BUILDING PERFORMANCE

Measuring and calculating the height and volume of agricultural dams

RESOURCE FOR DAM OWNERS

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
New Zealand Government

Ministry of Business, Innovation and Employment (MBIE)
Hīkina Whakatutuki – Lifting to make successful

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Version 2
Effective from March 2024

ISBN 978-1-99-102265-3 (online)

More information
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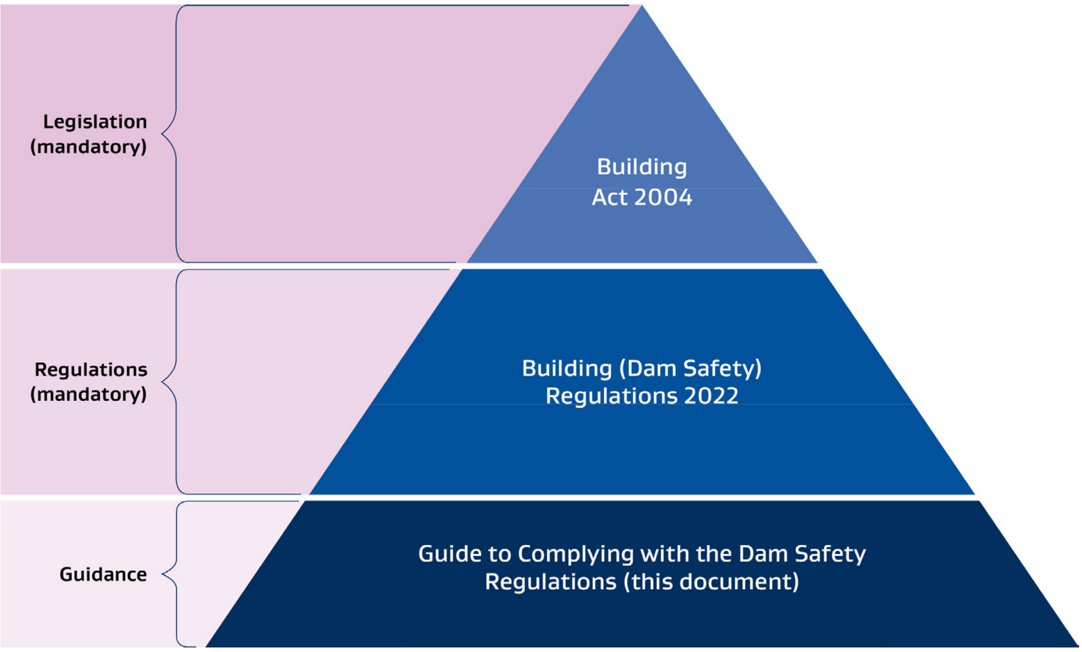
Preface

This guidance has been issued by MBIE's Building System Performance branch.

Figure 1 below illustrates where this guidance document sits within the building regulatory system.

Figure 1



Document status

This guidance is version 2 of MBIE's Measuring and calculating the height and volume of agricultural dams, and takes effect from March 2024.

Document history		
Status	**Commencement date**	**Alterations**
Version 1	July 2022	–
Version 2	March 2024	Minor content changes were made to reflect a change in the definition of a 'classifiable dam', as per regulation five of the Dam Safety Regulations.

Assumptions

The method used to calculate the height and stored volume[1] of a dam will depend on the resources available to the dam owner, and the type and geometrical properties of the dam.

The following assumptions have been made in the development of this resource:

- The reservoir shapes covered in this resource are simple geometric shapes which closely resemble a square/rectangular surface or a circular shape reservoir.
- The internal dam walls are constructed with consistent batters[2] that fall between 1:2 and 1:4. The three lookup tables in Step 3 of this resource have been developed and are suitable for a dam with a batter of 1:3 (ie the slope has a vertical rise of one metre for every three metres horizontal).
- The base of the dam and reservoir are generally level.
- The crest[3] is level around the perimeter of the dam, and the maximum water level that can be achieved before overtopping is limited by the crest height.

Disclaimer

This resource will be used and tested by those in the dam industry. Feedback received from the industry will be considered in future updates to this resource.

The information in this resource is intended to be used solely as an approximate method to calculate the height and volume of regular shaped dams and reservoirs.

This resource sets out a process to provide an initial estimate of dam dimensions. As it assumes some reasonably simple geometric forms and uniformity in construction, the actual volumes will likely have a margin of error where dams depart from those basic shapes and the assumptions about batters.

If a dam owner requires more accurate calculations and seeks to determine the exact height and volume of a dam and reservoir, especially for complex shapes, or if they are unable to use the methods outlined in this resource, then it is recommended that they seek advice from a technical practitioner[4].

1 See the glossary for a definition of stored volume.
2 See the glossary for a definition of batter.
3 See the glossary for a definition of crest.
4 See the glossary for a definition of technical practitioner.

Contents

Purpose

The purpose of this resource is to help the owners of agricultural dams (such as those used for farming reservoirs and irrigation canals) determine whether their dam meets the height and volume threshold to be a classifiable dam. Only owners of classifiable dams are impacted by the Building (Dam Safety) Regulations 2022 (the regulations). This resource provides information on estimating the heights of dams and the volumes of water they retain where these quantities are unknown.

Overview

On 12 May 2022, regulations were made and set the minimum regulatory requirements for dam safety in Aotearoa New Zealand. Only owners of classifiable dams are impacted by the regulations.

On 13 May 2024, the regulations commence which gives dam owners two years to prepare for their dam safety responsibilities.

