4.0 MANURE HANDLING AND STORAGE

Solids Content

The solids content of poultry manure determines the type of equipment used for manure handling. Poultry manure is classified as either solid, semi-solid or liquid by the following criteria (see Appendix E for manure production rates and characteristics):

(1) **Solid –** The manure's solid content is greater than 20%. Broiler manure normally contains approximately 20-25% moisture compared with liquid manure from layers which is 70% moisture content. The use of bedding material further contributes to the solids content of the manure. To produce a solid manure, the liquid must be drained off and the manure dried or bedding added. At this consistency, the solid manure can then be stacked.

(2) **Semi-Solid** (also referred to as slurry) – Contains 5% to 20% solids.

(3) **Liquid –** Contains less than 5% solids.

System Components

Most poultry operations have some form of confined housing and feeding facility, although turkeys may be raised for part of the year in drier climates on outdoor ranges. Houses for layer, broiler and turkey production may vary greatly in size, appearance and arrangement of facilities. There are two main types of confined poultry facilities: cage houses and floor houses. A variety of manure handling systems for these facilities are described below:

(1) *Cage House, Deep Pit Systems:* The deep pit offers operational advantages over other systems. For example, a separate manure storage facility is not required. In this system, manure is allowed to drop into a 1.5 m to 3.0 m (5 to 10 feet) deep pit under the cages where the droppings undergo a natural composting drying process. This causes a biological degradation of the wastes and reduces the weight and volume of the manure. Manure is usually removed from the storage twice each year. The success of the pit depends on the extent to which excess water can be excluded. If the manure is wet, the composting process will not occur, resulting in odours, fly problems and the need for frequent cleanouts.

If properly operated, a deep pit may not require cleaning for one to three years depending on the depth of the pit. This is an easy system to manage and requires only a front-end loader and a conventional manure spreader to clean out the pit. The deep pit should be constructed of concrete and be completely sealed to prevent groundwater seepage into the pit and escape of contaminants into the environment. In cases where the water table is very high, construction of the deep pit cage house completely aboveground is recommended.

(2) *Cage House, Shallow Pit Systems:* This system uses a concrete pit 15 cm to 20 cm (6 to 8 inches) deep to collect the droppings from overhead cages. The manure is

allowed to collect for a short time, preferably not more than one week, then it can be scraped into a holding facility with a dragline or tractor mounted scraper. In cases where cleaning on a weekly basis is not practical, the droppings may be allowed to "cone-up" under the cages. In this case, additional air circulation is recommended to dry the manure and reduce odours. Also, the droppings should be covered periodically with sawdust or shavings if the manure storage period is greater than one week.

(3) *Cage House, Liquid Systems:* Shallow pit systems can be adapted for liquid manure handling. In this case, manure is flushed frequently into a suitable liquid manure holding tank outside the poultry building.

(4) *Floor Houses, Litter System:* Broilers and turkeys are often raised on litter for at least part of their lives. Breeders and pullets are raised on litter in many cases. Any clean, absorbent material can be used for litter such as wood shavings, shredded paper products or sawdust if available. The litter should be dry and should not produce excessive amounts of dust. The floor should be covered with fresh litter material prior to the housing of each new flock of birds at a recommended depth of 4 to 8 cm (1.5 to 3 inches). The litter removed from the building must be stored in a suitable storage structure.

(5) *Floor Houses, Heated Floor System:* In other areas, the difficulty and expense of acquiring good quality litter has forced some producers to use hot water floor heating. In this system, hot water at approximately 37 to 50ÄC (100 to 120 ÄF) is circulated through plastic or steel pipes embedded in the solid concrete floor. By controlling the rate of circulation, the feed water temperature and pipe spacing, the floor temperature can be maintained between 18 and 35ÄC (65 and 85ÄF) depending on the age of the birds. An added benefit of this system is that the heat dries the manure, thereby reducing odours and simplifying manure handling.

(6) *Floor Houses, Partially Slatted Floor System:* Partially slatted floors offer some advantages over conventional solid floor litter systems. Placing waterers, feeders and roosts over the slatted portion of the floor results in much of the manure being collected in a pit beneath the slats. The litter on the solid portion of the floor remains cleaner and needs to be replaced less often. Up to 12 months of storage may be provided under the slatted floor. This system is not, however, recommended for new layer operations because of the probable odours and fly problems encountered with wet manure collected in the slatted area. However, partially slatted floor systems are commonly used for breeders and pullets and are considered acceptable alternatives for these operations. The partially slatted floor system must be constructed above ground where the watertable is very high.

