Local Land Services

Ground tank construction

Fact sheet

What is a ground tank?

A ground tank is a type of dam, that is excavated below the natural surface level of the land, which is filled with surface water run-off collected by diversion drains. Ground tanks are common in western NSW.

Design considerations

Soil type

It is recommended to drill pilot holes to initially determine if the location has suitable soil before tank construction.

The soil must contain at least 20% clay to ensure the excavation will seal and hold water. Clay content can be determined by a lab test or by a field ribbon test. A flat ribbon of at least 30 mm long indicates adequate clay content. Refer to reference 1 for instructions on how to conduct a soil ribbon test.

Drilling a test hole will also indicate if gravel or sand seams are present. If the ground tank is dug into a gravel or sand seam the water will leak out and the ground tank will not hold water.

Evaporation

Loss of water by evaporation is an important consideration when deciding on ground tank storage capacity. For example, a shallow ground tank with large surface area will evaporate more rapidly than a deep ground tank with smaller surface area.

Evaporation losses vary across the landscape due to climatic conditions, such as temperature, humidity and wind.

Table 1 summarises the variation in evaporation loss across western NSW (from reference 2).

Table 1: Total yearly water evaporation of locations across the western region.

Location	Evaporation loss per annum
Tibooburra	2.7 metres
Wanaaring	2.5 metres
Broken Hill/Cobar/Ivanhoe	2.0 metres
Buronga	1.8 metres

Water run-off

Catchment area

The minimum catchment size needed to fill a ground tank is worked out using the following formula:

$$\text{Min. catchment size } (m^2) = \frac{\text{dam volume } m^3}{\text{avg. annual rain (m)} \times \text{catchment yield \%}}$$

The yield of a catchment (run-off) is the amount of rainfall that runs off the surface and can be diverted to, and collected in ground tanks.

In western NSW, the yield of a catchment is approximately 2% of the average annual rainfall.

However, this is variable depending on site characteristics. For example, a hard, rocky, more steep catchment area can yield up to 5% of rainfall.

Worked example

If a landholder indends to construct a 5 mega litre (ML) ground tank in the Cobar area where the average annual rainfall is 394 mm, what is the minimum size catchment needed to fill that ground tank?

$$\text{Min. catchment size } (m^2) = \frac{5{,}000 \text{ m}^3}{0.394 \text{ m} \times 0.02} = 634{,}518 \text{ m}^2$$

63 ha is the minimum catchment size needed to fill a 5 ML ground tank.

$$\text{As, 1 ha} = 10{,}000 \text{ m}^2 \quad \frac{634{,}518\text{m}^2}{10{,}000} = 63 \text{ ha}$$

Diversion drains (tank drains)

Diversion drains collect and divert run-off from the catchment area into the ground tank.

Correct surveying and construction of diversion drains is vital to prevent erosion and breaching of drains.

Diversion drain - slope and surveying

A slight slope in the diversion drain is required to ensure water flows into the ground tank without causing erosion. A slope of 0.2 – 0.3% is ideal for bare earth channels.

- 0.2% should be used on highly erodible soils.
- 0.3% should be used on more robust soils.

The slope of the diversion drain determines the speed of water flow in the channel. If the slope is too steep, the water flows are too fast, causing the channel to erode. Eroding diversion drains cause excess sedimentation into the ground tank, which reduces capacity over time.

A laser level can be used to measure changes in land height and ensure correct slope percentage. To determine a slope of 0.2%, survey the drain commencing at the inlet of the ground tank and continue on a rising grade of 5 cm every 25 m (which equals to 20 cm rise every 100 m).

Bank height - construction

The bank of the diversion drain ensures water flows down the drain and into the ground tank. The height of the bank is dependent on the length of the diversion drain and the area of the intercepted catchment. Bank height is measured from natural ground level not the channel base, as seen in Figure 1.

As a rule of thumb, diversion banks which are less than 1 km long and have a catchment area less than 100 ha, should have a minimum settled bank height of 60 cm (see Figure 1 for dimensions).

If the catchment area is greater than 100 ha, a larger diversion drain will need to be constructed, with a wider channel and a minimum settled bank height of 80 cm.

