CE 61

Renovating Your Basement for Livability

Renovating a full-height basement can be a relatively easy and cost-effective way to add new living space to your house. But is your basement really a good candidate for a renovation?

If your basement isn't high, dry and sound, you should correct these problems before starting renovations.

If you are planning a basement renovation, you should inspect your basement for possible problems.

- Must you stoop to avoid bumping your head on a beam or duct?
- Are there intermittent or permanent traces of moisture or mold on the floor or walls?
- Is there a persistent musty odour in clothing and other objects that are stored in your basement?
- Are there cracks as wide as a pencil, or that appear to widen or shrink, in the walls or floor?

If the answer to any of these questions is "yes," you should include the costs of fixing these problems in your budget.

Photo by: Barry Craig

Figure 1 Terrace homes with basement bedrooms

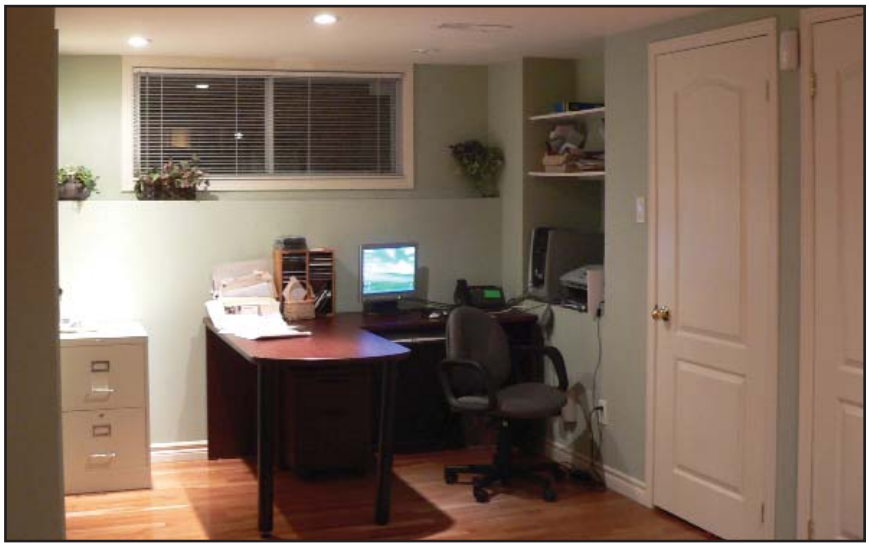

Photo by: John Burrows

Figure 2 Basement office

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PREPARING THE GROUNDWORK

Building permit

You must obtain a building permit if you intend to alter the structure of your house, increase the size of windows or exterior doors, or change the occupancy—for instance, by adding a self-contained apartment (see CMHC's *About Your House* fact sheet *Secondary Suites* for more information).

The building permit ensures that the changes respect minimum standards of health and safety. To make a good living space, a basement should be high enough to permit ceiling fixtures or fans with space beneath for a 1.8-m (6-ft.) tall person to stand. Most municipalities require a height of 2.1 m (6.8 ft.) from finished floor to ceiling before they will issue a building permit, which is also the minimum height required by most electrical codes for a ceiling light. Some jurisdictions permit limited obstructions, such as beams and heating duct bulkheads, within this space. Ask your building official what minimum heights are required.

Moisture sources

Dampness or leaks in the walls or floor must be corrected, because a damp or wet basement isn't a suitable living space. Moisture problems can ruin even the most expensive renovations and make your basement unlivable. Damp walls and floors result from holes or cracks in the foundation, insufficient dampproofing on the exterior face of walls, poor drainage at walls and footings and site grading that slopes towards the foundation (see Figure 3). Wetness may also be caused by a high water table, which exerts hydrostatic pressure on the walls and floor. The following are ways to repair common sources of moisture.

