

Waikato District Plan Review: Natural Hazards and Climate Change Economic Assessment

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m.e
consulting



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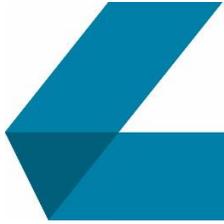
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1 Background

Market Economics (M.E) has been engaged by Waikato District Council (WDC) to undertake an economic assessment of a number of aspects of the proposed natural hazards and climate change provisions to be included in the Proposed District Plan (PDP), as compared to the Operative District Plan (ODP).

From an economic perspective, natural hazards and climate change can impact economic activities in both urban and rural environments. The costs and benefits associated with natural hazards and climate change can be managed by ensuring that land uses within identified areas occur a way that minimises the potential impacts. The negative impacts of natural hazards and climate change typically accrue to the wider community, both directly to landholders and to the wider public through flow-on impacts. It is well established in economic theory that the free market will fail to produce an optimal outcome in the presence of market failures. In the case of natural hazards and climate change, free markets will result in an outcome where too little consideration of the risks is incorporated in decision-making. In many cases, local governments will impose rules on activities that occur in vulnerable areas to assist the market to produce an optimal outcome.

While it is recognised that the development of natural hazard and climate change provisions will generate benefits to the community, it is also important to acknowledge that the provisions will result in corresponding negative impacts through the reduction of some activities or additional costs to the community on an ongoing and one-off basis. For example, some natural hazard and climate change provisions impose greater costs on developers in terms of building requirements (e.g. raised building floor levels). Alternatively, other rules may limit the locations where an activity can occur – as an example, restrictions on building in close proximity to the sea due to storm inundation and sea-level rising.

At this stage, our brief is to consider the costs and benefits generated by the key natural hazard and climate change provisions in the Plan, including Flooding¹, Coastal², Subsidence, Liquefaction³ and Climate Change⁴.

The scope of work for this report is based on the following information:

- **Natural Hazard Coverage:** This provides the spatial coverage for the natural hazards and climate change policy, both under the ODP and PDP.⁵ This information outlines which land is likely to be impacted by natural hazards as defined according to research conducted by appropriate natural hazards experts (in Council or external consultants). In some cases the spatial extent of the coverage of the natural hazard in question cannot be defined (especially for some of the flooding areas in the ODP).

¹ Includes the flood plain management area, high risk flood and defended areas.

² Both high risk coastal erosion and high risk coastal inundation areas.

³ This hazard is not mapped.

⁴ Not technically a natural hazard in itself.

⁵ Waikato District Council (2020) GIS Layers, received 10th February.

- **Zone Areas:** This provides the spatial coverage of the land use potential, both under the ODP and PDP.⁶ This is important because rural areas with a rural zoning have less development potential under the zone rules than other areas such as residential and commercial zones.
- **District Plan Provisions - Natural Hazards and Climate Change:** This provides the operative and proposed objectives, policies and rules that relate to natural hazards.⁷
- **Natural Hazards and Climate Change Activity Summary:** This provides a comparison of the ODP and PDP natural hazards and climate change in terms of activities.⁸
- **Residential Capacity Assessment:** This is a property level assessment of development potential within Waikato District under the ODP.⁹
- **Waikato District Hazard Reports:** These reports include assessments by experts in hydrological modelling¹⁰, coastal hazards¹¹ and subsidence risk¹². Each of these reports assesses hazards and include where applicable climate change and sea level rise allowances, although there was no reporting specifically provided on this topic. The council has not commissioned a district wide assessment of liquefaction, instead relying on government guidelines¹³, practice notes¹⁴ and a number of case study risk assessments that had been submitted by applicants.
- **Waikato Region Reports:** The regional assessment of earthquake risk and subsoil conditions was reviewed for this report to establish the potential risk of liquefaction in the District.¹⁵
- **Waikato Planning Framework Memo:** During the drafting of this report it became apparent that the existing planning framework for hazards did not and align with the practical application of the plan. M.E requested council officers to develop a memo that outlined how the Operative District plan is actually applied in practise. This memo has been used to update the report.¹⁶

We note that there are a number of other natural hazards provisions in the Plan, which are not assessed in this report (e.g. wildfire). During the scoping stage of this report it was noted by the client that the remaining rules would be outside the scope of this economic assessment.¹⁷

The aim of this report is to cover the specific scope requested, and enable informed discussion moving forward. Also, the results from this report will be used to inform s32 assessment of the proposed natural hazards and climate change provisions in the Plan to assist in the District Plan Review hearing processes.

⁶ Waikato District Council (2020) GIS Layers, received 10th February.

⁷ Waikato District Council (2019) Draft Waikato District Plan (Stage 2).

⁸ Waikato District Council (2020) Policy Option - ODP, PDP Stage 1 and Stage 2, received 14th February.

⁹ Market Economics (2018) National Policy Statement Urban Development Capacity – Residential Assessment.

¹⁰ DHI (2019) WRC Lower Waikato 2D Modelling - Huntly, Ohinewai and Horotiu Model Build.

¹¹ FOCUS (2020) Waikato District Coastal Hazard Assessment.

¹² RDCL (2019) Risk Assessment for Urban Development Areas – Huntly East Mine.

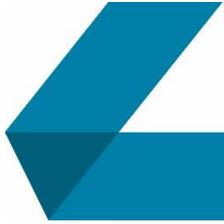
¹³ EQC, MBIE, MFE (2017) Planning and engineering guidance for potentially liquefaction-prone land

¹⁴ MBIE and NZ Geotechnical Society Inc (2016) Earthquake geotechnical engineering practice, Module 3: Identification, assessment and mitigation of liquefaction hazards.

¹⁵ Environment Waikato (1998) Earthquake Risk Mitigation Plan.

¹⁶ Waikato District Council (2020) Natural Hazards and Climate Change Planning Framework – Memo (draft) received 4th May.

¹⁷ Waikato District Council (2020) Natural Hazards and Climate Change Economic Assessment – Scoping Brief, received 20th February.



2 District Plan – Natural Hazards

The following section briefly outlines the natural hazards and climate change provisions in the Operative District Plan (ODP) and the Proposed District Plan (PDP). This section draws from the technical study conducted for the council, the GIS layers and Policy wording provided by council. The reader should refer to these documents to gain a more detailed understanding of the natural hazards and climate change provisions in the Plan. This section has also relied on council officers to provide detail about the revisions of the provisions that have occurred during the internal council planning and wider engagement processes.

In summary, Waikato District has significant natural hazards; most important are the flooding and coastal hazards, which are likely to be compounded by the effects of climate change.

In terms of flooding hazard, the Waikato River which traverses the District is New Zealand's longest river, and has a total catchment area of some 14,250 square kilometres.¹⁸ This includes its largest tributary, the Waipa River, which has a catchment of some 3,050 square kilometres, extending from South of Te Kuiti to join the Waikato River at Ngaruawahia.

The Lower Waikato has a flood plain of approximately 36,400 hectares originally dominated by lakes and wetlands. The flood plain has little fall through the river system, which can result in long term flooding or ponding, taking weeks to drain. Some 21,500 hectares has been defended using stopbanks, achieving a high standard of protection (mainly to 1% AEP).

In terms of coastal hazard, the shoreline of the Waikato District is extensive and diverse. Key areas around Raglan and Port Waikato are characterised by open coast sandy beaches, estuarine intertidal sand flats and estuarine beaches, cliffed shorelines, and low lying estuarine margins. The west coast is exposed to prevailing weather from the Tasman Sea, which includes large swells and storms. Continual erosion and coastal flooding events are also a significant natural hazard within the District.

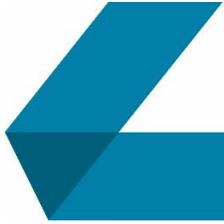
There are also a number of more localised natural hazards such as subsidence in Huntly and potential for liquefaction.

The following sections outline the provisions in the ODP and PDP that relate to these four natural hazards. The discussion begins with a summary of the natural hazard objectives and policies, then provides detail on the spatial extents and the rules.

2.1 Operative District Plan

There are currently two sections in the ODP, the Franklin section and the Waikato section. The Franklin section is a legacy of the amalgamation of the previous territorial authorities in Auckland into a single authority - Auckland Council. In this process the Franklin District was split in three, with one part being merged into the Waikato District, a small part merging with the Hauraki District and the remainder being merged into the Auckland Council.

¹⁸ Waikato Regional Council (2016) Lower Waikato Waipa Control Scheme Land Classification and Direct Benefit Analysis for Differential Rating Purposes.



Chapter 5 of the Waikato Section of the ODP addresses natural hazards, and includes three objectives which are summaries as follows:

- 5.2.1. minimise natural hazard risk to health, safety and property;
- 5.2.11. retain hydrological characteristics of Mangaonua, Mangaone and Mangaharakeke Streams and their tributaries; and
- 5.2.15. Avoid risks from ponding of surface water and poor drainage.

Part 7 of the Franklin Section includes four objectives which are summaries as follows:

- 7.2.2 - 1. reduce risk to activities on land subject to land instability;
- 7.2.2 - 2. reduce risk of flooding by watercourse/stormwater overflow and coastal inundation;
- 7.2.2 - 3. avoid, remedy, mitigate adverse effects of erosion on property and the environment; and,
- 7.2.2 - 4. Ensure public are informed of natural hazards.

Most of the natural hazard policies in Waikato section of the ODP relate to minimising risk. The policies are outlined in Chapter 5 and are summaries below:

- P5.2.2 Avoid use or development on land subject to significant natural hazards; P5.2.2.A Mitigate risks to health, safety and property on land subject to natural hazards; P5.2.3 Use or development of land subject to natural hazards should not increase risk or compromise natural processes; P5.2.4 Do not construct or alter buildings on land that will be subject to coastal hazards with 0.5m SLR; P5.2.5 Minimise impervious surfaces, provide adequate drainage and mitigate off site effects of stormwater; P5.2.6 Provide fire breaks and water source for firefighting; P5.2.7 Locate buildings away from fire risk; P5.2.8 Use, maintain or enhance natural buffers; P5.2.9 Development should be designed and located to avoid or mitigate the predicted effects of climate change on natural hazards and take a precautionary approach where information is incomplete.
- P5.2.12 Subdivision, use and development to maintain or enhance overall hydrological characteristics of gully streams and maintain surface and groundwater flows, ponding and drainage patterns; P5.2.13 Limit modifications to flow paths and drainage patterns to minor adjustments; P5.2.14 Manage stormwater close to source.
- P5.2.16 Subdivision, use and development to not increase ponding hazard; P5.2.17 Subdivision, use and development to avoid or mitigate adverse effects of surface water ponding; P5.2.18; Stormwater management practices and devices in accordance with low impact design principles.

Most of the natural hazard policies in the Franklin section of the ODP focus on avoiding, remedying or mitigating risk from land instability, inundation and erosion. The policies are outlined in 7.2.3 and are summaries below:

- **Instability:** (1) Avoid, remedy or mitigate adverse effects of land instability arising from subdivision and development; (2) Avoid stormwater discharge on land that is unstable; (3) Activity and development shall not cause instability or erosion in the coastal or riparian margins.
- **Inundation:** (4) Avoid land use, subdivision and development on flooding plains unless adverse effects can be avoided, remedied or mitigated; (5) Stormwater management systems should include low impact design responses where possible; (6), Avoid, remedy or mitigate adverse effects on flood protection works.

- **Erosion:** (7) Avoid accelerated erosion from land use, subdivision and development along the banks of streams, rivers, lakes and watercourses; (8) Land use, subdivision and development is located to avoid, remedy or mitigate adverse effects on or from natural coastal or river processes; (9) Only allow land use, subdivision and development if it maintains and enhances natural buffering of the coastal environment.
- **General:** (10) Where information on hazard risk is limited use a precautionary approach; (11) Use precautionary approach to other hazards (earthquake, volcanic activity, tsunami, sea level rise and climate change; (12) Avoid, remedy or mitigate adverse effects of natural hazards on historic heritage. There are a number of differences between the two sections of the ODP, which creates issues in terms of consistency of the treatment of natural hazards across the District.

The rest of this section will focus on the spatial extent of hazard areas and the rules that have been set out in the ODP that relate to natural hazards. The hazard extents and rules define how the objectives and policy described in the ODP are to be given effect to. Importantly they describe the types of activities that can occur as of right (Permitted) and the circumstances under which a resource consent will be required.

2.1.1 Flooding

Waikato Section

The flooding hazard within the District includes flooding and ponding around the various waterbodies, including rivers, streams and lakes. Figure 2.1 shows the spatial extents in the ODP that relate to flooding hazard. There are the following four extents,

- **Flood Risk Area:** is a set of polygons that note some of the areas that are at risk of flooding, and cover a total of approximately 600 hectares of land or 0.1% of the land in the District. Most of the land is located along the banks of the Waikato River and some along the Mangawara stream.
- **Design Flood Level:** is a set of reference points along the Waipa and Waikato rivers, Lake Waikare and the Whangamarino Wetland that indicate the 1% AEP flood level at the time the Lower Waikato-Waipā Flood Protection Scheme was constructed. These points were intended to be used to establish the floor level for buildings to mitigate against flooding. Based on land elevation approximately 24,000 hectares of land in the District is at elevations that are below the Design Flood Level, which is 5% of the land in the District.¹⁹ However, these reference points are largely outdated and although the design flood level notation is referenced in the Waikato Section rules for building in a flood risk area, these reference points are not currently used by council officers to determine compliance with the minimum floor level required by the rule. It is not possible to assess the area over which the ODP rules have effect.
- **Flood Limits:** is a line that indicates the extent of flooding around the township of Te Kauwhata. The flood limits relate to the north shore of Lake Waikare and the southern banks of the Whangamarino Wetland and covers approximately 300 hectares of land or 0.1% of the land in the District.
- **Huntly South Assessment Area:** is an area of land just south of Huntly that is at risk of ponding during a 1% AEP flood event, and covers a total of 17 hectares of land.

