A GUIDE TO FIXING YOUR DAMP BASEMENT

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Cette publication est aussi disponible en français sous le titre: ***Guide de correction des problèmes d'humidité dans les sous-sols***, 65887

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A guide to fixing your damp basement.

Issued also in French under title: guide de correction des problèmes d'humidité dans les sous-sols.
Previously issued 1992 under title: Investigating, diagnosing and treating your damp basement.
Includes bibliographical references: p.

ISBN 978-0-660-19781-4
Cat. no.: NH15-72/2007E

1. Basements – Moisture – Handbooks, manuals, etc.

2. Foundations – Moisture – Handbooks, manuals, etc.

I. Canada Mortgage and Housing Corporation.

TH7684 B35 G84 2007 643'.5 C2007-980289-3

Revised and reprinted 2008

Printed in Canada

Produced by CMHC

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PREFACE

A Guide to Fixing Your Damp Basement provides a quick method for diagnosing moisture problems, and identifying and deciding on the solutions to deal with these problems. This is not a do-it-yourself guide. *The Guide* assists in diagnosing the problems, provides options for solving these problems, and helps decide on the plan of action required.

For convenience, the *Guide* is set up in a manner that allows its use as a reference tool. The user, therefore, does not need to read it in its entirety. The user can refer to any of the sections or parts thereof to learn about moisture in his/her home and its implications for the building and occupants; diagnose the problem by determining moisture causes and sources; and identify and choose solutions related to any cause or source.

NOTE

All technical terms written in italics are explained in the glossary at the end of this guide.

INTRODUCTION

HOW TO USE THIS GUIDE

MOISTURE ASPECTS TO CONSIDER

A Guide to Fixing Your Damp Basement is intended to provide homeowners and homebuyers with guidelines to help deal with most problems relating to damp basements.

The "Introduction", provides general information on moisture, and guidance on how to diagnose problems.

"Basement Investigation, Diagnosis, Treatment"

"Symptoms", provides the list of basement moisture problems that do occur and points you to likely sources and causes.

"Sources And Causes", describes why the moisture problems are occurring.

"Solutions", tells you how to fix them. Solutions starts out with the ideal basement retrofit that resolves all problems, and then lists partial or temporary solutions that may work well enough for your own needs.

"Appendixes"

- A description of materials used to fix wet foundations
- A glossary of terms used in the book
- Websites with other views on foundation problems

High moisture levels can lead to damage to the basement construction, finishes and household effects stored there.

A damp and musty basement is not only unpleasant; it can also adversely affect the health of the occupants. According to a Health Canada survey, approximately 38 per cent of Canadian homes had indications of excessive dampness or *mold*. The survey indicates that the influence of dampness and *mold* on respiratory health is "an important public health issue."

Homeowners' and homebuyers' level of awareness and concern over the quality of indoor air in the home is increasing. Since many people spend a relatively significant portion of their lives at home, they need to be assured of good air quality in their homes.

In many instances, relatively minor measures will reduce, if not resolve, moisture problems in the basement.

NOTE

The terms in italics in the text are defined in the Glossary.

What is basement moisture?

Basement moisture can be defined as dampness in the form of water vapour in the air, soil and materials, as condensed liquid water on cool surfaces, and water from leakage. Condensed moisture can also be in the form of ice or frost. Exterior sources of moisture around the basement are shown in figure 1.

What is liquid flow by gravity?

Liquid water flows due to the effect of gravity, which causes water to run downward. *Hydrostatic pressure* can develop and force water through openings in the basement walls or floor. High *hydrostatic pressure* can be caused by flooding, extreme rainfall, snowmelt water or a high *water table*.

What is *capillary* action?

Capillary action is the movement of water which is wicked by fine pores (due to surface tension forces) in soil, concrete, brick, mortar, wood and other materials. It moves in any direction through these materials, but has a maximum upwards (vertical) rise above the source of liquid water that is dependent on pore size. In trees, it helps transport water all the way to the top leaves.

What is water vapour and how is it transported?

When liquid water evaporates it becomes part of the air. The amount of water vapour (moisture) that air can hold before it becomes saturated (that is, a condition where the air is holding, at a certain temperature, all of the moisture that it can) depends on the temperature of the air. The warmer the air, the more moisture it can hold. Water vapour can also travel by convective air transport (that is, carried along with air currents moving from one location to another, through cracks and openings in walls, floors and ceilings).

Why should you control moisture levels in the basement?

Dampness leads to an increase in the moisture content of materials and, in organic materials, can cause *mold*, rot and damage.

Basements can acquire an unpleasant odour because of chemicals given off when *mold* growth occurs (although some rot can occur without producing this characteristic musty odour). The emissions can result in a health hazard.

Leaky or damp basements supply moisture to the rest of the house. High levels of moisture lead to excessive window *condensation* during winter, and to *condensation* on exterior wall and floor surfaces, especially in summer.

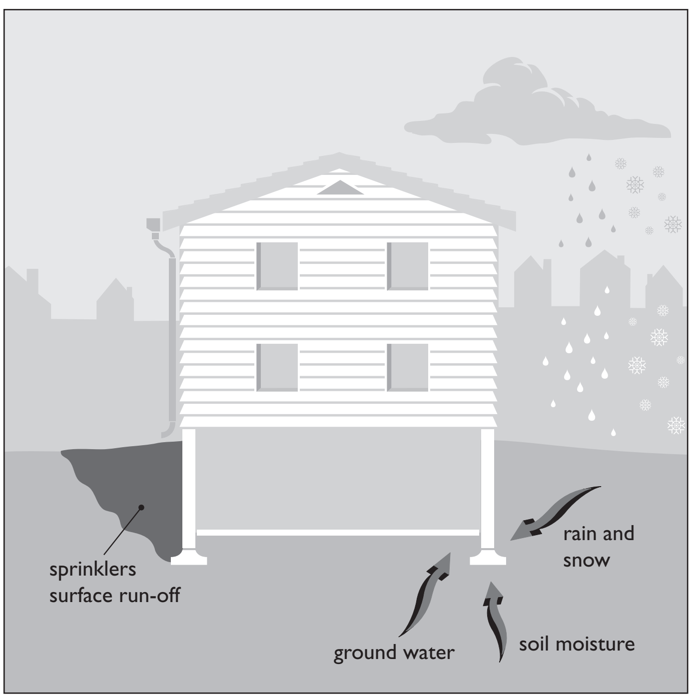


Figure 1 Exterior source of moisture around basement

How does moisture affect your home's indoor air quality and your health?

Big moisture sources or inadequate *ventilation* lead to high concentrations of water vapour and other pollutants. A house with high humidity will usually have higher levels of biological activity (*mold*, dust mites, bugs) and damage due to condensation in the winter.

High moisture levels can lead to increased respiratory infections in children and adults, according to a Health Canada survey on the influence of home dampness and *mold* on respiratory health. Chemical emissions from certain building materials and finishes increase with increased moisture levels.

What is relative humidity?

The amount of water vapour that air can hold depends on, or is "relative" to, the air temperature. Warm air can hold more water vapour than cooler air. (See figure 2)

Relative humidity indicates the percentage of moisture at saturation that the air holds. It is "relative" to saturation at a specified temperature. For example, at 20°C (68°F) and 50 per cent *relative humidity*, the moisture content (measured as the weight of water in air) of air is twice that of air at 10°C (50°F) and 50 per cent *relative humidity*. (See figure 3)

If air at 20°C and 50 per cent *relative humidity* is cooled to slightly below 10°C, its *relative humidity* reaches 100 per cent, or saturation. On further cooling, moisture will condense from the air. An example of this effect is the familiar dew on grass and mist on window panes. (See figure 4)

Frost is an example of dew that forms at below-freezing temperatures. Fog in the air is simply dew on dust particles floating in the air.

At greater than 70 per cent *relative humidity* and above 5°C (41°F), conditions are favourable for the growth of *mold* and the rot of wood. (See figure 5)

The best way to measure humidity is to buy a hygrometer (or *relative humidity* indicator) for less than $10 at a hardware store. Indoor relative humidity levels can be approximated by observation of window *condensation* in the home in winter. For example, if your home is equipped with double-glazed windows (with open curtains and a normal-depth window well) and you observe persistent *condensation* when outside temperatures are -10°C (14°F) (at a house temperature of 21°C (70°F), then your home's *relative humidity* is about 40 per cent.

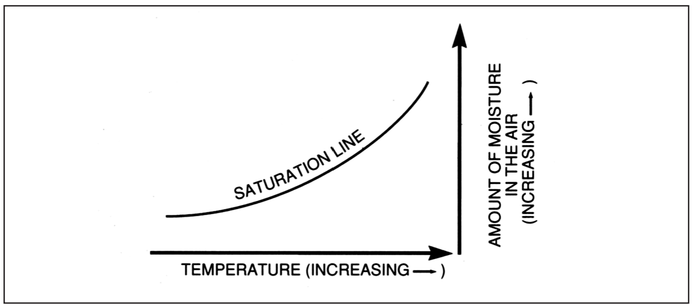


Figure 2

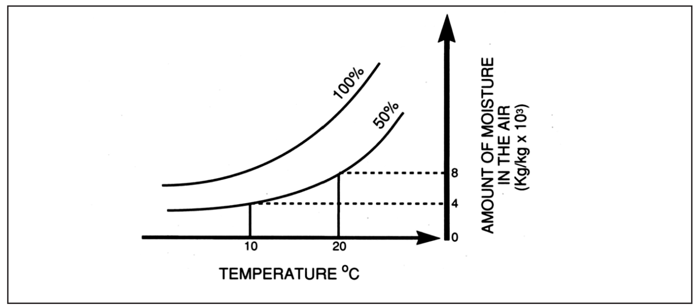


Figure 3

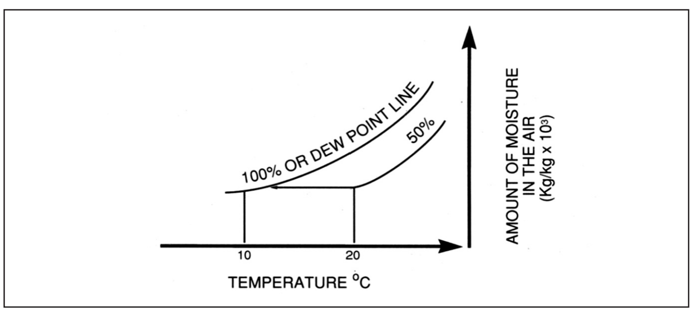


Figure 4

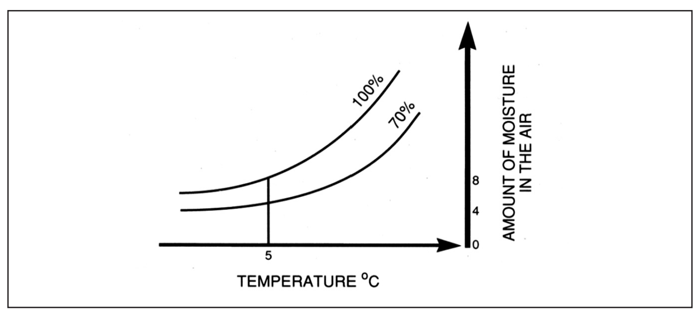


Figure 5

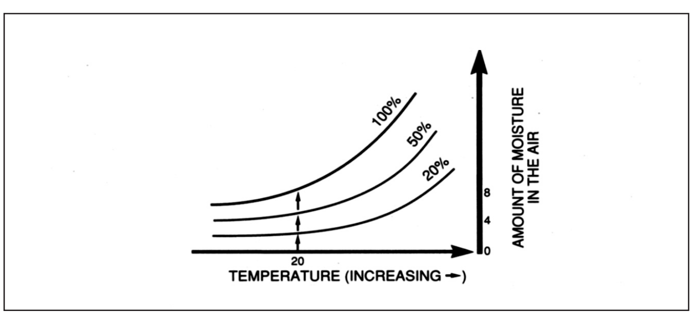


Figure 6

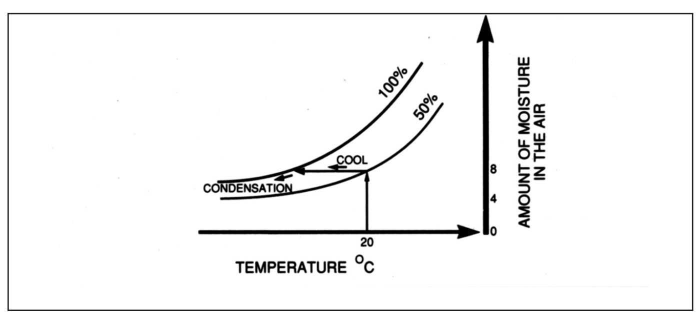


Figure 7

Note: In Figure 3 and Figure 4, "Kg/kg" is kilograms of water vapour over kilograms of dry air.

What is condensation and the dew point?

The terms "saturation," "100 per cent *relative humidity*" and "*dew point*" mean the same thing. They refer to that unique condition where the air is holding all of the moisture it can. Condensation occurs when surfaces are cooler than the *dew point* temperature.

When moisture is added to the air, its *relative humidity* increases, eventually reaching saturation at 100 per cent *relative humidity*. (See figure 6)

As the air is cooled, for example by coming in contact with a cool window surface or a cool wall, the *relative humidity* increases, eventually running into the *dew point* or 100 per cent relative humidity line. Cooling below this line will result in *condensation*. (See figure 7)

How To Search For And Diagnose Moisture Problems

Many damp basement symptoms can be easily recognized. Do a thorough and systematic search. Do not just visually scan the basement.

Use your senses when you inspect the basement. Look for any symptoms such as staining in corners; between basement walls and floor slab; behind furniture, storage lockers, drapes; underneath carpets; in the ceiling space between *headers* and *joist* ends; around windows, drains and other openings; and along walls. Keep an alert nose for strong and musty odours. Since the nose adapts to smells, take a walk outside and return quickly to troubled areas to confirm the problem.

Having identified the symptoms, start looking for the sources and causes of each of these symptoms. Again, be thorough and systematic in your search. Start looking for the source and cause at the location of the symptom, then move away from that location in a systematic manner if the cause is not close to the location. Check the interior basement area thoroughly, then check the exterior house perimeter. Do any testing for sources and causes as described in the "Sources and Causes."

Try to find the source or cause and determine whether it is seasonal, periodic or permanent.

Take notes to make sure you have covered all probable sources and causes. You may want to list items such as location of symptoms (you can also take photographs, which you can show to an engineer, home inspector or contractor), the time of year the symptoms occur and their history. Indicate the probable sources and causes of this symptom in your home. (The location, time of year and history can also be indicated) Then look at possible solutions. If you do the repair work yourself, this information will be helpful in planning the work. If you hire a professional, this information can assist in any discussion with that professional.

What Is The "Usual Solution"?

Try the no-cost/low-cost quick fixes.

- Control occupant moisture sources. This is usually an inexpensive and easy thing to do, but may require lifestyle modifications that you may not wish to continue.
- If the control of occupant moisture sources does not solve the problem, make any necessary adjustment to the *ventilation*. In summer install a dehumidifier— few Canadian homes get by without one.
- Choose the easy-to-do, low-cost solution that addresses the most critical problems. After rain or snowmelt, check grading. Redirect the *downspout* away from the house if leakage is associated with rain. If the problem persists, implement feasible structural solutions.

What other considerations might affect your decision?

- Can you fix it yourself?
- Is it safe to fix it yourself? Are you aware of safety considerations?
- Are there other important benefits to the proposed remedial action?
- Is the cost within your budget?
- Is the solution cost-effective over the long term (taking all benefits into account)?
- Are there any physical restrictions making the solution impractical or impossible to implement (for instance, can you access the area, dig a trench, use your neighbour's lot)?
- Is a building permit required? Municipal building departments can help in this regard.
- Is professional advice or help (engineer, architect, builder/contractor) required?
- Can walls be excavated without caving in? Check trenching bylaws.

The best solution is the most comprehensive one. See page 43 for a description of how to make your basement dry for decades.

BASEMENT INVESTIGATION, DIAGNOSIS, TREATMENT

HOW TO USE THIS GUIDE

SYMPTOMS

MOISTURE ASPECTS TO CONSIDER

SOURCES AND CAUSES

SOLUTIONS

1. WATER PENETRATING THROUGH BASEMENT WALLS AND FLOORS

Description

Water penetrates or leaks through cracks, seams, or openings in the basement envelope construction, including through interior insulation and/or finishes. (See figure 8.)

Water trickles out, causing wet spots on walls and/or standing water on the adjacent floor.

List of Probable Sources and Causes

- Lack of, or defective, *eavestroughs/downspouts.*
- Surface runoff due to poor grading.
- Slow draining *backfill* around basement.
- Improperly drained window wells
- Blocked or ineffective drainage system.
- Defective or missing *footing drainage* system.
- High water table.
- Melting snow adjacent to *foundation walls.*

Almost all listed sources and causes can be related to wet walls and floors.

