tasman district council | Te Kaunihera o te tai o Aorere

DAMS

A Guide to the Construction, Alteration and Maintenance of Earth Dams in the Tasman District

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1 INTRODUCTION

Dams within Tasman District range from the Cobb dam at around 40 metre crest height, while the majority of dams are in the range of 2-5 metres in height and are earth dams constructed of Moutere Gravels, with stream inflows that often cease in summer. One characteristic of Nelson summers is a rainfall deficit and dams are important because they provide storage for summer irrigation, stockwater etc.

The Tasman District Council is a unitary council and it administers both the Resource Management Act 1991 (RMA) and the Building Act 1991 and is required under these acts to avoid, remedy or mitigate any adverse effect of the activity of damming on the environment and to regulate the construction of dams. This guideline is particularly to assist the construction of earth dams and it applies to the whole of the Council's District and to structures owned privately, as well as those owned by the Crown or Council, used or to be used for the damming of any water (other than open coastal water), river or stream. It does not apply to any flood bank or channel training work.

For historical reasons, the rules that currently apply to the dams differ within the District and the opportunity exists in the longer term to simplify the rules relating to dams. This document is therefore on the basis of the regulations as they currently apply.

Briefly, in that part of the Upper Buller that is now part of Tasman District, regulations were inherited from the West Coast Regional Council and they differ from the remainder of the District. The situation is further complicated by the Water Conservation (Buller River) Order 2001, which significantly restricts the damming of water in this catchment.

2 CURRENT REGULATIONS

Under the RMA, Transitional Regional Plans (TRPs) were inherited by Council from both the Nelson-Marlborough and the Westland regional councils. The rules contained in these TRPs regulate dams in two ways, being structural safety of dams and the effects of the dam on the environment.

2.1 Dam Structural Safety

Under the Nelson-Marlborough TRP, Council's Water and Soil Bylaw 1990 regulates the design, construction, alteration, removal and repair of all dams and reservoirs (i.e. except in the Upper Buller) greater than 2 metres crest height **or** greater than 5,000 cubic metres storage **or** where the catchment area draining to the dam is 20 hectares or more. Earth dam structures smaller than this, should be constructed in accordance with the guidelines provided in this report. The purpose of the current rules is to ensure that dams are soundly constructed and maintained and that they are not a hazard to the public or the environment.

With the passing of the Building Act, Tasman District Council is now required to regulate the construction of dams and reservoirs larger than 3 metres of water depth **and** 20,000 cubic metres of storage. The result is that Council now must regulate the construction of all these larger dams throughout its region, including the Upper Buller.

Dams with crest heights above 3 metres, those with large or steep catchments, with site-specific problems, or significant safety issues, are considered to be of sufficient concern to

require their design, construction and certification by a registered chartered (civil) engineer or other similarly qualified person. Conditions requiring an engineer's involvement will be placed on permits issued for these dams and full engineering design may be required to be submitted with each application.

This same bylaw regulates and provides for the repair, maintenance and alteration of watercourses and requires (waterway) consent for the alteration or construction etc. of any defence against water, including the installation of any crossings, culverts, bridges, fords and floodbanks.

2.2 Effects of Damming

Under Rule 31.2.1 Tasman Resource Management Plan, (TRMP) the *damming* of fresh water where the catchment area is less than 20 hectares is a *permitted* activity, ie, a water permit to *dam* is not required. The reasoning is that streams produced from such small catchments only flow intermittently, and typically are dry in summer. Once dams on such streams are full there is unlikely to be any impact providing the dam, spillway, etc are well maintained.

Dams permitted in the Upper Buller under the Westland Regional Council TRP are those less than 3 metres above the river bed level **and** for purposes of creating a wildlife habitat, or providing a water supply for primary industry, or a domestic or stock water system **and** adverse affects are avoided or minimised. However, the WCO prohibits the construction of dams in a number of (Schedule 2) rivers where the damming can adversely affect recognised values such as fish passage.

Copies of the TRP and other existing rules can be requested from Council staff.

3 POSSIBLE CONSENTS REQUIRED

Consents that may be required for proposed dams are outlined below.

(a) *River bed* consent - Section 13 RMA - a *land use* resource consent is required for the placement of a structure in the bed of any river (including an intermittent stream).

