Best Management Practices

SUBSURFACE DRAINAGE

Healthy soils are well-drained and aerated. Properly managed, subsurface drainage systems reduce the impact of excess water, conserve topsoil, and improve crop input efficiency. Drainage contributes to higher productivity on our agricultural lands, helping to provide more food locally and improve resilience to excessively wet or dry conditions.

Subsurface (tile) drainage plays a critical role in an effective soil conservation system, and should be integrated into a soil health plan. However, while subsurface drainage promotes soil health, it cannot compensate for poor practices that promote soil degradation, such as plowpans.

This factsheet provides an overview of the types of drainage systems, benefits, considerations when planning and maintaining, and tips to making it work.

THE ROLE OF HEALTHY SOIL IN A CHANGING CLIMATE

Agriculture and climate are directly linked – anything that has a significant effect on our climate will influence farm production. Greenhouse gas (GHG) emissions and climate change are global concerns, and agriculture can be part of the solution.

BMPs that improve soil health can also help lower GHG emissions, reduce phosphorus loss from fields to surface water, and improve resilience to drought or excessively wet conditions. Healthy soil – an essential component of a healthy environment – is the foundation upon which a sustainable agriculture production system is built.

OFA Ontario Federation of Agriculture
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Agricultural drainage systems are an essential component of infrastructure for Ontario food production.

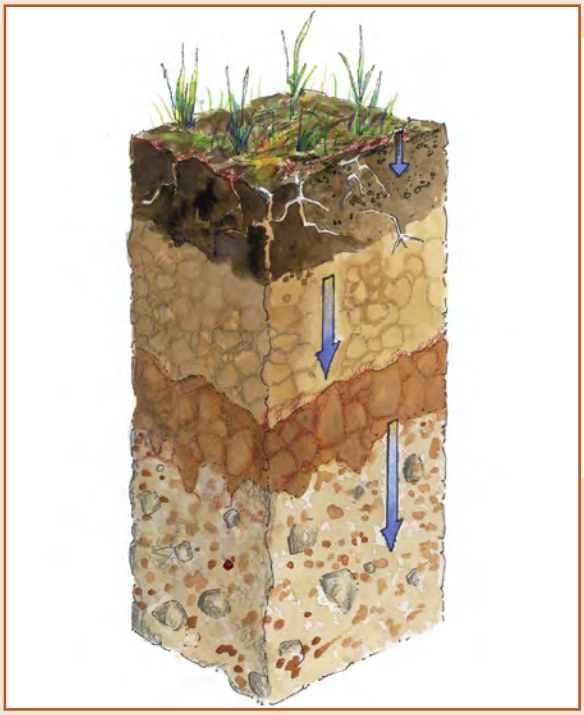
Soils that are naturally wet are most often found in level to depressional site positions, have shallow depths to soil water tables, and are most closely aligned with the "poor" to "very poor" soil drainage classes. These soils are prone to a long list of soil health challenges including runoff and compaction.

What drainage does for cropland

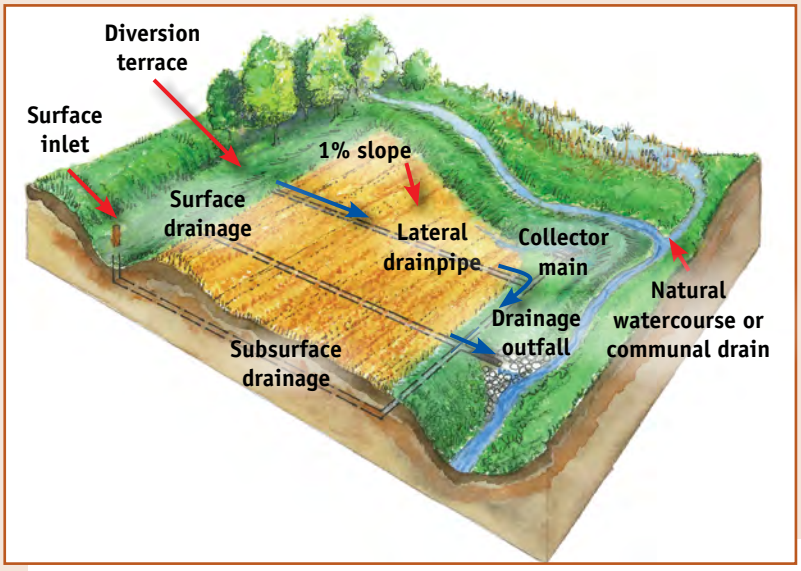
Soils classified as poorly drained are at risk of degradation. Poorly drained soils without subsurface (tile) drainage systems have high water tables, water-filled pores and poor aeration. They are wetter and more saturated than better-drained soils.

