REPORT

Tonkin+Taylor

Downtown West - Downtown Car Park Redevelopment

Flood hazard and risk assessment

Prepared for
Precinct Properties Holdings Limited

Prepared by
Tonkin & Taylor Ltd

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Document control

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22/07/24	1	Draft Report	BELU	JRRR	PJM
09/08/24	2	Final Report	BELU	JRRR	PJM
06/12/24	3	Ch. 1 updates to architect's information reference. Ch. 2 updates to freeboard guidance. Ch 3 (pt3) (pt 8) Change from 0.04m depth to 0.05 m. Ch 4 updates to retail space references in Section 5.	BELU	JRRR	PJM
12/12/2024	4	Ch. 1 addition of reference to architect's flood mitigation options information in Section 2. Ch. 2 addition of velocity and hazard classification information (also provided in the S92 response addendum document) to Section 2. Ch. 3 update to reference to number of car parks in Section 5.	BELU	JRRR	PJM

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1 Introduction

RCP, on behalf of Precinct Properties NZ Ltd (PPL), has engaged Tonkin & Taylor Ltd (T+T) to complete further flood assessment studies to assist PPL in the consenting process for the Downtown West – Downtown Car Park Redevelopment project.

The purpose of this memo is to present flood hazard information, coastal hazard information and a hazard risk assessment to support the resource consent application. This builds on flood hazard assessment work completed by T+T In December 2020.

All levels presented in this document are in Auckland 1946 vertical datum (AVD1946).

The report structure is as follows:

- Flood hazard.
- Coastal inundation.
- Freeboard.
- Natural hazard risk assessment.

2 Flood hazard

2.1 Background information

The Auckland Council (AC) mapped 1% AEP[1] floodplain, flood prone area and overland flow paths are shown in Figure 2.1.

The site is adjacent to a floodplain area identified on Hobson Street, Customs Street West and the laneway. There is an overland flowpath identified along the roads adjacent to the site on Customs Street West and Hobson Street.

Auckland Council Geomaps identifies a "flood prone area" located at the northeastern area of the site. The mapped extents of the flood prone area are incorrect, and the flood prone area is only confined to the laneway area. Flood prone areas can provide useful information relating to flood hazard when an outlet is blocked and this can support flood risk decision making when evaluated alongside considerations regarding likelihood of blockage.

[1] Annual Exceedance Probability (AEP). A 1% AEP is also referred to as a 100 year ARI (Average Recurrence Interval)

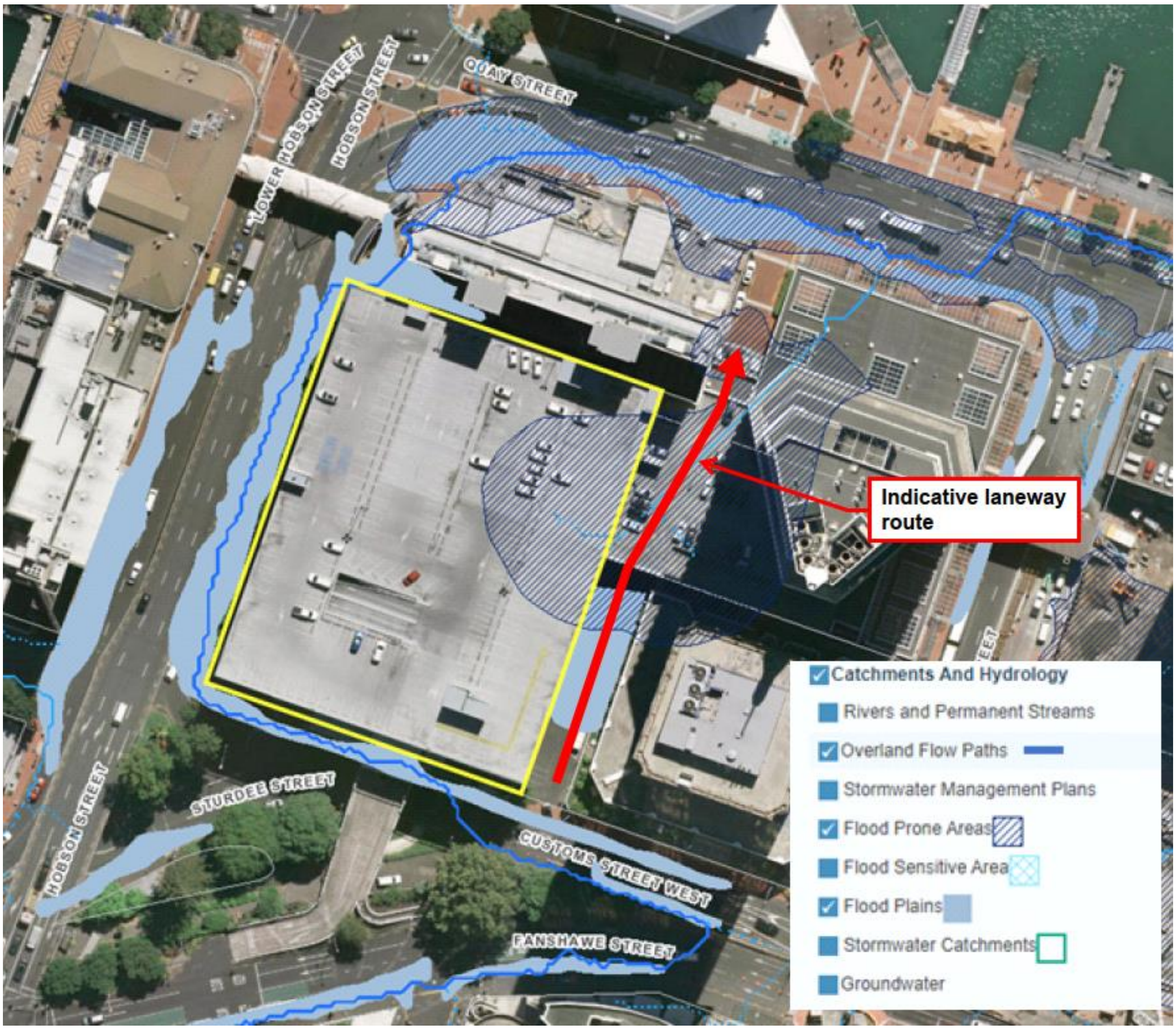

Figure 2.1: Overland flow paths, floodplain and flood prone areas (source: Auckland Council GeoMaps).

2.2 Flood hazard assessment

Auckland Council provided a copy of their Auckland CBD coupled (1D/2D) model (DHI software) for this flood assessment.