(b) *Land use* consent is required under the TRP for any dam greater than 2 metres in height, **or** impounding more than 5,000 cubic metres, **or** with an upstream catchment area greater than 20 hectares. This applies to "ring" or "turkey nest" dams outside of a river bed but does not apply to the Upper Buller catchment. Dams with crest heights above 3 metres, those with large catchments, with site-specific problems, or significant safety issues are typically required to be designed, construction supervised and certified by a registered civil (chartered) engineer or other similarly qualified person. Typically, full engineering design is required to be submitted with consent applications for these dams.

(c) *Building consent* - the construction of dams greater than 3 metres in height **and** storing greater than 20,000 cubic metres of water require building consent under the Building Act and are to be classified as low/medium/high impact. Owners of dams with a classification of "medium" or "high" impact shall provide a dam safety programme to the Council.

(d) Dams are defined as "Buildings" under the TRMP if they exceed 1.2 metres in height and setbacks to property boundaries therefore apply to both the structure, and any dammed water should not "trespass" onto neighbouring property. This also applies to road boundaries. Easements are required where impounded water may cover neighbouring property.

(e) A *water permit* to dam and take and use storage may be required. Where the catchment area draining into the dam is more than 20 hectares then a water permit (dam) consent is required. In addition, a water permit *to take and use* storage is required if the rate of taking exceeds the Council's *permitted* activity rate as stated in the TRMP. This varies between catchment but is typically less than 5 cubic metres (5,000 litres) per property per day.

(f) Land disturbance - Section 9 RMA and TRMP – *land use* consent is required for new dams if the area being recontoured is greater than 1 hectare or any cut exceeds 1 metre in height.

(g) The requirements of the Freshwater Fisheries Regulations 1983 for the provision of fish passage may also apply. These regulations are administered by the Department of Conservation.

As a unitary council, various of the above consents can be combined, so separate consent documents for each activity requiring consent is not necessary.

3.1 Construction Consent (Dam)

Having determined that the proposed construction or alteration of a dam requires a consent, then an application is necessary. Application is generally required to be on forms supplied by the Council, accompanied by the application deposit fee and with the following information:

(a) a Council-generated (GIS) aerial photograph showing the dam location relative property boundaries etc;

(b) a site plan drawn to an appropriate scale, including a dam elevation, a cross-section and other explanatory material;

(c) details of site investigations that have been carried out, design proposals, construction materials and methods and programmes of works.

All such information shall be of sufficient quality and clarity to show the exact nature of the proposal and will avoid additional costs in staff time etc.

If Council is satisfied that the proposed dam is soundly designed and that its presence will not represent a hazard to the public then the application will normally be granted as a non-notified application. Consent is granted subject to the general conditions for dam construction consents (see Appendix 10) and any special conditions that are considered appropriate. The time to process an application (if all information is provided) will generally be one to three weeks.

3.2 Water Permit

Having determined that the proposed dam or taking from storage will require a consent, then an application is necessary. Application is generally required to be on forms supplied by the Council, accompanied by the application deposit fee and signed and dated.

Damming water permits may need to be publicly notified and open to submissions where the potential for impact from the actual damming and taking of water is more than minor. Council encourages applicants to discuss your proposal with your neighbours, other potentially affected landowners but particularly with downstream water users. Written consent from these users for your proposal will assist the processing of any consent application.

The Act requires that you supply an assessment of what environmental effects, positive and negative, are likely to result from the proposed development. Clearly, the scope of this assessment and the detail necessary will depend on how complex or major the proposal. For example, fish bypass or recreational use issues are unlikely to exist if the stream to be dammed dries up in summer. Check also if Council has any specific policies or plans covering the river etc.

If the application is notified, it can take between three to six months to process a water permit if no submissions are received and no major issues are involved. Allow plenty of time by applying early with a complete application and assessment.

4 EARTH DAMS

4.1 Introduction

The most common type of dam is constructed of earth and the specifications, provided in Section 5, are a guide as to what the Council considers to be the minimum requirements for their construction.

There are two main types of earth dams, the gully dam and the off-creek storage dam, or ring dam. The gully dam is by far the most common and there is a wealth of local knowledge and experience constructing these dams. The decision to construct should follow a thorough evaluation of water requirements, water availability, environmental impact and costs and all consents must be obtained.

4.2 Water Requirement and Catchment Yield

If you propose to take storage for irrigation or some other use then the following may assist.

When designing your dam an important consideration is the degree of security against drought that is required or affordable. Other particular site factors include soil type, soil water-holding capacity and crop water demand.

