Landscaping Guide for Properties Built on Clay Soils

The Joint Committee for Houses with Settlement Cracks was set up in January 2003 to assist owners of buildings affected by pronounced foundation settlement resulting from the drying out of clay sub-soils.

This landscaping guide has been based on the various measures put in place by the Committee. It offers solutions and practical advice drawn from such sources as the Canada Mortgage and Housing Corporation (CMHC) and consultations with many specialists in this field. The implementation of the advice it contains may reduce the risk of settlement in susceptible zones. The Ville de Longueuil, in conjunction with several universities, is also continuing its studies to better understand this phenomenon and to find new methods of control.

This brochure is additional information to that published in June 2003 following the coming into force of the « Programme Rénovation Québec de la Ville de Longueuil, House with Settlement Cracks Section » that you may consult on the City’s Web site: www.longueuil.ca
How does landscaping affect the drying out of sub-soils?

Clay soils that are subject to drying out in drought conditions are prevalent in many parts of Canada, especially in the St. Lawrence River valley. Many factors influence the behaviour of clay soils and the potential damage that may be caused to foundations: the type of clay, the quantity of rainfall, the quantity and type of ground cover, and the type, age and depth of the foundations.

Before urban development, soils received and conserved water coming from precipitations (rain, snow); the surplus usually flowed into natural streams and watercourses. In our towns, a great percentage of such water is channelled into the sewer network (roof drainage, housing lots sloping towards the street, etc.). In addition, large impermeable areas for cars and terraces adjacent to our houses considerably reduce the quantity of water that can penetrate into the underlying soil. The soil therefore absorbs much less water than it used to do, which causes a progressive dehydration. In certain circumstances, this can even reach the foundation level of buildings.

It is important that special attention be paid to this phenomenon, and that changes are made to the landscaping of your lot in order to maintain a sufficiently high humidity level in the soil.

Rainfall Deficit
A rainfall deficit is a situation where the total precipitation for a given period is less than the normal for that period. Summer rainfall deficits have a greater impact on soils than those of other seasons.

Fig. 1. Extent of sensitive clay soils: Low-lying areas of the Ottawa River and the St. Lawrence River
Source: CMHC
Why is landscaping important in helping to maintain soil moisture levels?

To reduce soil dehydration, retain and adequately distribute precipitation over the whole of your property. Precipitation varies according to the season, the abundant rains in the spring and fall compensate for the drier summers. Most landscaping work can accommodate water in the spring without suffering any damage, thus allowing the soil to have a reserve of water to last it through the summer.

Adapt the slopes and counter-slopes

By changing the slopes in landscaping work, it is possible to make water flow around the house and so be uniformly distributed. However, to avoid the risk of infiltration, water should not be allowed to accumulate against the house foundations. To this end, a one-metre wide counter slope around the house should allow the clay to maintain sufficiently high moisture content (see fig. 2). If it is impossible to keep water away from the foundations, a waterproof membrane fixed to the foundations coupled with an efficient French drain will be enough to ensure that water does not infiltrate into the basement.

Increase the soil’s retention capacity

As clay at the correct moisture level does not absorb further moisture, it becomes necessary to change the composition of the surface soil in those zones where water will accumulate. You can increase the permeability of the soil by mixing the clay with other types of soil. Or, you can construct a “river” of pebbles approximately 1 to 2 metres wide and sufficiently deep to store water without flooding the surface (see fig. 3). Ideally, such a river of pebbles would be located immediately at the lower edge of a counter-slope.
Reduce “hard-top” surfaces

Hard-top surfaces such as asphalt, concrete, interlocking bricks, etc. around houses should be kept to a minimum.

Patios that allow rainwater to pass through to the underlying soil (e.g. wooden decks) are an ideal solution. If you really wish to build a patio using interlocking bricks, concrete, or flagstones, this should be located some 2 to 3 metres from the house and the intervening space filled with a “river” of pebbles. You could then link the patio to the house by means of an open-spaced wooden walkway.

In the case of driveways, it is possible to direct water to the soil under the driveway either by using drains that take water from “rivers” of pebbles at each side of the driveway or by using trenches covered with metal gratings. However, there is a risk of frost heave during the winter.

