GUIDE TO ENVIRONMENTALLY SOUND

BEEF CATTLE MANURE MANAGEMENT PRACTICES

FÉDÉRATION DES PRODUCTEURS DE BOVINS DU QUÉBEC

MINISTÈRE DE L'AGRICULTURE, DES PÊCHERIES ET DE L'ALIMENTATION DU QUÉBEC

MINISTÈRE DE L'ENVIRONNEMENT DU QUÉBEC

March 1999

The Guide to environmentally sound beef cattle manure management practices is published by :

La Fédération des producteurs de bovins du Québec

Jointly with :
Le ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec
Le ministère de l'Environnement du Québec

This document is available at :

La Fédération des producteurs de bovins du Québec
555 Roland-Therrien blvd.
Longueuil (Québec)
J4H 3Y9
Phone (450) 679-0530
Fax (450) 442-9348
Email : fpbq@upa.qc.ca

Or

All the office of the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec

Or

The documentation Centre of the ministère de l'Environnement du Québec
Envirodoq EN981494

ISBN 2-9801411-2-7
Legal deposit
Bibliothèque nationale du Québec, 1999
National library of Canada, 1999

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FOREWORD

In the context of sustainable development, the Table filière du boeuf gives preference to various tools. One is this guide of environmentally sound practices, which is designed as a flexible instrument for reducing pollution and enhancing awareness of needs, in keeping with technological change and the differences in Québec's regions and livestock operations.

Consequently, the Table filière du boeuf mandated a group of experts to draft this Guide to Environmentally Sound Beef Cattle Manure Management Practices.

The document was co-authored by the environment committee of the Table filière du boeuf, which comprises representatives from the production sector, including the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ), the Fédération des producteurs de bovins du Québec (FPBQ), and the ministère de l'Environnement du Québec.

Operations which apply the contents of this guide to the letter may use its management practices for pens, minimal housing and field storage of solid manure until March 31, 2003. Regardless of the exceptions made for small operations in the *Regulation respecting the reduction of pollution from agricultural sources* (RRPAS), all beef cattle operations which do not use grazing areas during the growing season or livestock buildings (barns)/exercise yards as specified in the RRPAS must comply with the criteria defined in this guide for raising beef cattle in pens. Such operations will have to meet the requirements of this guide and those of the RRPAS, making the adjustments required to reflect this guide.

In the interim, the management practices described herein will be assessed from an environmental viewpoint. If studies show that they respect environmental objectives, they may be permanently incorporated into the RRPAS. The environmentally sound agricultural practices described in this guide are based on current knowledge and will be improved as new research findings become available.

INTRODUCTION

Society in general and farm producers in particular are increasingly sensitive to the need for environmental protection and resource conservation for the benefit of present and future generations. These objectives can be achieved without sacrificing farm operation viability or competitiveness.

The Guide to Environmentally Sound Beef Cattle Manure Management Practices describes manure management systems and practices which attenuate adverse effects on water and soil quality while improving beef cattle health and productivity. It contains manure management data for the most common beef cattle production systems, and defines requirements for production in managed wintering pens and solid manure storage on cropland.

While the alternatives proposed in this guide make the RRPAS more flexible, wintering pens are limited to a maximum of 100 livestock units or 100 cow-calves (unweaned) per production site. A production site is defined as all buildings, exercise yards and wintering pens used for beef cattle production belonging to a single agricultural operation and separated by a distance of 150 m or less. Any additional pens must be set up more than 150 m back from the facilities of another site. Further environmental protection measures must be implemented, in keeping with the criteria in Appendix 1, for production sites between 100 and 200 cow-calves.

RRPAS requirements have been relaxed for certain practices related to manure storage on cropland and pens. All other agricultural practices, however, must comply with the RRPAS.

Beef cattle operations which already hold a ministère de l'Environnement certificate of authorization (C.A.) must continue to comply with their C.A. and current operating standards. Operations for which solid manure storage on cropland has been authorized need not obtain a new C.A. if they maintain this practice in keeping with the criteria contained in the guide rather than permanently covering the solid manure with impervious material. Operations for which solid manure storage in a pervious structure has been authorized need not have their C.A. amended in order to perform the work described in this guide for managed pens and vegetative strips. Other operators wishing to develop pens or vegetative strips as described in the guide must apply to ministère de l'Environnement for a C.A. All producers should consult the ministère de l'Environnement to determine whether the changes they plan to make require amendments to their C.A. or a new C.A.

For information on deadlines for financial assistance and the eligibility criteria, producers should refer to the Agro-environment Investment Assistance Program.

In this document, the term "bearing capacity" means that the cattle do not sink further than their ergot. To lighten the text, a cow and her unweaned calf correspond to one (1) livestock unit.

The measures proposed in this guide are intended to:

- Inform producers on environmentally responsible beef cattle management options;
- Assist beef cattle operators in their efforts to reduce pollution and ensure the environmental sustainability of agroecosystems;
- Implement development and herd management standards based on current scientific knowledge; and
- Meet needs for information on the environmental impact of various livestock production techniques.

1. THE QUÉBEC BEEF CATTLE INDUSTRY - CONTEXT

Québec produces only 15 % of the cut beef it consumes. While there is clearly room for development, this development is slow, primarily due to the low profit margins in this sector.

1.1 COW-CALF OPERATIONS

In January 1998, there are 5 607 cow-calf operations in Québec, for a total herd of 214 296 beef cows. Average herd size is only 38 head, or one third of the size of a typical farm run by one full-time worker (100 cows). Approximately 250 operations have more than 100 cows.

Cow-calf operations have large grazing and feeding areas. A typical cow-calf operation cultivates 2,25 hectares per head; much more than what is needed to spread its manure. The challenge consists in distributing this manure efficiently to make optimum use of its fertilizer value and reduce the need for mineral fertilizers.

Cow-calf operations entail extensive management, since the cattle are sent to pasture from mid-May to mid-October. Generally, cows and their calves move from parcel to parcel throughout the summer, and each parcel benefits from natural fertilization as the cattle deposit manure directly onto the land while feeding.

In winter, when the ground is frozen, cattle are often kept outdoors in pens with a service building or minimum shelter. This practice is preferable to claustration for animal health and production, particularly if barns are poorly ventilated. Where possible, wintering pens should be located near forest cover sheltered from the prevailing winds. Windbreaks should be built if the natural vegetation does not provide adequate protection. Calving generally takes place in the service building. Afterwards, the cow and her calf return to the herd in the wintering pen.

1.2 STEER OPERATIONS

In Québec, in 1998, around 725 operations produce fed cattle. Of the approximately 110 000 head produced, 80 000 are sold for slaughter; the remaining 30 000 being yearling. Average farm size in 1998 is 152 head, far fewer than the 400 required to supply full-time work for one person. Only about 50 operations produce more than 300 steer annually, and about 30 of these have more than 500 head.

Less than 20 % of the operations producing feeder cattle use slotted floor systems, where manure is handled and managed in liquid form and stored in watertight structures under the barn. Fewer and fewer operators use this method.

1.3 MANURE MANAGEMENT

Most operations currently handle their manure in solid form or manure pack (mix of manure and absorbent material) with field storage in windrows. Concrete exercise yards with a 1-2 % slope allow effluent to flow into tanks. The main absorbents used are sawdust, wood shavings and straw, although bedding may also comprise chopped corn stovers, flax straw, soybean straw and peat moss. Manure is spread on cropland before seeding, after haying, after small grain harvesting or before fall ploughing.

Critical manure management periods are during a winter thaw, during spring thawing and in late fall. For some sites, the time before groundfrost is also critical. These critical periods are very short, one or two months a year, although they may extend to 90 days under certain conditions. Good, properly sited developments and good management minimize the risk of water pollution and maintain herd health and productivity.

2. LEGISLATION

Current statutes, regulations and by-laws (government, municipal, Commission de protection du territoire agricole du Québec, etc.) must be taken into account when selecting, expanding or modifying a production site. Promoters must ensure that their projects comply with the applicable laws, regulations, by-laws and directives, and obtain the necessary authorizations from the appropriate authorities before carrying out their projects.

In the absence of municipal by-laws governing odours in accordance with government orientations, the new Guidelines for Determining Minimum Distances to Ensure Odour Management in Rural Environments, which came into force on March 18, 1998, shall apply.

Setbacks apply to livestock buildings, outdoor feedlots, farm manure storage structures or facilities, wintering pens and watering areas. They are obtained using formulas based on seven parameters: cattle density, odour load, manure and project type, odour control measures employed and uses to be preserved. Manure spreading setbacks depend on the type of manure and spreading system used, and vary depending on spreading time.

3. PROTECTING WATER AND AIR QUALITY

Beef cattle production entails certain environmental risks which must be minimized. The main ones are related to manure production, contaminant (nitrate, bacteria, etc.) infiltration into groundwater and runoff into surface waters (ammonia, nitrates, phosphorus, bacteria, suspended solids, etc.), and odour transport to neighbouring areas used for other purposes. Direct livestock access to watercourses also contributes to surface water contamination and riparian erosion. Runoff occurs primarily during heavy rains and spring thaw.

Environmentally sound management practices must keep the effects of livestock production on water, air and soil below the quantities these environments can recycle.