To calculate the volume of dam storage required to irrigate a crop, for example, an apple orchard, determine if it is on the basis of supplying irrigation throughout a dry summer. For example, assuming irrigation is required for 12 weeks at a maximum rate of 250 cubic

metres/hectare/week (ie, 25 millimetres per hectare per week) results in a water storage requirement of (12 x 250) 3,000 cubic metres per hectare per year. However, given the trend in recent years away from orcharding, other less water-demanding crops may well require lower irrigation rates and storage can be reduced.

When designing your dam, account should also be taken of evaporation losses from the dam surface and the likely requirement to retain some permanent storage for the survival of resident eels.

If the preferred option is a "gully" dam, you need to determine the catchment yield available to fill your dam. This is calculated on the basis of the amount of run-off likely in that location and for that catchment area. In the Moutere, depending on the catchment land use, we expect an average rainfall or 900-1,000 millimetres/annum. Of this rainfall and for a catchment with a pasture land use, expect run-off of 2-300 millimetres/annum, which is 2,500-3,000 cubic metres per hectare per year. For a catchment in plantation forestry, expect a reduced run-off of 150 millimetres/annum or 1,500 cubic metres per hectare per year. Therefore, for each hectare of available catchment you can estimate the likely maximum run-off potentially available to be stored in your dam.

In the Moutere as a "rule of thumb" when contemplating a potential dam site, allow 1 hectare of catchment for each 1 hectare of irrigated area and design a dam sufficient to hold up to 3,000 cubic metres for every hectare to be irrigated. For example, to fully irrigate 8 hectares of orchard will require a minimum dam storage of (8 x 3,000) 24,000 cubic metres.

In the Moutere, an important consideration is that both new and existing dams may be required to release or bypass water where the damming is likely to have an adverse effect on downstream users or instream values, for example, where a permanent stream or river is being dammed. What this requirement reinforces is the philosophy that dam storage should be sufficiently large so there is no need to depend on any summer stream inflow.

4.3 Site Selection

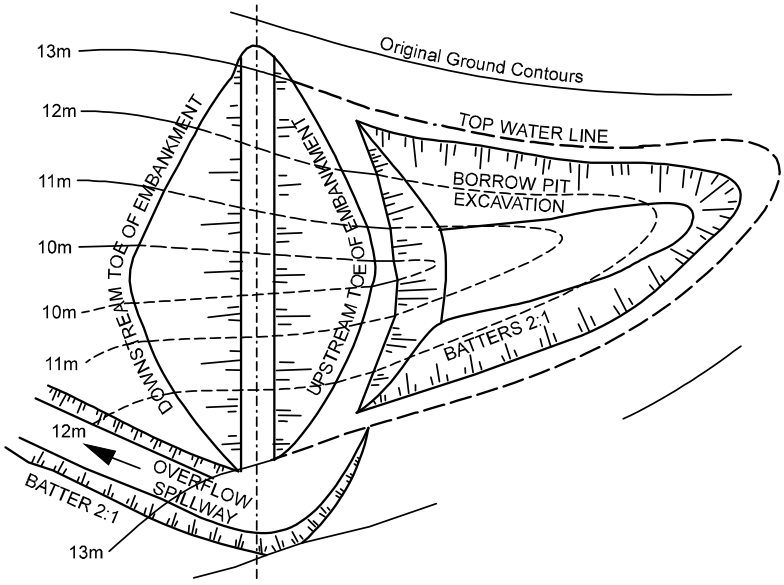
One important consideration when selecting between a "good" or "bad" dam site is the storage ratio:

$$\text{Storage ratio} = \frac{\text{volume of water stored}}{\text{volume of earth moved}}$$

The higher the above ratio, the more water stored per unit of earth moved and hence the lower the cost (and more economic) is the storage site.

Sites with high storage ratios generally have a flat bed slope, a wide, deep storage area and the gully sides narrow at the embankment site. In contrast, the construction of storage by excavating a hole in the ground has a very low ratio. Adding to their cost is the disposal of the excavated material. Note, that the doubling of the embankment height increases embankment volume by four times, whereas the doubling of embankment length only doubles its volume.