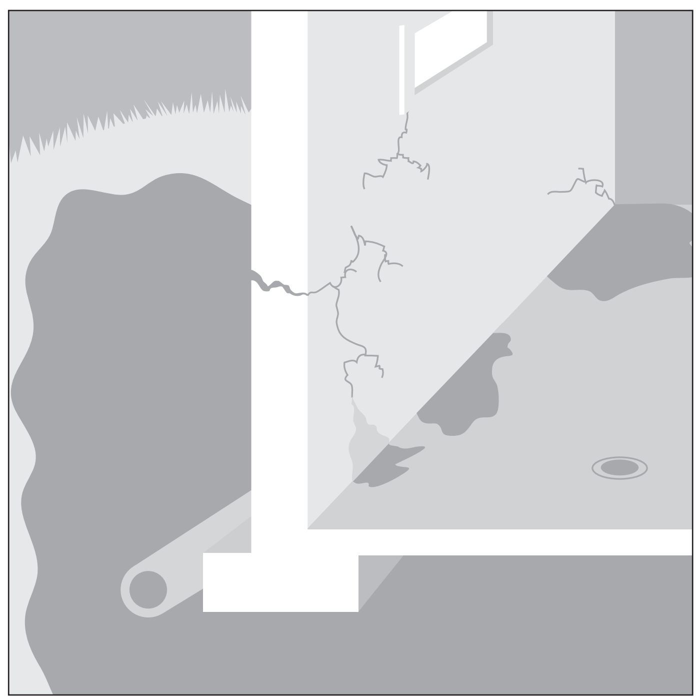


Figure 8 Water penetrates or leaks through cracks or openings in the basement foundation walls and floor slabs

2. WATER PENETRATING UP THROUGH BASEMENT FLOOR SLAB

Description

Water penetrates through cracks or openings in the basement floor (such as floor drains, cracks between the floor slab and basement walls, cracks in the floor itself, or other openings in the floor slab such as those for utilities). (See figure 8)

List of Probable Sources and Causes

- Blocked or ineffective drainage system.
- Ineffective sump pits or pumps.
- High *water table*.
- Ruptured municipal waterlines.

3. WATER SATURATING BASE OF MASONRY WALLS AND FLOOR SLAB

Description

Water saturates the base of masonry basement walls and saturates the basement floor slab.

Discussion

Due to rising moisture by capillarity or wicking action, the floor slab or the basement walls may become saturated and damp if this moisture cannot evaporate to the interior at a sufficient rate. The result is damp basement walls and floor, and excessively high basement/house *relative humidity*. (See figure 9.)

Capillary action will not and cannot result in the deposition of a visible layer of water (shiny surface); instead the surface will look like a damp clay flowerpot after watering.

Inspection/Test/Check (Block Walls)

- Blocked or ineffective drainage system.
- Inadequately draining backfill around basement.
- Ineffective sump pits or pumps.
- High *water table*.
- Ruptured municipal waterlines.

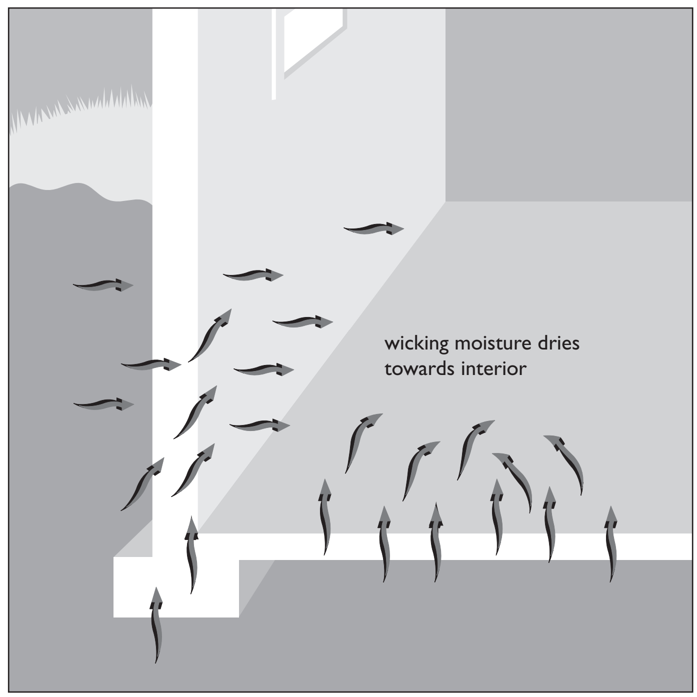


Figure 9 Rising moisture by wicking (capillary) action

4. DAMP FEELING AND HUMID BASEMENT AIR (WINTER)

Description

A general sensation of dampness and persisting winter *condensation* on windows indicates high relative humidity levels due to interior or exterior sources. (See figure 10.)

Odours from household activities that take place in the basement may tend to linger. This indicates that there is insufficient *ventilation* and distribution of *ventilation* air.

Frost and ice on cold surfaces also indicate moisture problems.

List of Probable Sources and Causes

- Air leakage from sumps and drains.
- Water vapour *diffusion* through walls/floor.
- High indoor humidity due to occupant/internal sources (and insufficient distribution of *ventilation air*).

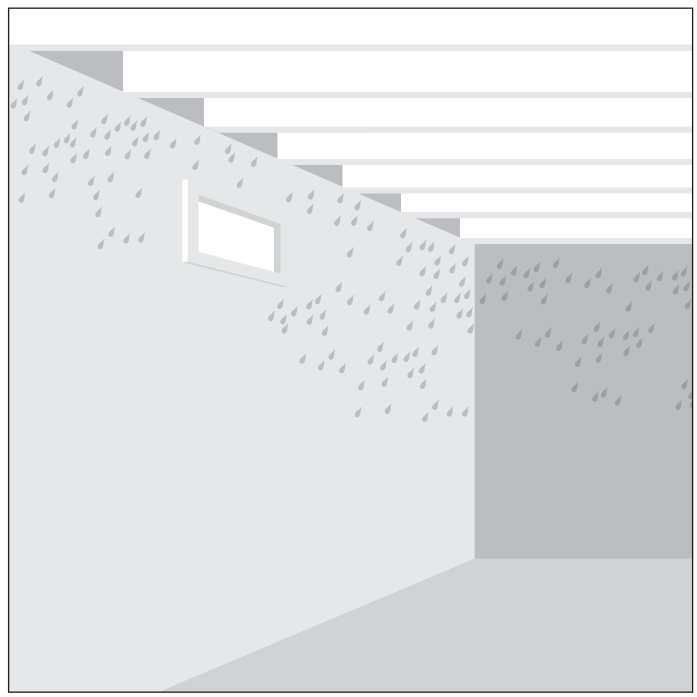


Figure 10 General damp feeling and condensation on cold surfaces

5. CONDENSATION ON COLD WALL, FLOOR OR OTHER SURFACES [SUMMER]

Description

Locations where *condensation* (or sweating of surfaces) in the basement can take place include: the interior, below-*grade* surfaces of exterior basement walls, floors, cold water pipes and cold air conditioning ducts.

Discussion

The moisture content of outside, warm summer air is high while basement walls, floor and air are cool and below the *dew point* of outside air. *Condensation* or sweating on surfaces is the result of moist outside air coming in contact with cool or cold surfaces.

(See figure 10) (Basement walls and floors that are not insulated are in contact with cool soil on the exterior, resulting in a surface temperature which is below the *dew point* temperature for *ventilation* air.)

List of Probable Sources and Causes

- Humid outside air used for summertime *ventilation*.
- High indoor humidity due to occupant/internal sources.
- Cold basement walls or floor.

6. ROT AND DECAY OF WOOD HEADERS, JOISTS AND SILL PLATES

Description

Wood-*decay fungi* include *mold*, mildew and *dry rot*.

Any sign of water stains, rot, or mushroom-like growths on or around *headers*, *sill plates* and *joist* ends indicates the onset of wood decay.

Discussion

Wood-*decay fungi* not only cause visible surface staining but can cause the breaking down of wood into soft and weak sections.

Decay fungi need a favourable environment to grow (temperatures above 5°C (41°F) and relative humidity above 70 per cent).

Decay often starts around headers, sill plates and joist ends, and can transport water and moisture to adjacent wood. (See figure 11) Decay-causing moisture can also pass through lime mortars and plaster.

A lack of a moisture barrier membrane between the wood and the damp concrete (or masonry) allows the wood to wick-up moisture and deteriorate. The "Pick Test" and "Tap Test" are useful in detecting wood decay. (See figure 12)

List of Probable Sources and Causes

- Lack of, or defective, *eavestroughs/downspouts.*
- Surface runoff due to poor grading.
- Blocked or ineffective drainage system
- Above-grade walls sending moisture to the foundation.
- Melting snow adjacent to foundation walls.
- High indoor humidity due to occupant/internal sources.

NOTE Any other sources and causes resulting in high basement relative humidity can result in the above symptoms.

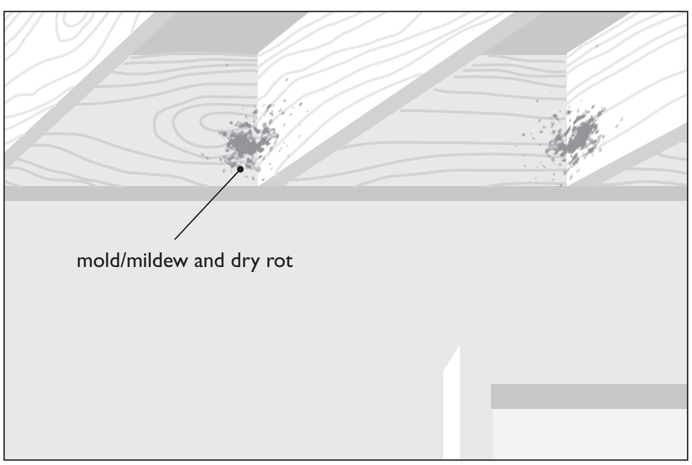


Figure 11 Rot and decay of wood headers, joists and sill plates

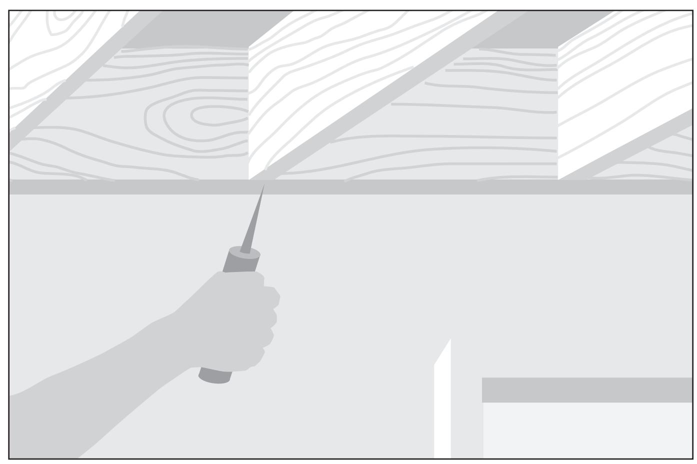


Figure 12 "Pick test" to detect wood decay. Long slivers when wood is split indicate sound wood; short slivers and breaks indicate decay.

"Tap Test" – A sharp and clear sound when wood is tapped indicates good and dry wood; a dull and soft sound indicates wet or decaying wood.

7. ODOUR, MOLD AND MILDEW

Description

Musty basement odours and moldy smells, especially during summer, indicate fungi growth in the form of *mold* and *mildew.*

Visible mold and *mildew* on walls and surfaces is often in the form of white, orange, green, brown or black stains. Certain growths are papery with vine-like strands and often have a dirty white or yellowish colour. These can exist on damp masonry surfaces, under carpets, or on framing in sub-floors. They can also be found behind moisture barriers (for example, plastic, tarpaper, etc.) placed between the foundation walls and the wood framing.

Another indication of the existence of mold and mildew is allergic responses such as coughing, sneezing, congestion, runny eyes and nose, shortness of breath and other respiratory difficulties. Other indications in sensitive people include itchy skin, rashes, fainting and even palpitations.

List of Probable Sources and Causes

- The householder should check the more obvious sources and causes first, starting with the easily and readily identifiable ones.
- The householder should also determine whether the symptom is seasonal, periodic or permanent, and then try to determine the source and cause.

8. BUCKLING OF WOOD SUBFLOOR AND UPLIFT OF FLOOR TILES AND CARPETING

Description

Wood subfloor over basement floor slab buckles and swells.

Floor tiles uplift and their surfaces deteriorate. (See Figure 13.)

Carpets and carpet tiles lift up and deteriorate.

List of Probable Sources and Causes

- Blocked or ineffective drainage system.
- Ineffective sump pits or pumps.
- High *water table*.
- *Diffusion* through the walls or floor slab.
- Cold basement walls or floor.

Figure 13 Uplift of floor tiles or buckling of wood subfloor

9. UPLIFT OF WALLPAPER AND DETERIORATION OF WOOD FINISHES

Description

Wallpaper lifts off gypsum board or other wall surface. (See figure 14.)

Blisters form under wallpaper.

Wood finishes warp, cup, swell and crack when allowed to dry. (See figure 14.)

Discussion

The above symptoms indicate the existence of moisture behind the wall finishes. The source may be an exterior one or an interior one, such as inside air leaking into the finished wall cavity and out at the bottom of the wall, leaving moisture behind.

List of Probable Sources and Causes

- The householder should check the more obvious sources and causes first, starting with the easily and readily identifiable ones. The householder should also determine whether the symptom is seasonal, periodic or permanent, and then try to determine the source and cause.

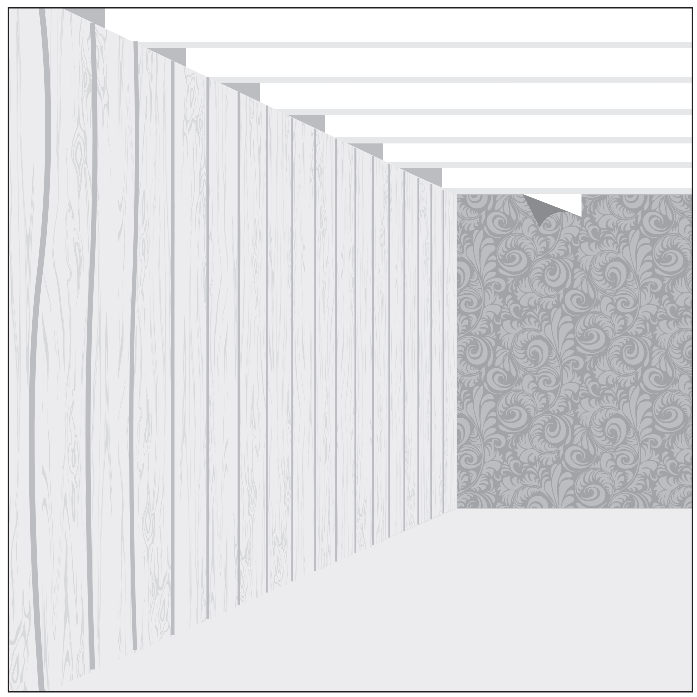


Figure 14 Lift-up of wall paper and deformation of wood finishes

10. DISCOLORATION, STAINING AND TEXTURE CHANGES OF INTERIOR FINISHES AND FURNISHINGS

Description

Discoloration, staining and texture change to interior finishes and furnishings indicate moisture damage. Visible signs include black or dark streaks or lines and stains.

Paint peels, blisters or cracks, and the underlying surface is exposed between cracks or under blisters.

Corrosion and rust occurs on metal surfaces.

List of Probable Sources and Causes

- The householder should check the more obvious sources and causes first, starting with the easily and readily identifiable ones. The householder should also determine whether the symptom is seasonal, periodic or permanent, and then try to determine the source and cause.

11. *EFFLORESCENCE*, SPALLING OR CRUMBLING OF CONCRETE AND MASONRY SURFACES

Description

Efflorescence, that is, white salt deposit (powdery substance) is calcium carbonate precipitate. It forms on masonry surfaces.

Concrete, concrete block and brick surfaces become crumbly.

Masonry surfaces chip and spall and mortar joints crumble

Paint on masonry basement walls and floors peels off.

Discussion

When the floor or walls are damp and drying towards the interior, the salts carried by the drying moisture are left on the surface as a white deposit (*efflorescence*), accumulate below the paint (causing blistering and flaking), or accumulate in the concrete or masonry surface layers (causing crumbling and spalling).

List of Probable Sources and Causes

- Lack of, or defective, eavestroughs/downspouts.
- Slow draining *backfill* material.
- Blocked or ineffective drainage system.
- High water table.
- Melting snow adjacent to *foundation walls*.
- Water vapour *diffusion* through walls/floors.

Introduction:

Moisture protection for building elements in contact with the ground is generally categorized as either waterproofing or dampproofing. Waterproofing provides continuous protection against water ingress and is intended to resist hydrostatic load. Dampproofing, on the other hand, does not provide a seal against water ingress and cannot withstand hydrostatic pressure. In general, Part 9 of the National Building Code would apparently require walls and floors in contact with the ground to be waterproofed.

