Freeboard for the Auckland Region

Guideline Document GD13

Version 1

December 2024

aucklandcouncil.govt.nz

Wells Point, Photograph by Jay Farnsworth

Freeboard for the Auckland Region. Guideline Document GD13. Version 1

@ 2024 Auckland Council, New Zealand

December 2024

Auckland Council

Guideline Document GD13

ISSN 2230-4541 (Print)

ISSN 2230-455X (Online)

ISBN 978-1-991146-36-6 (Print)

ISBN 978-1-991146-37-3 (PDF)

Reviewed and recommended for publication by:

Name: Branko Veljanovski

Position: Resilience & Infrastructure: Head of Engineering & Technical Services, Auckland Council

Approved for publication by

Name: Paul Klinac

Position: Resilience & Infrastructure: General Manager, Engineering, Assets and Technical Advisory, Auckland Council

Recommended citation:

Auckland Council (2024). Freeboard for the Auckland Region. Auckland Council Guideline Document, GD13. Version 1.

Acknowledgements

This document was prepared with technical input from industry experts, including, but not limited to, the following individuals:

Authors

Andrew Benson - Resilience & Infrastructure: Principal - Technical Guidance

Kevin Montgomerie - Resilience & Infrastructure: Technical Standards Practice Lead

Additional authors

Natasha Carpenter - Resilience & Infrastructure: Coastal Management Practice Lead

Fiona Macdonald - Healthy Waters and Flood Resilience: Principal - Flood Risk Modelling

Allan Leahy - Healthy Waters: Principal – Growth Planning

Tony Bullard - Resource Consents: Principal - Specialist Planning

Thanks are extended to technical experts who contributed significantly to this document including, but not limited to the following individuals:

Hock Lee – Regulatory Engineering: Principal Engineer

Daniel Sansbury – Regulatory Engineering: Head of Regulatory Engineering

Editorial authors

Janet MacKinnon – Resilience and Infrastructure: Principal Technical Capability

Preface

What is the purpose and scope of this guideline?

This guideline document, Freeboard for the Auckland Region (GD13), provides technical guidance for the determination of freeboard, a risk reduction measure, in accordance with site conditions encountered in Auckland. The aim is to support understanding and managing flood and coastal inundation risk and minimise potential adverse effects from locating buildings in areas susceptible to such risks.

GD13 provides technical design guidance to support Auckland Council's asset ownership and infrastructure operations as well as regulatory functions. It applies current good practice to align building design with land-use planning and natural hazard mitigation.

The primary intended audience of this document are professionals, designers, developers, and regulators.

Who was consulted in the preparation of this guideline?

During the development of this guideline drafts were distributed to, and consultations were undertaken with Council staff with operational, regulatory, and planning functions and responsibilities. Feedback was also invited from across external industry stakeholders.

Future revisions

Auckland Council intends to provide future revisions to this guideline periodically in response to changes in good practice, legislation, policies, technologies, national standards, and feedback from industry. There is a feedback form available to download along with this document which can be sent to *freeboard*@aucklandcouncil.govt.nz.

Contents:

Abbreviations i

1.0 Introduction 1

1.1 Aims and objectives of the guideline 2

1.2 Scope and application 2

1.3 Document structure 3

1.4 The natural hazard context 4

1.5 Te Ao Māori 6

2.0 Auckland's regulatory framework 7

2.1 The Resource Management Act 7

2.2 Auckland Unitary Plan and Auckland Council District Plan – Hauraki Gulf Islands Section 8

2.3 The Building Act 9

2.4 Key difference between the RMA and the Building Act 12

2.5 Other statutory provisions 13

2.6 Other Council plans 13

2.7 NZS 4404:2010 Land Development and Subdivision Infrastructure (Non-statutory) 14

2.8 Regulatory assessment 15

3.0 Fluvial and pluvial flood level information 16

3.1 Floodplains 16

3.2 Flood prone areas 18

3.3 Flood sensitive areas 19

3.4 Overland flow paths 19

3.5 Modelled vs actual flood areas 20

4.0 Coastal inundation 22

4.1 Coastal inundation maps 22

4.2 Modelled vs actual coastal inundation areas 25

4.3 Sea-level rise 25

5.0 Uncertainties in extreme water level estimation – the reason for freeboard 27

6.0 Default freeboard levels 30

6.1 Coastal storm inundation exception 31

7.0 Reviewing freeboard calculations - are the default freeboard levels appropriate? 32

7.1 Catchment stormwater flooding 32

7.1.1 Step 1: Catchment and hydrology – what flows and volumes are arriving at the site. 32

7.1.2 Step 2: Site specific hydraulic conditions – what are the flood levels and extents? 33

7.1.3 Step 3: Additional considerations 34
7.2 Coastal inundation 35
7.2.1 Step One – Determine freeboard 35
7.2.2 Step Two – Compare minimum floor level + default freeboard with determined freeboard 36
8.0 Summary 37
Glossary 38
References: 41
Appendices 43
Appendix A1.0 Worked examples 44

Tables

Table 1: Document structure 3
Table 2: RMA provisions 7
Table 3: Building Act provisions 10
Table 4: Auckland Council Stormwater Bylaw (2015) 13
Table 5: Other Auckland Council plans 13
Table 6: NZ Standard 4404:2010 Development and Subdivision Infrastructure 14
Table 7: Default freeboard levels for Auckland buildings 30
Table 8: Catchment and hydrology 32
Table 9: Site-specific hydraulic conditions 33
Table 10: Additional factors 34
Table 11: Coastal inundation – calculating freeboard 35
Table 12: Coastal inundation – determining freeboard 36

Figures

Figure 1: Flooding at Kumeu, West Auckland 1
Figure 2: Freeboard – measured from the calculated flood/coastal inundation-water level to the surface of the finished floor level. 5
Figure 3: Extract from GeoMaps of a flood plain area 17
Figure 4: Extract from GeoMaps of a flood-prone area 18
Figure 5: Storm debris partially blocking a culvert, potentially exacerbating the flood risk. 19
Figure 6: Overland flow path Asquith Avenue, Mt. Albert. 20

Figure 7: Schematic of causes of coastal inundation 22
Figure 8: Areas susceptible to coastal inundation at Mission Bay and Kohimarama. 23
Figure 9: Storm conditions elevating water levels overtops Tamaki Drive Seawall, floods road..................... 24
Figure 10: Vehicles driving through flood waters generating waves.. 28
Figure 11: Hazard warning 37

Abbreviations

Acronym	Definition
AEP	Annual Exceedance Probability
ACDPHGIS	Auckland Council District Plan Hauraki Gulf Islands Section
AR6	2021 IPCC Sixth Assessment Report
ARI	Average Recurrence Interval
AUP	Auckland Unitary Plan
MfE	Ministry for the Environment
RCPs	Representative concentration pathways
RMA	Resource Management Act 1991
SSPs	Shared socio-economic pathways
SWCoP	The Auckland Code of Practice for Land Development and Subdivision, *Chapter 4: Stormwater*
VLM	Vertical land movement

1.0 Introduction

GD13 provides guidance for the design and regulatory review of the provision for freeboard for building development in areas susceptible to flooding and coastal inundation in the Auckland region.

Flooding and coastal inundation are natural processes that occur when water covers land that is usually dry. They become a natural hazard when they adversely impact on people, infrastructure, structures, and buildings. Where development is proposed on land susceptible to flooding and/or coastal inundation, the inclusion of freeboard in the infrastructure and finished floor level design is a means to mitigate and reduce exposure and vulnerability to the natural hazards, thereby contributing to resilient and sustainable building development.

Freeboard is a factor of safety that provides for the imprecision and/or uncertainties in the estimation of flood/inundation water levels. In some cases, it may also include provision for phenomena such as waves and velocity head, which elevate the water surface, and are not explicitly included in flood or coastal inundation water-level modelling.

Figure 1: Flooding at Kumeu, West Auckland . Photo Brett Phibbs (Source: Stuff)

1.1 Aims and objectives of the guideline

The aim of this guideline is to provide good practice technical guidance in determining the appropriate freeboard for assets, structures, and buildings to be built within an area susceptible to flooding and/or coastal inundation.

Objectives:

- To contribute to building resilience by reducing the frequency and extent of exposure of developments to flooding and coastal inundation hazards
- To inform building designers, engineers, technical specialists, planners, decision makers, and interested parties on technical considerations appropriate to determining freeboard
- To inform building designers, engineers, technical specialists, planners, decision makers, and interested parties on including the site-specific safety in design requirements as part of determining the appropriate freeboard level
- Provide guidance that enables a consistent assessment of freeboard levels for building developments within areas susceptible to flooding and coastal inundation hazards.

1.2 Scope and application

GD13 focusses primarily on freeboard design considerations for habitable and non-habitable buildings, however, the principles are applicable to other structures. People, buildings, structures, and infrastructure are not all the same, and their vulnerability to flooding and coastal inundation varies significantly. The amount of freeboard should be proportionate to the nature and risk presented by the natural hazard.

GD13 has been prepared for use in the Auckland region. While many of the principles are universal, and can be used elsewhere, the guidance has been developed in the Auckland context.

A suitably qualified and experienced person (SQEP) is required to undertake site investigations, understand the factors that contribute to determining an appropriate amount of freeboard. Users of GD13 are responsible for working within their capabilities, obtained through training and experience, and for seeking specialist advice when appropriate.

1.3 Document structure

This guideline consists of eight sections as follows:

Table 1: Document structure

Section 1	Introduction
Section 2	The Auckland regulatory framework – the statutory context
Section 3	Auckland Council's fluvial and pluvial flood level information that is readily available in Auckland – physical context
Section 4	Auckland Council's coastal inundation level information that is readily available in Auckland – physical context
Section 5	Uncertainties in flood level estimation – this is one of the reasons for requiring freeboard
Section 6	The Auckland Code of Practice for Land Development and Subdivision provision for *(default)* freeboard levels.
Section 7	Determining whether a default freeboard level is appropriate. Focussing on hydrologic and hydraulic considerations.
Section 8	Summary.
Appendices	

The guideline should be read in conjunction with:

1) The area-specific Catchment Management Plan (where available)
2) The area-specific Flood Model Report
3) Auckland's Exposure to Coastal Inundation by Storm-tides and Waves, TR2020/024
4) The New Zealand Building Act (2004)
5) New Zealand Building Regulations (1992)
6) The New Zealand Building Code
7) The Resource Management Act (1991)
8) New Zealand Coastal Policy Statement (2010)
9) The Auckland Unitary Plan – Operative in part, or Auckland Council District Plan - Hauraki Gulf Islands Section as appropriate
10) Auckland Council's Code of Practice for Land Development and Subdivision – Chapter 4: Stormwater
11) Auckland Transport Code of Practice
12) Te Tāruke-ā-Tāwhiri – Auckland's Climate Plan (2020)
13) Climate Change Scenarios (GD15)
14) The Health & Safety at Work Act (2015), particularly Safety in Design.