The hydraulic model used was the AC “2018 baseline” CBD model. It is a more up to date version of the model than was used in the T+T 2020 flood assessment. Updates to the baseline model are summarised below:

Hydraulics

- Galway St model (December 2016, Stage 2, ACO Drain modified) in area encompassed by Queen St/Fort St/Britomart Pl:
  - Terrain update.
  - Pipe network update.
  - Catchment hydrology update.
- Myers Park pre-development model (August 2015) in Myers Park area:
  - Pipe network update.
- Downtown/Queen Elizabeth Square post-development model (November 2015):

  - Terrain update.
- Beca Survey (March 2018) of downtown area:
  - Terrain update.
- The model was updated to better represent the hydraulic connectivity through the existing laneway adjacent to the east side of the site.

Climate change scenarios

In addition to the scenarios previously assessed (up to 2.1 degrees of warming associated with climate change) an additional allowance for climate change up to 3.8 degrees was included in the assessment.

The downstream boundary was increased to 3.36 mRL to represent the Sea Level Rise (SLR) resulting from a 1% AEP storm surge event plus one meter sea level rise.

Development scenarios

The post-development modelled scenario incorporates the development as shown in Warren and Mahoney GA Level 00 drawing RC10-0010 dated 03/12/24. In comparison to the existing development the land use remains the same (i.e. 100% impervious) and the ground footprint remains similar (slight reduction). The ground footprint remains similar despite a smaller building footprint because of the raised walkway.

It is currently proposed to include flood barriers at either end of the laneway to prevent flood flows from entering the laneway and basement. These were represented in the post-development model, in line with Warren and Mahoney drawing pack 'Service Lane Flood Mitigation Options' 05/11/24.

Design opportunities to refine the location and design of the barriers remain open during subsequent design stages. The flood effects of the barriers are discussed further in the natural hazard risk assessment.

2.3 Flood hazard assessment results

Figures 2.2 – Figure 2.5 present the floodplain extents and flood depth around the property. The four figures represent scenarios with and without the proposed development and two different climate scenarios (2.1 degrees of warming and 3.8 degrees of warming).

There are 6 locations identified on each figure, and Table 2.1 identifies the flood depths and flood levels at each location.

Table 2.1: Predicted flood levels (refer to Figures 2.1 – 2.5 for ID locations)

ID	Predevelopment				Post development			
	2.1 degrees climate change		3.8 degrees climate change		2.1 degrees climate change		3.8 degrees climate change	
	Depth	Level	Depth	Level	Depth	Level	Depth	Level
1	0.18	3.83	0.19	3.84	0.19	3.84	0.21	3.86
2	0.13	3.62	0.14	3.62	0.13	3.62	0.14	3.62
3*	0.08	5.56	0.10	5.57	0.09	5.57	0.11	5.59
4	0.09	4.72	0.11	4.74	0.10	4.73	0.12	4.74
5	0.39	3.91	0.41	3.94	0.39	3.92	0.42	3.95
6	0.40	3.90	0.42	3.93	0.41	3.91	0.43	3.94
*The higher flood levels associated with Location 3 are due to the higher ground. There is a flowpath draining from east to west.								

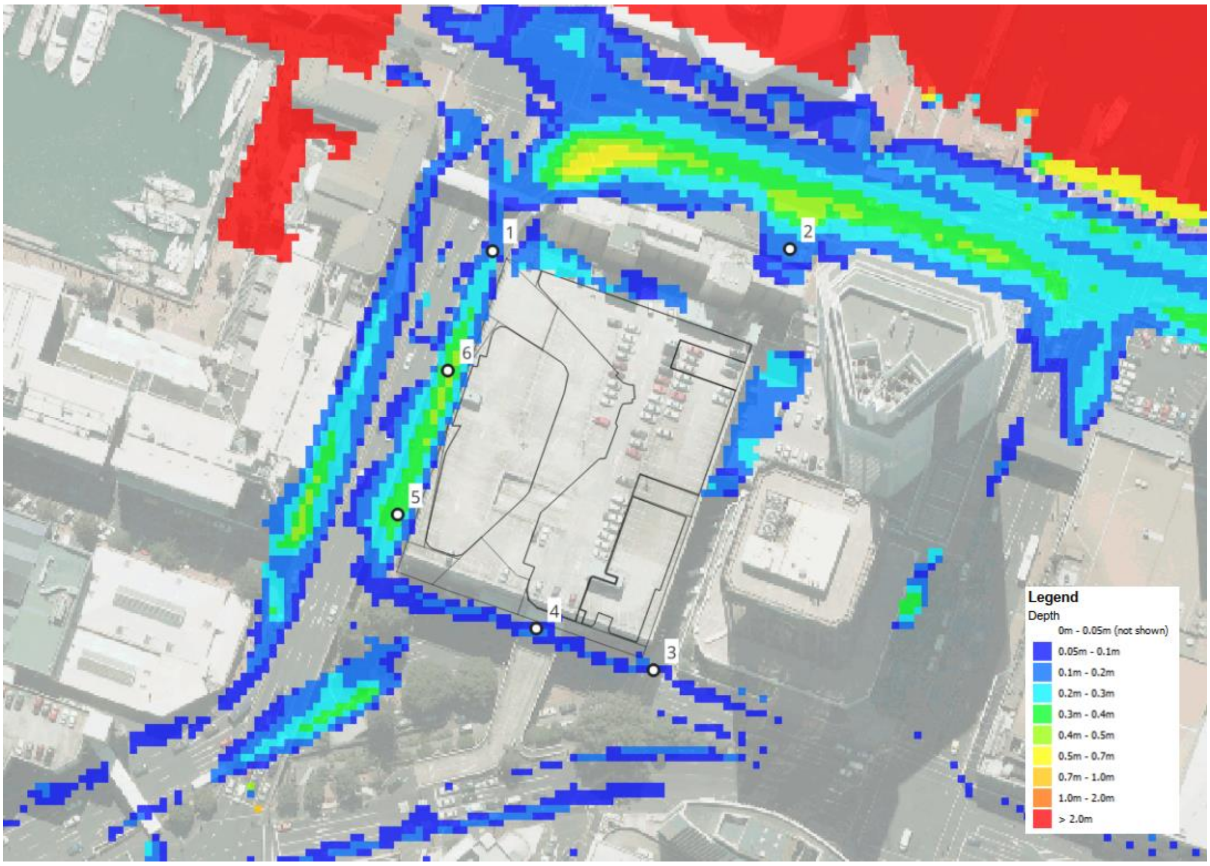

Figure 2.2: Pre-development 1% AEP floodplain - climate change 2.1 degrees.

