# Hydro Inundation Chapter and Overlay - Information Sheet

**Prepared by: Meridian Energy Limited and Mackenzie District Council, 11 April 2025**

## 1. How is dam safety managed in New Zealand?

The safety of dams in New Zealand is managed by a combination of legislative and regulatory requirements and industry best practice guidelines.

The **Building Act 2004** is the overarching piece of legislation in New Zealand that manages the construction, alteration, maintenance, and demolition of new and existing buildings, including dams. The Building Act, together with the **Building (Dam Safety) Regulations 2022**, require (amongst other matters) that dams are classified according to the potential impact of a failure of the dam on people, the community, historical or cultural sites, critical or major infrastructure, and the natural environment.

When classifying a dam, the owner must:

(a) Identify the likely effect that an uncontrolled release of all of the contents of the reservoir due to a failure of the dam when full would have on the community, cultural sites, critical or major infrastructure, and the natural environment (referred to as "*the specified categories*"); and

(b) Determine whether the damage level in each of the specified categories is likely to be catastrophic, major, moderate, or minimal, then select the highest damage level; and

(c) Estimate the population at risk and the potential loss of life.[1]

The potential impact classification (**PIC**) is determined by combining the potential impact of a failure of the dam on the specified categories, the potential population at risk and the potential loss of life.

Owners of dams with a medium or high PIC must hold and implement an audited dam safety assurance programme (**DSAP**). The DSAP must contain effective procedures for the following:

(a) Operating the dam and reservoir;

(b) Ensuring that persons operating the dam and reservoir have adequate experience and training;

(c) Maintaining accurate records of reservoir water levels under all loading conditions;

(d) Maintaining the functionality of the dam and reservoir;

(e) Surveillance of the dam, including procedures for—

i. collecting dam surveillance data, evaluating dam performance, and carrying out associated quality assurance processes;

[1] See clause 9 of the Building (Dam Safety) Regulations 2022

ii. carrying out visual inspections of the dam (including specifying the required frequency of the inspections);
iii. reading dam performance monitoring instruments (including specifying the required frequency of the readings);
iv. monitoring dam surveillance data management systems;
v. reporting surveillance and dam performance issues to the dam owner;

(f) Inspections and maintenance, including procedures for-

i. identifying and documenting appurtenant (permanent or immovable) structures;
ii. identifying and documenting the gate and valve systems that have dam or reservoir safety functions;
iii. inspecting and maintaining appurtenant structures;
iv. inspecting, maintaining, and testing the gate and valve systems that have dam or reservoir safety functions and other equipment or systems that have dam or reservoir safety functions.

(g) Intermediate Dam Safety Reviews, conducted every 12 months, consisting of-

i. on-site inspections of the dam and related structures;
ii. reviewing operation, surveillance, and maintenance records;
iii. reviewing maintenance and testing records of gate and valve systems;
iv. evaluating dam performance based on inspections and reviews;
v. preparation of a report detailing the review, including dam safety issues (if any) that have been identified;

(h) Comprehensive Dam Safety Reviews, conducted every 5 years, consisting of-

i. reviewing hazards and threats to dam performance;
ii. assessing potential failure modes and corresponding conditions;
iii. on-site inspections of the dam and related structures;
iv. testing gates, valves, and safety equipment;
v. assessing dam performance under all design loading conditions;
vi. reviewing safety management resources and procedures;
vii. preparation of a report detailing the review, including dam safety issues (if any) that have been identified including information on the adequacy of the resolution of those issues;

(i) Emergency planning and response, including procedures for-

i. maintaining and reviewing an emergency action plan;
ii. consulting and providing relevant local authorities and emergency services on the content of the plan;

(j) Identifying and managing dam safety issues, including procedures for-

i. recording, prioritising, and tracking dam safety issues; and
ii. investigating, assessing, and resolving dam safety issues.

The PIC and DSAP must be provided to the relevant regional council. The regional council must approve or refuse the PIC and DSAP, and the dam owner must submit annual DSAP compliance certificates.

The Ministry of Business, Innovation and Employment (**MBIE**) manages the regulatory system for building work, including for dams, and monitors its effectiveness. MBIE works closely with regional authorities to ensure compliance and investigate any breaches of the Building Act and associated regulations.

Regional authorities administer and monitor implementation of the Building Act and associated regulations, including:

a) Approving or refusing dam PICs;

b) Approving or refusing DSAPs;

c) Receiving annual dam compliance certificates;

d) Adopting and implementing a policy on dangerous dams; and

e) Establishing and maintaining a register of dams in its region.