This is typical postwar foundation construction:

- a hole is dug,
- underground services (water, sewer, etc.) are trenched to the house,
- a wide strip of concrete (the footing) is poured,
- the area which will be under the floor slab is filled with clear stone (no dust) to the height of the footings,
- forms are set up, and a solid wall is poured OR blocks are laid on top of the footing using mortar to hold them together,
- the exterior of block walls are "parged" with a thin layer of mortar,
- the walls are "dampproofed" with a single layer of tar,
- a clay weeping tile or perforated plastic pipe, which should lead to a sewer or sump pit, is laid beside the footings.
- the tile is covered with a minimum of 15 cm (6 in.) of clear stone,
- the original excavation material is used to fill the trench.
- the floor slab is eventually poured through a window.

The basic goal is for moisture to drain through the backfill material to the clear stone around the tiles. The stone allows water to enter through the gaps in the tiles or the holes in the plastic pipe. The tiles should lead directly to a sump pit or a sewer. The dampproofing layer, if intact, resists absorption of water into the porous concrete wall. A waterproofing layer would be more effective and certain, but is rarely present on older foundations.

Many problems result when the building code is ignored during construction or renovation. Typical foundations were built as described above. Over time the dampproofing layer fades and stress faults develop in the wall.

As water saturates the clay or sand on the way down to the tiles, hydrostatic pressure builds. In solid walls, hydrostatic pressure forces water directly through stress faults onto the floor slab.

With block walls, the water is forced through stress faults into the cavity of the blocks. As the cavity fills, pressure forces the water through the face of the extremely porous blocks onto the floor slab. The greatest point of pressure is at the bottom of the wall, and water typically forms where the wall meets the floor slab.

With inadequate exterior protection, either wall type will act like a sponge, absorbing moisture from wet or damp backfill. The moisture will then dry (or diffuse) into the basement.

Minimizing the amount of water around the foundation will minimize the resulting problems.

1. LACK OF, OR DEFECTIVE, EAVESTROUGHING AND DOWNSPOUTS

Description

Eavestroughing carries water from the roof and directs it to the *downspouts*. *Downspouts* carry the water from the eavestroughing to a point as far away from the foundation as is practical.

Five cm (2 in.) of rain on a roof 110 m^2 (1,200 sq. ft.) means 5.5 m^3 (1,200 gal.) of water falls on the roof.

Inspection/Test/Check

- What is the general condition of the system?
- Are the *eavestroughs* secured tightly to the fascia?
- Are there enough downspouts?
- Are the *downspout* sections coupled properly (tops fit into bottoms)?
- Are the *downspouts* plugged with roof solids (such as leaves and shingle coatings)?
- Do the *downspouts* disappear into the ground, and, if so, where do they go?
- Are the ends as far away as practical (1 to 2 m (3.2 to 6.5 ft.)?
- Can the *downspout* end discharge over snow or grass accumulation?
- Could the neighbours' *downspouts* be a contributing source?
- Are there physical depressions in the ground under the *downspouts*?
- Do the *eavestroughs* regularly overflow at points?
- Does the basement leak in the area under a *downspout* after a storm?

Interim Solution

Repair, add or redirect *eavestroughs* and *downspouts*. Do not allow downspouts to discharge into the footing drain system. Disconnect these if you find them and redirect roof water to the yard.

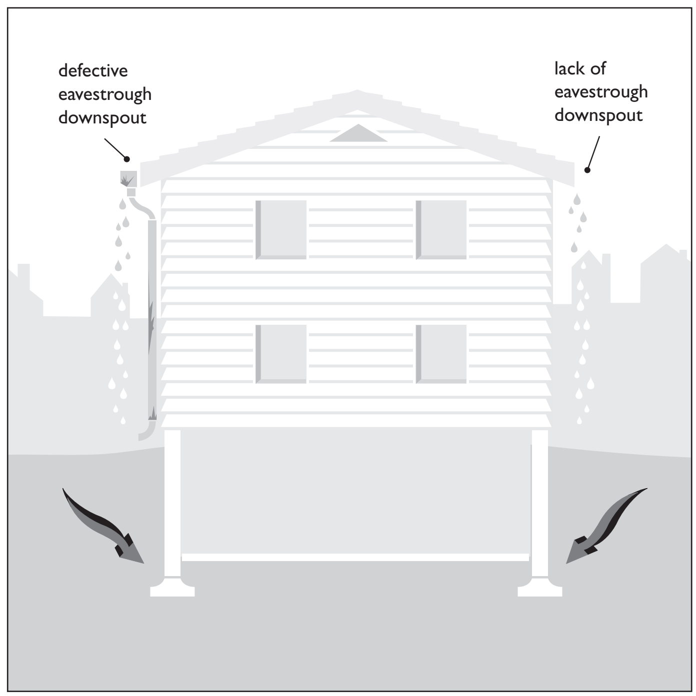


Figure 15 Lack of, or defective, eavestroughing and downspouts

2. GRADING

Description

Ideally, the grading (incline of the surface) should carry surface and downspout water as far away from the foundation as possible. The less water around the foundation, the less likely it is to saturate the backfill material next to the basement walls. Grades must have grass (or similar ground covers with strong root systems) to be effective in shedding the water. A non-erodable hard surface would work as well.

Inspection/Test/Check

- Is there a hard surface by the house (paving or established grass) or a porous surface (gravel, gardens, etc.)?
- Does the grade slope away from the house, especially under the downspouts?
- Has the patio or driveway settled back towards the house?
- Are there obvious depressions in the ground next to the foundation?
- Does water pool next to or close to the house in certain spots?
- Do the walls leak under those spots during storms?
- What practical limitations exist to improved grading (neighbour's property, existing structures, existing geography)?
- In suburbs, is water backing up onto your property because a neighbour has disregarded the official grade plan?

Interim Solution

Change grading around house. Note that a foundation that allows water to pass through (because of such things as inadequate dampproofing or waterproofing, or non-draining backfill) will always remain a problem. Changing grading can minimize the problem, but cannot prevent it entirely. This is a partial solution.

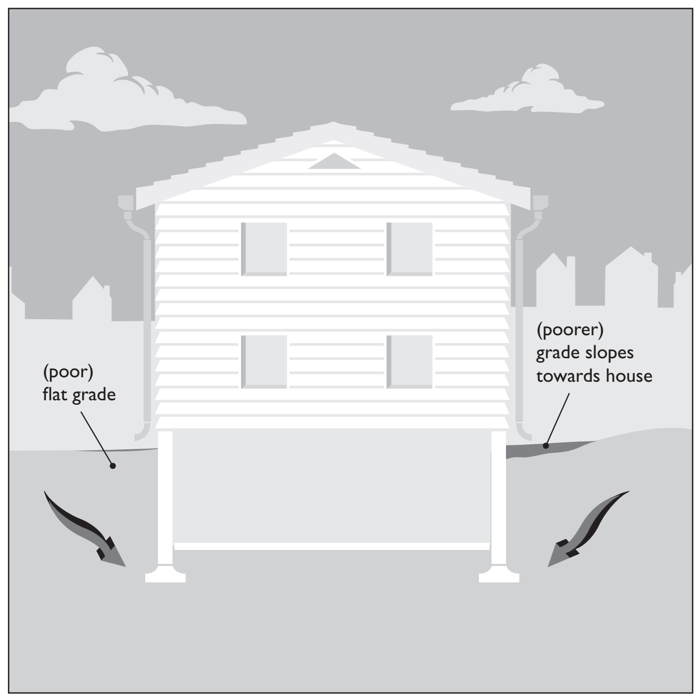


Figure 16 Poor grading around the foundation of the house

3. CRACKS OR STRESS FAULTS IN SOLID (POURED CONCRETE) WALLS

Description

The house weight is continually acting on the foundation walls. This weight is transferred through the walls to the footings, where it is spread out over a larger surface area.

Walls begin to break at the top as "hairline fractures," usually in corners and window wells. The cracks, or stress faults, head downward, more or less vertically, toward the bottom of the wall, and widen with time.

Inspection/Test/Check (Solid Walls)

- Inspect the above-grade foundation for hairline or larger cracks.
- Confirm cracks from the interior.
- Does water or moisture form in front of these cracks in the basement after a storm?
- Is there efflorescence on the wall or floor near the crack?
- Run the garden hose by the outside wall in the general area of the crack for a couple of hours to confirm the location of the leak.

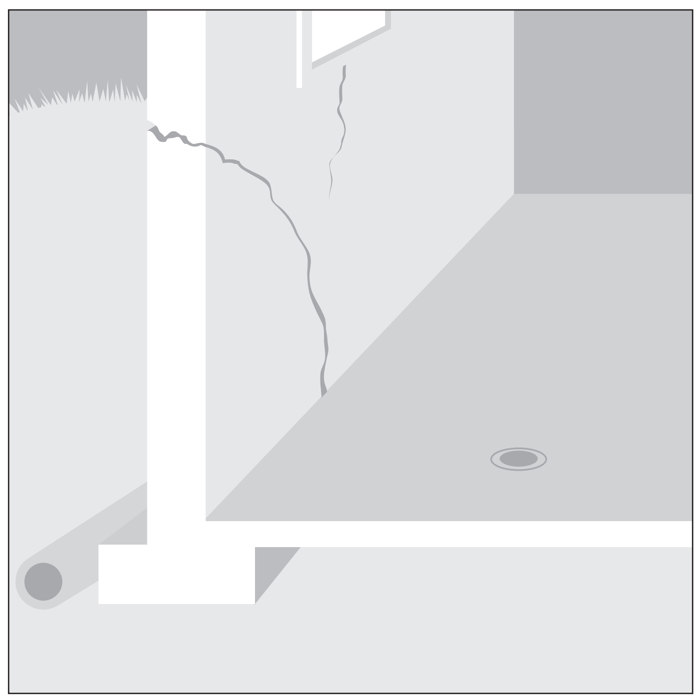


Figure 17 Small vs. large cracks

4. CRACKS OR STRESS FAULTS IN BLOCK WALLS

Description

Block walls break much like poured concrete walls, but the faults tend to follow mortar lines diagonally towards the bottom and normally end between the first and second course of blocks.

Block walls in particular suffer from the force of backfill material pushing in from the side. This pressure typically causes long horizontal stress faults, usually between the first course and the second course (up from the slab).

Inspection/Test/Check (Block Walls)

- When the walls leak, is the leak confined to specific areas (corners or lengths of walls, cold rooms)?
- Inspect the above-grade foundation for hairline or larger cracks in the finish parging. Note that these faults can be so fine that they may not be readily visible in the mortar work on the inside.
- Feel the wall between the first and second course. Is it beginning to move into the basement?
- Are there other obvious horizontal splits?
- Are there calcium or dark stains on the blocks or floor near the wall?
- Are there pyramid-shaped calcium deposits or dark stains on the walls in the corners?
- Do these deposits or stains appear under downspouts?
- Do the lower courses turn a darker shade of grey during wet weather?
- Do you notice mold growth along the base of the walls?

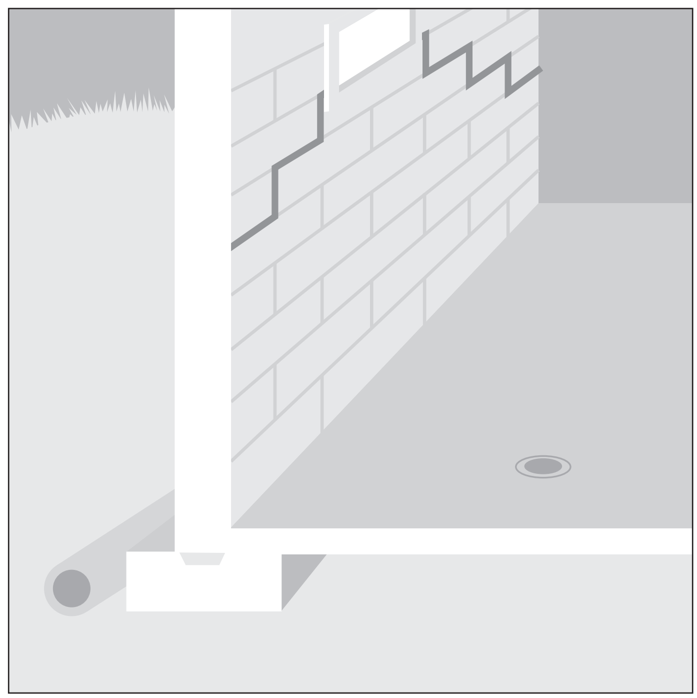


Figure 18 Cracking in block walls

5. CRACKS OR STRESS FAULTS IN CONCRETE SLABS

Concrete floor slabs can "crack" for a variety of reasons

- Floor slabs that are too thin to take the applied loads
- Inappropriate concrete
- Wide basement floors without control joints
- Problems due to setting or curing practice
- Water pressure under the slab that causes the slab to "float" and break

There should be a continuous layer of clear stone under the floor slab.

Inspection/Test/Check

- Look for liquid water at these cracks or effloresence appearing as evidence of water movement into the basement
- Does the clear stone under the slab connect directly to the sump pit? If there is no sump pit, it is more difficult to see whether the sub-slab is connected to a storm or sanitary drain.

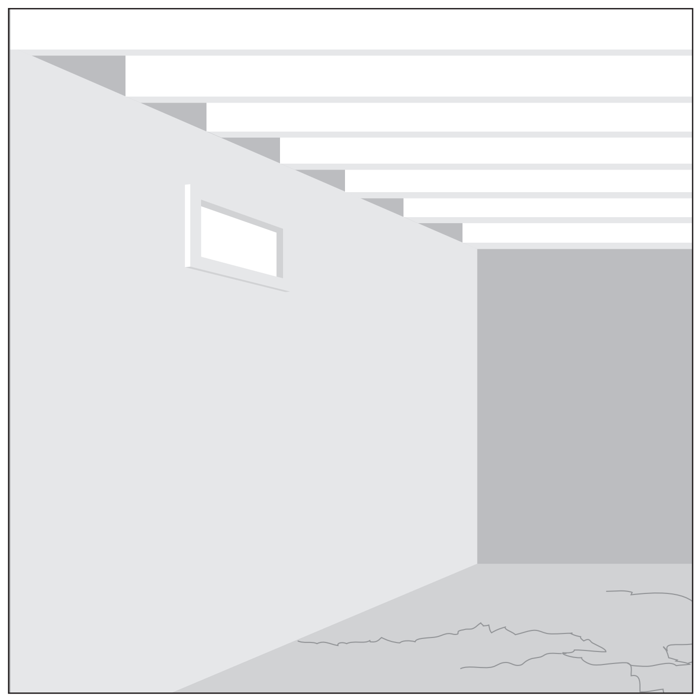


Figure 19 Cracking in concrete slabs

6. SLOW-DRAINING BACKFILL MATERIAL

Description

Ideally, backfill material should consist of 2 cm or 2.5 cm (¾ in. to 1 in.) clear or washed stone (the fines or dust having been removed at the quarry). This stone backfill should be from the footing up until grade, then capped with something that sheds water, such as sod on a slope away from the house. Water drains to the tiles quickly, without developing hydrostatic pressure.

This also minimizes the amount of weight or pressure being applied to the face of the wall because free-draining stone cannot become saturated. Dry stone, clay and sand weigh approximately 1,600 kg /m^3 (3,291 lb./cu.ft). Saturated clay or sand weigh up to 2,400 kg /m^3 (5,291 lb./cu.ft.).

Both clay and sandy backfill material will retain enormous amounts of moisture for extended periods of time.

Clay and sand contain fines (minute particles, or silt) which can wash into the tiles, eventually clogging them up. Clear stone eliminates this problem. "Settling" problems are also minimized when backfilling with clear stone.

Inspection/Test/Check

- Dig a shallow hole next to the foundation to confirm type of backfill material to inspect.
- Fill a 20 L (5 gal.) bucket with water and dump it into the hole. If the water takes a minute or more to drain, the backfill is not free-draining.

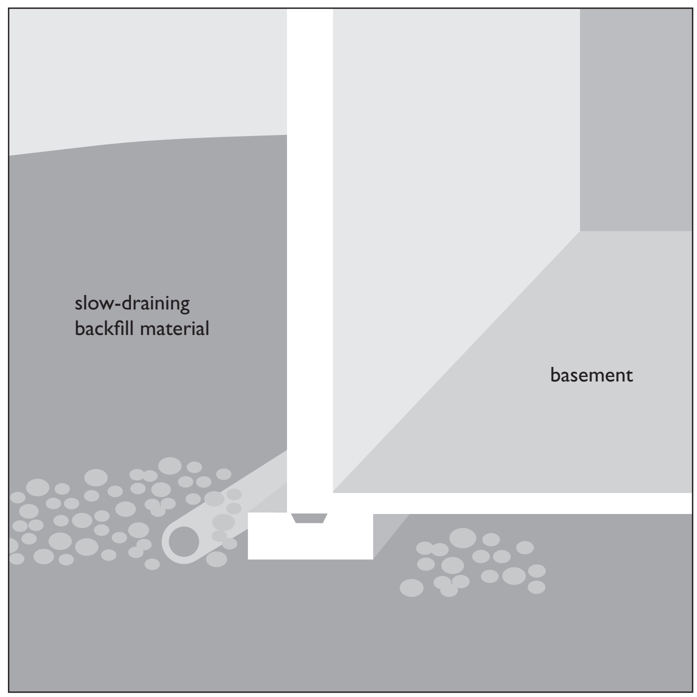


Figure 20 Slow-draining backfill

7. IMPROPERLY DRAINED WINDOW WELLS

Description

When basement windows, or parts of basement windows, must be below grade, these windows are provided with window wells for maximum light and ventilation. If the ground adjacent to these wells does not slope away from the edge of the wells, and if the wells are not properly drained, water may accumulate in the wells, leading to possible leakage into the basement through the window or through the frame connection to the *foundation wall*.

