RUNOFF MANAGEMENT FROM YARDS AND STORED FEEDS

THIS CHAPTER EXPLORES:

runoff – what it is, its risks, and how to estimate volume

management options – roofed yards, runoff collection and storage systems, vegetated filter strips, and constructed wetlands

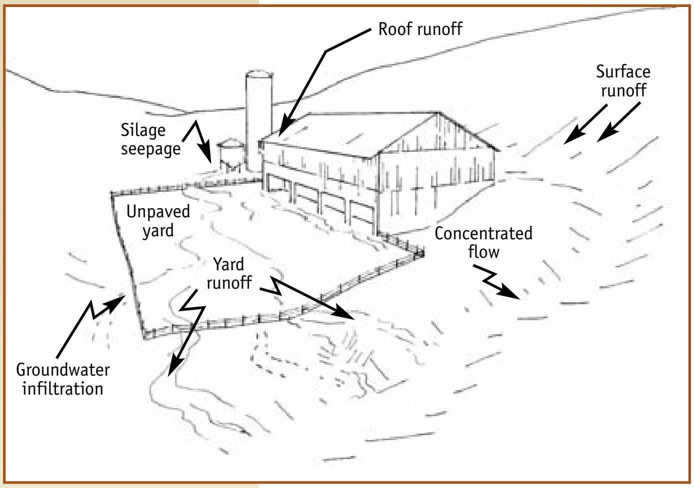
seepage from stored feeds as another form of runoff, and specific means of controlling it.

Livestock **yards and feedlots** provide confined outdoor space for feeding, exercising or loafing. They're a common sight in dairy, beef, sheep and goat operations.

Livestock **confinement areas** are considered yards or feedlots in facilities where grazing and foraging provide less than 50% of the livestock's feed requirements.

Runoff can be a problem. Runoff is a liquid that has come into contact with manure in a concrete yard or feedlot, and may contain components of manure in solution or suspension. The source of the water can be:

- direct rain
- snow and snowmelt
- eavestrough water
- excess water from waterers
- water from stored or deposited manure, and
- surface water flow.



Without proper management, runoff can flow over the ground and contaminate surface water such as streams. This in turn can leach to groundwater, potentially degrading drinking water quality.

Many operations have large yards that are not designed to manage wastes, or are not maintained to reduce runoff.

The constituents that may be found in runoff can be divided into liquid and solid portions. Typically, urine, washwater and contaminated water make up the liquid portion while the solid portion consists of manure, bedding, feed and soil.

Many of the same contaminants found in runoff can be found in liquid manure. Typically, runoff has a very low solids content (often referred to as dry matter content), resulting in considerably lower constituent levels than liquid manure.

RUNOFF VOLUME

Solid manure storages, concrete livestock yards and permanent outdoor confinement areas should be equipped with a runoff management system that handles all the runoff generated by the facility. Runoff should not be allowed to negatively affect surface water.

Current versions of the Ontario Ministry of Agriculture, Food and Rural Affairs's NMAN software can be used to calculate the volume of runoff. This volume is dependent on the factors outlined in the following chart.

"This eavestrough system directs clean water away from the outside yard." – Bob Stone, Agricultural Engineer, Ontario Ministry of Agriculture, Food and Rural Affairs

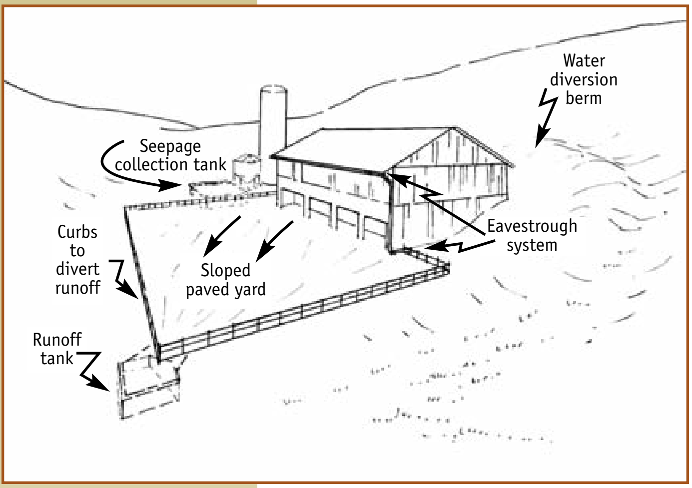
FACTORS USED TO CALCULATE RUNOFF VOLUME

DESIGN FACTOR	EXPLANATION
RAINFALL INTENSITY, DURATION AND FREQUENCY	NMAN uses a standard annual rainfall value for the province
LOT OR MANURE STORAGE SURFACE AREA	a smaller surface area reduces the runoff volume, which reduces the size of the runoff treatment or storage system
DRY MATTER CONTENT OF SOLID MANURE	depends on the type of livestock, amount of bedding or water added