The **New Zealand Dam Safety Guidelines 2024** (**the Guidelines**) have been prepared by the New Zealand Society on Large Dams based on technical bulletins published by the International Commission on Large Dams and other internationally recognised references on dam engineering. The Guidelines outline detailed practices for investigation, design, construction, operation, maintenance and emergency preparedness for dams in New Zealand. The Guidelines are periodically updated to incorporate advances in knowledge and technology thereby ensuring that dam safety practices remain current and effective. The Building (Dam Safety) Regulations 2022 set the minimum legal requirements, while the Guidelines provide detailed, industry-recommended practices for dam safety management.

The **Resource Management Act 1991** promotes the sustainable management of natural and physical resources. When managing potential effects of dams on natural and physical resources, resource consents often have dam safety related consent conditions. Some conditions are explicit in specifying how the dam is to be maintained and operated, while others are more general and refer to parts of the New Zealand Dam Safety Guidelines.

## 2. How is this applied to the Waitaki Power Scheme?

The various sections of the Waitaki Power Scheme have each been assessed to have PICs that range from Low to High.

The various sections of the Waitaki Power Scheme have specific DSAPs that comply with the Building Act 2004, the Building (Dam Safety) Regulations 2022 and the New Zealand Dam Safety Guidelines 2024. Meridian addresses all their dams and canals in a DSAP, regardless of their PIC.

The objective of the DSAPs is to ensure the safety and protection of Meridian's dams and canals throughout their operational lifetime. The DSAPs address the following (amongst other matters):

a) Dam and reservoir operation and maintenance;

b) Surveillance and monitoring;

c) Inspection, maintenance, and testing appurtenant structures and gate and valve systems;

d) Annual dam safety reviews;

e) Comprehensive dam safety reviews;

f) Emergency planning and response; and

g) Identifying and managing dam safety issues.

Meridian Energy Limited is required to provide their PICs, DSAPs and annual DSAP compliance certificates to Canterbury Regional Council.

## 3. What is the likelihood (probability) of a hydro inundation event associated with the Waitaki Power Scheme?

There is no requirement under the Building Act 2004, the Building (Dam Safety) Regulations 2022 or the New Zealand Dam Safety Guidelines 2024 to determine the likelihood of a dam failure occurring.

A dam's PIC addresses the potential consequences resulting from a dam failure. It does not provide an indication of the likelihood of a dam failure.

Rather than requiring that likelihood of a failure be determined, New Zealand's regulations and the Guidelines adopt a 'standards-based approach' to dam safety engineering. This approach controls risks by following established rules and minimum standards for defining design parameters and loads, structural capacity and defensive design measures.

The PIC of the dam determines the appropriate criteria to be applied for dam design, construction and post-construction operations.

Post construction DSAPs provide an overarching framework for managing dam safety risks through the operational phase of a dam or canal's lifecycle.

Because the Waitaki Power Scheme's dams and canals are managed under best practice DSAPs and comply with all relevant regulations, the probability of failure is very low.

## 4. What does the latest modelling tell us about the potential effects (consequences) of a hydro inundation event associated with the Waitaki Power Scheme?

Meridian has carried out assessments to determine the potential inundation hazards resulting from a breach of the Waitaki Power Scheme's dams and canals. These assessments generally used a computational hydraulic modelling approach to determine the effects of inundation (including extent, depth, velocity and timing) from a hypothetical worst-case dam

or canal failure scenario. These assessments were prepared following the methodologies recommended by the New Zealand Dam Safety Guidelines.

The results from the assessments informed the extent of the Hydro Inundation Hazard Overlay (**HIHO**) applied in the existing Mackenzie District Plan (**MDP**) and in Plan Change 28 (**PC28**). This overlay was developed by combining all previous dam or canal breach inundation information for the Waitaki Power Scheme's dams and canals into a single, composite layer. The HIHO provides the potential extent of inundation from a dam or canal breach, but does not provide detailed information on depth, velocity and timing.

Details of potential depth, velocity and timing differs depending on the location of the structural failure and the location of the effects.

For example, considering the Pukaki Airport, Lyford Lane and Flanagan Lane areas of the HIHO, these areas would be affected by hypothetical breaches of the following dams or canals:

Pukaki Airport: Pukaki Inlet Dam, Pukaki Canal (true right bank)

Lyford Lane: Pukaki Inlet Dam, Pukaki Canal (true right bank)

Flanagan Lane: Ohau Canal (true left bank)

The inundation hazard to people and property in these areas is in a "H5" to "H6" category based on definitions provided in the 2023 New South Wales Flood Risk Management Guideline. These are the most hazardous categories and mean that the severity of flood depths and velocities are unsafe for vehicles and people (inside or outside their homes) and buildings are considered vulnerable to failure.

