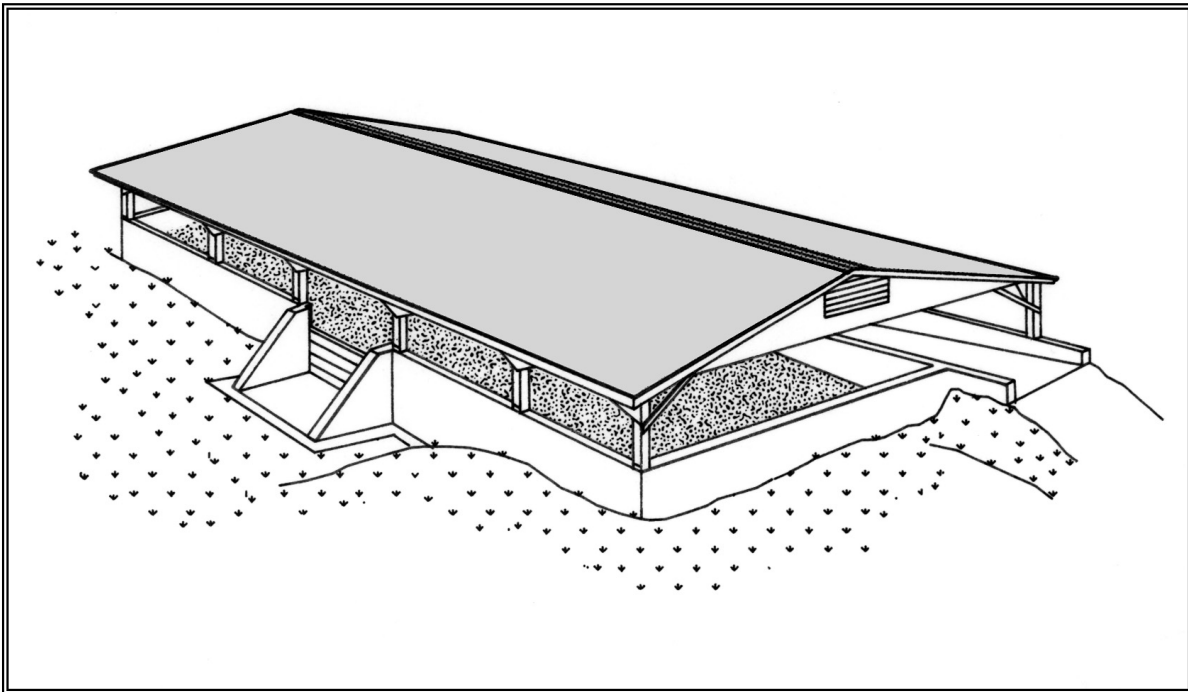


## SIZING DAIRY MANURE STORAGE STRUCTURES



### INTRODUCTION

Because environmental sustainability is increasingly recognized as a prime consideration in agricultural operations, dairy producers realize the value of well-planned and adequately-sized manure storage structures for their farms, especially as herds grow larger. Convenient manure handling and storage systems will provide greater flexibility in labour activities and will enable the operator to avoid spreading manure during times when runoff to surface watercourses or into groundwater may occur.

The first section of this leaflet shows the reader how to calculate the manure storage capacity required for a dairy operation. The necessary tables are given and a hypothetical case is worked through as an example.

In the second section, a table is provided which shows the required manure storage capacities for various sizes of free stall dairy operations. Many dairy farmers will be able to use these tables rather than working through detailed calculations.

### DETERMINING STORAGE CAPACITY

#### STEP 1: Storage Requirement Per Cow

The volume of liquid or semisolid manure produced per day by an average mature dairy cow weighing 640 kilograms (about 1400 pounds) is shown in Table 1 for three common types of housing. The tabulated values are not representative in cases where water is added and manure is diluted significantly for liquid handling. Storage volumes will need to be increased to accommodate milking centre wastes, contaminated runoff, silage juices and other wastes generated on the farm.

## STEP 2: Number of Cow Equivalents

The additional storage capacity required for replacement stock can be determined by converting the manure produced by heifers and calves to mature-cow-equivalent amounts as shown in Table 2.

## STEP 3: Storage Period

The number of days for which storage of manure is required will be affected by the availability of

equipment; current cropping practices; restraints imposed by rain, snow or other climatic conditions; economics; and regulatory requirements. For most areas of B.C., however, 180 – 200 days should be considered a minimum.