If diversion banks are longer than 1 km, the bank height closer to the ground tank should be increased. This is required to accommodate the larger volume of flows from the increased area of catchment.

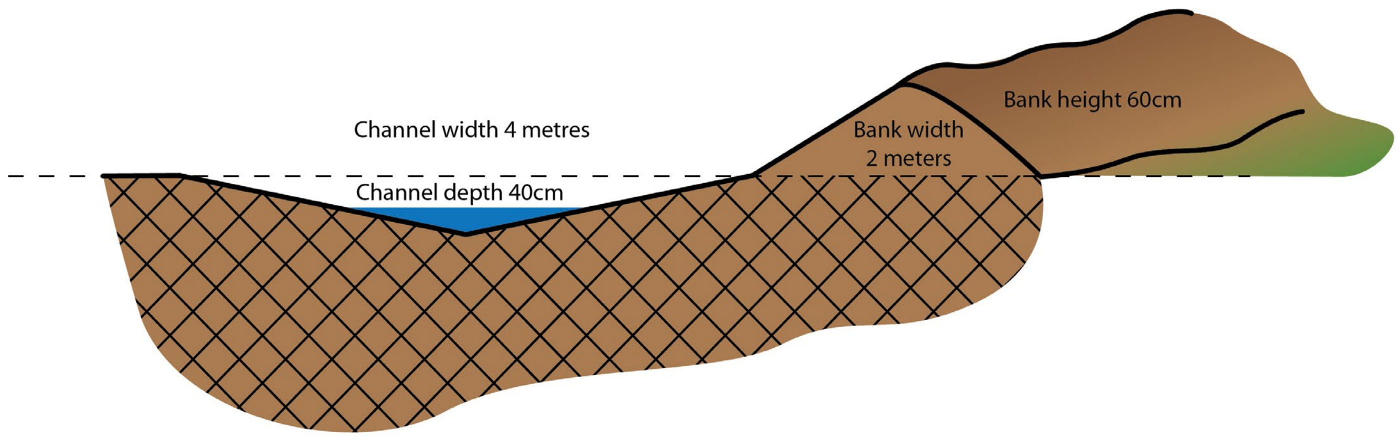

Figure 1

Embankment (tank bank)

An embankment contains the water in the ground tank. Adequate freeboard of the embankment is required to account for any surcharge during heavy inflow, wave action and clearance.

Freeboard is the height of the embankment above the top water level (spillway level). The freeboard of the embankment should be a minimum of 1 m (see Figure 2).