Owners of classifiable dams, who have limited or no dam safety procedures in place, will need to become familiar with their responsibilities under the Building Act 2004, the regulations, and what actions they must take, and by when.

Many dams in Aotearoa New Zealand have been well engineered and adequate information will be available on their dimensions and volumes. However, some agricultural dams may not have sufficient information on hand.

The purpose of this resource is to help the owners of agricultural dams determine whether they have a classifiable dam and are therefore impacted by the regulations. This resource focuses particularly on the size range and typical shapes that will be found on farms and growing operations used for irrigation, stock or other water uses.

This resource will help you estimate the:

1. **Height** of your dam
2. **Surface area** of the reservoir, in order to determine the
3. **Stored volume** of the dam

Once the height and stored volume of the dam are known, you can then determine if the regulations apply to you, what your next steps are, and whether you need to engage a technical practitioner to obtain more precise measurements of your dam and to support you with your responsibilities as per the regulations.

A glossary of key terms has been provided and is located towards the end of this resource.

What is a dam?

The Building Act 2004 (the Building Act) provides a definition of a dam. If your water retention structure meets the Building Act's definition of a dam, then the next step is to understand whether it is a classifiable dam.

What the law says:
The Building Act, section 7, defines a **dam** as:

(a) an artificial barrier, and its appurtenant structures, that –
  (i) is constructed to hold back water or other fluid under constant pressure so as to form a reservoir; and
  (ii) is used for the storage, control, or diversion of water or other fluid; and
(b) includes –
  (i) a flood control dam; and
  (ii) a natural feature that has been significantly modified to function as a dam; and
  (iii) a canal; but
(c) does not include a stopbank designed to control floodwaters.

What is a classifiable dam?

If your water retention structure meets the Building Act's definition of a dam, then the next step is to understand whether it is a classifiable dam. If your dam meets the definition below, then it is a classifiable dam.

What the law says:
Regulation five of the regulations defines a **classifiable dam** as one which has:

- A height of four or more metres and stores 20,000 or more cubic metres volume of water, or other fluid.

Methods to determine the height and stored volume of a dam

The methods outlined below provide dam owners with some options for how to determine the height and stored volume of their dam. The method used will depend on the resources available to the dam owner, and the type and geometrical properties of the dam.

This resource will focus on the *manual calculation* method.

- **Reservoir as-built information:** This should be the first port of call for dam height and stored volume information but may not be available for some smaller or older dams. This method uses construction drawings and/or an engineering design report if available. You may need the assistance of a surveyor or engineer to interpret engineering drawings or design reports. When using this method where a dam has a spillway, the reservoir as-built will likely include information about the storage volume at full supply level. This will be less than the theoretical maximum storage volume at the dam crest because the height of the dam above the dam spillway is generally not included in storage calculations for design purposes. The regulations require dam owners to measure from specific parts of the dam. Dam owners will need to include the water stored between the spillway level and the dam crest in their calculations. Assuming the as-built drawings are accurate, this source of information is likely to be close to 100 per cent accurate and will be of great use when determining whether the dam meets the height and volume thresholds to be defined as a classifiable dam.
- **Rough estimate:** Stored volume can be estimated using a formula based on the dam height and surface area. The reservoir's surface area can be scaled using a geographic browser (such as Google Earth) or from site measurements. This method could have as much as a 50 per cent error in volume estimation especially where the dam's height is uncertain. If this method results in an estimate close to the classifiable dam threshold, you should consider using the *manual calculation* method below. This process is referenced in the Ministry of Business, Innovation and Employment (MBIE) **Guide to complying with the Dam Safety Regulations.**

- **Manual calculation:** Because dams can be in a number of different shapes, this option is not always accurate. However, for typical small rural dams it is at least a starting point for determining the volume. This method uses the height of water stored above the natural ground level as opposed to the total depth of the dam. When using this method where a dam has a spillway, dam owners will not need to include the water stored between the spillway level and the dam crest in their calculations. This is because an allowance has already been made for the water stored between the spillway level and the dam crest. The stored volume captured in this method aligns with the definitions and requirements in the regulations and relies on the ratio between the surface area and the volume. There is a 10-20 per cent margin of uncertainty with this method, meaning it is more accurate than the *rough estimate* method mentioned above.

- **Topographic survey:** This is a method that can be used when the dam's reservoir is empty. It must be carried out by a surveyor using an appropriate topographic survey method (eg roving GPS[5] unit or UAV[6] aerial survey).

5 Global Positioning System.
6 Unmanned Aerial Vehicle.

- **Hydrographic survey:** This method would need to be carried out by a specialist surveyor using an appropriate method (eg single or multi-beam echo sounder). The topographic survey and the hydrographic survey are likely to be highly accurate but involve complex surveying processes and the expense of engaging the necessary expertise.

The following sections of this resource will focus on using the *manual calculation* method to determine the approximate height and stored volume of a dam. This method involves three steps:

1. **Measure the height of the dam**
2. **Measure the surface area of the reservoir**
3. **Calculate the stored volume of the dam**

Step 1:
Measure the height of the dam

To understand whether a dam is a classifiable dam, the first step is to measure the height of the dam. This can be a straightforward process if construction drawings, or a record of a building consent or resource consent are available. However, if these are not available, then on-site measurements of two key parameters of the dam will need to be taken. How easy it is to capture these measurements will depend on the type, shape, and accessibility of the dam.

Tools

If you wish to obtain the height of your dam on-site without the support of a technical practitioner, then you will need the following measuring tools:

Must have **both**:

- a tape measure; and
- a straight, two to three metre length of timber.