(7) *Outdoor Ranges:* A limited number of poultry operations in other areas of Canada utilize outdoor ranges. At proper bird densities such ranges are similar to cattle pastures where manure is utilized by pasture plants. Bird densities on outdoor ranges must not exceed 500 chickens (or 200 turkeys) per acre. Where densities exceed this level, the operation would be considered as a confined livestock area.

Manure from most types of broiler poultry operations in Newfoundland is handled and stored as a solid, mostly on the ground. Chicken and turkey broilers, roasters and broiler breeder flocks are raised in barns which utilize straw or wood shavings for bedding. The manure and bedding accumulates in the barn until it is periodically removed when the flock is replaced. Front end loaders are normally used to remove the manure from the barn and transfer it to the storage area. Regular cleaning of the barn is also important to a successful fly control program. Other fly control measures include removing wet feed during fly breeding season, disposing of dead birds and keeping manure storing areas dark. You can also store manure in enclosed structures, protect ventilation inlets with screens and regularly spray with approved insecticides.

Manure from some types of poultry operations (for example, layers) does not stockpile well. If manure has to be stockpiled, you must never stockpile manure over field drainage tiles, near surface water nor dump the manure in wooded or coastal areas. You must also ensure no leaching or run-off occurs and maintain the necessary separation distances.

Caged layer chickens and a limited number of breeder barns utilize manure collection and transfer systems which do not involve the use of any bedding material. The manure is in a liquid or semi-solid form and a variety of collection, transfer and storage systems are used. For example, some layer farms use conveyors to move the manure daily to an area in the barn where it is eventually moved to the storage. While several Newfoundland layer operations have manure lagoons and remove manure daily, many have no adequate storage. In the past, some operators used disposal systems using pipes which lead into the low tide areas of the ocean. Currently, only one operator has a permit to dispose of poultry manure in this manner.

These liquid and semi-solid systems often incorporate in-barn trenches or concrete pits which have limited storage capacity. See 5.1, Seasonal Considerations, for guidelines on manure spreading throughout the year.

The elements of a manure management system include collection, transfer, storage, treatment, utilization and disposal. The components of the various systems for solid, semi-solid and liquid poultry manure are summarized in Table 3.

TABLE 3
Manure Handling Systems for Various Types of Wastes

Operation	Solids	Semi-solid/Liquids
Collection	Front End Loaders	Slatted Floors
Transfer	Manure Wagons Open Tank Spreaders Dump Trucks Earth Moving Equipment Conveyors Pumps	Pumps submerged, open impeller piston pneumatic Augers Vacuum Tank Wagon Pipeline Gravity Continuous Flow Gutters Large Diameter Pipes
Storage	Stockpile Bunk Silo	In-Building Below Ground concrete (open/covered) earthen Above Ground concrete/glass lined steel
Treatment	Aerobic compost dry incinerate Anaerobic	Aerobic pre-storage partial total Anaerobic Solid/Liquid Separation
Utilize/Disposal	Land Application Energy Production Bedding	Land Application Irrigation Energy Production

Source: Farm Practices Guidelines for Poultry Producers in Manitoba.

- Dumping manure in coastal waters or wooded areas is prohibited in Newfoundland and Labrador unless by special permit; and,

- Some Newfoundland poultry producers are trucking manure to other livestock farms (for example, dairy farms) for either disposal or use on forage or vegetables crops. Some fur farms also provide a use for poultry manure for feeding.

4.1 POULTRY HOUSING MANAGEMENT FOR ODOUR CONTROL

Very little odour is given off by fresh manure. Once the manure starts to decompose, odour production begins. Inside a poultry building, even small deposits of manure are a likely source of odour. Solid manure tends to form fewer odours than liquid manure. By keeping conditions dry, the production of odour is reduced. Good housekeeping is the best management method.

While the control of odours within the barn may require additional time or expense, it is beneficial for the welfare of the poultry and the people working within the barn. Frequently, the conditions that contribute to odours also reduce productivity and can make the poultry more susceptible to disease.

The following guidelines for poultry housing management are recommended:

- collect and transfer manure from the barn to storage on a daily basis or every batch (usually every 6 to 7 weeks for broiler operations - layer operations vary) to reduce the production of odours from the building;

- maintain watering systems to prevent water from being added needlessly to manure and bedding;

- thoroughly clean and disinfect buildings between successive groups of poultry;

- do not surpass recommended bird densities in poultry buildings; and

- remove dust, clean ventilation fans and shafts. Keep dust levels low since odours are absorbed and carried in the air on dust particles.