Production/storage sites and manure spreading must be designed to protect the quality of groundwater, livestock drinking water and watercourses. They must meet the minimum requirements of the RRPAS, the Guidelines for Determining Minimum Distances to Ensure Odour Management in Rural Environments and this guide. Ideally, setbacks would exceed minimum values for each water supply point. Precautions must also be taken to prevent runoff from entering the production site. Where possible, cattle should not be allowed to drink directly from watercourses.

When planning a beef cattle operation, choose the location with the least adverse effects on

neighbouring residences. While odours can give rise to nuisance complaints from neighbours, the risk is reduced when the site is properly selected, the installation well designed and well managed. Various measures can also be implemented on existing sites to minimize these adverse effects.

Operations using claustration systems can take further protection measures to control odours. This is particularly true for those using a liquid manure management system.

Since cow-calf operations are management-intensive, they generate less odours: the cattle spend the summer in pasture and most of these farms practice solid manure management.

The following will help control odours:

- Surface bedding: solid manure generates less odour that liquid manure or slurry. Adding bedding reduces odours, while increasing bearing capacity.
- Manure removal: removing manure from the wintering pen as soon as site conditions allow helps reduce odours.
- Tillage and seeding: tilling areas early in the spring and then seeding allow crop uptake of residual nutrients while reducing the risk of odours and water pollution.
- Windbreaks: prevailing winds vary seasonally. A well-designed windbreak can reduce odour transport and protect cattle.

Site selection should also take the following factors into account: proximity to the forest, natural and man-made windbreaks, prevailing winds and land grade. Each situation is unique and must therefore be judged on its own merits.

4. CONFINED HOUSING SYSTEMS

4.1 Claustration

Manure management for operations using claustration systems exclusively differs depending on whether the operation produces solid or liquid manure.

4.1.1 Solid manure management

Solid manure management requires adding appropriate amounts of bedding, as defined below, to livestock waste so that the water content of the livestock waste-bedding mix is less than 85 %, making it possible to handle the manure as a solid. The water content must not exceed 80 % if the solid manure is to be field-stored. Section 37 of the RRPAS must be respected at all times: "the ground on which a livestock facility is constructed or laid out shall be protected from any contact with the livestock waste produced therein [...] The facility shall have the capacity to receive and to accumulate, without overflow, all of the livestock waste".

In free stall barns, the manure pack's water content must be less than 80 % for operations producing solid manure which is removed once or twice a week. In bedded housing, the water content should be 75 % or less. Manure may be allowed to build up longer to offer a better bearing capacity, fully retain the liquid contained in the waste and the contaminated water added thereto, and permit field storage.

The amount of bedding used depends on the length of time the cattle remain indoors, their weight, feed, the type of absorbent used and its moisture content (Table 1). The values contained in Table 1 are based on theoretical calculations. The amount of bedding and/or absorbent recommended for the various models was obtained from the attached information and observation data. In bedded housing with manure pack, an initial layer of 75-150 mm is necessary to ensure cattle comfort and contaminated water retention.

TABLE 1: Amount of bedding recommended to obtain manure with an 80 % moisture content.

Bedding (Cf. 1, 2 and 3)	Density (kg/m^3)	Absorption rate (%)	Water content (%)	Bedding added to obtain manure with an 80 % moisture content (Kg/650-kg cow-calf/ day)	Bedding added to obtain manure with an 80 % moisture content (Kg/400-kg steer/day)
Cereal straw:					
. bales	110 - 130	259			
. loose	50 - 60	304	12 - 17	2,8 – 3,0	2,2 – 2,4
. chopped	100 - 130	273			
Canola Straw:					
. loose	22.8	343	11	2,7	2,2
Hay:					
. bales	100 - 130	223			
. loose	60 - 80	268	11 - 14	2,8 – 3,0	2,1 – 2,3
. chopped	130 - 160	246			
Wood shavings:					
. bundles	200 - 300	138	12 - 15	2,8 – 3,0	2,2 – 2,3
. loose	100 - 150	138	12 - 15	2,8 – 3,0	2,2 – 2,3
Sawdust					
. mill,	225 - 275	55	58	8,0	6,2
. bulk, undried):	200 - 250	142	36	4,4	3,4

Note 1 : Bedding amounts are calculated using the moisture content of the fresh manure, bedding and desired moisture content.

Note 2 : Facilities using manure pack, without consideration for bearing capacity.
For example, since a 75 % moisture content is desirable to ensure bearing capacity, the amount of straw bedding required is 6 kg/head/day.

Note 3 : Other materials may also be used as absorbents, including chopped corn stovers, peat moss, etc.

Source : *Densité et capacité d'absorption de diverses litières utilisées dans les bâtiments d'élevage.* MAPAQ, 1990, AGDEX 538.
The Canadian Farm : Buildings Handbook. Agriculture and Agri-food Canada, 1988, 1822 E.
Symposium sur la R et D en gestion environnementale des effluents d'élevage au Québec.

MEF, 1992.

The use of less absorbent material such as "old hay" for bedding should be avoided. Straw may be used, but wood shavings and sawdust offer a better bearing capacity. All types of bedding are organic soil amendments.

When the bedding absorbs the liquid, the manure pack becomes solid. During the growing season, it is preferable to spread the manure from the resting area immediately. However, in the winter, the manure can be field-stored in keeping with the conditions for stockpiling solid manure on cropland (Section 6).

4.1.1.1 Barn with separate feeding and resting areas

These barns are divided lengthwise into two areas: a feeding area along a feedbunk running the length of the building either indoors or outdoors, and a resting area adjacent to the feeding area (Figure 1). Three manure management models are possible: feeding area without bedding and resting area with manure pack; feeding area with bedding and resting area with manure pack; feeding and resting area with bedding but without manure pack.

4.1.1.1.a Feeding area without bedding and resting area with manure pack

In this model, bedding is used only in the resting area, where approximately 30-40 % of the total livestock waste is produced. The mix's moisture content must be 75-80 %, with 75 % offering a better bearing capacity. In addition to adding bedding every day, a 75-100 mm layer of dry bedding should be laid down over the entire area before the cattle arrive.

For example, in the resting area, the amount of bedding with a moisture content of 12 % and required on a daily basis is 0,75-2,50 kg/steer, by weight, and 2,0 kg/cow-calf.

The resting area must be cleaned at least once a year, preferably when the manure can be spread directly. If the manure pack is removed more than once a year, it may be field-stored if the conditions for stockpiling solid manure on cropland (Section 6) are met.

Feeding area manure (60-70 % of the livestock waste produced) is removed once or twice a week. Since no bedding has been added, this semi-liquid manure must be stored in a slurry tank in keeping with RRPAS standards.

4.1.1.1.b Feeding area with bedding and resting area with manure pack

The amount of bedding added to the resting area must lower the moisture content to 75-80 %, with 75 % offering a better bearing capacity. Some bedding is added in the feeding area to lower the manure's moisture content to under 80 %.

For example, for both areas, the total amount of bedding with a moisture content of 12 % and required on a daily basis is 0,6-3,0 kg/steer/day, for steers weighing 160-500 kg, and approximately 3,0-4,0 kg/cow-calf/day.

Feeding area manure may be removed from the building once or twice a week to allow for a minimal absorption period, minimize the amount of bedding used before stockpiling on cropland (Section 6) and ensure cattle comfort.

4.1.1.1.c Feeding and resting area with bedding but without manure pack

This management method was developed by operators accustomed to scraping the feeding and resting areas regularly, about once a week. To fully benefit from this technique:

- Use chopped bedding;
- Spread the bedding until the manure pack is solid. Enough bedding should be applied over the entire floor surface to lower the manure pack's moisture content to 80 % or lower if it is then stockpiled on cropland, and to 85 % if it is stored in an watertight storage structure. Since there is no manure pack, larger amounts of bedding are required. For example, the amount of bedding with a moisture content of 12 % and required on a daily basis is 1,5-4,0 kg/steer/day and 4,0 kg/cow-calf/day.

4.1.1.2 Barn with manure pack over the entire floor surface

In this case, the manure and bedding accumulate for several weeks, and are then stockpiled on cropland.

Enough bedding to ensure bearing capacity must be applied over the entire building. The moisture content of the manure pack must be 75-80 %. For example, the amount of bedding with a moisture content of 12 % and required on a daily basis is 2,0-6,0 kg/steer/day, for steers weighing 160-500 kg, and up to 6,0 kg/cow-calf/day, in addition to the initial 150-mm bedding layer (Figure 2).

4.1.2 Liquid manure management

Liquid manure management entails adding very little or no bedding to the livestock waste. Two types of housing systems lend themselves to liquid manure management: slotted-floor

systems and concrete-floor systems.

4.1.2.1 Slotted-floor system

In slotted-floor systems, slurry is stored indoors in keeping with RRPAS requirements. While no bedding is applied, 300-450 mm of water are added to the pit to sufficiently dilute the manure to allow it to be agitated and pumped out on removal.

Slotted-floor systems can include a small concrete-floor outdoor exercise yard adjacent to the building, preferably with a southern exposure (Figure 3). This yard should allow approximately 1 m^2/steer and 2 m^2/cow-calf and should consist of a reinforced concrete floor, surrounded by an impermeable wall, and should slope towards the barn. The manure and slurry should be scraped and pushed into the manure pit under the slotted floor.

