How to Handle Seepage From Farm Silos

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Factsheet

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(replaces OMAFRA Factsheet 04-031, of the same name)

This Factsheet is written using common units used by the drainage industry. The use of imperial measurements represents the industry standards.

INTRODUCTION

Silage seepage presents two concerns for the agricultural industry — water pollution, and corrosion and deterioration caused by the silo silage juices.

When silage is harvested and stored at low moisture contents less than 70% for horizontal silos and 60% for tower silos, there is minimal corrosion and pollution threat. Above this moisture level, significant flow of silage juices (or seepage) from silos may occur (Table 1 and Figure 1). Corrosion happens where the seepage is trapped for a period of time.

The production of seepage can be reduced or eliminated through cropping techniques and harvest timing (see the OMAFRA Factsheet, *Harvesting Corn Silage at the Right Moisture*).

However, there are conditions where seepage can't be avoided. For example, weather conditions may force a farmer to harvest wet silage or ensile by-products such as sweet corn materials. Both will result in seepage production.

Table 1. Tower silo — maximum moisture content to minimize seepage, whole-plant silages

Silo Size	Max. Moisture Content
3 m x 11 m (12 ft x 40 ft)	72%
4 m x 15 m (14 ft x 50 ft)	70%
5 m x 18 m (16 ft x 60 ft)	68%
6 m x 21 m (20 ft x 70 ft)	66%
7 m x 26 m (24 ft x 85 ft)	63%
9 m x 33 m (30 ft x 110 ft)	60%

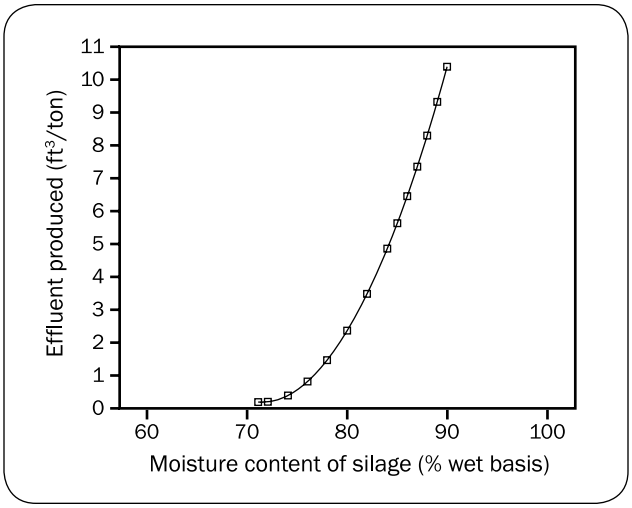

Figure 1. Horizontal silo — seepage production based on silage moisture content.

Most of the environmental problems associated with silage/haylage seepage on farms come from improper or inadequate collection and retention of the seepage draining from the silos. An adequate collection and storage/treatment system is essential if seepage is anticipated.

Table 2 provides information on the acids in silage seepage that cause silo corrosion. Detailed information on silo corrosion is available in the OMAFRA Factsheet, *Deterioration of Concrete Tower Silos*.

Table 2. Aggressive constituents of silage seepage

Constituents	Quantity
Lactic acid	4%–6%
Acetic acid	1%–2%
Butyric acid	normally less than 1%
pH	3.5–5.5

Ministry of Agriculture, Food and Rural Affairs

Ontario

Table 3. Constituents of Silage Seepage

Constituents	Silage Seepage (typical)	Dairy Manure Liquid (typical)
Dry matter	5% (2%–10%)	5%
Total nitrogen	1,500–4,400 mg/L	2,600 mg/L
Phosphorus	300–600 mg/L	1,100 mg/L
Potassium	3,400–5,200 mg/L	2,500 mg/L
pH	4.0 (3.6–5.5)	7.4
Biochemical oxygen demand	12,000–90,000 mg/L	5,000–10,000 mg/L

Source: Cornell University 1994 and OMAFRA.

SEEPAGE IS AN ENVIRONMENTAL PROBLEM

In 2013, farmers in Ontario made 5 million tonnes of corn fodder, producing in the process over 20 million L of silage seepage effluent. Silage seepage in an undiluted form has extremely high BOD (biochemical oxygen demand) values, ranging from 12,000–90,000 mg/L (Table 3), which is approximately 60–450 times stronger than domestic sanitary sewage. Even a small discharge of seepage into a watercourse can remove enough oxygen for a fish kill to occur. Reports from Pennsylvania, New York and Ontario have linked silage seepage to fish kills. In addition, cases of silage seepage contaminating wells in Ontario and the U.S. have been reported.

Table 3 shows that seepage contains significant nutrient concentrations (similar to liquid dairy manure). Seepage is an excellent nutrient source for growing crops if properly applied to land. However, similar to other nutrients, seepage can become a pollutant if it enters surface water or groundwater.

RATE AND VOLUME OF SEEPAGE PRODUCTION

The greatest percentage of silage seepage is produced within 5–10 days of storage loading. For normal silage and haylage production, the remaining seepage is usually produced within the following 30 days. The volumes produced are dependent on the vertical pressure in the silo and the initial moisture content of the crop (Figure 1). The addition of acid additives to silage facilitates higher crop moisture, which can result in a higher initial rate of silo seepage.

The ensiling of wetter materials such as sweet corn by-products or corn silage for biogas facilities results in much higher seepage production. This can occur throughout the entire period that the crop is stored.

Seepage flow out of vertical silos is the greatest during the first month of storage. In silos with good internal drainage (i.e., a network of floor drains to carry out leachate), it tapers off after that. Where internal drainage of the silo is poor (or the ensiled material is higher moisture), flow will occur throughout the total storage period as the silo is being emptied. Rainwater on uncovered silage can produce additional effluent.

For horizontal silos, the rain runoff or snow melt from the floor area inside the storage and feed preparation area adds more effluent to the collection system. The highly concentrated effluent base flow will be increased on occasion by rainstorms and snowmelt.

It is important that all the base flow from the silo along with the first flush of precipitation runoff is collected and stored, since this material has higher concentrations of organic matter and nutrients.