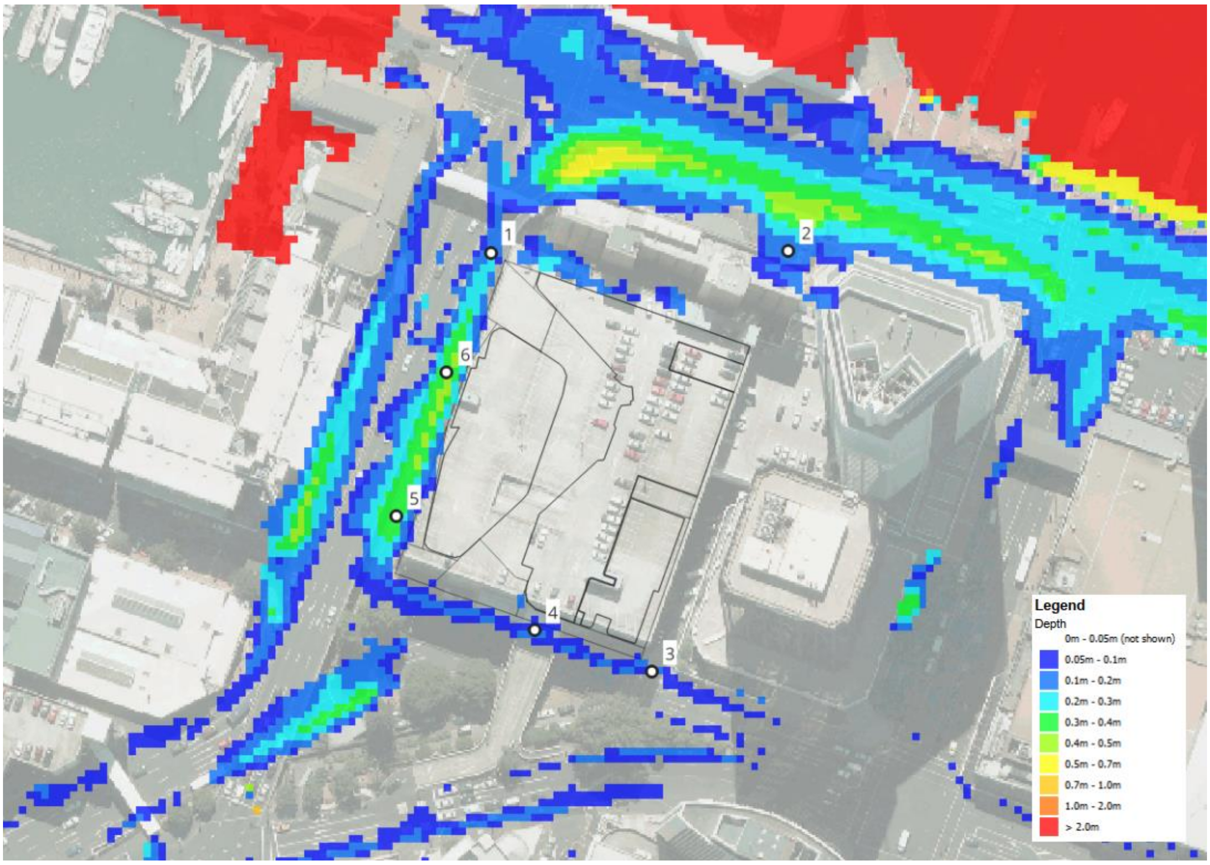

Figure 2.3: Post-development 1% AEP floodplain - climate change 2.1 degrees.

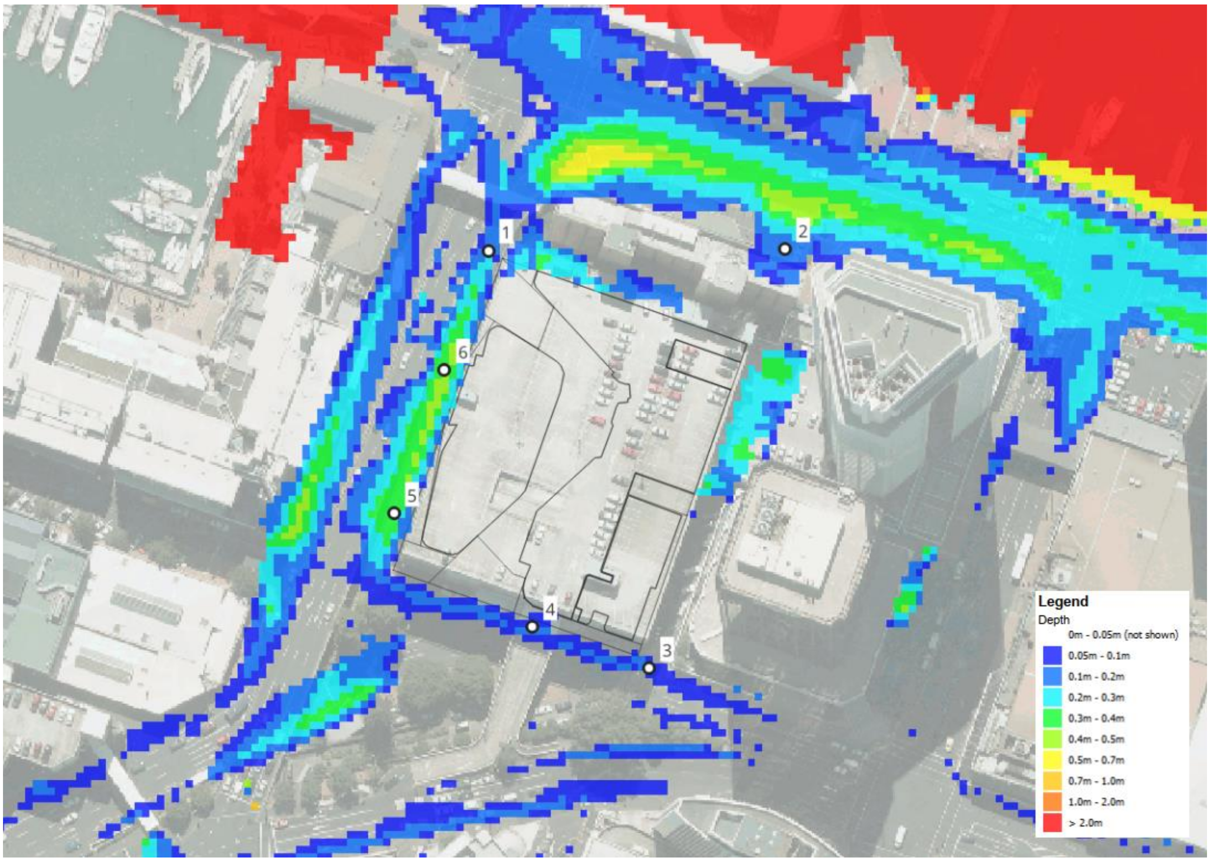

Figure 2.4: Pre-development 1% AEP floodplain - climate change 3.8 degrees.