4.1.2.2 Concrete-floor system

In concrete-floor systems, liquid manure handling requires little or no bedding, regardless of whether the building is divided into separate areas (Figure 1) or not.

For example, the maximum amount of bedding with a moisture content of 12 % that may be applied is 0,5 kg/steer/day and 1,0 kg/cow-calf/day.

During cleaning, the manure is stored in an impervious open outdoor tank to allow precipitation to sufficiently dilute it to enable handling in liquid form. This method is not recommended for reasons of health, hygiene and cattle comfort. This management system increases the humidity level in the barn, affecting both cattle health and building service life.

4.2 COMBINED CONFINED/OUTDOOR HOUSING SYSTEM

Management of a combined confined/outdoor housing system is more complicated since it requires buildings and concrete exercise yards or pens. Among other things, the buildings shelter the cattle during bad weather, provide resting areas for cows and calves, provide calving areas, provide optimum surroundings and offer maximum comfort.

Building approaches must be sited carefully to avoid the creation of mud holes. Eavestroughs are essential if the roof slopes toward the confinement area.

4.2.1 Open-front barn/impervious yard housing system

As shown in Figure 4, 3-4 m^2/cow-calf must be allotted if young stock is housed elsewhere,

and 5-6 m^2/cow-calf if they are housed in the same building. The impervious exercise yard must allot 5 m^2/cow-calf, excluding young stock, and 6 m^2/cow-calf including them. Allow 2 m^2/steer inside the building and 2,5 m^2/steer in the impervious exercise yard. Since the cattle feed outdoors, 60-70 % of the manure is produced on the impervious exercise yard and approximately 30-40 %, indoors.

The manure and bedding used in the resting area are managed as described in Section 4.1.1.1.a (Feeding area without bedding and resting area with manure pack) to ensure better bearing capacity. The impervious yard should have a 1-2 % slope towards one end, where a slurry tank is located. In the fall and spring, the yard must be scraped several times a week and the manure pushed into the slurry tank. Scraping is also necessary if winter thawing occurs. It is recommended that as much snow as possible be removed as it falls into the yard.

The slurry tank must be big enough to contain annual manure production and precipitation. Diversion ditches and berms must be build up to prevent runoff from entering the yard. The slurry tank may be replaced by a concrete manure pad with an earthen or concrete holding basin if sufficient bedding has been added to the yard to obtain solid manure. **Systems using an impervious yard with a slurry tank or manure pad/holding basin are generally expensive and not recommended for cow-calf operations.**

4.2.2 Open-front barn/managed wintering pen

This model allots 3-4 m^2/cow-calf inside the building if young stock is housed elsewhere. If it is housed in the same building, 5-6 m^2 should be allotted per cow-calf and approximately 2 m^2 per steer. Since the cattle feed outdoors, only 30-40 % of the manure is produced indoors.

The manure and bedding accumulate in the barn over the winter and are then spread or field-stored as described in Section 6. The daily amounts of bedding with a moisture content of 12 % are 2,0-3,0 kg/cow-calf and 1,5-3,0 kg/steer, by weight. The wintering pen shown in Figure 5 is a low-density pen which may or may not be coupled with a high-density pen. It must be designed according to the requirements of Section 5: Managed Wintering Housing Systems. If used as a high-density pen only, it should be used less than 90 days per year.

To increase cattle bearing capacity and movement at barn approaches and exits and to facilitate manure and bedding removal, a hard-surfaced area 6-8 m wide is developed along the building's entire length.

To achieve this hard-surfaced area:

- Remove topsoil (about 200 mm deep);
- Grade, creating a 2-3 % slope towards the pen to ensure proper runoff;
- Install a plastic trellis or geotextile membrane on the ground;
- Backfill with a sand-gravel mix about 200 mm deep;
- Grade, creating the same 2-3 % slope towards the pen;
- Cover with a layer of bedding (approximately 150 mm);
- Make sure that roof water falls elsewhere than in these spots, by installing eavestroughs, for instance.

This management model may be modified. An unheated, closed barn may be used in the spring and fall (instead of the high-density pen) and a managed wintering pen (low-density) set up during the winter.

5. MANAGED WINTERING HOUSING SYSTEMS

Minimal housings are a simple means for cow-calf and semi-finishing operations to house their cattle. Although herd management, particularly of young calves, requires more careful attention in this type of facility, it is particularly advantageous for scraping, herd feeding and managing groups of cattle. It is also less expensive to develop.

The techniques proposed are accessible and easy to apply, targeting increased productivity and better environmental protection than conventional techniques. Understanding this system and managing it properly are the keys to success.

Managed wintering pen housing systems are prohibited for beef cattle operations with more than 100 livestock units or 100 cow-calves, when calves are unweaned. Additional environmental protection measures must be implemented on sites of 100 to 200 cow-calves as described in Appendix 1. Different sites belonging to the same operation must be set back at least 150 m from one another.

5.1 MINIMAL HOUSING

Minimal housing combine various elements. They are used primarily for cow-calf operations and include a service building, high-and low-density wintering pens, a feeding area, calf hutches and a vegetative strip to capture contaminated waters. These elements are described

below and illustrated in figures 5, 6, 7 and 8.

Service building

Building containing calving areas, a cattle-handling corral, a maternity pen, a separate room with a space for storing medication and obstetric equipment, and a pen for emergency care.

Low-density wintering pen

Outdoor pen on natural soil where the cattle spend most of the winter, are fed and watered. Cattle density is less than 5 kg live weight per square metre. For cow-calf operations, this is approximately 150 m^2/cow-calf or 1,5 ha/100 cow-calves. If the pen is located near a woodland or in a clearing surrounded by trees, it must be fenced to prevent the cattle from accessing the forest. Terraces are required if the slope exceeds 7 %.

High-density spring/fall pen

A smaller outdoor pen, used to monitor calving and as an additional area for confining cattle in the critical spring/fall periods. Its use should be strictly minimized. Generally, it is used a maximum of 60-90 days per year in conjunction with a low-density wintering pen.

It is included in the 150 m^2 total required per cow-calf. Density is approximately 20 kg live weight per square meter, or about 30 m^2/cow-calf. Bearing capacity should be sufficient to ensure that the cattle do not sink down past their ergot. Capacity is increased by placing a bed of wood shavings, crushed bark (400-600 mm) or granular material (150-300 mm) on a geotextile and covering it with bedding, or hard-surfacing part or all of the confinement area. In the latter case, livestock density may be 110 kg live weight per square meter, which represents a minimum of 5 m^2/cow-calf. In both cases, sufficient bedding should be employed to ensure cattle comfort and keep livestock waste inside the pen.

Feeding and resting areas in managed wintering pens (low-density)

To concentrate livestock wastes, the feeding area must be limited to 10-15 % of the total area and sufficient bedding or fodder remains used to guarantee cattle comfort, i.e. approximately 2,0-3,0 kg/cow-calf/day. Since cattle lie close to their feeding bunks, no more than 20 % of the feeding and resting areas in the wintering pen is required for maximum manure and bedding recovery.

The feeding and resting areas must be located where pen elevation is highest, covered with bedding and preferably alternated on a yearly basis. Feeding bunk location should be changed

every year (uneaten hay helps absorb effluent). Applying this management system to the feeding area ensures maximum manure recovery. The feeding and resting areas must be far from water supply points, excluding watering areas.

Water supply in a managed wintering pen

Waterers must supply cattle without affecting natural watercourses. They should be removed from the feeding area so as not to hinder normal manure recovery. Waterers should be designed to provide a continuous water supply during winter. They are to be placed inside the pen on elevated, well-drained sites as far away as possible from watercourses and other water supply points. All waterers shall be at least 60 m from a watercourse (30 m when the pen slopes away from the water supply point). This setback may be reduced to 15 m when the water cannot be supplied by gravity less than 60 m from the pen due to the absence of electricity near the production site. In this case, the producer must set up a fenced access lane less than 15 m wide, linking the pen and the watering facility.

Cattle must not have free access to watercourses for drinking. Ideally, the same should apply in grazing areas.

Mobile calf hutch

Many producers build mobile floorless calf hutches on runners that can be moved from one pen to another for maximum calf comfort (Figure 9). Moving hutches around ensures that the floor remains clean and prevents the spread of disease among calves. Newborn calves require abundant bedding 200 mm thick. These hutches may also be used as additional calving facilities.

Vegetative strip

Leachate and contaminated runoff from the confinement areas are among the prime sources of pollution caused by beef cattle operations. However, taking the proper precautions around feeding and resting areas greatly reduces the risk of pollution.

A vegetative strip which cattle access only under exceptional circumstances as a back-up pasture should be provide between pens and water supply points to ensure better environmental protection. This strip should be designed to distribute and capture, over a maximum surface area, contaminated water from high- and low-density wintering pens and prevent it from running into lakes, swamps, natural marshes, ponds, watercourses, wells, springs, water intakes or the water table. If the strip's slope exceeds 7 %, terraces are required.

During the growing season, the plants in this area use the nutrients that flow from the confinement areas, thereby reducing the pollutant loading. Current knowledge on the behaviour of confinement area effluent leads us to believe that using grasses in vegetative strips maximizes nitrogen absorption. This vegetation should be harvested mechanically at least once a year. Under exceptional conditions, this area could be used as a back-up pasture.