Figure 1: Plan of a Gully Dam *(Not to Scale)*



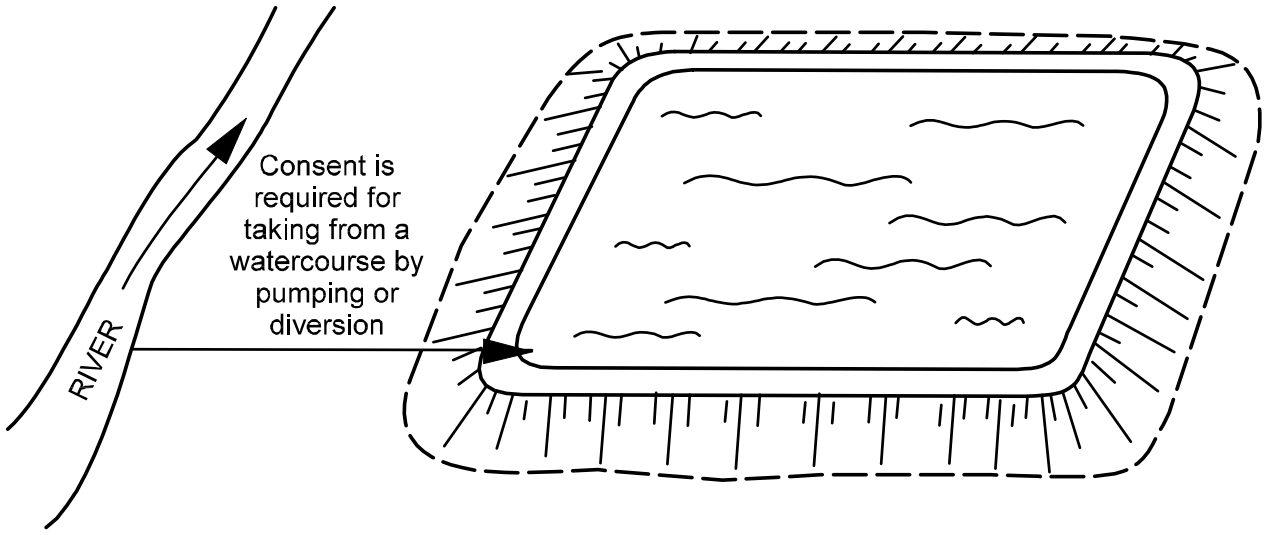
4.4 Dams Other Than Earth Dams

The construction of dams of materials other than earth are more common in permanent rivers (often with large catchments) where the purpose of the dam is to provide, or maintain, a pool or head of water for the operation of a pump or a gravity intake system; and water storage is typically not needed.

For example, dams supplying gravity-feed piped systems are often concrete structures, with the intake pipe embedded in the concrete base of the dam. Flood flows are designed to overtop these permanent structures. In contrast, "temporary" dams may be constructed of anything from gravel to sandbags to steel and wood and tend to be used in conjunction with irrigation intakes etc.

There are additional problems associated with the construction and maintenance of these dams in permanent streams, such as problems of impeding fish passage, and the effect of taking and using the water on downstream users. These dams typically require a water permit (to dam a river) unless permitted by a rule in a regional plan and, if the use of water is for irrigation, this activity must also be authorised.

Figure 2: Turkey's Nest or Ring Dam *(Note: no spillway required)*



5 CONSTRUCTION OF EARTH DAMS

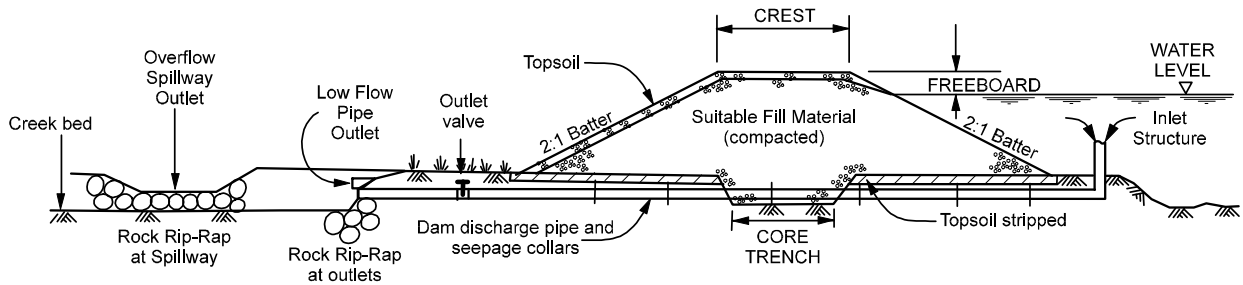
5.1 Site Preparation

(a) Both the borrow area and the complete base area of the dam shall be cleared of all vegetation, including trees, stumps and large roots and these shall be removed from the site. Turf and topsoil shall be removed from both the borrow area and the base of the dam.