And **one of the following**:

- spirit level; or
- simple plumb bob.[7]

And **one of the following**:

- clinometer; or
- clinometer app on your cell phone; or
- a protractor.

7 See the glossary for a definition of plumb bob.

Method for measuring height

The height of a dam is the vertical distance from the crest[8] of the dam to a point which is set out in the Building Act. For example, exactly where you need to take measurements from to determine the height of a dam for a dam not across a stream, is from the lowest elevation at the outside limit of the dam. Figure two below illustrates where to take measurements from to determine the height of a dam.

What the law says:

The Building Act, section 133B, sets out how to measure the height of a dam.

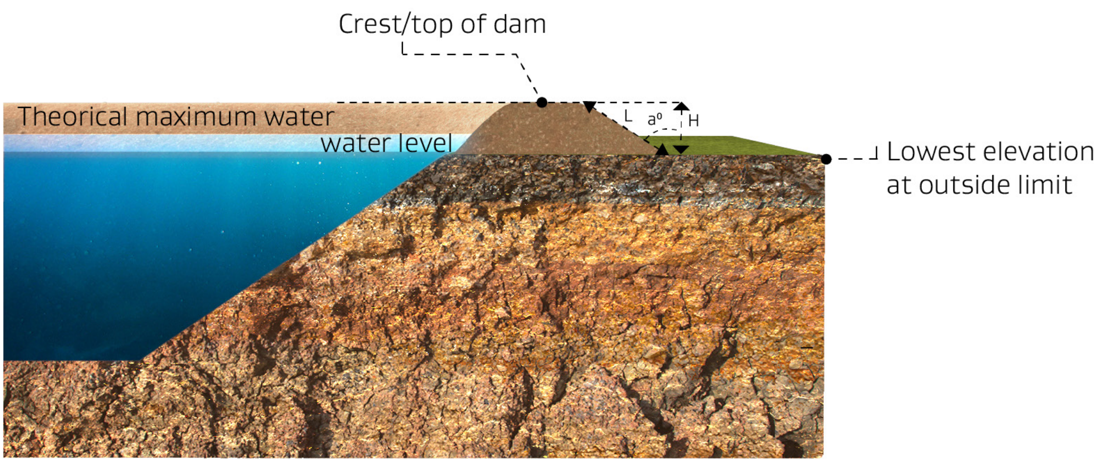
The height of a dam is the vertical distance from the crest of the dam, and must be measured:

a) in the case of a dam across a stream, from the natural bed of the stream at the lowest downstream outside limit of the dam; and

b) in the case of a dam not across a stream, from the lowest elevation at the outside limit of the dam; and

c) in the case of a canal, from the invert of the canal.

Figure 2: Diagram of a dam which illustrates what measurement must be taken and from where, in order to determine the height of a dam.



Key:

Symbol	Stands for	Remark
L	Length of the downstream face of the dam (in metres)	To be measured on-site
aº	Angle of slope (in degrees)	To be measured on-site
H	Height (in metres)	To be calculated using the on-site measurements of L and aº

8 See the glossary for a definition of crest.

Step 1a – measure the length (L) of the downstream face of the dam

Using a tape measure, measure the length (L) of the downstream face of the dam from the highest point on the dam wall (the crest) to the lowest elevation at outside limit.

Step 1b – determine the angle (aº) of the slope

- **Set foundation to measure from** – lay the two to three metre length of timber on the downstream face of the wall (the slope) in a position that best represents the slope.
- **Set vertical plumb line/reference line** – stand your spirit level upright/vertically or set up the plumb bob[9] at the lower end of the piece of timber. This will give you the vertical plumb line to measure the angle against.
- **Measuring the angle of slope** – using a clinometer, a clinometer app on your phone, or a protractor, set your chosen tool down on the length of timber and up against the spirit level or plumb bob. You should now be able to determine the angle of the dam's slope compared to the vertical plumb line.

Step 1c – determine cosine (Cos)

Using the measured angle from step 1b above, you can determine cosine by using Table 2: Lookup table of cosine values for each angle (aº) below.

Table 2: Lookup table of cosine values for each angle (aº)

Angle	Cosine	Angle	Cosine	Angle	Cosine	Angle	Cosine	Angle	Cosine
20	0.940	30	0.866	40	0.766	50	0.643	60	0.500
21	0.934	31	0.857	41	0.755	51	0.629	61	0.485
22	0.927	32	0.848	42	0.743	52	0.616	62	0.469
23	0.921	33	0.839	43	0.731	53	0.602	63	0.454
24	0.914	34	0.829	44	0.719	54	0.588	64	0.438
25	0.906	35	0.819	45	0.707	55	0.574	65	0.423
26	0.899	36	0.809	46	0.695	56	0.559	66	0.407
27	0.891	37	0.799	47	0.682	57	0.545	67	0.391
28	0.883	38	0.788	48	0.669	58	0.530	68	0.375
29	0.875	39	0.777	49	0.656	59	0.515	69	0.358

9 See the glossary for a definition of plumb bob.

Step 1d – calculate the height of the dam

You should now have the following measurements:

- Length (L) of the downstream face of the dam in metres.
- Angle (aº) of the slope in degrees.

To calculate the height (H) of the dam, multiply the length (L) by the cosine of the angle of the slope (aº) as per the following formula:

- H = cosine (aº) x length of the downstream face.