In general, runoff volumes from outside lots and solid manure storages are much higher than most farmers anticipate. For example, an outdoor lot can produce up to 36.6 cm (1.2 ft) of depth of runoff water per square foot of feedlot area over a 240-day period.

This amount of runoff depends on the dry matter content of the manure and manure quantity on the feedlot during this period. A significant percentage of the liquid that falls on the outside lot can be absorbed by solid manure. However, when there's a small amount of solid manure on the outside lot, more runoff will result.

Before considering a runoff management system, divert all clean water away from the solid manure storage, livestock yard or permanent outdoor confinement area. Clean water is rain, snowmelt or other water that has not come in contact with manure. Directing clean water away from the facility will reduce the volume of contaminated runoff that has to be handled.



BMPs for diverting water include: earthen berms and diversions; drop-pipe inlet structures upslope from yard; grassed waterways; and gutter and eavestrough systems on roofs of livestock facilities.

A runoff management system capable of handing all runoff generated for a 240-day period (with some exceptions) should be part of all outdoor confinement areas, concrete yards and permanent solid manure storages.

There are four general best management practices for runoff management that we'll look at here. One, or better yet a combination, of the following may work for you:

- ▶ roofed yards
- ▶ runoff collection and storage systems
- ▶ vegetated filter strip systems
- ▶ constructed wetlands.

ROOFED STORAGE OR ROOFED OUTSIDE YARDS

Constructing a roof over a livestock yard or solid manure storage prevents rain and snow from entering the facility. Rain and snowmelt increase the runoff volume that needs to be stored or treated. Additional water may also change the dry matter content of the manure, which may change the type of treatment system used.

RUNOFF COLLECTION AND STORAGE SYSTEMS

You have two options:

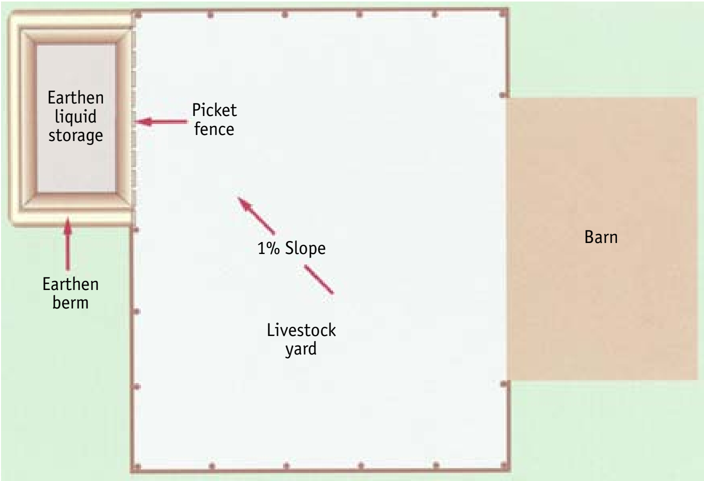
- ► divert to existing liquid manure storage (suitable for paved yards and some dry lots), or
- ► divert to separate storage.

DIVERSION TO LIQUID MANURE STORAGE

- ► existing storage should be sized to meet additional storage requirements from runoff
- ► yards should be designed to convey contaminated water and all precipitation (including storm events) to the liquid storage
- ► concrete curbs, gutters, and a picket-fence outlet to storage may be part of the paved yard design
- ► these systems work best with regular scraping of manure, bedding and wasted feed, plus unplugging the picket-fence outlet area