Minimum wintering pen setback is 60 m from watercourses or ditches for the first 60 livestock units, and an additional 1 m for each additional livestock unit, for a minimum of 100 m for a herd of 100 livestock units. If the pen slopes away from water supply points, this minimum is 30 m. The vegetative strip should be at least 1 m^2/livestock unit/day over the entire period spent in the wintering pen (low-density for winter and high-density for spring/fall).

When a beef cattle operation is located near a wooded area, vegetative strips may be composed wholly or partially of trees or shrubs. To reflect the problems inherent in uniformly distributing contaminated waters in a forest environment, these strips should be at least 3,5 m^2/livestock unit/day over the entire period spent in the wintering pen. The minimum distance between the wintering pen and any water supply point (lake, swamp, natural marsh, pond, watercourse, well, spring, water intake, water table, apart from wells or water intakes used to supply the operation) is 90 m for the first 60 livestock units and an additional 1,5 m for each additional livestock unit, for a minimum of 150 m for a herd of 100 livestock units. Should a grassed or treed strip be used, the size and minimum setback from the watercourse should be calculated on a pro-rata basis for the area covered.

The sizes of the vegetative strips discussed here are minimums. When setting up an operation, we suggest that producers develop the largest possible strip, up to 5 m^2/livestock unit/day over the entire period spent in the wintering pen.

Access road

Road linking the various ##pens to the service building and feed storage sites. It should be available for use at all times by machinery (feed transport, manure spreading) and for cattle monitoring and movement.

5.2 MANAGEMENT OF WINTERING PEN

While it is particularly advantageous for cow-calf operations to employ minimal housing facilities, these areas must be properly managed to avoid the creation of veritable mud holes which, in addition to degrading the environment, adversely affect calf life expectancy and herd health. Since both are closely linked, initiatives to improve cattle comfort and hygiene often

double as environmental protection measures.

To maintain a good ground cover, recycle residual fertilizers and enhance confinement area hygiene, bare patches in the wintering pen must be seeded down (ray grass, fescue, timothy grass, etc.). Calving should be restricted to the service building to facilitate monitoring. After a week or two, healthy young calves and their mothers can return to the wintering pen. The high-density pen may also be used to monitor calving.

Wintering pen management may vary somewhat by region, precipitation and soil type, but should be adapted to cattle and herd management. Most developments and their management are often a variant or combination of the two systems described below.

5.2.1 Management on clay soil

Fall management - high-density confinement pen : During the fall rains, when pastureland bearing capacity is insufficient and the risk of damaging fields high, producers move their herds into high-density pens for feeding until the ground freezes.

After this time, to avoid frozen manure accumulation and the ensuing problems, the cattle should be moved to a low-density pen for overwintering.

Winter management - low-density wintering pen : The management method recommended during winter is similar to that of former ‘iceboxes’. This pen is used when the ground is frozen and impervious. In addition to feed losses from the mobile feedbunk, bedding is added as needed, up to 2,0-3,0 kg/cow-calf/day, to constitute a comfortable ‘mattress’. Particular care should be taken during critical periods to ensure sufficient bearing capacity and limit runoff from the pen.

This mattress should be concentrated in the resting and feeding areas, which occupy approximately 30 m^2/cow-calf, or 20 % of the pen. It facilitates manure recovery, keeps the ground from freezing and maintains the bearing capacity. This pack should be rotated annually throughout the pen to promote soil and vegetation restoration.

In the early spring, before the thaw, after having transferred the herd into the high-density pen, one last layer of bedding should be applied to ward off melting, thereby giving the vegetative strip time to absorb the effluent.

It is a good idea to take advantage of ice accumulation to scrape the manure in successive layers, as thawing proceeds, and stockpiling it. This will facilitate machinery travel and reduce the risk of effluent runoff and infiltration. This manure must be removed from the pen as soon

as possible, no later than the following August 1. It may be spread on cropland directly if soil and crop conditions are amenable, or field-stored on cropland and managed in keeping with the provisions of Section 6.

Spring management : Depending on how early spring comes and how the pen is managed in winter, so that the cattle do not sink in as the ground thaws, they can be moved to a low-density pen with a good bearing capacity relatively early, until grazing areas offer a suitable bearing capacity.

5.2.2 Management on sandy soil

Fall management : On this type of soil, the herd can generally remain in pasture until very late in the fall.

Winter management - low-density wintering pen : In winter, the cattle are transferred to a low-density wintering pen. However, it is important to ensure that the ground is frozen hard before the cattle arrive to reduce the risk of infiltration. During this time, the wintering pen should be managed similar to a low-density pen, as described in Section 5.2.1.

Spring management : If, during early spring thawing, there is a danger of cattle sinking in, they should be moved from the wintering pen. If the grazing area is not yet accessible, they should be directed to another high- or low-density pen while awaiting an appropriate bearing capacity.

5.3 SUMMARY

1. Operators should tend to maximize pen setback from watercourses or ditches. Minimum distances between high- or low-density wintering pens and watercourses or ditches is 60 m for the first 60 livestock units, with an additional 1 m for each additional livestock unit, for a minimum of 100 m for a herd of 100 livestock units. If the strip consists solely of trees, the minimum distance is 90 m for the first 60 livestock units, with an additional 1,5 m for each additional livestock unit, for a minimum of 150 m per herd of 100 livestock units. If the pen is located on land sloping away from water supply points, the minimum distance is 30 m.

2. Pens must be managed for maximum effluent capture and diversion as far as possible from water supply points. In addition to the water supply points mentioned in paragraph 1, minimum pen setbacks are:

   - 300 m from a water intake used to produce spring water or mineral water within the meaning of the *Regulation respecting bottled water* (R.R.Q., 1981, c. Q-2, r.5) or to supply a municipal waterworks or a waterworks operated by the holder of a permit issued under section 32.1 of the *Environment Quality Act*;
   - 75 m from a spring, individual well for human drinking water or individual surface water intake. This distance does not, however, apply to pen where individual wells are concerned and must meet the same criteria as regulations governing production and storage sites;
   - 75 m from a swamp, natural marsh or pond, excluding any pond reserved solely for firefighting or for crop irrigation;
   - 150 m from a lake or river.

3. Pens must be located outside the 20-year floodplains of watercourses or lakes.

4. Ideally, low-density wintering pens should not be located close to the service building to allow minimum manure accumulation and reduce calf disease. It is strongly recommended that calving take place in the service building.

5. Pens must be protected from the wind by natural or man-made windbreaks.

6. Feeding and resting areas, which represent 15-20 % of the surface area of the low-density pen (20-30 m^2/cow-calf), must be sited as far as possible from ditches, watercourses and water supply points.

7. Concentrating feeding and resting areas ensures maximum manure recovery. Manure must be removed on an annual basis. Feedbunk location must be changed every year.

8. Enough bedding must be used to lower the manure's water content to 80 % or lower, and retain the livestock waste inside the pen.

9. Bedding must be applied to increase feeding area bearing capacity and slow down melting. The wintering pen must be cleaned in successive layers during the spring thaw.

10. If the pen is located near a woodland or in a clearing surrounded by trees, it must be fenced to prevent the cattle from wandering into the forest. This ensures maximum manure recovery and protects the trees.

11. Manure must be removed from the pen as soon as possible and no later than the following August 1. It may be spread on cropland directly if soil and crop conditions are amenable, or be stockpiled on cropland and managed in keeping with the provisions of Section 6.

12. Cattle should be kept in the high-density pen for as short a time as possible, no more than 90 days per year.

13. Cattle should be sent to pasture as soon as soil conditions allow.

14. Swales and low spots in the pen and vegetative strips should be backfilled so as to better distribute runoff from the pen and avoid localized accumulation. Terraces are required if the pen slope exceeds 7 %.

15. Surface waters should be diverted from pens using intercepting ditches, berms or any other appropriate measure.

16. Bare patches in the pens should be seeded down (ray grass, fescue, timothy grass, etc.) to maintain good ground cover, recycle residual fertilizers and enhance the pen's hygiene.

17. At least 1 m^2/livestock unit/day should be allotted for grassed strips over the entire period and 3,5 m^2/livestock unit/day for treed strips.

18. A good ground cover should be maintained in the vegetative strips. This vegetation should be harvested annually. Exceptionally, these strips may be used as back-up pastures.

6. STOCKPILING SOLID MANURE ON CROPLAND

Stockpiling solid manure on cropland is relatively inexpensive. Producers wishing to use this technique for beef cattle manure, without a tarp, must meet the following criteria.

Basic rule : Producers must use enough absorbents to lower the water content of the livestock wastes to 80 % or less before storing the manure on cropland in order to retain the liquid contained in the waste and contaminated water added thereto.

Producers must follow an authorized individual's recommendations to define the land base required to spread the manure produced by their operation in keeping with the criteria stipulated in the *Regulation respecting the reduction of pollution from agricultural sources* (RRPAS). They must own or hold the right to use the areas in question for their operation or have entered into manure spreading agreements with other operators.

The slope of the land on which the facility is layed out should be less than 5 % and the facility must be moved every year. Manure stockpiles on cropland must not exceed 4 m in width at the base and 2 m in height. The volume of the mound is limited by the nutrient requirements of the cropland on which it is to be spread, as described in the RRPAS.