Ventilation of farm buildings, in addition to controlling the temperature and humidity, also controls the production and build-up of poisonous and odourous gases. The following guidelines should be observed:

- maintain maximum air flow through poultry buildings. This will assist to keep conditions as dry as possible and will promote aerobic conditions so that fewer odours are produced. It is also effective in diluting odourous gases as they are released to the outside environment;

- maintain and repair ventilation fans and ensure they have the appropriate capacity for the number of birds being housed in the building; and

- assess local conditions such as the prevailing wind direction and velocity when considering poultry building ventilation.

The position, design and height of exhaust outlets affects the dilution of odourous gases outside of poultry buildings. In general, higher outlets provide greater dilution of exhaust gases. Options for ventilation design may be discussed with experts in the field.

Exhaust gases from poultry buildings may be treated for odour control as part of the ventilation process. Treatment requires additional expenditure, but may be warranted in certain circumstances. For these methods to be effective they must be designed and installed correctly. Qualified professionals should be consulted.

N.B. It is important the general public understand that from time to time, farm activity associated with poultry farms, will result in farm odours, noise, dust, etc. which are a normal part of farming.

4.2 EQUIPMENT SELECTION AND MAINTENANCE

Regardless of the type of manure being transferred, it is important to use equipment designed for that purpose and to operate and maintain the equipment according to manufacturer's instructions. The

equipment must be capable of functioning reliably in a corrosive environment. Equipment also requires proper maintenance if it is expected to have a long service life. Although maintenance of manure handling equipment may be unpleasant, a disruption of spreading due to major repairs is a greater inconvenience and may lead to problems with neighbours.

Preventative maintenance and the use of reliable equipment are critical for avoiding problems when handling manure. For example, a flat tire on a manure spreader may present serious problems. Often the spreader must be emptied before the tire can be repaired. Unless the flat happens near the manure storage it may be difficult to empty the spreader without dumping the manure in an unacceptable place. Another example could be a valve on a manure tank that does not close properly may allow manure to spill onto a public road during transportation.

Pumps used in liquid systems require some method of screening out solid materials. Problems occur when objects enter the pump. In slurries, solids will separate from liquids during storage, therefore, some agitation is required to bring the solids back into suspension. Chopper pumps are appropriate since they do not easily become plugged with hair, etc. These agitation pumps have capacities of about 200 litres (44 gallons) per second. Pumps used for irrigation, on the other hand, may range in capacity from 20-60 litres (4.4-13.2 gallons) per second and can transfer manure up to 1.25 kilometres (.775 miles) through irrigation pipe.

While liquids are transferred by gravity or pumps, solid manure is usually transferred by conveyors, augers, piston pumps or front end loaders.

4.3 PLANNING A MANURE STORAGE

A storage facility is a permanent structure or location designed and operated to contain manure in an environmentally sound manner for the period of time required to allow the manure to be used as an organic fertilizer. The design of the storage will depend upon:

- the location of the storage;
- the storage capacity required for the poultry operation;
- the characteristics of the manure (such as the amount of solids); and
- the methods of filling and emptying.

Although some design considerations are discussed, producers are advised to contact an agricultural engineer for complete design information. Manure storage structures must also provide the following:

- flexibility for timing manure spreading;
- sufficiently impervious to prevent leakage; and
- an appropriate level of odour control.

All manure storage systems must be evaluated to ensure pollution is not occurring and that the

facility meets the requirements under the various acts and legislation existing in Newfoundland and Labrador. Furthermore, if there is insufficient land on the farm to handle the manure, the operator must supply written commitments ensuring that the manure will be removed and used in a fashion acceptable to the Government Services Centre. This issue is addressed in Section 5.7, Acceptable Application Rates.

Location

Groundwater and soil conditions must be evaluated to ensure that the site is suitable for the type of storage planned. For example, where the groundwater levels are near the bottom of the storage, do not use an earthen storage without a suitable liner (for example, a flexible membrane, concrete or equivalent material). Refer to Section 4.6, Liquid Manure Storage for further information on earthen manure storages.

The site for the storage must provide the following:

- the storage must be located close enough to the barns to allow for convenient filling and still permit expansion of the facilities;
- it must be accessible by an all-weather road for field spreading equipment;
- if possible, it should be located out of sight of the road and dwellings;
- the storage must be located to avoid collecting surface and roof run-off; and
- manure storages must not be constructed on the banks of water bodies, including rivers, drainage, channel ponds and wetlands (bogs, fens). A buffer of 50 metres or more is recommended.

