when it's needed unless it's hooked to some sort of elaborate switching system. There is always the possibility of using a gasoline or even LP gas powered pumps, like the pumps shown in the Photo Quiz on the Website. These pumps come large enough to handle an unlimited amount of water, but should only be used in emergencies such as hurricanes or floods because they require monitoring, which in extreme circumstances can be a reasonable alternative to losing the contents of a basement.

If there is no choice but to install a sump pump, selecting the right pump should be based on the severity of the situation. There are many types on the market, but I prefer the submersible style with a built-in of-off switch, especially in extreme situations. Excessive dampness can quickly corrode unprotected motors on pedestal pumps and a power failure that allows water to completely cover an unprotected motor can require replacement of the entire pump.

Also, there are automatic switches now available that allow sump pumps to draw water down to within a fraction of an inch of the floor and to turn on when water is only slightly deeper. This can be helpful for occasionally dewatering a basement without digging a sump hole through the concrete floor or having the basement flood to several inches deep before the pump automatically comes on.

Electric pumps should be sized to adequately handle the volume of water flowing into the sump with relative ease, but should run longer than a few seconds at a time for their long term well being. It can be difficult to judge this flow demand in many, if not most cases, because Mother Nature does not drop water the same amount of water on us each time it rains. It is, therefore, better to be safe than sorry and use a larger pump than might be necessary, even if the pump does not get to operate for a minute or more during each cycle as it should for optimum longevity.

Much of this "engineering" for the worst case scenario should be based on the value of the area to be protected. A seldom used cellar with nothing on the floor needs far less protection than a finished basement with carpeted floors. Seeking the advice of a good plumber or plumbing supply store in a rural area is a wise measure for choosing the best pump for your application.

sketch of WaterRamp with pump in pan [Photo 3.3.3 A]

3.3.3 a Sump design & location Many times I find sump pump pits that are constructed so they cannot store enough water to optimize the run-time of a sump pump. Therefore the pump runs for three or four seconds, empties the pit and shuts of, the pit refills in just a few more seconds, and the cycle repeats, over and over and over. Another closely related problem I often see is that the drainage system is not designed to allow water to get to the sump as fast as it should so the pump can do its job correctly.

> A soggy example of a sump that was poorly designed served a house in a nearby town since the 1950's. When the owner, who I had gotten to know, found out that I messed around with basement drains he asked me to have a look at his situation. Because the house was built in a hole blasted out of the ledge, the sump pump was relied on to get water out of the basement. The sump pump worked okay but the basement floor was always wet in spite of it.
>
> When I looked at the situation I was thoroughly puzzled at the design of the pit, as it appeared to be a concrete box with a concrete bottom that was cast securely into the concrete basement floor. The whole structure appeared to be absolutely watertight. This could only mean that the sump was not connected to the source of the groundwater, that is, the underside of the slab, but rather that it only collected water after it was forced to rise up around the perimeter of the floor and run over the floor to get to the sump.
>
> I hammerdilled a three quarter inch hole in the side of the sump and, sure enough, water shot into the sump like it was coming out the end of a hose. I drilled another hole just for good measure and went home a hero. Fortunately the house is constructed like a concrete bunker with a concrete ceiling over the basement area, so it had not suffered too seriously for its forty years of being waterlogged, unlike the things that had been left in it. [3.3.3 B]

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It is critical that a sump be designed and placed so that ground water can get to it. For any situation, whether building new or solving an existing problem, this means installing a drainage system that will lead the water to the pit just as it would have sent water downhill to a drywell or to a daylight outlet if it were possible. Many sump installation are adequate only to get rid of a little bit of water when it finally reaches the sump, much like the one in the extreme example above, resulting in some standing water remaining in the basement or, at least, damagingly high humidity during times of high groundwater.

If a basement floor were constructed with a layer of porous crushed stone beneath it, or a web of drainage pipes leading to a sump or to daylight, there would be little chance of water wicking up through the floor and water would easily follow the pipe and/or stone to the sump or outlet. However, many sumps are installed as an afterthought with inadequate provision for water to get to them.

A sump should be just like the distribution box in a septic system, but with the reverse function, that is, to gather water rather than disperse it. A sump can be made out of virtually any material that resists deterioration in a repeatedly wet environment. Concrete and plastic are both well suited, with plastic being my material of choice for several reasons. Not the least of these is that plastic is readily available as culvert pipe these days and there are also many ready made pump stations as well as plastic distribution boxes for septic system installations that might be able to double as sump pits. I tend to use plastic culvert, the new style that has a smooth interior wall, because it should last forever in wet ground since that's what it's designed for, and it's easy to work with. The culvert is very strong so there is no danger of collapsing it during installation. I can cut it to the length I need to provide enough depth below the floor to draw water low enough to overcome the capillary action of the soil under the floor. This is especially helpful if there is no system under the floor to readily get water to the sump. This employs the same principle as locating a perimeter drain pipe as low as possible below the footing to reduce capillary wicking under the slab.

The difference between the sump and the perimeter drain is that drawing the water level substantially below the floor by using a deep sump can help to buy a "grace" period during a short power outage or pump failure. (This isn't needed with a gravity vent, since gravity is seldom prone to failure.) The deeper the water level is drawn down, the longer the basement can remain dry before the power comes back on or the pump get repaired. The disadvantage of this scenario is that it forces the pump to run longer or more often to keep the water level lower. This may be of little consequence in tight soils that give up water slowly, but can mean a substantial difference in very porous gravel or sand.