Fig. 4. Example of landscaping to help maintain soil moisture.
Landscaping work that minimizes water evaporation

By using diverse colours and shapes, landscaping around our homes greatly contributes to the image and pleasant character of our neighbourhoods. Some older districts are even sought after because of their mature trees and flowerbeds. Although some plants can accelerate the drying out of clay soils, a careful choice of flowerbeds, garden plants, lawns and ornamental trees can contribute to preventing this phenomenon.

By cutting back on landscaping that requires a lot of watering, such as lawns and traditional flowerbeds, and by avoiding certain types of trees and replacing them with others that require less water, it is possible to reduce the natural evaporation of the soil while still retaining pleasant landscaping.

Choose plants and flowerbeds that require little water

Traditional plants and flowerbeds are usually composed of a mixture of perennials (ground-cover plants, flowers, bushes, and bulbs) and seasonal plants (mainly flowers). Often, more permanent elements such as dwarf walls, prefabricated structures, or decorative stones are used to act as borders or highlights. Such landscaping work generally requires regular and abundant watering, mainly due to the choice of plants, which are often exotic, and to the absence of mulch.

It is possible to reduce the requirement for water by choosing indigenous plants that can withstand summer droughts. Also, the use of mineral mulch (pebbles, broken bricks) or vegetable mulch (bark, wood chips) around the base of the plants will considerably reduce the evaporation of water from the soil.

An alternative solution to the traditional flowerbed is the use of wild meadow flowers. This type of landscaping is typified by the use of indigenous grasses and wild flowers that are to be found in natural meadows and grasslands. Sufficiently thick to keep the soil cool, and requiring very little water, this type of landscaping also requires very little maintenance.

Consult a horticultural centre or a landscaping specialist to obtain more details about indigenous plants or plants requiring little water.

Many of the ideas presented here come from the concept of “zero landscaping”. This type of layout makes use of indigenous or hardy plants that need little water. As well as reducing or even eliminating watering, these plants draw little water, thereby reducing the drying out of the soil.

If you wish to know more about the landscaping ideas discussed in this section, you may consult the document entitled “Taking the best decisions for you and for the environment” published by the CMHC.
Choose easily maintained lawns

The very popular traditional lawn is mainly composed of two or three types of grass. It requires a great deal of attention: regular cutting, periodic fertilizing, and manual weeding. Also, the dense grass and turf does not allow rain to be easily absorbed, thus reducing the re-hydration capacity of the soil. This situation can be improved by aerating the lawn each spring. In sensitive zones, it is preferable to limit this type of lawn or to replace it altogether by mulches or by wild flowers.

An alternative to the traditional lawn is the easy-maintenance lawn. Made up of hardy, slow-growing grasses that are drought resistant and by broad leaf plants such as clover, this type of lawn does not require frequent cutting. As well as having little need for fertilizing or spraying, these lawns generally do not require watering. Like the traditional lawn, the easy-maintenance lawn does require aerating each spring to encourage the absorption of rainwater.

Choosing the right type of tree

As well as increasing the value of a property and the attractiveness of a neighbourhood, trees provide shade, ensure shelter for birds and other small animals, and display magnificent colours in the fall; conifers also offer protection against cold winter winds. The influence of trees on soils is limited to the area covered by their roots. In clay soils, the roots are mainly concentrated in the first 30 cm of the soil, and rarely exceed a depth of 1.50 metre in other types of soil.

In prolonged periods of drought, trees become dormant and only use the minimum amount of water necessary for survival. The quantity of water required depends on the size and species of the tree. Trees may be classified into three distinct groups according to their need for water. Xerophytes have low water requirements but are not suited to clay soils which are too “wet” at certain times of the year. At the opposite end of the scale, hygrophytes have a great need for water throughout the year and will have a tendency towards aggressive taking of water from the soil during periods of drought. Finally, the term mesophyte covers a large group of trees capable of withstanding both drought and very wet conditions. These are the trees that are best adapted to growing in clay soils.

Xerophytes require very little water and can rarely tolerate wet ground conditions (e.g. pine trees).

Hygrophytes require a great deal of water and like to “have their feet in the water.” They are intolerant of dry soils (e.g. willows and poplars).