Wet soils have a limited capacity to store additional water from precipitation or snowmelt, making them prone to the following soil health challenges:

- ponding and runoff
- compaction and anaerobic conditions
- lower growth, less cover and shallow rooting
- higher greenhouse gas (GHG) emissions.



Soils with water tables that don't rise within 60 cm (24 in.) from the soil surface (e.g. moderately well-drained soils), or imperfect to poorly drained soils with adequate subsurface drainage are less prone to these challenges.



Agricultural drainage systems have several components: surface drainage and erosion control, subsurface drainage, outlets and channels.

EROSION CONTROL

Soils with adequate drainage and good soil health have the capacity to store water. This reduces the risk of ponding, runoff and erosion during storm events.

SOIL RESILIENCE

Subsurface drainage removes excess water. Surface soils dry sooner in the spring – so field operations can proceed with minimal risk of compaction and other forms of degradation.

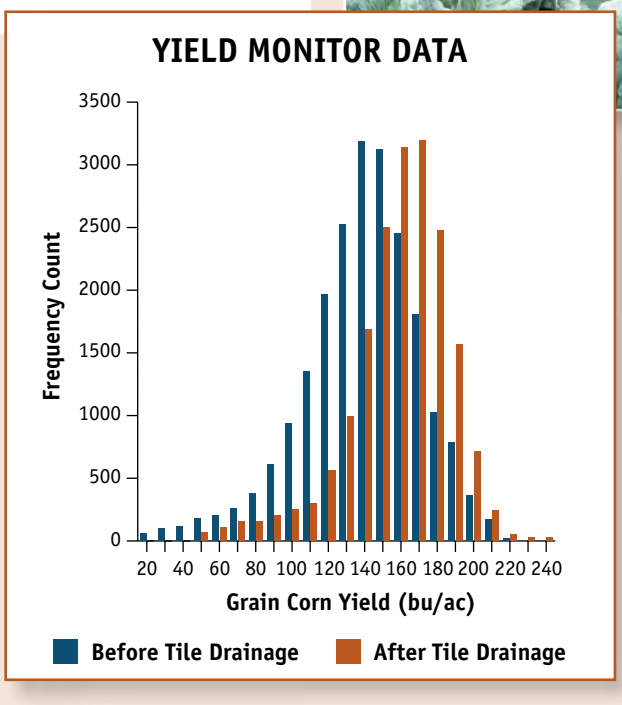
IMPROVED GROWING CONDITIONS

Well-drained soils warm up faster in the spring. Roots of growing crops can exploit moist, well-aerated soils for water and nutrients. High-yielding crops are normally found on healthy, adequately drained soils.

IMPROVED CROP YIELD AND QUALITY

Crop yield and quality are higher on well-drained soils.

This graph shows U.S.-sourced data showing yield ranges on a field before and after tile drainage.