5.2 Foundations

(a) Foundations shall consist of low permeability material such as clay and/or fine, silty soils. Any pockets of peat, seams of shingle or coarse sand or any other material which is not of low permeability that occur in the foundations shall be dug out and removed from the site. Dams may only be built on permeable foundations such as shingle or coarse sand, or directly onto rocks if consent has been obtained from the Council. Typically, such structures require supervision by a civil engineer.

Figure 3: Cross-section through Earth Dam *(Not to scale)*



5.3 Core Trench

(a) Foundations shall either extend down to low permeability material or be sufficiently deep that the length of the flow path under the dam is long enough to eliminate piping problems.

5.4 Inspection

(a) Consent holders may be required to notify the Council when excavation of the core trench is completed, thereby permitting inspection by an officer of the Council before filling operations commence.

5.5 Selection of Fill Material

(a) Material for the fill shall have a low coefficient of permeability. For example, a soil which is graded from coarse sand particles to clay particles and which contains no less than 20% by weight of fine particles, will normally be adequate.

(b) A soil which is made up of uniform sand particles, whether coarse or fine, shall not be used as fill material.

(c) A soil which is predominantly clay, shall not be used for the outside of the dam, but may be used in the core section of the dam.

(d) Topsoil, vegetation or coarse gravel shall not be used for fill under any circumstances.

5.6 Placement of Fill Material

(a) It is advantageous for the borrow pit to be located upstream of the embankment to provide increased storage capacity. If however, it is necessary for it to be outside the storage area, it should be reinstated with adequate topsoil once construction is completed. The borrow pit shall not be located immediately downstream of the dam.

(b) The fill shall be laid evenly in 150 millimetre layers and shall be compacted to achieve a minimum of 95% of optimum density.

(c) The fill material should be at a moisture content which permits the required compaction and construction shall not commence until satisfactory compaction can be achieved (and must cease if ground conditions preclude this).

(d) As a guide, the moisture content of the fill (particularly clay fill) shall be such that when it is kneaded in the hand it shall just form a ball that does not readily separate.

(e) Great care shall be taken to compact the fill by hand to its optimum density around any pipe passing through the dam.

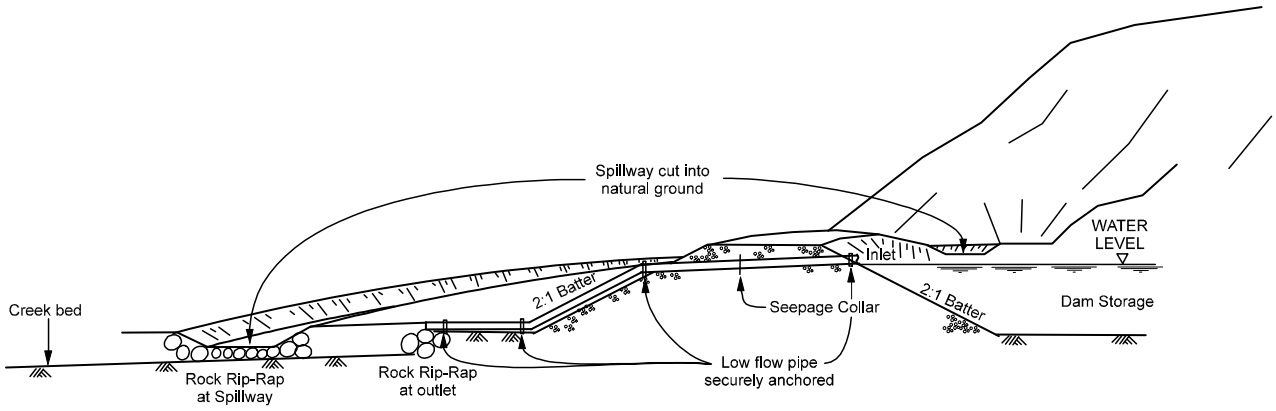
(f) Batters on both the upstream (water side) and downstream sides shall not be steeper than 2 (horizontal) to 1 (vertical). The minimum crest width of any dam shall be 3 metres.

