Best Management Practices

EROSION CONTROL STRUCTURES

For the most part, soil health is about building soil quality and protecting the soil surface. Adding organic soil amendments, rotating crops, and reducing tillage help to increase organic matter and improve structure, infiltration (water entering soil surface) and percolation (water moving through the soil).

Residue management, cover crops and windbreaks are some of the best management practices (BMPs) that protect the surface.

There is no question that healthy soils, where soil BMPs are in place, are more resilient to challenges such as erosion by wind and water. However, healthy soils alone may not eliminate the risk entirely for erosion and runoff.

Erosion control structures are designed to manage runoff from intense storm events. This factsheet explains their unique role in soil management, different types and their specific functions, how to get started, and design, management and maintenance considerations.

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.

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Managing runoff from intense storm events

Most of the loss of soil from cropland in Ontario is from intense rain and runoff events – especially when soils are either bare (late winter to early spring) or when growing row crops provide inadequate cover to protect the soil (late spring). During these events, the rate of precipitation exceeds the infiltration and percolation rate of the soil. Excess water runs off. Such intense storm events will also result in runoff from healthy soils: it just might take a little longer.

Experts estimate that 20% of our storms cause 80% of the runoff and erosion from Ontario croplands.

Most of the runoff from these events that starts as sheet flow moves over the landscape and begins to collect and flow in the low draws, forming channelized flow. This is the same type of flow that leads to rills and gullies.

Soil management or soil health BMPs will improve soil resilience and reduce the risk of erosion and runoff. However, they will not eliminate the risk and will not stop channelized flow during heavy storm events.

An ***erosion control structure*** (ECS) can help to manage surface water and reduce soil loss along the channelized flow pathways. It is designed to control erosion and safely convey surface water to a proper outlet.

A ***surface drainage system*** removes excess surface water from cropland through drainage channels, land grading, and surface inlets.

Erosion control structures like this grassed waterway will help to reduce runoff and erosion by directing the flow over a grassed channel to a safe outlet. In this way, erosion control structures complement other BMPs to form a suite of measures that prevent and control soil erosion and runoff. Where necessary, these structures are an essential component of a soil conservation system.

Why cropland soil erosion should be controlled

SOIL LOSS = LOSS OF SOIL HEALTH AND PRODUCTIVITY

Eroded soils are degraded soils. Loss of soil can lead to further soil loss, structural degradation and lower soil moisture-holding capacities. Degraded soils – as indicated by the patches of yellow, stunted corn plants on knoll positions – don't provide the same growth conditions as healthy soils.

CONTAMINATION OF SURFACE WATER

Runoff flowing over streambanks carries with it sediment, organic matter and crop nutrients – any or all of which may contaminate surface waters.

IMPACT ON FIELD OPERATIONS **Large rills and gullies, formed by heavy volumes of channelized flow over cropland, will limit access for cropping and tillage equipment to all parts of the field.**

Types of erosion control structures

Erosion control structures are designed and constructed to protect land from the erosive energy of runoff water and safely convey this water to a proper outlet.

The most common types of erosion control structures are grassed waterways, chute spillways, drop pipe inlets, grade control structures, diversion terraces, and water and sediment control basins (WASCoBs). Each type performs differently, and its suitability will be determined by needs and site-specific conditions.

For example, standpipe inlets with calibrated flow restrictors (e.g. Hickenbottom inlets) in WASCoBs, which move surface water runoff to subsurface drainage systems, will reduce sediment loading from runoff events by helping the water to pond for a short period of time and encouraging soil particles to settle out before entering the inlet.

Other erosion control structures, which in effect reduce slope length, will move surface runoff to surface or subsurface drainage systems and limit the erosive forces of runoff events. This type includes diversion terraces and narrow-based terraces.

WASCOBS are earthen embankments across draws, with retention basins and standpipe inlets (drop pipe inlets) to convey water to a subsurface drainage system. These structures reduce downstream erosion. The duration of temporary ponding is carefully engineered to reduce the risk of damaging the crop.

GRASSED WATERWAYS are graded and grassed channels placed in draws with subsurface drainage systems, intended to divert and transfer runoff to a proper outlet. They work best when established as part of an erosion control system that includes cropland soil conservation BMPs such as no-till and mulch tillage.

DROP PIPE A large-diameter pipe (drop pipe) is installed to convey water down steep slopes or high drops to prevent ponded water or concentrated flow from forming large rills or gullies.

RISER INLET Riser (stand-pipe) inlets are for temporarily ponding small surface flows.

CATCH BASIN Catch basins are covered by a grate, identified by markers, and located in low-lying areas. They intercept surface water and are connected to a subsurface drainage system for transmitting water to a proper outlet.