Mesophytes require a moderate amount of water and are generally capable of surviving wide variations of ground water conditions (e.g. fir trees and walnut trees).
When planting a new tree, certain precautions should be taken to limit its effect on clay soils adjacent to foundations:

- The tree should be planted as far away as possible from the house and never less than a distance equivalent to its height at maturity.
- Avoid planting a tree in a restricted space such as the side setback between two houses.
- A number of small trees grouped together may have the same effect as one large tree.
- When these recommended distances cannot be met, another type of tree should be selected or preventative measures taken as the tree grows.
- Because the root system will not develop under a hard-top pavement such as a driveway or road, steps must be taken to ensure that the roots do not extend towards the house. This could take the form of providing a collection area for precipitation between the tree and the road.
- To provide for efficient watering, the area around the tree trunk corresponding to half the spread of the branches must be kept free of grass. To conserve the humidity while keeping down undesirable weeds, this area should be covered with mulch.

To obtain more information about mesophytic trees, consult a horticultural centre or a professional landscaper.
The use of mulch

As well as being used to control weeds, mulches are particularly efficient at reducing water evaporation from the soil. There are two main types of mulch: those made from vegetation (strips of bark, wood chips, etc.) and those made from broken stones or bricks, gravel, pebbles, etc. Each type has its advantages and disadvantages. The use of one rather than another will depend on the type of landscaping being carried out.

In flowerbeds, the mulch must entirely cover the ground between the plants. If the mulch is sufficiently thick (approximately 10 cm), especially for organic mulch, weed growth will be greatly reduced if not eliminated and the humidity level of the soil will be maintained.

As previously mentioned, for efficient watering of trees, the lawn under the tree must be replaced by mulch (see “Choosing the right type of tree”). By ensuring water reaches the tree where it is needed, the mulch will control the spread of both surface and deep roots.

Measures for controlling trees

Although trees are not solely responsible for ground settlement, they can accelerate the process if they are planted too near the foundations (see “Choosing the right type of tree” in the “Landscaping work that minimizes water evaporation” section). Here are some gardening tips that may help to control the growth of a tree or the volume of its roots:

- Whenever possible, provide increased watering or the presence of water on the side of the tree opposite the foundations so as to encourage root growth away from the foundations.
- The volume of a tree’s root system is closely linked to the volume of its branches. Maintenance pruning or pruning to restrict the growth of the branches will also have the effect of reducing root growth. This work must be carried out regularly by an experienced forester, ideally from the time the tree is planted.
- When a tree is located very close to a building, an anti-root barrier may be used to keep the roots away from the foundations. Such barriers can be made using thick geo-textile membranes buried vertically in the ground (see figure 7 below). This can be an effective solution for houses that do not have deep foundations.

A question of cost

Controlling the growth of trees by pruning can be a very expensive process. When planting a tree, it is better to choose one that is more suited to the distance between it and the foundations.
Water conservation and distribution during periods of drought

Thanks to your careful landscaping, your land is now able to conserve rainwater and the moisture level of the soil is maintained so that it requires little water. All that remains is to ensure a supply of water during times of drought without having to resort to using costly drinking water from the mains.

Natural rainwater, although scarce during droughts, is the main available source. The other potential source is water from swimming pools, which have to be backwashed regularly to clean the filters. In both cases, however, the problem is storing the water for future distribution.

Generally speaking, most houses with sloping roofs are equipped with gutters. A traditional method used for storing rainwater is to install a barrel under each downspout. However, due to the West Nile virus, the barrels should be covered with mosquito netting to prevent the insects from laying their eggs in the stagnant water.

To find out more:
www.longueuil.ca

Drinking water

Drinking water is a precious resource and is costly to produce. The Ville de Longueuil does not recommend watering to compensate for rainfall deficits. Drought most usually occurs during a period of restricted water use. Landscaping layouts exist (e.g. zero-landscaping concept) that offer the possibility of having beautiful gardens requiring very little water.

Watering

Here are some tips for increasing the soil’s ability to absorb and retain moisture:
• Aerate the lawns in the spring;
• Use mulches to help the soil retain moisture;
• Water early in the morning or in the evening (while complying with municipal restrictions);
• Heavy watering, a few times a week (in accordance with the by-laws in force in your borough) is more effective than light daily watering;
• Use a perforated pipe to water the soil in flowerbeds.
For more information, consult the Canada Mortgage and Housing Corporation’s Web site at www.cmhc-schl.gc.ca where you will find the document “Interaction between Trees, Sensitive Clay Soils and Your Foundation” in the About Your Home series (use the “search” function to look for document CE 31).
Water from swimming pools could be directed onto the soil or into a “river of pebbles” rather than onto the road.

