**Introduction**

Information sheet 18 outlines the Regional Fresh Water Plan’s requirements for environmental protection, which need to be observed when building a farm dam. Briefly, these are:

- Safe construction to minimise risk of failure
- Avoidance of flooding or drainage problems on neighbours’ land upstream
- Avoidance of bed scour or bank erosion in the channel downstream
- Minimisation of adverse impacts on aquatic habitat or riparian vegetation.

Information sheet 18 also outlines circumstances where the Taranaki Regional Council requires farmers to obtain a resource consent for a dam, to ensure these principles are maintained.

Irrespective of whether a dam is small enough to be a permitted activity, or big enough to warrant a resource consent, it has to be well-constructed to hold water and avoid failure. This information sheet outlines some practices which should be observed during dam construction.

![Figure 1 - Good construction practices are needed to avoid dam failure](image)

**Water requirement**

As a rule of thumb, the water flowing down a stream in the course of a year is roughly equal to rainfall, less evapotranspiration by vegetation in its catchment. The difference can be used to estimate how much water a small dam will supply. For instance, if local rainfall is 1800 mm and evapotranspiration is 600 mm, then runoff is 1200 mm. Each 100 mm of runoff from a hectare equals 1000 cubic metres of water, so a small stream with a catchment of 10 hectares can supply 120,000 cubic metres of water annually.

The entire volume does not need to be stored. For example, if the farm’s requirement is for 10,000 litres of stock water a day, that is 10 cubic metres. 300 cubic metres will be needed each month. In the example, 10,000 cubic metres flows downstream on average each month, so a dam with 300 cubic metres’ storage capacity should easily re-fill, even in months when rainfall and streamflow are well below normal.

**Site selection**

A good dam site has advantageous natural features, like a swampy valley floor, a point where adjacent spurs pinch the stream, and firm ground underneath.

Sites to avoid are springs, old slips, permeable ground - it leaks beneath dam foundations - and outcrops or shelves of solid rock - foundations are hard to bond.

Some sites have better storage ratios than others. If a large volume of water can be stored by excavating and placing a small volume of fill, then the storage ratio is good. The dam will be cheap to construct, relative to the volume of water it can deliver. Sites with high storage ratios generally have flat or low-gradient valley floors, narrow valley sides at the dam site, and a wider valley upstream.

Low, long dams have better storage ratios than high, narrow ones. Doubling embankment length generally doubles volume of fill, because the dam’s cross-sectional area stays the same. Doubling embankment height generally increases the volume of fill four-fold, because the cross-section then needs to have a wider base.

Another important consideration is downstream safety - if the dam fails, what will happen? A large storage volume, suddenly released, may scour the channel downstream, taking out bridges, sweeping away stock, and even endangering houses and their occupants. It is best to site a dam where there are no farm assets or public roads in the immediate vicinity.

**Site preparation**

The borrow area, the dam site, and the storage area behind should be cleared of all vegetation including trees, stumps and roots. Turf and topsoil should be...
removed and stockpiled, to use for site restoration afterwards.

Foundations should be low-permeability material - peat, gravel, or sand need to be dug out.

**Borrow area**

Material used for fill should be clay. Sand, gravel, topsoil, peat or humus (decaying plant matter) should never be incorporated in fill under any circumstances.

Fill can be taken from the upstream part of a dam’s storage area, to provide increased storage capacity, but should never be taken too close to the dam’s foundations. If fill has to be excavated from outside the dam site, stockpile topsoil for spreading before the borrow area is re-grassed. Do not locate the borrow area downstream of the dam, as it may destabilise the structure.

**Core trench (key)**

A core trench filled with heavy clay will prevent seepage under the dam. This trench should project into the bank on either side, and should be deep enough to reach into water-tight soil (see Figure 2).

**Embankment**

The water of even a small pond exerts great pressure, so a farm dam must be constructed with firm foundations on a broad base.