Cracks

Although small cracks may be patched on the inside, large cracks and other causes of dampness are best repaired from the outside. This often means using heavy machinery to excavate around the foundation walls to the footings. Once the walls and the top of the footings are exposed, it is possible to patch small holes or cracks with water-resistant grout. If cracks are large or appear to be moving, you should hire a structural engineer to investigate and recommend repairs.

Drainage

Water can seep up through the basement floor, appear at cracks and holes and accumulate at the perimeter where the floor meets the walls. If this occurs frequently or seasonally, it may be the result of an improperly functioning foundation drain. The drainage tile or pipe around the

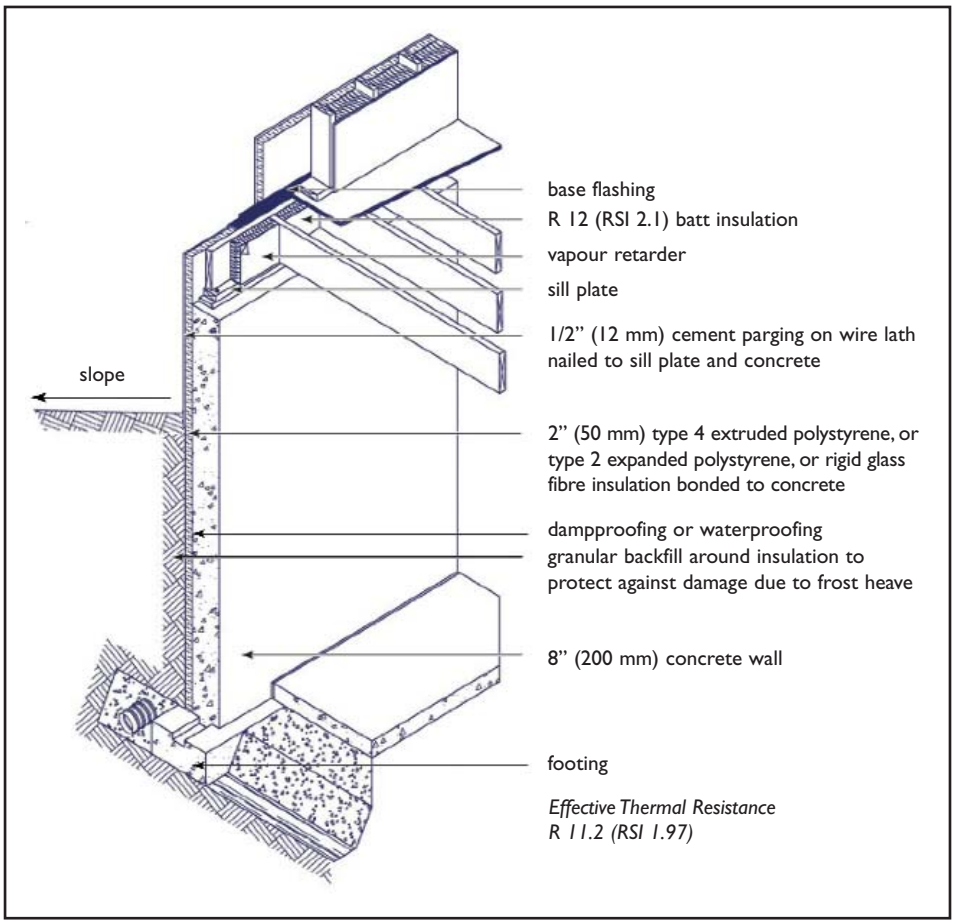

Figure 3 Concrete foundation wall with insulated exterior face

footing may be crushed, plugged or missing, and should be repaired or replaced. The drainage tile should be perforated with holes to collect groundwater, and positioned so that its bottom is below the basement floor.

Some builders enclose the drainage tile with a geotextile "sock" to keep fine soil material from clogging the tile. The tile and sock should be covered with at least 100 mm (4 in.) of clear, crushed stone extending to a free-draining zone over the face of the foundation. A length of unobstructed pipe should slope downwards from the foundation drain to the storm sewer to carry away any water that collects around the footings.