The proximity of these areas to the upstream dams and canals also means that there would be limited time for warning and evacuation of people. For example, in the case of a breach of the Pukaki Canal upstream of the Lyford Lane area, the canal breach flood waters would take approximately 1 hour to arrive at the Lyford Lane area, with the peak flood discharge arriving approximately 1.5 hours after the initial breach. This timeframe is relatively short and may not be sufficient to allow for the dissemination of warnings to people in the area or for people to move to safer locations.

# 5. How has the hydro inundation risk been managed in the Mackenzie District Plan prior to notification of Plan Change 28?

## 5.1. Identifying the Hydro Inundation Hazard Overlay

The overall approach to the management of risks to people and property from hydro inundation in PC28 is predominantly the same as it is in the MDP.

In both the MDP and PC28 a HIHO is identified on planning maps. The HIHO was originally prepared during the Plan Change 13 (**PC13**) process for the MDP (i.e. between 2013 and 2018).

The HIHO was developed by Opus International Consulting Ltd and Damwatch Engineering Ltd using all available dam and canal breach hazard information, including:

a) Comprehensive dam breach flood hazard maps for a hypothetical breach of the Pukaki Dam (prepared by Works Consultancy Services in 1990);

b) Broad scale dam breach flood hazard maps for a hypothetical breach of the Pukaki Inlet Dam (prepared for Meridian Energy by Damwatch in 2014);

c) Broad scale canal breach flood hazard maps for hypothetical breaches of the Ohau A, Ohau B and Ohau C Canals (prepared by a joint Damwatch and Opus study in 2005);

d) Detailed canal breach flood hazard maps pertaining to specific hypothetical breach scenarios for the Tekapo Canal (prepared for Genesis Energy by Opus in 2013); and

e) Detailed canal breach flood hazard maps pertaining to specific hypothetical breach scenarios for the Pukaki, Ohau Canals and Ruataniwha Dam (prepared for Meridian Energy by Damwatch in 2013).

The inundation hazard areas defined for all hypothetical canal and dam breach locations and scenarios from these studies were integrated (overlaid) to produce the HIHO.

The scope of PC13 was limited to the Rural Zone. For this reason, the HIHO in the MDP does not include areas outside the Rural Zone that have the potential for hydro inundation. This gap has been addressed in PC28's HIHO which identifies all known areas with the potential for hydro inundation. Areas added to the HIHO by PC28 are associated with the Pukaki Airport, Lyford Lane and Flanagan Lane.

## 5.2. District plan provisions

In the MDP there is no objective that specifically addresses the need to manage risks to people and property associated with hydro inundation. This gap has been addressed in PC28 by inserting the following proposed objective:

> *Development in the Hydro Inundation Hazard Overlay minimises risks to human health and property from hydro inundation, and avoids reverse sensitivity effects on hydro electricity generation activities. (PC28, HI Objective)*

This objective contributes to achieving the MDP's Strategic Objective ATC-O4 and Policies A and D of the National Policy Statement for Renewable Electricity Generation (**NPS-REG**) by recognising the national significance of the Mackenzie District's renewable electricity generation assets and activities and seeking to avoid new development that may result in reverse sensitivity effects on such assets and activities. The objective also contributes to achieving ATC-O6 which seeks to ensure that the location and effects of activities are managed to minimise conflicts between incompatible activities and protect important existing activities from reverse sensitivity effects.

In the MDP, the hydro inundation hazard policy (Policy 3B11) is:

> *Avoid occupied buildings that are likely to result in a requirement to cease to operate, upgrade, modify or replace the hydro-electricity related structures or*

*significantly alter the operation of the affected portion of the hydroelectricity scheme*.

The hydro inundation policy in PC28 is consistent with Policy 3B11, while being clearer about the need to manage the potential for harm to people and property. The proposed PC28 policy reads:

> *Avoid, as far as practicable, changes to existing land use activities in the Hydro Inundation Hazard Overlay that may increase the likelihood or scale of harm to people or property from hydro inundation, or the potential for reverse sensitivity effects. Where it has been demonstrated that avoidance is not practicable, minimise the potential for harm.*

Concerning *new occupied buildings* in the Rural Zone, Rule 3.1.2.g in Section 7 of the MDP states that there shall be no occupied buildings located within a hydro-electricity inundation hazard area identified on the hazard map in Appendix U unless certain conditions are met. The conditions are:

1) *It is demonstrated that the building, will not raise the PIC level (Low, Medium, High) under the Building Act 2004 with the consequence of a requirement to cease to operate, upgrade, modify or replace the hydro-electricity related structures or that it will significantly alter the operation of the affected portion of the hydroelectricity scheme; and*

2) *It is located at least 150 metres from the toe of the embankment of any canal in fill or any dam or associated structure; and*

3) *Is sited within an area of low hazard*[2] *that would result from any dam breach within a hydro-electricity inundation hazard area; and*

4) *Is designed so that any habitable floor area of any residential structure is a minimum of 300mm above the maximum inundation level that would result from any dam breach; or*

5) *The building is a temporary structure required by the dam owner/operator to give effect to maintenance of any dam and associated structure, and the structure is in place for not longer than 12 months.*

Where one or more of these conditions cannot be complied with, the activity becomes a discretionary activity under the MDP and will require a resource consent.

Concerning *new occupied buildings*[3] in the General Rural Zone (**GRUZ**) that is in the HIHO, PC28 is consistent with the preceding rule, that is it permits such activities if they comply

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[2] In Rule 3.1.2.g of Section 7 of the existing Mackanzie District Plan, "Low Hazard Area" means those areas that result from any dam breach which are subject to inundation where the water depth (metres) x velocity (metres per second) is less than or equal to 1, or where depths are less than 0.5 metres.

[3] In PC28 an occupied building is defined as "*a building in which people reside, occupy or work on a permanent or regular basis; and includes residential units, home occupations, factory farming, wintering barns, herd homes and dairy sheds*". This is consistent with the definition for the same

with the same conditions. Where one or more of the conditions cannot be complied with, the activity is a discretionary activity and will require a resource consent. This allows MDC to assess the proposal against the objectives and policies in the plan, and manage the potential for reverse sensitive effects and risks to people and the community. See Rule HI-R1 of PC28.

Concerning *residential units* in the Rural Lifestyle Zone (**RLZ**) that is in the HIHO, the MDP has no specific rule for such activities because the HIHO in the MDP does not apply to the RLZ. The same activity (residential units) in PC28 is permitted provided that there is no more than one residential unit per site. If more than one residential unit is sought, the activity becomes a discretionary activity, and a resource consent is needed. See Rule HI-R2 of PC28.

Concerning *residential visitor accommodation*[4] in the GRUZ that is in the HIHO, Rule 8.2 of Section 7 of the MDP requires that such activities hold a resource consent as a discretionary activity. Rule HI-R3 in PC28 adopts the same requirement to hold a resource consent as a discretionary activity.

Concerning *residential visitor accommodation* in the RLZ that is in the HIHO, the MDP has no specific rule for such activities for the area at Flanagan's Lane partly because the HIHO in the MDP does not apply to the RLZ, however this activity is already non-complying at Lyford Lane. The same activity in PC28 is a non-complying activity in the RLZ, and will require a resource consent. See Rule HI-R3 of PC28.

Concerning *residential visitor accommodation* in the Airport Zone (**AIRPZ**) that is in the HIHO, the MDP has no specific rule for such activities because the HIHO in the MDP does not apply to the AIRPZ. The same activity in PC28 is a non-complying activity and will require a resource consent. See Rule HI-R3 of PC28.

In summary, the approach to addressing hydro inundation risks in the MDP is largely already adopted in the Plan from PC13. The key points of difference result from PC28 now including more complete mapping of areas of hydro inundation risk and clearer provisions that give effect to the MDP's Strategic Objectives ATC-O4 and ATC-O6 and the NPS-REG.

## 6. Has a risk-based approach (i.e. probability x consequence) been applied in the development of the notified Hydro Inundation provisions in Plan Change 28 to the Mackenzie District Plan?

Risk is commonly defined as:

*Risk = Likelihood x Consequence*

activity in the MDP, with the exception that PC28 refers to "*residential units*" while the MDP refers to "*residential accommodation*". This point of difference aligns PC28 with the National Planning Standards.

[4] In the PC28, "*residential visitor accommodation*" means "*the use of a residential unit for visitor accommodation including any residential unit used as a holiday home*".

Development of PC28 recognises that the likelihood of a dam or canal failure associated with the Waitaki Power Scheme is very low. At the same time, development of PC28 recognises that if a dam or canal failure was to occur, the potential adverse impact on people, the community, cultural sites, critical or major infrastructure, or the natural environment in the HIHO could be significant.