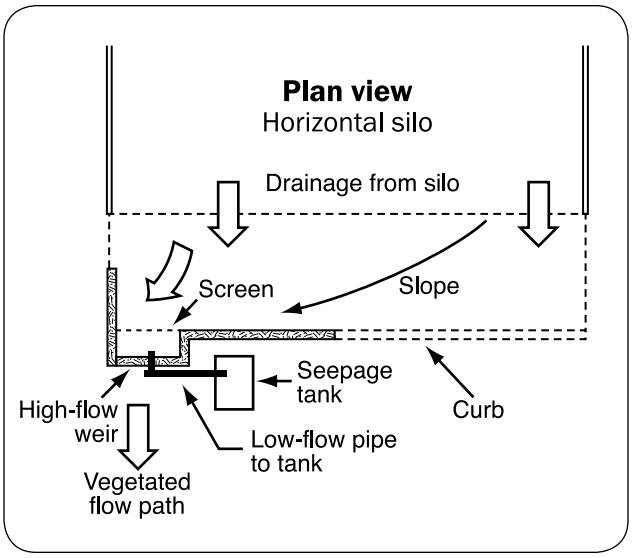

Figure 2. Horizontal silo front-flow seepage system — diluted liquid to vegetated area.

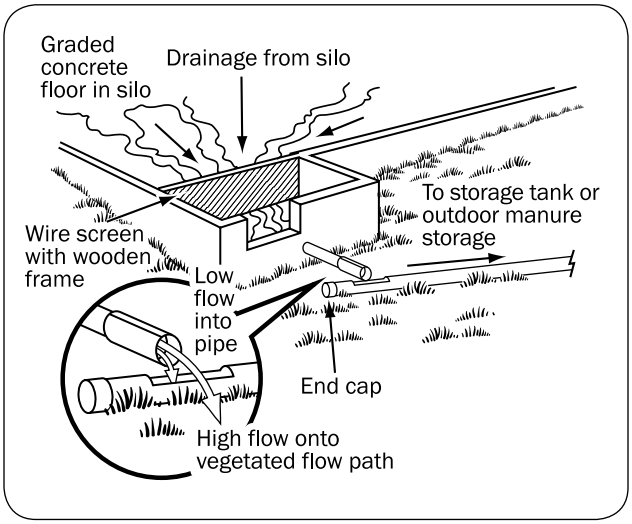

Figure 3. Low-flow collection system diagram. (*Source:* AEM)

Figure 4. Low-flow collection system.

Storage and Treatment of Silage Seepage

Collect the seepage and runoff in a small storage at the silo site and transfer it to an outdoor liquid manure or runoff storage on the farm. Do not contain silage leachate in an under-barn storage (located below animals), because dangerous gases may be produced when the effluent and manure are mixed. Where outdoor liquid manure or runoff storages are not available on the farm, provide a separate storage to contain seepage plus runoff material. During the cropping season, apply seepage on land in the same way as you would apply manure. If seepage is applied to the land, account for the nutrients in the seepage in the Nutrient Management Plan.

Another means of handling and treating seepage involves collecting and storing only the low-flow rates of concentrated leachate from the silo in a storage tank (Figure 2). Allow the diluted high-flow rates of material to flow to a vegetated flow path. Use a low-flow collection system (Figures 3 and 4) to separate the concentrated low-flow seepage.

Reduction of Seepage

Harvest silage/haylage at low moisture:

- <65% moisture content for tower silos less than 12 m (40 ft) deep
- <60% moisture content for tower silos over 12 m (40 ft) deep
- <70% for horizontal silos

Planting shorter-season varieties of corn will result in a drier crop, lowering seepage production. Avoid ensiling wet by-products such as sweet corn residue.

Bunker Silo Sealing/Covering Systems

Using a bunker silo sealing or covering system will reduce silage infiltration by air and water. A sealing system consists of a layer of white or black plastic used as a cover and seal. Old tires are placed edge to edge over the surface of this plastic to help seal the silage.

Figure 5. Tarpaulin and sausage bag system for silage protection.

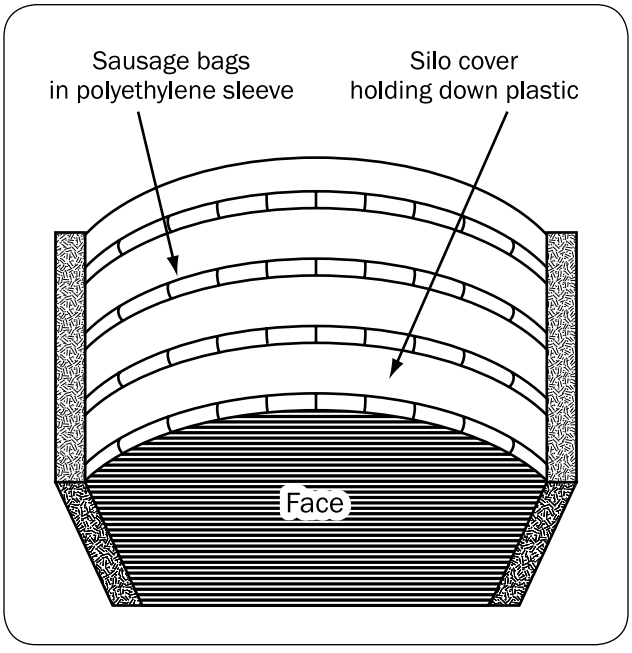

Figure 6. Sausage bag placement.

New Silo Sealing System — "No Tires Used"

In this system, traditional plastic sheeting is covered with a second layer. Instead of tires, sausage-bags filled with sand or gravel anchor the cover in place (Figures 5 and 6). The advantages of this system are the added protection, improved sealing, flexibility, and ease of installation and storage of the sandbags.

- A polyethylene sleeve holds together several of the sausage-bags across the width of a silo. This product reduces the chance of air infiltration between the sausage bags. Figure 6 shows sausage bag placement.
- Use the sausage bags directly on the silo plastic, to reduce the cost and replace the use of tires. This is a good solution if birds or animals tear the plastic seal.
- Adding absorbents designed to take up excess moisture will result in very low or no seepage production. Materials include oatmeal, dried sugar beet pulp, dried corncobs, ground corn and hay cubes. To be effective, add enough material to absorb the anticipated seepage. Proper use of these materials is necessary. It may be possible to feed these materials, however, first get proper advice on how to make sure the material is safe as a feed source.
- 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, seepage is likely. Add absorbent materials to "absorb" this seepage. Table 4 lists the water-holding capacity of various materials.

Table 4. Water-holding capacity of various materials

Moisture content	Material (on an air-dry basis)	Water-holding capacity (kg/100 kg of material) (lb/100 lb of material)
10%	Ground corn grain	58
	Ground oats	69
	Ground wheat	61
	Corn cob: Coarse grind (½ in.)	143
	Corn cob: Medium-to-fine grind	192
	Corn cob: Fine grind (1⁄16 in.)	192
12%	Sugar beet pulp	248
	Alfalfa hay	194
	Mixed grass hay	195
	Oat straw	218

Source: University of Minnesota (1980).