¹⁹ Coverage based on elevation data (Waikato District Council (2019) Contour Composite – GIS layer of 1 metre contours) and the levels noted in each point of the Design Flood Level.

Figure 2.1: Map of Flooding Extents in Operative District Plan and Zones

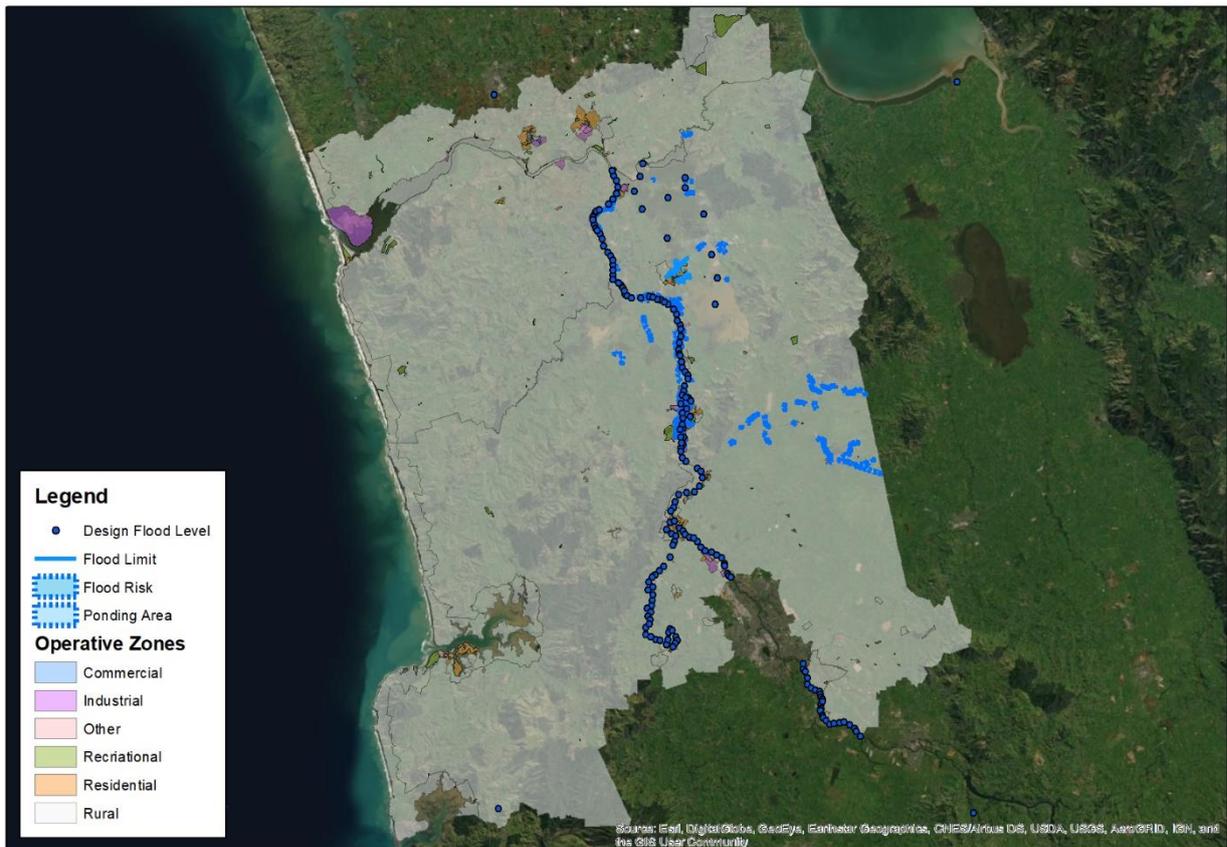


Table 2.1 shows the distribution of land within the flooding extents in the ODP based on the current ODP zones. The majority of the land covered by flooding is currently zoned Rural (83%) or Other²⁰ (5%). Also, many of the largest towns in the District are located near the flooding areas, which means that some of the more intensively used areas in the District will be affected by flooding hazard, in total over 100 hectares of urban land falls within the extents.

Table 2.1: Flooding Extents in Operative District Plan and Zones, hectares of land

ODP Zones	Flood Level	Flood Limit	Flood Risk	Ponding	Total	% of land in extents
Residential	Coverage	2	57	7	66	7%
Business		13	18	8	40	4%
Rural	No Data	285	453	1	739	83%
Other		7	41	2	49	5%
Total Flood Area		307	569	17	893	100%

²⁰ Includes reserves and roads.

While it is not possible to precisely quantify the practical application of the ODP Flood Level provisions, it is likely to be a large area of land in the District. The practical application of the ODP provisions is likely to cover more land in the District than the Proposed Plan 1% AEP Floodplain extent.

The rules within the Waikato section of the ODP aim to ensure that buildings are designed and located to mitigate the effects of flooding. The floor level of habitable rooms within dwellings, commercial or community buildings must be at least 0.3 metres above the 1% AEP flood level. For non-habitable rooms the floor level must be at or above the 1% AEP level. If these standards are met the building is permitted. It would be difficult to get a consent to construct a building that does not meet the required floor levels as it would be a discretionary activity in the Industrial Zone and a non-complying activity in all other zones.

The rules within the Waikato section of the ODP are designed to enable most utilities as a Permitted activity within the flood areas. However, if the works relate to buildings then the building rule applies and any non-compliance with minimum floor level will default to a Discretionary activity (Industrial Zone) or Non-Complying (all other zones) resource consent.

Generally earthworks in a flood risk area require a resource consent (either Discretionary or Restricted Discretionary depending on the purpose and type of earthworks). The ODP rules provides an exception for earthworks that relate to filling for access or foundations (Permitted).

Subdivision is a Discretionary activity within a flood risk area.

Table 2.2: Flooding Extents Operative District Plan Provisions -Waikato Section

Rule	Activity/Use	Status	Notes
	Habitable Rooms - Dwellings, Commercial or Community buildings	P (NC)	Permitted if minimum floor level for habitable rooms at least 0.3m above 1% AEP flood level. Otherwise Discretionary (Industrial Zone) or Non-complying (all other zones).
	Non-habitable Rooms - Dwellings, Commercial or Community buildings	P (D/NC)	Permitted if at least at the 1% AEP flood level. Otherwise Discretionary (Industrial Zone) or Non-complying (all other zones).
	Utilities	P (D)	Permitted, unless a building then Discretionary or non-complying (see above).
	Earthworks - Filling	P (D/RD)	Permitted if filling is no more than necessary to provide foundations and access for building approved by building Consent. Otherwise Discretionary (Living/Business/Rural) or Restricted Discretionary (industrial).
	Earthworks – Other	D	Discretionary, requires a consent to undertake earthworks in flood area.
	Subdivision	D	Discretionary, requires a consent to undertake subdivision in flood risk area.

Franklin Section

The rules within the Franklin section of the ODP aim to ensure that the occupiable floor space of buildings are designed and located to mitigate the effects of flooding. To be a permitted activity the minimum floor level of any occupiable floor space of buildings must be 0.5 metres above the 1% AEP flood level. There is

no requirement to meet a minimum floor level for parts of buildings that do not meet the definition for occupiable floor space. Where a proposal cannot meet the conditions for a permitted activity, a restricted discretionary resource consent is required.

The rules within the ODP for the operation and maintenance of utilities are permitted where all conditions are met. The Franklin Section rules require buildings and structures to not inhibit or divert overland flow paths or to exacerbate flooding. If these conditions are not met, a consent is required as either a controlled, restricted discretionary or discretionary activity depending on the nature of the proposed utility.

Earthworks are regulated based on quantity or location in relation to a waterbody. Where compliance with conditions for a permitted activity cannot be met then Restricted Discretionary consent is required.

Subdivision is a controlled activity if new lots are sited to avoid natural hazards. The subdivision defaults to a discretionary activity if compliance with this condition cannot be met.

Table 2.3: Flooding Extents Provisions Operative District Plan - Franklin Section

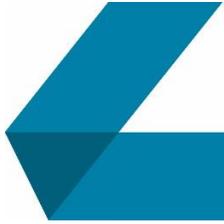
Rule	Activity/Use	Status	Notes
	Residential Buildings	P (D)	Permitted if minimum floor level for occupiable floor space of any building is at least 0.5m above 1% AEP flood level. Otherwise Discretionary.
	Business and Industrial Buildings	P (RD)	Permitted if at least at the 1% AEP flood level. Otherwise Discretionary.
	Utilities	P (RD)	Permitted, unless a works exacerbates flooding hazard then Restricted Discretionary.
	Subdivision	C/RD (D)	Lots shall be sited so as to avoid or mitigate the potential effects of natural hazards. Otherwise Discretionary.

2.1.2 Coastal

Coastal hazards within the District include inundation and erosion around the open coast and estuary shorelines. These hazards are not mapped in either section of the ODP. However, both sections of the plan include a set of building rules that require a specified coastal setback distance from Mean High Water Springs (MHWS) and a minimum floor level (habitable room or occupiable floor space) above a specified datum or inundation level.

The building setback distance ranges from 100 metres in the Coastal Zone (Waikato Section) and 23-30 metres in the urban zones of Port Waikato and Raglan. The Waikato Section states that building setbacks from MHWS are to provide space for esplanade reserves and public access, to preserve natural character and amenity and to go some way towards mitigating the effects of coastal hazards. The building setback in the Coastal Zone of the Waikato Section is 100m unless the entire allotment is within the 100m setback and then a 32m setback applies. The building setback distance in the Coastal Zone of the Franklin Section is not specified but the building platform for new buildings or new allotments must be located to avoid or mitigate the effects of natural hazards.

Within the Waikato Section, the minimum floor levels have been calculated to include a 0.3m freeboard plus combined spring tides, storm surges and a 0.5m sea level rise due to climate change.



The Waikato Section minimum floor level is 3.7m above Moturiki Datum (Raglan). The Franklin Section minimum floor level is RL 3m in Port Waikato and RL 3.5m (Firth of Thames) or 0.5m above the highest observable flood level.

In total approximately 2,450 hectares of land is within the area covered by the coastal setback provisions. However, as noted above the coastal setbacks in the ODP are defined based on several factors, not just coastal hazards. Therefore, some of the area within the coastal setbacks will have been included to account for these other factors and will be unrelated to coastal hazards. It is not possible to establish the extents of the coastal hazards or the practical application of the provisions are applied.

Figure 2.2: Map of Coastal Setback in Operative District Plan and Zones



Table 2.4 shows the distribution of land that is subject to the building setback rules in the ODP. The majority of this land is currently used for rural (95%) and other (4%) activities. The other 1% of land within the coastal building setbacks is zoned for residential and business land uses and although the land area is smaller, it is more intensely developed than the rural areas (approximately 22 hectares of residential and 2 hectares of business). The coastal building setback rules affect 1% of the residential land in the District and 0.2% of the business land in the District.

Table 2.4: Coastal Extents Operative District Plan and Zones, hectares of land

ODP Zones	Coastal Setback	% of land in extents
Residential	22	1%
Business	2	0%
Rural	2,318	95%
Other	109	4%
Total Coastal Area	2,451	100%

The rules within the ODP aim to ensure that buildings are designed and located to mitigate the effects on the coastal area (including hazards). Rules in the Waikato section of the ODP require buildings to be setback between 23-30 metres in urban zones and up to 100 metres back in Coastal Zone. Also, for residential buildings, the habitable parts of dwellings must be built to a level of 3.7 metres above the Moturiki Datum. If these standards are met the building is a permitted activity but where compliance cannot be achieved the activity is discretionary and a resource consent is required (Living and Business Zones). Most buildings in the Coastal Zone require a controlled activity resource consent. If the building setback distances cannot be achieved the activity will require resource consent for a non-complying activity.

Rules in the Franklin section of the ODP require buildings to be setback 30 metres in the Village Zone. Coastal building setbacks in the Coastal Zone are not defined but are based on the ability of the development to avoid or mitigate natural hazards. If these standards are not met a resource consent is required (Restricted Discretionary). The Franklin rules only cover a small part of the western coastline, including around Port Waikato.