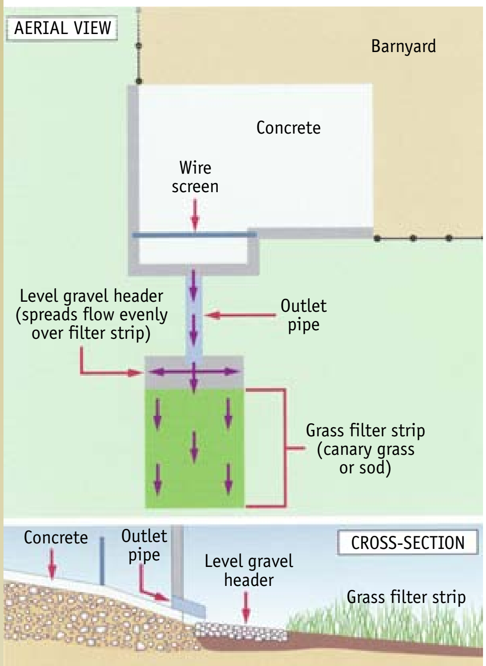
DIVERSION TO SEPARATE STORAGE

- ► yards need to be shaped to channel contaminated water and all precipitation (including storm events) to the designated storage
- ► properly designed concrete curbs, concrete gutters or grassed diversions and a picket-fence outlet may be part of the paved yard design
- ► these systems will only work effectively with scraping of manure, bedding and wasted feed, plus unplugging the picket-fence outlet area



Separate storage systems for yard runoff are more effective if some of the solids are prevented from entering the storage.

VEGETATED FILTER STRIP SYSTEMS



Vegetated filter strip systems are designed and constructed to intercept and treat runoff by settling, filtration, dilution and absorption of pollutants, and infiltration into the soil.

Runoff can be collected and transferred by diversions, curbs, gutters, lot paving, and, in some cases, by pumping.

The runoff is controlled in two stages – one for solids and one for liquids. A settling basin/storage is needed to remove solids. Liquids go to a vegetated area where the liquid is filtered and infiltrates the soil.

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SETTLING BASIN/STORAGE

A settling basin/storage provides a method to retain runoff and reduce the flow rate for settling out solids. The liquids are transferred to a vegetated infiltration area, and the solids remain in the basin/storage for drying and later removal and spreading. The settling basin/storage keeps solids out of the infiltration area and prevents clogging of the pump, pipes, etc.

There are two types of settling basins/storages.

Settling Basin/Storage on Paved Yard

A concrete curb is constructed around the lower part of the paved yard to a height adequate to hold a 25-year 24-hour storm. The runoff may be ponded in this area during a 4–10 hour period, during which the heavier sediment-type material settles out. This settled material can be scraped up with the solid manure. A screening system at the outlet of the curbed area further assists in retaining the settled portion on the paved yard. The liquid portion moves to a sump from where it's transferred by gravity or by pump to the infiltration area.

External Settling Basin/Storage

An external basin/storage may better suit your operation, although it's considerably more expensive to construct than locating a settling area on the paved yard. The liquid runoff moves off the paved yard through a picket-fence area for coarse screening to the external basin/storage. The basin/storage is large enough to slow the flow rate to allow settling of the solid material. The solids are removed for later field application. The settling basin/storage prevents solids from moving to the infiltration area and prevents clogging of the pump, pipes, etc.

The best basin/storage shape is a relatively large surface area that's shallow – usually less than 1 metre (3 ft) deep. The settling basin/storage should be concrete or at least have a concrete bottom for solids removal. Typically, runoff solids will settle out in about 30 minutes, so design the basin/storage accordingly. The basin/storage will require a properly screened outlet to prevent solids from moving to the sump, pump, pipes and infiltration area. Several types of outlet pipes are available to drain liquids from the full depth of the basin/storage and dewater the solids, including perforated pipes and slotted pipes. The basin/storage should be cleaned after every runoff event and frequent unplugging of the outlets is necessary. Typically more maintenance is required with the external basin/storage than with the basin/storage located on the paved yard.

Perforated pipes can be used to transfer liquids to the vegetative filter area.