EXAMPLE – CALCULATE THE HEIGHT OF THE DAM

Stuart is a farmer in Canterbury and has a rectangular dam which he uses for irrigation. Stuart wants to know the height of his dam, but unfortunately, he doesn't have any documentation which tells him this. Stuart completes the following steps to determine his dam's height:

1. *Stuart uses a measuring tape to measure the length of the downstream face of his dam. This comes to* ***10 metres****.*
2. *Stuart lays some timber on the downstream face of the dam's wall, stands up his spirit level on the timber, puts his clinometer on the timber next to the spirit level, and determines that the angle of the slope is* ***60 degrees****.*
3. *Stuart uses Table 2: Lookup table of cosine values for each angle (aº), finds the angle of 60 degrees, and this gives him a* ***cosine angle of 0.500****.*
4. *Using the formula for height (H = cosine (aº) x length of the downstream face), Stuart multiplies 0.500 (cosine for 60 degrees), by the length of the downstream face, which in his case is 10 metres. The result indicates that the approximate* ***height of Stu's dam is 5 metres****. This height measurement is the height of the water held back behind the dam that is above ground level.*

Symbol	*Stands for*	*Stu's dam*
L	*Length of downstream face of the dam*	*10 metres*
aº	*Angle of slope*	*60 degrees*
Cos	*Cosine*	*0.500*
H	*Height*	*5 metres*

Stuart records the height of his dam (5 metres), as it he'll need it for later to determine the volume of his dam.

Step 2:
Measure the surface area of the dam's reservoir

The next step is to determine the surface area of the dam's reservoir.

Tools

If you wish to obtain the surface area of your dam's reservoir without the support of a technical practitioner, then you need to have one of the following measuring tools:

- a map to scale, for instance an online aerial map such as Google Earth[10], or farm map, or
- measuring wheel (also known as a surveyors wheel), or
- long tape measure or string measurement tool.

Methods for measuring surface area

There are various ways you can determine the surface area of your dam's reservoir.

Aerial image method or using farm map

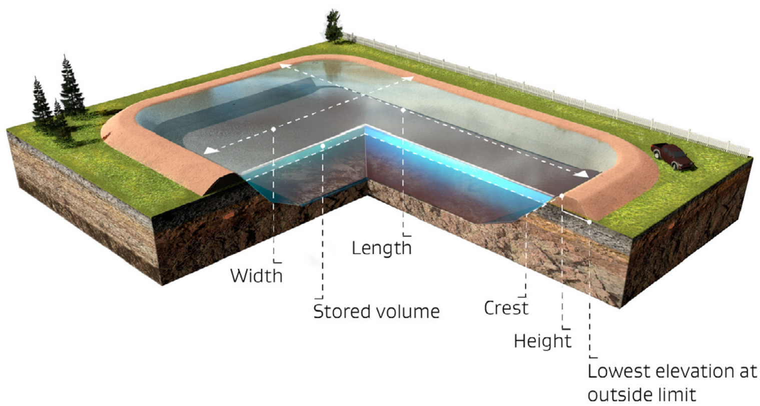
You can locate your dam on Google Earth or other online mapping software and draw around the perimeter of the reservoir using the 'measure distance and area' function. The outcome is the surface area of your dam's reservoir.

Physical measurement method

Square or rectangular shaped dam

This is an embankment dam which is typically rectangular or square and has dam fill around its perimeter. This type of dam may also be referred to as a turkey's nest, ring dam, or offstream storage.

Figure 3: The typical cross-section of a rectangular dam with key features labelled.



10 Check your local council's website, as some have maps available.

The measurements you need to capture are:

- width; and
- length.

These measurements can be obtained by physically visiting the dam, or by referring to your farm map (if it has a scale).

For a square/rectangular dam you can directly measure both sides of the dam in metres (m) and multiply these to calculate the surface area in metres squared (m^2).

EXAMPLE CONTINUED – STUART'S DAM

Stuart is a farmer in Canterbury and has a rectangular dam which he uses for irrigation.

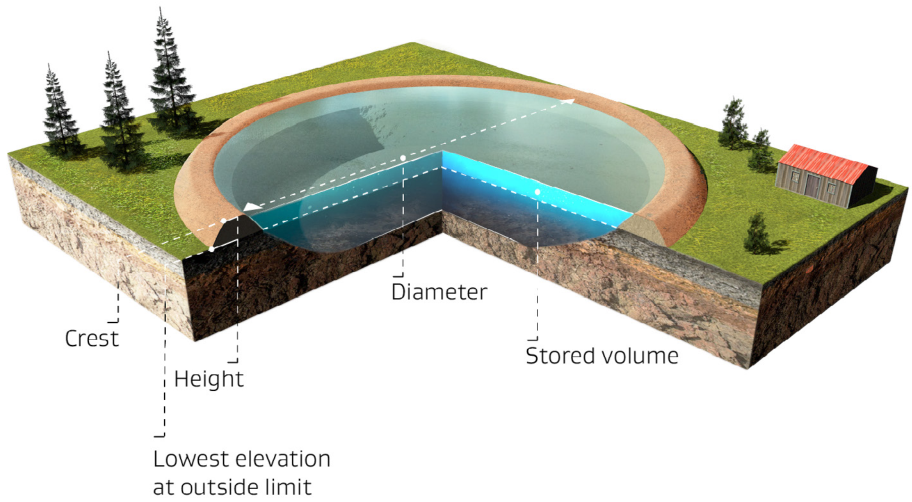
Using Google Earth on his laptop, Stuart locates his dam and uses the 'measure distance and area' function to trace around the perimeter of his dam. This generates a surface area of approximately 7,500m^2.

Stuart wants to double check this, so he gathers his measuring wheel, goes out on the farm to his dam, and measures its width and length. Stu's dam has a width of 75m and a length of 100 metres. He multiples 75 by 100, which gives him a surface area of 7,500m^2. This number aligns with what Google Earth generated.