Ensure that the foundation wall has an uninterrupted coating of bituminous dampproofing, or a waterproof membrane when there is hydrostatic pressure. The coating should extend from finished grade to the top of the footing and seal the joint between the wall and footing. Cover this with a drainage membrane or free-draining fill to provide the drainage zone mentioned above, and slope the backfill so it will carry surface water away from the foundation wall. As an added precaution, create a clay "dam" around the foundation walls just below the topsoil, to deflect surface water away from the house. Figure 3 shows a foundation drainage system.

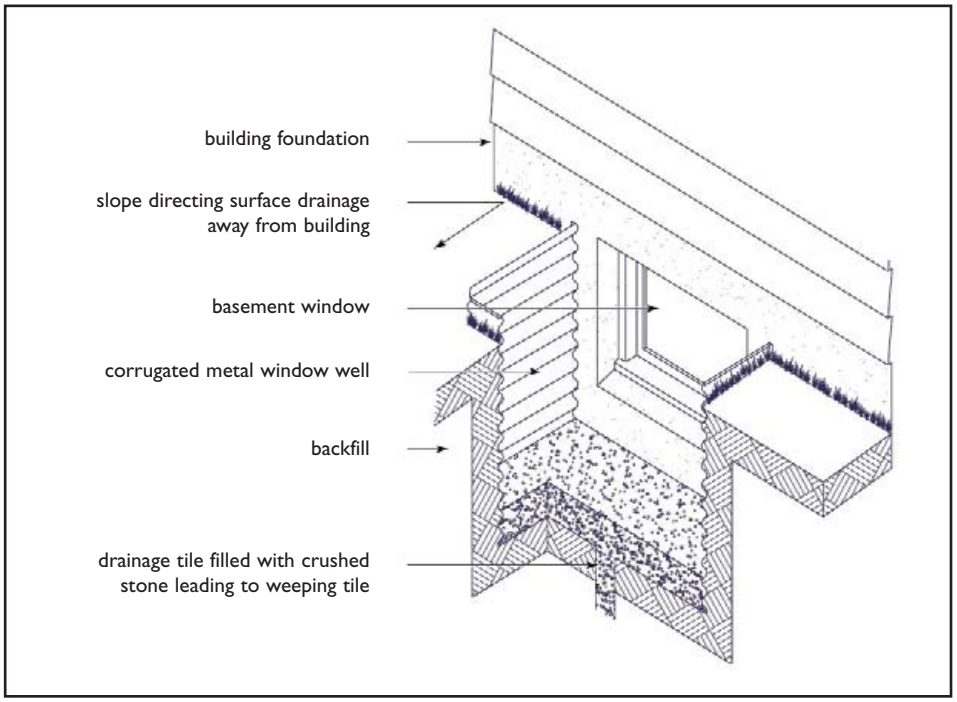

Figure 4 Window well at basement wall

Eavestroughs and downspouts

Eavestroughs collect water from the roof and rainwater leaders, or downspouts, and carry it to the ground. When the downspout fails to direct the water away from the foundation, or the grade doesn't slope away from the walls, this water may leak into your basement. A simple solution is to extend the bottom section of the rainwater leader at least 1,200 mm (4 ft.) away from the foundation, and to adjust the grade around the foundation so that it slopes away from the house.

Window wells

Window wells can collect snow and water, and often contribute to dampness in basements.

The base of a window well should consist of 150–200 mm (6–8 in.) of free-draining material, such as crushed stone, and must be at least 150 mm (6 in.) below the bottom of the window.

Window wells are places where snow and water will naturally collect. Install a length of drainage tile filled with crushed stone from the bottom of the well to the foundation drain, to ensure rapid removal of standing water from the well. As an added precaution, consider installing a clear plexiglass cover over the well if you don't plan to use the window for ventilation. If the bottom of the window well is less than 1,800 mm (6 ft) above the footing, consult a geotechnical engineer about protecting the footing from frost action.