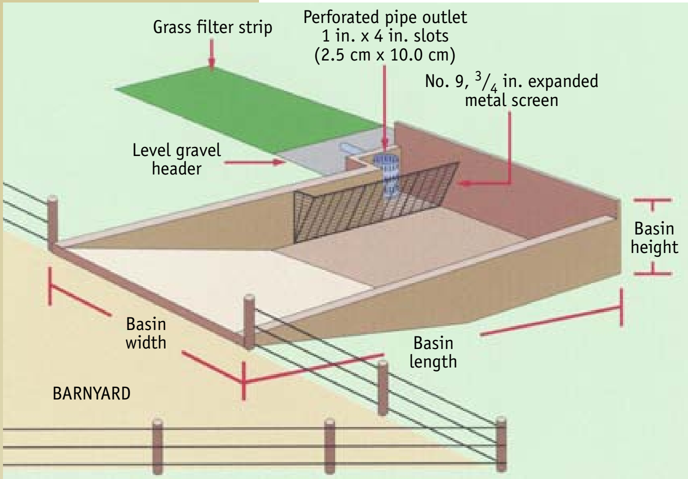
VEGETATED INFILTRATION AREA

From the settling basin/storage, the runoff either flows by gravity or is pumped to the vegetated infiltration area. Treatment occurs as runoff moves down the grass strip and infiltrates the soil.

It's essential that solids be settled out before runoff enters the infiltration area. To be effective, a vegetated infiltration area must be designed, constructed, vegetated, and adequately maintained. Generally, this area is grassed with a slope away from the point where runoff enters the infiltration area. The infiltration strip is surrounded by a berm that diverts all outside surface water so that only lot runoff and direct precipitation enter the vegetated infiltration area.

Approval under the Ontario Water Resources Act may be required from Ontario Ministry of the Environment for installation of a vegetated filter strip system.

Prepare a construction plan for each site. The success of the infiltration area depends on good planning and consideration of site characteristics (e.g., soil infiltration, hydraulic conductivity). Vegetated infiltration areas need to be properly established and maintained with a good stand of vegetation.



A well-designed vegetated infiltration area will take into account liquid volumes and site features, and will divert clean water away from the system.

A CONSTRUCTED FLOW PATH –
NOT A BEST MANAGEMENT PRACTICE

A constructed flow path provides minimal treatment and does not contain yard runoff. A surface pathway, channel or depression, it conducts liquid away from yards and outdoor confinement areas.

The flow path is a permanently vegetated area that is not tiled, and runs between the facility and surface water and/or tile inlets. Some treatment occurs as the runoff moves down the length of the flow path. Flow paths may be suitable for areas with low livestock density and located at a distance of greater than 300 metres (984 ft) to surface water.

CONSTRUCTED WETLANDS

Natural wetlands have long been known to treat contaminated waters, which move through them by a combination of physical, chemical and biological activities. These natural processes can be duplicated in constructed wetlands.

Constructed wetlands are manmade systems that are designed, built and operated to emulate natural wetlands or their functions for human desires and needs. They create optimal conditions for natural organisms to do their work.

Constructed wetlands are essentially wastewater treatment systems that are designed to transform many pollutants into gaseous forms for release to the atmosphere or to trap other pollutants in the substrate. They effectively treat contaminated waters high in nitrogen, phosphorous, bacteria, organic matter and suspended sediment.

This bioengineering technique uses aquatic vegetation to purify wastewater. Oxygen is transported down to the plant root zone through the aquatic vegetation where an aerobic region supports various microbiological activities. This aerobic zone allows for bacterial decomposition and the breakdown of various pollutants containing nitrogen, sulphur and other organic material from human activities (BOD).

Wetlands constructed for wastewater treatment are classified as either:

- ► surface-flow or free-water surface systems, or
- ► subsurface-flow systems.

With surface-flow systems, the incoming wastewater flows across and largely above the surface of the substrate materials, i.e., native soils and clay. In subsurface-flow systems, wastewater flows through the system passing entirely within the substrate, i.e., gravel, crushed rock, soil, and free water is not visible. Most of the constructed wetlands installed in Ontario to date have been the surface-flow or free-water surface systems.

Constructed wetlands will occupy 0.4–0.8 hectares (1–2 ac) on the farmstead. During the planning stages, a complete site investigation has to be made to determine the soil condition and depth to groundwater. It's important to minimize environmental impacts on groundwater.