In response to the risk posed, PC28 focuses on the following:

a) The potential consequences of a full dam or canal breach (which is consistent with the Building Act 2004, the Building (Dam Safety) Regulations 2022, the New Zealand Dam Safety Guidelines 2024); and

b) Managing the potential consequences in a way that ensures that people and the community are resilient to the risks without unnecessarily constraining their activities; and

c) Recognising the national significance of the Mackenzie District's renewable electricity generation assets and activities (which is consistent with Policy A of the NPS-REG); and

d) Avoiding new development that may result in reverse sensitivity effects on renewable electricity generation activities (which is consistent with the MDP's Strategic Objectives ATC-O4 and ATC-O6 and is consistent with the Policy D of the NPS-REG).

## 7. Is it possible to assign a relative numeric value to risk (i.e. probability x consequence)?

Given the evidence behind identification of the HIHO and the potential consequences of a dam or canal failure in the Waitaki Power Scheme, it was not considered necessary to assign a number to the risk during development of PC28. Further to this, the Building Act 2004, the Building (Dam Safety) Regulations 2022 and the New Zealand Dam Safety Guidelines 2024 do not require that a numeric value be assigned to the risk of a dam or canal breach.

## 8. Is there consistency between the risk-based approach applied to the Hydro Inundation provisions and the Natural Hazards provisions in Plan Change 28 to the Mackenzie District Plan?

The natural hazards managed by PC28 include flood hazards, surface fault rupture as a result of earthquakes, liquefaction as a result of earthquakes, and wildfire hazards. The planning approach applied to the Natural Hazards provisions is generally consistent with the approach applied to the hydro inundation provisions, that is it manages the potential impact of a natural hazard event on people and communities.

The key point of difference between the Hydro Inundation provisions and the Natural Hazards provisions is recognition that the Waitaki Power Scheme is lawfully established nationally significant infrastructure that must comply with the Building Act 2004 and the Building (Dam Safety) Regulations 2022. As discussed in the answer to Question 1, the Act and Regulations require that dams are classified according to the potential impact of a failure

of the dam on people, the community, cultural sites, critical or major infrastructure, and the natural environment; and based on this classification tailored dam safety assurance programmes are approved and implemented.

Changes to land use in the HIHO can result in a higher PIC and/or changes to the statutory requirements for the dam's safety management and performance criteria, even if there is no change to the structural integrity of the dam or canal. This can lead to significant ongoing design and management changes being required of Meridian Energy Limited. Changing requirements and associated costs to Meridian in response to future land use changes by others is known as a '*reverse sensitivity effect*'.

The Hydro Inundation and Natural Hazard provisions of PC28 must be consistent with the Strategic Objectives in the MDP. Strategic Objective ATC-O4 and Policy D of the NPS-REG require that reverse sensitivity effects on the Waitaki Power Scheme (i.e. nationally significant renewable electricity generation assets and activities) are avoided.

At the same time, ATC-O1 aims to ensure that:

> "*the Mackenzie District is a desirable place to live, work, play and visit, where: there are a range of living options, businesses, and recreation activities to meet community needs; activities that are important to the community's social, economic and cultural well-being, including appropriate economic development opportunities, are provided for…*".

To be consistent with the NPS-REG and the MDP's Strategic Objectives, the provisions that apply to the HIHO aim to provide (as far as practicable) for the activities anticipated in each zone that lie within the HIHO, while also ensuring that reverse sensitivity effects on the Waitaki Power Scheme are avoided and potential hydro inundation risks to people and the community are managed.

## 9. Is it feasible to construct a stop bank, or similar structure, to protect properties from hydro inundation?

Dam owners are required, through the Building Act 2004, the Building (Dam Safety) Regulations 2022 and the New Zealand Dam Safety Guidelines 2024, to take actions to keep their dams safe and reduce the risk of dam or canal failures. Measures must be taken by dam and canal owners to achieve an appropriate level of safety that is commensurate with the structure's PIC.

This approach means that dam owners are required to prioritise investments directly into the dam or canal assets, and asset management programs, to ensure their structural integrity and safety.

In New Zealand and internationally, the construction of infrastructure downstream of dams or canals to mitigate the consequences of dam failure (e.g. stop banks to deflect dam-break waters away from people and communities) is not considered to be best practice.

Constructing, maintaining and relying on downstream infrastructure would divert investment from prioritising the integrity of the dam or canal assets; present significant

engineering challenges to withstand dam-break inundation which is typically of an order of magnitude more damaging than natural flood hazards; and require agreement from a network of private property owners to allow the construction and maintenance of such structures on their land.

For these reasons, dam owners prioritise investments directly into the dam's safety, rather than focusing on downstream ‘back-up’ infrastructure.