Table 2.5: Coastal Extents Operative District Plan Provisions

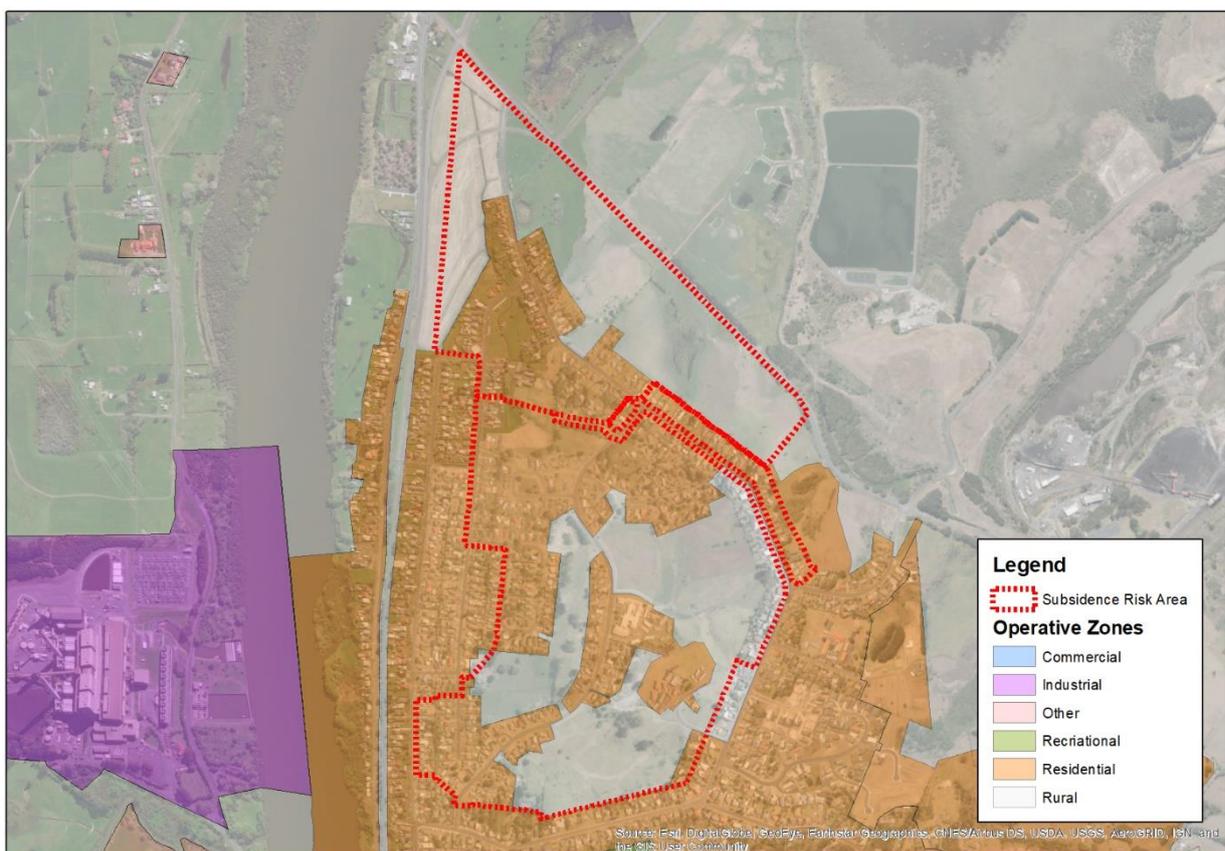
Section	Activity/Use	Status	Notes
Waikato	Building setbacks from MHWS.	P (D)	Permitted if floor level for any habitable room to be at least 3.7m above Moturiki Datum and setback according to following zone: <ul style="list-style-type: none"> • Living - 23m • Business - 23m • Industrial - 30m • Coastal - 100m • Country Living - 27.5m • Recreation - 32m Otherwise Discretionary.
Franklin	Building setbacks from MHWS	P (RD)	Permitted if setback according to following zone: <ul style="list-style-type: none"> • Village - 30m • Wetland Conservation & Forest Conservation - Coastal Marine Area - 60m • Coastal - Buildings must be sited to avoid or mitigate natural hazards and have a safe and stable building platform. Otherwise Discretionary

2.1.3 Subsidence

Ongoing surface settlement (subsidence) following closure of underground mine workings is a well-recognised phenomenon in other parts of the world.²¹ The Huntly Mine Subsidence Area is located in the north-eastern part of Huntly. This area has been subject to ground subsidence as a result of historic underground mining carried out in the late 1970s and early 1980s. The Huntly Mine Subsidence Area currently 125 hectares of land, of which 50 ha is residential (Living Zone) and 64 ha rural (Rural Zone).

Under the Waikato section of the ODP activities such as building, earthworks and subdivision are discretionary activities and can only be carried out with a resource consent. This means the development of land in this area will be relatively more costly to carry out compared to other parts of Huntly. There are no subsidence provisions in the Franklin section of the ODP.

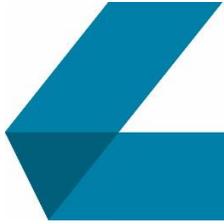
Figure 2.3: Map of Subsidence Extent in Operative District Plan and Zones.



2.1.4 Liquefaction

There are no provisions in either section of the ODP that specifically refer to liquefaction. However, geotechnical investigations and assessments of natural hazards, which can include liquefaction, are required to fully assess the effects of some building proposal (depending on location) and all subdivision proposals and are currently part of the Council's consenting process.

²¹ RDCL (2019) Risk Assessment for Urban Development Areas – Huntly East Mine.



For example, an application for resource consent to subdivide land to create an additional lot is required to include a geotechnical report. In some instances, this report is to include an assessment of liquefaction risk. Council requires an investigation of natural hazard risk when undertaking a subdivision fulfil its obligations under s106 of the Resource Management Act.

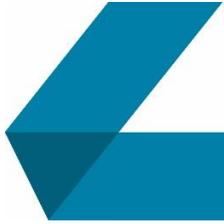
2.1.5 Climate Change

Climate change and sea level rise are not a hazard in their own right. However, they impact the frequency and intensity of a range of the natural hazards which the council must undertake planning for.

Chapter 5 of the Waikato section includes policies to address the predicted effects of climate change, including sea level rise and to take a precautionary approach when there is incomplete information available. This suggests that planning for natural hazards should take into account the possible impacts of climate change on the frequency and intensity of weather events (s5.3.8), as well as sea level rise (s5.3.9). While there are limited mentions of climate change or sea level rise in the rest of the ODP, these policies potentially allow Council consent planners, where relevant, to require natural hazard assessments to include the predicted effects of climate change, including sea level rise, on development proposals such as building or subdivision near the coast or in hazard risk areas.

Part 7 of the Franklin section includes reference to taking a precautionary approach when avoiding or mitigating the adverse effects of climate change and sea level rise). Again this gives Council consent planners scope to consider the predicted effects of climate change and sea level rise when assessing discretionary or non-complying development proposals.

Apart from the policy framework, the only rule that includes the predicted effects of sea level rise is the requirement for a 3.7m minimum floor level above Moturiki Datum for habitable rooms within buildings near the coast (Waikato section). This level includes allowance for a 0.3m freeboard above combined spring tides, storm surges and a 0.5m predicted SLR due to Climate change. The Franklin section of the plan refers to the use of coastal development setbacks as a means to partially address hazards such as sea level rise. However, it is unlikely that this statement is based on any technical assessment that confirms the development setback distances are sufficient to avoid or mitigate hazard risk as a result of future sea level rise.



2.2 Proposed District Plan

The review of any district plan provisions must include a review of any relevant higher order policy documents and where applicable it must give effect to the higher order policy through the provisions in the proposed district plan. In the case of the Waikato District Plan Review (Stage 2), the relevant higher order policy direction comes from the New Zealand Coastal Policy Statement 2010 (NZCPS) and the Waikato Regional Policy Statement 2016 (WRPS). These documents contain objectives and policies to address a range of resource management issues and some of these policies are required to be given effect to through district plan provisions.

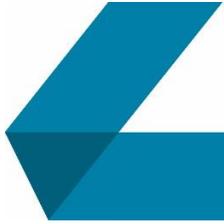
In order to give effect to the higher order policy documents, the Waikato District Council has:

- identified and assessed the spatial extent of land potentially affected by natural hazards, such as flooding, ponding, land subsidence, and coastal inundation and erosion;
- factored in the effects of climate change on weather related natural hazards and sea level rise;
- assessed the level of risk associated with each hazard;
- designed a regulatory framework that allows for land use and development where risk can be reduced through avoidance, remediation or appropriate mitigation;
- significantly restricted land use and development where the risk to people and property cannot be avoided, remedied or appropriately mitigated.

The coastal hazard assessment and the development of the proposed coastal hazard provisions have been largely directed by the NZCPS, the WRPS and the Ministry for the Environment Coastal Hazards and Climate Change: Guidance for Local Government (2017). These documents have guided the development of a risk based regulatory framework and the identification and assessment of land that is currently affected by coastal inundation and/or erosion along with the land that will potentially be affected over the next 100 years with 1m of sea level rise. The provisions for management of land use and development on land that will potentially be affected by future hazards recognises that the risk is not imminent and that the land can continue to be used as long as new development is able to easily adapt to future scenarios.

The development of the Flood Management Area, the High Risk Flood Area and Defended Area rules work in conjunction with the spatial hazard areas identified through flood modelling either carried out by, or commissioned by, the Waikato Regional Council. The provisions for development in these areas also follow a risk based approach. This approach allows for development to occur in areas where the risk can be either avoided or appropriately mitigated. In areas where avoidance or mitigation is not considered feasible, certain types of land use activities and development are significantly restricted.

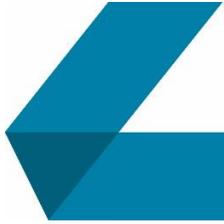
The PDP includes three objectives; 1) Resilience to natural hazard risk, 2) Awareness of natural hazard risk and 3) Climate change. The objectives are to be achieved through the avoidance and mitigation of the risks associated with natural hazards; by informing the community of the types and extent of natural hazards affecting the district, as well as preparing them to respond and recover from natural hazard events; and by mitigating and adapting to the effects of climate change.



The proposed policies are summarised as follows:

- Policies 1.1 – 1.3 manage new development; changes to existing land use and development; and new emergency services and hospitals in high hazard areas by ensuring risk is avoided
- Policy 1.5 provides for the operation, maintenance and minor upgrading of existing infrastructure, while policy 1.4 provides for new infrastructure where risk is not increased.
- Policy 1.6 provides for rezoning, subdivision and development outside high risk area where risk is adequately assessed and avoided, remedied or mitigated.
- Policies 1.7 – 1.11 address hazard protection through recognising the importance of natural features and buffers and soft hazard protection works; limitations on hard protection works; protecting, maintaining or enhancing natural features and buffers that provide natural hazard protection; controlling subdivision, land use and development in areas defended by stopbanks; and avoiding new development in areas that will create demand for new protection structures.
- Policies 1.12 – 1.15 provide for development and earthworks on the 1% AEP floodplain where the potential for flood damage to buildings is either avoided, remedied or mitigated; the adverse effects of filling are avoided or mitigated; the location and storage of hazardous substances do not create unacceptable risk; and new subdivision and development within flood ponding areas and overland flow paths use an integrated catchment plan based stormwater management methods.
- Policies 1.16 provides for controls on subdivision, land use and development, in coastal areas that will potentially be affected by coastal hazards over the next 100 years due to sea level rise by undertaking site specific assessments which include measures to address the effects of climate change;
- Policy 1.17 addresses coastal hazard risk by requiring built development to be setback from the coast unless there is a functional or operational need for it to be at or near the coast;
- Policy 1.18 address fire risk to residential development through appropriate buffers or setbacks;
- Policies 1.19 – 1.21 manage new subdivision, use and development and stormwater discharge in areas subject to land instability and subsidence, including the Mine Subsidence Risk Area, through appropriate assessments and mitigation measures;
- Policies 1.22 and 1.23 control new land use, subdivision and development on land potentially susceptible to liquefaction through a level of assessment that reflects the type and scale of subdivision, use or development and that the level of risk is acceptable;
- Policies 2.1 – 2.2 provide for access to natural hazard risk information through various mechanisms; and improvements to response and recovery from natural hazard events through awareness and use of information and methods in Community Response Plans;
- Policies 3.1 – 3.5 address climate change through making adequate allowances for the projected effects of climate change in the design and location of new subdivision and development; increasing the ability of the community to adapt to the effect of climate change when undertaking future land use planning; adopting a precautionary approach for new subdivision, use and development where the adverse effects are potentially significant or irreversible but for which there is incomplete or uncertain information; providing for sufficient development setbacks; and assessing the impact of climate change on the level of natural hazard risk.

The rest of this section will focus on the spatial extent and the rules that have been set out in the PDP that relate to natural hazards and climate change. The extents and rules define how the objectives and



policies described in the PDP will be given effect to in the Plan. Importantly they define the types of activities that can occur as of right (Permitted) or those that require a resource consent.

