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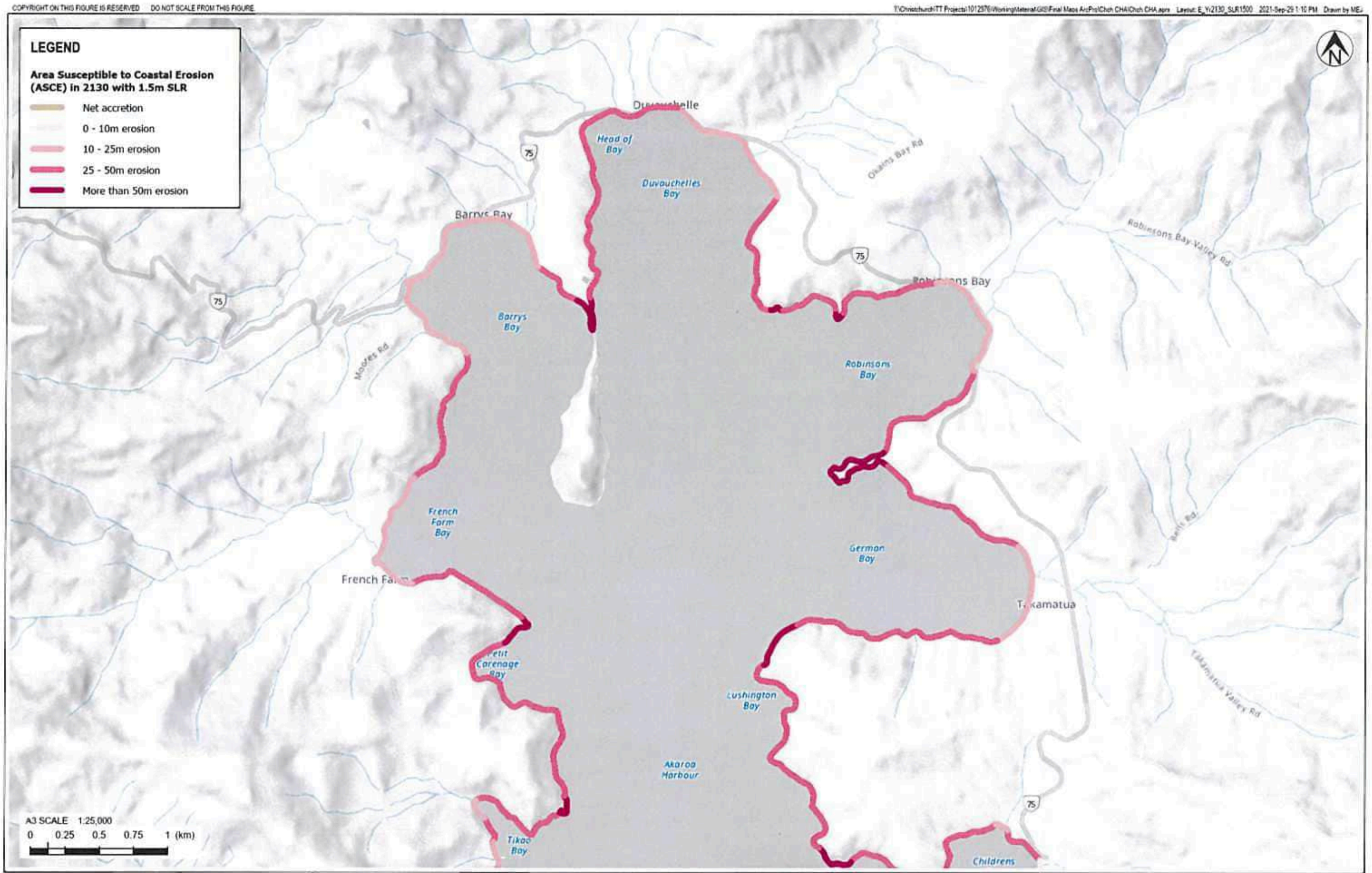


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**NOTES:**
1. For detailed analysis areas, this map shows the P5 erosion distance (5% probability that erosion will be greater for this scenario).
2. For regional screening analysis areas, this map shows the upper envelope erosion distance.
3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth. © OpenStreetMap contributors.

| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | RHAU | 29/09/21 |

LOCATION PLAN

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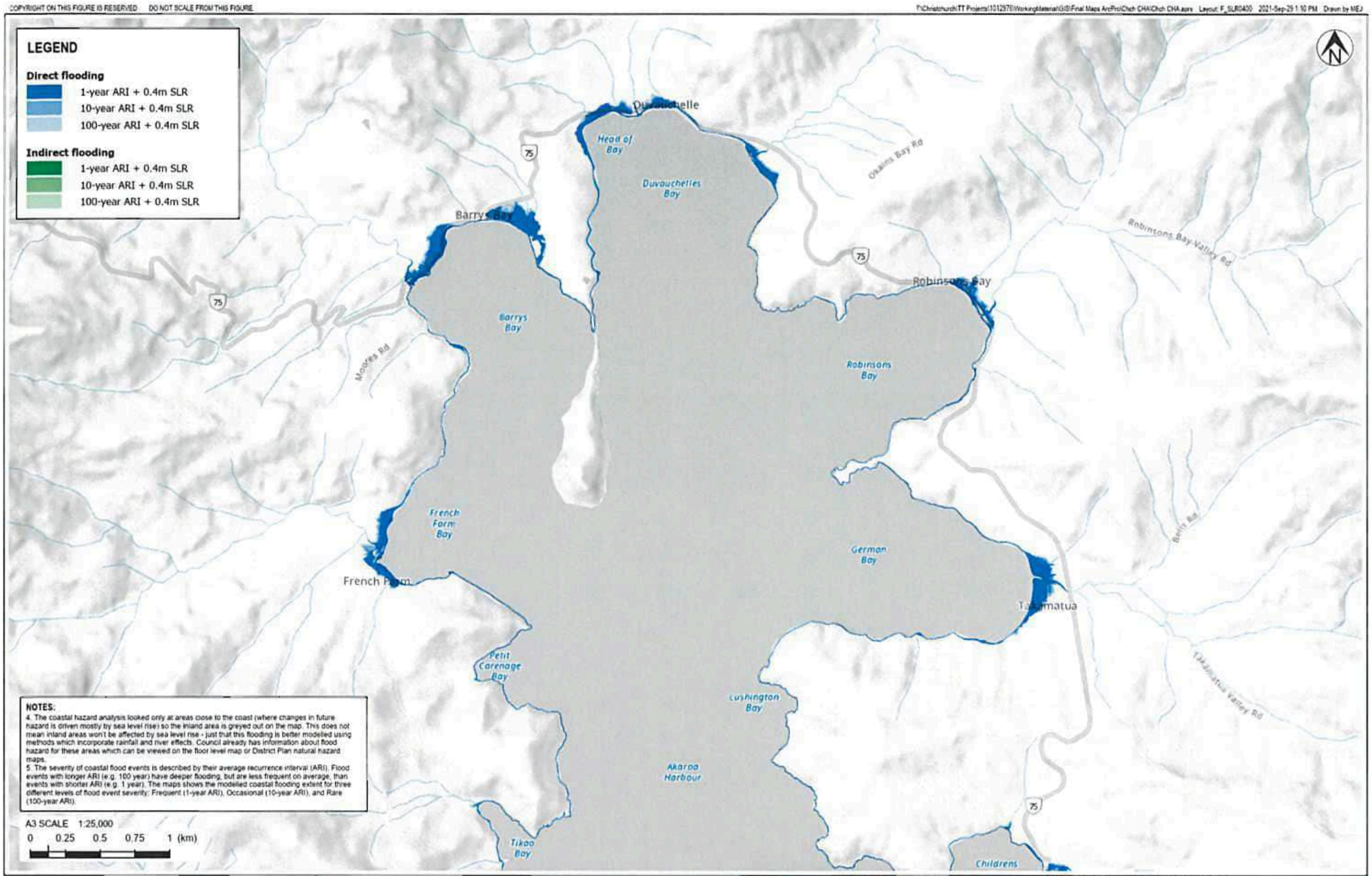
| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE

SCALE (A3) 1:25,000  FIG No. FIGURE 8B  REV 1




NOTES:
4. The coastal hazard analysis looked only at areas close to the coast (where changes in future hazard is driven mostly by sea level rise) so the inland area is greyed out on the map. This does not mean inland areas won't be affected by sea level rise - just that this flooding is better modelled using methods which incorporate rainfall and river effects. Council already has information about flood hazard for these areas which can be viewed on the floor level map or District Plan natural hazard maps.
5. The severity of coastal flood events is described by their average recurrence interval (ARI). Flood events with longer ARI (e.g. 100 year) have deeper flooding, but are less frequent on average, than events with shorter ARI (e.g. 1 year). The maps shows the modelled coastal flooding extent for three different levels of flood event severity: Frequent (1-year ARI), Occasional (10-year ARI), and Rare (100-year ARI).