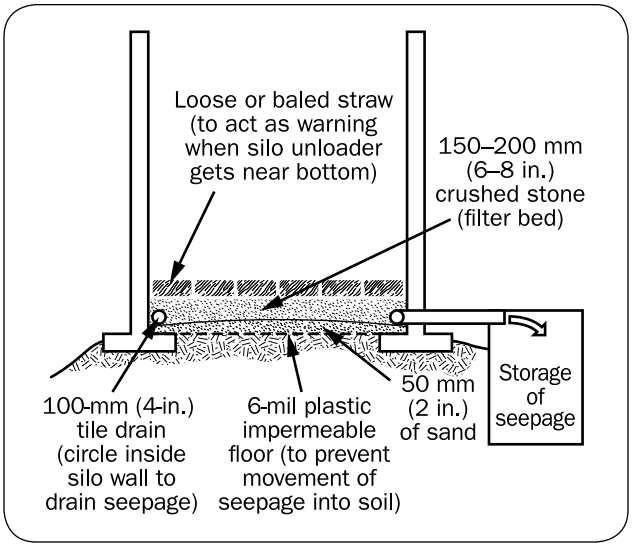

Figure 7. Tower silo seepage storage system.

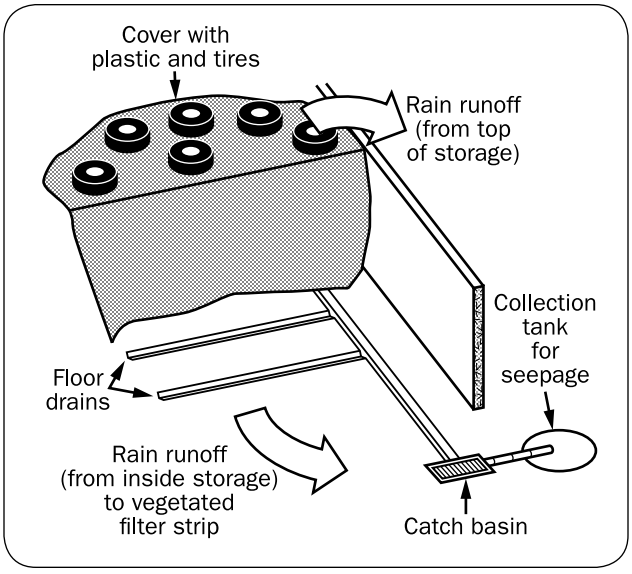

Figure 8. Horizontal silo seepage floor-drain collection system.

Notes:

- Install cross drains 75 mm x 75 mm (3 in. x 3 in.) on 6-m (20-ft) spacing, filled with 20 mm (⅞ in.) of clear stone. Drain should pick up seepage and first flush of rain runoff.
- Drain cross drains to storage tank with header drain 100 mm x 100 mm (4 in. x 4 in.).
- Rain runoff from top of storage may be considered as clean water and will not reach the collection system.
- Collect, store and spread rain runoff from inside of the storage on cropland.
- Treat diluted rain runoff using an approved vegetated filter strip.

MANAGING SILO SEEPAGE AND PRECIPITATION RUNOFF

Recommended practices for managing silo seepage include:

- Cover the silo — this prevents precipitation from entering and leaching through the silage/haylage.
- Divert all surface water away from the silo site, as this is considered clean water and does not require collection and storage.
- For new silos where any seepage is expected, install a seepage collection and storage system as shown in Figures 2, 7 or 8.
- Inspect the interior silo surface each time the silo is empty for signs of corrosion. Wherever corrosion is severe, recoat the inside of the silo.
- For horizontal silos, there are several options to manage seepage:
  - Existing horizontal silos: Place a 100-mm (4-in.) tile drain on the floor where the wall meets the silo floor (Option A, Figure 9)
  - New silos: Form holes in the wall to drain silo seepage to an outside drain (Option B, Figure 9.) **CAUTION:** Protect steel from silage acids with adequate (75 mm (3 in.)) concrete cover.
  - Existing or new horizontal silos with good floor drainage to the front of the silo: Install a catch basin that collects seepage and drains to a long-term storage tank (Figures 3, 4 and 10).
- Flow may occur throughout the total storage period as the silo is emptied. Diluted flow or flow in periods where seepage is not collected must not directly enter a watercourse or catch basin or run across land with shallow bedrock (Figure 2).

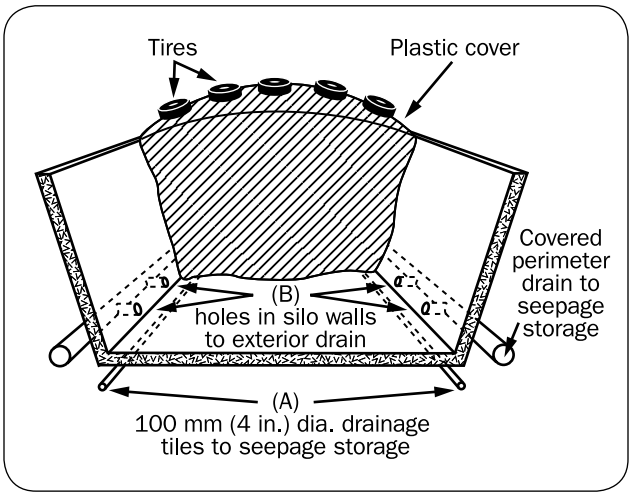

Figure 9. Outside-drain collection system for existing horizontal silo.

Notes:

(A) 100-mm (4-in.) diameter tile drains placed on silo floor.

(B) Holes in silo walls lead to an exterior covered drain. Collect, store and spread rain runoff from inside storage on cropland. Treat diluted rain runoff using an approved vegetated filter strip.