2.2.1 Flooding

Waikato Regional Council (WRC) engaged DHI Water and Environment Ltd to model and produce maps of flood inundation for the 1% AEP flood event, including the future climate scenario based on the Relative Concentration Pathway (RCP) 6.0 with 2.3°C temperature increase.²² **Error! Not a valid bookmark self-reference.** shows the spatial extents in the PDP that relate to the 1% AEP flood plain and areas that would flood in a 1% AEP flood event were it not for structural defences (stopbanks). There are the following four extents,

- **High Risk Flood Area:** an area located within the Flood Plain Management Area where, during a 1% AEP flood event, the depth of flood water exceeds 1 metre, and the speed of flood water exceeds 2 metres per second, or the flood depth x the flood speed exceeds 1. The High Risk Flood Area covers a total of 560 hectares of land or 0.1% of the land in the District. The High Risk Flood Area has only been assessed in the 2D 1% AEP flood model between Horotiu and Ohinewai.
- **Flood Plain Management Area:** this area identifies the spatial extent of flooding from the Waipa and Waikato Rivers during a 1% AEP flood event. It consists of a total of 9,600 hectares of land or 2% of the land in the District and extends along both the Waipa and Waikato Rivers from the southern boundary of the district to Port Waikato.
- **Flood Ponding Area:** is located adjacent to the Waikato River in an area just south of the Huntly town centre and an area around Lake Waahi and Lake Puketirini on the western side of Huntly. These areas have a total of 580 hectares of land.
- **Defended Area:** this area identifies the spatial extent of the areas defended by a 1% AEP design stopbanks. The defended areas have a total of 13,800 hectares of land, or 3.% of the land in the District. Subdivision is restricted within in the Defended Area. Also building and earthworks is restricted within 50 metres around the stopbanks.²³

²² DHI Water and Environment Ltd (2019) WRC Lower Waikato 2D Modelling - Huntly, Ohinewai and Horotiu Model Build.

²³ The area covered by this restriction is around 850 hectares of land or 0.2% of the land in the District.

Figure 2.4: Map of Flooding Extents and Defended Area in Proposed District Plan and Zones

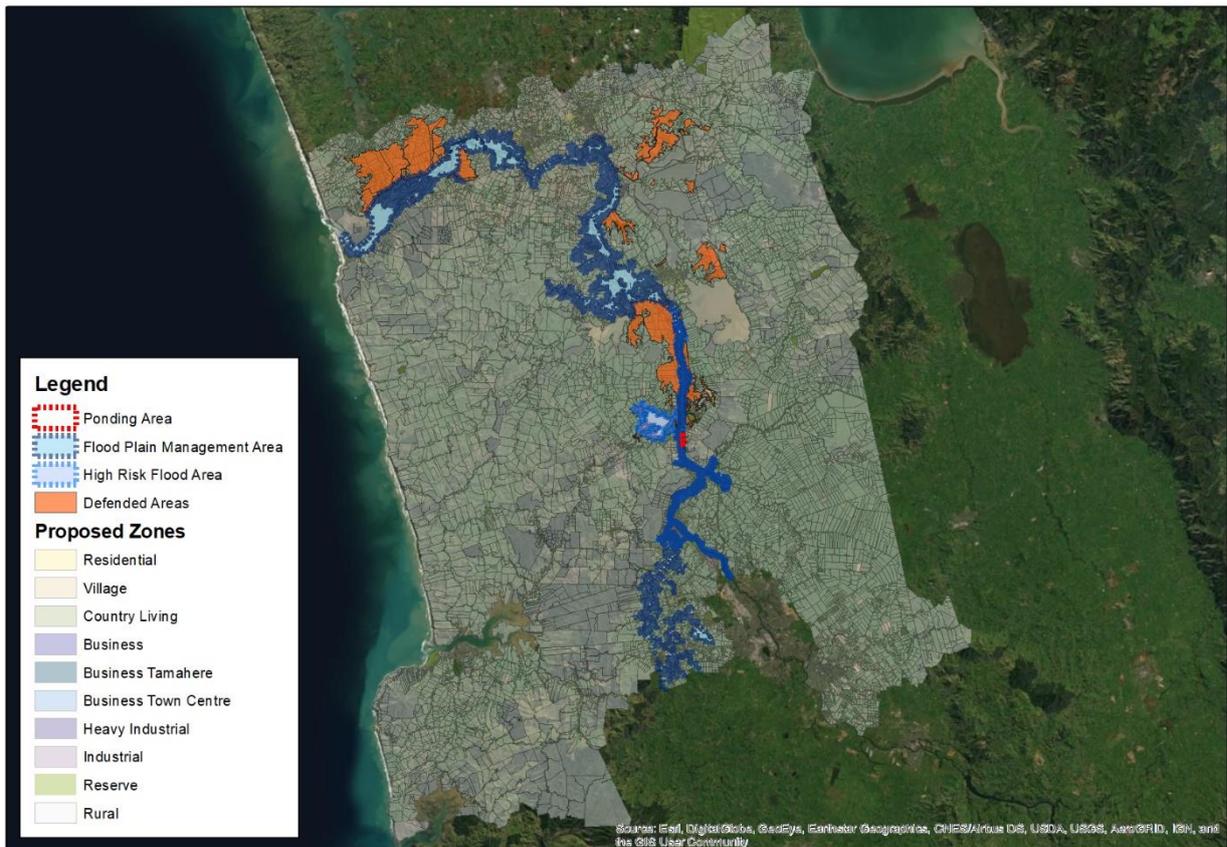
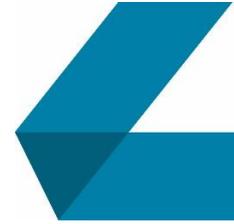


Table 2.6 shows the distribution of land within the Flood Plain Management Area in the PDP based on the current PDP zones. The majority of the land within the flood extents is currently zoned Rural (95%) or Other (4%). However, Huntly and Ngaruawahia are both partially located in the flood plain. This means that some of the more densely developed areas in the District are likely to be affected by flooding during a 1% AEP flood event, in total almost 246 hectares of urban land falls within the flood extents.

Table 2.6: Flooding Extents and Defended Area Proposed District Plan and Zones, hectares of land

PDP Zones	Flood Plain	High Risk Flood	Stopbank	Ponding	Defended	Total	% of land in extents
Residential	54	26	7	6	91	184	1%
Business	16	7	9	6	24	62	0.2%
Rural	9,173	483	761	488	13,143	24,048	95%
Other	327	41	72	79	516	1,035	4%
Total Flood Area	9,570	557	850	579	13,773	25,329	100%

Relative to the ODP the amount of land covered by flooding extents is likely to be smaller. As discussed in the previous section, the Design Flood Level are not an accurate way to evaluate the 1% AEP flood extent, so it is not possible to accurately establish the change in the extents of the flood provisions. However, it is considered likely that the PDP extents are refinement compared to the ODP, which means that the



natural hazard provisions in the will impact fewer landholders, households and businesses than in the ODP.

The PDP has introduced a number of new rules which increase the requirement to mitigate the effects of flooding. First, for areas with a high risk of flooding most buildings are non-complying, which means that it will be difficult to get a consent to build in this area. Second, for properties in the Flood Plain Management Area, buildings must be built to a level of 0.5 metres above the 1% AEP, which is 0.2 metres higher than under the ODP (Waikato Section). The Franklin Section rules currently require a 0.5 metre freeboard above the 1% AEP flood level. There are some exceptions to the minimum floor level requirement, including additions up to 15m² to the ground floor area of an existing building; a standalone garage up to 40m²; and accessory buildings or farm buildings without a floor. A proposal to construct a building that does not meet the conditions for a permitted activity will require a resource consent for a discretionary activity and through that process, alternative mitigation measures can be considered.

The rules within the PDP are designed to enable the establishment, operation, replacement, repair, maintenance or upgrading of utilities and associated earthworks as a Permitted activity within the Flood Plain Management Area. The rules are more restrictive in the High Risk Flood Area, where a restricted discretionary resource consent is required for the establishment of new utilities and a more than minor upgrade to existing utilities.

The proposed rules are more restrictive than the ODP in some cases as highlighted below;

- **Earthworks:** Currently the ODP requires a discretionary resource consent for earthworks in a flood risk area with an exception for earthworks to provide a building foundation and access to the building and up to 50m³ for minor upgrading of existing electricity lines. The PDP rules in the Flood Plain Management Area (not the High Risk Flood Area) provide for earthworks associated with the establishment, replacement, repair, maintenance or upgrading of utilities, as well as for the creation of a building platform for residential purposes as a permitted activity, and small quantities of excavation and filling which is less restrictive than the ODP.
- **Subdivision:** is a Discretionary activity in the proposed Flood Plain Management Area where the subdivision creates one or more additional lots and is either discretionary or non-complying in the High Risk Flood Area, depending on the location of the lots and building platforms. Subdivision within a Flood Risk Area in the ODP is a discretionary activity.
- **Defended Area:** any building or earthworks within 50 metres of a stopbank is a Discretionary activity, and all subdivision to create one or more additional lots is a Restricted Discretionary. There is no equivalent area or rules in the ODP.

Table 2.7: Flooding Extents Proposed District Plan Provisions

Rule	Activity/Use	Status	Notes
	Building in High Risk Flood Area	P(NC)	Addition to an existing lawfully established building up to 15m ² and accessory building with no floors are Permitted. Otherwise Non-complying
	Building in Flood Management Area	P (D)	Building with minimum floor level at least 0.5m above 1% AEP flood level or accessory building with no floor or addition to an existing lawfully established building up to 15m ² Permitted. Otherwise Discretionary.

	Utilities in Flood Plain Management Area, High Risk Flood Area	P	Establishment, operation, replacement, repair, maintenance and upgrading of utilities are generally permitted in non-high risk areas. In high risk flood area and high risk coastal overlays, new utilities mostly require RDA consent (new telecommunication lines, poles, cabinets, masts and poles are permitted). The establishment of new utilities or more than minor upgrade of existing utilities in the High Risk Flood Area is a restricted discretionary activity.
	Earthworks	P (RD)	Permitted 0.2m maximum height of filling above natural ground level and 0.5m maximum depth of excavation . Maximum permitted cumulative volume of filling varies between zones but range from 20m ³ – 200m ³ per site. Filling for a building platform for residential purposes is permitted if it is only to the extent necessary to achieve compliance with minimum floor level. Earthworks associated with the establishment, operation, replacement, repair, maintenance and upgrading of utilities is permitted. Otherwise Restricted Discretionary.
	Subdivision in Flood Plain Management Area, High Risk Flood Area and Defended Area	RD/D (NC)	Discretionary consent required to undertake subdivision in the flood plain and where new lots are located partially within the High Risk Flood Area, the building platform is not located in the high risk flood area (otherwise Non-Complying). Restricted Discretionary Consent required to subdivide within the defended area.
	Defended Area	D	Building and earthworks within 50m from a Council or Crown owned stopbank.

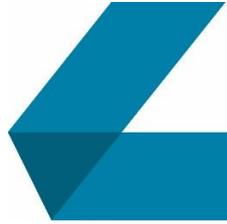
2.2.2 Coastal

Focus Resource Management Group (FRMG) was commissioned by the Council to define areas potentially vulnerable to coastal erosion and coastal flooding in Waikato District.²⁴ This study has included a District wide broad scale coastal hazard assessment and management recommendations, and a more detailed assessment of hazards and management approaches for Raglan and Port Waikato. That research identified hazard areas which include areas of greatest risk with existing sea level, and additional areas that could be affected with projected sea level rise over the next 100 years. This work did not include the eastern coastline at Miranda. The assessment of coastal hazards on the east coast is part of the Hauraki District Council’s Wharekawa Coast 2120 project.

The coastal hazard study defined two coastal erosion hazard areas and two coastal flood hazard areas for developed sites in Raglan and Port Waikato:

- High risk coastal erosion/inundation areas, identifying the areas where there is significant risk from coastal erosion or flooding with existing sea level and coastal processes in the short term (within the lifespan of the District Plan).
- Coastal erosion/inundation sensitivity areas, identifying the areas potentially vulnerable to coastal erosion/inundation over the period to 2120, assuming sea level rise of 1.0 metre. In the rural areas, i.e. along the open coastline and estuaries, a single coastal hazard sensitivity area was identified, which is made up of areas of the coastal margin that could potentially be impacted by coastal inundation and/or coastal erosion, assuming sea level rise of 1.0 metre to 2120.

²⁴ FOCUS (2020) Waikato District Coastal Hazard Assessment.



In total, over 3,830 hectares of land is located within the coastal hazard extents which covers almost 1% of the land in the District. **Error! Not a valid bookmark self-reference.** shows the spatial extents in the PDP that relate to coastal hazards. There are the following five extents,

- **High Risk Coastal Hazard (Inundation) Area:** This spatial extent identifies the areas that are at high risks of flooding with current sea level and coastal processes, and consist of a total of 140 hectares of land or less than 0.1% of the land in the District.
- **Coastal Sensitive Area (Inundation):** This spatial extent identifies land that is potentially at risks of flooding over the next 100 year period, assuming 1 metre of sea level rise, and consists of a total of 310 hectares of land or 0.1% of the land.
- **High Risk Coastal Hazard (Erosion) Area:** This spatial extent identifies areas that are at high risks of erosion with current sea level and coastal processes, and consist of a total of 22 hectares of land.
- **Coastal Sensitive Area (Erosion):** This spatial extent identifies land that is potentially at risks of erosion over the next 100 year period, assuming 1 metre of sea level rise, and consists of a total of 3,800 hectares of land or 1% of the land in the District, the majority of which is within the Rural Zone.
- **Coastal setback Area:** The coastal setback area is set as 23 metres from MHWs for most zones (including rural). In total the setback includes 720 hectares of land or 0.2% of the land in the District.

Figure 2.5: Map of Coastal Extents in Proposed District Plan and Zones



Error! Not a valid bookmark self-reference. shows the distribution of land within the coastal extents in the PDP based on the current PDP zones. The majority of land affected by the coastal inundation hazard areas is currently zoned Rural (90%) or Other (8%). In total approximately 50 hectares of urban land falls within the coastal hazard extents compared with 3,480 hectares of rural land.