The method used to stockpile solid manure on cropland must respect the following minimum setbacks:

- 300 m from a spring, well or water intake used to produce spring water or mineral water or to supply a waterworks;
- 150 m from a lake, watercourse, natural marsh, swamp or pond;
- 30 m from a ditch.

The facility must not be located within the 20-year floodplain of a watercourse or lake.

Producers must do their utmost to prevent runoff from entering the stockpile and to ensure that no manure or contaminated water therefrom reaches a lake, swamp, natural marsh, pond, watercourse, ditch, well, spring, water intake or the water table.

Manure stockpiled on cropland between October 1 and May 31 must be spread as soon as soil and crop conditions allow, before the following August 1. Spreading of manure stockpiled on cropland between June 1 and September 30 must comply with the *Regulation respecting the reduction of pollution from agricultural sources.*

Based on the ‘good neighbour’ policy, it is suggested that producers avoid spreading manure on certain days in the summer, such as June 24 and July 1, when many people are on holiday.

7. CONCLUSION

The methods and solutions described in this guide are designed to significantly reduce pollution, while maintaining beef sector competitiveness.

The Guide to Environmentally Sound Beef Cattle Manure Management Practices discusses various principles which help reduce fertilizer discharge into the environment by limiting contaminated water runoff more effectively than conventional systems without impervious storage, and directing this water to promote nutrient uptake by crops.

We feel that the solutions identified are feasible and among the most acceptable for successfully reducing the risk of pollution. The authors feel that the options chosen constitute a definite improvement over certain current practices. The systems presented are based on the latest findings. However, on-farm testing, particularly in the use of vegetative strips, and scientific validation of the results will help improve this guide still further in the years to come.

8. REFERENCES

AUTHOR UNKNOWN, 1988. *Guide CPAQ, AGDEX 420, Viande bovine, croissance et finition.* Conseil des productions animales du Québec Inc., MAPAQ.

BRITISH COLUMBIA FEDERATION OF AGRICULTURE, 1994. *Environmental guidelines for dairy producers in British Columbia*.

DELISLE, U. et al., 1993. *Développement des modalités de conception et d'exploitation des systèmes de cour d'exercice et de filtre végétal pour bovins*. Final report presented to the Ministère de l'Environnement du Québec.

FORTIER, M., DUSSAULT, M., QUEVILLON, M., FISK, D. and M. VALLIÈRES, 1989. *Cour d'exercice pour le bétail : présentation et recommandations.*

GAGNON, A. and P. PROULX, 1994. *Enclos extérieur pour bovins de boucherie*.

MAINE AGRICULTURE, 1993. *Description of best management systems and best management practices*. U.S.

MANITOBA AGRICULTURE, 1994. *Farm practices guidelines for beef producers in Manitoba*. Prepared by the Agricultural Guidelines Development Committee in conjunction with the Manitoba Cattle Producers Association.

RIVERAIN, H. LAPOINTE, R. and L. LAROUCHE, 1993. *Logement minimum en production bovine*. Taken from the Conseil des productions animales du Québec Inc. symposium on cow-calf production.

SAVOIE, V. and R. LEBLANC, 1994. *Aménagement minimum et aire de repos pour troupeau vache-veau.*

APPENDIX 1

ADDITIONAL ENVIRONMENTAL PROTECTION MEASURES FOR OPERATIONS WITH MORE THAN 100 COW-CALVES

MEASURE #1

For a maximum of 50 additional cow-calves, i.e. for 100 to 150 cow-calves:

For each cow-calf added to 100 and up to 150, the density in the low-density wintering pen will be less than 4 kg of live weight per square meter. This represents an additional area of 185 m^2/additional cow-calf. For grassed strips, an additional 3 m^2/additional cow-calf/day shall be allotted over the entire time the cattle are in the wintering pen, and for treed strips, 5 m^2/additional cow-calf/day. A minimum setback of 1 m/additional cow-calf shall be maintained between the wintering pen and watercourses or ditches.

MEASURE #2

If the operation has croplands of 1,5 ha (including pastures)/livestock unit AND if the operation is located in a municipality with low livestock density, i.e. a municipality with at least 1,3 ha of cropland (including pastures)/livestock unit, as defined by MAPAQ data:

It may house a maximum of 50 additional cow-calves, i.e. for 100 to 150 cow-calves:

For each cow-calf added to 100 and up to 150, the pen shall be increased by 150 m^2 to maintain a density of less than 5 kg of live weight per square meter. For grassed strips, an additional 1,5 m^2/additional cow-calf/day shall be allotted over the entire time the cattle are in the wintering pen, and for treed strips, 5 m^2/additional cow-calf/day. A minimum setback of 1 m/additional cow-calf shall be maintained between the wintering pen and watercourses or ditches.

It may house a maximum of 50 additional cow-calves, i.e. for 150 to 200 cow-calves:

For each cow-calf added to 150 and up to 200, the pen shall be increased by 150 m^2 to maintain a density of less than 5 kg of live weight per square meter. For grassed strips, an additional 3 m^2/additional cow-calf/day shall be allotted over the entire time the cattle are in the wintering pen, and for treed strips, 5 m^2/additional cow-calf/day. A minimum setback of 150 m shall be maintained between the wintering pen and watercourses or ditches.

FIGURES

FIGURE 1. Example of unheated, closed barn with separate feeding and resting areas