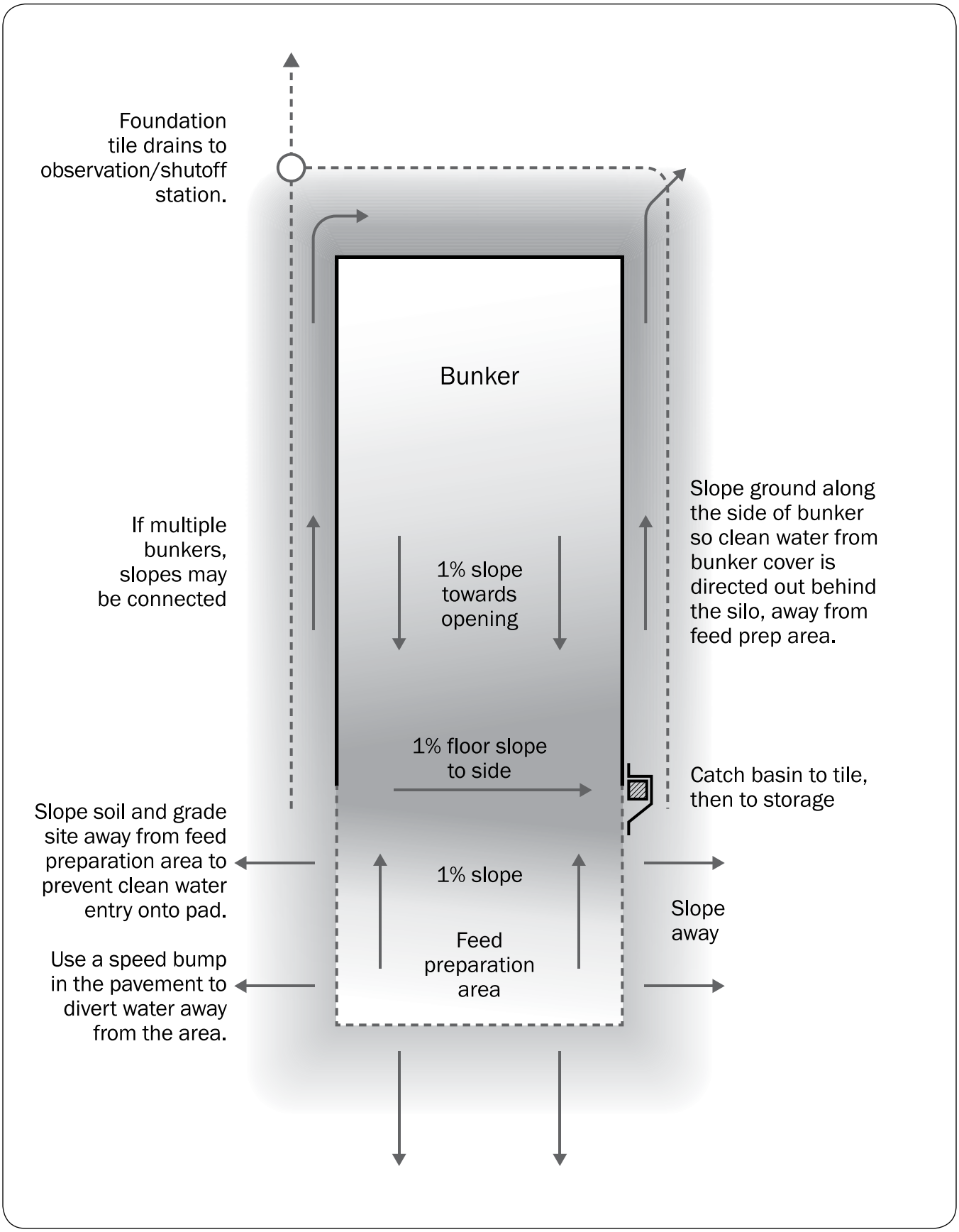

Figure 10. Bunker seepage and clean water run-off system.

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.

MANAGEMENT OF SEEPAGE

Concentrated seepage may have to be mixed with the same amount of water (1:1) for application directly onto crops. Seepage is considered a nutrient, and the amount being applied must be accounted for in the Nutrient Management Plan.

Seepage is also used as a supplementary feed. Due to its high potassium and nitrate levels, only feed seepage after getting expert advice.

Seepage can also be used as an input for a digester system. To avoid operational issues, make sure it is introduced slowly.

Release any dilute material or runoff to a vegetated area. Do not do this if the vegetated area is on shallow bedrock. Make sure adequate distance to surface water or tile drain inlets exists.

SITE LOCATIONS FOR SEEPAGE COLLECTION TANKS AND VEGETATED FLOW PATHS

As a good management practice, the Environmental Farm Plan recommends:

- locating seepage collection tanks at a distance of 60 m (200 ft) or greater from surface water (i.e., streams, ditches, ponds or tile inlets)
- setting separation distances between seepage tanks and wells at 23 m (76 ft) or greater for a drilled well and 46 m (151 ft) or greater for a bored/dug well

Locate storage sites for bagged, wrapped or tubed haylage (baylage) at least 9 m (30 ft) from surface water sources and field drainage tiles to reduce the risk of contamination.

SIZING OF SMALL SEEPAGE TANKS

Install additional storage to deal with wet years when seepage production is higher. Size the storage to include expected seepage volumes and runoff calculated at 0.0015 m^3/m^2/day (0.005 ft^3/ft^2/day) for the period of time that the flow is directed to the tank. Often the tank is sized to collect seepage for 1–2 months after the last filling of the silo occurred.

If the material in the seepage storage tank is not used immediately, leave enough freeboard in the tank for direct rainwater entry. Often, a 240-day period is used, requiring 0.6 m (2 ft) of freeboard.

Horizontal Silos

- If the crop is stored at >80% moisture, size the storage for 10 m^3/100 tonnes (320 ft^3/100 ton) of crop storage.
- If the crop is stored at 70%–80% moisture, size the seepage storage for 3.1 m^3/100 tonnes (100 ft^3/100 tons) of crop stored.
- If the crop is stored at <70% moisture, use 1.55 m^3/100 tonnes (50 ft^3/100 tons) of crop stored.

Example 1:

Size a storage to contain seepage and runoff from a horizontal silo measuring 12 m x 30 m x 3.5 m (40 ft x 100 ft x 12 ft) for a 1-month period. Feed preparation apron area is 12 m x 6 m (40 ft x 20 ft). Crop moisture content is 75%. See Tables 5, 6 and 7.