1.4 The natural hazard context

In Auckland, flooding and coastal inundation are high to medium frequency events with consequences that range from relatively minor to severe[1].

Flooding occurs during or after heavy rainfall, when the drainage capacity of the natural environment or built systems cannot cope. The level and intensity of flooding depends on several factors including:

- Rainfall intensity and duration
- Soil moisture conditions
- Local river levels
- The physical characteristics of catchments
- The existence or lack of flood prevention measures.

Coastal inundation, which is sometimes called coastal flooding, occurs when a combination of processes including high astronomical tides, low atmospheric pressure (storm surge), and wind direction and strength elevates the sea level and inundates low-lying coastal areas. Coastal inundation is most likely to occur when high tides and storm surge coincide.

Climate change and sea-level rise are predicted to increase the frequency and magnitude of flooding and coastal inundation hazards over time. It is important therefore, to take account of up-to-date knowledge on future climate change impacts when defining minimum floor levels of new buildings and structures.

Flooding and coastal inundation can result in significant tangible and intangible impacts on the community because of direct damage (due to actual contact with flood waters) or indirect damage (disruption caused by a flood). The severity can vary widely between locations, and for the same location within the floodplain/inundated area for the same flood/inundation event.

Areas most susceptible to these hazards are identified on published maps which are indicative of the actual floodplain or coastal inundation area due to a range of factors, including flood model input factors, ongoing development, new information, and the scale at which they are produced. Consequently, some sites that are susceptible to the flooding and/or coastal inundation hazards may not be shown to be within the published 1% AEP floodplain or coastal inundation maps, e.g. some sites round the periphery of the mapped areas. Therefore it is appropriate that a suitably qualified and experienced person assesses the site-specific flood/coastal inundation risk and utilises that information in the consideration of an appropriate freeboard. The published floodplain and coastal inundation area maps, and the information used to produce them are available to aid that assessment.

Where development is proposed and consented on land susceptible to flooding and/or coastal inundation, the setting of minimum floor levels that includes a freeboard is a conventional means of reducing (mitigating) the exposure and vulnerability to the natural hazard.

---

[1] Natural Hazard Risk Management Action Plan (2020)

The 1 % Annual Exceedance Probability (AEP) flood and/or coastal inundation event (likelihood of occurrence generally considered to be rare to very rare) is often the standard used for the prerequisite risk assessment. The 1% AEP probability percentage is specified in the Auckland Unitary Plan (AUP) for flooding and coastal inundation hazard risk assessments. Notably, under the Building Code, the minimum standard a building work must perform to is *surface water, resulting from an event having a 2% probability of occurring annually, shall not enter buildings* (Performance Standard E1.3.2). This legislative difference is covered in Section 2: Auckland's regulatory framework.

Notwithstanding the standard adhered to a residual risk always exists, e.g. a floor level based on the 2% AEP event may be at risk from flooding/inundation in a 1% AEP event. Likewise, a floor level based on the 1% AEP event may be at risk from a flooding or inundation event larger than a 1% AEP event.

Freeboard is a factor of safety that provides for imprecision and/or uncertainties in the estimation of flood and coastal inundation water levels. If appropriate, it may also include provision for phenomena which are not explicitly included in flood or coastal inundation level modelling. For example, waves and velocity head elevate the water surface, but are generally not included in flood or coastal inundation level modelling.

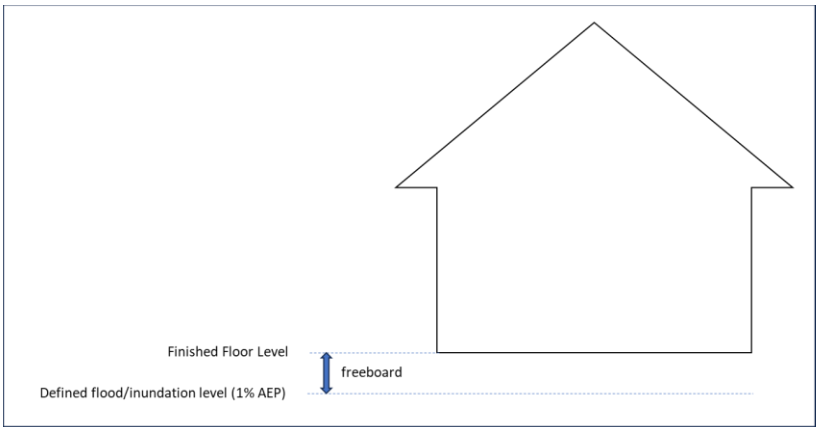

Figure 2: Freeboard – measured from the calculated flood/coastal inundation-water level to the surface of the finished floor level.

As people, buildings and infrastructure are not all the same, and their vulnerability to flooding and coastal inundation varies significantly, the amount of freeboard that is appropriate for a particular development at a particular site requires site-specific consideration. For example freeboard to reduce the risk exposure of more vulnerable developments or for developments with an emergency response role (e.g. hospitals), may incorporate a larger freeboard (risk proportionate)[2].

Inclusion of an appropriate freeboard will contribute to more resilient building stock within areas exposed to flooding or coastal inundation. Figure 2 illustrates where freeboard is incorporated.

---

2 Another potentially appropriate alternative would be to use a more conservative AEP or predicted flood/inundation water level, plus provision of freeboard/papa kore utu.

1.5 Te Ao Māori

Mana whenua have lived with and experienced Tāmaki Makaurau's natural hazards for at least 700 years and have adapted to the ever-present risk of natural hazards capable of disrupting communities and threatening lives.

Māori concepts and beliefs are anchored upon intergenerational relationships between people, place, nature, and the wider universe (whole living systems) and the reciprocal responsibilities and obligations to care for, protect, activate, maintain, and regenerate whakapapa relationships. As kaitiaki, mana whenua have the responsibility of ensuring that the spiritual and cultural aspects of natural resources are maintained for future generations, which involves the ongoing protection of the taiao (environment) from damage, destruction, or modification.

A Māori world view acknowledges that natural hazards are an integral part of life and natural hazard events cannot be controlled by human beings. However, by caring for and protecting the taiao and designing our built environment and infrastructure to be respectful of the environment and the connectedness of all things, sustainability and resilience are woven into our lives as Aucklanders, allowing us to better manage the risk of natural hazards.

Te Aranga Design Principles[3] have been developed to provide a clear process for positive engagement with mana whenua to shape our built environment and acknowledge our position as a city distinguished by the world's largest Māori population. The principles arise from a widely held desire to enhance mana whenua presence, visibility and participation in the design of the physical realm and are founded on intrinsic Māori cultural values. These core values of Te Aranga Design principles should be considered in the context of the built environment and provide key guidance when considering a Māori world view.

---

3 http://www.aucklanddesignmanual.co.nz/design-thinking/maori-design/te_aranga_principles

2.0 Auckland's regulatory framework

The Resource Management Act (RMA), Building Act and Building Code provide the statutory framework for the consideration of freeboard.

2.1 The Resource Management Act

The RMA is New Zealand's primary statute for land use planning. The New Zealand Coastal Policy Statement, Auckland Unitary Plan, and Auckland Council District Plan – Hauraki Gulf Islands Section prepared under the RMA are the key resource management instruments for the management of risk from natural hazards to achieve building resilience and sustainability in the Auckland region. The following table identifies key provisions of the documents that pertain to freeboard.

Table 2: RMA provisions

Source	Provision	Reference
Resource Management Act	• To promote the sustainable management of natural and physical resources requires managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people to provide for their social, economic and cultural well-being and for their health and safety while, … avoiding, remedying, or mitigating any adverse effects of activities on the environment.	Section 5
	• Management of significant risks from natural hazards	Section 6(h)
	• To control the use of land for the purpose of the avoidance or mitigation of natural hazards.	Section 30(1)(c)(iv)
	• To control any actual or potential effects of the use, development, or protection of land for the purpose of the avoidance or mitigation of natural hazards.	Section 30(1)(c)(iv) Section 31
	• May refuse subdivision consent if there is a significant risk from natural hazards.	Section 106
New Zealand Coastal Policy Statement	• Adoption of a precautionary approach.	Policy 3
	• Policies relating to the identification of coastal hazards and subdivision, use, and development within hazard areas. For example: ○ Avoid increasing risk in a coastal hazard area ○ The statement specifies a planning horizon for assessing coastal hazard risk of at least 100 years and directs regard to taking into account national guidance and the best available information on the	Policies 24 - 27

Source	Provision	Reference
	likely effects of climate change on the region or district.	
Auckland Unitary Plan	Chapter B10. Ngā tūpono ki te taiao - Environmental risk	B10.2.1(1) – (4) Objectives E36.2 (1) – (5).
	Chapter E36. Natural hazards and flooding	Policies E36.3 (1), (3)-(6), (8), (9), (13)-(17), (22), (25) Activity Table 36.4.1 E36.9 Special information requirements
	Chapter E 38 Subdivision Urban	E38.2 Objectives (2), (10). E38.3 Policy (2) Activity Table 38.4.1
	Chapter E 39 Subdivision - Rural	E39.2 Objectives (2), (17). E39.3 Policy (2) Activity Table 39.4.1
Auckland Council District Plan – Hauraki Gulf Islands Section	Part 8 – Natural Hazards	Objective 8.3.1 Policies 8.3.1.1 & 8.3.1.3 General Rule 12.6.

2.2 Auckland Unitary Plan and Auckland Council District Plan – Hauraki Gulf Islands Section

All new proposals for subdivision, use and development are subject to assessment against the requirements set out in the Auckland Unitary Plan (AUP) or, for the Hauraki Gulf Islands, the provisions of the Auckland Council District Plan - Hauraki Gulf Islands Section (a legacy plan).