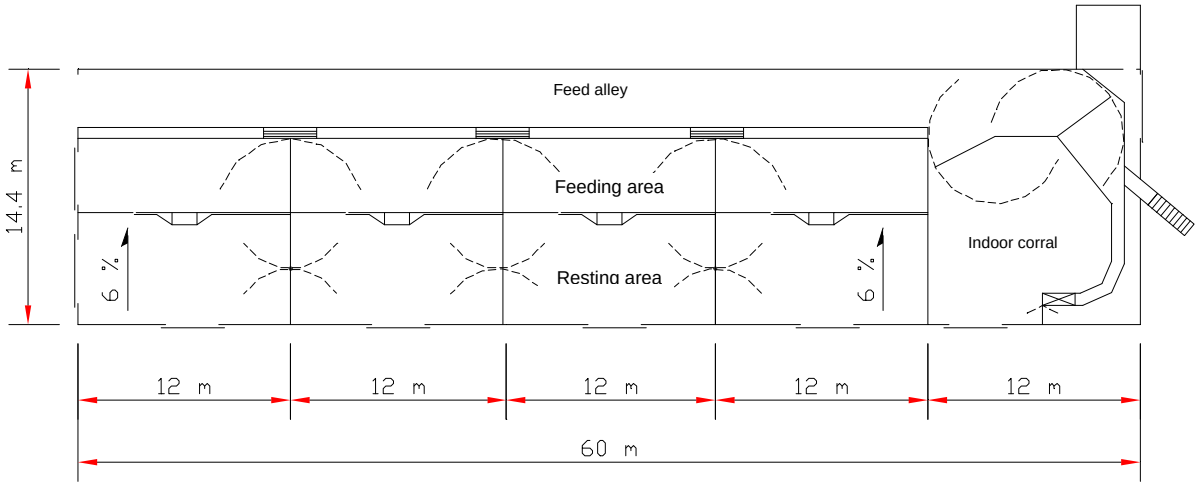

FIGURE 2. Example of barn with manure pack over the entire floor surface

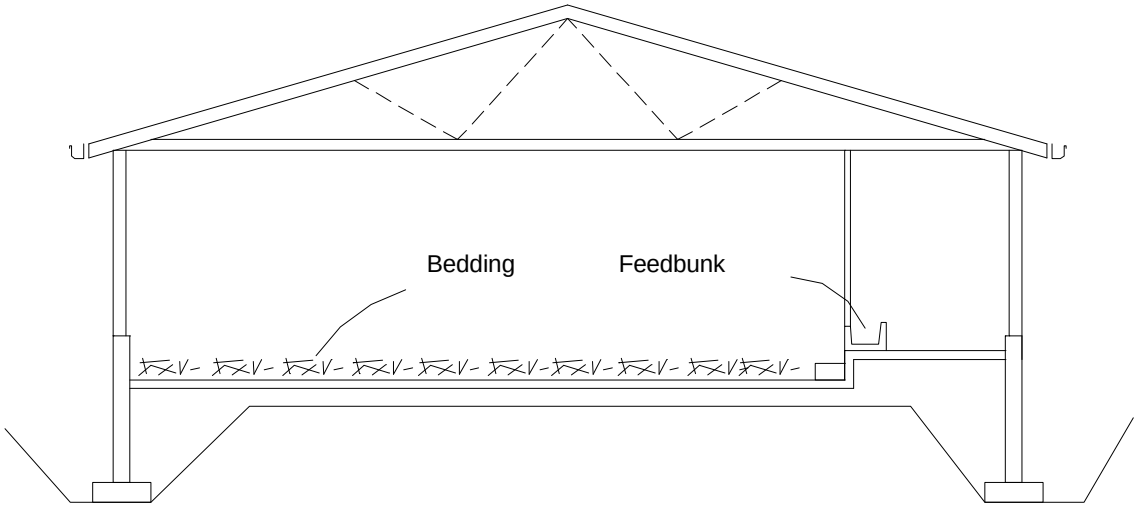

FIGURE 3. Example of slotted-floor barn

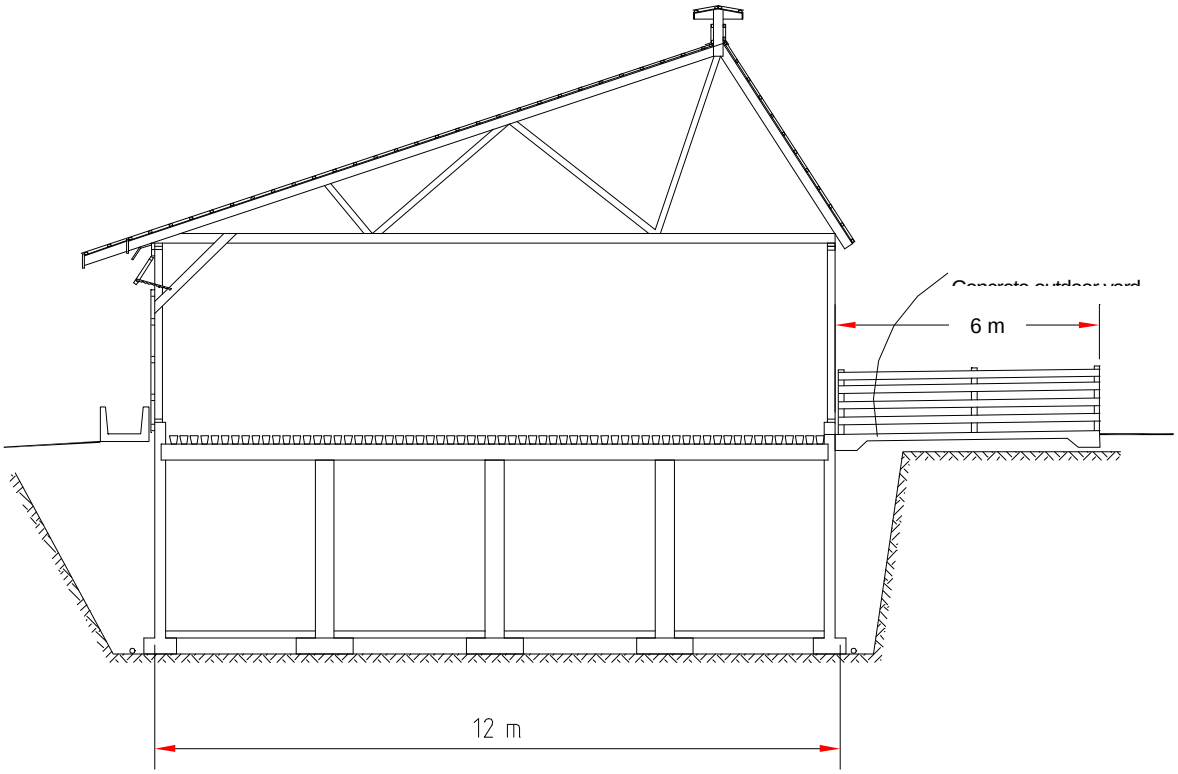

FIGURE 4. Example of open-front barn/impervious yard system

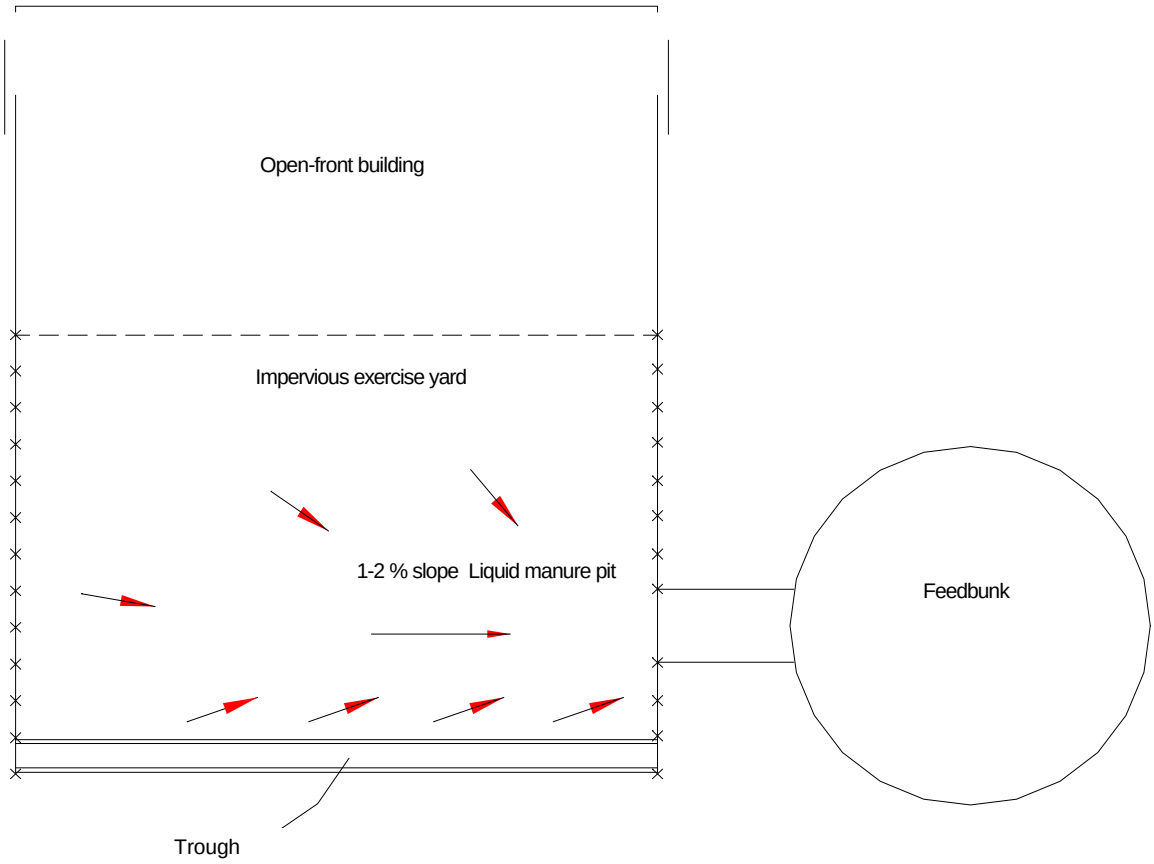

FIGURE 5. Example of open-front cow-calf barn/low-density pen, separated into two cattle groups

Legend

8 Mobile round-bale feeding rack
9 Waterer on 3-x-3 m concrete base
10 Feeding area (10-15 % of pen surface)
11 Windbreak, 20 % slotted
12 Intercepting ditch whose elevation is higher than pen
13 Ditch located whose elevation is lower than pen
14 Watercourse
15 Minimum setback
- Minimum setback for vegetative strips is 60 m for the first 60 livestock units, and an additional 1 m for each additional livestock unit, for a minimum of 100 m for a herd of 100 livestock units
- Minimum pen setback for treed strips is between 90 and 150 m from watercourses or ditches whose elevation is lower than confined area, depending of livestock unit number.
- Whenever the elevation of ditches or watercourses is higher than the pen, minimum setback is 30 m
- For grassed or treed strips, minimum pen setback from watercourses or ditches is calculated on a pro-rata basis for the area covered

16 Low-density pen (two lots of approx. 150 m^2/cow calf)

1 Vegetative or treed strip
- More than 1 m^2/cow-calf/day for vegetative strip
- More than 3,5 m^2/cow-calf/day for treed strip
- For grassed/treed strip, surface area is calculated on a pro-rata basis for the area covered
- Terrace required if vegetative slope exceeds 7 % (ref. Application sheet)
- Vegetative strip surface to be graded to prevent preferential flow

2 Terrace required if pen slope exceeds 7 % (ref. Application sheet)
3 Dike
4 Hard-surfaced area (man-made) 6-8 m large
5 Holding pen
6 Open-front shelter for calving, calf hutches and spring/fall housing
7 Diversion channel

Note :
It is preferable for pen to be located further from buildings but linked by an access road