Storage Capacity (T)

T70 = 980 tonnes (1,080 tons) (see Tables 5, 6 and 7)
(storage capacity at 70% moisture)

T75 = 0.3 (T70)/(1-M) (storage capacity at 75% moisture)
= 0.3 (1,080)/(1–0.75)
= 1,180 tonnes (1,296 tons)

Seepage Storage Volume

Seepage = 3.1 m^3/100 tonnes x 1,180 tonnes
(100 ft^3/100 tons x 1,296 tons)
= 36.5 m^3 (1,296 ft^3)

Rainfall Storage Volume

= 0.0015 m^3/100 tonnes (0.005 ft^3/ft^2/day)
x 30 days
x (area of silo m^2 (ft^2) + apron area m^2 (ft^2))
= 20 m^3 (720 ft^3)

Required Storage Size

= 3.65 m^3 + 20 m^3 (1,296 ft^3+ 720 ft^3)
= 56.5 m^3 (2,016 ft^3)

Seepage and Precipitation Storage Size 614 m^3 (2,016 ft^3)

Use Table 9 to find the dimensions of the required storage capacity = width x length x height

57 m^3 (2,016 ft^3) = 4.3 x 4.9 x 2.7 m (14 x 16 x 9 ft)

In addition, a flow path or vegetated area must be available to manage flows during the 11-month period when seepage is not expected. Do not design the flow path over tiles or shallow bedrock.

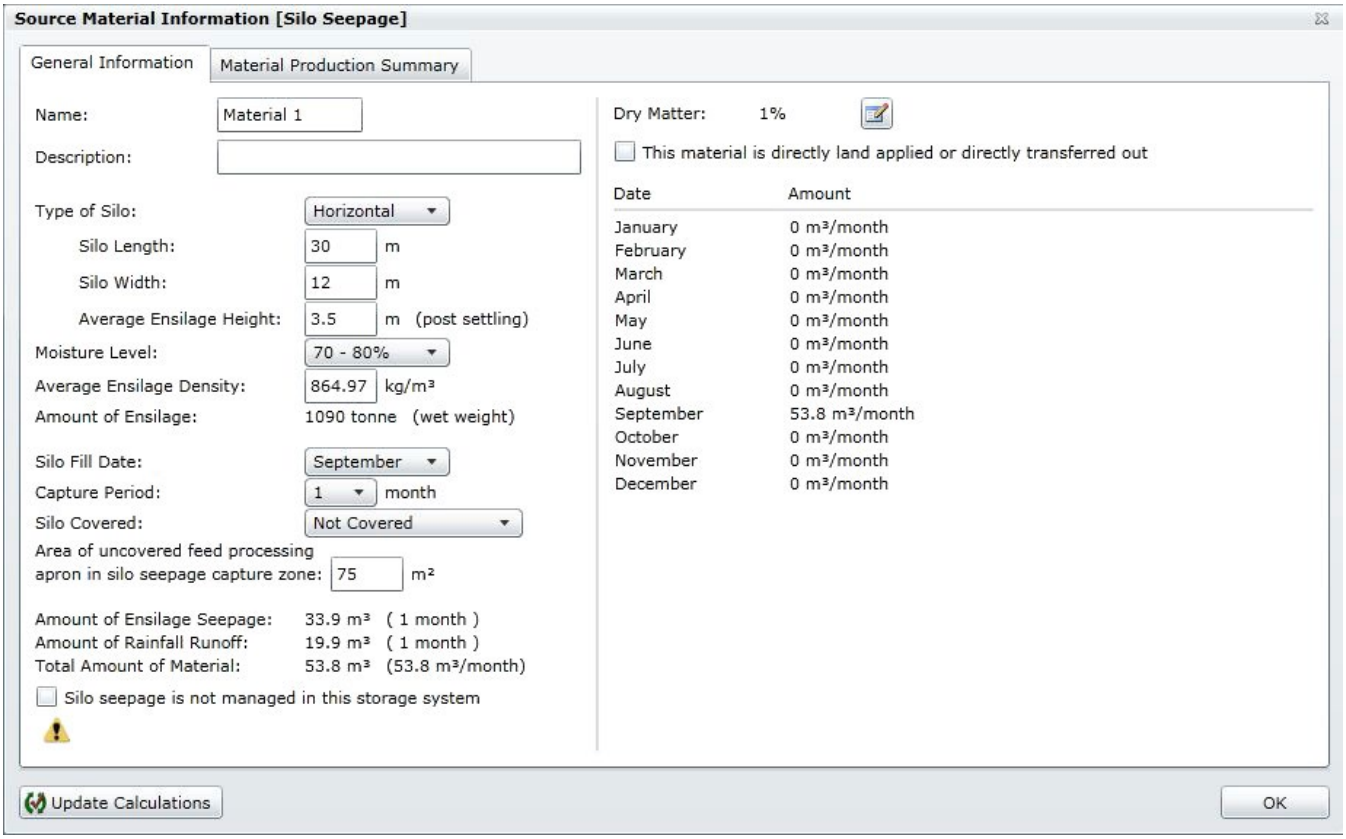

Figure 11. NMAN source material information for silo seepage.

Seepage Calculations in Software

OMAFRA has a software program called Agrisuite that includes the ability to complete silo seepage calculations. This information is in the MStor worksheet of this software. Figure 11 shows an MStor calculation for information described in Example 1.

Agrisuite is available from the OMAFRA website at ontario.ca/omafra. Search for Agrisuite.

Tower Silos

- If the crop is stored at >70% moisture, size the seepage storage for 3.1 m^3/100 tonnes (100 ft^3/100 tons) of crop stored.
- If the crop is stored at/or below 70% moisture, use 1.55 m^3/100 tonnes (50 ft^3/100 tons) of crop stored.
- The design criteria will give a minimum of 2 days of storage for the seepage material. Provide up to 1 year of storage with very low-moisture crops (i.e., <60% moisture).
- Cover tower silos with roofs to keep out rain.

Example 2:

Size a seepage tank based on the following criteria:

- tower concrete silo measuring 6 m x 21 m (20 ft x 70 ft)
- alfalfa silage at 70% moisture
- see Table 8 for capacity

Storage capacity
= 640 tonnes (703 tons)

Required seepage storage size
= 1.55 m^3/100 tonnes x 640 tonnes
(50 ft^3/100 tons x 703 tons)
= 10 m^3 (352 ft^3)

Storage size (10 m^3 (352 ft^3))
= width x length x height

Use Table 9 to find the dimensions of the required storage capacity.

10.5 m^3 (384 ft^3)
= 2.5 m (8 ft) x 2.5 m (8 ft) x 1.7 m (6 ft)

If the tank is not covered, an additional 0.6 m (2 ft) of depth is required for direct rainfall entry.

Table 5. Capacities for common horizontal silo sizes (silo length 100–160 ft)

(Capacity is in tons for a grass or corn silage density of 45 lb/ft^3, at 70% moisture.)