Floor drains and sump pumps

Most basement floors in houses built after 1900 are sloped to a drain that, in turn, slopes to a sewer or dry well. It became common practice after about 1940 to install a 'P' trap in the drain, to prevent sewer gases from entering the basement.

If you intend to live in your basement, ensure there is a proper drain with a trap situated at the low point of the floor. The trap should be kept full of water to function properly and should be topped up periodically.

If there is no sanitary sewer in your vicinity, you may install a sump pit with a pump near the lowest point in the basement floor. The sump pit should be capped and sealed to prevent soil gases from entering. The pump should discharge to a dry well or to a location above ground where the water will not leak into the basement.

Backwater valves

A backwater valve is a device that automatically closes to prevent sewage in an overloaded sewer line from backing up into your basement. A properly installed backwater valve should be located to prevent sewage from coming through any fixtures in your basement, such as sinks, toilets, showers and laundry tubs. Installing a backwater valve may be expensive, but it can protect your basement renovation from serious damage, such as that which often occurs during periods of heavy rain.

PREPARING THE SPACE

Foundation walls

To prevent heat loss to the surrounding earth, most jurisdictions require exterior basement walls to be insulated for most of their height. Although builders usually place the insulation on the inside face of the foundation wall and cover it with gypsum board, it would be better to place water-resistant insulation on the exterior face where it can keep the foundation warm. If the wall is warm, the dew point, the point at which air vapour condenses as water, occurs on the exterior of the foundation wall where condensation will do no harm.

When insulating the foundation on the inside, you should expect some moisture to condense on the inside face of the foundation wall. Place a moisture barrier, such as vapour-permeable building paper, on the interior face of the foundation from exterior grade to the bottom of the wall to prevent this moisture from wetting the insulation. The top of the wall and the space between the joists should be insulated, because it is here that most of the basement heat loss occurs. Cover the warm face of the insulation with a polyethylene vapour retarder and seal with caulking where the polyethylene meets the floor, walls and ceiling, and at all laps to prevent moisture from getting into the wall. Consult the building code for your jurisdiction for your basement insulation requirements.

Photo by: John Burrows

Figure 5 Heating plenum disguised as a lighting fixture

Floors

Dampness and cold can enter a basement floor from the ground beneath it. Building codes require an occupied basement in a new house to have a moisture barrier, such as polyethylene, beneath the slab. If you have an older house with no moisture barrier below the floor, consider placing polyethylene over the existing floor before installing the finished flooring. If space and headroom permit, you might also install water-resistant insulation, such as extruded polystyrene, beneath the finished flooring to obtain a warmer floor.

PUTTING THE SYSTEMS IN PLACE

Canadian houses contain mechanical and plumbing systems that contribute to our comfort and health. The National Building Code of Canada (NBCC) sets minimum standards for water and waste piping in kitchens and bathrooms and for heat and ventilation in habitable rooms. All new NBCC "Part IX" residential dwellings and small buildings that are supplied with electrical power require mechanical ventilation, to ensure a continuous and adequate fresh air supply. The ventilation capacity required of exhaust appliances for kitchens and bathrooms is set out in Section 9.32.3 of the NBCC.

Air circulation

Excessive humidity and insufficient air movement contribute to two common problems in basements: mold growth and stale air.

Once you have repaired sources of water entry, you may put in heating and air circulation to make the space comfortable. Electric baseboards supply heat, but provide no circulation. If your house has a forced-air heating system, the furnace can provide heat and air circulation to the basement. Most furnaces provide circulation by pushing heated air out of registers and pulling cooler air into return-air grilles. The supply registers should be close to the floor in all rooms to allow the room air to mix effectively and should be near cold surfaces, such as windows.

Return-air grilles should also be located near the floor in all rooms, except the furnace room, to remove the layer of cooler air that tends to collect there and ensure proper air circulation.