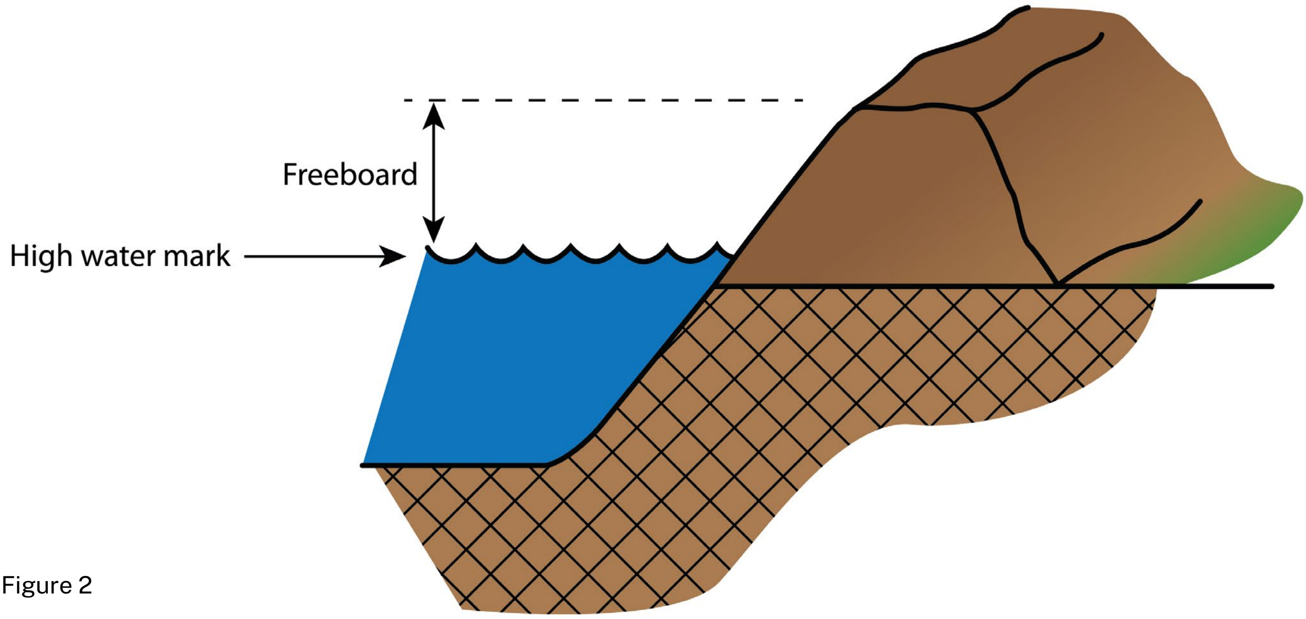

Figure 2

Spillway (by-wash)

A spillway provides an outlet for excess water to be disposed of without causing damage to the tank or surrounding area.

A spillway should be located on low, broad areas to allow water flows to spread out and lose energy.

A good rule of thumb is to create the spillway at 3 times the width of the inlet. For example, if the inlet is 20 m, the width of the spillway should be 60 m.

This may be created with 2 spillways of 30 m, as seen in Figure 3.

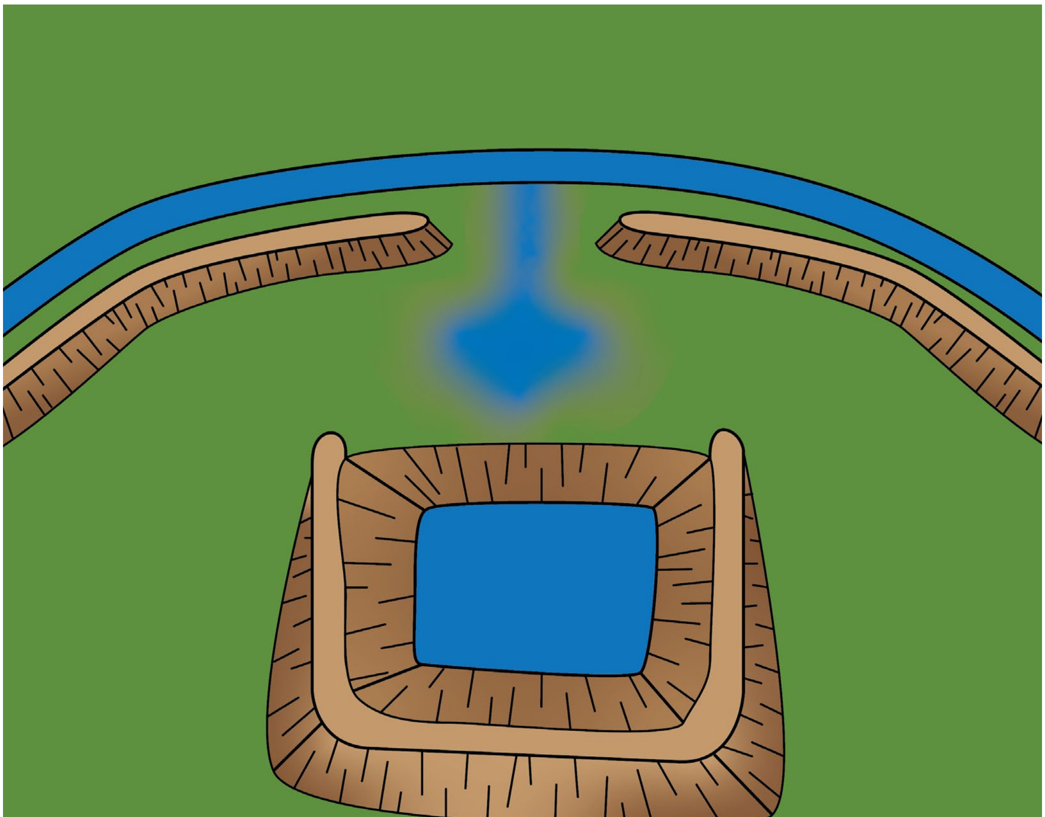

Figure 3

Water requirements

When determining tank size, stock and domestic requirements the evaporation loss needs to be considered.