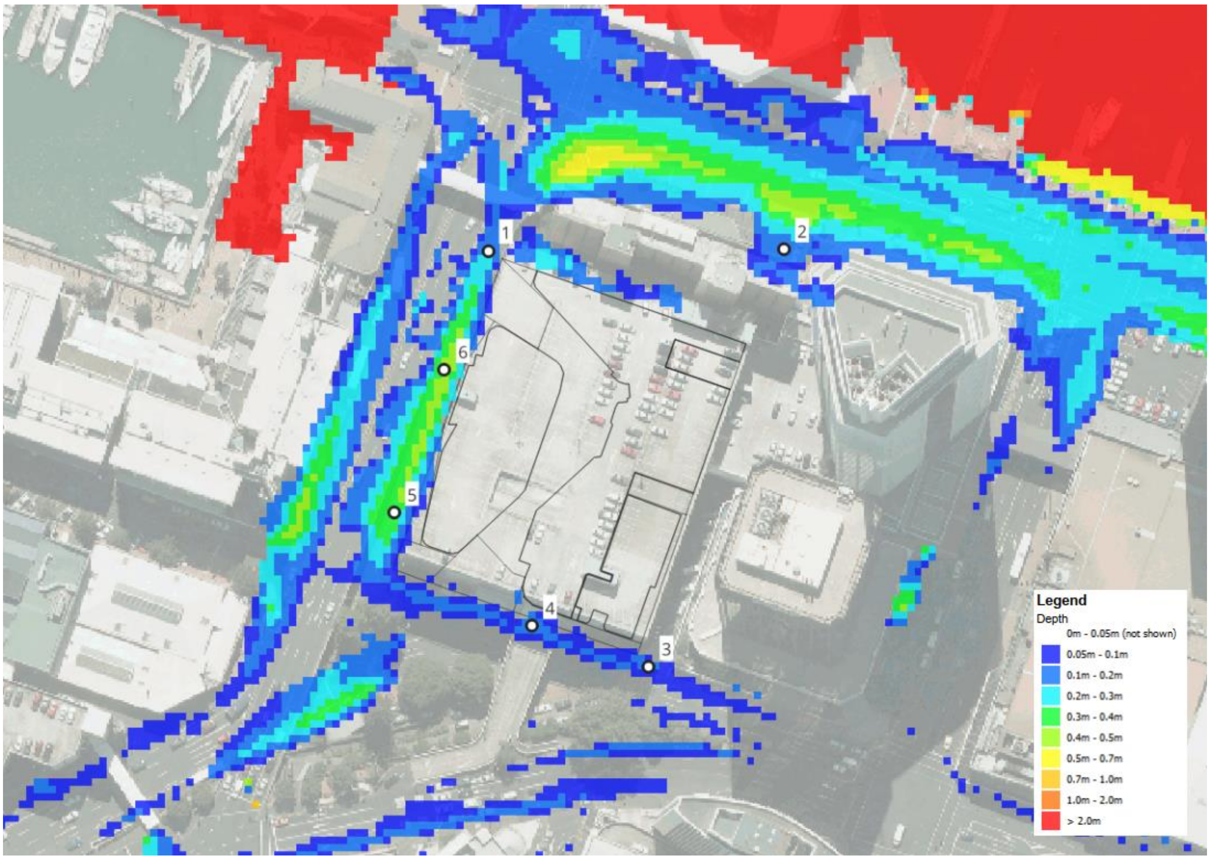

Figure 2.5: Post-development 1% AEP floodplain - climate change 3.8 degrees.

Figure 2.6 and Figure 2.7 represent maximum velocity values with and without the proposed development for the 3.8 degrees climate change scenario. Depth and velocity hazards have been classified using the flood hazard curves provided in the ARR (Australian Rainfall and Runoff) Book 6 – Flood Hydraulics[2] and are shown in Figure 2.8 and Figure 2.9.

The hazard categories are used to determine risk to people, vehicles and buildings for a range of depths and velocities. Refer to Figure 2.10 for further detail.

Table 2.2 below identifies maximum velocity and ARR hazard classification values at 6 locations on each figure. These are the same locations as in Table 2.1 above.

[2] ARR (Australian Rainfall and Runoff) Book 6 – Flood Hydraulics figure 6.7.9. Combined Flood Hazard Curves (Smith et al., 2014)

Table 2.2: Predicted maximum velocity and ARR hazard classification values

ID	Pre-development		Post-development	
	ARR Hazard Category	Velocity (m/s)	ARR Hazard Category	Velocity (m/s)
1	H1	0.10	H1	0.10
2	H1	0.81	H1	0.90
3	H1	0.81	H1	0.84
4	H1	0.28	H1	0.29
5	H2	0.22	H2	0.22
6	H2	0.84	H2	0.91

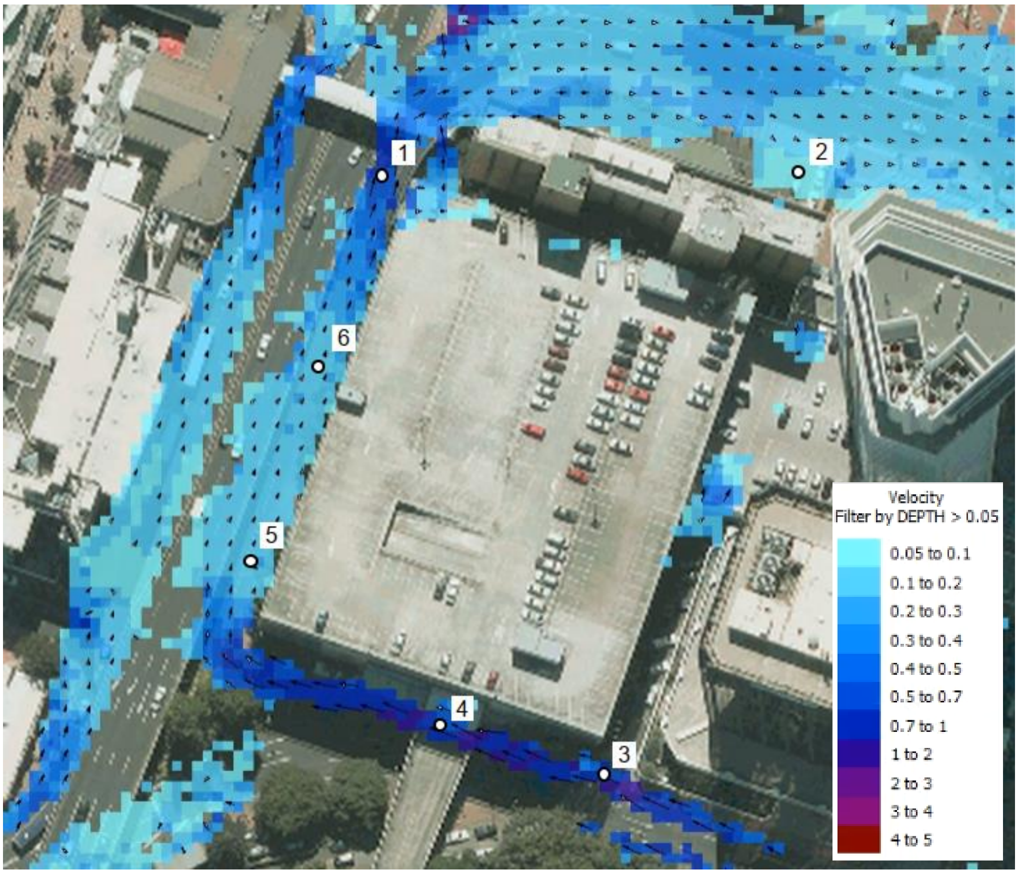

Figure 2.6: Pre-development 1% AEP maximum velocity values - climate change 3.8 degrees.