Table 2.8: Coastal Extents Proposed District Plan and Zones, hectares of land

PDP Zones	Coastal Sensitivity Erosion	High Risk Coastal Erosion	Coastal Sensitivity Inundation	High Risk Coastal Inundation	Coastal Setback	Total*	% of land in extents
Residential	42	7	5	19	11	49	1%
Business	0	0	1	2	2	1	0%
Rural	3,478	3	263	65	578	3,481	90%
Other	306	13	38	53	130	319	8%
Total Coastal Area	3,827	22	307	139	721	3,849	100%

**Note that the coastal overlays overlap. To avoid double counting land the total presented here is the sum of the two coastal erosion overlays.*

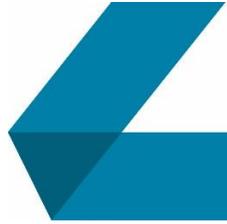
There are no coastal hazard extent areas in the ODP. However there are rules that require buildings to be setback from MHWS.²⁵ For this reason it is difficult to carry out a comparison between the ODP provisions and the PDP provisions for coastal hazard extent areas.

The rules within the PDP are designed to ensure that buildings are designed and located to mitigate the effects of coastal hazards. Most building within the high risk areas will be heavily restricted, with a non-complying activity status meaning that it would be difficult to get consent to build in this area. Also most building within Coastal Sensitive areas will be either permitted or require a resource consent, for a Restricted Discretionary activity. Permitted activities include minor additions to existing buildings, accessory or farm buildings without floors and utilities. The PDP includes coastal building setbacks that are similar to the ODP building setback rules, with the main change being the reduction in the building setbacks in the Coastal Zone (now Rural Zone) from 100m to 23m. The proposed coastal building setback distances are defined according to requirements for access (esplanade) rather than coastal hazards. The PDP also requires a consent for subdivisions within the coastal risk areas, with subdivision in the Coastal Sensitive areas being Discretionary and Non-complying in some parts of the High Risk Coastal Hazard areas.

Table 2.9: Coastal Extents Proposed District Plan Provisions

Rule	Activity/Use	Status	Notes
	Building in High Risk Area (Erosion and Flood).	P/D/NC	Construction of an accessory building or farm building without a floor up to 40m ² - Permitted Re-siting/replacement of existing building within the same site – Discretionary Construction of a new building or additions not provided for as a permitted or discretionary activity - Non-complying.

²⁵ Coastal building setback distances range from 100 metres in the Coastal Zone (Waikato Section) to 23 metres in the Living Zone (Waikato Section). Building within these setback distances requires either a Restricted Discretionary or Discretionary resource consent. These setbacks distances have been defined to provide some mitigation for the effects of coastal hazards but are not calculated specifically for that purpose.



	Building in Coastal Sensitive Area (Erosion and Flood).	P/RD (D)	<p>One off addition up to 15m² ground floor area and accessory buildings without a floor – Permitted</p> <p>Construction of an accessory building or farm building without a floor - Permitted</p> <p>New building or additions to an existing building is a restricted discretionary activity. Matters of discretion include structural design including the ability to relocate the building</p>
	Building setbacks	P (D)	<p>Permitted if Setback according to following zone,</p> <ul style="list-style-type: none"> • Residential - 23m, • Business - 23m, • Rural - 23m, • Country Living - 27.5m, • Recreation - 32m and • Rangitahi - 23m. <p>Otherwise, Discretionary.</p>
	Subdivision in Coastal Risk Area	D (NC)	<p>Subdivision of land entirely outside the high risk areas or building platform can be located outside high risk area - Discretionary (Otherwise Non-complying).</p> <p>Subdivision in the coastal sensitivity areas is Discretionary</p>

2.2.3 Subsidence

In late 2015 the Huntly East Mine was closed permanently and without actively pumping water out of the underground mine workings, they are now filling with groundwater. This change in conditions within the underground mine presented potential for further subsidence through pillar collapse and the potential for methane gas to be forced out of the mine workings as they fill with water and to find its way to the ground surface where, given the right conditions, it may become an explosive hazard. The Council commissioned a study to assess risk presented by the closed underground mine, both in terms of subsidence and gas leakage.²⁶ That assessment found that the subsidence is likely or possible in the area currently defined in the ODP. However, suitable arrangements to mitigate moderate differential settlements can be incorporated in the building design via the building code. The assessment provided detailed mapping of the hazard area, which has resulted in the extent being amended. This has resulted in the removal of the extent in some areas and extending it in others. The net result is that this hazard area now covers approximately 137 hectares of land, which is mostly residential (53 ha) and rural (69 ha). There is a small increase in residential land impacted (3 hectares).

The gas hazard was considered to pose a low risk due to the impermeable nature of the ground conditions above the mine. As a result the PDP does not include any regulatory framework to mitigate the hazard.

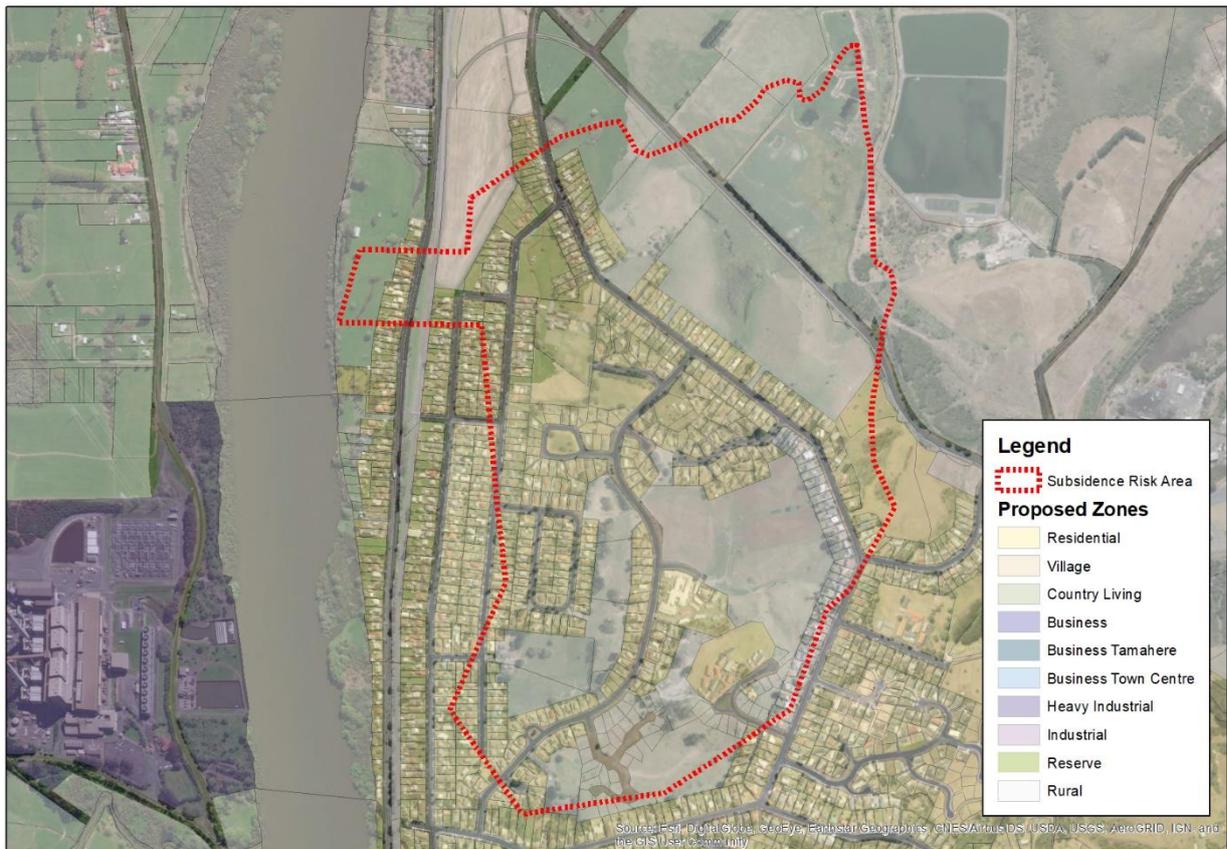
The proposed rules do however continue to regulate activities such as buildings, earthworks and subdivision in terms of subsidence as discretionary activities. The main difference between the current and proposed rules is that there are now some activities that can be carried out without requiring a resource consent. These include minor additions to existing buildings, standalone garages, utilities and small quantities of earthworks, see table 2.10 below.

Table 2.10: Mine Subsidence Risk Area Extent Provisions Proposed District Plan

Rule	Activity/Use	Status	Notes
	Additions to an existing building	P (D)	Additions to the gross floor area to 15m ² and do not result in any wall exceeding 20m.
	Standalone Garages	P (D)	Do not exceed 55m ² gross floor area and the maximum length of any wall does not exceed 20m.
	Establishment, operation, replacement, repair, upgrading or maintenance of utilities	P	The activity must meet the definition of utility
	Earthworks	P (D)	Maximum volume of filling not to exceed 20m ³ and maximum excavation depth not to exceed 1m above or below ground level

²⁶ RDCL (2019) Risk Assessment for Urban Development Areas – Huntly East Mine.

Figure 2.6: Map of Subsidence Extent in Proposed District Plan and Zones.



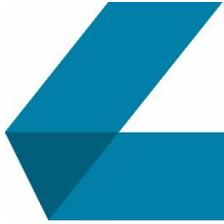
In terms of the provisions in the PDP, the Council is proposing to maintain the activity status of most construction as Discretionary, which means that a consent is required. The main change is that some types of earthworks, garages up to 55m² and small additions (under 15m²) to existing buildings will become Permitted in the PDP, which means that landholders no longer need a resource consent from the Council for these activities. Land use in this area will be relatively more enabling compared to the ODP. The rules for subdivision are unchanged, with a consent being required (Discretionary).

2.2.4 Liquefaction

The PDP has included additional matters for assessing liquefaction risk, which apply to restricted discretionary activities where liquefaction is listed as a matter that discretion is restricted to, i.e. subdivision and multi-unit²⁷ development.

This is not a significant departure from the current situation. Currently Council officers can request a liquefaction assessment as part of the information that accompanies a subdivision consent application even though there is no provision for liquefaction assessments in the Operative District Plan. Council consent planners are required to understand the level of risk from natural hazards on any subdivision proposal in order to determine whether to grant or decline the consent pursuant to Section 106 RMA.

²⁷ PDP defines Multi Unit as Apartments or Duplex. The definition excludes retirement villages, Kainga Ora or detached housing that may have multiple units.



The purpose of the proposed additional matters of discretion are to provide clearer guidance for planners, development engineers and applicants with regard to who should undertake the assessment and what information is required to be included in a liquefaction assessment, i.e. determining the liquefaction vulnerability category and where applicable detailing appropriate remediation or mitigation measures.

This is a different approach to the regulatory framework for other natural hazards in the Proposed District Plan. Other hazards are generally based on modelling and technical assessments that identify a spatial hazard area to which the provisions apply. The requirement for liquefaction risk assessments places the onus of proof on the landholder to establish the liquefaction risk. However, the new assessment matters do allow for alternative accepted methods to determine if a site is potentially susceptible to liquefaction, i.e. observation or desk-top assessments.

2.2.5 Climate Change

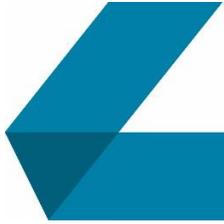
As noted above in the ODP, climate change and sea level rise are not hazards in their own right. However, they impact the frequency and intensity of a range of the hazards which the council must take into consideration when planning for land use and development. The PDP has included the effects of climate change in the 2D modelling of the 1% AEP flood extent and also includes the effects of climate change on coastal hazards, based on the effects of 1 metre of sea level rise on coastal erosion and inundation over the next 100 years to 2120

Allowances for climate change are implicit in the floodplain management area rules (2D modelled extents only) and rules for the coastal sensitivity areas. The Coastal Sensitivity Area provisions allow for the continued use and development of land that may potentially be affected by coastal hazards over the next 100 years but requires new development to be either minor additions to existing buildings or easily adaptable. Minor additions to an existing building (up to 15m²); an accessory or farm building without a floor; and the establishment, operation, upgrading, replacement, repair or maintenance of utilities are all provided for as a permitted activity. New buildings and more than minor additions to existing buildings are provided for as a restricted discretionary activity. Discretion is restricted to matters such as the requirement for an coastal hazard risk assessment; mitigation measures such as appropriate setback distance from the coast, engineering and structure design solutions, including minimum floor levels, and the ability for the building to be removed or relocated; and the ability to impose triggers that determine when the building should be removed or relocated.

2.3 Findings of District Plan Review

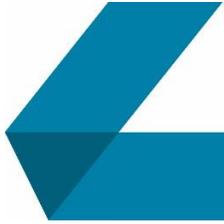
The assessment of natural hazard extents and rules in the ODP and PDP in this section shows that in many instances the differences between the policies is insignificant. However, there are some instances where the changes are significant. Based on this assessment of the policies, the following initial findings are made for each natural hazard;

- **Flooding:** The proposed provisions in the PDP are likely to generate significant positive effects, for the following four reasons.
 - First, the area of land affected by the flooding provisions is likely to be reduced in size from ODP to PDP. The detailed modelling conducted by experts has allowed WDC to narrow the application of policy to a specific area that is likely to be at risk of flooding.