DIVERSION TERRACE A diversion terrace acts to safely divert runoff over land to a proper outlet. Diversion terraces can be sized to match the anticipated flow volumes. They shorten flow path lengths, but to a lesser extent and and for a lower cost than field terracing.

WHY EROSION CONTROL STRUCTURES ARE EFFECTIVE

Erosion control structures perform one or more of the following functions.

SHORTEN SLOPES **Long steep slopes are prone to erosion. Reducing erosive forces by shortening slopes reduces the energy in runoff to suspend soil particles. Diversion terraces and berms shorten slopes.**

DIVERT RUNOFF **Diverting flowing water to grassed pathways will help keep the soil in place, reduce erosion, and keep runoff from surface waters.**

REDUCE THE GRADE **Reducing the grade of a concentrated flow pathway such as a waterway or ditch will slow the velocity and therefore the erosive forces of the runoff water. Placed along a drainageway, grade control structures, chute spillways (shown below), and drop pipe inlets make it possible to reduce the grade. They provide targeted protection (e.g. rock riprap) along a short, steeply graded section of the drainageway, resulting in reduced downstream velocity of the flow.**

Considerations when farming with erosion control structures

Erosion control structures are an essential part of an effective soil conservation system. However, they are expensive and require careful planning and ongoing maintenance to work well.

DESIGN

- **Size and area –** The area contributing runoff extends beyond field and farm boundaries in most cases. In order to design an erosion control structure, contributing area and volume of water to be handled need to be considered. Most erosion control structures require a proper outlet. Work with a professional engineer and/or soil erosion control contractor certificate holder. **omafra.gov.on.ca/english/engineer/facts/soilerosioncontractors.htm**
- **Soil and slope conditions –** Soil texture influences how quickly water runs off a field. Slope shape, steepness and length influence how erosive the runoff becomes. When designing a structure, consideration of all these factors is critical.
- **Equipment and management –** Consider your existing farm field implements and management when designing an erosion control structure. This will help ensure that the structure's presence does not become an obstacle – instead blending well with field operations. Also, plan for any changes to cropping and tillage practices, as these have implications for equipment type and size, as well as for the overall design and maintenance of the erosion control structure.
- **Climate change –** Storm events are becoming more isolated, sudden and intense. This can greatly increase soil erosion if the land is not prepared for it. It is important to consider the potential for soil erosion all year long.

Intense storm events are the new normal. The rate and overall volume of water can cause runoff in most cropping and tillage systems. Erosion control structures can reduce this risk if designed with these storm events in mind.

SYSTEMS APPROACH

Erosion control structures and surface and subsurface drainage systems are part of a soil conservation/soil health management system. As such they need to be complemented by cropland soil conservation and soil-building BMPs (such as residue management and forage-based rotations) to be effective.

These systems work best on healthy soils with adequate infiltration rates. Soil with poor soil structure cannot be fixed with surface drainage. The soil structure needs to be improved by measures such as reducing tillage and adding organic matter so that erosion control structures or surface drainage systems can work effectively.

Subsurface drainage systems remove excess gravitational waters – making room for precipitation and runoff to infiltrate cropland soils. In this regard, subsurface drainage systems are an integral component of soil and water conservation systems. Soil infiltration rates are improved further when the soil's structure is enhanced with additional soil health BMPs, such as adding organic amendments, rotating with forages, and growing cover crops.

MANAGEMENT IMPLICATIONS

- **Maintenance** – Protect your erosion control investment with an ongoing maintenance program. This plan will determine how effective the structural controls are and how long they will last. In general, all erosion control structures should be inspected regularly and repaired as concerns are found. Some maintenance recommendations for several structures are provided further on in this factsheet. More specific recommendations are provided in the BMP booklet *Controlling Soil Erosion on the Farm*.
- **Manure application** – When spreading livestock manure, maintain a minimum distance of 30 metres (100 ft) from open watercourses, catch basins and standpipe inlets. The EFP Worksheet #17, *Use and Management of Manure and Other Organic Materials* provides excellent recommendations regarding the use of manure on farm fields.
- **Physical structures** – If poorly planned and designed, surface inlets and other erosion control structures can become obstacles to field operations. Moreover, structures can fail if not complemented with agronomic soil conservation practices (e.g. residue management or cover crops).

ECONOMICS

Determine if the crops being grown are high-value and/or water-sensitive, and whether they would benefit from a suitable erosion control structure or surface water management. Measured yield increases from controlled water removal and better soil moisture conditions may pay for the structure within a few years.

Grassed waterways are best maintained when field operations (i.e. tillage) are conducted at right angles to the waterway. Otherwise tillage furrows will form channels for overland flow downslope along the edge of the waterway.