Inspection/Test/Check

- Is there persistent pooling of water in the window wells, especially after snow melts or heavy rainfall?

Solution

Dig out the well down to the tiles and backfill with clear stone, providing free drainage to the footing tiles. A vertical drain tile connected to the footing drain may also be acceptable. The top of the tile must be protected from leaves and other debris.

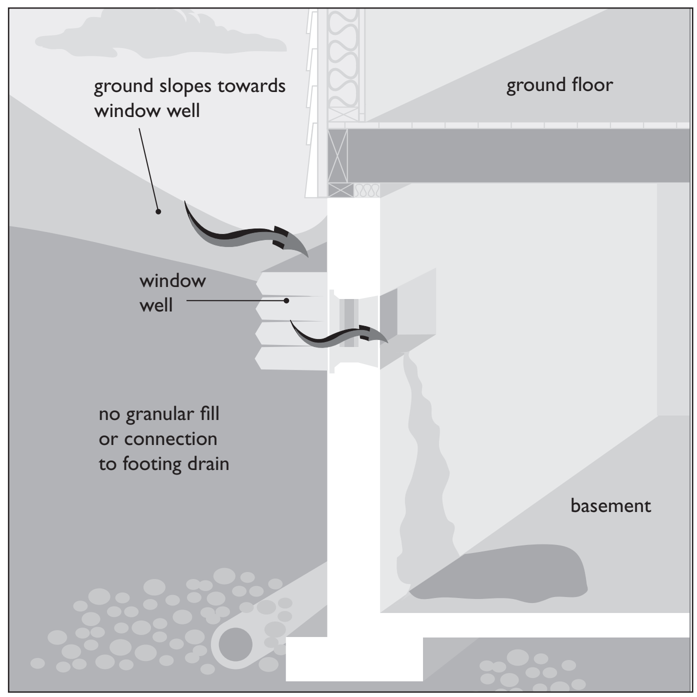


Figure 21 Improperly drained window wells

8. BLOCKED OR INEFFECTIVE DRAINAGE SYSTEM

Description

Water that has drained through the backfill material reaches the clear stone around the foundation drainage tiles. Clay tiles are laid end-to-end around the foundations beside the footing with a slight gap between them to allow water to “weep” into them. Modern plastic variations allow water in through tiny perforations.

It is vitally important that these tiles be placed directly beside the footing (no higher and no lower) and that they are surrounded by at least 15 cm (6 in.) of clear stone. The tiles must lead directly to a sewer or sump pit (or in rare occasions may be gravity-fed to an outlet, for instance to a ditch or a dry well).

Typical problems include tiles that lead nowhere, improper location, wrong type of tile, no tile, no stone around the tiles, or tiles clogged by silt or tree roots.

Inspection/Test/Check

- If you have a sump pit in your basement, make sure there is a physical connection between it and the exterior tiles. This usually consists of a tile purposely left under the footing during construction and connected to the side of the sump pit.
- Does water pour out of this tile in wet weather?
- If you do not have a sump pit and are in an urban setting, call your municipality to confirm what type of sewer the exterior tiles are connected to: sanitary or storm. In some older houses, the tiles are not connected to any sewer, rendering them next to useless.
- Are there willow trees nearby?
- If your inspections do not reveal why the drainage system is not functioning, you will have to excavate and visually inspect the tiles (read “excavations” in Appendix).
- Your should realize that one excavation “test pit” may not be typical of the entire system.
- After excavation, inspect the tiles. Are they: silted, beside the footing, have enough stone around them, the right type?
- If you have gone this far and all appears normal, run the garden hose for 2–3 hours to confirm that the tiles are connected to something.
- Use the garden hose on both exposed ends to confirm if the tiles are connected to a sump pit or sewer or if there is a blockage in one section or another.

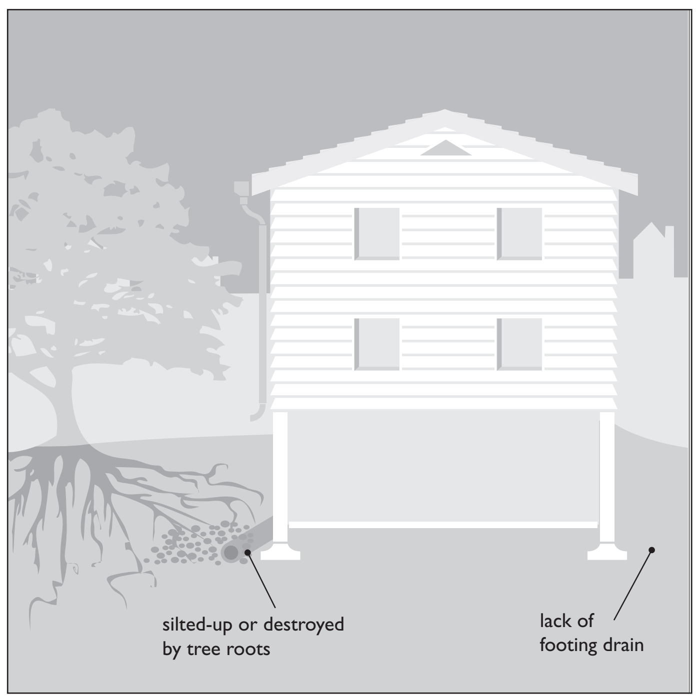


Figure 22 Blocked or ineffective drainage

9. ABOVE-GRADE WALLS SENDING MOISTURE TO THE FOUNDATION

Description

Blocked drainage (for exemple, weepholes in brick veneer walls) or a lack of proper *flashing* at the base of the exterior walls of the house can lead to water accumulating on top of the *foundation walls* and eventually draining into the basement, instead of to the outside. In an attempt at energy conservation or a misguided attempt at solving moisture problems, weepholes are sometimes sealed with caulking. Mortar droppings often block weepholes in brick veneer walls.

Inspection/Test/Check

- Are weepholes in brick walls sealed/clogged?
- Try to verify if *flashing* has been provided at the base of the exterior wall.
- Is water leaking from above the sill plate and header area? Look for standing water on the plate or staining. If so, then wall drainage could be the cause.
- Does the water entry happen when the wind is blowing at that particular wall?

Solution

Clear exterior weepholes on brick walls.

Retrofit flashing to existing wall with siding. (This is near impossible to retrofit if you have brick siding but is possible with wood, vinyl, or aluminum siding.)

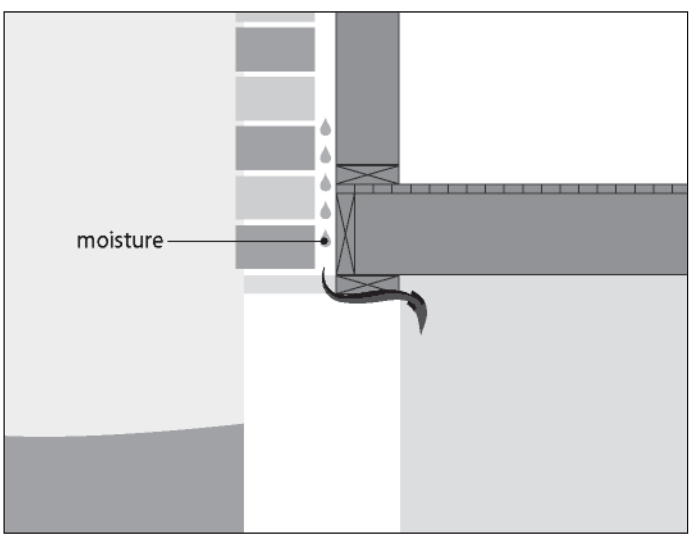


Figure 23 Above-grade walls sending moisture to the foundation

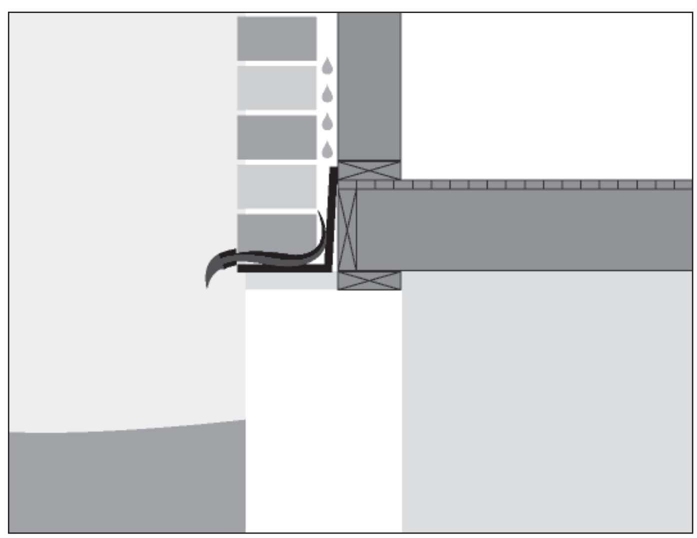


Figure 24 Lack of proper flashing

10. INEFFECTIVE SUMP PITS OR PUMPS

A sump pit is simply a hole in the ground where drained water can collect in order that it may be pumped out. The foundation drainage tiles must be directly connected to the pit to work properly. Water from under the floor slab should also have free access to the pit.

An automatic sump pump should be placed in the pit and securely covered. Discharged water should be pumped out in a way that complies with local bylaws. Never connect a sump pump directly into an on-site septic system.

Inspection/Test/Check

- The depth of the sump pit in your basement can be critical to proper foundation drainage. Check with the local building department or foundation drainage contractors about the recommended depth for your area.
- If you have a sump pit in your basement, make sure there is a physical connection between it and the exterior tiles. This usually consists of a tile purposely left under the footing during construction. Does water pour out of this tile during wet weather?
- Are the sides or bottom of the pit "open" to allow water under-the-floor access?
- If the pit consists of a manufactured plastic barrel, are the tile access "punch-outs" punched out?
- Does the barrel require extra holes in its sides to accept the quantity of water under the slab?
- Is your pit securely covered and vented to the outside?
- Are there tree roots or silt in the pit? (These could suggest blockage outside.)

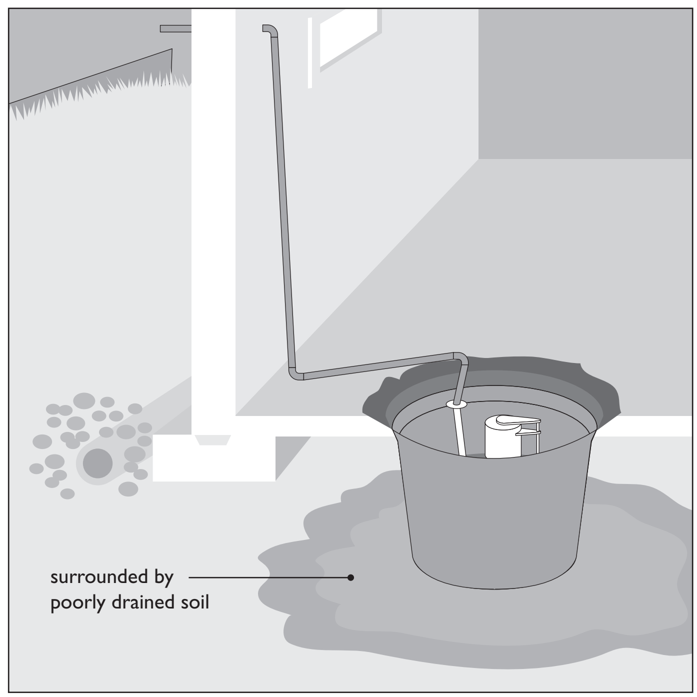


Figure 25 Poorly connected sump

11. HIGH WATER TABLE

Description

Surface water that soaks into the ground collects in pockets below the surface at a depth that is more or less static (the water table). Fluctuations in depth typically occur seasonally, causing water higher tables, for example, during wet seasons. The depth may be as much as 60 m (197 ft.) below grade, or very close to grade. The water table is not to be confused with temporary groundwater caused by such events as heavy rains or snowmelting.

When a foundation is built into or near the water table, tremendous hydrostatic pressure will be applied to the bottom of the floor slab and the lower parts of the foundation walls.

The effects of this phenomenon are not subtle. Think of your house being lowered into a lake. This much pressure can easily "float" the floor slab until it cracks under its own weight.

Inspection/Test/Check

- If you are in a rural area and have access to your wellhead, you can check the depth of the water table with a tape measure.
- Does your basement suffer repeated complete flooding (unrelated to sewer backup)?
- Does your sump pump run continually? (It is not uncommon for some sump pumps to evacuate 2,700 to 12,000 L (594 to 2,640 gal.) per day, every day of the year)
- Is the floor slab cracked and uneven?
- Does water "gush" out of these cracks?
- Are the floor slabs and lower wall sections perpetually damp and wet?
- Are there bullrushes in the vicinity of the house? Is the surrounding land swampy or wet?

There is no easy solution to a high water table problem.

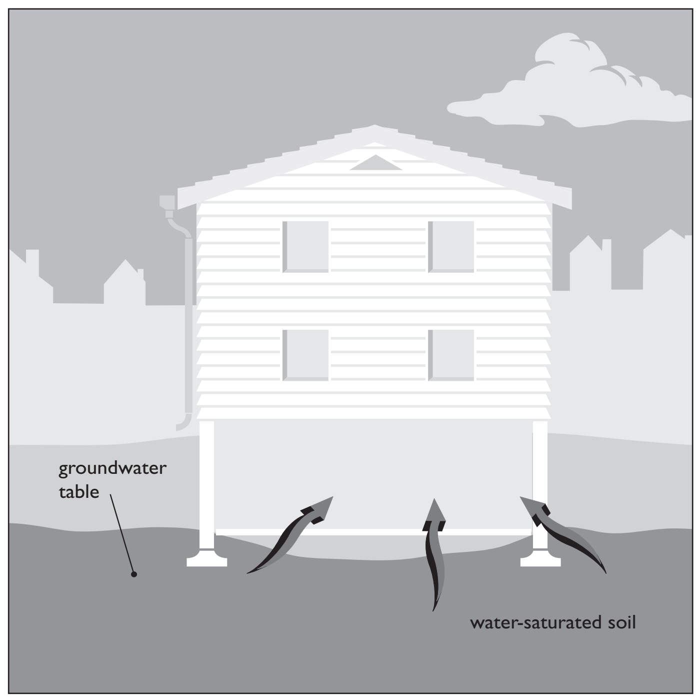


Figure 26 High water table

12. MELTING SNOW ADJACENT TO FOUNDATION WALLS

Description

Melting snow (as well as rain and surface water) adjacent to foundation walls can lead to water entering at the point where paved or grassed areas meet the foundation walls. From there it can often leak through the foundation walls and into the basement. With concrete block walls, it can leak at the surface of the yard but then drop through the block cavities and come out at the floor-wall junction.

If the snow melts next to the wall but not further away (because of heat loss from the basement and solar reflection by the exterior walls), melt water cannot exit along normal grading slopes, but is blocked and can flood the basement or floor space.

Inspection/Test/Check

- Check for any gaps between paved/grassed areas and the foundation walls, and for any paths that might direct water from melted snow into the basement
- Does there appear to be water in the basement near the suspected point of entry?

Interim Solutions

Change grading around house. The grade should be at least 10 cm (4 in.) below the top of the foundation wall, and higher in snowy areas.

Remove adjacent snow and provide drain path for standing water. Ensure that downspouts and leaders are not blocked with debris or ice. If ice is present in the downspout, melt the leader with a bucket of hot water.

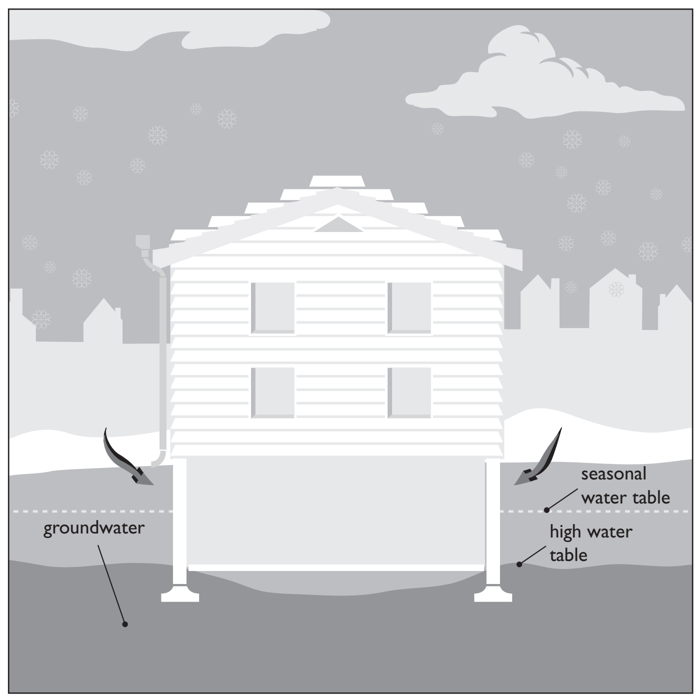


Figure 27 Melting snow adjacent to foundation walls

13. SERVICES ENTERING THROUGH THE FOUNDATION WALL

Description

Utilities such as electricity, water and natural gas are commonly delivered into the home below-grade. The wires, pipes, and hoses that carry them must enter the house through a hole in the foundation walls. Great care should be taken to re-seal these points of access.