Also, under the ODP the application of the policy was not accurately defined which introduced uncertainty and cost to landholders, there may have been landholders outside the areas noted above that would have been required to commission experts to establish any flood risks.

- Second, the area covered by the provisions is relatively large (approximately 6% of the District in the PDP), which is likely to have sizable effects when considered at the local or district level.
- Third, the rules within the PDP introduce more stringent requirements for activities which may impact costs of building and using the land.
- Fourth, the simplification from two sets of rules in the ODP (Waikato and Franklin) to one set of rules is likely to result in lower administration, assessment, and application costs. The change is likely to improve the consistency of the application of the flooding provisions.
- **Coastal:** The proposed provisions are likely to generate significant positive effects, for the following four reasons.
 - First, the area covered by the coastal provisions is relatively large (1% of the District in the PDP), which is likely to have sizable effects when considered at the local or district level.
 - Second, the rules within the PDP introduce more stringent requirements for activities within the hazard areas which may impact costs of building and using the land.
 - Third, the simplification from two sets of rules in the ODP (Waikato and Franklin) to one set of rules is likely to result in lower administration, assessment and application costs.
- **Subsidence:** The proposed provisions are likely to generate relatively insignificant effects, but they will be positive for the following three reasons.
 - First, the spatial definition of the area covered by this natural hazard extent is similar in size between the ODP and PDP (increased marginally by 12 hectares).
 - Second, the area covered by the extent is relatively small (less than 0.05% of the District), which is likely to have limited impact when considered at the district or local level.
 - Third, changes to the rules will permit more activity, which means that the PDP is more flexible than the ODP. For these three reasons it is considered that the difference between the ODP and PDP is likely to be positive, however not significant.
- **Liquefaction:** The proposed provisions are likely to generate insignificant effects, but will be positive for the following three reasons.
 - First, while there are no existing rules in the ODP that cover this hazard, applications for subdivision are currently required to include an assessment of liquefaction risk as a requirement under s106 RMA to determine if there is a significant risk from a natural hazard present. The PDP merely codifies this requirement within specific liquefaction provisions.
 - Second, the coverage will remain the same within the PDP as the current application of the ODP (i.e. entire District).
 - Third, the PDP also requires assessment of liquefaction for multi-unit developments. The apartment or duplex developments is relatively rare in Waikato District, this means that the impact of this provision will be limited.

- 
- **Climate Change:** The effects associated with climate change are captured in the other natural hazards. Therefore, the climate change provisions are not assessed separately in the remainder of this report.

In terms of natural hazard provisions the main difference between the ODP and PDP is that the area covered by an extent have been refined based on better information – especially flooding and coastal hazards. For the remainder of this report the subsidence, liquefaction and climate change hazards are not assessed. Given the potential significance of the effects of the flooding and coastal hazard policies, these hazards are assessed in more detail in the remainder of this report.

3 Economic Assessment – Natural Hazards

The following section draws from existing research to establish potential costs and benefits associated with flooding and coastal provisions. Our assessment establishes the marginal value of the PDP, as compared to the existing provisions in the ODP.

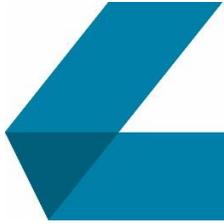
This economic assessment starts with a qualitative discussion of costs and benefits associated with the plan provisions. Section 32(2)(b) of the RMA requires that, where practicable, the benefits and costs of a proposal are to be quantified. The economic assessment provides a quantitative estimation, where possible, of the value of some of the costs and benefits. This assessment provides an understanding of the potential outcome for each of the natural hazards individually, as well as the whole package of provisions.

3.1 Costs and Benefits

The flooding and coastal provisions in the Plan are likely to result in benefits and costs accruing to the Waikato community, both in terms of activity in the economy and other non-market values. The literature search conducted for this report indicates that the following eleven costs and benefits are generally important for natural hazard and climate change provisions:

- Community Safety²⁸,
- Protection of Economic Activity, loss of income and work disruption
- Protection of Buildings,
- Compliance Costs,
- Construction Costs,
- Development Opportunity,
- Land Value,
- Administration,
- Development Pattern Efficiency,
- Cultural, and
- Biophysical/environmental.

²⁸ Includes preventing loss of life and injury, and psychological /social impact including displacement



The following subsections provide a qualitative discussion of the processes by which these costs and benefits accrue to the community, as a result of the proposed Plan provisions.

3.1.1 Community Safety

The most important element of the natural hazard provisions is that they protect the community from harm during a natural disaster. Risks associated with natural disasters are inherently uncertain, however it is clear that over a long enough time horizon the likelihood of a natural disaster occurring increases. In addition to increasing likelihood, natural disasters can have significant impacts on community safety including injury and loss of life.

It is common to assess risk severity using two dimensions, likelihood²⁹ and consequences³⁰. More detail on the standard risk assessment can be found in RDCL report on subsidence.³¹ In terms of planning, the ODP and PDP have generally applied a conservative approach that takes into account hazards that have a range of likelihood of Unlikely-Rare (e.g. 1% AEP), which is an event that is conceivable but highly unlikely (expected to occur once in a generation or longer, i.e. 1:20 to 1:200). The consequences of the event that are accounted for in the ODP and PDP tend to have minor to catastrophic outcomes.

The following risk profiles apply to the natural hazards included in the District Plans,

- **Major Flooding:** This has been defined within the DHI report as a 1% AEP, which is by definition a “Rare” event (one-in-one-hundred-year).³² But is likely to have “Catastrophic” impacts because of the likely extent of the event (including urban areas). While these events are expected to occur rarely, they can result in significant health/safety issues (injuries and fatalities), damage to infrastructure (housing, roads, services) and impacts on the environment (eco-systems being harmed).³³
- **Major Coastal Event:** This has been defined within the Waikato District Coastal Hazard Assessment as a 1% AEP, which is by definition a “Rare” event (one-in-one-hundred-year).³⁴ But could have ‘Major’ impacts. While these events are expected to occur rarely, they can result in health/safety issues (injuries), damage to infrastructure (housing, roads, services) and impacts on the environment (eco-systems being harmed).³⁵
- **Subsidence Risk:** This is a risk that is “Likely” to “Possible” but could have ‘Moderate’ impacts.³⁶
- **Liquefaction Risk:** As noted above the council has not commissioned an assessment of the liquefaction risks. Based on the information we have collected from other sources it is considered that the risk is “Very Rare” but could have a “Catastrophic” impact on the community. The likelihood of liquefaction hazard relates to two factors, the chance of an earthquake and the subsoil conditions. First, the chances of a large earthquakes (5.0 or more) occurring in Waikato

²⁹ Almost Certain/Likely/Possible/Unlikely/Rare.

³⁰ Catastrophic/Major/Moderate/Minor/Negligible.

³¹ RDCL (2019) Risk Assessment for Urban Development Areas – Huntly East Mine.

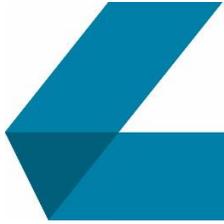
³² DHI Water and Environment Ltd (2019) WRC Lower Waikato 2D Modelling - Huntly, Ohinewai and Horotiu Model Build.

³³ Note: that some minor flooding can be expected to occur more frequently but the natural hazard provisions in the plan account for extreme flooding events, rather than common or seasonal issues.

³⁴ FOCUS (2020) Waikato District Coastal Hazard Assessment.

³⁵ Note: that some minor flooding can be expected to occur more frequently but the natural hazard provisions in the plan account for extreme flooding events, rather than common or seasonal issues.

³⁶ RDCL (2019) Risk Assessment for Urban Development Areas – Huntly East Mine.



area is low (once every 5,000 years³⁷) which means the official building code places all of the District in low seismic risk area.³⁸ Second, the subsoil conditions within much of western and northern parts of the District have been classified as either “Least” or “Not Very” hazardous for liquefaction, however areas northeast of Hamilton and along Waikato River have either “Quite” or “Most” hazardous.³⁹ It would seem that the risk of liquefaction is very rare, which sits outside of the normal risk evaluation. However, the potential consequences of an earthquake and liquefaction could be catastrophic. Therefore, it would seem rational for council to plan for such an event, especially given relatively recent issues in Christchurch City and Waimakariri District since the earthquakes of 2010 and 2011.

Given the relatively high consequence of natural hazards on community safety, this benefit should be assessed. It is acknowledged that while the likelihood of disaster events occurring during the life of the District Plan is low, it is very likely that a natural hazard event will occur during the life of buildings or subdivisions that are controlled by the natural hazard provisions. Also, that the rural nature of the District means that much of the impact will occur in farm areas, either along the coastline or the Waikato River. However, much of the community lives within the areas affected by natural hazards.

Finally, while the majority of impacts on the community relate to health and safety there may be other social benefits associated with the natural hazard provisions. For example, the PDP has an objective that relates to awareness of natural hazards. The provision of information and civil defence planning may create social benefits because the wider community is better prepared for an event and hence be more resilient. It would be difficult to assess the potential impacts of the ODP or PDP on the preparedness or resilience of the community and any associated social benefits. This report has assessed social benefits in terms of community safety.

3.1.2 Protection of Economic Activity

Another important element of the natural hazard provisions is that they are likely to mitigate impacts on the economy from harm during a natural disaster. As noted above, much of the land within the natural hazard areas is used for farming purposes. There is also some land that is used for industrial and commercial activities. Mitigation measures within the ODP and PDP can minimise the chances of negative impacts on the economy.

The above discussion about risk severity using; dimensions, likelihood and consequences, also applies to understanding of protection of economic activity. In summary, there will be relatively high consequences of natural hazards on economic activity, and therefore this benefit needs to be assessed. However, it is acknowledged that the likelihood of disaster events means that any impact will be rare to very rare during the life of the District Plan.

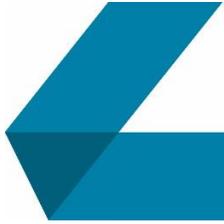
3.1.3 Protection of Buildings

The natural hazard provisions are also likely to mitigate impacts on the buildings during a natural disaster. Mitigation measures within the ODP and PDP can minimise the chances of negative impacts on the buildings that are developed in the District.

³⁷ Waikato University (2019) Project to investigate earthquake frequency and activity on Hamilton’s faults.

³⁸ Ministry of Business Innovation and Employment (2017) Z-values to determine seismic risk.

³⁹ Environment Waikato (1998) Earthquake Risk Mitigation Plan.



The above discussion about risk severity using; dimensions, likelihood and consequences, also applies to understanding of protection of building stock. In summary, there will be relatively high consequences of natural hazards on economic activity, and therefore this benefit needs to be assessed. However, it is acknowledged that the likelihood of disaster events means that any impact will be rare to very rare during the life of the District Plan.

3.1.4 Compliance Costs

The natural hazard provisions can require additional assessments for developments that occur within the extents. These assessments will be required to ensure that buildings or land uses within the affected areas comply with any additional requirements set out in the provisions.

For example, flooding and coastal rules requires a report to be submitted to council that shows that building floor level will be above 0.5m above the 1% AEP. Also, liquefaction rules will require a geotechnical report that outlines whether there is a risk of liquefaction for all buildings and subdivision.

Given the relatively large scale and location of each of the natural hazard provisions, this cost is likely to be important. The rules will require many applicants within the District to commission experts to enable them to undertake certain activities.

3.1.5 Construction Costs

There can be additional development costs associated with some of the natural hazard provisions in the Plan. These costs will mostly accrue to households and businesses that build/buy buildings in the areas of the District within the extent areas (as discussed in the previous subsection). These costs are mostly related to additional costs to cover specific building requirements that such as minimum floor height or subfloor design. For example, requiring greater floor height to mitigate flooding will result in some additional costs, would may include more materials and engineering design.⁴⁰

Given the relatively large scale and location of each of the natural hazard provisions this cost is likely to be important. The rules will require many applicants within the District to commission experts to enable them to undertake certain activities.

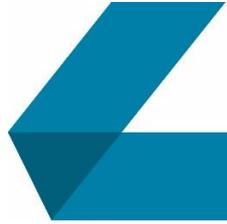
3.1.6 Development Opportunity

Some of the natural hazard provisions will impact on development opportunities in some parts of the District. The provisions can impact whether the land could be subdivided and/or where dwellings can be constructed on the land (e.g. high risk areas along the coast line).

In some instances, provisions may reduce the type of activity or nature of building that could be developed. This represents a lost opportunity to the landholders.

Given the relatively small scale and location of the restrictive provisions this cost is likely to be not significant. There are only a few locations where activities are likely to be curtailed.

⁴⁰ QS Cost Management Limited (2003) Assessment of Building Costs by Floor Level - Christchurch.



3.1.7 Land Value

The presence of planning extents on top of a property can result in reduction in land values. The difference in land value can be caused by a number of factors. Some of these factors have already been addresses above, which includes additional costs required to use the land (Compliance and Construction costs), lost potential use of the land (Development Opportunity) and potential risks associated with using the land (Safety and Economic). These direct costs associated with natural hazards are not addressed in this discussion of land values.

However, it is considered likely that the natural hazard extents will cause some land value loss beyond the direct values noted above. There may be perception of lower land value because of impacts of natural hazards on the landholders other non-market uses of the land. For example, the landholder's enjoyment of land within a hazard zone may be interrupted when an event occurs, such that the benefits from land are reduced. This type of impact may result in a lower value for land in the area affected.