Table 3 shows the recommended tank sizes across western NSW, considering stock requirements and evaporation losses based on dry sheep equivalent (DSE) water consumption estimates. Domestic requirements are not taken into account.

Table 2: Dimensions of a square ground tank required for different ground tank capacities.

Capacity (ML)	Tank dimensions (metres)		
	Top	Depth	Diagonal
1	27	3	38.2
4	41.5	6	58.7
5	45	6	63.6
7	50.5	6.5	71.1
9	55	6.5	77.8
12	60.5	7	85.6
15	65.5	7.5	92.4

Adapted from: Soil Conservation Service of NSW.

Worked example

A landholder in the Cobar area wants to construct a tank to supply 500 DSE with water. Using the map (Figure 4), we can see Cobar is located in J1. The tank size required considers a 2 year period of evaporation and no inflow.

By locating J1 and 500 DSE in Table 3, the landholder will need a 5 ML capacity ground tank.

From Table 2, we can see that a 5 ML tank can be built with the following dimensions: Top: 45 metres; Depth: 6 metres; Diagonal: 63.6 metres.

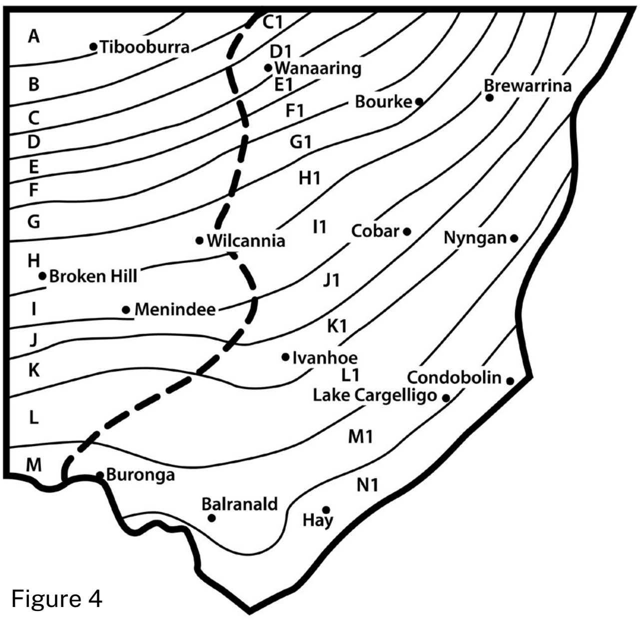

Figure 4

Table 3: Excavated tank sizes (ML) for stock water requirements, considering a 2 year period of evaporation and no inflows.

Area (see Fig 4)	No. of dry sheep equivalent (4.5 litres / day)		
	250	500	1000
A	8	12	17
B	8	11	16
C	7	10	15
D	7	9	14
E	6	8	13
F	6	7	12
G	5	7	11
H	5	6	10
I	4	6	9
J	4	5	9
K	4	5	8
L	3	4	8
M	3	4	7
C1	7	10	15
D1	7	9	14
E1	6	8	13
F1	6	7	12
G1	5	7	11
H1	5	6	10
I1	4	6	9
J1	4	5	9
K1	4	5	8
L1	3	5	8
M1	3	4	7
N1	3	4	7

Adapted from: Soil Conservation Service of NSW.

References

1. **Ribboning Technique**

   Determining soil texture using the ribboning technique, Primefact 1363, First edition, December 2014, NSW Government , Department of Primary Industries, Agriculture NSW Water Unit.

2. **Average pan evaporation – Annual**

   Average annual, monthly and seasonal evaporation, 2006, Product code: IDCJCM0006, Australian Government, Bureau of Meteorology.

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