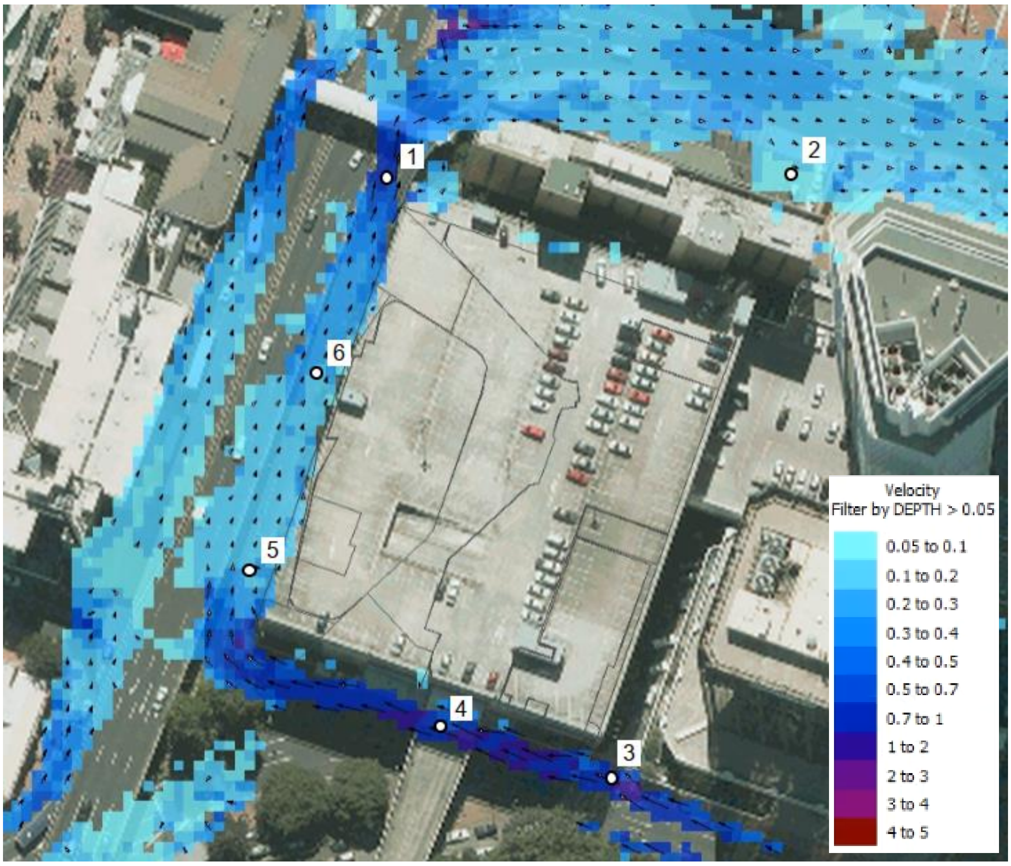

Figure 2.7: Post-development 1% AEP maximum velocity values - climate change 3.8 degrees.

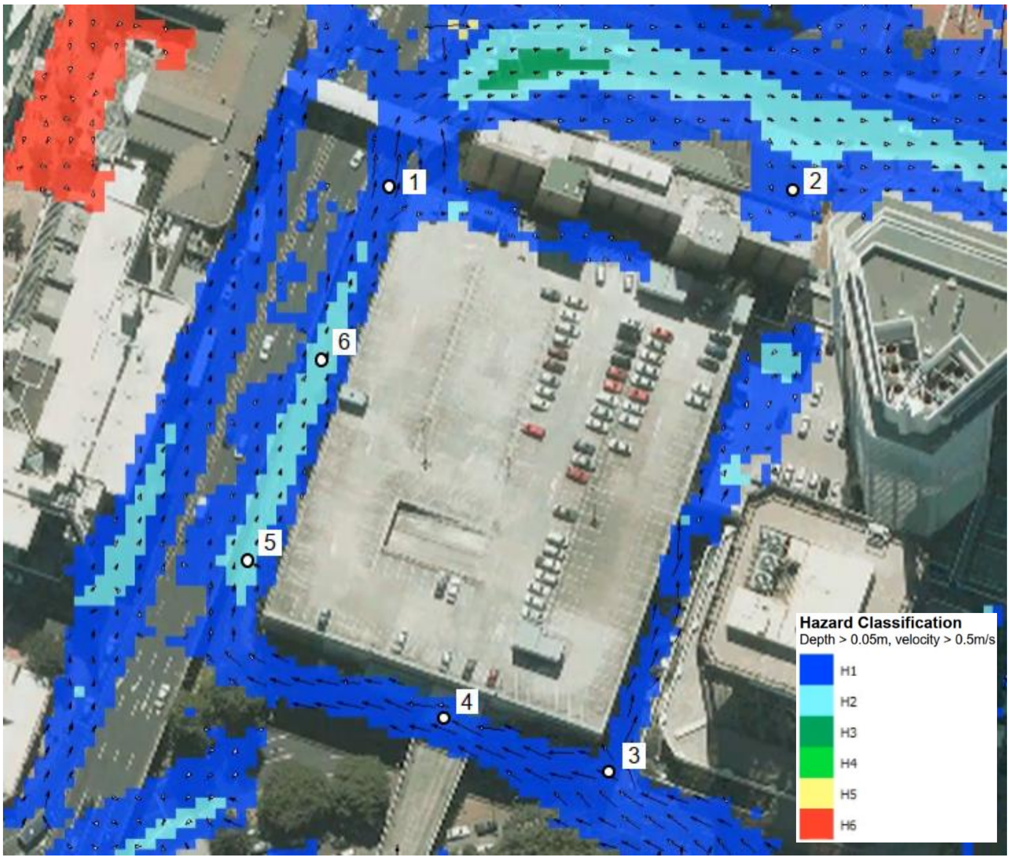

Figure 2.8: Pre-development 1% AEP ARR hazard classification values - climate change 3.8 degrees..