Perforated plastic drain pipe is commonly used as a conduit for water lines from wells. If the lines lead directly to a hole in the foundation, they will collect and deliver water directly to that hole, just as they were designed to do.

Inspection/Test/Check

- Does water leak into the basement directly under holes created for utilities (such as at the electrical panel) during wet weather?

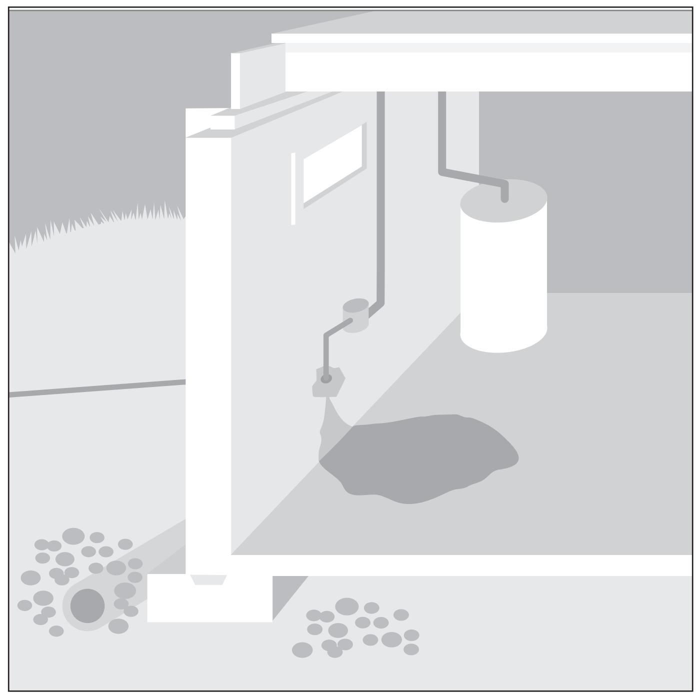


Figure 28 Leaking service entry

14. RUPTURED MUNICIPAL WATER LINES

Description

On occasion, water lines (those feeding single residences, as well as trunk lines) will rupture, for a variety of reasons, resulting in a flow of water below grade in the general vicinity of the breach. If your basement fills up with water for no other apparent reason, this may be the problem.

Municipal operators rely on information from the public to let them know about such problems.

Inspection/Test/Check

- Your municipal water department can test the water for chlorine.
- A member of the department can examine the service with a stethoscope to determine if there is a leak.

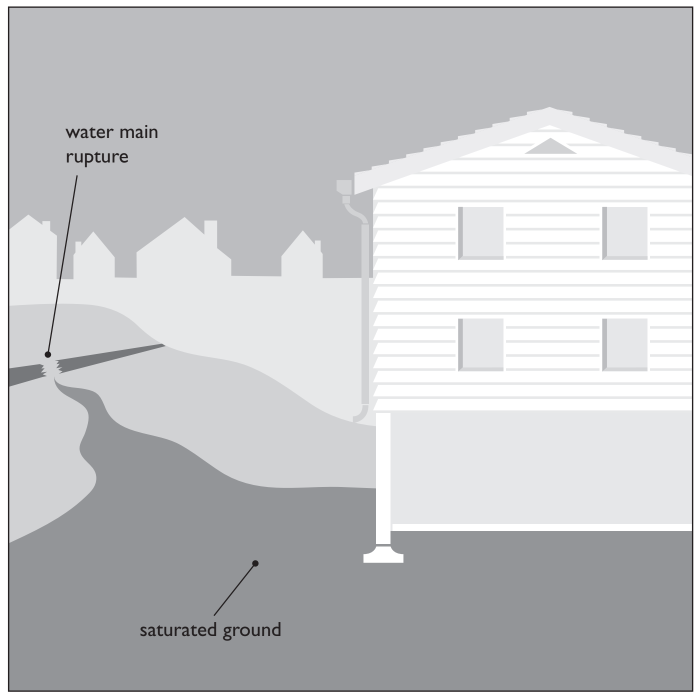


Figure 29 Ruptured water line

15. HUMID OUTSIDE AIR USED FOR SUMMER VENTILATION

Description

The dew point temperature of outside summer air used to ventilate the basement can be above the basement wall/floor surface temperature. This results in condensation inside the basement on the cooler basement walls, floors and other surfaces.

Inspection/Test/Check

- Measure the basement relative humidity with a hygrometer ($10 at a hardware store). Consult the CMHC publication *Measuring Humidity in Your Home*, available at www.cmhc.ca
- Are windows open during summer and hot and humid spring/fall periods?
- Check for *condensation* on walls, floors, ducts, pipes and other surfaces.
- Are basement carpets damp?
- In spring check to see if *condensation* covers the entire wall from top to bottom. This can indicate *condensation* from humid outside air and not from leakage.

Solution

Add dehumidifier

Keep the windows closed, and circulate indoor air.

Waterproof, insulate, and drain exterior basement walls.

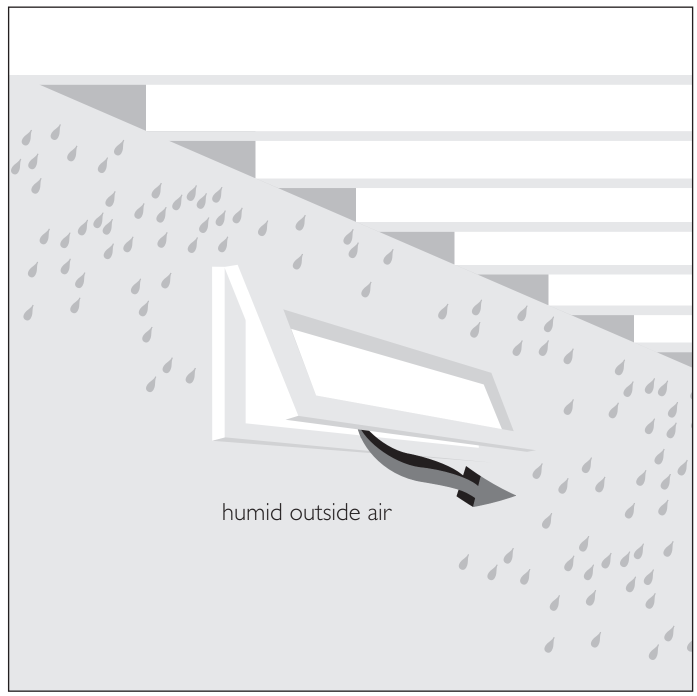


Figure 30 Humid outside air used for summer ventilation

16. DIFFUSION THROUGH THE WALLS OR FLOOR SLAB

Description

The floor slab should be poured over a 10 cm (4 in.) layer of clear stone, preferably directly upon a vapour barrier (most commonly a polyethylene sheet). A properly working drain tile or sump will generally keep the stone under the slab dry. A floor slab that comes into direct contact with water or damp sub-soil will absorb this moisture. The slab will then dry (or diffuse moisture) into the basement.

Discussion

High rates of vapour diffusion are usually due to inadequate damp proofing of the walls and floor, and a lack of capillary breaks on the exterior. Soil-gas water vapour pressure can drive vapour flow indoors if the pressure is higher than the basement vapour pressure. Soil water can also wet the foundation wall and basement slab surfaces so that capillarity can wick water to indoor surfaces. Evaporation of water from these surfaces wets the indoor air.

Inspection/Test/Check

- If there is an open sump pit, inspect under the concrete slab to see if it is supported by clear stone, and if there is a vapour barrier.
- If there is no ready access, make a hole in the floor and inspect. (Avoid hitting under-the-floor services, such as sewer or water lines.)
- Keep in mind that what you see around your "test" hole may not reflect everything under the floor slab.

To check whether water vapour is diffusing through the basement walls and/or floor slab, fasten a small, 300 mm x 300 mm (12 in. by 12 in.) piece of plastic film (polyethylene) to an exposed interior section of the waII/ floor. Remove this piece in one to two days, and check if moisture is condensed on the wall/floor side of the film. If this is the case, then water vapour is probably diffusing/wicking through the walls. Otherwise, the source of moisture may be from occupants or other internal sources. It is often difficult to determine whether diffusion or capillarity is the major flow mechanism, and both may be at work at various depths through the wall.

Possible Solutions

Dehumidify (does not resolve problem but reduces likelihood of mold growth)

Provide exterior moisture protection.

Lower water table using a sump and pump, or lower the existing sump pit level.

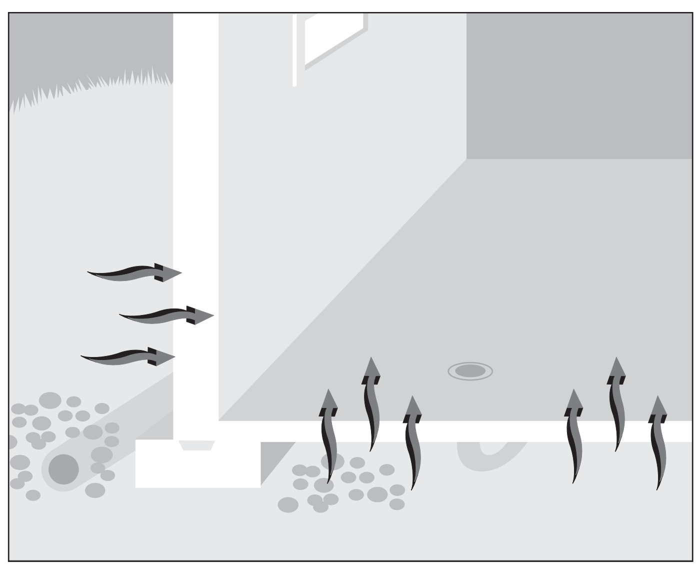


Figure 31 Diffusion through the walls or floor slabs

17. HIGH INDOOR HUMIDITY DUE TO OCCUPANT-INTERNAL SOURCES

Description

You can have properly protected basement and still have a moisture problem if the moisture comes from occupant activities. These could include:

- Drying large amounts of firewood in the basement.
- Having an unvented clothes dryer or a drying rack in the basement.
- Having several aquariums or plant-growing beds.
- Excessive house humidification during winter with a humidifier.

Solution

Measure your basement humidity with a hygrometer or relative humidity device (available at most hardware stores for $10 or less). Do not let it exceed 30-40 per cent in mid-winter.

If you have a large humidity source, such as stored firewood or an aquarium, consider removing it.

There is also the possibility that you do not have excessive humidity sources, but that your basement is underventilated. If you have a furnace or air conditioner with the air being distributed by a forced- air system, usually the basement will be ventilated during the time of operation of these devices.

However, houses with electric and hydronic heating and no moving air may see stagnant, moist air in the basement. This could also happen to houses with forced-air systems in the spring and fall, when no heating or cooling takes place. The easiest solution is to leave the basement uncluttered so air distribution is not as critical. If that is not possible, moving air with fans (either exhaust or circulation fans) may help to alleviate the damp, underventilated spaces. Increasing the house or basement ventilation rate in the heating season will tend to dry the house air as well.

18. COLD BASEMENT WALLS OR FLOORS

The inside surface of basement walls or floors can be very cold, especially when uninsulated and exposed. Condensation can occur on these cold surfaces. This often happens in spring or early summer when the soil at the base of the foundation is coldest, and outdoor air is used for ventilation. Cold walls or floors can be avoided through insulation. If the foundation is insulated from the outside (difficult to do on an already constructed floor), then the walls will remain as warm as basement air temperatures and will usually not create condensation.

If the foundation is insulated on the inside, the walls or floor behind the insulation will be even colder. That is why that it is important to have a good air barrier (for exemple, drywall, polyethylene, extruded polystyrene boards, etc.) between the basement air and these cold surfaces to avoid the occurrence of condensation of inside air on the wall. Note, though, if there is moisture movement from outside through the foundation and into the wall assembly, a wall with a good air and vapour barrier will not dry to the inside.

BEST SOLUTION: WATERPROOF, DRAIN AND INSULATE EXTERIOR BASEMENT WALLS

Description

There are a number of advantages to an exterior basement insulation retrofit, if such a retrofit is possible and feasible. The basement wall temperature is raised and condensation of water vapour from either interior or exterior sources can be eliminated. A vapour barrier is therefore no longer necessary on the interior surfaces of basement walls. Air leakage can be more easily controlled when exterior insulation is carried past the level of headers. Certain types of rigid exterior insulation (draining insulation) can direct any sub-surface water to footing drains before it leaks through or saturates the basement walls. Such draining insulation also creates a capillary break and reduces hydrostatic pressure against the walls.

Ideally, an exterior basement retrofit will include:

- A waterproof membrane on the exterior surfaces of basement walls;
- Insulation;
- New or repaired footing drains;
- Clear stone backfill; and
- Grading the finished surface away from basement walls.

Excavation and exterior insulation retrofit is a major cost. However, exterior insulation should be installed if the foundation wall is ever excavated for any reason because insulation represents a low additional cost if excavation has already been done. If the basement has no current moisture problems, excavating to install exterior insulation probably is not worth the expense, but then you would not be reading this publication either.

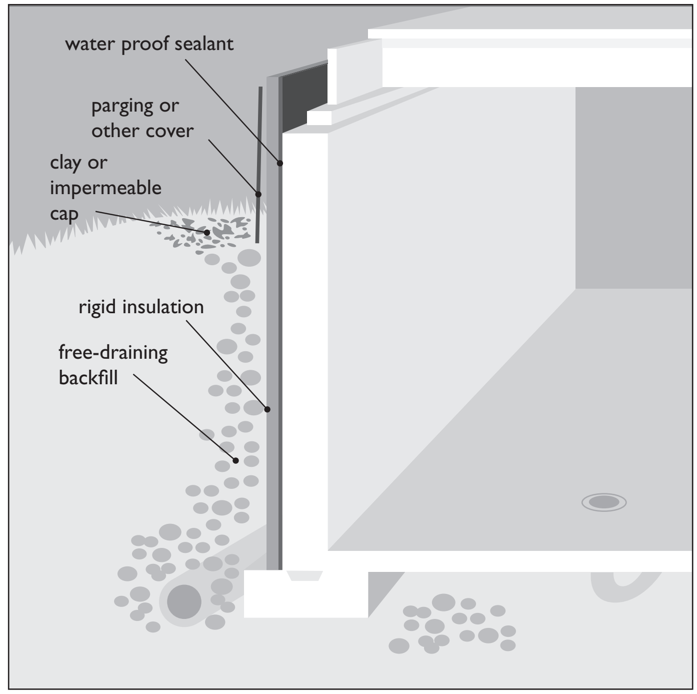


Figure 32 Best solution

Details

Exterior waterproofing (to prevent the passage of liquid water under pressure) is recommended if the basement is to be used as a living space. Waterproofing stops the entry of any form of water. Waterproofing is applied up to ground level only to allow the exposed part of the concrete foundation to evaporate moisture from within the walls.

Acceptable exterior waterproofing (when applied with diligence) include tar and fabric, spray-on membranes and self-adhering membranes.

Three characteristics that all true waterproof membranes must share are:

- They must exhibit 100 per cent adhesion to the substrate;
- They must be on the pressure positive side of the wall (the outside); and
- They must be able to withstand repeated exposure to water and water pressure.

All membranes should conform to the appropriate requirements of the Canadian General Standards Board (CGSB).

Exterior dampproofing (mainly to resist capillary flow and the passage of water vapour) could be adequate if the soil at the surface and backfill are well-drained. Dampproofing prevents the wetting of wall materials, thereby decreasing capillarity and slowing vapour diffusion. It is not as effective as waterproofing and usually not as durable.

Acceptable exterior dampproofing usually is asphalt coatings, which can be sprayed, brushed or trowelled, and applied hot or cold. Such a coating is often applied above parging or cement grout coatings.

Note that dampproofing will fail if there is cracking in the wall structure and if there is water against these imperfections (due to a drainage failure or a perched water table). Waterproofing is a more reliable basement wall repair.

Enhanced drainage includes draining membranes in dimpled plastic or rigid fibreglass. They are neither water-proofing or dampproofing, but are effective at reducing water entry under some conditions.

Waterproofing an existing structure requires excavation, which will consume about a third of the budget of a major basement retrofit. Backfilling and landscaping will also consume roughly a third of the budget. As such, it only makes good financial sense to go "all out" in your effort while the trench is open.

Following are step-by-step instructions on how to waterproof, insulate, and create a drainage system for most existing postwar basements as described earlier. There are, however, many anomalies out there that will require the assistance of a structural engineer.