How does water get through the culvert pipe into the sump? If there are no pipes under the floor leading to the sump, I drill a gridwork of ½" to 5/8 holes through the valleys in the corrugations of the pipe. Any pattern for the holes is fine since it doesn't matter to the incoming water, but what does matter is having lots of holes, say 50 to 100, so water can flow in easily. After the sump is set in place, I backfill around the outside with a mixture of ¾" stone and peastone if I'm working in fine soil. The small stone is intended to help hold back the original soil as discussed in section 3.2.3.

If there is a piping system under the floor, I drill 4¼ holes with a hole saw that slip fits typical 4" SDR perfectly. Because the culvert is round, I can position the incoming pipes anywhere around its circumference. When drilling the 4½"holes, it's easiest to center the pilot drill for the hole saw on top of the ridges of the pipe rather than in the valleys, so it helps to plan the level of the pipe so that the center of one of the rings is close to the vertical center of where the pipes will enter the sump.

I generally use 15" culvert for smaller sumps and 18" for larger, with the area required for the pump and the desired storage area dictating how big the pipe should be. Sometimes I set a concrete patio block as a base for the sump to set on to provide a solid, non-eroding base for the pump. I've also used sheet plastic goods, such as recycled sign sheet acrylic plastic that I've screwed onto the bottom ring to hold it together until it's all in place and backfilled.

For covers, there are new plastic septic tank riser covers that fit very nicely onto 18" culvert and 24" would make a very finished top to a culvert sump.

If used instead of culvert, a plastic sump package will also require having holes drilled in it in order to let water in, either from the stone bedding surrounding the sump or through incoming 4 pipes. These are similar to what many of the commercial waterproofing companies use. Also, if there is a need for radon mitigation in the basement (airborne, rather than waterborne) a sump with a sealed cover can double as an interception area, as the principal for gathering radon is very similar for that of collecting water, except that radon is always a gas.

3.3.3 b Setting the pump switch level: Many pumps come with their own on/off switch built in. Some of these switches are adjustable for differential, that is, the level of Turn-On versus the level of Turn-Off. This can be a help in some situations where you might need to keep the water pumped as far down in the sump as possible either to lower the water level under the slab to reduce capillary action, or to provide some grace period because of frequent power failures.

In order to minimize total pump running time it's possible to set the pump so that it turns on when water rises to just a little below the floor level, and turns off at the preset 6" to 8" below. Setting the pump on 2" or 4" concrete blocks can make this adjustment possible. If the floor appears too damp, try lowering the pump in the sump or resetting the float level if possible. Another option is to purchase what is called a "manual" pump, meaning one with no on/off switch. A float switch can be purchased separately and the pump cord plugs piggyback style into the float plug. This allows the pump itself to be set into the bottom of the sump and the separate switch to be mounted on the discharge line where it can be moved up and down for optimum setting.

3.3.3 c Locating the sump: A dewatering sump can be located inside of a basement in a utility area or outside of a house, preferably on the side where the discharge runs. The same principles apply to either, except that the exterior sump will, of necessity, usually be much taller, making culvert pipe a good choice because of the lengths in which ist is available (20). It may be difficult to purchase a 3' or 4' piece of culvert from the typical supplier, so I'd look for a local sitework contractor to see if he can provide a cutoff from some job.

An advantage of locating the sump outside of the house is the reduction in noise by not having the pump in the basement. This may be a shot in the foot for some, however, who may appreciate hearing the rhythm of the pump during a spring rain to know the basement is being kept dry.

3.3.3 d Discharge lines, frost protection

3.3.4 Obtaining necessary permits and/or permission to discharge

4.0 DEALING WITH CONDENSATION:

The effects of condensation can be as devastating to a home as water leakage, causing rot, mold, mildew and generally disgusting and, possibly, unsafe conditions. I've even seen mushrooms growing inside a house on one occasion. Because so many of our local dwellings are vacation homes, many are lived in only a part of the time. This can mean inadequate ventilation (as houses are closed up much of the time) which is often aggravated by colder than normal internal temperatures. Many of these homes are only heated to just above freezing during much of the winter, if at all. When folks arrive for the summer, they open the house, letting in warm, humid air that looses its moisture as it condenses on cool basement surfaces. [Photo here]

Perhaps the best solution for this is to have the house opened earlier in the springtime, allowing the basement temperature to equalize. Dehumidifiers can also help, but at least one basement drainage expert warns that dehumidifiers may actually cause more damage to basements by pulling in more humid air, like bug killers pull in the neighbor's bugs also. This may be true when the basement is opened to outside air, but probably not true if it is left sealed up so the dehumidifier can work on just the moist air that's already there.

In conclusion, the keys to effectively addressing a basement moisture problem are:

- Proper diagnosis- choosing whether the source is surface or ground water or warm, moist air condensing on cool surfaces, or a combination of two or more of these sources,
- Following accepted practices to keep water from entering through the basement walls and/or lower the water table around the structure, and
- Maintaining the drainage system to make sure that water goes where you want it to!

Also see the University of Minnesota Extension Bulletin Moisture in Basements: Causes and Solutions www.extension.umn.edu/Documents/D/K/DK7051.html

PART II: AVOIDING PROBLEMS IN NEW HOMES …
to be added when time permits