Circular shaped dam

This is a typical embankment dam in a circular shape, which has dam fill around its perimeter.

Figure 4: The typical cross-section of a circular dam with key features labelled.



To determine the surface area you need to know the diameter, which can be obtained by:

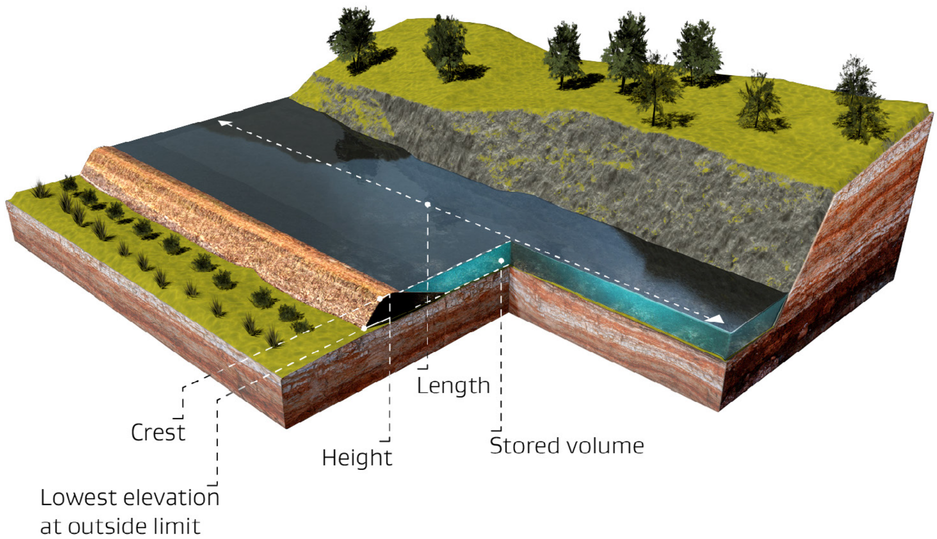
- taking physical measurements at the dam,
- farm map (if it has a scale), or
- online mapping tools.

Once the diameter is known, you can use the lookup table in Step 3 to find the surface area and stored volume of the dam.

Dam(s) within a canal

The diagram below illustrates a sidling canal dam within a canal system. The dam is cut on one side, and is dam fill on the other.

Figure 5: The typical cross-section of a canal dam with key features labelled.



To determine the surface area you need to know the length of the canal, which can be obtained by:

- taking physical measurements at the dam,
- farm map (if it has a scale), or
- online mapping tools.

For a canal dam, you will need to measure the length along the centre line of the canal route to account for any bends and curves.

You should measure between adjacent weirs[11] or drop structures and treat each section as a separate dam, rather than measuring the entire length of the canal.

If a stretch of canal is fully excavated below ground level between adjacent drop structures, then the regulations do not consider this to be a dam within a canal because the water is not stored above natural ground level. An overall canal network may be made up of a combination of sections, with some below and others above ground level.

Once the length of the canal is known, you can use the lookup table in Step 3 to find the approximate stored volume of the dam. You do not need to measure the width of the canal as this is factored into the lookup table in Step 3.

What the law says:

The Building Act, section 134BA, sets out Classification of dams that are canals

- A dam that is a canal that must be classified under section 134B may have different classifications for different sections of the canal and in that case each of those sections must be treated as a separate dam for the purposes of sections 134 to 139.

11 See the glossary for a definition of weir and drop structure.

Step 3:
Calculate the stored volume of the dam

Only water or other fluid which is held above ground level is considered to be stored water. This is because water stored below ground level is not being held back by the dam and won't be released if the dam was to fail. The diagrams in step 2 illustrate this.

What the law says:

Regulation seven of the regulations sets out what the stored volume of water or other fluid does not include. In measuring a dam's stored volume for the purposes of regulation five of the regulations, the stored volume of water or other fluid does not include:

a) in the case of a dam across a stream, water or fluid that is lower than the natural ground level at the lowest downstream outside limit of the dam;

b) in the case of a dam not across a stream, water or fluid that is lower than the natural ground level at the lowest elevation at the outside limit of the dam; or

c) in the case of a canal where the canal invert is below the natural ground level, water or fluid that is lower than the natural ground level at the lowest elevation at the outside limit of the canal structure.

Tools

The method you select will determine which tools you will require to calculate the stored volume of your dam.

Method for calculating volume

If you have a rectangular, square dam, or canal dam, then you should have obtained height and surface area measurements using information in steps 1 and 2 of this resource.

If you have a circular dam, then you should have obtained height and diameter measurements using information in steps 1 and 2 of this resource.

The lookup tables in step 3 of this resource will enable you to use an estimate of the height of the water relative to the lowest elevation outside limit (height of your dam), plus surface area or diameter of your dam, to get a rough estimate of your dam's stored volume.

You do not need to know the overall internal depth of the water as the regulations are not concerned with water held below ground level.

ASSUMPTION

The *manual calculation* method focussed on in this resource makes an assumption about the typical batter or slope of the external embankment face[12] that has been used in the construction of an earth dam. This batter range is often between 1:2 and 1:4 to create a stable wall. The difference in volume has been determined to be minimal for the purposes of these calculations across this batter range; the tables have therefore been developed using a batter of 1:3.

Method

Your dam's shape will determine which lookup table you need to use. The lookup tables are colour coded to give you an indication about whether your dam is classifiable or not based on the measurements available to you.