In certain situations, a home owner may decide to remove the gutters around the house (either partially or completely) so that rainwater is distributed naturally around the property. However, steps must be taken to avoid soil erosion and water infiltration into the basement (areas covered in pebbles, counter slopes, etc.). Before going ahead with such measures, a competent professional (architect or technologist) should be consulted.

**Use of innovative solutions**

New methods be developed by owners or landscaping professionals. This could be along the lines of a drainage network similar to a septic tank filter bed, located some 30 cm under the surface of the soil (see fig. 8 and 9). Spread around the house, the network could be fed by the gutters and by the swimming pool outlet pipe. Crushed stone around the drains would act as a reservoir. Screens should be provided in such a system to avoid the network being blocked by debris over the long term. An automatic overflow should also be provided against periods of prolonged rainfall or when lowering the level of the swimming pool in the fall. The network could also extend under paved surfaces to hydrate the adjoining ground. However, such a system should not be installed without ensuring that the foundations are watertight and that the French drain is working correctly so as to avoid water infiltrating into the basement.
How to avoid the crawl space drying out

The under-floor space or crawl space is that area, often of restricted height, under the ground floor that avoids the floor being in direct contact with the soil. Usually having an earth floor, crawl spaces are often ventilated, and sometimes heated to make the ground-level living area more comfortable. However, this heating and ventilation may dry out the exposed soil and this in turn can lead to settlement of the soil under footings, load-bearing columns and foundations. It is possible to prevent this drying out by installing polythene sheeting (0.15 mm thick or more) over the entire surface of the crawl space and covering this sheeting with dry sand or pebbles to protect it. In this way, the humidity level in the soil will be maintained without affecting the comfort in the home.

Trees to avoid and trees to choose

Trees to avoid on clay soils

These species grow to great heights and require a considerable quantity of water. They are to be avoided on properties located on clay soils.

- Silver maple  
  * Acer saccharinum
- Poplars  
  * Populus sp.
- Willows  
  * Salix sp.

Trees to avoid within 10 metres of a foundation

These species may grow to a large size and they should not be planted within 10 metres of foundation walls on clay soils.

- Norwegian maple  
  * Acer platanoides (except fastigated or globular cultivars)
- Red maple  
  * Acer rubrum
- Sugar maple  
  * Acer saccharum
- Red oak  
  * Quercus rubrum (except fastigated cultivars)
- American ash  
  * Fraxinus americana
- American linden  
  * Tilia americana
- American beech  
  * Fagus grandifolia
- American elm  
  * Ulmus americana

Trees to choose for a clay soil

- Norwegian maple  
  * Acer platanoides (only fastigated or globular cultivars)
- Amur maple  
  * Acer ginnala
- Red oak  
  * Quercus rubrum (only fastigated cultivars)
- Weeping birch  
  * Betula pendula Gracilis
- Eastern white cedar  
  * Thuja occidentalis
- Japanese lilac  
  * Syringa reticulata
- Bauman horse chestnut  
  * Aesculus hippocastanum Baumanii
- Bohemian olive  
  * Elaeagnus angustifolia
- Eastern hop hornbeam  
  * Ostrya virginiana
- Austrian pine  
  * Pinus nigra austriaca
- Crab apple  
  * Malus sp.
- Mountain ash  
  * Sorbus aucuparia Rossica
- Cherry  
  * Prunus sp.
To learn more

Consult the following documents:
- Programme Rénovation Québec de la Ville de Longueuil for Houses with Settlement Cracks Section.
- Document CE 23 “Water Saving Tips for your Lawn and Garden” from the CMHC.
- Document “CE 31 Interaction Between Trees, Sensitive Clay Soils and Your Foundation,” from the CMHC.
- Document “Taking the Best Decisions for You and for the Environment,” from the CMHC.

References
- Leaflets 1 and 2 “Your house is cracked” from the ACQC (Association des consommateurs pour la qualité dans la construction)

Supplementary Information
For all supplementary information, please contact the Ville de Longueuil’s Direction de l’aménagement et du développement du territoire at (450) 463-7276.

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