If a resource consent is required for the subdivision of land (per AUP Chapters E38 and E39, and ACDPHGIS Part 12), for a land use activity (per AUP Chapter E36, and ACDPHGIS Part 8), or for an activity in the coastal marine area (CMA) (per AUP Chapters F2-F7), the finished floor level, including freeboard, will be set in the resource consent.

The Chapter E36, E38 and E39 rules apply when the proposed site is:

- Within the 1% Annual Exceedance Probability (AEP) floodplain, or
- Within or over an overland flow path, or
- Within the coastal storm inundation 1% AEP area, or
- Within the coastal storm inundation 1% AEP plus 1 m sea-level rise area.

The 1% AEP threshold is also specified for use in the Auckland Council Stormwater Code of Practice (SWCoP) and is the size of event that secondary stormwater infrastructure is designed for.

Maps of the 1% AEP floodplain, overland flow paths, and coastal inundation extent are published on Council's GIS viewer (GeoMaps)[4]. The maps, which include an allowance for climate change, indicate whether a site is affected by a 1% AEP storm event. As the maps are indicative only, it is necessary to assess whether the site is subject to a 1% AEP hazard event.

The AUP and ACDPHGIS rules address a range of effects, including:

- The health and economic wellbeing of occupants of buildings within natural hazard areas
- The cumulative effects of natural hazards generated by more intensive use and development within flood and coastal inundation hazard areas
- The effects on the safety and well-being of individual households, present and future, and of those that are required to assist those people during flood/coastal inundation events.

It is the applicant's responsibility to demonstrate, as part of their consent application, that the proposed activity is appropriate/consistent with the provisions of the AUP/ACDPHGIS.

A subdivision consent will typically specify the safe and stable building platform and may include a condition of consent by way of a consent notice registered on the property title (when issuing a *Section 224(c) Restrictions upon deposit of survey plan certificate*)[5] specifying a finished floor level. The purpose of the condition is to ensure the flood/inundation hazard is recognised and provided for. However, further consideration of the finished floor level should also occur at the land-use consenting stage, to take into account any significant change and the sophistication of the flood/inundation hazard assessment at the subdivision consenting stage.

Prior to the building consent stage, generally, a resource consent is required for the development of a site subject to a natural hazard. Where a proposal only involves subdivision and provision of future utility connections and no building work is proposed to be undertaken, a building consent is not required.

2.3 The Building Act

The Building Act (BA) provides the national framework for building control. The Act governs the building sector and sets the rules for the construction and alteration of new and existing buildings. It contains provisions relating to the construction of buildings on land subject to natural hazards. If the land which supports a building is subject to the flooding and coastal inundation hazards, then Sections 71 to 74 of the Act may apply. The focus is to ensure that by granting a building consent for construction of or major alteration to a building on land subject to a natural hazard will not accelerate, worsen, or result in a natural hazard on the land on which the building work is to be carried out or any other property. The following table identifies the key provisions of the Building Act and Building Code.

[4] Link to GeoMaps: https://geomapspublic.aucklandcouncil.govt.nz/viewer/index.html

[5] The Section 224(c) Certificate (issued under the RMA) is one of the key documents needed to obtain Land Title.

Table 3: Building Act provisions

	Provision	Reference
Building Act	• The purpose of the Building Act includes that buildings are designed, constructed, and able to be used in ways that promote sustainable development.	
	• Provides for the setting of performance standards for buildings on land subject to natural hazards - including inundation (flooding, overland flow, storm surge, tidal effects, and ponding) - to ensure that people who use buildings can do so safely and without endangering their health; and buildings have attributes that contribute appropriately to health, physical independence, and well-being of the people who use them.	Sections: 32, 49, 71 – 74, 94
Building Code	• Sets out the mandatory requirements and performance criteria that buildings need to comply with. All building work/buildings must comply with the Building Code, whether or not a building consent is required in respect of that building.	Clause E1 Objective E1.1 Functional requirement E1.2 Performance E1.3.2
	• Prescribes the functional requirements for buildings and the performance criteria with which buildings must comply with in their intended use.	Clause B2 Objective B2.1 Functional requirement B2.2 Performance B2.3.1
Verification Methods and Acceptable Solutions	• A design that complies with a VMAS must be accepted by a building authority as complying with the Building Code, to which the VMAS relates	Verification Method E1/VM1
	• Acceptable Solutions and Verification Methods for New Zealand Building Code Clause E1 Surface Water	Clause 4.3.1

Building consents are required under the Act to ensure that the building work and the completed building or structure is safe, durable and does not endanger the health and well-being of current and potential future users. As with resource consent applications, the provision of sufficient and high-quality information is critical for the acceptance of the application and the efficiency of the consenting process.

Under section 49(1) of the Act, a building consent authority must grant a building consent if it is satisfied that building work complies with the Building Code. However, if the proposed building work is on land that is subject to one or more natural hazards, then Sections 71-74 of the Building Act must be applied. Those sections specify restrictions on building consents in relation to all new buildings and major alterations on land subject to natural hazards – the Building Act definition of natural hazards includes flooding and inundation (Section 71).

Section 71(1) includes a requirement for the consent authority to refuse to grant a building consent where the land is, or is likely to be, subject to one or more natural hazards. However, the Building Act does not specify minimum levels as to the probability or likelihood of natural hazards occurring. Recent MBIE determinations[6] have taken the approach that a 1% AEP event would satisfy the requirement in Section 71(1) that the:

> *"land on which the building work is to be carried out is likely to be subject to inundation"* (MBIE Determination 2021/013 para 6.41; Determinations 2019/067 para 8.2.4, 2019/034 para 6.2.2).

Section 71(2) provides an exception to S.71(1):

> *'S.71(1) does not apply if the building consent authority is satisfied that adequate provision has been made or will be made to protect the land, building work or other property from the natural hazard/s.'*

In such circumstances, a building consent must be granted under S.49(1) with no S.73 notification.

With respect to *adequate provision*, recent MBIE determinations have taken the view that compliance with the Building Code is accepted as:

> '…*adequate provision to protect the building work* (*MBIE Determination 2021/013, and 2017/080*).'

If *adequate provision* under S.71(2) cannot be made, a building consent can be granted under S.72 if certain criteria are satisfied. Section 73 sets out the conditions that must be included in a building consent granted under S.72. A requirement of S.73 is for a S.73 notification, which provides the building consent authority exemption from civil liability.

When a property owner exercises their rights to build on land subject to a natural hazard, Auckland Council is protected against civil liability under Section 392 of the Building Act 2004 when it grants a building consent pursuant to Section 72 and follows the requirements of the Building Act 2004.

As the implications arising from natural hazards are not straightforward, Auckland Council requires a statement from the applicant/owner that they have consulted with expert engineers and legal advisers, and that they understand the nature of the natural hazard and legal ramifications of a notice registered on the property tile under S.73. Council has a form – currently, AC2141 Acknowledgement of Risks from Owner(s) – to be used to record agreements.

If a building consent is granted under S.72, the Council (as the building consent authority) must notify the Surveyor-General, the Registrar of the Māori Land Court, or the Registrar-General of Land, as the case may be, who must enter on their record of title to the land on which the building work is to be carried out the notification and the particulars that identify the natural hazard (Ss. 73 & 74).

---

6 Determinations are made by MBIE on matters of doubt or dispute to do with building work. Rulings are legally binding, but only in relation to each case. Though previous determinations provide some guidance.

2.4 Key difference between the RMA and the Building Act

There are some key differences between the RMA and Building Act and debate as to whether provisions in plans and resource consents under the RMA relating to buildings and natural hazards can exceed the Building Act provisions.

In regard to establishing the finished floor levels of buildings in areas susceptible to flooding and coastal inundation, key differences between the Building Act and RMA are:

- Purpose: RMA controls the effects of natural hazards on the environment, whereas the Building Act is mostly focussed on the structural performance of buildings.
- Timeframe: under the Building Act, the *specified intended life of a building … not less than 50 years* vs NZCPS *hazard risks, over at least 100 years, are to be assessed*. Resource consents for land use and subdivision is unlimited, unless otherwise specified in a consent (a resource consent may have a maximum duration of 35 years).
- Annual exceedance of probability: The Building Code sets the performance standard of: *Surface water, resulting from an event having a 2% probability of occurring annually, shall not enter buildings*. Whereas the AUP specifies the use of a 1% AEP event threshold for flooding and coastal inundation (including the effects of climate change). The AUP is generally aligned with Ministry for the Environment guidance, e.g. MfE, 2017, that over more than 100 years should be considered to avoid hazard risk.
- In flood management, the 1% AEP flood event has largely been accepted as good hydrological engineering practice under the RMA, though it is also relevant to consider events with a lower probability of occurrence.
- Climate change and sea-level rise: Climate change is not explicitly referenced in the Building Act, whereas it is in the RMA, and plans under the RMA.
- The RMA addresses a wider range of effects and issues than addressed under the Building Act.

Where both the RMA and Building Act apply, the requirements of both Acts must be adhered to. However, if an RMA reason (the control of activities or the effects of activities in terms of the RMA) for imposing a condition requiring freeboard of consent is clearly articulated, the condition will not be inconsistent with the natural hazard sections in the Building Act and may complement them. In principle, there is nothing preventing a resource consent condition requiring a freeboard that is more stringent than (can be) specified in a building consent. A more stringent requirement under one Act can't be negated by compliance to a lesser requirement imposed under another Act.

2.5 Other statutory provisions

The Auckland Council Stormwater Bylaw (2015) is also a relevant regulatory provision in regard to freeboard, particularly for assets to be vested in Auckland Council. Refer to Table 4.

Table 4: Auckland Council Stormwater Bylaw (2015)

Bylaw	Provision
Auckland Council Stormwater Bylaw (2015)	• Key purpose is to provide a consistent regulatory approach for managing the public stormwater network across Auckland. • Provides the legal basis for the implementation of The Auckland Code of Practice for Land Development and Subdivision, Chapter 4: Stormwater (SWCoP). • The SWCoP sets out the minimum technical standards, including for freeboard, for the design and construction of new stormwater infrastructure that is to be vested in Auckland Council ownership.

2.6 Other Council plans

In the broader planning framework, the plans in the table below provide guidance for management of flooding and coastal inundation hazards and building resilience.