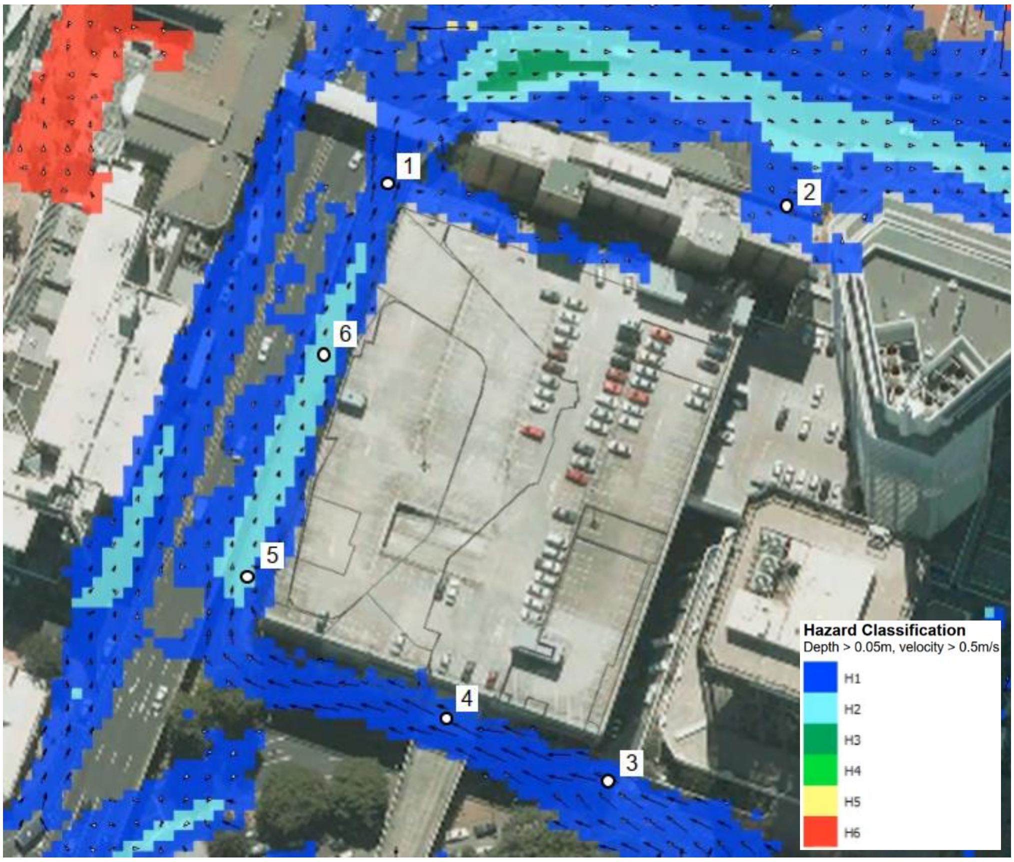

Figure 2.9: Post-development 1% AEP ARR hazard classification values - climate change 3.8 degrees

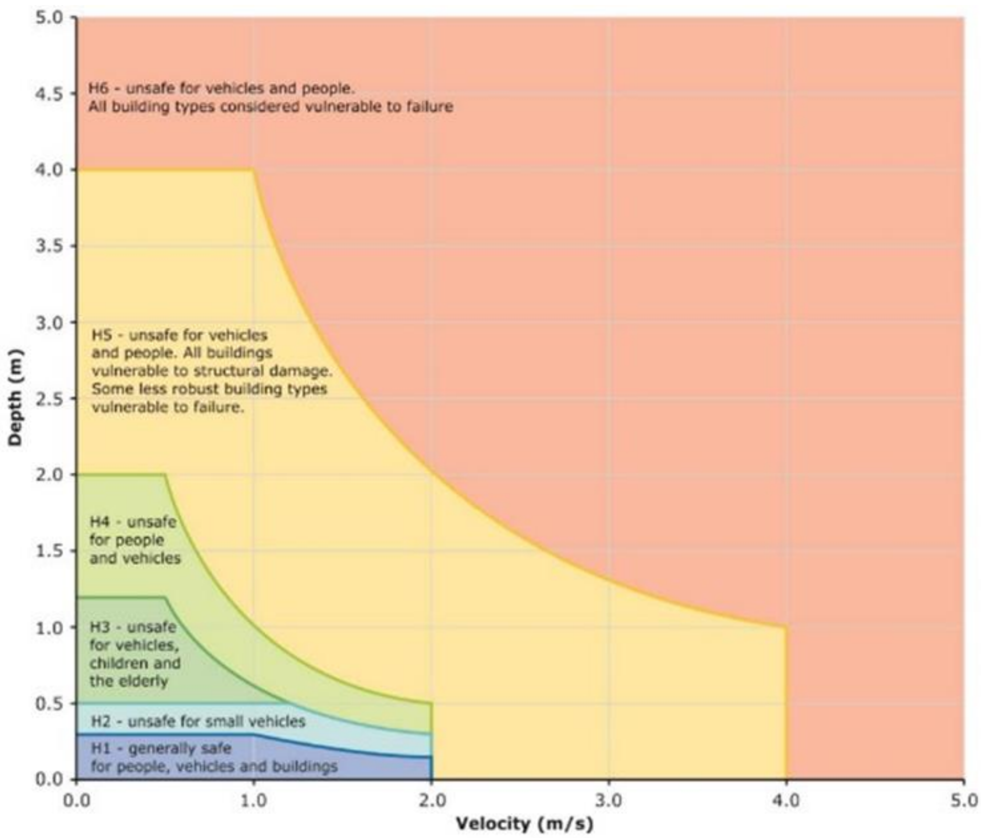

Figure 2.10: ARR Combined Flood Hazard Curves - ARR Book 6 - Flood Hydraulics (figure 6.7.9)

3 Costal inundation

Auckland Council's coastal inundation maps representing a 100 year ARI scenario for 1 m and 2 m sea level rise are shown in Figure 3.1 and Figure 3.2 respectively.

Figure 3.1: Coastal inundation (100 year ARI plus 1 m sea level rise) – Source: Auckland Council Geomaps.

Figure 3.2: Coastal inundation (100 year ARI plus 2 m sea level rise) – Source: Auckland Council Geomaps.

The latest sea level rise guidance from the Ministry for the Environment (2024) has been written to serve as a primary input to hazard and risk assessments. This guidance highlights the importance of latest IPCC AR6 Sea Level Rise (SLR) projections in conjunction with Vertical Land Movement (VLM) projections (MfE, 2024) when assessing coastal inundation to allow for relative changes between sea level and the landform. This guidance recommends medium confidence scenarios (out to 2150) and their associated SLR and Relative Sea Level Rise (RSLR) projections to cover a range of plausible coastal futures. These include five Socioeconomic Pathway (SSP) scenarios that form the basis of SLR projections and are shown in Figure 3.3.