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NOTES:
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| REV | DESCRIPTION | GIS | CHK | DATE |
|---|---|---|---|---|
| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

| PROJECT No. | 1012976 | |
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| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE
SCALE (A3) 1:25,000 FIG No. FIGURE 8C REV 1

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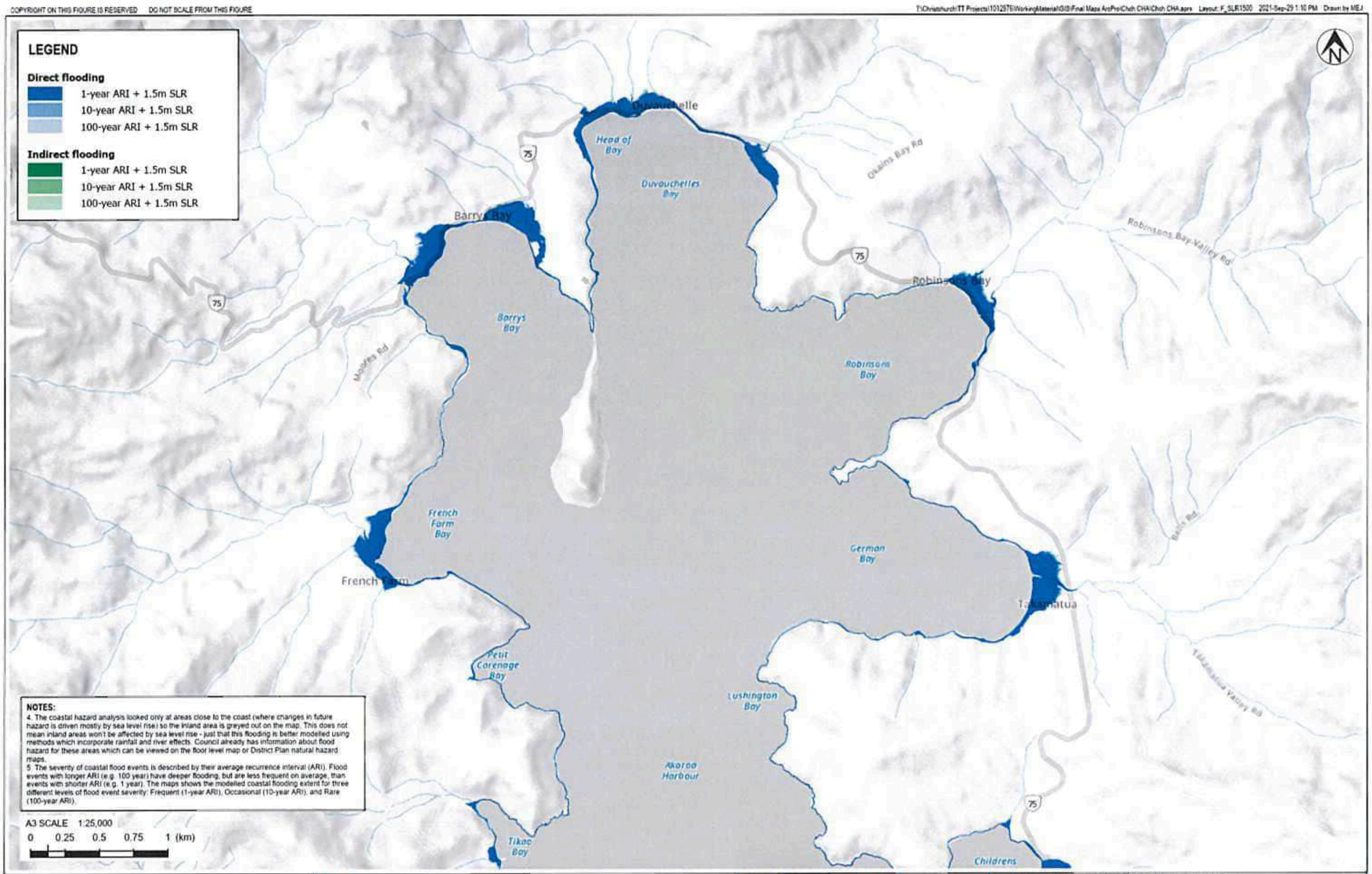


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A3 SCALE 1:25,000

0 0.25 0.5 0.75 1 (km)