Table 5: Other Auckland Council plans

Other Council Plans	Provision
Auckland Plan 2050	• The plan outlines the big issues facing Auckland, including the need to reduce and mitigate the threats of natural hazards and minimise the impacts on people, e.g. by having safe and secure houses.
Te Tāruke-a-Tāwhiri: Auckland's Climate Plan (2020)	• Council's roadmap for the long-term approach to climate action. • It recognises Auckland's existing exposure to flood hazards, the potential for climate change to increase the severity and frequency of flooding, and the need to manage the built environment to be resilient to climate change and other natural hazards. • Both the Auckland Plan 2050 and Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan advocate for greater resilience to severe storms and flood events.
National Hazards Risk Management Action Plan	• Create resilience to the potential risks of natural hazards, supported by strengthening our cultural uniqueness with a network of prepared communities and a sustainable environment.

Both the Auckland Plan 2050 and Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan advocate for greater resilience to severe storms and flood events.

The Natural Hazard Risk Management Action Plan is a key component of Auckland Council's natural hazard management approach and sits alongside other strategic documents such as Auckland Civil Defence Emergency Management's (CDEM) Group Plan 2016-2021 (under review) and the Coastal Management Framework (2017). This guidance has been developed in accordance with Action 10.2 of the NHRMAP.

2.7 NZS 4404:2010 Land Development and Subdivision Infrastructure (Non-statutory)

This Standard is a non-statutory guide and contains the following provisions regarding stormwater and freeboard (see Table 6).

Table 6: NZ Standard 4404:2010 Development and Subdivision Infrastructure

<table>
<tr><th>Standard</th><th>Provision</th></tr>
<tr><td>NZS 4404:2010 land Development and Subdivision Infrastructure (Non-statutory)</td><td>4.3.5.2 Freeboard
The minimum freeboard height additional to the computed top water level of the 1% AEP design storm should be as follows or as specified in the district or regional plan:
<table>
<tr><td>Freeboard</td><td>Minimum height</td></tr>
<tr><td>Habitable dwellings (including attached garages)</td><td>0.5 m</td></tr>
<tr><td>Commercial and industrial buildings</td><td>0.3 m</td></tr>
<tr><td>Non-habitable residential buildings and detached garages</td><td>0.2 m</td></tr>
</table>
The minimum freeboard shall be measured from the top water level to the building platform level or the underside of the floor joists or underside of the floor slab, whichever is applicable.</td></tr>
</table>

The Standard defines freeboard as:

> *A provision for flood-level design estimate imprecision, construction tolerances, and natural phenomena (such as waves, debris, aggradations, channel transition, and bend effects) not explicitly included in the calculations.*

In NZS 4404:2010 it is stipulated:

> *The minimum freeboard shall be measured from the top water level to the building platform level or the underside of the floor joists or underside the floor slab*

… whereas the Building Code and Council applies freeboard in relation to finished floor levels.

2.8 Regulatory assessment

Auckland Council's regulatory assessment is an independent process whereby an applicant's proposal is assessed to determine conformity with the relevant regulatory requirements. The assessor's role is to determine whether the work reviewed meets the regulatory requirements, accepted industry standards and is of a suitable quality and level to inform the required decision making. Technical expertise, current best-practice and unbiased judgement is used to review the work.

The assessment should consider:

- Whether:
  - The modelled flood water level is suitable for the purpose
  - All appropriate factors have been adequately considered
  - Any deviations from the freeboard determination process outlined are reasonable and appropriate
  - Documentation provided in support of the application is clear
  - The proposed minimum floor level, including freeboard, is robust and defendable
- What is current best practice
- A sense check of results.

The regulatory assessment provides a layer of scrutiny to give confidence that the recommended minimum floor level, including freeboard, is suitable for the intended purpose. It is based on information provided by the applicant and does not replace the applicant's overall responsibility.

The recommended first step for most land development projects is a pre-application meeting with Auckland Council to identify a range of consent requirement issues, including those relating to the Engineering Approval process.

Engineering plan approval is an integral part of the land development process and is generally required by a condition of the subdivision consent. Unless engineering plan approval is obtained, the subdivision consent has not been fully complied with and no Section 224(c) Certificate can be issued.

3.0 Fluvial and pluvial flood level information

Flooding resulting from rainfall is Auckland's most commonly occurring natural hazard. Flood events vary in size, frequency, and location. Approximately 16% of the Auckland land area is within the 1% AEP floodplain. A 1% AEP event is experienced somewhere in the region every three to five years.

Flooding can be caused by long, intense rainfall events over a large spatial area and, as more commonly experienced in Auckland, high intensity rainfall events on a smaller geographic scale. These cause flooding in a number of catchments or sub-catchments.

Most catchments in urban Auckland are relatively small and prone to impacts from high intensity, short duration rainfall events. The time of concentration can be in the order of 30 minutes or less. In comparison, the time to peak discharge in large river catchments can be hours or days.

Factors influencing flood levels, especially in small urban catchments, are:

- The often-significant proportion of impervious surfaces
- The capacity of artificial drainage – pipes and concrete channels
- Reduced storage in floodplains, e.g. through earthworks and building development
- Obstacles in the flow path, e.g. culverts, buildings, landscaping.

Auckland Council has a developed an extensive flood mapping programme. The modelled spatial extent of potential flooding is published on Auckland Council's web-based portal GeoMaps (under the Natural Hazards theme). The flood hazard maps developed at catchment scale indicate flood plains, flood-prone areas, flood-sensitive areas, and overland flow paths which may be affected by a rainfall event that has a 1% AEP (which is also generally known as a 1 in 100-year ARI).

The flood-level information is published as a non-statutory layer of the AUP to make Council's most up-to-date information[7] easily available to the public, developers, and their agents.

3.1 Floodplains

Flood plains are defined in the Auckland Unitary Plan (AUP) as: "the area of land that is inundated by runoff from a specified rainfall event", with an upstream catchment generating 2 m^3/s or greater of above-ground flow (flow up to 2 m^3/s is considered to be overland flow).

The flood maps, produced at catchment scale, were developed using digital terrain models (based on ground surface data collected from airborne LiDAR surveys, supplemented by ground-based surveys) and a variety of hydrological and hydraulic models. Figure 3 below is an extract from GeoMaps of a flood plain area.

[7] To check whether there has been an up-date yet to be published contact: HWDevelopment@aucklandcouncil.govt.nz

Figure 3: Extract from GeoMaps of a flood plain area (the blue shaded polygon areas)

The hydrological and hydraulic models used to produce the maps account for variations in:

- Rainfall
- Climate change effects (for the majority of areas)
- Soil types
- Runoff
- Catchment area
- Impervious coverage (including potential future increases in impervious areas that may arise from changes in land use enabled by the policies and zonings of the AUP)
- Topography
- Drainage paths
- Travel times through a catchment
- Obstructions to flow paths.

Information specific to each mapped flood plain is accessible via GeoMaps – using the Identify tool, and the flood model report – and/or from Auckland Council's Healthy Waters & Flood Resilience Catchment Planning Team (HWDevelopment@aucklandcouncil.govt.nz).

The majority of flood hazard maps include an allowance for the effects of climate change, in line with climate change projections and requirements at the time of production. As a result, the climate change projections/assumptions applied to the flood hazard maps can differ depending on the date they were produced. Some flood hazard maps may incorporate what is now considered to be out-of-date (lower) climate change projections.

The regional floodplain models and maps are updated periodically, generally on a 10 - 15 year rolling cycle, to take into account updated data, e.g. new rainfall, topographic and network data, and new climate change information.

The calculation of flood flows and flood levels is sophisticated, but not an exact science. Knowledge of flood mechanisms and extents is continually evolving and improving, as are datasets. Auckland Council's flood-hazard maps provide an understanding of the flood hazard extent and inform site-specific flood assessments. However, as flood risks at a property/site level can be influenced by local factors, a site-specific assessment by a suitably qualified and experienced person of the extent, depth and flow characteristics of the floodplain is the best way to determine the extent of the flood hazard.

3.2 Flood prone areas

Flood-prone areas are areas where ponding may occur in a 1% AEP rainfall event, assuming any outlet to the flood-prone area is blocked. The mapped extent is the area that water will pond up to before starting to spill downstream. Flood-prone areas can occur naturally, or because of constructed features, e.g. road embankments can act as dams when stormwater outlets are blocked. Figure 4 is an extract from GeoMaps illustrating a mapped flood-prone area.

Flood-prone areas have been identified using GIS techniques and are not based on hydraulic modelling. Ground surface data collected from airborne LiDAR surveys (flown in 2016 – 2017), the maximum probable development (MPD) as defined in the AUP for the catchment, and a 2.1^0 climate change scenario – termed future scenario – were used in the identification of the currently published flood-prone areas.

Figure 4: Extract from GeoMaps of a flood-prone area (the hatched area)

The risk of blockage, particularly at culverts along overland flow paths is present for most flow paths. As flood-prone areas can fill in a frequent event if their outlet is blocked, they should not be considered to be of low risk and should be considered in the site-specific flood risk assessment. Figure 5 illustrates partial blockage of a culvert.

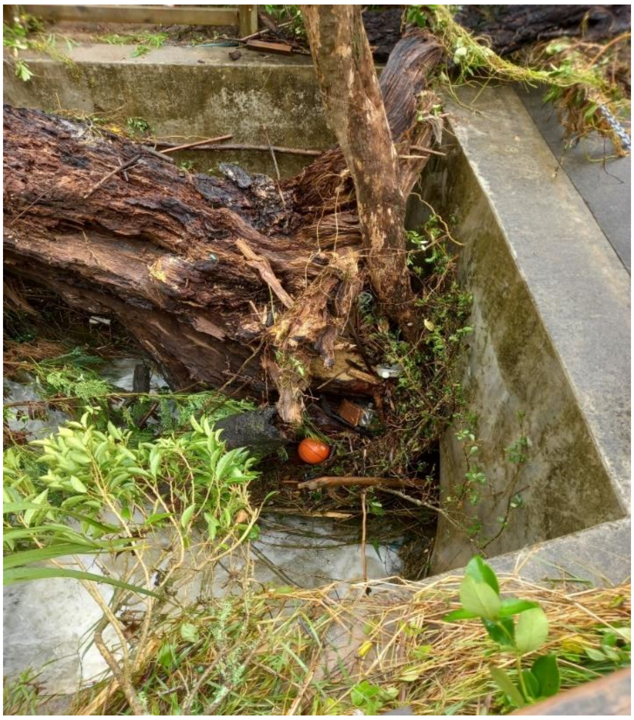

Figure 5: Storm debris partially blocking a culvert, potentially exacerbating the flood risk.