This table lists the approximate wet tons capacity for a number of common silo sizes. The table takes into account a 1:2 sloping front face. Widths given are inside to inside and do not include space taken up by posts and planking. When using this table, calculate the daily feed removal to ensure enough feed is removed to prevent spoilage. For capacity in tonnes, multiply by 0.91.

Average Silage Density (lb/ft^3)	Silo Height (ft)	Silo Width (ft)	Removal Rate (tons/day)			Silo Capacity (tons)						
			4 in./day	6 in./day	12 in./day	100-ft silo	110-ft silo	120-ft silo	130-ft silo	140-ft silo	150-ft silo	160-ft silo
45	8	20	1.2	1.8	3.6	360	396	432	468	504	540	576
45	8	24	1.4	2.2	4.3	432	475	518	562	605	648	691
45	8	30	1.8	2.7	5.4	540	594	648	702	756	810	864
45	8	40	2.4	3.6	7.2	720	792	864	936	1,008	1,080	1,152
45	8	50	3.0	4.5	9.0	900	990	1,080	1,170	1,260	1,350	1,440
45	8	60	3.6	5.4	10.8	1,080	1,188	1,296	1,404	1,512	1,620	1,728
45	10	20	1.5	2.3	4.5	450	495	540	585	630	675	720
45	10	24	1.8	2.7	5.4	540	594	648	702	756	810	864
45	10	30	2.3	3.4	6.8	675	743	810	878	945	1,013	1,080
45	10	40	3.0	4.5	9.0	900	990	1,080	1,170	1,260	1,350	1,440
45	10	50	3.8	5.6	11.3	1,125	1,238	1,350	1,463	1,575	1,688	1,800
45	10	60	4.5	6.8	13.5	1,350	1,485	1,620	1,755	1,890	2,025	2,160
45	12	20	1.8	2.7	5.4	540	594	648	702	756	810	864
45	12	24	2.2	3.2	6.5	648	713	778	842	907	972	1,037
45	12	30	2.7	4.1	8.1	810	891	972	1,053	1,134	1,215	1,296
45	12	40	3.6	5.4	10.8	1,080	1,188	1,296	1,404	1,512	1,620	1,728
45	12	50	4.5	6.8	13.5	1,350	1,485	1,620	1,755	1,890	2,025	2,160
45	12	60	5.4	8.1	16.2	1,620	1,782	1,944	2,106	2,268	2,430	2,592
45	14	20	2.1	3.2	6.3	630	693	756	819	882	945	1,008
45	14	24	2.5	3.8	7.6	756	832	907	983	1,058	1,134	1,210
45	14	30	3.2	4.7	9.5	945	1,040	1,134	1,229	1,323	1,418	1,512
45	14	40	4.2	6.3	12.6	1,260	1,386	1,512	1,638	1,764	1,890	2,016
45	14	50	5.3	7.9	15.8	1,575	1,733	1,890	2,048	2,205	2,363	2,520
45	14	60	6.3	9.5	18.9	1,890	2,079	2,268	2,457	2,646	2,835	3,024
45	16	20	2.4	3.6	7.2	720	792	864	936	1,008	1,080	1,152
45	16	24	2.9	4.3	8.6	864	950	1,037	1,123	1,210	1,296	1,382
45	16	30	3.6	5.4	10.8	1,080	1,188	1,296	1,404	1,512	1,620	1,728
45	16	40	4.8	7.2	14.4	1,440	1,584	1,728	1,872	2,016	2,160	2,304
45	16	50	6.0	9.0	18.0	1,800	1,980	2,160	2,340	2,520	2,700	2,880
45	16	60	7.2	10.8	21.6	2,160	2,376	2,592	2,808	3,024	3,240	3,456
45	18	20	2.7	4.1	8.1	810	891	972	1,053	1,134	1,215	1,296
45	18	24	3.2	4.9	9.7	972	1,069	1,166	1,264	1,361	1,458	1,555
45	18	30	4.1	6.1	12.2	1,215	1,337	1,458	1,580	1,701	1,823	1,944
45	18	40	5.4	8.1	16.2	1,620	1,782	1,944	2,106	2,268	2,430	2,592
45	18	50	6.8	10.1	20.3	2,025	2,228	2,430	2,633	2,835	3,038	3,240
45	18	60	8.1	12.2	24.3	2,430	2,673	2,916	3,159	3,402	3,645	3,888

Table 6. Capacities for common horizontal silo sizes (silo length 170–230 ft)
(Capacity is in tons for a grass or corn silage density of 45 lb/ft^3, at 70% moisture.)

This table lists the approximate wet tons capacity for a number of common silo sizes. The table takes into account a 1:2 sloping front face. Widths given are inside to inside and do not include space taken up by posts and planking. When using this table, calculate the daily feed removal to ensure enough feed is removed to prevent spoilage. For capacity in tonnes, multiply by 0.91.