Getting started

FIELD SYMPTOMS

Highly erodible soils can be predicted based on practical experience. Erosion can be verified onsite by looking for:

- eroded knolls ("whitecaps") and shoulder slopes (usually the result of tillage erosion)
- washouts (rills)
- aprons of topsoil in depressional areas or at the edge of a field after a storm event
- offsite (or onsite) movement of runoff and sediment.

In a field with a 5% slope and loamy soils, the rate of soil loss and runoff would be even greater if there were small pathways for water to run downhill. Unchecked, these small pathways can lead to larger rills and even gullies.

Soil erosion problems are likely to present themselves if soils are left bare.

PLANNING

Seek technical advice for design and construction from professional engineers and/or soil erosion control contractor certificate holders.

✓ Consider all of the following factors in the planning process:

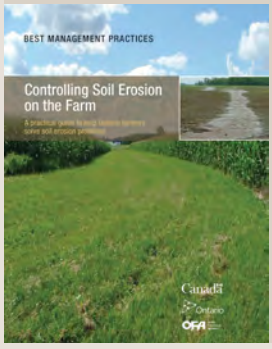
- future land use – whether the land will remain in its current land use
- slope, slope length, soil type, contributing watershed area – all must be considered when designing structures for size and safety
- cropping and tillage practices – how compatible a particular structure would be for given crop types, field operations
- cost of options – which option provides the most value for the investment required
- potential improvements or changes to the downstream water system.

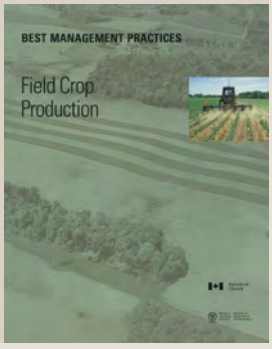
✓ To manage concentrated flow and reduce potential risks, you could:

- protect the flow pathway with permanent vegetation or protective material like stone riprap
- break the momentum of the flowing water by segmenting the drainageway into smaller units (e.g. terracing)
- reduce the grade to convey water in a more controlled manner
- divert the overland flow below the surface to a subsurface drainage system.

In fact, most erosion control structures are designed to attain one or more of these goals. For example, WASCoBs break the momentum of drainage water by temporarily ponding it and diverting the flow to a subsurface drainage system. Multiple units can be installed.

For more on the management of cropland conservation structures, see two BMP publications: *Controlling Soil Erosion on the Farm* and *Field Crop Production*.





For more information on the design of Erosion Control Structures, please see OMAFRA Publication 832: *Agricultural Erosion Control Structures – A Design and Construction Manual*. Software design tools are also available for those trained in the design principles behind agricultural erosion control structures.

BMPs for maintenance of some erosion control structures

Maintenance is essential to ensure the long-term integrity of the structural erosion control system.

Catch basin grates should be inspected regularly and after major storm events, and debris should be removed.

WASCoBs reduce downstream erosion. The duration of temporary ponding is carefully engineered to reduce the risk of damaging the crop. Inspect after major storm events and ensure that the inlet pipe is not blocked by sediment or crop debris.

Protect the ponding area from excessive sedimentation by using crop rotations and conservation tillage. If there is excess sediment buildup within the ponding area, have it removed to keep the system working.

MAINTENANCE OF BERMS, DIVERSION TERRACES AND INLETS

✓ Inspect the berm, inlet and subsurface drainage system regularly for burrowing animals, cracking, settling and other concerns.

✓ Consider mowing occasionally to control woody vegetative growth.

Check the emergency spillway, especially after extreme runoff events. Carry out necessary repairs immediately.

MAINTENANCE OF GRASSED WATERWAYS

Good regular maintenance is required to ensure the ongoing and long-term functioning of the grassed waterway.

Do:

✓ Work land perpendicular to the waterway and raise farm implements when crossing it.

✓ Harvest forage crops from the grassed waterway.

✓ Avoid spray drift.

Do not:

✓ Spray with herbicide.

✓ Use the waterway as a travel lane or as a turning strip during field operations, especially under wet soil conditions.

It is important to design and construct the grassed waterway properly. If it is not sized and shaped correctly, flows may regularly exceed its capacity and its usefulness will be short-lived. Establish and keep a dense, vigorous growth of grass through regular mowing, fertilizing, and over-seeding.

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 **ontario.ca/omafra** or ordered through ServiceOntario.

- *Agricultural Erosion Control Structures – A Design and Construction Manual*
- *Drainage Guide for Ontario*
- Publication 811, *Agronomy Guide for Field Crops*
- Publication 611, *Soil Fertility Handbook*

Best Management Practices Series

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

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

- #15, *Soil Management*
- #16, *Managing Nutrients in Growing Crops*
- #18, *Horticultural Production*
- #19, *Field Crop Production*
- #21, *Stream, Ditch and Floodplain Management*

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