Square or rectangular shaped dam

Using the height and surface area measurements for your dam, refer to Table 3: Lookup table for square or rectangular dam. Find the range in which your dam height and surface area measurements are located. You can estimate between the measured values and between the table values to get the stored volume of your dam.

The top row of Table 3 gives examples of square dams with equal sides to calculate surface area. However for rectangular dams with different widths versus lengths, you may wish to use the surface area calculation and go straight to the nearest surface area in the second row of numbers (which start at 5000m^2).

12 A "batter", a term typically used in the construction of embankments has an equivalent angle as used in trigonometry calculations; a batter of 1:3 is equivalent of an angle of 18o from horizontal or 72o from vertical.

Table 3: Lookup table for a square or rectangular dam

Square dam with sides of equal length (m)	70	75	80	85	100	125	150	175	205	225	250	300
Surface area (m²)	5,000	6,000	6,500	7,000	10,000	16,000	23,000	31,000	42,000	51,000	63,000	90,000
Height (m) 10	19,000	23,000	28,000	33,000	52,000	93,000	147,000	213,000	309,000	383,000	487,000	732,000
9	19,000	23,000	27,000	32,000	50,000	89,000	138,000	199,000	287,000	355,000	450,000	673,000
8	18,000	22,000	27,000	31,000	48,000	83,000	129,000	184,000	264,000	325,000	410,000	611,000
7	18,000	21,000	25,000	30,000	45,000	77,000	118,000	167,000	238,000	292,000	368,000	546,000
6	17,000	20,000	24,000	28,000	41,000	69,000	105,000	149,000	210,000	258,000	324,000	478,000
5	16,000	18,000	22,000	25,000	37,000	61,000	92,000	128,000	181,000	221,000	277,000	407,000
4	14,000	16,000	19,000	22,000	31,000	51,000	76,000	106,000	149,000	182,000	227,000	332,000
3	11,000	13,000	15,000	17,000	25,000	40,000	60,000	83,000	115,000	140,000	174,000	254,000
2	8,000	10,000	11,000	13,000	18,000	28,000	41,000	57,000	79,000	96,000	119,000	173,000
1	4,000	5,000	6,000	7,000	9,000	15,000	22,000	30,000	41,000	49,000	61,000	88,000
075	3,000	4,000	5,000	5,000	7,000	11,000	16,000	22,000	31,000	37,000	46,000	66,000
0.5	2,000	3,000	3,000	3,000	5,000	8,000	11,000	15,000	21,000	25,000	31,000	45,000

Key:

Colour code or feature	Is it a classifiable dam?	Threshold
Orange	Classifiable dam	Over four metres in height, and 20,000 cubic metres in stored volume
Blue	Not a classifiable dam	N/A
	Features to help readers follow the examples below.	

EXAMPLE CONTINUED – CALCULATE THE VOLUME OF A DAM

Stuart has determined that his rectangular dam (75m x 100m) is 5 metres in height and has a ***surface area of 7,500m²****.*

Using Table 3, Stuart locates the height of his dam. Stuart then uses row two in the table (surface area) and locates the surface area nearest to that of his dam's. In Stu's case this is ***7,000m²****.*

Using the height and surface area of his dam and the lookup table, Stuart can determine that his dam has an approximate volume of ***25,000 cubic metres (m³)****. This volume falls in the* ***orange*** *part of the table meaning Stu's dam is above the threshold of 4m in height and 20,000m³ so is considered classifiable.*

EXAMPLE TWO – DAM WHICH IS NOT BIG ENOUGH TO BE A CLASSIFIABLE DAM

Francine has a square dam which has a ***height of 3 metres*** *and is* ***70 metres*** *in both length and width.*

Using Table 3, Francine locates the height of her dam. Francine then uses the top row in the table (sides of equal length / m x m) and locates 70 metres. Francine can now determine that her dam has an approximate volume of ***11,000 cubic metres (m³)****. This volume falls in the* ***blue*** *part of the table, meaning Francine's dam is below the threshold to be a classifiable dam.*

Circular shaped dam

Using the height and diameter measurements for your dam, refer to Table 4: Lookup table for a circular dam. Find the range in which your dam height and diameter measurements are located. You can estimate between the measured values and between the table values to get the stored volume of your dam.

Table 4: Lookup table for a circular dam

Diameter (m)	**70**	**80**	**90**	**100**	**110**	**120**	**140**	**160**	**180**	**200**	**220**	**240**
Surface area (m^2)	**3,800**	**5,000**	**6,400**	**7,900**	**9,500**	**11,300**	**15,400**	**20,100**	**25,400**	**31,400**	**38,000**	**45,200**
Height (m) 8	14,500	20,900	28,600	37,500	47,700	59,100	85,800	117,400	154,100	195,800	242,600	294,400
7	14,000	19,900	27,000	35,100	44,400	54,700	78,700	107,000	139,800	177,000	218,500	264,500
6	13,300	18,600	24,900	32,200	40,400	49,500	70,600	95,500	124,200	156,600	192,800	232,800
5	12,200	16,900	22,400	28,700	35,700	43,600	61,700	82,900	107,200	134,700	165,300	199,100
4	10,700	14,700	19,300	24,500	30,300	36,800	51,600	69,000	88,800	111,200	136,100	163,500
3	8,800	11,900	15,500	19,600	24,100	29,100	40,500	53,800	69,000	86,000	105,000	125,800
2	6,500	8,600	11,100	13,900	17,000	20,400	28,200	37,300	47,600	59,100	72,000	86,000
1	3,500	4,700	5,900	7,400	9,000	10,800	14,700	19,400	24,600	30,500	37,000	44,100
075	2,700	3,600	4,500	5,600	6,800	8,200	11,200	14,700	18,600	23,000	27,900	33,300
0.5	1,800	2,400	3,100	3,800	4,600	5,500	7,500	9,900	12,500	15,500	18,700	22,300

Key:

Colour code or feature	**Is it a classifiable dam?**	**Threshold**
Orange	Classifiable dam	Over four metres in height, and 20,000 cubic metres in stored volume
Blue	Not a classifiable dam	N/A
	Features to help readers follow the examples below.	