Install a groundwater controlling drain around the manure facility to prevent the entry of groundwater into both earthen or concrete storages. For earthen structures, this drainage prevents groundwater from entering the storage. Groundwater reduces storage capacity and weakens the manure sealing capacity by lowering the total solids content. For concrete structures, this drainage prevents frost heaving, reduces external groundwater pressure when the storage is empty and prevents water entry.

In order to minimize any risk of pollution, all manure storages are required to meet the minimum separation distances discussed earlier in this report.

Size

Manure storage requirements for poultry farms depend on:

- management practices and facilities;
- the type and number of animals;

- the amount of water from spillage or from washing;
- the length of storage time needed;
- the amount of precipitation and/or groundwater added to storage contents;
- the amount of dilution water added;
- the amount of evaporation;
- the amount of bedding material used; and
- additional freeboard (also known as unused manure storage space). Newfoundland guidelines are 60 cm (2 feet) for earthen storages or 45 cm (1.5 feet) for concrete manure storages.

The storage must have some reserve capacity to allow for the accumulation of solids and for precipitation. When the storage is ready for clean out it must have enough capacity to handle a major rainstorm without overflowing. This is especially important for the east coast of Newfoundland which receives higher rates of precipitation.

It is important to estimate manure production rates accurately, especially for expensive covered concrete systems. An agricultural engineer should be contacted to assist in the evaluation of these systems. A useful guide in preparing your estimates is the following equation:

Storage Volume Required = (Manure Volume + Bedding Volume + Wastewater Volume) x (days of storage period)...
+ Precipitation Volume (if an open storage)...
+ Runoff Volume (if applicable) from roofs...
less Evaporation Volume (approx. 10-20% of precipitation in Newfoundland & Labrador)

In preparing your estimate of storage requirements, consider the following:

- examine a facility similar to that being proposed;
- use the above formula and the guidelines for manure production shown in Table 4; and/or,
- contact one of the resource groups listed in Section 10 (Sources of Information).

Overflow of the manure storage is a serious environmental concern and therefore is prohibited. Livestock producers must construct sufficient storage capacity to eliminate the need for winter manure spreading. A minimum storage capacity of 180 days is required by the Department of Environment. Storage capacity of 200 or more days is recommended. If the circumstances of lot layout and adjacent land use/land ownership prevent the construction of a manure storage with this capacity, the farmer will have to implement a manure management/storage plan acceptable to the Government Services Centre and the Agrifoods Branch in consultation with the local municipality. This will also help to minimize the extra management time, labour time and equipment use associated with short term storage. It also provides flexibility in:

- poor weather conditions;
- labour shortages; and
- equipment breakdowns.

TABLE 4

Annual Manure Production

Poultry Type	Housing System	Annual Production per Bird Space	
		kg/yr (lb/yr)	L/yr (ft^3/yr)
Chicken:			
Broilers	floor[2]	10.4 (22.9)	34.8 (1.23)
Roasters	floor[2]	10.4 (22.9)	32.8 (1.16)
Layers	cage[1] floor[3]	15.6 (34.3) 19.8 (43.6)	47.3 (1.67) 47.8 (1.68)
Pullets	cage[1] floor[2]	4.7 (10.3) 6.8 (15.0)	14.0 (0.49) 21.3 (0.75)
Broiler Breeder Pullets	floor[2]	8.8 (19.4)	28.1 (0.99)
Broiler Breeder Hens	cage[1] floor[3]	17.2 (37.8) 26.0 (57.2)	52.0 (1.83) 65.5 (2.30)
Turkey:			
Broilers	floor[2]	33.8 (74.4)	104.0 (3.67)
Heavy Toms	floor[2]	55.1 (121.2)	172.0 (6.06)
Heavy Hens	floor[2]	47.8 (105.2)	151.0 (5.32)

1. Manure removed from barn at 25% moisture content with a density of 320 kg/m^3 (20 lb/ft^3).
2. 50 mm shavings placed on floor. Manure and litter removed from barn at 25% moisture content, with a density of 320 kg/m^3 (20 lb/ft^3).
3. One third litter floor, two-thirds slatted floor. Manure and litter removed from barn at 40% moisture content, with a density of 400 kg/m^3 (25 lb/ft^3).

Source: Farm Practices Guidelines for Poultry Producers in Manitoba.