3.3 Flood sensitive areas

Mapped flood-sensitive areas are published for some catchments (currently for North Shore areas) bordering the mapped 1% AEP flood plain areas that are within 0.5 m elevation of the modelled 1% AEP – 100-year ARI flood level. These maps highlight the areas near to the 1% AEP floodplain that are potentially influenced by 1% AEP flood events.

3.4 Overland flow paths

Overland flow paths are defined in the AUP as low points in terrain, excluding a permanent watercourse or intermittent river or stream, where surface runoff will flow, with an upstream catchment exceeding 4000 m^2. Mapped overland flow paths indicate the location and direction of the overland flow of stormwater when the stormwater network is overloaded.

Overland flow path locations are indicated by a line feature, representing the modelled centreline of the primary flow (estimated for shallow sheet flows), and accordingly, do not show the extent of the flow, only its general location and direction.

Figure 6: Overland flow path Asquith Avenue, Mt. Albert. The left-hand image is a photo taken of the Asquith Ave / New North Road intersection during an extreme rain event 2023. The right-hand image is an extract from GeoMaps of the same intersection showing the mapped overland flow paths. The blue lines indicate the overland flow path.

As for flood-prone areas, overland flow paths have been identified using GIS techniques. Mapped overland flow paths total 94,000 km in length across the region. Figure 6 is an extract from GeoMaps, with an accompanying photograph of the overland flow path in an extreme storm event.

The function of an overland flow path is to safely pass flows that are not able to be contained within the primary stormwater network (whether that be pipes or streams) without adversely affecting public safety, property, or buildings.

3.5 Modelled vs actual flood areas

Differences between the mapped flood hazard areas published in GeoMaps and the actual extent of flooding in a storm event can be because of a number of factors including:

- The magnitude of the storm event
- The scale (catchment) at which the maps are produced
- Rainfall
- Variability over the catchment
- Blockages in the stormwater conveyance network
- Climate change
- Changes in land use
- Site-specific features.

As the frequency and intensity of hazard events are changing (result of climate change) we can no longer simply rely on the occurrence of past events as a reliable indicator of future events. The published flood hazard areas therefore do not necessarily show all areas that may be subject to flooding. Hence the need for site-specific assessments.

When determining the site-specific extent of a flood hazard for a particular site, a suitably qualified and experienced person can review the model assumptions, inputs, and limitations (contained in the modelling report) and discuss the limitations or matters arising with a specialist in Auckland Council's Healthy Waters Catchment Planning Team. (HWDevelopment@aucklandcouncil.govt.nz).

4.0 Coastal inundation

Coastal inundation is the flooding of normally dry, low-lying coastal land due to extreme high sea-water levels. Extreme sea levels can result from several processes including astronomical tides, monthly mean sea-level anomalies, and storm-surge. In areas of open coast, waves during certain conditions can also raise the effective sea level.

Extreme high sea-water levels (commonly referred to as storm tides) are a result of a storm surge coinciding with a high spring tide. When king tides (the highest spring tides that occur over the year – when the Earth, Sun and moon are nearly in alignment, and the moon is either new or full and closest to Earth) occur the risk of inundation is greatest, whereas a large storm surge coinciding with a neap high tide is unlikely to cause any inundation (Figure 7).

A storm surge occurs due to relatively low atmospheric pressure (the" inverted barometer" effect of a 1 cm rise in sea level per 1 hPa fall in pressure) combined with water level set-up at the coast from onshore winds or alongshore winds. The lowest known recorded barometric pressure at Auckland Airport is 972 hPa (17-Aug-1990), which acting alone would have produced an increase in sea level of 0.44 metres, leaving aside any wind or wave set-up contribution to water level.

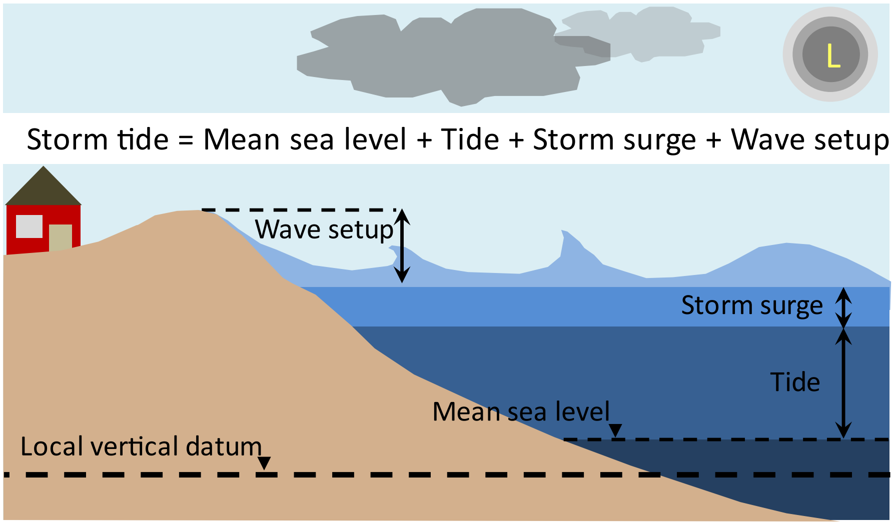

Figure 7: Schematic of causes of coastal inundation

4.1 Coastal inundation maps

Auckland Council's best available information for determining extreme high sea-water values in the Auckland region is presented in Auckland Council Technical Report TR2020/024: *Auckland's exposure to coastal inundation by storm-tides and waves*[8]. The report collates four separate reports across the Auckland region, detailing the inundation modelling methodologies applied and resultant

[8] Auckland's Exposure to Coastal Inundation by Storm-tides and Waves, TR2020/024, Carpenter, N; R Roberts and P Klinac (Auckland Council 2020)

predicted extreme water levels. The separate reports did not calculate wave set-up and sea-level rise was not calculated in all four reports.

The report supports the online spatial mapping of potential coastal inundation published on GeoMaps (Natural hazards theme).

Coastal inundation information is published as a non-statutory layer of the AUP to make the most up-to-date information Auckland Council has easily available to the public, developers, and their agents. Figure 8 provides an extract from GeoMaps illustrating the predicted area of coastal inundation for a specific locality.

Figure 8: Areas susceptible to coastal inundation at Mission Bay and Kohimarama. The left-hand image is an extract from GeoMaps of the base map. The right-hand image is the same map illustrating the predicted extent of coastal inundation in three scenarios: in a 1% AEP storm event (dark blue area), in a 1% AEP storm event plus 1m sea-level rise (grey area), and in a 1% AEP plus 2m sea- level rise scenario (light blue area).

The coastal inundation maps were developed using digital terrain models (based on ground surface data collected from airborne LiDAR surveys), and calculated extreme high-seawater values at fixed locations across the region using:

- Sea-level/tide-gauge data
- Monthly mean sea-level anomalies
- Historic storm surge data
- Hydrodynamic models.

Predicted coastal inundation areas were mapped using the static level inundation mapping technique; whereby all land lying below the calculated extreme water level that has a direct flow path to the coast is assumed to be flooded in its entirety.

Static inundation mapping provides a region-wide and consistent basis for delineating areas exposed to both present-day and future coastal storm inundation. However, the technique is conservative and does not fully capture the dynamic and time-variant processes that occur during a coastal-storm event along some of Auckland’s coasts such as in upper harbour estuarine areas, e.g. Parakai/ Helensville in the south of the Kaipara Harbour.

The extent of land that may be inundated in a coastal inundation 1% AEP event and in a 1% AEP event plus 1 m and plus 2 m sea-level rise has been mapped. The coastal inundation maps are not the definition of whether a specific site is affected by coastal inundation, rather they are indicative of the extent of the coastal area likely to be inundated.

As for the determination of the area susceptible to flooding, the calculation of the areas susceptible to coastal inundation is sophisticated, but not an exact science. Our knowledge of coastal processes is continually evolving and improving. Auckland Council's coastal inundation mapping is at the regional level, whereas coastal inundation risks at a property or site level can be influenced by local factors. The published information provides an understanding of the coastal inundation hazard extent and informs site-specific flood assessment. However, site-specific assessment of the factors that may affect a site or property is required to determine the extent and water level of the coastal inundation hazard. Figure 9 illustrates elevated water levels, and consequent inundation on Tamaki Drive.

Figure 9: Storm conditions elevating water levels overtops Tamaki Drive Seawall, floods road. (Source: Simon Maude Stuff)

4.2 Modelled vs actual coastal inundation areas

All coastal inundation risk assessments are complex, hence they need to be site-specific and carried out by technical experts.

There will be differences between the published mapped coastal inundation hazard areas in GeoMaps and what occurs in the real world. For example, wave set-up and wave run-up can further increase extreme water levels, and so where appropriate, also need to be considered, e.g. on open coasts. Further, the frequency and intensity of hazard events are changing as a result of climate change.

It is appropriate to consider recent information (more so than when the maps were developed), including changes in the built environment, and updated regional climate projections for Auckland.

Fluvial and pluvial flooding may also contribute to flooding by coastal inundation, e.g. when the flood discharge is constrained within narrow sections of an estuary. A site-specific assessment will need to determine the cumulative impacts or dominant processes on overall flood water levels.

4.3 Sea-level rise

Determining coastal inundation extreme water levels also requires consideration of sea-level rise and vertical land movement (relative sea-level rise). Sea level is significant as it controls where particular forces act upon the shoreline, including whether storm surge may inundate low-lying coastal areas.

The AUP requires consideration of a 1 m sea-level rise over a 100-year timeframe[9], based on the best available information at the time the AUP was produced (2016). However, since then, more up-to-date sea-level rise projections have been provided, and it is appropriate to take that information into account as well.

The Intergovernmental Panel on Climate Change (IPCC) periodically reports on climate change and its effect on sea-level. The latest and sixth IPCC report (IPCC AR6, 2021), based on new information, includes five emission scenarios (three of which are similar to those presented in their previous 2013 AR5 report). The AR6 report projects slightly more warming for a given pathway than the scenarios reported in its previous report and an associated increase in sea-level projections. The AR6 report also includes a scenario for a potential low likelihood, high consequence event of marine ice cliff instability/collapse.