EXAMPLE

Samantha has a circular dam which has a ***height of 5 metres*** *and a* ***diameter of 90 metres****.*

Using Table 4, Samantha locates the height of her dam. Samantha then uses the top row in the table (diameter) and finds the column for 90 metres. Samantha can now determine that her dam has an approximate volume of ***22,400 cubic metres (m^3)****. This volume falls in the* ***orange*** *part of the table meaning Samantha's dam is above the threshold of 4m in height and 20,000m^3 so is considered classifiable.*

Dam(s) within a canal

Using the height and length measurements for your canal, refer to Table 5: Lookup table for dam(s) within a canal.

Table 5 below uses the canal's height multiplied by the length to show volume in relation to the thresholds in the regulations.

Table 5: Lookup table for dam(s) within a canal

Height (m)	Length (m) (distance between adjacent weir/drop structures)											
	100	**200**	**250**	**300**	**400**	**500**	**1,000**	**1,500**	**2,000**	**5,000**	**10,000**	**12,500**
6	8,400	16,800	21,000	25,200	33,600	42,000	84,000	126,000	168,000	420,000	840,000	105,0000
5	6,000	12,000	15,000	18,000	24,000	30,000	60,000	90,000	120,000	300,000	600,000	750,000
4	4,000	8,000	10,000	12,000	16,000	20,000	40,000	60,000	80,000	200,000	400,000	500,000
3	2,400	4,800	6,000	7,200	9,600	12,000	24,000	36,000	48,000	120,000	240,000	300,000
2	1,200	2,400	3,000	3,600	4,800	6,000	12,000	18,000	24,000	60,000	120,000	150,000
1	400	800	1,000	1,200	1,600	2,000	4,000	6,000	8,000	20,000	40,000	50,000

Key:

Colour code or feature	Is it a classifiable dam?	Threshold
Orange	Classifiable dam	Over four metres in height, and 20,000 cubic metres in stored volume
Blue	Not a classifiable dam	N/A
	Features to help readers follow the examples below.	

EXAMPLE

Sarah has a canal dam which has a ***height of 2 metres*** *and a* ***length of 5,000 metres****. Using Table 5, Sarah locates the height and length of her dam. Sarah can now determine that her dam has an approximate volume of* ***60,000 cubic metres (m^3)****. This volume falls in the* ***blue*** *part of the table meaning Sarah's dam is not considered classifiable.*

EXAMPLE – DAM WHICH IS NOT BIG ENOUGH TO BE A CLASSIFIABLE DAM

Peter has a canal dam which has a ***height of 4 metres and a length of 1,000 metres****.*
Using Table 5, Peter locates the height and length of his dam. Peter can now determine that his dam has an approximate volume of ***40,000 cubic metres (m^3)****. This volume falls in the* ***orange*** *part of the table meaning Peter's dam is above the threshold of 4m in height and 20,000m^3 so is considered classifiable.*

Note: *as shown in the example above, dams within a canal have to be of a considerable length in order to meet the classifiable dam thresholds.*

ASSUMPTION MADE FOR CALCULATING THE STORED VOLUME OF A CANAL

An assumption has been made that the typical batter slope of a canal wall is approximately 1:2 (ie the slope has a vertical rise of one metre for every two metres horizontal).

An assumption has also been made that the canal has a minimum base of two metres. This has been done to provide a reasonable estimation of the cross-section area. By multiplying the cross-sectional area by the centreline length this provides a first order volume approximation for canals with a consistent bed slope over the reach analysed.

These assumptions have been made to simplify the process for dam owners, and to make Table 5 easier to use.

What happens next?