4.4 SOLID MANURE STOCKPILES

Solid manure containing larger amounts of bedding is often stored in stockpiles. These storages must:

- be constructed and managed to contain all seepage and runoff;
- be constructed to help divert away or contain runoff from surrounding areas (this has the added benefit of minimizing manure volume);
- contain a concrete bucking wall to assist filling the bucket if emptying with a front end loader;
- provide access for unloading and haul out equipment; and
- depending on soil conditions, be constructed with a sloping concrete slab to prevent seepage and facilitate collecting the liquid runoff which can then be collected for removal by vacuum tanker or transferred to a separate storage.

4.5 SEMI-SOLID MANURE STORAGE

Wet manure and liquid runoff can be contained by a storage consisting of earthen dykes in combination with a reinforced concrete wall. Seepage can also be controlled by a concrete slab, depending on soil conditions at the site. By sloping the slab to the corner opposite the entrance ramp, excess liquids can be removed by vacuum tanker or transferred to a separate storage.

A ramp entrance provides access for the front end loader or other removal equipment. This entrance ramp must be crowned to prevent surface water from the yard entering the storage.

4.6 LIQUID MANURE STORAGE

Poultry manure is sometimes stored as a liquid by adding dilution water to facilitate pumping. Liquid poultry manure can be stored in three types of storages:

- concrete tanks below ground;
- lined earthen storages; or
- concrete or steel tanks above ground.

All barns with a proposed system of manure washdown should ideally have a water meter to monitor the volume of water used.

(a) Concrete Tanks Below Ground

The two main benefits of a concrete manure storage include:

- reduced loss of valuable nutrients (see Appendix E for a comparison of losses from different systems); and,
- odours are generally not released except when the manure is agitated

before the storage is emptied.

Concrete tanks are more costly than earthen storages, but because they are impermeable, they are suitable for use in areas having sandy soils. In areas with a high water table level, above ground storage tanks are preferable. There are also a number of synthetic materials designed for use in earthen storages that provide impermeable barriers without the high costs of concrete storages. These are discussed under the section on earthen storages.

Concrete tanks must be designed to withstand all earth, hydrostatic and live loads. In planning the design of the storage, carefully consider the following:

- how the manure is to be agitated (please note that minimizing agitation reduces odours produced during transfer);
- there must be sufficient access ports for the pump if the tank is to be covered;
- liquid manure tanks connected to animal buildings must have gas traps or valves between them to prevent gases from entering the building;
- openings must be covered with grills or covers (these covers must weigh at least 20 kilograms (44 pounds) so they cannot be removed by children or displaced by animals and be of sufficient design so they can not drop through the opening-permanently secure covers with a safety chain);
- open tanks must be surrounded with a fence (at least 1.2 metres or 4 feet high except where the tank walls extend this distance above the adjacent ground level) to prevent accidental entry into the pit;
- agitation is more effective when large tanks are divided into a series of compartments; and
- warning signs must be installed near all covered tanks to warn about noxious gas hazards.

You must wear a self contained breathing apparatus when entering indoor or covered storage tanks. The manure tank must be ventilated with a fan 30 minutes prior to entry and thereafter continuously while any person is in the tank. Wear a safety harness and have on hand two people capable of pulling you out in case of emergency. Never use open flames while inspecting or working in an unventilated storage tank-some manure gases, especially methane, can be explosive. The hazards of dangerous gases are described in Appendix F, Safety.

(b) Earthen Storages

Earthen storages are used for storing liquid manure. The attraction of earthen manure storage is their low capital cost. Unfortunately, this type of structure is responsible for the

most complaints since the manure in these facilities is kept under anaerobic conditions and the large exposed surface area permits large quantities of odourous gases to be released into the air. The odours are generally worst when the manure begins to warm up in the spring. Other disadvantages include:

- the risk of seepage if constructed in improper soil conditions;
- the nutrient loss and the maintenance requirements;
- they should not be used in densely populated areas (see Section 3, Site Selection);
- open storages such as this can be dangerous to children and animals (although the crusted surface may appear solid, it will not support a person); and,
- Earthen lagoons for liquid manure must be lined. This applies to facilities constructed after the approval of these guidelines.
- A maximum permeability 10^{-7} cm/sec should be used as a criteria when considering a site for an earthen lagoon. A hydrological assessment must be conducted before such a facility is constructed.

Several considerations in designing earthen manure storages include: (Siting criteria taken from Manure Management Guidelines for New Brunswick, New Brunswick Agriculture and Rural Development, November 4, 1996.)