The IPCC reported sea-level rise is accelerating and is likely to continue to do so. By 2100, the IPCC expect sea level to rise between 0.4 – 1.1 m, depending on global greenhouse gas emissions and polar ice-sheet instabilities. By 2150, the projected range of sea-level rise is 0.7 – 2.0 m.

---

9 AUP Chapter E.36, Policies E36.3(5) & (9)

The NZSeaRise research programme[10] released updated sea-level rise projections for New Zealand that combine the IPCC AR6 sea-level data with calculated localised rates of vertical land movement round the coast – estimating relative sea-level rise. The sea-level rise projections are available from NZSeaRise website[11].

MfE's (2024) *Coastal hazards and climate change guidance* contains guidance on risk assessments, timeframes, scenarios, sea-level rise and vertical land movement projections. MfE recommends planning for a possible range of sea-level rise scenarios; precautionary planning to build longer term resilience for coastal developments and natural environments using the new "medium confidence" shared socio-economic pathways (SSPs) and their associated sea-level rise projections. MfE also recommends using relative sea-level rise scenarios that include the local vertical land movement rate at the local scale, and the high-end emissions scenario SSP5-8.5 H+, which represents a plausible upper range for relative sea-level rise, to reflect the deep uncertainties associated with changes to future sea-level.

See also MfE's National Adaptation Plan (2022), which provides recommendations for hazard and risk assessments.

The *Land inundation from sea-level rise in the Auckland Region* report by NIWA (currently work in progress) will provide an indication of the areas of land at risk from future sea-level rise.

---

10 A five-year (2018 – 2023) research programme funded by the Ministry of Business, Innovation and Employment

11 https://www.searise.nz/maps-2

5.0 Uncertainties in extreme water level estimation – the reason for freeboard

The reason for freeboard is to limit and reduce risk to flooding and coastal inundation natural hazards, thereby ensuring more resilient and sustainable building development.

Freeboard is a factor of safety or risk reduction mitigation that provides for the uncertainties and/or imprecision in the estimation of flood/inundation water levels, and for phenomena which are not explicitly included in flood or coastal inundation water level calculation or modelling. For example, waves and velocity head are processes which elevate the water surface that are generally not accounted for in flood modelling. See Figure 10, showing vehicle traffic generating waves (elevate surface water level) in a flooding event.

If an appropriate freeboard is not included for a development in an area susceptible to a flood and/or coastal inundation hazard, there is a lower degree of certainty that the asset will not be flooded/inundated in the design event (generally 1% AEP) over its design life. Whereas inclusion of an appropriate freeboard provides a high degree of confidence of mitigation/protection to the design life standard.

There are several sources and types of uncertainty. Some can be known (little uncertainty), and some unknown and cannot be eliminated or reduced (deep uncertainty), e.g. because of the variability of natural systems. For example, it is reasonably certain sea level will continue to rise for at least several centuries, however there is deep uncertainty on the rate or magnitude of the rise.

The uncertainty in modelling outputs is often not quantified, yet freeboard is to provide for uncertainty.

Where serious risk exists alongside scientific uncertainty, it is appropriate to take a precautionary approach, as Auckland Council's infrastructure needs to be resilient to protect and enhance the wellbeing of Aucklanders.

Auckland Council's flood and coastal inundation-level modelling includes elements of uncertainty at the site-specific level, as they are developed at the catchment level and as they (like all models) are a simplification of reality and include a series of assumptions which will affect individual properties differently. The level of detail appropriate at a site-specific location depends on, and should be proportional to, the use and potential value at risk.

Figure 10: Vehicles driving through flood waters generating waves. Source: NZ Herald

The consideration of uncertainties and imprecision in the calculation of freeboard should be of parameters that can directly influence determination of the finished floor level, including:

- Scientific and engineering uncertainties, such as information and data gaps including:
  - Relatively short records of past flood and coastal inundation events
  - Frequency of hazard events is changing (can no longer rely on occurrence of past events as a reliable indicator of future events)
  - Accuracy of hydrological and hydraulic data inputs
  - Accuracy of determination of other physical processes
  - The performance of stormwater soakage devices within a catchment
  - Incomplete understanding of the climate change system
  - Vertical land movement: arising from both the quality of the VLM data and the uncertainty of how VLM trends will track in the future.
- Modelling uncertainties and simplifications, including:
  - Local factors that can result in differences in extreme water levels across the floodplain and coastal inundation area
  - Site-specific factors that have the potential to increase actual flood levels include: the effect of local/neighbouring buildings, fences, walls; topography; locally generated waves. Near the coast, wind-generated waves
  - Waves can result from local factors: wind from meteorological events, and movement of vehicles through flooded/inundated areas

    - Level of detail included within hydrological and hydraulic analysis
    - Assumption of static/flat extreme water levels do not replicate the undulations in surface water levels that occur during flood or coastal inundation events.
- The cumulative effect of intensification and infill development
- How fast changes may manifest themselves
- How assets at risk will change in physical and monetary terms, and the level of protection that can be implemented to reduce their vulnerability to potential losses through adaptation measures.

In addition to checking the sources of potential error, undertaking sensitivity analysis of inputs, e.g. of infiltration loss or percentage of impervious area plus/minus 10%, is a common means to inform site-specific decision making.

Transparency on the matters that determine a calculated or modelled extreme water level, the accuracy with which the various factors have been measured, calculated, and modelled, and clear definition of the acceptable level of future risk for a site-specific development and use are key to determining appropriate freeboard allowance.

6.0 Default freeboard levels

The Auckland Code of Practice for Land Development and Subdivision, *Chapter 4: Stormwater* sets out the minimum freeboard for the design and construction of new stormwater infrastructure that is to be vested in Auckland Council ownership. The specified freeboard levels are provided in Table 7. They are based on past practical stormwater management and industry practice, range from 0.15–0.5 m, and are consistent with the freeboard which is generally required by New Zealand local government agencies.

Table 7: Default freeboard levels for Auckland buildings

Scenario	Freeboard
More Vulnerable Activities* in floodplains	• 500 mm
Less Vulnerable Activities* in floodplains	• 300 mm
Overland flow paths where flow is less than 2 m^3/s	• 500 mm where surface water has a depth of 100 mm or more and extends from the building directly to a road or car park, other than a car park for a single dwelling • 150 mm for all other cases
Overland flow paths, where flow is equal to or in excess of 2 m^3/s	• 500 mm for More Vulnerable Activities* • 300 mm for Less Vulnerable Activities*
Coastal Storm Inundation Areas (1% AEP including 1 m sea-level rise) **	• 500 mm for dwellings and habitable rooms which are subject to wave action from the sea • 150 mm for all other cases

* As defined in the AUP.

** See Section 6.1

Here, those freeboard levels are referred to as *default freeboard levels,* indicating they are likely to be appropriate in most circumstances, but that needs to be demonstrated via a site-specific assessment commensurate with the level of risk by a suitably qualified and experienced person. The flood/inundation hazard assessment is an essential element to inform designers of the proposed development of the associated risks.

There are some circumstances where the default freeboard levels are more unlikely to be sufficient than others, including:

- Where blockage, or partial blockage of a watercourse is likely to elevate the flood/inundation level at the site
- Where neighbouring structures including fences may exacerbate the flood hazard. The AUP specifies standards for buildings/fences in order to mitigate and avoid the 1% AEP flood hazard
- Where pluvial flood and coastal inundation occur/affect the same site

- Where the default freeboard/mitigation may be not proportionate to the risk, e.g. perhaps for a retirement home proposal.

In such circumstances a higher freeboard may be appropriate.

6.1 Coastal storm inundation exception

If a proposed new building containing a habitable room (e.g. a dwelling) is not to be located within a 1% AEP coastal storm inundation area but would be located within a 1% AEP coastal storm inundation plus 1 m sea-level rise (SLR) area, and its proposed floor level is above the 1% AEP coastal storm inundation level plus 1 m SLR, then a landuse consent is not required (Rules (A11) and (A12), Activity Table E36.4.1, AUP).

In such circumstances, freeboard for coastal storm inundation mitigation cannot be required by a condition of a land-use consent and cannot be required under the Building Act. However, provision of freeboard should be encouraged, e.g. during a pre-application meeting, to protect the building and its use. Serious consideration should be given to issuing a s.73 Notice[12] under the Building Act if a freeboard is not agreed upon.

This *coastal storm inundation exception* only applies if no landuse consent is required. If a subdivision consent is required, then the issue can be fully assessed, including any appropriate freeboard levels, as part of the application for subdivision consent. Any minimum finished floor levels including freeboard can be imposed by a consent notice on the subdivision.

---

12 A s73 Notice alerts future owners to the presence of hazards and ensures that councils are protected against civil liability when granting consent to build on land subject to a natural hazard.

7.0 Reviewing freeboard calculations - are the default freeboard levels appropriate?

This section sets out key matters that should be considered by a suitably qualified and experienced person to determine whether a default level of freeboard is appropriate for a particular site. People, buildings, structures, and infrastructure are not all the same, and their vulnerability to flooding and coastal inundation varies significantly. The amount of freeboard should be proportionate to the nature and risk presented by the natural hazard.

Understanding the uncertainties, quantification and transparency on the matters considered in calculating a proposed freeboard better informs decision-makers and provides for confidence in the design of resilient infrastructure and finished floor levels.

7.1 Catchment stormwater flooding

Confirming whether the default freeboard is appropriate for any specific location is a three-step process:

7.1.1 Step 1: Catchment and hydrology – what flows and volumes are arriving at the site.

The upstream catchment and flows arriving at the site and uncertainties associated with those flows need to be considered (Table 8).

Table 8: Catchment and hydrology

Determine potential flooding level (extreme water level)	• Use Council's flood hazard maps, flood model and catchment reports to identify (desk top level) whether a particular site is on land susceptible to a flooding hazard, and the modelled extreme water level for specific design events.
Understand the specific model assumptions and inputs (hydrology/design	• Does the hydrological model include a climate change allowance in accordance with the current central government and Auckland Council advice on climate change? • In the event that the modelled climate change allowances are less than RCP8.5/SSP5 at 2110[13]; has a sensitivity analysis been carried out (using this allowance) which has confirmed that the modelled flood flow results are not sensitive to a more conservative or long-term climate change assumption?[14]

[13] For the Auckland Region, the projected temperature increases for this scenario at 2110 is 3.5^{0} C or more (Te-Tāruke-ā-Tāwhiri: Auckland's Climate Plan). More recently it has been determined a temperature increase of 3.8^{0} C should be applied (Climate scenarios. Auckland Council Guideline Document, GD15), which remains consistent with the Te-Tāruke-ā-Tāwhiri: Auckland's Climate Plan direction.