REDUCED GREENHOUSE GAS EMISSIONS

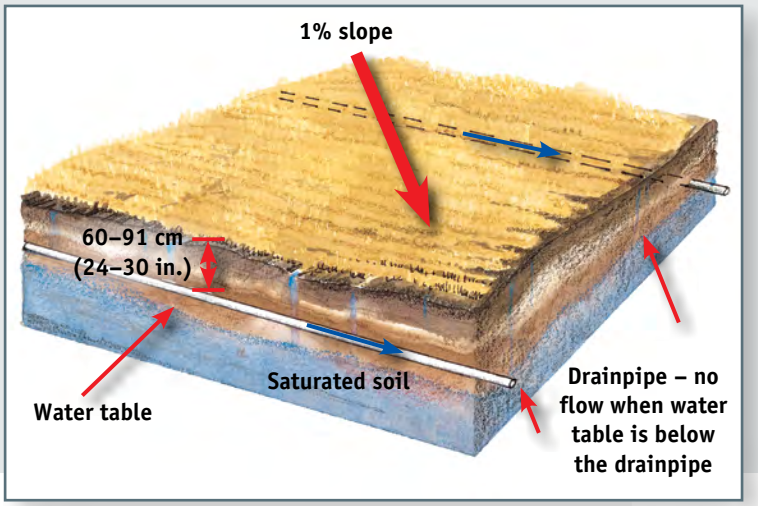
Improved soil drainage helps to reduce soil saturation, surface ponding and anaerobic conditions in the soil – thereby reducing the risk of emissions of methane and nitrous oxide from the soil.

How subsurface drainage works

Surface drainage removes excess surface water from cropland through drainage channels, land grading, and surface inlets.

Subsurface drainpipes convey excess water from above the drainpipe, plus water collected from surface inlets, to a larger-diameter collector drainpipe or main. The drainpipe will continue to remove the gravitational water until the water table is lowered to the bottom of the drainpipe.

Drainage water will then exit to either a natural watercourse or more often to a constructed drainage channel – usually an open ditch or a buried larger-diameter drainpipe. Ultimately, drainage water is conveyed to larger bodies of surface water, including streams, creeks, rivers or lakes.



Subsurface drainage removes excess soil moisture (gravitational moisture) from the soil profile using plastic tubing, clay tile and concrete tile. Only excess water in the soil profile above the drainpipe (usually installed at 60–91 cm or 24–36 in. depth) is removed. With a subsurface drainage system in place, the excess (gravitational) water seeps into the drainpipe, either through small holes in the plastic tubing or through the small space between the ends of adjacent clay or concrete tile.

Considerations when installing or farming with subsurface drainage

VERIFY THE NEED FOR DRAINAGE

POORLY DRAINED SOILS

Soils with a high water table most often require subsurface drainage to grow crops. Soil colour features such as rust spots (mottling) and grey (gley colours) indicate water table activity and fluctuation in the soil profile. See the BMPs for Soil Health Diagnostic Infosheet *Cold and Wet Soils* for more information.

SUBSURFACE COMPACTION

Poor drainage may be caused by past management or other problems. Subsurface drainage will not solve all soil management problems. One example is subsurface compaction: whereas improved drainage will reduce the incidence of traffic on wet soils – so as to reduce the risk of further compaction – it won't remediate an existing compaction problem.

HEAVY CLAYS

Some soils such as the Bearbrook heavy clay in eastern Ontario have properties that hinder soil water movement so drastically that subsurface drainage is ineffective. Surface water management and sod-based rotations may work best on these soils so they can be used on a marginal basis.