Average Silage Density (lb/ft^3)	Silo Height (ft)	Silo Width (ft)	Removal Rate (tons/day)			Silo Capacity (tons)						
			4 in./day	6 in./day	12 in./day	170-ft silo	180-ft silo	190-ft silo	200-ft silo	210-ft silo	220-ft silo	230-ft silo
45	8	20	1.2	1.8	3.6	612	648	684	720	756	792	828
45	8	24	1.4	2.2	4.3	734	778	821	864	907	950	994
45	8	30	1.8	2.7	5.4	918	972	1,026	1,080	1,134	1,188	1,242
45	8	40	2.4	3.6	7.2	1,224	1,296	1,368	1,440	1,512	1,584	1,656
45	8	50	3.0	4.5	9.0	1,530	1,620	1,710	1,800	1,890	1,980	2,070
45	8	60	3.6	5.4	10.8	1,836	1,944	2,052	2,160	2,268	2,376	2,484
45	10	20	1.5	2.3	4.5	765	810	855	900	945	990	1,035
45	10	24	1.8	2.7	5.4	918	972	1,026	1,080	1,134	1,188	1,242
45	10	30	2.3	3.4	6.8	1,148	1,215	1,283	1,350	1,418	1,485	1,553
45	10	40	3.0	4.5	9.0	1,530	1,620	1,710	1,800	1,890	1,980	2,070
45	10	50	3.8	5.6	11.3	1,913	2,025	2,138	2,250	2,363	2,475	2,588
45	10	60	4.5	6.8	13.5	2,295	2,430	2,565	2,700	2,835	2,970	3,105
45	12	20	1.8	2.7	5.4	918	972	1,026	1,080	1,134	1,188	1,242
45	12	24	2.2	3.2	6.5	1,102	1,166	1,231	1,296	1,361	1,426	1,490
45	12	30	2.7	4.1	8.1	1,377	1,458	1,539	1,620	1,701	1,782	1,863
45	12	40	3.6	5.4	10.8	1,836	1,944	2,052	2,160	2,268	2,376	2,484
45	12	50	4.5	6.8	13.5	2,295	2,430	2,565	2,700	2,835	2,970	3,105
45	12	60	5.4	8.1	16.2	2,754	2,916	3,078	3,240	3,402	3,564	3,726
45	14	20	2.1	3.2	6.3	1,071	1,134	1,197	1,260	1,323	1,386	1,449
45	14	24	2.5	3.8	7.6	1,285	1,361	1,436	1,512	1,588	1,663	1,739
45	14	30	3.2	4.7	9.5	1,607	1,701	1,796	1,890	1,985	2,079	2,174
45	14	40	4.2	6.3	12.6	2,142	2,268	2,394	2,520	2,646	2,772	2,898
45	14	50	5.3	7.9	15.8	2,678	2,835	2,993	3,150	3,308	3,465	3,623
45	14	60	6.3	9.5	18.9	3,213	3,402	3,591	3,780	3,969	4,158	4,347
45	16	20	2.4	3.6	7.2	1,224	1,296	1,368	1,440	1,512	1,584	1,656
45	16	24	2.9	4.3	8.6	1,469	1,555	1,642	1,728	1,814	1,901	1,987
45	16	30	3.6	5.4	10.8	1,836	1,944	2,052	2,160	2,268	2,376	2,484
45	16	40	4.8	7.2	14.4	2,448	2,592	2,736	2,880	3,024	3,168	3,312
45	16	50	6.0	9.0	18.0	3,060	3,240	3,420	3,600	3,780	3,960	4,140
45	16	60	7.2	10.8	21.6	3,672	3,888	4,104	4,320	4,536	4,752	4,968
45	18	20	2.7	4.1	8.1	1,377	1,458	1,539	1,620	1,701	1,782	1,863
45	18	24	3.2	4.9	9.7	1,652	1,750	1,847	1,944	2,041	2,138	2,236
45	18	30	4.1	6.1	12.2	2,066	2,187	2,309	2,430	2,552	2,673	2,795
45	18	40	5.4	8.1	16.2	2,754	2,916	3,078	3,240	3,402	3,564	3,726
45	18	50	6.8	10.1	20.3	3,443	3,645	3,848	4,050	4,253	4,455	4,658
45	18	60	8.1	12.2	24.3	4,131	4,374	4,617	4,860	5,103	5,346	5,589

Table 7. Capacities for common horizontal silo sizes (silo length 240–300 ft)
(Capacity is in tons for a grass or corn silage density of 45 lb/ft^3, at 70% moisture.)

This table lists the approximate wet tons capacity for a number of common silo sizes. The table takes into account a 1:2 sloping front face. Widths given are inside to inside and do not include space taken up by posts and planking. When using this table, calculate the daily feed removal to ensure enough feed is removed to prevent spoilage. For capacity in tonnes, multiply by 0.91.

Average Silage Density (lb/ft^3)	Silo Height (ft)	Silo Width (ft)	Removal Rate (tons/day)			Silo Capacity (tons)						
			4 in./day	6 in./day	12 in./day	240-ft silo	250-ft silo	260-ft silo	270-ft silo	280-ft silo	290-ft silo	300-ft silo
45	8	20	1.2	1.8	3.6	864	900	936	972	1,008	1,044	1,080
45	8	24	1.4	2.2	4.3	1,037	1,080	1,123	1,166	1,210	1,253	1,296
45	8	30	1.8	2.7	5.4	1,296	1,350	1,404	1,458	1,512	1,566	1,620
45	8	40	2.4	3.6	7.2	1,728	1,800	1,872	1,944	2,016	2,088	2,160
45	8	50	3.0	4.5	9.0	2,160	2,250	2,340	2,430	2,520	2,610	2,700
45	8	60	3.6	5.4	10.8	2,592	2,700	2,808	2,916	3,024	3,132	3,240
45	10	20	1.5	2.3	4.5	1,080	1,125	1,170	1,215	1,260	1,305	1,350
45	10	24	1.8	2.7	5.4	1,296	1,350	1,404	1,458	1,512	1,566	1,620
45	10	30	2.3	3.4	6.8	1,620	1,688	1,755	1,823	1,890	1,958	2,025
45	10	40	3.0	4.5	9.0	2,160	2,250	2,340	2,430	2,520	2,610	2,700
45	10	50	3.8	5.6	11.3	2,700	2,813	2,925	3,038	3,150	3,263	3,375
45	10	60	4.5	6.8	13.5	3,240	3,375	3,510	3,645	3,780	3,915	4,050
45	12	20	1.8	2.7	5.4	1,296	1,350	1,404	1,458	1,512	1,566	1,620
45	12	24	2.2	3.2	6.5	1,555	1,620	1,685	1,750	1,814	1,879	1,944
45	12	30	2.7	4.1	8.1	1,944	2,025	2,106	2,187	2,268	2,349	2,430
45	12	40	3.6	5.4	10.8	2,592	2,700	2,808	2,916	3,024	3,132	3,240
45	12	50	4.5	6.8	13.5	3,240	3,375	3,510	3,645	3,780	3,915	4,050
45	12	60	5.4	8.1	16.2	3,888	4,050	4,212	4,374	4,536	4,698	4,860
45	14	20	2.1	3.2	6.3	1,512	1,575	1,638	1,701	1,764	1,827	1,890
45	14	24	2.5	3.8	7.6	1,814	1,890	1,966	2,041	2,117	2,192	2,268
45	14	30	3.2	4.7	9.5	2,268	2,363	2,457	2,552	2,646	2,741	2,835
45	14	40	4.2	6.3	12.6	3,024	3,150	3,276	3,402	3,528	3,654	3,780
45	14	50	5.3	7.9	15.8	3,780	3,938	4,095	4,253	4,410	4,568	4,725
45	14	60	6.3	9.5	18.9	4,536	4,725	4,914	5,103	5,292	5,481	5,670
45	16	20	2.4	3.6	7.2	1,728	1,800	1,872	1,944	2,016	2,088	2,160
45	16	24	2.9	4.3	8.6	2,074	2,160	2,246	2,333	2,419	2,506	2,592
45	16	30	3.6	5.4	10.8	2,592	2,700	2,808	2,916	3,024	3,132	3,240
45	16	40	4.8	7.2	14.4	3,456	3,600	3,744	3,888	4,032	4,176	4,320
45	16	50	6.0	9.0	18.0	4,320	4,500	4,680	4,860	5,040	5,220	5,400
45	16	60	7.2	10.8	21.6	5,184	5,400	5,616	5,832	6,048	6,264	6,480
45	18	20	2.7	4.1	8.1	1,944	2,025	2,106	2,187	2,268	2,349	2,430
45	18	24	3.2	4.9	9.7	2,333	2,430	2,527	2,624	2,722	2,819	2,916
45	18	30	4.1	6.1	12.2	2,916	3,038	3,159	3,281	3,402	3,524	3,645
45	18	40	5.4	8.1	16.2	3,888	4,050	4,212	4,374	4,536	4,698	4,860
45	18	50	6.8	10.1	20.3	4,860	5,063	5,265	5,468	5,670	5,873	6,075
45	18	60	8.1	12.2	24.3	5,832	6,075	6,318	6,561	6,804	7,047	7,290