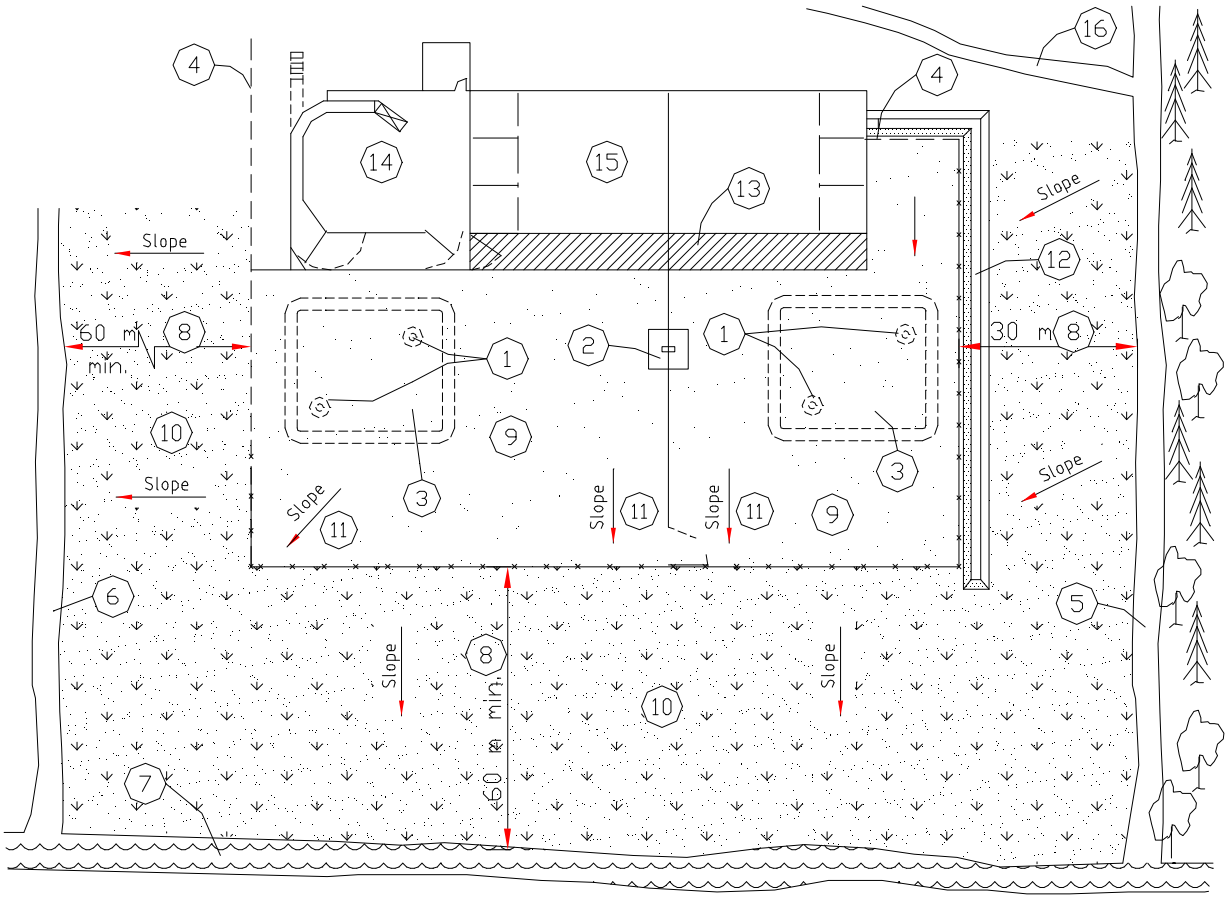

FIGURE 6. Example of low- and high-density concrete-floor pen

Legend

9 Mobile round-bale feeding rack
10 Waterer on 3-x-3 m concrete base
11 Feeding and resting area (20 % of pen surface)
12 Windbreak, 20 % slotted
13 Intercepting ditch whose elevation is higher than pen
14 Ditch located whose elevation is lower than pen
15 Watercourse
16 Minimum setback
- Minimum setback for vegetative strips is 60 m for the first 60 livestock units, and an additional 1 m for each additional livestock unit, for a minimum of 100 m for a herd of 100 livestock units
- Minimum pen setback for treed strips is between 90 and 150 m from watercourses or ditches whose elevation is lower than confined area, depending of livestock unit number.
- Whenever the elevation of ditches or watercourses is higher than the pen, minimum setback is 30 m
- For grassed or treed strips, minimum pen setback from watercourses or ditches is calculated on a pro-rata basis for the area covered

17 Low-density pen (two lots of approx. 150 m^2/cow calf)
- Low-density pen setbacks from the high-density and service building may vary to a maximum of 500 m

1 Vegetative or treed filter strip
- More than 1 m^2/cow/day for vegetative filter strip.
- More than 3.5 m^2/cow/day for treed filter strip.
- For grassed/treed filter strip, surface area is calculated on a pro-rata basis for the area covered.
- Terrace required if vegetative filter slope exceeds 7%. (ref. Application sheet)
- Vegetative filter strip surface to be graded to prevent preferential flow.

2 Terrace required if confined livestock area slope exceeds 7% (ref. Application sheet)
3 Rows of trees serving as windbreak or forest
4 Mobile calf hutch
5 Access to high-density pen and building
- Coarse 300 mm chips or sand-covered geotextile.

6 High-density pen (Max. 90 days / year)
A: Resting area
15 - 16 m^2/cow-calf; 400-600 mm elevation.
B: Hard-surfaced feeding area
3 - 4 m^2/cow-calf

7 Diversion channel
8 Maternity area

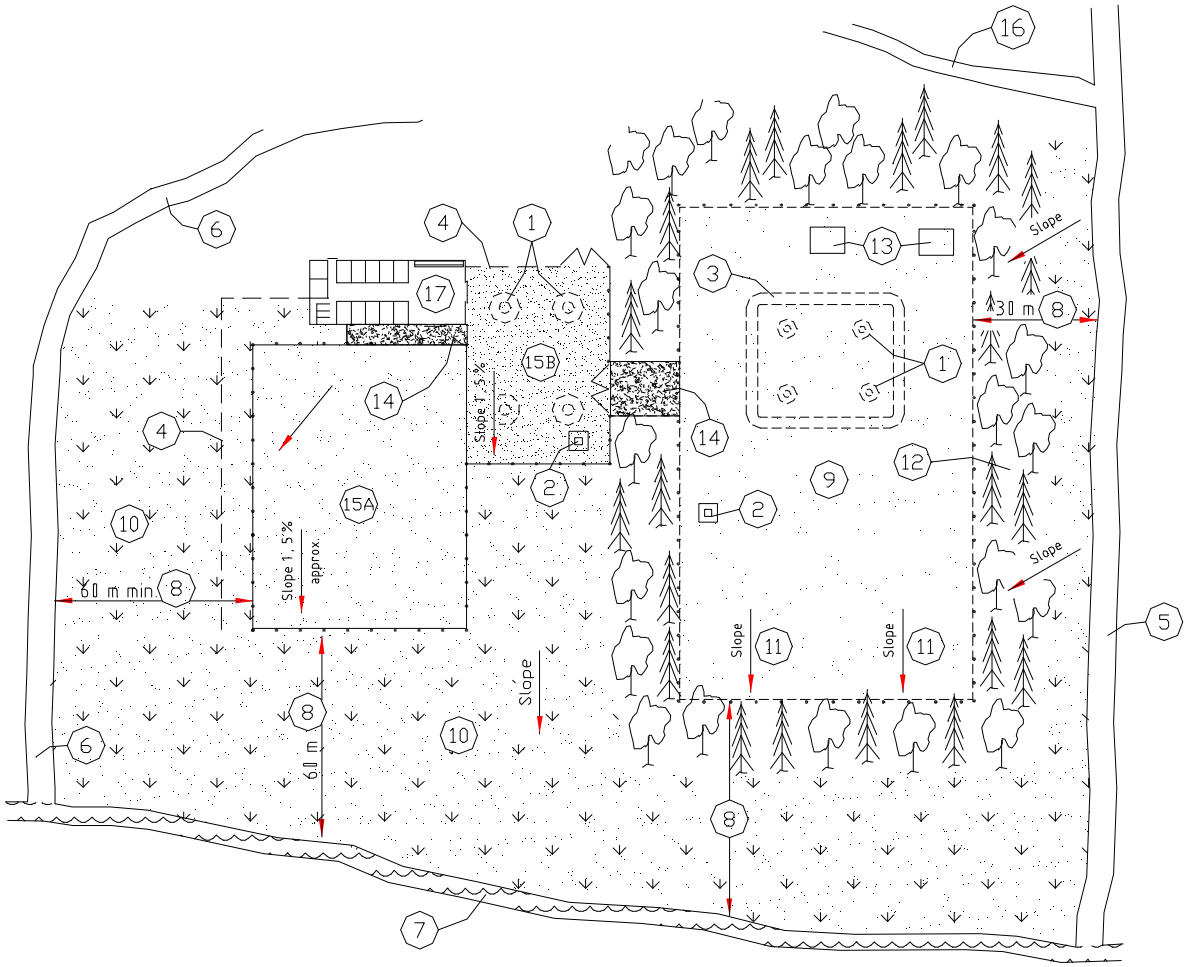

FIGURE 7. Example of low- and high-density pen

Legend

1 Mobile round-bale feeding rack
2 Waterer on 3-x-3 m concrete base
3 Feeding and resting area (20 % of pen surface)
4 Windbreak, 20 % slotted
5 Intercepting ditch whose elevation is higher than pen
6 Ditch located whose elevation is lower than pen
7 Watercourse
8 Minimum setback
- Minimum setback for vegetative strips is 60 m for the first 60 livestock units, and an additional 1 m for each additional livestock unit, for a minimum of 100 m for a herd of 100 livestock units
- Minimum pen setback for treed strips is between 90 and 150 m from watercourses or ditches whose elevation is lower than confined area, depending of livestock unit number.
- Whenever the elevation of ditches or watercourses is higher than the pen, minimum setback is 30 m
- For grassed or treed strips, minimum pen setback from watercourses or ditches is calculated on a pro-rata basis for the area covered

9 Low-density pen (approx. 150 m^2/cow calf)
- Low-density pen may be setbacks from the high density pen

10 Vegetative or treed filter strip
- More than 1 m^2/cow/day for vegetative filter strip.
- More than 3.5 m^2/cow/day for treed filter strip.
- For grassed/treed filter strip, surface area is calculated on a pro-rata basis for the area covered.
- Terrace required if vegetative filter slope exceeds 7% (ref. Application sheet)
- Vegetative filter strip surface to be graded to prevent preferential flow.