PLAN CAREFULLY

PROFESSIONAL ASSISTANCE

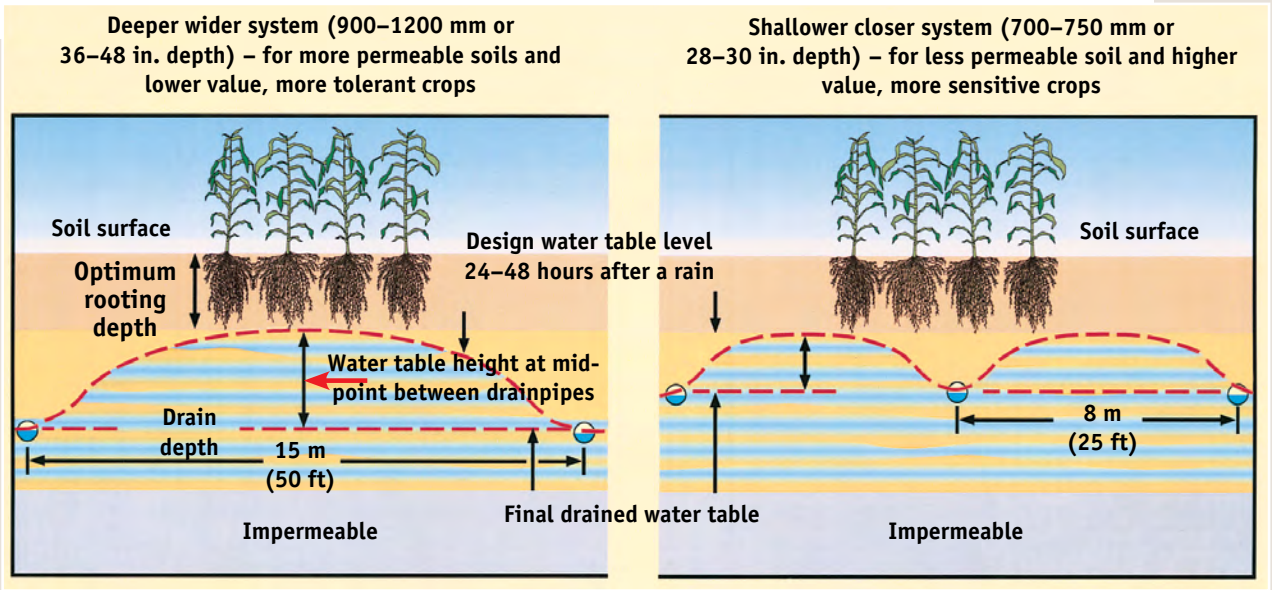
Landowners should work closely with a trained and licensed drainage contractor to plan a prospective drainage project. During this process, check for soil type (series), soil drainage class, nature of problem, location of suitable outlet and feasibility of project. See pg. 6 for a link to OMAFRA's list of licensed drainage contractors.

PROPER OUTLET

Location of an outlet for the water (ditch or closed communal drain) will determine if a subsurface water drainage system is feasible.

DESIGN PROPERLY

Professional engineers and licensed drainage contractors have the expertise required to properly design subsurface drainage systems. Following a thorough planning phase, a hired professional will design a drainage system that will remove only the necessary amount of water to support field operations, crop production and runoff control. Crop requirements and tolerances are important considerations when designing subsurface systems.



IMPROVE SOIL MANAGEMENT

Complex soil moisture problems most often require a systems approach for effectiveness: combining improved drainage with soil health BMPs works best.

MAINTAIN REGULARLY

Subsurface drainage systems and pipes can become blocked, clogged (with sediment or roots), cracked and crushed. Neglect of basic system maintenance can lead to serious flow problems such as blowouts or cave-ins.

CHECK INPUTS

Cropland drainage systems – whether by surface inlets or macropores above the lateral lines – can be a conduit for crop inputs and soil particles. Improved drainage may require improvements in the use and application of manure, fertilizers and pesticides.

PLANNING AND DESIGNING A SUBSURFACE DRAINAGE SYSTEM

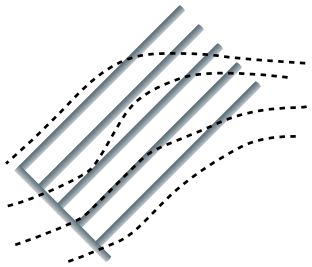
- ✓ Have a clear understanding of the problem, the types of crops to be grown, which drainage designs will work, an estimate of the cost and value of expected benefits, and the impacts of the project.
- ✓ Hire a professional licensed drainage contractor to conduct more detailed examinations and surveys that determine the size of the area, the drainage pattern, proper outlet options, and special features where riparian vegetation, wetlands, or rock outcrops exist.