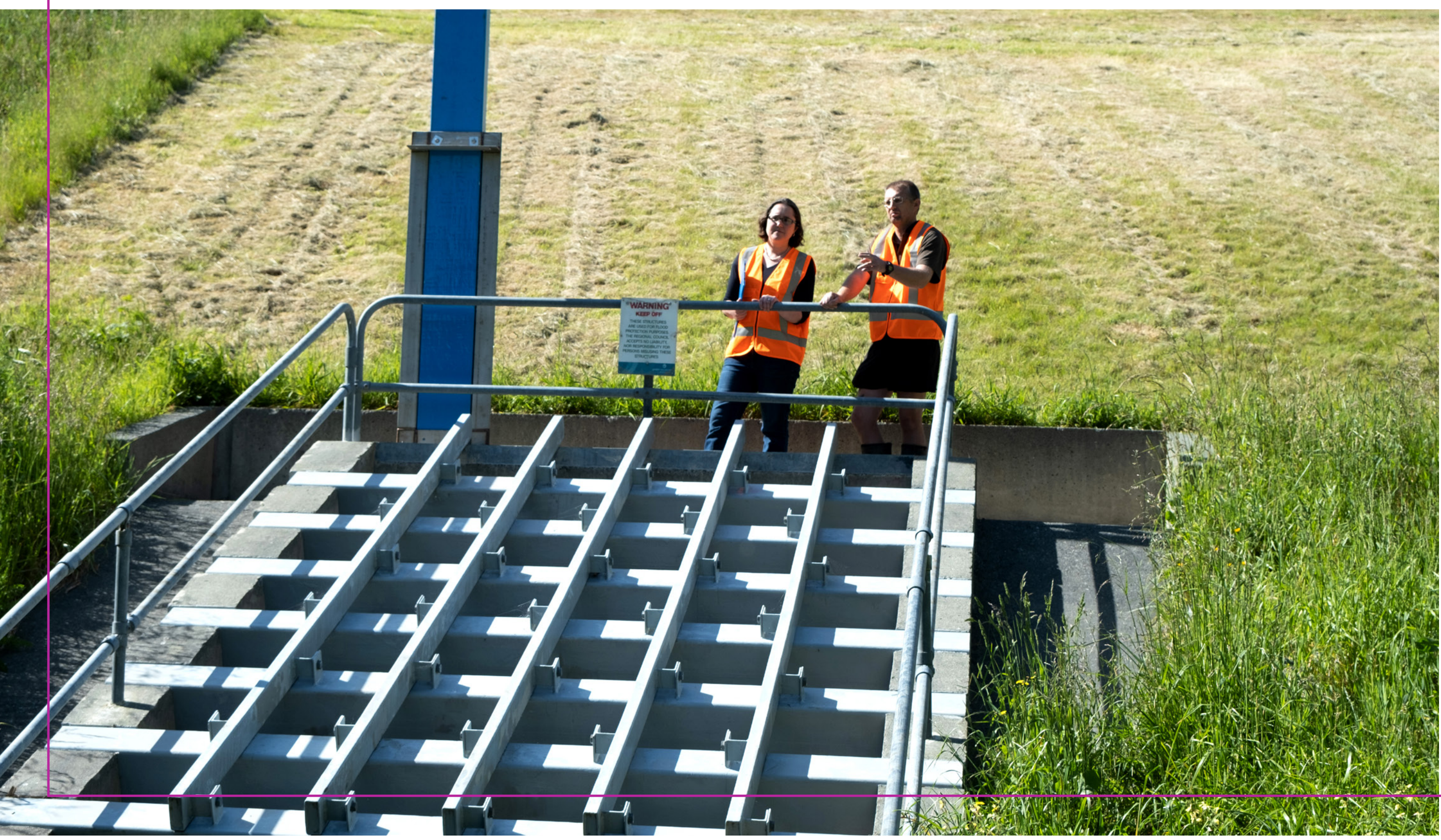
The purpose of this resource is to help the owners of agricultural dams determine whether they have a classifiable dam and are therefore impacted by the regulations.

It is the responsibility of the dam owner to determine whether they have a classifiable dam. This can be determined by engaging a technical practitioner, or as this resource demonstrates, it is possible for dam owners to determine the approximate height and volume of their dam by themselves.

The disclaimers outlined in the beginning of this resource should be noted, and if after following the instructions in this resource you have a dam which appears to be below but is close to the classifiable dam threshold, then it is recommended that you seek the services of a technical practitioner.

If your dam exceeds the height and volume thresholds to be a classifiable dam, then as per the regulations, the next step is for you to conduct a potential impact classification, as set out in the regulations and MBIE's Guide to complying with the Dam Safety Regulations. While an owner can undertake this if they have the necessary skills, the regulations require this activity to be certified by a recognised engineer.

MBIE's Building Performance website has a range of resources to help those impacted by the regulations, understand their responsibilities www.building.govt.nz/managing-buildings/dam-safety/resources/



Glossary

Term	Definition
As-built drawings	A set of plans and diagrams that show exactly how a structure was finally built.
Batter	Batter is a term typically used in the construction of embankments has an equivalent angle as used in trigonometry calculations; a batter of 1:3 is equivalent of an angle of 180 from horizontal or 720 from vertical.
Crest	Section 7 of the Building Act defines a crest, in relation to a dam, as the uppermost surface of a dam, not taking into account any camber allowed for settlement, or any curbs, parapets, guard rails, or other structures that are not part of the water-retaining structure; and for the avoidance of doubt, any freeboard is part of the water-retaining structure for the purposes of this definition.
Cross section	The surface area of an imaginary vertical wall that slices through a storage structure.
Hydrographic survey	Hydrographic survey of a reservoir when it is full using equipment similar to a depth sounder or fish finder that you may find on a recreational boat that can measure distances underwater.
Plumb bob	Is a weight which is suspended from a string and used as a vertical reference line, or plumb line.
Recognised engineer	A person who has demonstrated that they have the prescribed qualification and competency requirements for recognised engineers as set out regulations 21 to 23 of the regulations.
Sidling canal dam	A sidling canal dam may have cut on one side (ie into a hill), and dam fill on the other.
Stored volume	Stored water or other fluid that is retained by a dam. Only water or other fluid which is held above ground level is considered to be stored water.
Technical practitioner	An individual who has the knowledge and skills necessary to prepare potential impact classifications (PICs) and dam safety assurance programmes (DSAPs). But they may not be a recognised engineer and therefore are not able to audit PICs or DSAPs.
Topographic survey	Topographic survey measures the physical dimensions of a reservoir when it is empty. A surveyor would be employed to use RTK GPS (Real-Time Kinematic Global Positioning Satellite survey) or remote sensing, ie LiDAR (laser imaging, detection, and ranging survey) or using a drone.
Turkey nest dam	A small water retention structure, normally circular or square, where all containment walls have been formed from excavation of material from the middle of the storage.
Weir or drop structure	A weir is a low barrier which is built across a canal or river in order to control or direct the flow of water, often from a higher to a lower elevation.

Te Kāwanatanga o Aotearoa
New Zealand Government

BP 8207