Providing your basement with a heating and ventilation system that equals the one in the rest of the house should improve air quality and comfort during the heating season. But what about the period when the furnace is off and there is no air movement?

Mechanical ventilation

It is advisable to run the furnace fan year round, or use a furnace cycling device to circulate the air throughout the house. Because fan operation consumes energy, consider replacing a conventional furnace with one equipped with an electronically commutated motor (ECM). This will enable you to select the fan speed to suit your airflow needs and conserve energy. Opening windows usually increases humidity during the warm season, because this is the period when the outside air contains the greatest concentration of moisture. Dehumidifiers and air conditioners are more effective at drying and cooling indoor air during the non-heating months.

A heat recovery ventilator (HRV) is a valuable addition to a ventilation system, because it can exhaust stale air to the outside and replace it with fresh exterior air. The fresh air recovers heat from the exhaust air, then mixes with the house air and is heated and circulated by the furnace.

The stale air in most of our houses is exhausted by the kitchen and bathroom fans, and replaced by fresh air leaking in through cracks and openings. This results in drafts, heat loss and uncertain air quality. A properly designed and installed HRV system can correct these problems in the basement and throughout the house.

It is common for occupants to not use, or to disable noisy bathroom and kitchen fans. This leads to higher relative humidity and increased concentrations of volatile organic compounds (VOCs) in the air. Rather than compromise your air circulation, consider replacing a noisy fan with a quieter model. For more information, see the *About Your House* fact sheet *The Importance of Bathroom and Kitchen Fans*.

In some jurisdictions, the fan can be connected to the light switch so that it operates when the room is in use. More information on VOCs can be obtained from Health Canada.

Control of humidity

Humidity is a common source of discomfort in basements and can contribute to odours, staining, mold growth and wood decay. High humidity can result in fungal growth, progressively damaging organically based materials, such as wood and wood-based products, and natural fibres in carpets and upholstery.

Excessive humidity is caused by leaks; damp materials; improperly installed insulation, air barriers and vapour retarders; weather conditions and building occupants. Table 1 shows how human activities, such as bathing, can significantly increase moisture in the air. Conditions of high relative humidity (RH) permit mold and wood rot to become established. Therefore, it is important to keep room humidity levels within an acceptable range to prevent mold growth and preserve occupant health.

If the air circulation provided by the furnace does not limit excessive humidity, a dehumidifier can be placed in the damp space or connected to the furnace. If you put a bathroom or kitchen in your basement, you are introducing a potential source of moisture. Humidistats can be installed in kitchen and bathroom fans, to start them automatically when the RH exceeds a selected level, and shut them off when the humidity has decreased sufficiently. This measure is relatively inexpensive and removes some of the humidity at its source. It also ensures that the fans will run when they are needed most, when cooking and bathing are taking place.

KEEPING IT SAFE

Fire and smoke detection

Smoke alarms are required on all floors of a residence and near bedrooms. Although most smoke alarms are wired directly to the electrical panel in newly constructed houses, some jurisdictions permit battery-powered alarms in existing construction. It is prudent to install a carbon monoxide (CO) detector near a fuel-fired appliance, such as a fireplace or furnace, and near a doorway to an attached garage.

Table 1 Daily moisture generated by a family of four

Source	Moisture produced—litres per day
Four occupants	5
Humidifier	2–20+
Whirlpool bath	2–20+
Firewood (by cord)	1–3
Floor washing	2
Cooking	1.5
Gas cooking appliance	1
Plant (each)	0.2
Seasonal release of moisture (autumn)	3–8+
Total per day	**30**

Source: adapted from G. Christian.

Electrical outlets and fixtures

The electrical code requires electrical outlets to be placed at intervals around all finished rooms. They are usually located no more than 3,600 mm (12 ft.) apart, and from 100 mm (4 in.) to 300 mm (1 ft.) above the floor. Kitchen outlets should be on a separate circuit and provided with ground fault protection to prevent shocks. Some appliances, such as stoves, ovens and dryers, require higher voltages with special outlets. Electrical fixtures and wiring must be installed and inspected by a certified electrician in most jurisdictions.