Table 8. Estimated silo wet ton capacities for forages in concrete tower silos

LEGEND: m.c. = moisture content

Silo Diameter x Settled Depth (ft)	Alfalfa Silage (tons)				Corn Silage (tons)			
	40% m.c.	50% m.c.	60% m.c.	70% m.c.	55% m.c.	60% m.c.	65% m.c.	70% m.c.
12 x 30	35	44	57	83	47	54	62	74
12 x 40	50	62	80	116	66	75	87	102
12 x 50	63	78	103	150	85	97	111	132
14 x 40	69	86	113	163	92	106	121	143
14 x 50	89	111	147	212	121	136	157	185
14 x 55	99	124	164	237	134	153	175	206
16 x 50	120	151	199	287	163	184	210	246
16 x 60	149	186	246	355	200	227	259	303
16 x 65	162	204	270	389	220	248	284	330
18 x 50	156	196	260	373	210	238	272	317
18 x 60	194	243	322	463	261	293	334	388
18 x 70	232	290	386	554	311	349	397	461
20 x 60	246	309	409	586	328	369	419	486
20 x 70	295	371	491	703	393	439	498	576
20 x 80	345	433	574	821	457	510	579	668
24 x 60	372	465	615	876	486	543	616	712
24 x 70	448	562	741	1,052	582	649	734	844
24 x 80	527	660	869	1,230	678	754	850	977
24 x 90	606	759	999	1,409	774	860	968	1,110
30 x 80	876	1,092	1,427	1,994	1,088	1,280	1,477	1,628
30 x 90	1,012	1,261	1,643	2,287	1,242	1,475	1,702	1,877
30 x 100	1,151	1,431	1,861	2,581	1,397	1,672	1,929	2,127
30 x 110	1,290	1,603	2,080	2,875	1,552	1,871	2,158	2,382

Source: OMAFRA Factsheet *Tower Silo Capacities*.

Table 9. Seepage and precipitation storage sizes in ft^3

Storage Width x Length (ft)	Storage Height											
	1 ft	**2 ft**	**3 ft**	**4 ft**	**5 ft**	**6 ft**	**7 ft**	**8 ft**	**9 ft**	**10 ft**	**11 ft**	**12 ft**
5 x 5	25	50	75	100	125	150	175	200	225	250	275	300
6 x 6	36	72	108	144	180	216	252	288	324	360	396	432
7 x 7	49	98	147	196	245	294	343	392	441	490	539	588
8 x 8	64	128	192	256	320	384	448	512	576	640	704	768
9 x 9	81	162	243	324	405	486	567	648	729	810	891	972
10 x 10	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200
11 x 11	121	242	363	484	605	726	847	968	1,089	1,210	1,331	1,452
12 x 12	144	288	432	576	720	864	1,008	1,152	1,296	1,440	1,584	1,728
13 x 13	169	338	507	676	845	1,014	1,183	1,352	1,521	1,690	1,859	2,028
14 x 14	196	392	588	784	980	1,176	1,372	1,568	1,764	1,960	2,156	2,352
15 x 15	225	450	675	900	1,125	1,350	1,575	1,800	2,025	2,250	2,475	2,700
16 x 16	256	512	768	1,024	1,280	1,536	1,792	2,048	2,304	2,560	2,816	3,072
17 x 17	289	578	867	1,156	1,445	1,734	2,023	2,312	2,601	2,890	3,179	3,468
18 x 18	324	648	972	1,296	1,620	1,944	2,268	2,592	2,916	3,240	3,564	3,888
19 x 19	361	722	,1083	1,444	1,805	2,166	2,527	2,888	3,249	3,610	3,971	4,332
20 x 20	400	800	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800
21 x 21	441	882	1,323	1,764	2,205	2,646	3,087	3,528	3,969	4,410	4,851	5,292
22 x 22	484	968	1,452	1,936	2,420	2,904	3,388	3,872	4,356	4,840	5,324	5,808
23 x 23	529	1,058	1,587	2,116	2,645	3,174	3,703	4,232	4,761	5,290	5,819	6,348
24 x 24	576	1,152	1,728	2,304	2,880	3,456	4,032	4,608	5,184	5,760	6,336	6,912
25 x 25	625	1,250	1,875	2,500	3,125	3,750	4,375	5,000	5,625	6,250	6,875	7,500

SUMMARY

Silo seepage can be a pollutant or safety hazard if managed incorrectly. The methods to properly manage silo seepage include collection, storage and use of the nutrient rich source on the farm and elimination of the liquid seepage.

This Factsheet was revised by Don Hilborn, P.Eng., By-Products Engineer, OMAFRA, Woodstock, and Steve Clarke, P.Eng., Energy & Crop Engineer, OMAFRA, Kemptville.

Do you know about Ontario's *Nutrient Management Act*?

The provincial *Nutrient Management Act* (NMA) and the Regulation 267/03 regulate the storage, handling and application of nutrients that could be applied to agricultural cropland. The objective is to protect Ontario's surface and groundwater resources.

Please consult the regulation and protocols for the specific legal details. This Factsheet is not meant to provide legal advice. Consult your lawyer if you have questions about your legal obligations.

For more information on the NMA, call the Agricultural Information Contact Centre at 1-877-424-1300, e-mail nman.omafra@ontario.ca or visit Ontario.ca/omafra.

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