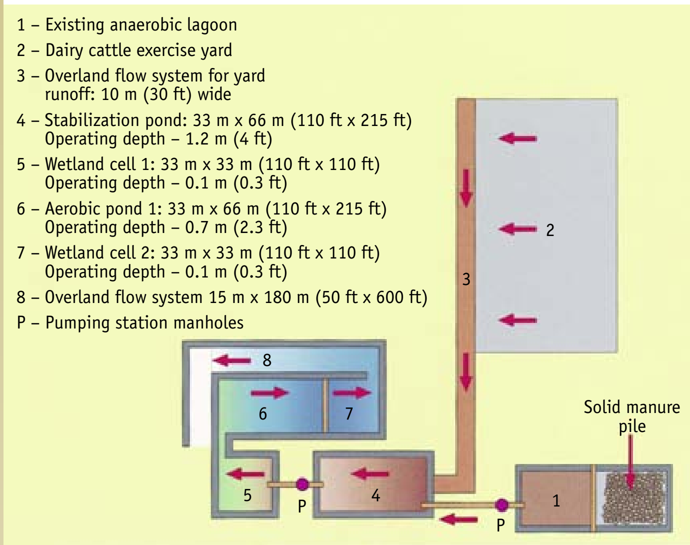
Properly constructed wetlands designed to treat runoff and washwater (e.g., milking centre washwater) are expensive to install. Several constructed wetlands have been installed on Ontario farms on an experimental basis. A proper design for the constructed wetland is essential.

Check with Ministry of the Environment regarding approval to install a constructed wetland.

SYSTEM COMPONENTS

The components outlined in this chart are typical of a surface-flow constructed wetland system. Refer to the illustration on the next page.

COMPONENT	FUNCTION
PRE-TREATMENT POND/TANK (#1)	• a pre-treatment or sediment pond/tank situated at the entry to the constructed wetland removes solids, debris, etc. and acts as an inlet control to the next component of the system • washwaters will have to be stored during the seasons of the year when the wetland is not able to provide the desired level of treatment • storage will also be required in this pond to contain any precipitation or runoff generated by precipitation
FACULTATIVE STABILIZATION POND (#4)	• the facultative stabilization pond reduces the organic content of the wastes to a level acceptable for wetland vegetation • solids that can settle will also be removed in this pond • the liquid depth in this pond is approximately 1.2 m (4 ft) • the facultative stabilization pond also provides flow equalization and acts as a wastewater reserve in dry season, i.e., July, August
WETLAND / AEROBIC POND / WETLAND SYSTEM (#5, 6, 7)	• the wetland / aerobic pond / wetland system further reduces the BOD and nutrient levels • the wetland vegetation, i.e., cattails, which carry the biomass, degrade the soluble organic matter • oxygen is transferred to the soil surrounding the roots, creating sites favourable to aerobic digestion and nitrification
INFILTRATION / EVAPORATION FIELD (#8)	• the infiltration / evaporation field completes the treatment system • phosphorous is removed by adsorption in the soil while other nutrients are removed as the hay is harvested



MANAGING MANURE FROM YARDS AND PERMANENT OUTDOOR CONFINEMENT AREAS

Manure can be mounded to make for easier movement and handling of livestock in the confinement area. Unless it's mounded, manure should be removed from an outdoor confinement area.

Manage all solids. Scrape them to the solid manure storage system (see section on solid manure systems). Clean frequently. Clean yards are less prone to contaminated runoff, methane and nitrous oxide emissions (greenhouse gases), and less likely to cause livestock injury and spread livestock diseases.

MANAGING SNOW THAT CONTAINS MANURE

Snow that contains manure removed from livestock yards or outdoor feedlots is known as "feedlot snow", "winter yard scrapings" or "brown sugar". This material is bulky and low in nutrient content.

Your best management approach is to:

- prevent – by roofing the outdoor confinement area
- reduce – with windbreaks and frequent maintenance
- contain – store with liquid manure storage or separate runoff storage, or
- apply – apply manure to field, but with the following restrictions.

To apply brown sugar to a field, you should ensure that:

- the field has a maximum sustained slope of less than 3%
- the snow is applied no closer than 40 metres (130 ft) from the top of the nearest bank of any surface water in the field
- there is a 6-metre (20-ft) vegetated buffer zone along all surface water in the field and downslope edges of the field, and
- the application rate is one-half of the maximum rate of application for nutrients otherwise established for the field.

MANAGING SEEPAGE FROM STORED FEEDS

Silage can be made from corn, cereal grains, alfalfa, and canning company wastes such as processed sweet corn waste.

Under good harvesting and storage conditions, silage should be of little risk to your water supply. However, without proper containment, excess silage juices can contaminate groundwater and surface water. Too much water or pressure in the silo will cause these liquids to seep out.

Any silage stored at over 65% moisture content will produce a leachate. Most leaching will occur in the first three weeks of storage. Grass silage can produce a trickle of leachate at 75% moisture and 353 litres per tonne (79 gal/ton) at 85% moisture.