## STEP 4: Calculating Storage Capacity

Once the above information is known, manure storage capacity may be calculated as follows.

$$\begin{array}{c} \text{Total Manure} \\ \text{Storage Capacity} \\ \text{(litres or cubic feet)} \end{array} = \begin{array}{c} \text{Daily Storage Required} \\ \text{Per Cow Equivalent} \\ \text{(litres or cubic feet)} \\ \text{See Table 1} \end{array} \times \begin{array}{c} \text{Number of Mature} \\ \text{Cow Equivalents} \\ \text{See Tables 2 and 3} \end{array} \times \begin{array}{c} \text{Desired Length} \\ \text{of Storage} \\ \text{(days)} \end{array}$$

TABLE 1

| DAILY MANURE PRODUCTION FOR A MATURE DAIRY COW |                    |              |
|--|--------------------|--------------|
| Type of Housing                                | Volume of Manure * |              |
|  | (litres)           | (cubic feet) |
| Free Stall                                     | 75                 | 2.65         |
| Tie Stall                                      | 67                 | 2.37         |
| Loose Housing                                  | 60                 | 2.12         |

TABLE 2

| MATURE COW EQUIVALENTS FOR REPLACEMENT STOCK |                           |
|--|---------------------------|
| Age Group                                    | Number Per Cow Equivalent |
| Heifers (10 – 24 months)                     | 2                         |
| Calves (3 – 10 months)                       | 4                         |
| Calves (0 – 3 months)                        | 10                        |

\* These volumes typically include spilled water and washwater amounts. If these amounts are disregarded, manure production is 60 litres per mature cow per day. Parlour washwater and other milking centre wastes are not included and, if applicable, will result in additional storage requirements of approximately 30 litres per milking cow per day. In addition, contaminated runoff, silage juices and other wastes may need to be considered.

TABLE 3

| RATIO OF REPLACEMENT STOCK TO MATURE COWS FOR A TYPICAL DAIRY HERD |          |                          |                        |                       |
|--|----------|--------------------------|------------------------|-----------------------|
| Mature Cows  | Dry Cows | Heifers (10 – 24 months) | Calves (3 - 10 months) | Calves (0 – 3 months) |
| 1  | 0.18     | 0.71                     | 0.35                   | 0.12                  |

Source: Canadian Farm Buildings Handbook, 1990 Edition

## EXAMPLE NO. 1

Determine the manure storage capacity needed for a 120-cow milking herd for cows weighing an average of 640 kilograms (1400 pounds) and housed in a free stall barn. Dry cows and replacement heifers also use free stalls while calves are kept in bedded pens.

### STEP 1: Storage Requirement Per Cow

In this example, the majority of the animals are housed in free stalls. Therefore, the value for dairy manure production is read from Table 1 as 75 litres (2.65 cubic feet) per day per milking cow.

### STEP 2: Number of Cow Equivalents

Normally, a farmer will know the number of dry cows, replacement heifers and calves for which

manure storage is required. In this example, the numbers of these animals can only be estimated based on the assumption that the ratios of cows to young animals are typical for a farm that raises its own replacement stock.

The number of cow equivalents for each group of replacement animals is calculated by dividing the number of animals by the applicable figure from Table 2 to determine mature-cow-equivalent manure production. For example, 12 calves ranging in age from 3 months to 10 months are equivalent to 3 mature cow equivalents (12 divided by 4).

The number of mature cow equivalents for a 120-cow milking herd works out to be 198 head as shown in the accompanying table.

| AGE                             | NUMBER OF ANIMALS * | NUMBER OF COW EQUIVALENTS * |
|---------------------------------|---------------------|-----------------------------|
| Milking cows                    | 120                 | 120                         |
| Dry cows                        | 22                  | 22                          |
| Heifers, 10 months to 24 months | 85                  | 43                          |
| Calves, 3 months to 10 months   | 43                  | 11                          |
| Calves, 0 to 3 months           | 15                  | 2                           |
| Totals                          | 285                 | 198                         |

\* Each number is rounded up after calculating replacement numbers from Table 3 and equivalents from Table 2.

### STEP 3: Storage Period

For the purposes of this example, a storage period of 180 days is assumed.