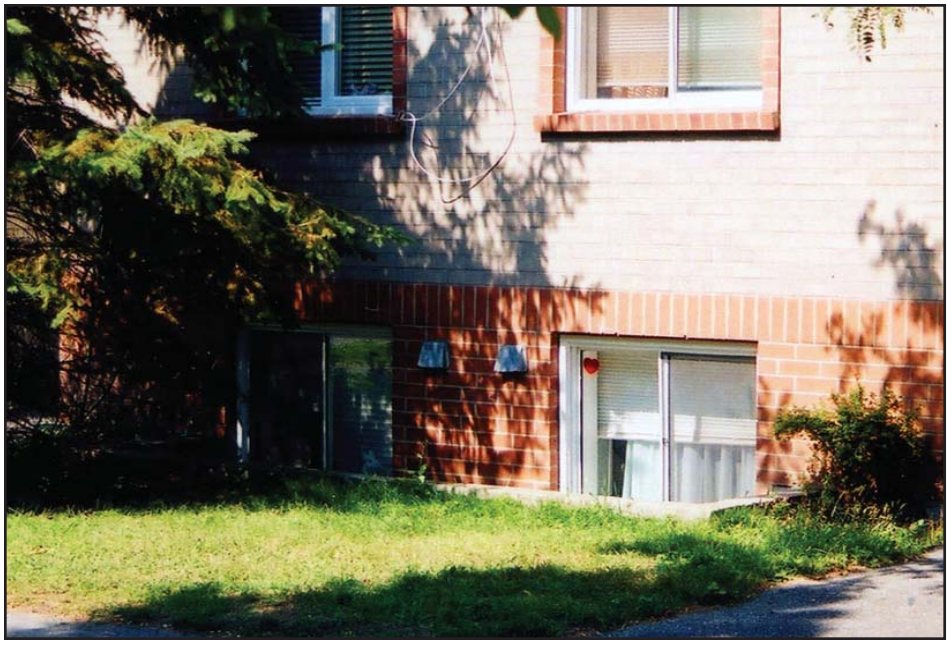

Photo by: Barry Craig

Figure 6 Large wells permit big basement windows, improve natural light and ventilation and may facilitate exiting

Windows

Windows serve three purposes in the building code: ventilation, natural light and emergency escape.

Unless mechanical ventilation is provided, the natural ventilation requirements for new dwellings in existing houses must comply with the applicable building code. The NBCC requires each bedroom, dining room, living room, kitchen, den, combined room and any other finished room other than a bathroom, to have an unobstructed opening of at least 0.28 m^2 (3 sq. ft.) for ventilation during the non-heating season. To provide adequate natural light, it is recommended that the unobstructed area of glass in a window be at least five per cent of the floor area of each room or combination of rooms.

Where a window is required to be a means of escape, it must be large enough and easily reached from the living space, and provide safe access to grade level. If the suite is not protected by sprinklers, the NBCC requires each bedroom to have an unobstructed opening of at least 0.35 m^2 (3.77 sq. ft.) with no dimension smaller than 380 mm (15 in.). It might be necessary to replace or enlarge your existing windows to meet these requirements.

Windows near grade might be subject to forcible entry and require special locks or protective bars. Consult the building code for your jurisdiction for specific requirements for windows.

Windows are susceptible to condensation in cold weather because the glass and frame are usually colder than the surrounding walls. If the window is deeply recessed in the wall, heated room air may not reach the glass surface to remove the condensation and moisture damage might occur around the frame and sill.

An insulated window should be positioned so the air space between the glass panes does not extend outside the insulation on the surrounding wall. Where possible, install the windows near the inside face of the wall to prevent condensation on the glass. Be sure to seal the perimeter of the window where it meets the exterior wall and slope the exterior sill down and out beyond the wall face, to prevent leaks. Most building codes require the bottom of a window to be at least 150 mm (6 in.) above ground.