(g) When the dam has been constructed to full height and final slope, sufficient topsoil to provide a good seed bed for grass shall be spread over the downstream face of the dam.

5.7 Overflow Spillway

(a) The spillway shall be cut through natural ground to one side of the dam and no part of it shall pass over the newly formed dam itself. The spillway discharge location shall be well clear of any fill material.

Figure 4: Overflow Spillway *(Not to scale)*



(b) The spillway width and depth shall be sufficient to allow the whole flow of the catchment to bypass the dam without it being topped in up to a 1-in-50 year flood. As a guide, spillways in catchments up to 50 hectares should have a base width of 3 metres and a minimum depth of 0.5 metres.

(c) Spillway side slopes shall be cut at 2:1 batters.

(d) Invert level of the spillway, along the dam centre line, shall be below the constructed height of the dam crest by a minimum of 0.8 metre.

(e) Downstream of the dam centre line, the spillway shall be contoured down the hillside at a non-scouring gradient to meet the valley floor downstream of the dam. The surface of this overflow spillway shall be carefully graded and sloped then dressed with 0.10 metre of topsoil prior to topdressing and sowing with an accepted mixture of fertiliser and grass seed. The surface of the spillway may be protected until a strong growth of grass has been achieved by a layer of hay held down by wire mesh, or other accepted method.

(f) A vegetative cover, or other protective measure, capable of resisting erosion (while not reducing the spillway's discharge capacity) shall be maintained as long as the dam remains in existence.

(g) Where it is not possible to achieve the non-scouring gradient (less than 5% or 1:20) required for grassed spillways, alternative solutions such as drop structures, concrete or stone protected spillways shall be required.

5.8 Low Flow Pipe

(a) Where a grassed spillway or similar is likely to discharge for long periods of time (more than four consecutive days) a low flow pipe, capable of carrying the long term discharge, shall be installed.

(b) Where installed, the low flow pipe sets the upper limit to normal water level in the dam and shall not be less than 0.30 metres below the intake level of the overflow spillway.

(c) The slope of the low flow pipe, from pipe entrance to pipe exit through the dam crest, shall be not steeper than 10%. A seepage collar, of minimum dimensions 1 metre x 1 metre x 0.1 metre thick, shall surround the pipe at its halfway point to limit flow around the outside of the pipe.

(d) Backfill around the low flow pipe and the seepage collar shall be in layers not greater than 0.100 metres thick, and thoroughly rammed into place around the pipe to a depth of 0.600 metres (over the crown and over the top of the seepage collar) before any machinery passes over the pipe. It cannot be overemphasised how critical thorough compaction is around this and the dam discharge pipe (see below).

(e) The low flow pipe shall discharge directly to the channel downstream of the dam and an anti-scour apron of rock riprap or similar shall be provided at its outlet.

5.9 Dam Discharge Pipe

(a) If a dam discharge pipe is to be installed, seepage collars of permanent material, and minimum dimensions 1 metre x 1 metre x 0.1 metre thick, shall be placed along it at intervals of not more than 9 metres.

(b) Backfill around the dam discharge pipe and seepage collars shall be as described above for the low flow pipe.

(c) The outlet of this pipe shall be anchored and an anti-scour apron of rock riprap or similar shall be provided for at its outlet.

6 Dam Maintenance and Removal

The owner or occupier of any land on which a dam is located is required to maintain that dam and its associated structures such as spillways in a good state of repair. If the owner or occupier fails to maintain a dam or spillway etc, the Council may require that person to repair or alter or remove the dam. Upon receipt of a notice requiring such work, the owner has 14 days to appeal to the Council in writing for modification or withdrawal of the notice.

7 MISCELLANEOUS

7.1 Algal Growth

A common problem, especially during summer is phytoplankton (algal) growth in dams. Copper sulphate and more recently copper oxychloride have been used in the District to control this nuisance, but currently this practice requires a resource consent.

An alternative, more environmentally friendly option, is the use of barley straw bales at the rate of 10 grams of straw per cubic metre, or two to three bales per hectare of water, with an average depth of 1 metre (ie, two to three bales per 10,000 cubic metres of storage).

The rotting barley straw bales are thought to produce one or more algicidal or algistatic chemicals and take about one month to begin working, with action tapering off after six months.