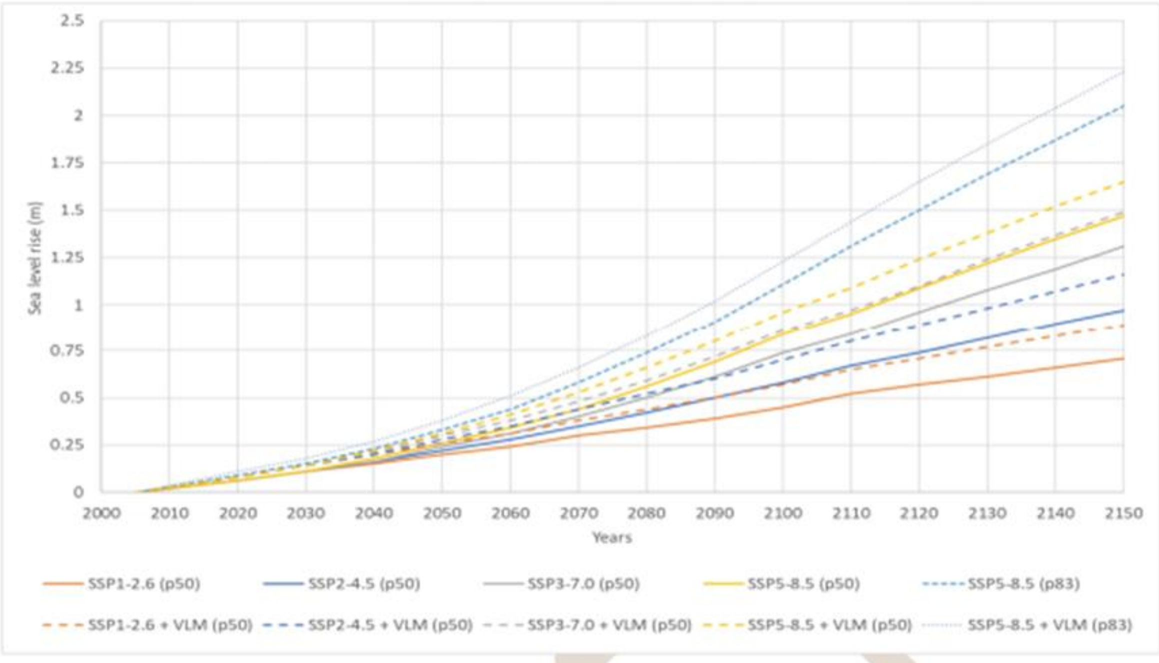

Figure 3.3: SLR projections for a range of future emission scenario (Data from SeaRise website).

The AUP discusses consideration of 1 m sea level rise, with no specific mention of any particular associated climate projection or timeframe. The MfE guidance therefore introduces two additional considerations, that of RSLR, and sensitivity across a range of scenarios. The 1 m increase in RSLR stipulated in the AUP guidance is not expected prior to 2150 under the SSP1-2.6, however it could be expected by 2130 under the SSP2-4.5, and by 2090 under the SSP5-8.5M.

The Mean High Water Spring (MHWS), Highest Astronomical Tide (HAT) and coastal inundation levels associated with 10% AEP and 1% AEP storms for the present-day and future RSLR values have been tabulated in Table 3.1. This table provides context for coastal inundation and helps indicate the time horizon they may occur (when compared with Figure 3.3).

Table 3.1: Water levels (mRL) based on a combination of astronomic or storm tides and RSLR

Water level condition	RSLR				
	0 m	**0.5 m**	**1.0 m**	**1.25 m**	**1.5 m**
MHWS	1.56	2.06	2.56	2.81	3.06
HAT	1.98	2.48	2.98	3.23	3.48
10% AEP	2.18	2.68	3.18	3.43	3.68
1% AEP	2.37	2.87	3.37	3.62	3.87

4 Freeboard

Table 4.1 summarises the freeboard guidelines as applicable to the Downtown carpark, in relation to more vulnerable and less vulnerable activities (as defined in the AUP). The reader is referred to Freeboard for the Auckland Region Guidelines document GD13 (March 2024) for further guidance and information[3].

Freeboard is a factor of safety that provides for the imprecision and/or uncertainties in the estimation of flood/inundation water levels. It is important to note that the final decision on freeboard allowances should consider the levels of uncertainty and commercial risk tolerance.

Table 4.1: Freeboard guidelines for the 1% AEP flood plain and 1% AEP coastal storm inundation

Scenario	Freeboard	Relevance for Downtown carpark
More Vulnerable Activities* in floodplains	500 mm	Entrance/s to the hotel/residential lobby.
Less Vulnerable Activities* in floodplains	300 mm	Entrances to the retail area.
Overland flow paths, where flow is less than 2 m^3/s	500 mm where surface water has a depth of 100 mm or more and extends from the building directly to a road or car park, other than a car park for a single dwelling. 150 mm for all other cases.	Where a floodplain <u>and</u> overland flowpath exists, adopt floodplain freeboards. Adopt overland flowpath guidance where only overland flowpaths exist. This may only apply to the laneway, although the presence of the overland flow path is subject to finalisation of the flood barrier arrangement.
Overland flow paths, where flow is equal to or greater than 2 m^3/s	500 mm for More Vulnerable Activities* 300 mm for Less Vulnerable Activities*	
Coastal Storm Inundation Areas (1% AEP including 1 m sea-level rise)	500 mm for dwellings and habitable rooms which are subject to wave action from the sea. 150 mm for all other cases.	Coastal inundation may occur around the property (but not in the property).
*** As defined in the AUP J1 Definitions**		

5 Natural hazard risk assessment

The following natural hazard risk assessment has been compiled in accordance with the requirement of E36.9 of the Auckland Unitary Plan (AUP). The need to carry out the assessment is triggered by the property's location alongside a 1% AEP floodplain. The property is not located within the 1% AEP coastal storm inundation extent with 1m sea level rise which also triggers the E36.9 assessment. However, due to updated MfE guidance (2024) it is considered prudent that we comment on the hazard and risk associated with future coastal inundation.

1 The type, frequency and scale of the natural hazard and whether adverse effects on the development will be temporary or permanent.

[3] https://www.aucklanddesignmanual.co.nz/content/dam/adm/adm-website/developing-infrastructure/infrastructure-technical-guides/gd13-freeboard/GD13_Freeboard_for_the_Auckland_Region_Guideline_document_v1_draf_March_2024.pdf

The development is exposed to flood hazard for a temporary period of time under extreme scenarios (1% AEP with allowances for climate change) until flood waters pass. The temporary period of time is likely to be less than one hour.