Means of egress

The occupants in all parts of the house, including a finished basement, should have a safe means of egress, or exit path, to the outside. The NBCC regulates the size of the components that make up the exit path.

Doors as a means of egress must be at least 810 mm (32 in.) wide and 2,030 mm (80 in.) high. Corridors must be at least 900 mm (35 in.) wide. The stair must be at least 860 mm (34 in.) wide between wall faces and have at least 1,950 mm (77 in.) head room. You may also need a handrail and a protective guard on the open side of the stair.

If you are converting an unfinished basement into living space, the rise, run and tread depth of the stairs may have to be modified to conform to the building code in your jurisdiction.

Enclosure of mechanical room

Your furnace and hot water heater are powered by electricity or fossil fuels, such as oil, propane or natural gas. Fossil fuel-fired appliances will exhaust through chimneys or vents to the outside. High-efficiency furnaces are equipped with combustion air intakes that conduct fresh air from the exterior to the burners. Medium- and low-efficiency furnaces use room air for combustion and should have an unrestricted supply of air. If you have a medium- or low-efficiency furnace enclosed in a small room, it is critical to ensure that the furnace is supplied with adequate air. Consider installing a louver in the door or wall between the furnace room and the living space. This ensures the appliance has adequate combustion air and is less likely to pull gases down the chimney. As an added precaution, it is wise to install a CO detector in the living space near the furnace.

ADDITIONAL REQUIREMENTS FOR MULTIPLE OCCUPANCIES

If you convert part of your basement into a separate apartment, the NBCC requires you to provide additional fire safety measures that include the following:

- Apartments must be separated by smoke-tight construction that will resist the spread of fire from one apartment to another for at least 45 minutes.
- Structural elements, such as bearing walls, beams and columns that support one apartment above another must be protected for at least 45 minutes against collapse from exposure to fire.
- The heating, ventilation system and plumbing must be separate for each apartment and enclosed to prevent the spread of fire and smoke between apartments.
- Each apartment must have its own entry that is separate from the other and protected from fire and smoke.

- The floor and wall assemblies that separate apartments from one another must be constructed to resist the transmission of noise. The NBCC requires a sound transmission class (STC) of 50 or more between apartments.

The requirements for multiple occupancies aren't the same in each province and territory. Refer to your building code for a comprehensive description of the requirements that govern construction in your jurisdiction.

FINISHES AND COVERINGS

Even the best-designed basement may experience a serious leak, spill or flood. It is prudent to install water-resistant or impermeable floor and wall finishes, such as vinyl flooring and ceramic tile, to lessen the likelihood of damage and make clean-up easier.

If carpet and underpad are used, they should contain no organic materials that may promote mold. Area rugs can be removed and cleaned or disposed of in the event of a flood. Furniture should have legs that keep upholstery above the level of the flood water. Refer to the *About Your House* fact sheet *Avoiding Basement Flooding* for advice about protecting your basement from floods.

Most drywall and fibreglass batt insulation must be removed and discarded if they become wet from flooding. Cement board and polystyrene insulation are less risky alternatives because they are almost unsusceptible to water damage. Refer to CMHC's *Research Highlight: Basement Walls That Dry Quickly* for advice on the construction of walls that might be damaged by water.

SOURCES OF INFORMATION

Additional sources of information related to basements are listed on the following page. Consult with your municipality and comply with the building regulations in your jurisdiction if you choose to renovate your basement.

To find more *About Your House* fact sheets plus a wide variety of information products, visit our website at www.cmhc.ca. You can also reach us by telephone at 1-800-668-2642 or by fax at 1-800-245-9274.

Priced Publications

A Guide to Fixing Your Damp Basement	*Order No. 65886*

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Secondary Suites	*Order No. 66497*

Research Highlight *fact sheets*

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