- the storage must be constructed to be compatible with equipment used for emptying, agitating and maintaining the slopes;
- locate the earthen storage in areas where the depth to the bedrock exceeds one metre for clay soils and three metres for sandy or loamy soils;
- the base of the earthen storage should be a minimum of one metre above the level of the high water table;
- install a groundwater controlling drain;
- provide a berm width of at least 3.0 metres to allow access for tractors and pumps;
- the slope of the sides must not exceed 1.5:1 (run to rise) in parent soil or 2:1 where a clay liner exists (outside slopes must be seeded to grass and maintained);
- the lateral distance from an earthen storage to a subsurface drain must be a minimum of 15 metres (50 ft);

- install concrete pads below inlets and at agitation points to reduce erosion of the bottom;

- plant shelter belts to screen the storage from view; and

- install fencing around the storage for safety.

Earthen manure storage facilities have been accepted as environmentally safe as long as the soil used to build them contains at least 15% clay content. However, as mentioned, new facilities must comply with the maximum permeability as previously stated. Coarse sands and gravel are not considered environmentally safe and must be lined with an artificial seal. Products composed of Bentonite (a fine clay material which mixes with the soil to form a liner) or other materials such as synthetic and plastic membranes, geotextiles, bentonite-geotextile membranes, asphalt concrete and asphalt can be used as earthen manure storage liners. Newer types of bentonite liners in which the bentonite clay is held together with two layers of non-woven synthetic materials may be more suitable. For more information on the various earthen manure storage liners contact the structural and environmental specialist within the Department of Forest Resources and Agrifoods. You can obtain more information on the various liners by contacting the Eastern Canada Soil and Water Conservation Centre in Grand-Falls, New Brunswick (506-475-4040) or the Agricultural Engineering Department of McGill University in Ste. Anne de Bellevue, Quebec.

(c) Concrete Tanks Above Ground

Above ground tanks can be either circular silo type with an open or enclosed top or rectangular structures. Depending on the size, the silo structures are generally more expensive than in-ground concrete tanks. Because of the cost, these systems are generally not used to store diluted wastes. This type of storage may be the only choice in conditions where space is limiting or where soil conditions do not permit the use of an in-ground storage. A benefit of this type of structure is that the small surface area may permit formation of a crust on top which would reduce odour production considerably.

The storage may be constructed from concrete staves, reinforced cast-in place concrete, glass lined steel panels or spiral wound coated steel. Some tanks are equipped with filling and agitation equipment designed specifically for that purpose.

4.7 MANURE STORAGE FOR ODOUR CONTROL

Most odour causing gases are formed when manure is in storage. In practice, most manure storage is anaerobic (meaning in the absence of oxygen). The anaerobic conditions promote odour production. These gases either escape from the storage to cause immediate problems or are released later during spreading.

Fewer odours are produced by solid manure handling systems than by liquid systems. An undisturbed solid manure stack is self sealing so few odours are given off until the pile is disturbed. Covered storages are an effective way to minimize odour generation. Storage covers: (1) reduce occasional manure agitation caused by wind and rain; (2) reduce the movement of odourous air from storage areas to neighbouring residences; and (3) reduce the addition of water from rain and snow thereby also reducing the total volume of manure to be spread. While in most instances the cost may

preclude covering storage areas, in certain circumstances this expense may be justified.

When evaluating manure storages, consider the following guidelines to reduce the potential for nuisance odours:

- provide additional storage volume for greater flexibility in the timing of manure application. This can reduce the likelihood of storage overflow and permit application to coincide with the most appropriate timing and weather conditions;

- with solid and semi-solid manure management systems, separate the liquid and solid portions of manure in storage to reduce the promotion of anaerobic conditions;

- avoid the addition of silage effluent and waste food products to the manure storage reservoir. These combinations create strong odours; and

- planting a buffer zone of trees around manure storage areas to reduce the movement of air over the manure surface, thereby lowering the amount of odour released. This has the added benefit of removing the storage from the sight of neighbours and improves the image of the farm by providing a pleasant, aesthetically pleasing appearance.

Treatment of manure before it enters long term storage avoids odour problems in storage and during spreading. Treatment systems must be designed to handle the manure volumes generated by the poultry operation. An improperly designed or managed treatment facility will prove unsatisfactory. Often treatment is performed in short-term storage so less expensive reservoirs can be used for the larger, long-term storage. Some treatment methods for odour control are listed in Appendix A. It is important to note these treatments are mostly used in rare cases when dealing with severe odour problems.