[14] New Zealand's National Adaptation Plan (MfE 2022) recommends sensitivity analyses be carried out using SSP5 to 2130. At the time of writing this Guidance Document, information was not readily available to enable analysis to this timeframe. Once that information is publicly available for New Zealand that should become the default basis for sensitivity analysis. Until that information is available it is recommended that the analysis be based on the mid-range of RCP8.5 to 2110 (3.8^{0}C for Auckland).

flowrates and volumes)	• Does the model include an impervious area for the maximum probable development scenario that has been estimated based on AUP's maximum allowable permitted impervious areas for various land uses? • Does the model (either Auckland Council or applicant provided) accurately represent the existing landform in the contributing catchment? • Confirm no significant changes have occurred that influence flow direction/rate since the model was developed, e.g. no fences, walls or other structures, or earthworks constructed that will influence flowrates or volumes. *If you answer 'No' to any of these questions, site-specific analysis is required*

7.1.2 Step 2: Site specific hydraulic conditions – what are the flood levels and extents?

Site-specific hydraulic conditions (Table 9) can affect flood levels and extents resulting from those flows. As a general rule, modelled flow and level information provided from Auckland Council models will not include site-specific hydraulic analysis and does not consider site-specific development proposals.

Table 9: Site-specific hydraulic conditions

Understand the site-specific situation (hydraulics)	• Is the site located within a Flood Hazard Area? If so:
	  ○ If the site is within a Flood Prone Area, best practice is to use the 1% flood prone level[15], or a specific calculation by the developer if the flood-prone area overtops. (It will be higher than the flood-prone level documented as it has to overflow the crest).
	• Is the site at or below 6 m RL? If so:
	  ○ Is the downstream boundary condition lower than specified in the current Auckland Council (Healthy Waters) Stormwater Modelling Specification[16]?
	  ○ Is the building in an area that may be subject to deposition and hence at risk of the effective flood elevation being raised?
	• Are there any (existing or proposed) features of the site, or near the site, that would or could impact on flood extent or levels, that are not picked up in the modelling?
	  ○ E.g. walls, buildings or building components (e.g. columns, piles, beams, joists, bearers etc.), fences, etc.
	• An applicant is to confirm the accuracy of stormwater asset data in this area:
	  ○ Confirm that the stormwater asset data is accurately reflected in the modelling carried out to support the flood levels.
	  ○ Where accuracy of asset data is poor or unknown, could any differences in asset data affect the predicted flood level?

15 This can be found in GeoMaps as the 'flood prone elevation in 100yr ARI event (mRL).

16 The Modelling Specification can be provided via enquiry to HWdevelopment@aucklandcouncil.govt.nz.

	• Is the velocity of flow though the site greater than 2 m/s in a 1% AEP event? • Are there, or will there be, any changes in direction of flow on the site that create superelevation at the location of change that has not been considered? If you answer 'Yes' to any of these questions, specific analysis is required to determine the sensitivity of the flood level to these hydraulic controls and whether a higher freeboard is appropriate to manage the impacts of that sensitivity.

7.1.3 Step 3: Additional considerations

Identify any additional factors that may affect the design flood level and the calculation of freeboard (Table 10). Calculate the potential amount of freeboard required and compare that against the default freeboard. Record the rationale for the proposed amount of freeboard.

Table 10: Additional factors

Cause of flooding	• Is the site is also susceptible to coastal inundation, and if so will that superelevate overall flood water levels?
Consider uncertainties	• Consider the range of uncertainties, in particular any additional to those considered as part of preceding steps, e.g. is the site potentially exposed to vehicle generated waves elevating floodwater level?
Calculate potential minimum floor level and freeboard	• Calculate the potential minimum floor level
Is a lower freeboard appropriate?	• For example consider: ○ Is the application regarding a building that will only occupy the site for a (short) temporary period? ○ Are the hydraulic conditions such that the surface flood water level cannot exceed the proposed finished minimum floor level, e.g. the surface flood water level can only reach a certain level due to spill level of a depression, and the risk of waves and velocity head is minimal? ○ Would the maximum flood water depth be less than 100 mm? ○ Are there factors such as structures that may attentuate inundation? • If any of these apply, then a freeboard lower than default may be acceptable – site-specific anlaysis is required to support a proposed lower freeboard.
Compare	• Compare the derived freeboard (derived in calculation of potential minimum floor level in the step above) against the default freeboard.
Determine	• Determine proposed freeboard, document the rationale.

7.2 Coastal inundation

Confirming whether the default freeboard is appropriate for any specific location susceptible to coastal inundation involves assessment of a range of factors as outlined below (Table 11 and 12):

7.2.1 Step One – Determine freeboard

Table 11: Coastal inundation – calculating freeboard

Determine potential inundation level (extreme water level)	• Use Auckland's exposure to coastal inundation by storm-tides and waves, Auckland Council technical report 2020/024[17].
Understand the specific model assumptions and inputs	• Consider the coastal environment, i.e.: ○ Open coast/sheltered coast/harbour/estuarine environment ○ The model applied, i.e. static or hydrodynamic modelling ○ Whether wave setup is included. • Does the model (either Auckland Council or applicant provided) accurately represent the existing landform? ○ Confirm no significant changes have occurred that influence flow direction/rate since the model was developed, e.g. no fences, walls or other structures, or earthworks constructed that will influence flowrates or volumes.
Adequate provision for sea-level rise	• Use the latest Central Government guidance (currently NAP 2022 and *Coastal hazards and climate change guidance* (MfE, 2024)). • Whilst the AUP specifically[18] requires consideration of a 1 m sea-level rise, the most up-to-date SLR figures should also be used. • Determine whether a mean sea-level offset is required in relation to the NZ local vertical datum.
Vertical land movement	• Address provision for vertical land movement (as relevant).
Wave setup	• Identify the extent of likely wave setup, as relevant, e.g. open coast sites.
Wave runup	• Identify the site's potential exposure to wave runup
Cause of inundation/ flooding	• If the site is also subject to fluvial or pluvial flooding, determine the dominant processes on overall flood water levels.
Consider uncertainties	• Consider the range of uncertainties, in particular any additional to those considered as part of preceding steps, e.g. potential for vehicle-generated waves elevating inundation level.

[17] Auckland's Exposure to Coastal Inundation by Storm-tides and Waves, TR2020/024, Carpenter, N; R Roberts and P Klinac (Auckland Council 2020)

[18] AUP Policies 36.3 (5) & (9), but also see (1), (6) & (8).

Calculate potential minimum floor level and freeboard	• Calculate the potential minimum floor level.
Any other factors	• For example consider: ○ Are there factors such as structures that may attentuate inundation? ○ Is the maximum inundation water depth less than 100 mm?

7.2.2 Step Two – Compare minimum floor level + default freeboard with determined freeboard

Table 12: Coastal inundation – determining freeboard

Compare	• Compare the derived freeboard (derived in calculation of potential minimum floor level in the step above) against the default freeboard.
Determine	• Determine proposed freeboard, document the rationale.

8.0 Summary

Flooding and coastal inundation are a relatively common occurrence in Auckland, which will be exacerbated by climate change and increases in impervious areas. The flooding and coastal inundation hazards are matters that are dealt with in the RMA, the Building Act, and the Building Code.

Where development is allowed on land susceptible to flooding and/or coastal inundation hazards, the inclusion of an appropriate freeboard when setting finished floor levels is one means to mitigate and reduce the risk and lessen the impacts on people, buildings, and their contents.

Freeboard is a factor of safety or risk reduction mitigation that provides for the uncertainties and/or imprecision in the estimation of flood/inundation water levels, and for phenomena which are not explicitly included in flood or coastal inundation water level calculation or modelling, e.g. vehicle generated waves which elevate the water surface.

Default freeboard levels are provided in The Auckland Code of Practice for Land Development and Subdivision (SWCoP V.4). However, as local factors can influence flood and coastal inundation risks at a site level, site-specific assessment by a suitably qualified and experienced person is required to identify the amount of freeboard that is proportionate to the risk.

Key to determining appropriate freeboard allowance/informing decision makers are the following:

- Transparency on the matters considered in the assessment of extreme water level and freeboard, e.g. what uncertainties considered,
- How they have been quantified, and
- A clear definition of the acceptable level of future risk for a site-specific development and use.

The inclusion of an appropriate freeboard contributes to resilient and sustainable building development and more resilient communities.

Figure 11: Hazard warning

Glossary

Term	Definition
Annual Exceedance Probability (AEP)	• The probability of exceeding a given threshold within a period of one year. For flooding, a one percent AEP floodplain is the area that would be inundated in a storm event of a scale that has a one percent or greater probability of occurring in one year. Usually expressed as a probability (e.g. 0.01) or a percentage (e.g. 1%). • Equivalentaverage return intervals (ARI) are: ○ 1% AEP = 100-year ARI ○ 10% AEP = 10-year ARI
Auckland Design Manual	• A best practice guide for designing the built environment. Available online at: http://www.aucklanddesignmanual.co.nz/.
AUP	• Auckland Unitary Plan: Operative in part
Average Recurrence Interval (ARI)	• A common measurement of likelihood (the chance of something happening), also called 'return period'. Natural hazard events are often referred to as 1:50 or 1:100-year events, meaning they are expected to occur "once in 50 years", or "once in 100 years" respectively.
Brownfield	• Any already urbanised land to be redeveloped, often for more intensive or different land use.
Building platform	• An area of land suitable for buildings to be constructed. This area is shown in the drawings associated with a geotechnical completion report or equivalent document. The area is commonly larger than the Building Footprint, to allow for flexibility in the future design of the building which is commonly not commenced until after earthworks are completed.
Catchment	• The total surface area draining to a particular point of interest or discharge point. Note: in reticulated urban areas the piped catchment may not be identical to the overland flow catchment.
Coastal inundation	• The flooding of otherwise normally 'dry' low-lying coastal land due to extreme high sea water levels.
Coastal Marine Area	• Generally, for the purpose of this document the areas seawards of the line of mean high water spring tide level.
Culvert	• Any conduit that transfers the flows of a watercourse or waterway across a road or embankment.
Design flows	• The flows selected as a basis for the design of works in the system.
Design storm	• The rainfall calculated from historical records that can be expected for a specific return period and duration.
Finished Floor Level	• The level of the finished top surface of the bottom floor of a building.