1) Define where the problem exists. It is only necessary to repair specific cracks in solid walls or sections of block walls that leak. After living through repeated floods, you should have a good idea as to where to excavate (extend the excavation at least 1 m. (3 ft.) "beyond" the point of ingress in block walls).
2) Contact your municipal building department and inquire if permits are required. If permits are optional, consider buying them if only to have your project professionally inspected and recorded on the property title.
3) Book service locations. Gas, electricity, water, sewer, telephone, cable TV suppliers must all be notified. They will identify the position of their services free of charge, but they usually require one or two weeks notice. The person doing the excavation is normally financially responsible for damage under any circumstances.
4) Inform your neighbours. Besides alleviating unnecessary anxiety, in many instances you may also require permission from them to cross their property.

5) Excavate and remove the existing backfill material to the depth of the bottom of the footings. If there are anomalies in the foundation construction or tile system, etc., you will learn of them right now. Have this material taken away.
6) Fill in depressions (if any) below the footings with clear stone.
7) Scrape the wall as clean as possible.
8) Using a pressure washer (always protect your eyes and ears), clean the entire surface, removing any loose parging at the same time.
9) Attach new, total-perforated, plastic drain tile to the existing tile system using manufactured couplings. The new tile must sit beside the footing, not necessarily touching, but close. It must be no higher or lower than the footing. If the existing tiles are directly connected to an existing sump pit or sewer, continue. If not, look at "Sump Pumps" below.
10) Cover the sides and the top of footing drains with 150 mm (6 in.) of 19 mm (¾ to 1 in.) clear stone.
11) Using mortar mix, create a smooth cove between the wall and the footing. Fill in any depressions, rough edges, holes, seams around services, etc. Allow parging to completely dry.
12) Apply waterproof membrane as per manufacturer's specification and allow to dry.
13) Insulate wall, preferably the full foundation height.
14) Provide flashing and wall covering for the above-grade portion of the wall insulation (if installed).
15) Backfill with clear stone almost to grade.
16) Reinstate the landscape, ensuring positive grading of soil away form the house.

Sump Pumps

Continually draining the envelope to the bottom of the footings is an integral part of the solution. Sumps and pumps are used where the perimeter drain cannot be connected to a storm sewer or a gravity drain to a lower elevation (such as a ditch).

If there is no convenient sewer line, sump pits and pumps are the only option. Some installations have tile laid under or through the footing allowing water to access the sump pit in the basement (the sides of the pit should also allow water under the floor slab free access). The covered sump pit contains a sump pump which is activated automatically by a float switch. The water should be discharged back out of the house on to the homeowner's property without interfering with the neighbour's property. Some municipalities allow discharged water into their drainage ditches. Ask your building or engineering department what is legal.

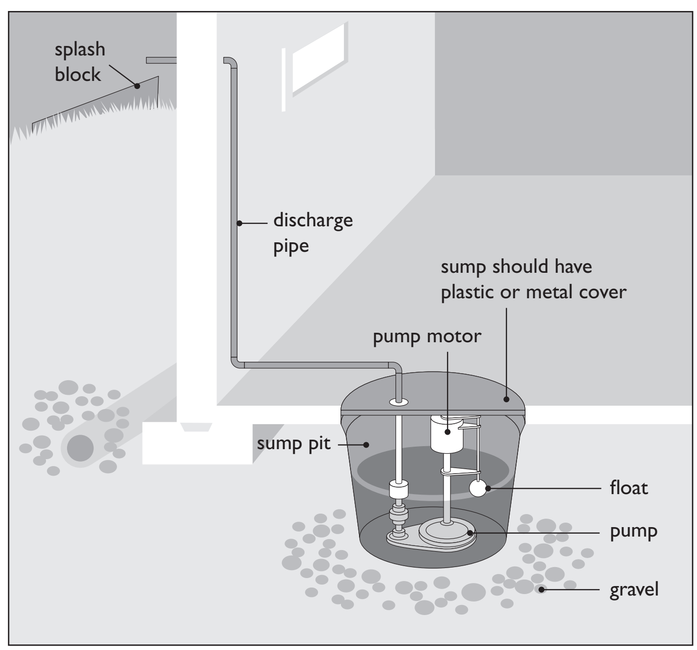


Figure 33 Sump pump

1. Add an internal sump pit and pump

- Excavate outside the house to confirm the existence and shape of the tile system
- Dig a hole through the floor slab down about 45 cm. (17 ½ in.) on the opposite side of the wall inside the basement
- Dig a tunnel under the footing connecting the two
- Have the tiles empty directly into the sump pit
- Allow water under the floor slab free access to the pit
- If using manufactured plastic "pails" as sump pits, make sure they have enough access holes punched or drilled into them
- Secure a sump pump into the pit and direct discharge water in a legal fashion (do not flush water directly into septic tanks)
- Securely cover the pit
- Backfill exterior hole with as much clear stone as possible

To avoid soil gases, sumps should be covered and vented to outdoors.

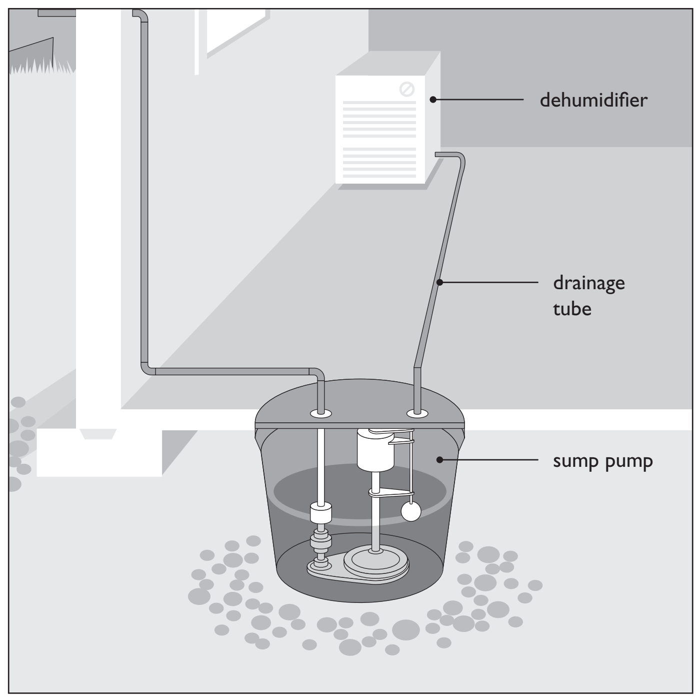


Figure 34 Interior sump pump

2. Add an external sump pit and pump

Sump pits and pumps may be located outside of the house:

- Excavate a pit approximately 50 cm (20 in.) below the bottom of the footing
- Use a 30 cm. (12 in.) or 45 cm. (17 ¾ in.) diameter culvert section for a "housing"
- Make sure that your submersible pump will fit the diameter of the housing
- Make sure that the float has no obstructions
- Access the tiles directly into the sides of the housing
- Use a good submersible pump
- If possible, create a separate electrical circuit to feed the pump
- Bring the discharge line up to the surface so that after it discharges there is no water left in the line
- Do not use a check valve in this system (to avoid freeze-up)
- Make sure the top is securely covered, while maintaining access
- Minimize cold air entering from the surface with sealing and insulation

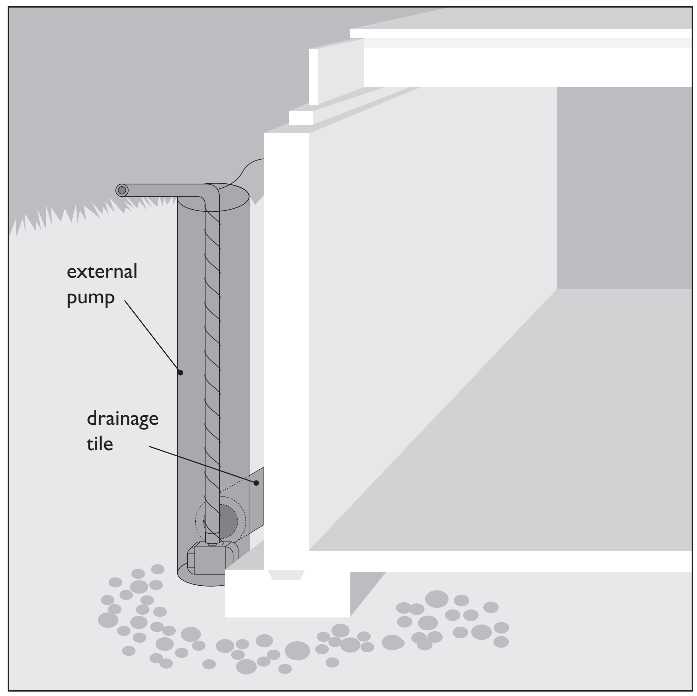


Figure 35 External sump pump

TEMPORARY SOLUTIONS OR SOLUTIONS THAT MINIMIZE SYMPTOMS

Introduction

Before resorting to extensive excavation, it is sometimes advisable to attempt less-expensive measures to correct obvious problems. In many cases attempting to minimize the symptoms will result in a basement that is "good enough" for its intended uses. This also may involve lowering your expectations of what the basement can be used for. As mentioned earlier, these attempts are not always 100 per cent successful, hence experimentation is part of the process. Bear in mind that even "attempts" cost money, and in many cases cumulative failed attempts have cost more then actually waterproofing and draining parts, or all, of the structure.

Description

"Minimizing" is separated into several classes ranked loosely in order of effectiveness and order of suggested execution:

1. Minimize amount of physical water around the foundation
   - A. eavestroughing and downspouts
   - B. grading
   - C. snow removal
   - D. window wells
2. Minimize water entering into the basement
   - A. sealing cracks in solid concrete walls
   - B. sealing cracks in block walls
   - C. flashings and weepholes
   - D. interior dampproofing
3. Reduce indoor humidity
   - A. dehumidification
   - B. mechanical ventilation and minimizing humid air entry
   - C. minimizing soil gas entry
   - D. minimizing occupant sources
4. Collect physical water (after-the-fact)
   - A. floor drains
   - B. sump pit

1) MINIMIZE AMOUNT OF PHYSICAL WATER AROUND THE FOUNDATION

A. Repair, add, or redirect eavestroughs and downspouts

Roofs supply tremendous amounts of water to surface areas around the foundation walls. Eavestroughing and downspouts are designed to collect and deliver this water to several locations around the house, where it can then flow away from the house via the grade.

Here are some problem areas and their solutions.

Eavestroughing

- Water fails to fall into the eavestrough
  - make sure shingles shed directly into the eavestroughing
  - make sure that the eavestroughing is secured to the fascia.
- Water overflows the eavestrough
  - remove blockages, preferably before the torrential rains
  - install wider eavestrough (for exemple, 15 cm – 6 in.) if problem persists
  - install "baffles" where roof valleys direct extra water to the eavestrough.

Downspouts

- Water backs up in downspout
  - remove blockage from downspouts
  - install larger diameter or more numerous down spouts to handle the flow
  - disconnect direct downspout drainage to footing drains.
- Water pours out of downspout prematurely
  - ensure downspout ends are not blocked by debris, obstructions, or damaged downspout sections
  - couple sections securely using screws or rivets (top pieces fit into lower pieces, funnel fashion).
- Water does not flow away after leaving downspout
  - ensure final section is as long as practically possible (or tolerable)
  - grade soil away from the foundation where the water hits the ground, but never bring grade above the foundation wall.

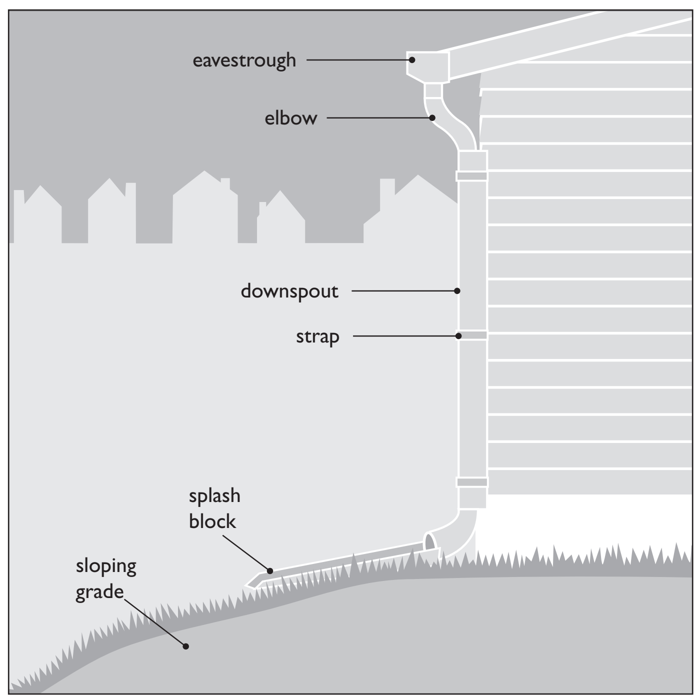


Figure 36 Repair, add, or redirect eavestrough and downspout

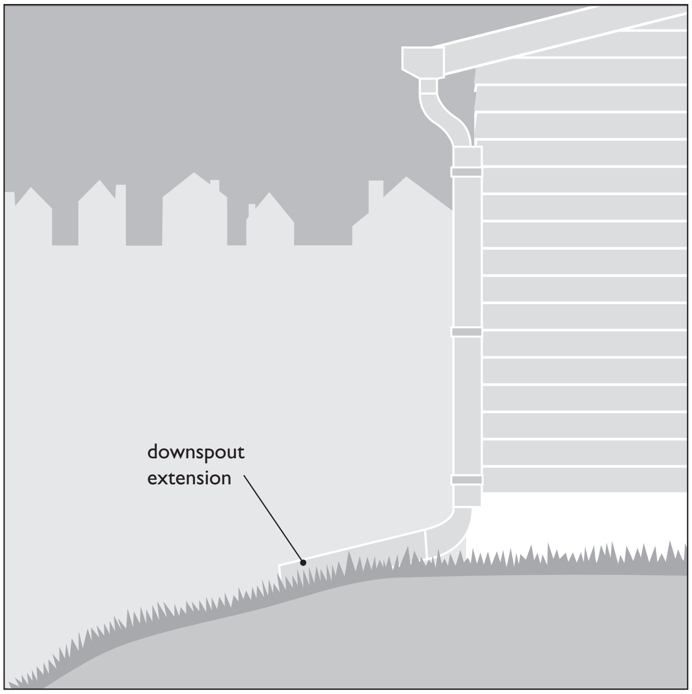


Figure 37 Downspout extension

Limitations

In most parts of Canada, it is next to impossible to keep eavestroughing and downspouts free from ice and snow during the winter. This will become apparent during January/February "melt downs" and early spring "runoffs".

Many modern suburbs allow as little as 2.5 m. (8 ft.) between foundations. Are your neighbour's downspouts a contributing to your problems (and vice versa)? Bear in mind that everyone's roof water must flow somewhere, and often you are limited as to where the downspouts can be located.

Once the water hits the ground there must be a "grade" to carry it as far from the foundation as possible. Often in urban settings it is difficult or impossible to attain the perfect grade desired under downspouts.

A concrete ground gutter, or splash block, can also carry water away from the point of discharge to prevent water pooling and the deterioration of grade below that point. Splash blocks are sloped away from the house, with their edges flush with grade.

Downspout systems designed to drain roof water to the footing drain (weeping tile) should be avoided for three reasons. First, leaves and shingle debris can clog the passage and this blockage will be difficult to clear. Second, if the weeping tile diameter is inadequate, back-up of water and flooding can result. Third, if the below-grade portion of the downspout is later disconnected or broken, it can cause back-up of water and flooding.

B. Change grading around house

Ideally, the grading (incline of the surface) should carry surface and downspout water as far away from the foundation as possible. To be effective the grade must carry water at least 3 m. (10 ft.) away from the foundation. The less water around the foundation, the less likely it is to saturate the backfill material next to the basement walls. Remember to remove or make paths for melting snow. Graded surfaces must be covered with a lawn (or similar coverings with strong root systems) in order to shed the water effectively.

Although this seems a very straightforward measure there are often physical limitations in achieving the perfect grade. Never bring the grade above the foundation walls. With that in mind:

- Will the existing geography allow you to effectively re-grade the property?
- Will your actions affect the “official grade plan” of the neighbourhood?
- Will fixtures (trees, fences, adjoining properties, rock) allow effective re-grading?
- Does the cost justify the possible results? Soft landscaping (lawns, beds, etc) can be expensive in its own right and, if re-grading fails, it will have to be re-done if an excavation is required. Hard landscaping (concrete work, driveways, etc.) is even more expensive to replace twice.

Limitations

Regardless of the grade around your house, there are certain times of the year where the subsoil becomes saturated. Picture 2 cm (¾ in.) of rain every day for two weeks. The subsoil is like a sponge and will inevitably become saturated at times.

The grade around the basement walls should be sloped away from the house for a distance of 2.5 m to 3.5 m (8 ft. to 11 ft.), wherever possible and feasible.

A slope of 10% to 12% (1 in 10 to 1 in 8) is adequate to drain away surface water and avoid pooling.