11 Terrace required if pen slope exceeds 7% (ref. Application sheet)
12 Dike
13 Mobile calf hutch
14 Access to high-density pen and building
- Coarse 300 mm chips or sand-covered geotextile

15 High-density pen (Max. 90 days / year)
A: Resting and feeding areas (approx. 30 m^2/cow-calf)
16 Diversion channel
17 Maternity area

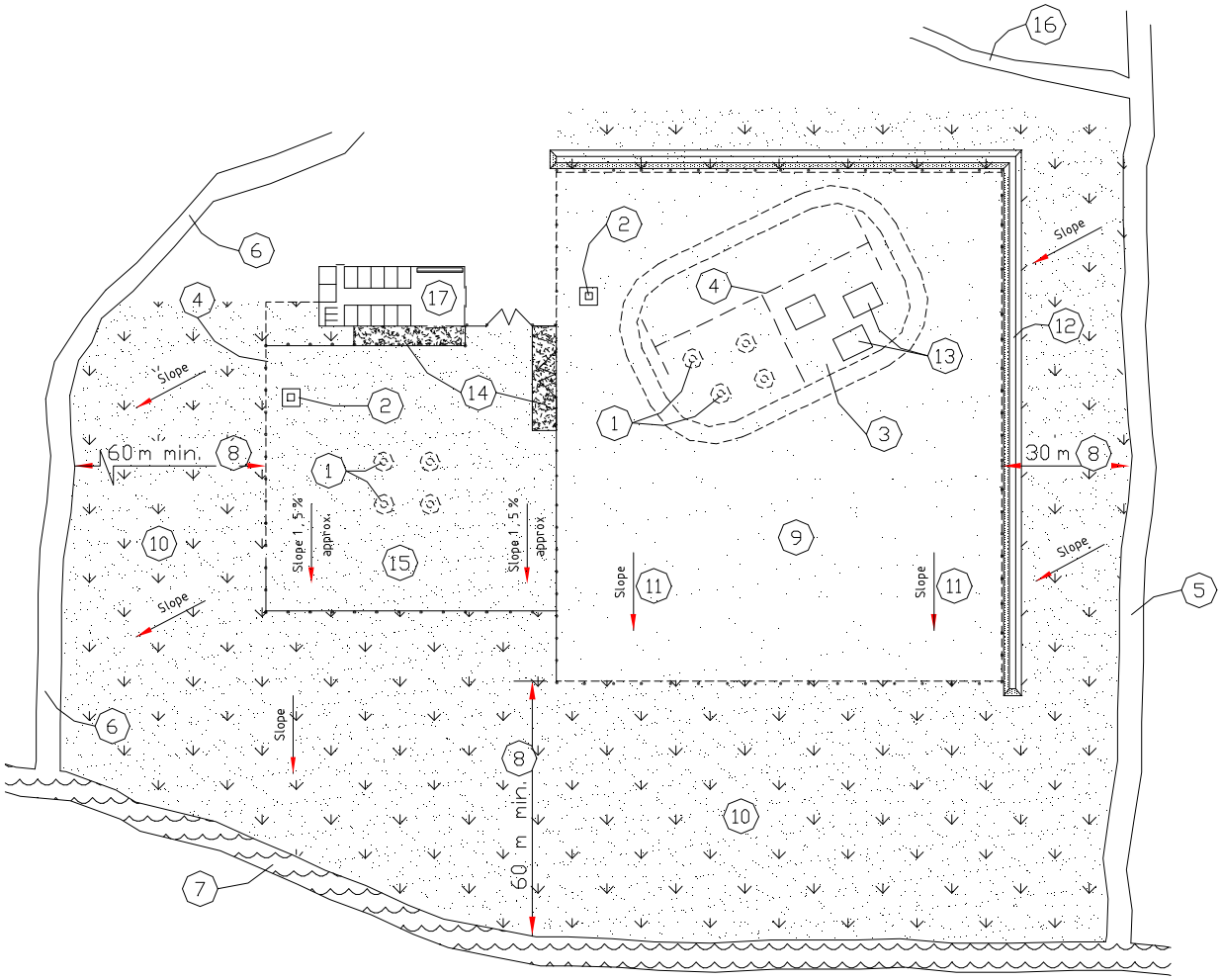

FIGURE 8. Example of a low-density pen

Legend

7 Mobile round-bale feeding rack
8 Waterer on 3-x-3 m concrete base
9 Feeding and resting area (20 % of pen surface)
10 Windbreak, 20 % slotted
11 Intercepting ditch whose elevation is higher than pen
12 Ditch located whose elevation is lower than pen
13 Watercourse
14 Minimum setback
- Minimum setback for vegetative strips is 60 m for the first 60 livestock units, and an additional 1 m for each additional livestock unit, for a minimum of 100 m for a herd of 100 livestock units
- Minimum pen setback for treed strips is between 90 and 150 m from watercourses or ditches whose elevation is lower than confined area, depending of livestock unit number.
- Whenever the elevation of ditches or watercourses is higher than the pen, minimum setback is 30 m
- For grassed or treed strips, minimum pen setback from watercourses or ditches is calculated on a pro-rata basis for the area covered

15 Low-density pen (approx. 150 m^2/cow calf)
- Low-density pen setbacks from the service building may vary to a maximum of 500 m

1 Vegetative or treed filter strip
- More than 1 m^2/cow/day for vegetative filter strip.
- More than 3.5 m^2/cow/day for treed filter strip.
- For grassed/treed filter strip, surface area is calculated on a pro-rata basis for the area covered.
- Terrace required if vegetative filter slope exceeds 7% (ref. Application sheet)
- Vegetative filter strip surface to be graded to prevent preferential flow.

2 Terrace required if pen slope exceeds 7% (ref. Application sheet)
3 Dike
4 Mobile calf hutch
5 Rows of trees serving as windbreak or forest
6 Diversion channel

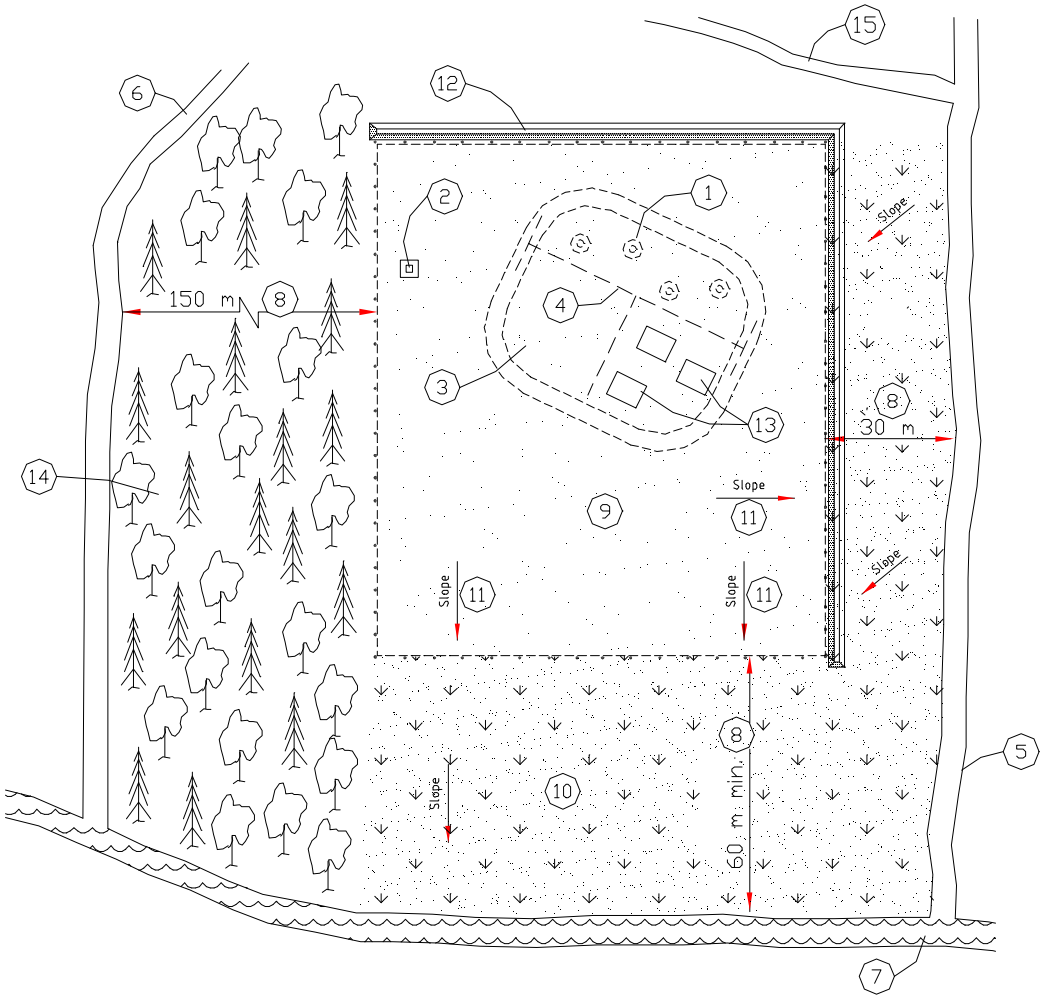

FIGURE 9. Example of a mobile calf hutch