7.2 Alternative Storage Linings

Off-stream water storage structures such as "turkey nest dams" are increasingly being considered adjacent to Moutere streams, as summer surface and groundwater resources become fully allocated and no new permits are available. An alternative to the use of clay to seal off-stream structures is the use of polyethylene membranes which, to date, have been prohibitively expensive and only used for sewerage (pond) schemes.

Membranes are about 330 microns thick, available New Zealand-made and a 10 year warranty against UV breakdown is available. Ponds are constructed with maximum batter slopes of 2 (horizontal): 1 (vertical) and an advantage is that, like the "turkey nest", excavated material is used to construct the surrounding retaining walls. Another liner is butyl rubber.

7.3 Tall Vegetation on Dams

Do not allow the establishment of trees on the wall of any water storing structure. As the tree grows its roots go looking for water but they die when they find it, the root rots and the potential for piping of water and dam failure then follows. Shallow rooting shrubs may be used on the dam wall and some of these can be particularly useful to control wave-lap erosion of the dam crest. A recommended native is toe-toe (*Cortaderia richardii*) and another plant is reed canary grass (*Phalaris aquatica*). If the dam is to pond a permanent water body, in contrast to a seasonally depleted irrigation dam, there is a greater variety of suitable plants, including the native flaxes. Otherwise, keep the wall grassed and mown and any problems can be readily spotted and repaired.

7.4 Annual Charges

Where a current water permit (dam) is required under Council rules then these are subject to annual charges (Section 36 of the RMA). The charges are set by Council in the Annual Plan. Any additional permits held by the grantee may also be subject to annual charges but a multiple (consent) discount may apply.

8 GLOSSARY OF TERMS

In this guideline, unless the context otherwise requires:

Council means the Tasman District Council.

Engineer means a suitably qualified, experienced and competent registered chartered (civil) engineer, acceptable to and approved of by the Council.

Dam means any structure in a river/watercourse or lake that raises the level of water above that which would otherwise occur. Any measurement of the height of a dam is from the dam crest to the natural ground level along the dam centre line. A flood bank or channel training work is not included in the definition of a dam.

Dam Discharge Pipe is the pipe through the base of the dam used for dam discharge and/or water supply purposes.

District means the Tasman District.

Ephemeral or Intermittent means short-lived, and it is used to describe streams that flow following rain events and, in Nelson, during winter months, but always cease to flow during summer months.

Local Authority is defined by the Resource Management Act 1991.

Notice means a notice made and delivered in accordance with the Resource Management Act 1991.

Occupier means the inhabitant occupier of any land and, if there is no such person, then "occupier" means the owner of the land, except where any person other than the owner has a right to occupy the land by virtue of a lease, licence, tenancy or other authority, in which case "occupier" means that other person.

Permit means a consent in writing, with or without terms, conditions, or restrictions and includes an authorisation.

Person includes a corporation sole and also a body of person whether corporate or unincorporated.

Piping in this text means water movement along the "canal" left when tree roots rot, ie, through the compacted clay embankment, which will erode the clay embankment and can potentially lead to embankment failure.

Site-Specific Problems are those conditions, circumstances or features of a particular site that prevent compliance with the Council's requirements and specifications for the construction and maintenance of earth dams as detailed in Section 5 of this guideline.

Water Permit means any consent in respect of natural water granted or authorised by or under the Resource Management Act 1991.

8.1 Measurement of "Height"

In this guideline, reference to the height of a dam shall be the maximum height for dam crest to the natural ground level as measured along the dam centre line.

9 CONSTRUCTION CONSENT CONDITIONS

9.1 This consent shall be valid for a period of one year from the date of issue and shall expire after that period unless the holder of this consent has substantially exercised the consent.

9.2 This consent is transferable only to another owner or occupier of this site.

9.3 The holder of this consent shall not make or cause to be made any departure from the particulars of the approved plans and specifications without first submitting revised documents detailing any such departure and obtaining the Council's consent to the same.

9.4 The holder of this consent shall advise the Council of the commencement of the works, at completion of core trench excavation and of the completion of the works as soon as is practicable after such commencement or completion.

9.5 This consent may be revoked where any condition of this consent is not complied with.

9.6 The dam and spillway ancillary works shall be constructed to the satisfaction of Council and as a minimum the spillway shall be capable of bypassing a flow of "x" cubic metres without scouring.

9.7 The holder of this consent shall maintain the dam and associated works in good working order.