For small farm dams, the following dimensions are recommended (Figure 2):

- Minimum crest width 3 metres
- Maximum height 3 metres
- Minimum base width 4x dam height, plus crest width
- Maximum batter of 1 in 3 on upstream, and 1 in 2 on downstream side of embankment

When placing fill in the core trench (key) and cross-section (embankment), lay it evenly in 150 mm layers, and compact it. Place fill only when moist enough to compact - as a guide, if it can be kneaded by hand into a ball which does not readily crumble. If fill appears too dry, cease construction until it moistens again.

If the design incorporates a drainage pipe, take particular care to compact the fill to optimum density around the pipe, so that there isn’t any seepage around its outside.

Once the fill has been placed to full height and final slope, spread sufficient topsoil to provide a good seedbed, over the crest and downstream face, before re-grassing.

Do not plant trees on the top or face of a dam, as the roots allow water to percolate, causing leaks or washouts.

Until the embankment consolidates, wave action can easily damage it. It can be protected by placing a thick layer of turf, or spreading manuka brush, or straw secured with wire netting.

**High-level spillway**

A high-level spillway is needed to take overflow during floods. Cut it through natural ground to one side of the dam (Figure 3); not the fill in the embankment. Ensure its point of discharge is well clear of the dam’s base.

Spillway inlet height, width and depth should be sufficient to allow floods to bypass the dam without filling to crest level and overtopping. As a guide, in small catchments less than 50 hectares, use a minimum base width of 3 metres and minimum depth of 0.5 metres, with sides at a 2:1 batter, and inlet level a minimum 0.8 metres below the dam’s crest.

Spillway gradient should slope evenly to meet the valley floor well downstream of the dam. A well-grassed spillway will resist the eroding power of...
floodwater. It can be boarded-over or concreted for further protection, if need be.

**Low-level spillway or pipe**
Where a dam is installed on a permanent stream, a low-level spillway or pipe is needed to take normal flow, once the dam has filled. It sets an upper limit to water level in the dam. As a guide, its inlet should be placed at least 0.5 metres below the high-level spillway intake.

Site the low-level spillway in solid ground to one side of the dam. It can be constructed from timber, metal or concrete fluming.

A low-flow pipe through the dam is an alternative. Its gradient, from upstream inlet to where it passes out of the dam, should be no more than 1 in 10. It should have a seepage collar, at least 1m by 1m by 0.1 m thick, placed around it at its half-way point. Backfill around a low-flow pipe and seepage collar should be placed in 0.1 m layers, rammed into place to a depth of 0.6 m over the pipe and the top of the seepage collar, before earthmoving machinery passes over. Its inlet should be protected from blockage by a wire mesh screen.

A low-level spillway or pipe should disperse water onto the natural valley floor, well downstream of the dam. If normal flow is small, it is possible to combine the low-level spillway with the high-level one, as a small channel cut in its base. If this is done, the small channel may need timber, stone or concrete checks placed at intervals to prevent scour by floodwater.

**Drainage pipe**
If a pipe is to be installed through the base of the dam, enabling its pond to be drained and cleaned, then it must be set in a prepared solid foundation (Figure 2). Seepage collars 1m by 1m by 0.1m should be placed along it a minimum of every 9 metres, with backfill placed as described for the low flow pipe. The drainage pipe outlet must have a valve which can be easily opened and closed. Its outlet should be anchored in the stream channel downstream of the dam’s base, with an anti-scour apron of geotextile, rock or concrete.

**Concluding remarks**
This advice is offered by the Regional Council by way of guidance for farmers and contractors. It should suffice for constructing small farm dams, which are permitted activities under the Regional Fresh Water Plan; and for which engineering designs are rarely prepared.

While useful guidance for the construction of larger earth dams, the Council requires landowners to obtain consents for these before construction. Good engineering design and supervision are essential for larger dams to endure; and the Council expects that these would feature in a consent application.

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**Figure 3  High-level spillway**

**Figure 4  A well-constructed dam is a farm asset**

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**For further advice or information contact:**

**The River Control Section, or Consents Section at Taranaki Regional Council, Private Bag 713 Stratford Ph: 06 765 7127 Fax: 06 765 5097**