  A professional licensed drainage contractor should determine if and where structures like berms and hickenbottoms would be located and how they would be connected into the subsurface drainpipes. The contractor will design the subsurface system, including sizing to accommodate surface water.

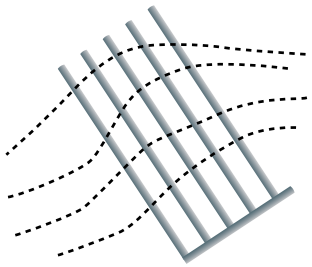
Overland flow water can be intercepted and directed to tiles with the use of other structural BMPs. An Erosion Control Contractor holding a Certificate of Achievement from the OMAFRA Agricultural Erosion Control Structures Course has specific training in the design and construction of structural BMPs. For OMAFRA's listing of Soil Erosion Control Contractors Certificate Holders, see: **www.omafra.gov.on.ca/english/engineer/facts/soilerosioncontractors.htm**

- ✓ Be aware of manure, chemical, and fuel storages nearby. Maintain suitable distances from any potential point-source pollutants.
- ✓ Discuss your soil type and crop needs with the drainage contractor. The contractor will determine the appropriate drainage coefficient(s) for your land.
- ✓ Proper design by the drainage contractor should result in the most effective choice of lateral spacing and depth of tiles in the field.
- ✓ Drainpipe sizing is to be determined by the drainage contractor through the use of approved design criteria.

LATERAL LAYOUT AND SLOPE



Desirable: laterals are aligned with field contours



Undesirable: laterals cross field contours at right angles

Orient lateral drains nearly parallel to the field's contours, crossing the slope – not straight up and down. This way, subsurface water moving downslope can be intercepted by laterals and the system will function more effectively and produce more uniform results.

✓ Orient lateral drains askew to tillage and planting pattern. This ensures that tracking of heavy equipment will be across the drainpipe and not lengthwise, thus reducing potential for damage and providing better traction for machinery. Also, tillage or row planting can alter the flow path of surface water.

An askew pattern of drainage will ensure that gravitational water will be better intercepted by laterals and that drainage will be more uniform.

✓ Minimize the number of short lateral drains to reduce costs and restrictions to water flow in tile. Each lateral requires excavation to start installation and a connection to the header main.

✓ Balance the number and size of header mains for capacity and to reduce costs.

✓ Minimize number of outlets to reduce costs and maintenance.

INSTALLATION

During installation, a **professional contractor** should:

- follow all applicable safety guidelines
- avoid installing drainpipe when the soil is wet to reduce soil smearing and compaction
- provide the landowner with a plan indicating dates, layout, material used and location of subsurface drainpipes.

A **landowner** should:

- make sure all legal requirements are met
- specify season for installation – summer or fall installations experience the least soil damage
- remove physical obstacles (such as rock fencerows) that will hinder pipe installation
- inspect drains yearly and conduct maintenance as required
- keep records of where drains are in fields.

Installing drainpipe when conditions are dry will reduce the risk of subsurface compaction and smearing of soil along the excavated trench.

For more information

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

Many sources of supplementary information are available.

Below are some suggestions to get you started. Most can be found online at **omafra.gov.on.ca/english/landuse/drain-pub.htm** and ordered through ServiceOntario.

- *Agricultural Tile Drainage Installation Act*
- *Drainage Guide for Ontario*
- Publication 811, *Agronomy Guide for Field Crops*

Best Management Practices Series

- *Buffer Strips*
- *Controlling Soil Erosion on the Farm*
- *Cropland Drainage*
- *Establishing Tree Cover*
- *Field Crop Production*
- *Soil Management*

Environmental Farm Plan (4th ed.) and EFP Infosheets

- #15, *Soil Management*
- #19, *Field Crop Management*
- #21, *Stream, Ditch and Floodplain Management*

Inquiries to the Ontario Ministry of Agriculture, Food and Rural Affairs

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