Coastal inundation around the property (but not within the property) may occur during the highlighted green scenarios shown in the table below. The ground flood (Level 00) is above all the inundation levels. The inundation around the property would be temporary.

Water level condition	**RSLR**				
	0 m	**0.5 m**	**1.0 m**	**1.25 m**	**1.5 m**
MHWS	1.56	2.06	2.56	2.81	3.06
HAT	1.98	2.48	2.98	3.23	3.48
10% AEP	2.18	2.68	3.18	3.43	3.68
1% AEP	2.37	2.87	3.37	3.62	3.87

Adverse effects on the development have been mitigated using the approaches discussed in bullet point 8.

2 The type of activity being undertaken and its vulnerability to natural hazard events.

The activities associated with the development comprise both vulnerable and less-vulnerable activities (as defined in the AUP). However, this risk has been mitigated using the approaches discussed in bullet point 8 in this section below.

3 The consequences of a natural hazard event in relation to the proposed activity and the people likely to be involved in that activity.

The property design incorporates measures that fully mitigate the flood consequences up to a 1% AEP flood scenario with allowance for 2.1 degrees of warming, and the coastal inundation levels for scenarios allowing up to 1.5 m sea level rise (refer bullet point 1 in this section above).

In the high emission future climate scenario (3.8 degrees warming) 0.05m of flood inundation is predicted in Retail units 8 and 9 and in the access/egress area immediately to the north. These areas currently have proposed floor levels of 3.9m RL, and further options will be considered during subsequent design stages. All other units are situated above the predicted flood levels from the high emission 3.8 degree climate change scenario.

The mitigation measures that have made the property resilient to flooding are discussed more fully in bullet point 8 of this section below.

4 The potential effects on public safety and other property.

Refer to the response provided in bullet point 3 above. In addition, 0.05m of flooding is considered very low risk for public safety for those people on the property.

We consider there to be no flood effects on other properties and the rationale for this is provided below both qualitatively, and quantitatively using the model.

In general terms, the hydraulic and hydrological effects of a development are caused when there are changes in land use and landform (i.e. topography). The land use for the proposed development remains hydrologically the same as the existing development (i.e. both are 100% impervious).

Therefore, because there are no changes in hydrological land use, land use changes cannot cause an adverse effect[4].

Changes to the landform within the floodplain have the potential to cause an effect. With the exception of the proposed flood barriers to the laneway, there are no notable changes[5] to the landform within the floodplain and therefore the proposed development will not create new adverse flood effects.

To confirm that the changes in property footprint do not cause adverse effects, and to consider the effects of the flood barriers, the flood model was used to compare pre-development and post-development flood levels and flood depths. The model results are presented in Table 2.1 and in Figures 2.1-2.5. Changes in modelled flood level and flood depth were all less than 0.02 m and located along the public roads to the south (Customs Street West) and west (Lower Hobson Street). There were no flood increases observed along Quay Street, which is due to the small influence that the Laneway flood volumes can have on the large floodplain that exists along Quay Street.

5 Any exacerbation of an existing natural hazard risks or creation of a new natural hazard risks.

There are no increases in flood or coastal hazards caused by the development. The development changes the natural hazard risk profile for the area because of changes in use by people:

- There will be a reduction in the number of car parks at the property from approximately 2000 spaces to 540.
- There will be an increase in the patronage of the area as a result of the:
  - Three podium buildings between 7 and 9 levels.
  - Two towers between 45 and 56 levels.
  - Public spaces and new laneways to provide connection across the city.

Given the mitigation measures that have made the property resilient to flooding (refer bullet point 8 in this section below) we consider the risks to people on the property to be acceptable. Given the low flood depths along Custom Street West (which are approximately 0.1m at their deepest) we also consider that there will be safe egress routes from the area.

The current assessment has considered a flood barrier at both entrances to the laneway. During subsequent design phases land recontouring options can be considered further for the Custom Street West access to allow vehicular access and egress under extreme flood scenarios.

6 Whether any building, structure or activity located on land subject to natural hazards near the coast can be relocated in the event of severe coastal erosion, coastal storm inundation or shoreline retreat.

The buildings, structures and activities cannot be relocated in the event of severe coastal erosion, coastal storm inundation or shoreline retreat.

7 The ability to use non-structural solutions, such as planting or the retention or enhancement of natural landform buffers to avoid, remedy or mitigate the hazard, rather than hard engineering solutions or protection structures.

Not applicable.

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[4] We do not consider that time of concentration differences caused by differences in roof runoff versus path runoff will make a material difference. We are currently unaware of any design intent to include rainwater harvesting or roof gardens in the building design.

[5] There is a small decrease in building footprint within the floodplain caused by the proposed setback from the property boundary. However we do not consider this a noteworthy positive effect.

8 The design and construction of buildings and structures to mitigate the effects of natural hazards.

The primary design and construction method to mitigate flood and coastal inundation hazards has been to raise ground levels above the predicted flood levels. The ground levels (Level 00) are generally all elevated to RL4.5m or above, which is above all the inundation levels from the scenarios considered in this assessment. Retail units 8, 9 and an access/egress area to the north are currently 600mm lower (RL 3.9m) although this may be reviewed at Preliminary design. These areas may flood up to 0.05 m (50 mm) in a future 1% AEP event with 3.8 degrees of warming to allow for climate change.

Flood barriers are currently proposed at either end of the laneway to prevent floodwaters entering the laneway and draining into the basement.

9 The effect of structures used to mitigate hazards on landscape values and public access.

Flood barriers are currently proposed at either end of the laneway to prevent floodwaters entering the laneway and draining into the basement. When in use, flood barriers would prevent vehicular access and egress to/from the basement car parking. Therefore, alternatives may potentially be investigated during preliminary design, particularly along Customs Street West.

10 Site layout and management to avoid or mitigate the adverse effects of natural hazards, including access and exit during a natural hazard event.

Risk to property and users of the property has been addressed in previous responses.

The use of flood barriers and the potential impact on vehicular access/egress has been addressed in previous responses, including the potential to revise the Customs Street West approach in subsequent design phases.

Customs Street West provides the most flood resilient access and exit pathway for inundation events due to the higher land and lower flood depths. It also provides a range of connections to other elevated parts of Auckland.

11 The duration of consent and how this may limit the exposure for more or less vulnerable activities to the effects of natural hazards including the effects of climate change.

The hazards and risks for a range of timeframes and climate scenarios have been provided in this report. There is no further comment regarding duration of consent from the authors of this report.

12 Any measures and/ or plans proposed to mitigate the natural hazard or the effects of the natural hazard.

Refer to previous responses above.

6 Applicability

This report has been prepared for the exclusive use of our client Precinct Properties Holdings Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

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