Given the relatively large scale and location of each of the natural hazard provisions this cost is likely to be important. However, the fact that most extents have been refined to smaller areas in the PDP suggests that land values may actually improve overall, as a result of the changes from the ODP.

3.1.8 Administration Costs

The Council expends resources administering the natural hazard provisions, both in terms of the development of the PDP and reviewing new applications for activities.

Given the relatively large scale and location of each of the natural hazard provisions this cost is likely to be important. The rules will require many resource consent applications, which will result in the Council needing to undertake assessments of the material presented by the applicants.

3.1.9 Development Pattern Efficiency

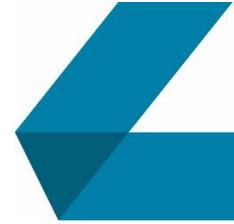
The natural hazard provisions may have implications for development patterns in the District. The provisions could result in changes in the location of urban and rural settlements and developments. In some cases, the costs of complying with the provisions could result in developments not being financially feasible (i.e. additional building costs may result in developers choosing not to develop in the extent areas). Also, the high-risk areas may result in some land no longer being developable for dwellings, which will impact on the overall value of the land.

Therefore, natural hazard provisions may result in a different development pattern. The potential shifting of development from relatively more connected locations to less connected locations may have negative impacts on the efficiency of the District economy.

Given the relatively small scale and location of each of the natural hazard provisions this cost is likely to be insignificant and is not assessed in the following section.

3.1.10 Cultural

There may well be cultural impacts associated with the natural hazard provisions in the ODP and PDP. For example, coastal areas tend to have a high incidence of culturally important sites. These cultural sites may be impacted positively (better protection) and/or negatively (impact customary uses). It is not possible to



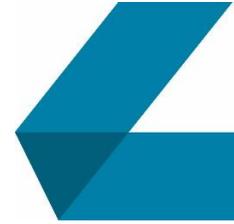
assess these values in this report as there is no data or evidence that can be used to establish the potential impacts on the cultural value.

While there are a number of natural hazard provisions in the ODP and PDP that may impact the cultural values. It is considered that the cultural implications of the natural hazards provisions would have been assessed within other research on the wider cultural topics, which is beyond the scope of this report. Also, it is beyond the expertise of Market Economics to assess the potential values of these benefits. For the remainder of this report the cultural impacts of the natural hazard provisions are not addressed.

3.1.11 Biophysical/environmental

Finally, the natural hazard provisions in the ODP and PDP may have impacts on the biophysical environmental. For example, the ODP and PDP both have policies that encourage the use of natural features (soft defences) rather than hard features (concrete defences) for mitigation against erosion and flooding. The encouragement of soft defences in the provisions may mitigate some of the effects of natural hazards on the environment. Another example is that the provisions may encourage utility operators to design and locate their networks to avoid the risks of natural hazard. This may limit the chances that these networks fail and/or need maintenance, both of which can harm the environment.

There are a number of natural hazard provisions in the ODP and PDP that may impact the environment. It is considered that the environmental implications of the natural hazards provisions would have been assessed within other research on the wider environmental topics, which is beyond the scope of this report. Also, it is beyond the expertise of Market Economics to assess the potential values of these benefits. For the remainder of this report the environmental impacts of the natural hazard provisions are not addressed.



3.2 Estimating Value of Costs and Benefits

The following section provides a quantitative assessment, where possible, of the costs and benefits discussed in the previous section for each of the key natural hazard provisions in the Plan. The quantification could not be conducted using a marginal assessment – i.e. What are the additional costs and benefits that the natural hazard provisions in the Plan will produce compared to the existing provisions in the ODP? This is because the council has been unable to provide a robust set of information about the extents of the ODP application. Also, the hazard provisions in the ODP have become redundant, such that the practical application of the provisions by council officers cannot be established. Therefore, this report has focused in quantifying the costs and benefits of the PDP and then providing a qualitative discussion of how these values are likely to compare to the situation under the ODP.

The following assessment is conducted using information from 2019, which is applied for the coming five decades. The time period has been selected because most activities that are controlled by the natural hazard provisions will be in place for at least this period (i.e. building life tends to be 30-50 years). Specifically, the planning framework will have implications for the long term, beyond the life of the plan. The assessment in the following section applied standard Net Present Value method to convert future values into one comparable value.⁴¹

Also the costs and benefits associated with the natural hazard provisions have been grouped into three categories based on who they accrue to – i.e. by stakeholder groups that are impacted. The three groupings used in the following section are, Community Impacts, Landholder Impacts and Council Impacts.

Matters to be taken into account when assessing benefits and costs of natural hazards are as follows:

- i. the likelihood of the event,
- ii. the consequences of the event,
- iii. the coverage of the event; and
- iv. the types of activity that are impacted.

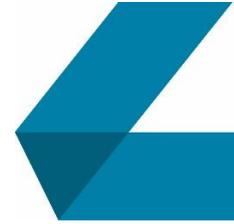
In order to assess the benefits and costs this report makes a number of assumptions about these four matters.

Table 3.1 shows the assumed likelihood of the two natural hazards assessed in this section of the report. The flooding and coastal hazards are assumed to be “Rare”, with an expected frequency of once every hundred years. This is based on the modelling conducted by DHI Water and Environment Ltd (flooding) and Focus Resource Management Group (coastal), that applies a “1% AEP” which by definition models an event that occurs every hundred years.

Table 3.1: Natural Hazard Likelihood and Frequency

Event	Likelihood	Frequency
Flooding	Rare	1 : 100
Coastal	Rare	1 : 100

⁴¹ The discount rate applied in the NPV was set at 5%.



In terms of consequence, it is assumed that both natural hazards can result in ‘Major’ to ‘Catastrophic’ damages. The impacts range from significant impacts on community safety (fatalities, serious injury and minor injury) and damage to properties (destroyed buildings). However, the consequence also relates to the coverage of the natural risks.

Coverage of the events is assumed to relate to the land which is covered by the natural hazard extents (as outlined in the Section 2) and the potential new activity during the life of the District Plan. The assessment is conducted using new growth, in terms of population and employment, between 2018 and 2033. For this report it is assumed that all existing activity will continue to occur, regardless of the provisions in the ODP or PDP.

Given the time constraints of this study and the ambiguity around the coverage of the existing hazard provisions, it was not possible to develop a fine grained growth estimate which matches the spatial definition of the natural hazard extents. For this study the results from the capacity assessment 2017⁴² have been used to estimate the proportion of growth in each Census Area Unit which may be impacted by the natural hazard. Specifically, the growth in each Census Area Unit has been applied pro-rata according to the share of capacity in that area. For example, if 20% of the capacity within a Census Area Unit was located in the hazard extent defined in the PDP, then it is assumed that 20% of the growth may be impacted by the hazard. It is acknowledged that this may result in an overestimation of the amount of population that could be impacted by hazards, as the provisions within the ODP and PDP are designed in many cases to inhibit new growth locating in the areas affected by the hazards. Notwithstanding, it is considered that this overestimation will not change the overall findings of this report.

Table 3.2 shows the maximum number of households and jobs that could be impacted by each natural hazard. The growth is established using Stats New Zealand Population Projections⁴³ and M.E employment forecasts⁴⁴.

- **Flooding:** could impact less than 3,500 new residents and 200 new jobs, and
- **Coastal:** could impact less than 800 new residents and 50 new jobs.

Table 3.2: Potential Growth in Natural Hazard areas (based on CAU in PDP Extents)

Coverage	Population	Emplymnt*
Flooding	3,500	200
Coastal	800	50

**excludes primary sectors, farming and mining*

Impacted activities are assessed according to the rules set out in either the ODP or PDP. This includes residential and business activity, while rural activity is not covered as this activity is (mostly) unaffected by the natural hazard provisions within the ODP or PDP.⁴⁵ Specifically, the natural hazard provisions in the

⁴² Market Economics (2018) Residential Capacity Assessment – Future Proof Partners.

⁴³ Stats NZ (2018) Subnational Population Projections.

⁴⁴ Market Economics (2018) Economic Forecasts modelling.

⁴⁵ It is acknowledged that natural hazards will affect rural activities. However the impacts will be more or less the same under the ODP and PDP, as the provisions do not control this activity.

ODP and PDP manage building, subdivision, earthworks and utilities, as such will have little impact on the operation of most rural activities.

3.2.1 Community Impacts (Safety, Economic Activity and Buildings)

In this report community impacts have been quantified by estimating the effects of each natural hazard in terms of safety, lost economic activity and protection of buildings under the PDP. The estimation has been established using an equation and a set of assumptions, which is designed to provide an indicative understanding of the potential order of magnitude of the values rather than a definitive quantification.

First, the expected safety impacts of each natural hazard (S_{NH}) in any given year has been valued using the following formula,

$$S_{NH} = R_{NH} \times Pop_{NH} \times EI_{NH}$$

Where,

NH denotes the natural hazard, which includes flooding and coastal,

R_{NH} is the risk of natural hazard NH occurring in any given year (as defined in Table 3.1),

Pop_{NH} is the population of new people that may live in NH hazard area (as defined in Table 3.2),

EI_{NH} is the expected injury costs that could occur to an individual during natural hazard NH .

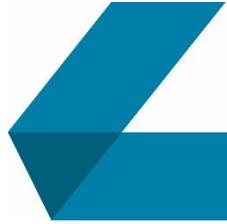
There is no data available on the expected injury cost that could occur during a natural disaster, either at the national level or for the District. In order to estimate the safety impacts of each natural hazard we must make assumptions about the cost and probability of an injury. The following assumptions have been used to derive a proxy value for EI_{NH} .

- **Social Cost of Injury:** for each injury there is a social cost, both to individual and the wider community. For this study the cost has been set based on the official values ascribed by Ministry of Transport.⁴⁶ These Social Cost values are used by the Ministry to assess the merits of investments in safety improvements to the transport network. However they should be sufficiently accurate for the purposes of understanding injuries from natural hazards. The research of the Ministry suggests that minor injury has a social cost of \$0.1 million and a serious injury has a social cost of \$0.5 million, while a fatality has a social cost of \$4.4 million.
- **Probability of Injury:** there is no data available on the probability of injury during a natural disaster, either at the national level or for the District. We consider that probability of injury during a natural event is likely to be very low. For this report it is assumed that during a natural hazard event one in a hundred people are impacted by a minor injury (probability of 1%) and one in ten thousand people are impacted by a serious injury (probability of 0.01%). Finally, it is assumed that fatality is very unlikely during a natural hazard event, with a chance of one in a million people being impacted (probability of 0.0001%).

The following formula is used to establish the expected injury cost (EI_{NH}),

$$EI = \sum_{In} Prob_{In} \times SC_{In}$$

⁴⁶ Ministry of Transport (2018) Social Cost of Road Crashes and Injuries.



In denotes the range of injuries that could affect a person, which includes minor, serious and fatal.

$Prob_{In}$ is the probability of a person having an injury In during an event.

SC_{In} is the social cost of injury In , as defined in Ministry of Transport official road injury data described above.

The results from the social safety cost formula show that the annual expected cost of flooding natural hazard is the most significant, at \$32,000 per annum. This is understandable as this natural hazard covers a wide area which has a number of important urban areas and this type of event has a relatively higher risk of occurring. The coastal hazard, which is also has a relatively higher risk of occurring, has a smaller coverage and of which most is rural land which means that the social cost is lower at \$7,000 per annum. Finally, the table also shows the total expected safety cost over the coming 50 years. This indicative assessment suggest that the total safety cost of the hazards could be valued at,

- \$0.5 million for flooding hazard, and
- \$0.1 million for coastal hazard.

Table 3.3: Indicative Social Cost of Natural Hazard (Safety)

Safety	Hazard Risk (R_{NH})	Population (Pop_{NH})	Expected Injury (EI_{NM})	Annual Social Cost (S_{NH})	Total Cost (NPV @5%)
Flooding	1.00%	3,500	\$900	\$ 32,000	\$ 463,000
Coastal	1.00%	800		\$ 7,000	\$ 101,000

Second, requires assessing the economic benefits associated with the natural hazard extents. The majority of the economic activity that falls within the extents is primary sector in nature (farming, agriculture, mining, forestry etc.). While these primary sector activities will be impacted by natural hazards, there are limited provisions in the ODP or PDP that restrict these activities. Therefore, it is assumed in this report that the outcomes for the primary sector are the same under both the ODP and PDP.

The focus of the following discussion is on economic activity that generally locates within the urban areas of the District (retail, offices, accommodation, factories, warehouses, etc.). In the event of a natural hazard occurring some businesses and employees may be impacted, with business activity either ceasing for the duration of the event or potentially being stopped for a longer period if the premises is destroyed.

In this report the expected economic impacts of each natural hazard (E_{NH}) in any given year has been valued using the following formula,

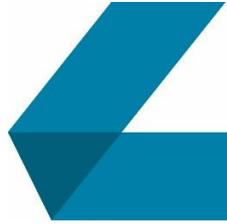
$$E_{NH} = R_{NH} \times Emp_{NH} \times ES_{NH}$$

Where,

NH denotes the natural hazard, which includes flooding and coastal,

R_{NH} is the risk of natural hazard NH occurring in any given year (as defined in Table 3.1),

Emp_{NH} is the new employment that operates in NH hazard area (as defined in Table 3.2),



ES_{NH} is the expected stoppage costs that could occur to an individual during natural hazard NH .