The liquids from this silage contain high amounts of:

- nitrates
- ammonia
- iron
- acidity
- organic compounds.

These nutrient-rich liquids, if allowed to reach a stream, can decrease the oxygen content in water, affecting fish and other stream life.

In terms of moisture, tower silos less than 12 metres (40 ft) in depth should have a moisture content below 65%. Above this depth, the moisture content should be below 60%. Moisture content should be less than 70% for horizontal silos.

Before considering a silage seepage management system, divert all clean water away from the silage storage area. As with manure and yard runoff, directing clean water away from the facility will reduce the volume of contaminated fluid to be handled.

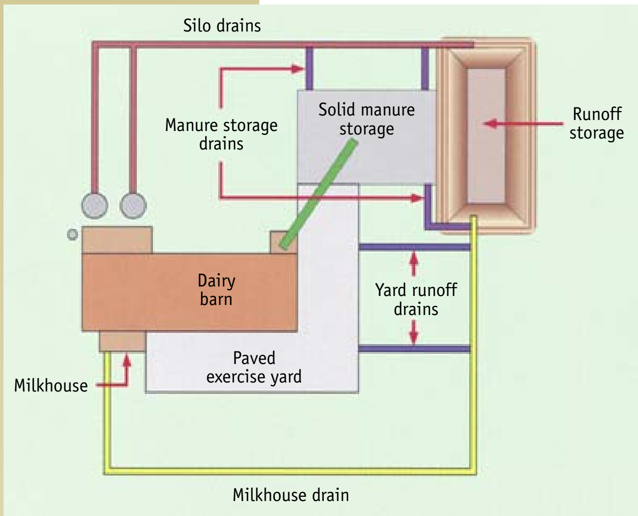
To divert water, use the following approaches:

- silo cover
- earthen berms and diversions
- drop pipe inlet structures upslope from yard, and
- grassed waterways.

Best management options should be linked with yard and feedlot runoff management and include:

- reducing seepage with a physical barrier, i.e., diversion berm
- seepage storage in a separate tank
- storage with runoff or liquid manure storage, and/or
- concentrated seepage to storage tank and diluted high flows to approved vegetated filter strip system.

REDUCING SEEPAGE



One method for managing silage liquids is to store them with liquid manure or yard runoff.

Silage/haylage should be harvested at proper moisture content (i.e., below 60%) for tower silos and below 70% for horizontal silos. Planting shorter-season varieties of corn will result in a drier crop and therefore lower seepage production.

Adding absorbents designed to take up excess moisture will result in low or no seepage production. Material that can be used includes straw, oatmeal, dried sugar, beet pulp, dried corncobs, ground corn, and hay cubes. To be effective, enough material must be added to absorb the anticipated seepage.

On many occasions it may not be possible to wilt the forage adequately or harvest at the desired dry matter content. If the forage is too wet, then seepage is likely. Absorbent materials can be added to “absorb” this seepage.

SEEPAGE COLLECTION AND STORAGE SYSTEM

Whether vertical or horizontal, all silos should have a silage seepage collection and storage system. This seepage system would link to the runoff system used for stored solid manure and/or yard runoff.

Locate seepage collection tanks a safe distance from water wells and surface water (streams, ditches, ponds) to reduce the risk of contamination. See the section on siting storages on page 30.

Likewise, storage sites for bagged, wrapped or tubed haylage should be located a safe distance from water wells and surface water (streams, ditches, ponds) to reduce the risk of contamination.

Storage tanks for seepage should be sized according to the Ontario Ministry of Agriculture, Food and Rural Affairs factsheet on how to handle seepage from farm silos.

Flow will occur throughout the total storage period as the silo is emptied. Where proper silo drainage exists, most of the volume is excreted within the first 30 days after loading. Separate tanks should be sized according to Ontario Ministry of Agriculture, Food and Rural Affairs factsheet on how to handle seepage from farm silos.

Beyond this 30-day period, the dilute seepage can be directed to an outside liquid manure or runoff storage. If there’s no liquid storage on the farm, consider building a storage to contain runoff and seepage for a minimum storage period of 240 days. Another option is to treat this dilute liquid on an approved vegetated filter strip system.

Caution: Never mix silage effluent in enclosed tanks, especially tanks within barns, because silage effluent mixed with manure slurry will accelerate the release of hydrogen sulphide gas. Add seepage only to uncovered outdoor storages.