### STEP 4: Calculating Storage Capacity

Using the formula from Page 1, and the numbers generated by going through Steps 1, 2 and 3, the required storage capacity is:

$$\begin{aligned} &75 \text{ litres per day per mature cow equivalent} \times 198 \\ &\text{mature cow equivalents} \times 180 \text{ days} = 2,673,000 \\ &\text{litres} = 2,673 \text{ cubic metres} = \text{approximately} \\ &94,400 \text{ cubic feet} \end{aligned}$$

For a storage chosen to be 50 feet wide and 8 feet deep, the calculated required length is 236 feet. This length assumes that no other wastes are to be incorporated and that the structure is roofed to prevent precipitation from entering.

## USING TABLES FOR SIZING MANURE STORAGE

The required manure storage capacity can always be calculated using the method previously described and will be necessary if site-specific volumes and conditions are to be included. Because most dairy operations will involve similar numbers of replacement stock and dry cows, it is possible to prepare representative tables of required storage capacities. Knowing the number of milking cows and the length of the storage period, the appropriate storage capacity may be read directly from Table 4. Additional storage volumes are necessary if milking centre amounts, contaminated runoff, silage juices and other waste sources are to be added.

## EXAMPLE NO. 2

Given the same information as provided in Example No. 1 but using Table 4 directly, determine the required manure storage capacity.

Reading from Table 4 for a 120-cow milking herd (using free stall housing) and a desired storage period of 180 days, the total storage capacity required is 2,673,000 litres (94,400 cubic feet).

**TABLE 4**

| <b>REQUIRED MANURE STORAGE CAPACITY FOR A FREE STALL DAIRY OPERATION WITH A GIVEN NUMBER OF MILKING COWS</b> |                 |                     |                 |                     |                 |                     |
|--|-----------------|---------------------|-----------------|---------------------|-----------------|---------------------|
| <b>Number of Milking Cows</b>  | <b>180 days</b> |                     | <b>210 days</b> |                     | <b>240 days</b> |                     |
|  | <b>(litres)</b> | <b>(cubic feet)</b> | <b>(litres)</b> | <b>(cubic feet)</b> | <b>(litres)</b> | <b>(cubic feet)</b> |
| 40   | 918,000         | 32,400              | 1,071,000       | 37,800              | 1,224,000       | 43,200              |
| 50   | 1,121,000       | 39,600              | 1,307,000       | 46,200              | 1,494,000       | 52,800              |
| 60   | 1,350,000       | 47,700              | 1,575,000       | 55,600              | 1,800,000       | 63,600              |
| 70   | 1,566,000       | 55,300              | 1,827,000       | 64,500              | 2,088,000       | 73,700              |
| 80   | 1,796,000       | 63,400              | 2,095,000       | 74,000              | 2,394,000       | 84,600              |
| 90   | 1,998,000       | 70,600              | 2,331,000       | 82,300              | 2,664,000       | 94,100              |
| 100  | 2,228,000       | 78,700              | 2,599,000       | 91,800              | 2,970,000       | 104,900             |
| 120  | 2,673,000       | 94,400              | 3,119,000       | 110,200             | 3,564,000       | 125,900             |
| 150  | 3,321,000       | 117,300             | 3,875,000       | 136,900             | 4,428,000       | 156,400             |
| 200  | 4,428,000       | 156,400             | 5,166,000       | 182,500             | 5,904,000       | 208,500             |
| 300  | 6,615,000       | 233,600             | 7,718,000       | 272,600             | 8,820,000       | 311,500             |

\* Based on mature cow weights of 640 kilograms (1400 pounds) and an average number of replacement stock as shown in the Canadian Farm Buildings Handbook. Volumes do not include milking centre wastes, contaminated runoff, silage juices or any other site specific wastes that need to be stored.

## DAIRY WASH WATER AND OTHER MILKING CENTRE WASTES

The volume of water used in modern parlour-milking operations can vary from 20 litres to 50 litres (approximately 5 to 10 imperial gallons) per milking cow per day. Storage of this wash water, floor flushing water and milking equipment cleaning

water with the manure will reduce the effective storage capacity of the manure tank by at least 50 percent. For further related information, see also B.C. Ministry of Agriculture factsheet No. 383.000-1 entitled *Manure Storage Structures*.

### FOR FURTHER INFORMATION CONTACT

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