A layer of native topsoil or clay placed on the slope prior to sodding can provide a relatively impervious layer. This layer reduces penetration of surface water into the backfill adjacent to basement walls.

Sloped grade can be paved or topped with grass.

Sodding of a newly graded slope can prevent the washing away of the top layer of the soil.

Surface runoff from nearby areas can be diverted with shallow swales perpendicular to the direction of the water flow.

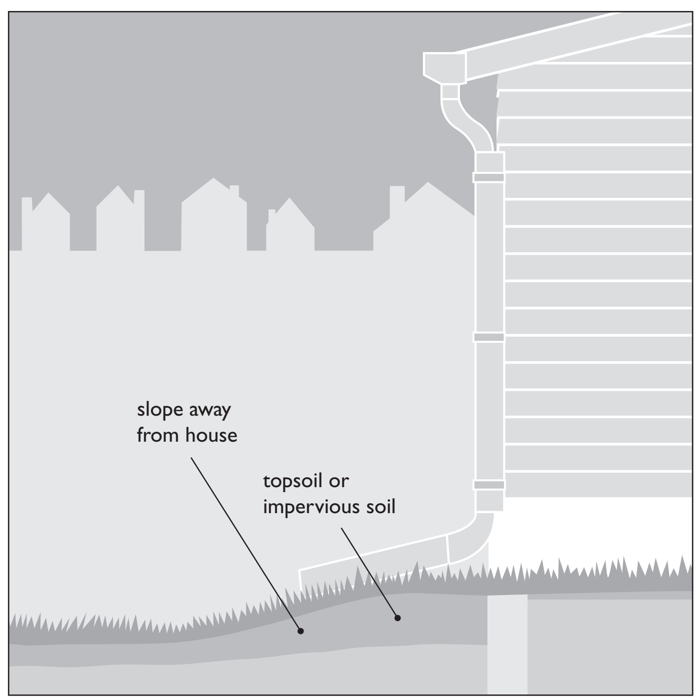


Figure 38 Change grading around house

C. Remove adjacent snow and provide drain path for standing water

Surface grading away from basement walls should be maintained and drainage channels provided. If pooling occurs due to snow melt, the snow adjacent to basement walls should be removed in the spring before it melts and forms dikes that prevent drainage. Flower and vegetable beds should be graded away from the house perimeter to prevent accumulations of standing water. They could also be placed away from the house perimeter.

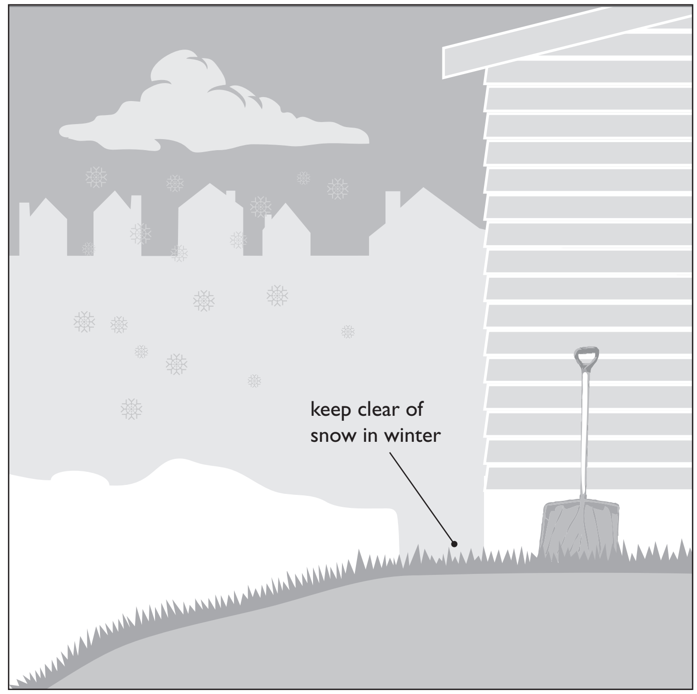


Figure 39 Remove adjacent snow and provide drain path for standing water

D. Upgrade window wells

Windows or parts of windows that are below grade should be protected by metal or masonry window wells. The bottom of the well should contain clear stone to permit good drainage towards the footing drain, and to prevent pooling and moisture sources adjacent to the basement foundation wall. Walls of window wells are usually made of galvanized corrugated sheet metal.

Surface runoff should be directed away from the window well.

If the backfill below the well does not drain well, then the bottom of the well can be connected to a footing drain via a column of clear stone.

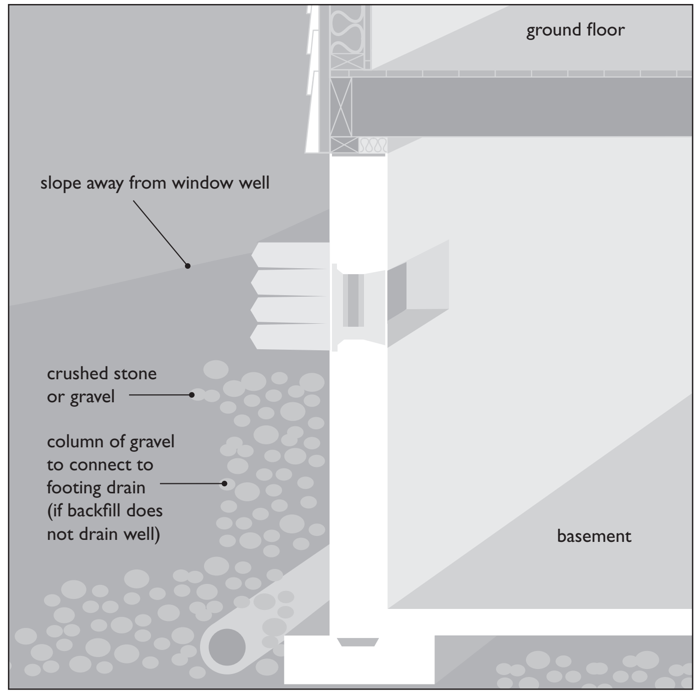


Figure 40 Upgrade window wells

2) MINIMIZE WATER ENTERING THE BASEMENT

A) Sealing cracks from the inside, solid walls

Once a solid wall has cracked there now exist two pieces of concrete. If water is passing through this crack it may be possible to plug it from the inside.

Hydraulic cement:

Hydraulic cement comes under a variety of trade names, readily available at most building supply stores. It possesses exceptional bonding properties. Be aware that it sets up very quickly, and is extremely caustic. Following manufacturers instructions:

- identify the crack
- using an angle grinder with a masonry or diamond blade (or a chisel), create a "trough" around the crack
- clean the trough thoroughly
- mix enough cement to fill the void in one go (there is no time for art work)
- fill the void beginning at the bottom, working your way up.

Epoxy or polyurethane injection:

Epoxy or polyurethane may be injected into the crack. Typically chemicals are mixed then injected into the crack under pressure (using a tool similar to a grease gun). The chemicals then expand and set in the crack providing an effective deterrent to water passing through. This type of work is generally done by contractors listed under "water-proofing" in the telephone business directory.

Limitations:

If there is enough water pressure behind the wall (or the crack widens after the fact) it will push past any kind of cork you care to put in its way. On the other hand, if minor hydrostatic conditions exist, this may be enough to convince water to remain outside.

B) Sealing block walls from the inside

Epoxy or cement based paints, powders, etc., are usually designed for solid walls only. At best, sealing a block wall from the interior using these materials only serves to hold water and moisture in the cavity of the blocks. Typically, water pressure continues to build in the cavity until is appears at a seam (where you have stopped using the material), or the water simply comes out further down the wall, or higher up the wall.

This remaining moisture will eventually decay the bonded surfaces (the seam between the two) and cause such materials to “flake or peel off. ”

In either case, water that is left in the cavity will eventually diffuse into the basement. Many of these products are intended for solid walls only: read the fine print.

C) Clear exterior house wall weepholes, install flashing

To avoid rainwater draining to the top of the basement walls, flashing should be installed at the bottom of the exterior wall air cavity. Ensure that weepholes are operational. Install or replace flashing on walls with wood, aluminum, or vinyl as required. It will be impossible to retrofit flashing to an existing brick wall. Caulking does not last forever, and must be replaced from time to time.

Other flashings, around the chimney for example, can allow water to pass from the roof through the wall cavities into the basement. Similar problems include decayed window frames, which allow water to pass directly into the wall cavity.

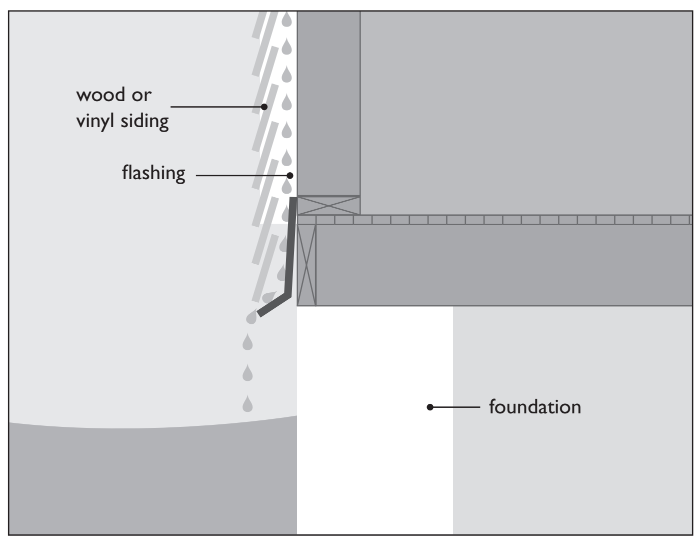


Figure 41 Proper flashing

D) Interior Moisture-proofing

Interior moisture-proofing coatings are usually called for when walls/floors are damp. These coatings will not withstand hydrostatic pressure but will prevent the penetration of water vapour and liquid water under low hydrostatic pressure. The major problem with coatings is that they tend to peel off the wall as a result of water and salt buildup behind the wall. Coatings should be applied up to grade level only, to allow evaporation of any trapped moisture within the wall. Coatings include:

- Epoxy paints that are either water-or petroleum-based and are mixed from two components prior to use. Epoxy paints, especially water-based, are the best overall performers.
- Ready-mixed, cement-based coatings that are based on synthetic resins and Portland cement mixed in a solvent. These coatings are readily available to homeowners and usually have acceptable performance.
- Cement-based dry powders that are mixed with water or with pre-packaged liquids before application. These coatings are generally acceptable.

  (All materials should conform to the applicable requirements of the Canadian General Standards Board (CGSB).)
- Do not use tar, asphaltic coatings, or similar odorous products on interior walls

NOTE

These coatings are temporary measures to reduce moisture entry into unused basements. They work only in cases where the water cannot build up to form a hydrostatic head behind the wall, and often only for a few years. If water sometimes leaks out in streams or jets, these coatings are not appropriate solutions. They are also not appropriate for finished basements or basements used for dry storage.

3) REDUCE INDOOR HUMIDITY

A) Dehumidification

One way of reducing high relative humidity in the basement is to use a dehumidifier. This will not correct the source of the problem but can alleviate the symptoms. The use of a dehumidifier is most effective in summer or humid spring/fall periods. Basement windows should be kept closed. For good circulation, the dehumidifier should be placed in the centre of the basement.

Chemical dehumidifiers using desiccants, such as silica gel, in containers are not practical for basements and large spaces since the chemicals may have to be replaced or dried out on a daily basis.

Mechanical dehumidifiers used in basements are of the refrigeration type that remove moisture by drawing air over a cooling coil (condenser). Water vapour condenses on the cooling coil and drains off into a collection pan, or through a hose to the floor drain. Their use will actually add heat to the room as they operate, but the dehumidification is worth the small amount of additional heat added.

Dehumidifier efficiency is rated at the ability to condense water from air at 27°C (80°F) and 60% relative humidity. Efficiency drops at room temperatures, and there is a practical lower limit to the relative humidity that can be produced by a dehumidifier. During summer, one should be satisfied if basement relative humidity is brought down to 60%.

The capacity of collection pans of dehumidifiers vary. The pans and the coils should be cleaned regularly to prevent the growth of mold and other organisms.

Similarly, air conditioning may be used to cool and dehumidify basement air. As such, condensation will be minimized.

B) Mechanical ventilation and minimizing humid outside air entry

Mechanical ventilation through exhaust fans or heat recovery ventilators (HRVs) will tend to dry the basement out during the heating season. They will have little or no drying effect most days in the summer. During hot and humid periods, you should NOT ventilate the basement with outdoor air as the warm, moist outside air can condense on any cool basement walls or floor. In most parts of central Canada, there is perhaps one day a week where the outside air is sufficiently cool and dry to make ventilation with outdoor air effective. This may not be true of coastal climates. Natural ventilation is not reliable in controlling moisture levels in the basement.

C) Minimizing soil gas entry

Gases coming from the soil around the foundation will usually be damp, as well as carrying other potential pollutants (for exemple, radon). Any surfaces with exposed soil should be covered with heavy plastic. Other recommendations include:

- Cover sump pit.
- Seal joints between the floor slab and foundation walls with appropriate caulking.
- Tightly fit floor drains and sump pits with covers, and use a trap primer for the drain trap. An alernative is using a self-sealing trap, usually obtainable from suppliers of remedial measures for radon.
- Grout or seal cracks in the floor slab and foundation walls.
- Seal or fill the top course of concrete block walls (unless they are solid).

D) Minimizing occupant sources

- Vent the clothes dryer to the outside. Harmful chemicals can be released when anti-static chemicals are used in a dryer, so they must be vented outdoors. Avoid line-drying of clothes in the basement.
- Install an exhaust fan in basement bathrooms.
- Remove damp materials, such as firewood and excessive numbers of plants.
- Have a heating technician deal with a poorly drafting furnace and vent any fuel-burning heaters. Do not tamper with any fuel-burning equipment. Call an expert!
- Remove humidifiers from basement, including any furnace humidifiers.
- Fix water leaks from cooling or heating systems.
- Control frequency of floor mopping.
- Reduce use of whirlpools and hot tubs.

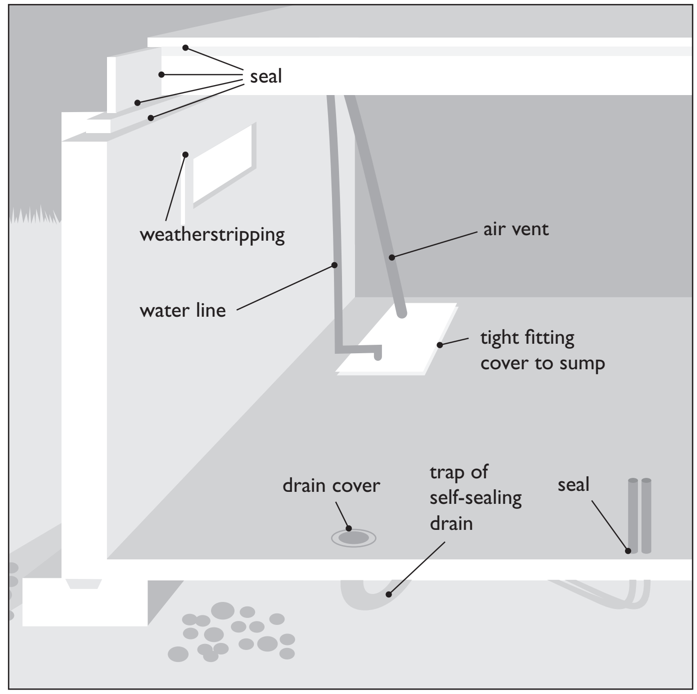


Figure 42 Minimize water entering the basement

4. COLLECT WATER AFTER IT ENTERS THE BASEMENT

There is nothing left in the basement, and you have minimized water ingress as much as is humanly possible short of excavation. Water that continues to pass into the basement should be collected as efficiently as possible.

A) Floor drains

Existing floor drains (urban settings) should be maintained to accept flood water. Typically these are coupled into the house's sanitary system with a "P" trap to control sewer gas from escaping into the basement's interior. Some "floor drains" can simply be "holes in the floor slab" which greatly diminishes their value. Investigate thoroughly.

B) Sump pits

Failing effective floor drains, a sump pit and pump will pick up water flooding into the basement (or coming up through the floor slab if a drainage layer exists). These are also good for broken water lines or washing machine mishaps.

These are not to be confused with sump systems that collect water from the outside tiles. The sump pit for interior drainage is simply a hole dug into the floor (slab or dirt) with an automatic pump in it. As long as the pump is operational it will minimize flooding over the level of the floor. Try to place these at the lowest point of the floor as is practically possible. Do not discharge into a septic field.

Always try to minimize liquid water accumulating on the floor. What can't be pumped or bailed out should be mopped up as quickly as possible.

WHAT NOT TO DO

In desperation, and sometimes under sales pressure, homeowners have made fundamental mistakes in trying to control water and moisture problems. Mistakes that can increase the symptoms, cause structural damage, promote poor occupant health, void the insurance you normally carry on your foundation, and leave the foundation valueless.

If you think you have come across a "better idea," discuss it with your municipal building or engineering department, a structural engineer or your home insurance agent before you do irreparable damage to your home.