Term	Definition
Floodplain	• The area of land that is inundated by runoff from a specified rainfall event, with an upstream catchment generating 2m^3/s or greater of above ground flow, taking into account: ○ Any increases in impervious areas that would arise from changes in land use enabled by the policies and zonings of the Plan; ○ The effects of climate change over a 100-year timeframe in respect of the frequency and duration of rain fall events and a 1m sea-level rise; and ○ Assuming that primary drainage is not blocked.
Flood prone area	• As per Council GeoMaps – Flood Prone Area layer Low-lying areas where water can become trapped and collect during heavy rain, especially if the stormwater outlet is blocked or reaches capacity (Flood Viewer)
Fluvial flooding	• Occurs during periods of extended significant rainfall when rivers and streams breach their banks and flood adjacent land (flood plain).
Freeboard	• Additional clearance above estimated flood/inundation level (including 1 m sea-level rise for coastal inundation) to allow for uncertainties in flood/inundation level estimation, wave action and localised water level variations.
Greenfield	• Land identified for future urban development that has not been previously developed.
Less vulnerable activities	• Means activities listed in the following nesting tables of the AUP: ○ Commerce ○ Community, excluding care centres, and healthcare facilities with overnight stay facilities ○ Industry ○ Rural • See J1.1 and J1.3 Nesting Tables in Chapter J – *Definitions* of the AUP
Mean sea level	• The mean non-tidal component of sea level averaged over a defined time period, usually several years.
More vulnerable activities	• Means activities listed in the residential nesting table of the AUP and includes care centres, and healthcare facilities with overnight stay facilities. • See J1.1 and J1.3 Nesting Tables in Chapter J – *Definitions* of the AUP
Open coast	• That part of the coastline located outside of sheltered harbours and estuaries, in locations subject to ocean waves including swell.
Overland flow path	• The route taken by stormwater when flowing over land.
Peak flow	• The maximum flow reached in a stormwater system during any storm (or at any time in other reticulation).
Pluvial flooding	• Occurs when an extreme rainfall event, which in Auckland is often short duration high intensity rainfall, creates a flood independent of an overflowing water body.

Term	Definition
RCP	• Representative Concentration Pathway is a greenhouse gas concentration (not emissions) trajectory adopted by the Intergovernmental Panel on Climate Change (IPCC).
RMA	• Resource Management Act 1991. New Zealand's main piece of environmental legislation that sets out how we should manage our environment.
Runoff	• The portion of rainfall which runs off the land and into the drainage system and overland flow path.
Secondary flow path	• The route taken by stormwater runoff when the primary system capacity has been exceeded or is blocked.
SSP	• Shared Socioeconomic Pathways (SSPs) are scenarios of projected socioeconomic global changes up to 2100. They are used to derive greenhouse gas emissions scenarios with different climate policies.
Storm surge	• The rise in sea level due to storm meteorological effects. Storm surge has timescales of sea-level response that coincide with typical synoptic weather motions; typically, 1–3 days.
Storm-tide	• The sea-level peak reached during a storm event, from a combination of monthly mean sea-level anomaly + tide + storm surge.
Stormwater (SW)	• Rainfall runoff from land, including constructed impervious areas such as roads, pavement, roofs, and urban areas which may contain dissolved or entrained contaminants, and which is diverted and discharged to land and water.
Surface water	• All naturally occurring water, other than sub-surface water, which results from rainfall on the site or water flowing onto the site, including that flowing from a drain, stream, river, lake or sea.
Time of Concentration	• The time it takes for water to arrive from the top of the cacthment to a location downstream.
Wave overtopping	• When a wave/s overtop a dune, embankment or seawall crest and may include ‘wave splash’, ‘wind spray’ and sporadic shallow over-wash of flowing ‘green water’.
Wave runup	• The maximum vertical extent of wave ‘up-rush’ on a beach or structure above the still water level (that would occur without waves). Constitutes only a short-term upper-bound fluctuation in water level relative to wave setup.
Wave setup	• The average temporary increase in the mean still-water sea level at the coast, resulting from the release of wave energy in the surf zone as waves break.

References:

Auckland Council. 2016. Auckland Unitary Plan (*operative in part*). Auckland Council, Auckland, New Zealand.

Auckland Council, 2022. The Auckland Code of Practice for Land Development and Subdivision. Chapter 4: Stormwater. Version 4 (*Stormwater Code of Practice* (*SWCoP*)).

Brown N.Z., 2015. Statement of Evidence on Behalf of Auckland Council. Independent Hearings Panel (IHP). Auckland Council, Auckland.

Building Industry Authority, 1999. Determination N0.99/005 Floor level for a house on a flood-prone site.

Carpenter N., Roberts R., & Klinac P., 2020. *Auckland's Exposure to Coastal Inundation by Storm tides and Waves,* TR2020/024, (Auckland Council 2020).

Carter J., Evans R., Belgrave B., Beck F., & Cook K., 2021. Discussion paper of Building Act and Resource Management Act tensions and issues. GNS Science report 2021/21. December 2021.

eCoast, 2022. *Coastal Hazard Assessment: 69 West End, Westmere, Auckland* – submitted in support of a resource consent application.

Howe T., Roberts R., Fung J., Sinclair S., Carpenter N., Doherty A., and Brown N., 2021. Natural Hazards Risk Management Action Plan – Part 2, Auckland Council.

Kirby A.M. and Ash J.R.V., 2000. Fluvial Freeboard Guidance Note. R&D Technical report W187.

Intergovernmental Panel on Climate Change, 2023, AR6 Synthesis Report. Climate Change 2023.

McComb I.R. and Pennington M. 2016. Would you like freeboard with that? 2016 Stormwater Conference https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=2132

~~Ministry for the Environment, 2017. Coastal Hazards and Climate Change. Guidance for local government.~~

Ministry for the Environment, 2018. Climate Change projections for New Zealand

Ministry for the Environment, 2022. Interim guidance on the use of new sea-level rise projections.

Ministry for the Environment, 2024. Coastal hazards and climate change guidance.

Ministry of Business, Innovation & Employment, 2017. Granting of building consent for alterations, subject to notification that land is subject to a natural hazard. Determination 2017/080.

Ministry of Business, Innovation & Employment, 2019. Granting a building consent for the construction of a dwelling without requiring notification under section 73 of the Building Act. Determination 2019/034.

Ministry of Business, Innovation & Employment, 2019. The decision to grant a building consent subject to notification under section 73 for a site adjacent to a coastal estuary.

Ministry of Business, Innovation & Employment, 2021. Regarding the proposed granting of a building consent for an alteration to a building on land subject to a natural hazard. Determination 2021/013.

Ministry of Business, Innovation & Employment, 2023. Acceptable Solutions and Verification Methods. For New Zealand Building Code Clause E1 Surface Water.

Pearce, P., R. G. Bell, H. Bostock, T. Carey-Smith, D. Collins, N. Fedaeff, A. Kachhara, G. Macara, B. Mullan, R. Paulik, E. Somervell, A. Sood, A. Tait, S. Wadwha, and J.-M. Woolley. 2018. Auckland Region climate change projections and impacts. Auckland Council Technical Report TR2017/030-2, National Institute of Water and Atmospheric Research, Auckland.

Standards New Zealand, 2010. New Zealand Standard – land Development and Subdivision Infrastructure. NZS 4404:2010.

State of NSW and Department of Planning and Environment, 2023. Understanding and managing flood risk.

Legislation and Plans

Auckland Council Stormwater Bylaw (2015)

Auckland Council District Plan: Hauraki Gulf Islands Section

Auckland Plan 2050 (2018)

Auckland Unitary Plan

Building Act 2004

B.uilding Code

Local Government Act 2002

National Adaptation Plan 2022

New Zealand Coastal Policy Statement 2010

Resource Management Act 1991

Te-Tāruke-ā-Tāwhiri: Auckland's Climate Plan (2020)

Appendices

Appendix A1.0 Worked examples

Address	391 Hibiscus Coast Highway, Orewa (Open Coast)	12 Te Moau Av, Parakai
Determine potential inundation level (extreme water level)	1.97 m RL1% AEP	3.01 m RL 1% AEP towards mouth
Understand the specific model assumptions and inputs	Open coast, high confidence	Hydrodynamic model, high confidence
Factor in sea-level rise	0.35-0.58 m 2070 0.6-1.69 m 2130	Modelled with 1 m SLR = 3.79 m RL OR As set out left but likely over conservative
Wave setup	Raise 1% AEP to 2. 5 m RL	NA
Vertical land movement	-0.49 mm/yr Relative SLR (upper bound): 2070 – 0.65 m 2130 – 1.8 1m	-2.25 mm/yr Relative SLR (upper bound) 2070 – 0.78 m 2130 – 2.05 m
Rainfall flooding	? In a flood plain but unlikely dominant	Significant, site specific flood assessment also required?
Determine extreme inundation water level	Say use SSP8.5 m to 2130 + VLM = 1.29 m 3.79 m RL	SSPM8.5 m + VLM = 1.52 If added to 1% AEP = 4.53 m RL
Wave runup	0.5 m on top of everything else? 4.29 m RL	NA
Consider uncertainties		No hydrodynamic modelling of broader SLR scenarios, VLM error margin
Calculate potential minimum floor level and freeboard	AUP 1%+1 m = 3.5 m RL Above level 4.29 m RL Freeboard – 0.79 m	AUP = 3.79 m RL Above level = 4.53 Freeboard = 0.74
Any other factors		
Compare	Default freeboard 0.5 m = 4.0 m RL	Default freeboard 150 mm = 3.94 m RL
Determine		Default freeboard too low but how to enforce?

Freeboard for the Auckland region. Guideline document GD13. Version 1 draft

March 2024

ISSN 2230-4541 (Print)
ISSN 2230-455X (Online)

ISBN 978-1-991146-36-6 (Print)
ISBN 978-1-991146-37-3 (PDF)

To find out more email: freeboard@aucklandcouncil.govt.nz