For this report the expected stoppage is equal to one month of salary for each employee⁴⁷ multiplied by the probability of being impacted which is set at 25%. This means that one in every four jobs is assumed to stop for a month. This may overestimate the true economic impacts, as in many cases jobs will be able to shift to a new premises and stoppage of an entire month is likely to be longer than what normally occurs in a natural hazard event. The expected stoppage (ES_{NH}) is set at \$1,000 per job.

The results from the economic cost formula shows that the annual expected cost of flooding natural hazard is the most significant, at \$2,000 per annum. This is understandable as the natural hazard covers a wide geography containing a number of important business areas and this type of event has a high risk of occurring. The coastal hazard is expected to have limited impact on the economy as the hazard covers an area with little business activity. Table 3.4 also shows the total expected economic cost over the coming 50 years. This indicative assessment suggest that the total economic cost of the hazards could be valued at,

- \$0.03 million for flooding hazard, and
- \$0.01 million for coastal hazard.

Table 3.4: Indicative Economic Cost of Natural Hazard

Economic	Hazard Risk (R_{NH})	Employment (Emp_{NH})	Expected Stoppage (ES_{NM})	Economic Cost (E_{NH})	Total Cost (NPV @5%)
Flooding	1.00%	200	\$1,000	\$ 2,000	\$ 29,000
Coastal	1.00%	50		\$ 500	\$ 7,000

Third, requires assessing the potential damage to buildings associated with the natural hazard extents. As discussed above there is limited urban business activity within the extent areas, so the focus of the following estimation is on residential buildings. In the event of a natural hazard occurring some buildings may be impacted, either minor damage or even being destroyed.

In this report the expected building impacts of each natural hazard (B_{NH}) in any given year has been valued using the following formula,

$$B_{NH} = R_{NH} \times Dwe_{NH} \times ED_{NH}$$

Where,

NH denotes the natural hazard, which includes flooding and coastal,

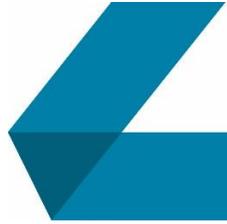
R_{NH} is the risk of natural hazard NH occurring in any given year (as defined in Table 3.1),

Dwe_{NH} is the number of new dwellings that are built in NH hazard area⁴⁸,

ED_{NH} is the expected damage that could occur to a building during natural hazard NH .

⁴⁷ Salary is assumed to be \$50,000 per annum.

⁴⁸ Population in Table 3.2 divided, by an assumed household size of 2.5 persons per dwelling.



For this report the expected damage is equal to \$100,000 multiplied by the probability of being impacted which is set at 25%. This means that one in every four dwellings is impacted by \$100,000 of damage. This may overestimate the true damage, as in many cases impacts will be minimal. The expected damage (ED_{NH}) is set at \$25,000 per dwelling.

The results from the building damage formula shows that the annual expected cost of flooding natural hazard is the most significant, at \$350,000 per annum. This is understandable as the natural hazard covers a wide geography containing a number of important business areas and this type of event has a relatively higher risk of occurring. The coastal hazard is expected to have lower impact on the buildings as the hazard covers an area with less development potential (\$75,000 per annum). Table 3.5 also shows the total expected building damage cost over the coming 50 years. This indicative assessment suggest that the total economic cost of the hazards could be valued at,

- \$5.1 million for flooding hazard, and
- \$1.1 million for coastal hazard.

Table 3.5: Indicative Building Damage Cost of Natural Hazard

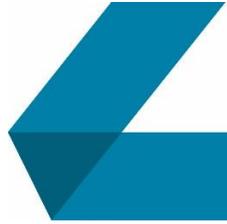
Building Damage	Hazard Risk (R_{NH})	Dwellings (Dwe_{NH})	Expected Damage (ED_{NM})	Building Cost (E_{NH})	Total Cost District Plan Period
Flooding	1.00%	1,400	\$25,000	\$ 350,000	\$5,065,000
Coastal	1.00%	300		\$ 75,000	\$1,085,000

These indicative results provide an understanding of the relativity of the safety, economic costs and build damage costs associated with the two main natural hazards in Waikato District. However, the difference between the ODP and PDP provisions will also result in different levels of safety mitigation and protection of economic activity. For example, the flooding provisions in the ODP require buildings to have floor level of 0.3m above 1% AEP compared to the PDP that requires floor level of 0.5m above 1% AEP. Likewise, the coastal hazard provisions in the PDP provide an understanding of the areas that are at risk (high risk and sensitive) which will ensure that human activity takes into account the risks associated with this hazard, in the ODP there was no specific provisions for this hazard. Therefore, it is likely that the safety outcome in the PDP should be better than the ODP. However, the benefit from the provision can only be a proportion of the value estimated above.

Given the lack of spatial data and time constraints of this report, it is not possible to estimate the marginal difference between the safety and economic outcomes between the ODP and PDP. However, it is considered very likely that the PDP will result in positive safety, economic benefits and build damage benefits relative to the ODP. The value of these benefits is likely to be a subset of the values shown in tables above.

3.2.2 Landholder Impacts (Compliance, Construction, Opportunity, Land Value)

In this report the landholder impacts have been quantified by estimating the effects of each natural hazard in terms of Compliance, Construction, Opportunity and Land Value. The estimation has been established by combining the number of new building (dwellings) or land that could be impacted under the PDP, along with assumed costs.



First, in order to build within the extent areas, the landholder will need to commission experts to establish the risks associated with the natural hazards. For the flooding and coastal extent areas the landholders will need to pay for a surveyor report to establish that the floor level is sufficient to meet the provisions in the District Plan. In the absence of evidence on the potential cost, it has been assumed that these reports will cost \$500 per dwelling.

Table 3.6 outlines an indicative estimate of compliance costs associated with each of the natural hazards. The table shows the annual number of dwellings that may be built within each of the natural hazard extent areas for the PDP. These results indicate the cost of compliance for new dwellings within the flooding and coastal extents in the PDP will be relatively small compared to the potential harm that could be inflicted during a hazard event. The final information in the table shows the total compliance cost for the dwellings built during the District Plan period.⁴⁹ This data shows the following compliance costs,

- \$0.5 million for flooding hazard, and
- \$0.1 million for coastal hazard.

Table 3.6: Indicative Compliance Costs of Natural Hazard

Compliance Costs	Annual Dwellings	Assumed Costs	Annual Cost (\$m)	District Plan Period
Flooding	140	-\$ 500	-\$ 70,000	-\$ 541,000
Coastal	30	-\$ 500	-\$ 15,000	-\$ 116,000

Second, in order to build within the extent areas, the landholder may need to build to a higher standard to mitigate the risks associated with the natural hazards. For the flooding and coastal extent areas the landholders may need to build to a higher floor level that is sufficient to meet the provisions in the District Plan (applies in the ODP and PDP). In the absence of district specific evidence on the potential additional build cost, it has been assumed that building to a higher floor level will cost \$2,000 per dwelling.⁵⁰

⁴⁹ For a building the risk of hazard impacts occurs every year, while the compliance cost only occurs once when the landholder applies to develop the land. That is once built there are no additional compliance costs for the dwellings built during the District Plan.

⁵⁰ This assumption is broadly consistent with QS Cost Management Ltd Floor Level Cost regression equation, which suggests a \$2,012 to build an extra 200mm.



Table 3.7 outlines an indicative estimate of the additional build costs associated with each of the natural hazards. Again, the table shows the annual number of dwellings that may be built within each of the natural hazard extent areas for the PDP. The tables then apply the assumed building cost per new dwelling to establish the annual cost of compliance for the PDP. The final information in the table shows the total additional build cost of dwellings built during the District Plan period. This data shows the following construction costs,

- \$2.2 million for flooding hazard, and
- \$0.5 million for coastal hazard.

Table 3.7: Indicative Constructoin Costs of Natural Hazard

Construction Costs	Annual Dwellings	Assumed Costs	Annual Cost (\$m)	District Plan Period
Flooding	140	-\$ 2,000	-\$ 280,000	-\$ 2,162,000
Coastal	30	-\$ 2,000	-\$ 60,000	-\$ 463,000

Third, in some instances the extent areas may result in building being very difficult (Non-complying). For the high-risk flooding and coastal extent areas building may be difficult. While the landholder may lose development potential on their land, it is very likely that development will occur somewhere else within the District. For this report we assess the marginal change in development opportunity, which has been estimated by assuming a marginal cost of 10% of the average section price in the District (i.e. \$26,000) and assumes that development potential has a one in ten chance of being developed during the life of the District Plan.

Table 3.8 outlines the indicative estimate of the lost building opportunity associated with each of the natural hazards. The table shows the annual number of dwellings that may be built within each of the high risk extent areas for the PDP. The tables then apply the assumed lost development opportunity per new dwelling, to establish the annual cost for the PDP. The final information in the table shows the total lost development opportunity during the District Plan period. This data shows the following opportunity costs,

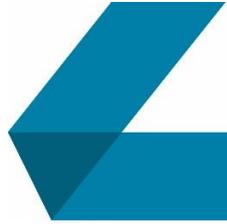
- \$1.2 million for flooding hazard (cost), and
- \$0.4 million for coastal hazard.

Table 3.8: Indicative Lost Development Opportunity of Natural Hazard

Opportunity Costs	Annual Dwellings	Assumed Costs	Annual Cost (\$m)	District Plan Period
Flooding	6	-\$ 26,000	-\$ 156,000	-\$ 1,205,000
Coastal	2	-\$ 26,000	-\$ 52,000	-\$ 402,000

Finally, the hazard extent areas can cause a negative impact on land values. For example economic research suggests flooding extents can cause a -2.3% impact on land values in the extent areas compared to land outside of the extent.⁵¹ However, in this case it has not been possible to assess the potential

⁵¹ Samarasinghe, O. and Sharp, B. (2010) Flood prone risk and amenity values: a spatial hedonic analysis



impacts of the PDP in terms of land values. It is not clear how the PDP hazards will be recorded against the properties or how existing ODP hazards are currently recorded. We consider that more research would be required to assess this value.

In summary, we consider that landholders will face costs to comply with the PDP. However, in marginal terms much of this cost will also occur under the ODP. Given the lack of information on the ODP it is not possible to establish the exact nature of the costs to landholders. However it is considered likely that much of the costs discussed above will accrue to landholders under the ODP and PDP.

3.2.3 Council Impacts (Administration)

In this report the council impacts have been quantified by estimating the effects of each natural hazard in terms of administration costs. The ODP and PDP both require the council to assess the materials provided by the applicants, both in terms of compliance reports and build specifications.

For this report it is assumed that for every compliance report relating to the natural hazards a council officer must expend 5 hours of time at a cost of \$500. It is also assumed that for every building consent relating to the natural hazards a council officer must expended a further 5 hours of time at a cost of \$500. In total council administration costs could be in the order of \$1,000 per dwelling.

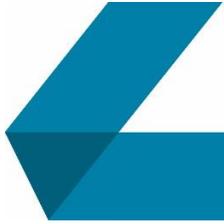
Table 3.9 outlines the indicative estimate of the administration costs associated with each of the natural hazards. The final information in the table shows the total administration cost over the District Plan period. This data shows the following compliance costs,

- \$1.0 million for flooding hazard, and
- \$0.2 million for coastal hazard.

Table 3.9: Indicative Administration Costs of Natural Hazard

Administration Costs	Annual Dwellings	Assumed Costs	Annual Cost (\$m)	District Plan Period
Flooding	140	-\$ 1,000	-\$ 140,000	-\$ 1,081,000
Coastal	30	-\$ 1,000	-\$ 30,000	-\$ 232,000

In summary, we consider that Council will face costs to administer the PDP. However, in marginal terms much of this cost will also occur under the ODP. Given the lack of information on the ODP it is not possible to establish the exact nature of the costs to Council. However, it is considered likely that much of the costs discussed above will accrue to Council under the ODP and PDP. The PDP may actually result in a small positive savings for the natural hazards, because the provisions will enable council officers to assess applications more quickly.



4 Conclusion

This report has applied an economic assessment to establish the net outcome if the natural hazard provisions in the Operative District Plan are changed to the provisions as outlined in the Proposed District Plan. Specifically, this report has drawn on all available data to assess the potential costs and benefits for the key natural hazard provisions.

While the lack of information on the ODP has resulted in this report not being able to provide definitive quantifications of the marginal benefits of the PDP, it is still possible to conclude that the PDP is likely to result in a net positive benefit for the community.

A key point noted during this report is that the extent of the application of the natural hazard provisions has tended to be refined as more research is conducted. This has allowed the council to refine the coverage of natural hazard extents, which retains the benefits (safety, economic and buildings) while minimising the costs (landholder and council). In summary the chance of false positives⁵² is reduced in the PDP, which allows the community to maximise the use of the land while reducing the risks of harm from natural hazard events. We are informed that this approach will also be adopted for liquefaction, with council undertaking future research to minimise the instances of false positives.

Caveat: it is important to note that it is inherently difficult to undertake an economic assessment of costs and benefits associated with natural hazards. This report has been based information provided by council officers and other experts. Notwithstanding the difficulty of the assessment, this report has quantified each of the costs and benefits based on a range of assumptions.

⁵² i.e. instances where a landholder must meet the requirements of the natural hazard provisions, when in fact their land is not at risk of a natural hazard.