Never drill holes into a foundation wall: Encouraging water to pass through your foundation is a fundamental mistake.

Block walls are held together by mortar. Mortar is created from crushed, baked limestone (as are all cements). Its constituent compound is calcium carbonate, CaCO. Calcium Carbonate is soluble in water, and fresh water is an excellent solvent. Physical evidence of this are the white stains or powders (effloresence) left on the wall/floor areas where problems exist.

As water passes through a broken mortar line it dissolves some of the mortar into solution. As the mortar lines dissolve, a larger "crack" is created; flooding becomes more frequent, water passes through in greater volume, and the wall incrementally loses its structural integrity. If left unchecked, pressure from saturated backfill material will eventually push the weakened block wall into the basement.

Drilling holes into the first course of blocks to allow water to flow under the floor slab in a "out-of-sight/out-of-mind" style only encourages greater volumes of water to pass through the wall and into your living space. There are also soil gas entry problems with many of the systems sold.

Never insulate and finish the interior of a basement until all moisture problems have been properly addressed.

APPENDIXES

A. MATERIAL INFORMATION

B. GLOSSARY

C. FURTHER READING

INSULATION

Batt or blanket insulation (interior use)

Batt or blanket insulation includes glass fibre and mineral wool. This insulation is easy to install in frame wall cavities and is available in batts or continuous rolls (blankets).

Rigid board insulation (interior or exterior use)

Rigid board insulations are manufactured from foam polymer materials or glass fibre and are generally more costly than batt or blanket insulation. They have, however, a higher insulating value per unit thickness. If used on the interior, foam insulation boards must be covered with a fire-resistant material such as gypsum board. Rigid glass fibre is not flammable and does not need protection when used on the interior. On the above-grade portions of the exterior, boards must be protected from prolonged exposure to sunlight and any solvents.

Glass Fibre (Fibreglass) Boards. In basement applications, a high-density, semi-rigid glass fibre board specifically designed for below-grade, exterior use is recommended due to the drainage properties of its unidirectional structure. This does not provide waterproofing and may not be required if the proper clear stone backfill is specified.

Expanded Polystyrene. Expanded polystyrene is also known as "bead board." High-density versions of these boards can be used on the exterior of foundation walls, while either high- or low-density boards may be used on the interior if protected with a fire-resistant material. Type I, low-density, must not be used in contact with soil.

Extruded Polystyrene. Extruded polystyrene contains fine, closed cells and is manufactured in high and low densities.

Polyurethane and Polyisocyanurate Boards. Similar to extruded polystyrene, these board have closed cells and are often double-faced with foil. As with other rigid board insulation, they must be covered with a fire-resistant material when used on the inside of the basement.

Loose fill insulation

Loose fill insulation, such as blown or poured cellulose fibre, chopped glass fibre, mineral wool (slag and rock wool) and vermiculite (expanded mica material), is rarely used for below-grade applications, but could be used with appropriable detailing.

Spray Polyurethane Foam (SPF)

SPF can be used both as internal or external insulation, with proper protection. It creates both an air seal and insulating layer, and resists moisture. It tends to be more expensive than alternatives.

SEALING

Sealants

Many types of sealants are commercially available.

- **Acoustical Sealants.** Acoustical sealants bond well to most surfaces and especially to concrete, gypsum and metal. They are very durable (20-year life expectancy) and are the best sealants for overlap stapled joints in poly air/vapour retarders.
- **Silicone Sealants.** Silicone sealants are highly durable (over 20-year life expectancy), flexible and all-purpose sealants. They do not, however, bond well to concrete, mortar or to poly air/vapour retarders.

- **Polysulphide Sealants.** Polysulphide sealants are ideal for concrete, masonry and stone when used with the appropriate primer and are very durable (25-year life expectancy).
- **Acrylic Sealants.** Acrylic sealants are good for most sealing purposes, especially for narrow joints. They have a lower life expectancy than other sealants and are not suitable for sealing poly air/vapour retarders.
- **Butyl-Based Sealants.** Butyl-based sealants bond best to metal and masonry but tend to shrink and have a lower life expectancy than other sealants.
- **Urethane Foam Sealants.** Urethane foam sealants are particularly suited for cracks or gaps exceeding 20 mm (3/4 in.) in width and for rough gaps in and around foundation walls. They are only suitable for interior use and should be covered with a fire-resistant material

Gaskets

Where caulking may not be suitable, specialty gaskets are used for sealing joints. Polyethylene foam strips (sill gaskets) are used when sealing between horizontal structural joints such as: top of foundation wall/sill plate; sill plate/header; and header/sub-floor. For deep gaps or cracks, a foam backer rod (compressible foam "rope") is used in conjunction with sealants.Where movement is to be expected, such as around plumbing stacks, flexible neoprene gaskets are used. Sheathing tape may be used for sealing seams of polyethylene air/vapour retarder sheets.

EXTERIOR

Protective covers for exterior insulation above grade

Protective covers for exterior, rigid-insulation boards above grade, include: pressure-treated plywood; galvanized-metal lath with a parge coating; rigid-vinyl sheeting; painted-metal sheeting; aluminum sheeting; fibre-reinforced, polymer-modified Portland cement; vinyl-acrylic coating; fibre-reinforced plastic sheet; composite protective coating, laminated to insulation; and parging on lath.

Exterior basement insulation flashing

Flashing for exterior basement insulation and for draining out water from within wall cavities includes galvanized steel (0.33 mm) or zinc. Wood is sometimes used for retrofitting situations.

Parging

Parging is a 12.5 mm (½ in.) coat of Portland cement and sand mix (1:2.5 by volume) or a Type M mortar applied in two, 6.25 mm (¼ in.) layers. The masonry surface should be cleaned and sprayed with water immediately prior to parging.

Exterior dampproofing

Dampproofing does not stop bulk water movement. It is intended to prevent capillary movement of water through bulk materials by preventing wetting of one surface of those materials. It is not intended to bridge gaps or to withstand the pressure of a built-up wall of water, such as caused by a high water table and/or a blocked footing drain. It does not stop leaks or soil gas flow. Dampproofing can include:

- Cement-grout coatings consist of Portland cement and fine sand equal volumes) mixed with water to a thick consistency. Such coatings are applied with a stiff-bristle brush. Two coats are applied, with a 24-hour period between applications.
- Asphalt coatings can be applied, hot or cold, by spraying, brushing or trowelling (preferred method). They should be applied as per manufacturers' instructions. These coatings are often applied in addition to parging or cement-grout coatings.

Enhanced drainage membranes

Dimpled plastic membranes or rigid fibreglass insulation provide a means for water to drain to the footing drain below. They provide some moisture protection, and can be used as part of an insulated exterior basement finishing. They are not as effective as true waterproofing, and are usually less expensive to install.

Exterior waterproofing

Waterproofing is intended to withstand a moderate head of water pressure, say during a temporarily high excursion of the water table during spring, but may not continue to stop leaks if the head is high and continuous. A waterproofing layer does stop water and soil gas leaks, at least for short periods of time. Residential foundation waterproofing materials include:

- **Felt or Fabric** with one or more coats of hot pitch or rubberized asphalt. This can be effective if properly applied.
- **Synthetic-rubber Sheet Membranes** self-adhering membranes that are fully-bonded to the exterior masonry wall, according to the manufacturers instructions.
- **Rubber Copolymer Liquids** that are sprayed on by applicators to form a seamless, impermeable membrane.

MISCELLANEOUS

Air/vapour retarders (or barriers)

The effectiveness of vapour retarders is measured in perm rating (the lower the perm, the more effective the barrier).

- **Polyethylene Sheeting** For air barrier use polyethylene sheets should be at least 0.15 mm (6 mil) thick and made from new material conforming to the Canadian General Standards Board (CAN/CGSB 51.34-M86). Polyethylene sheets can function as air/vapour retarders if properly supported on both sides.
- **Rigid Materials** Most rigid or solid building materials, including rigid insulation foam boards, can serve as air barriers. This is true if all joints, seams and penetrations are properly sealed with suitable sealants and gaskets. Rigid materials may also act as vapour barriers if used in conjunction with 0.05 mm (2 mil) polyethylene sheets or a vapour retarder paint, or if they have a low permeability (e.g. extruded polystyrene)
- Other vapour retarders include aluminum foil, some paints, and vinyl wallpaper.

Eavestroughs (gutters) and downspouts

Eavestroughs and downspouts are usually made of aluminum, galvanized steel or solid vinyl.

- **Prepainted Aluminum** Inexpensive, rustproof, but very soft for supporting weights (ladder, for example).
- **Galvanized Steel** Strong, durable (with factory-applied finish), difficult to paint if not properly prepared with primer.
- **Vinyl** More durable than either aluminum or galvanized steel but more expensive; not a large selection of colours.

Moisture-proofing interior basement walls

Interior moisture proofing is a partial or temporary solution. The various approaches do not provide a permanent fix against a water entry problem. They will reduce the amount of humidity transferred through a foundation. A wide variety of materials are available for interior moisture-proofing:

- **Epoxy Paints** are mixed from two components, usually the epoxy polymer and a hardener. Epoxy paints are petroleum- or water-based and are generally very good for interior moisture-proofing.
- **Ready-mixed, Cement-based Paints** consist of Portland cement mixed with a synthetic resin and solvent. They are commonly available and are generally good for interior moisture-proofing.
- **Dry, Cement-based Powders** are also available and are applied after mixing with water or packaged liquid ingredients.
- **Latex-based Paints,** which are water soluble until dry, are generally unacceptable for interior basement wall dampproofing and waterproofing.
- **Other Products** include rubber paints and acrylic and urethane paints. Water repellents (water seals) are not waterproofing products.

AIR BARRIER

Material used in the house envelope to retard the passage of air. A well-supported vapour retarder can fulfil both functions and is then called an air-vapour barrier.

BACKFILL

The material used for a trench or around a foundation wall to replace the void left by excavation.

CAPILLARY FLOW (CAPILLARITY)

The flow of liquid within small pore passages in a material. This is also called wicking. The water transport mechanism is what allows a sponge to soak up water

CLEAR STONE

Aggregate suitable for drainage and backfilling. The usual specification is for 19mm (¾ in.) (or even one inch) clear stone for basement applications. There should be little fine material. No more than 10% of the aggregate should pass through a 4.75 mm (0.19 in.) sieve.

CONDENSATION

The transformation of the vapour content of the air into water on cold surfaces.

DAMPPROOFING

The process of coating the outside of a foundation wall with a special preparation to resist the passage of moisture through the wall. Also, material used to resist the passage of moisture through concrete floor slabs and from masonry to wood. Dampproofing is not designed to stop the passage of liquid water. That is the function of waterproofing.

DECAY FUNGI

Fungi are known by their group names: mushrooms, yeasts, molds and mildews. Fungi grow in materials or on surfaces and can cause problems when a large number of their spores, or parts of the colonies and structures, are breathed in and deposited in the lung.

DEW POINT [TEMPERATURE]

The temperature at which a given air/water vapour mixture is saturated with water vapour (that is, 100 per cent relative humidity). If air is in contact with a surface below this temperature, condensation will form on the surface.

DIFFUSION (WATER VAPOUR DIFFUSION)

The movement of water vapour between two areas caused by a difference in vapour pressure, independent of air movement.

DOWNSPOUT

A pipe which carries water from the eavestrough to the ground or the drainage system.

DRAINAGE SWALE

A small channel that is usually grassed and is wider than deep. It is used for the removal of surface water from a site by natural run-off.

DRY ROT

Decay of timber due to the attack of certain fungi.

EAVESTROUGH

A trough fixed to eaves to collect and carry away the run-off form the roof. Also called gutters.

EFFLORESCENCE

Formation of a white crystalline deposit on the face of masonry walls due to excessive moisture movement within masonry walls.

FLASHING

Sheet metal or other material used in roof and wall construction to shed water.

FOOTING DRAIN

Pipe laid in gravel around the footings of a building to drain sub-surface water away from the foundation walls. These were usually clay tile pipes in older houses and plastic, corrugated, continuous pipes in recent years. A footing drain must discharge its water (for exemple, to a municipal sewer) in order to be effective.

FOUNDATION WALL

The lower portion of a structure, usually concrete or masonry, including the footings, which transfers the weight of, and loads on, the structure to the ground.

GRADE

The average level of proposed or finished ground adjoining a building at all exterior walls.

GRANULAR MATERIALS

Granular materials include crushed stone, gravel or certain soils and are used for backfill or under floors to allow for drainage of water towards the footing drains.

GUTTER

(See EAVESTROUGH)

HEADER

A wood member at right angles to a series of joists or rafters at which the joists or rafters terminate. When used at openings in the floor or roof system, the header supports the joists or rafters and acts as a beam.

HYDROSTATIC PRESSURE (HYDROSTATIC HEAD)

Pressure exerted by a buildup of liquid water. It is sometimes expressed as a height or "head" of water which exerts that amount of pressure.

IMPERVIOUS MATERIAL

Material that will not permit the passage of water.

JOIST

One of a series of horizontal wood members, usually of 50 mm nominal thickness, used for support: thus, floor joist, ceiling joist or roof joist.

MILDEW

(See DECAY FUNGI)

MOLD

(See DECAY FUNGI)

NAILER [NAILING STRIP]

Usually a strip of wood used to secure panels and allow for nailing of finish materials.

PERMEABLE MATERIAL

(For a drainage application): Material that permits the passage of water through holes or voids.

ROT

(See DRY ROT)

R-VALUE

The overall coefficient of thermal resistance of a building material or assembly.

RADON

An odourless and colourless radioactive gas that can enter a house from the soil beneath and around the house foundation. Other soil gases can include methane or even carbon monoxide (for exemple, if close to a blasting site).

RELATIVE HUMIDITY

The percentage of the existing partial pressure of water vapour in a space compared to the saturation pressure at the same temperature; for example, air containing one half the amount of moisture it is capable of holding has a relative humidity of 50 per cent.

SEALANT

A flexible material used on the inside (or outside) of a building to seal gaps in the building envelope in order to prevent uncontrolled air infiltration and exfiltration.

SILL PLATE

A structural member anchored to the top of a foundation wall, upon which the floor joists rest.

VAPOUR DIFFUSION

(See DIFFUSION)

VAPOUR RETARDER (BARRIER)

Material (or system) used in the house envelope to retard the passage of water vapour or moisture. The performance is rated in perms.

VENTILATION

The movement of outdoor air through the exterior envelope of the house via leaks or intended openings, both inward and outward again. Distribution is the transfer of ventilation air into and out of rooms or other confined spaces inside the house's envelope. Circulation is the movement of air (including a fraction of the ventilation air) within rooms or confined space.

WATERPROOFING (WATERPROOF MEMBRANE)

Sheet materials applied to a roof or wall surface to prevent the penetration of water, often in several layers or "plies".

WATER TABLE

The level below which the ground is semi-permanently saturated with water. In places, the soil may still be saturated with water above the water table if there is a layer of impermeable material or frozen ground, for instance.

WEEPING TILE

(See FOOTING DRAIN)

WICKING ACTION

(See CAPILLARY FLOW)

APPENDIX C - FURTHER READING

Basements seem simple but their construction and maintenance can be quite complex. There are still many questions about the "proper" way to build, drain, and insulate foundations. For instance, on the subject of vapour barriers, current recommendations for interior insulated walls range widely from:

a. Put a layer of polyethylene against the wall up to grade (the "moisture barrier"). Build your stud wall and insulate. Cover the stud wall with another layer of polyethylene (the "air and vapour barrier") and then drywall.

to

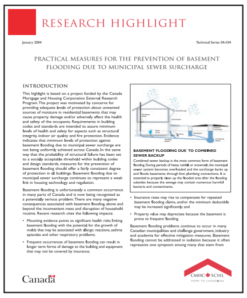
b. Have all interior finishing vapour permeable (that is, no polyethylene in the assembly) so that humidity can migrate through the wall.

This advice can also be regionally specific. What works in a very cold climate may be the wrong assembly for a mild climate with frequent air conditioning.

Here are three comprehensive websites that have descriptions of how to properly build basements. The advice in them is not identical. If you want to consider other points of view, these websites are a good place to start. Search under "foundations."

1. The National Research Council of Canada: *Performance Guide Lines for Basement Envelope Systems and Materials: Final Research Report*, English and French, retrieved April 2007, from http://irc.nrc-cnrc.gc.ca/pubs/rr/rr199/index_e.html
2. Oak Ridges National Laboratory (U.S.): www.ornl.gov/sci/roofs+walls/facts/foundation/foundation.pdf
3. Building Science Corporation (U.S.): http://buildingscience.com/

National and provincial building codes are also good sources of advice, especially when resolving issues in new construction.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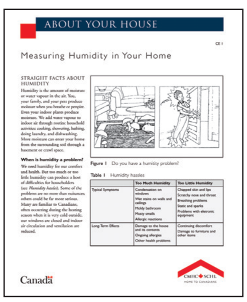
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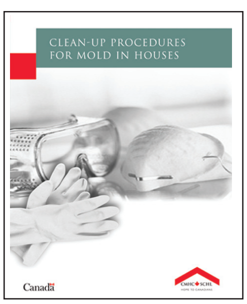

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