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LOCATION PLAN

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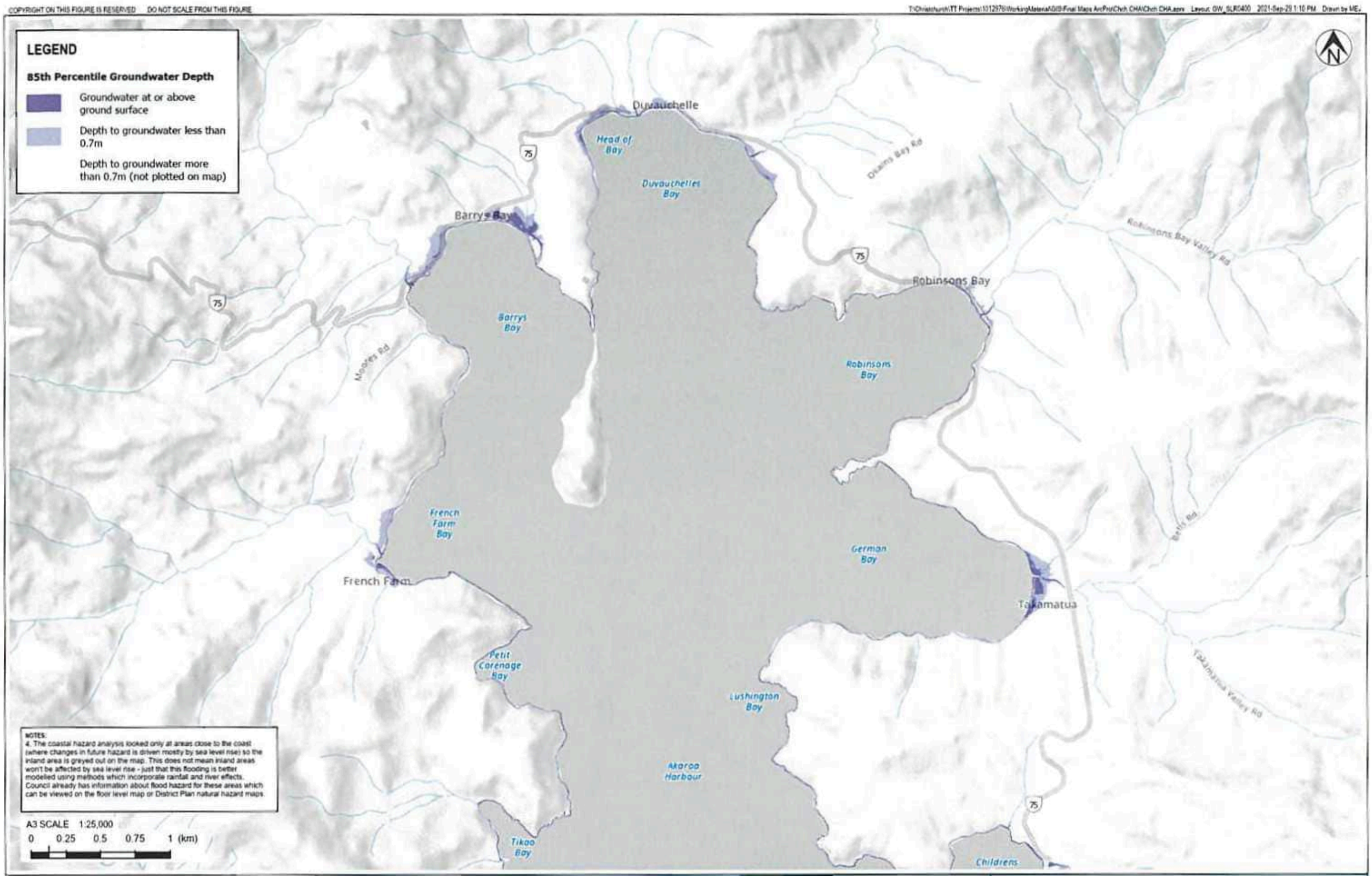
| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| | P COCHRANE | 29/09/21 |
| | APPROVED | DATE |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:25,000   FIG No. FIGURE 8D   REV 1

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**NOTES:**

1. For Christchurch urban flatland area, map shows 85th percentile groundwater model from Aqualinc (2020) "LDRP45: Impacts of earthquakes and sea level rise on shallow groundwater levels." Report prepared for Christchurch City Council, August 2020.
2. For Banks Peninsula, map assumes that 85th percentile groundwater level is approximately equal to MHWS high tide level.
3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ.

| REV | DESCRIPTION | GIS | CHK | DATE |
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LOCATION PLAN

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:25,000    FIG No. FIGURE 8E    REV 1

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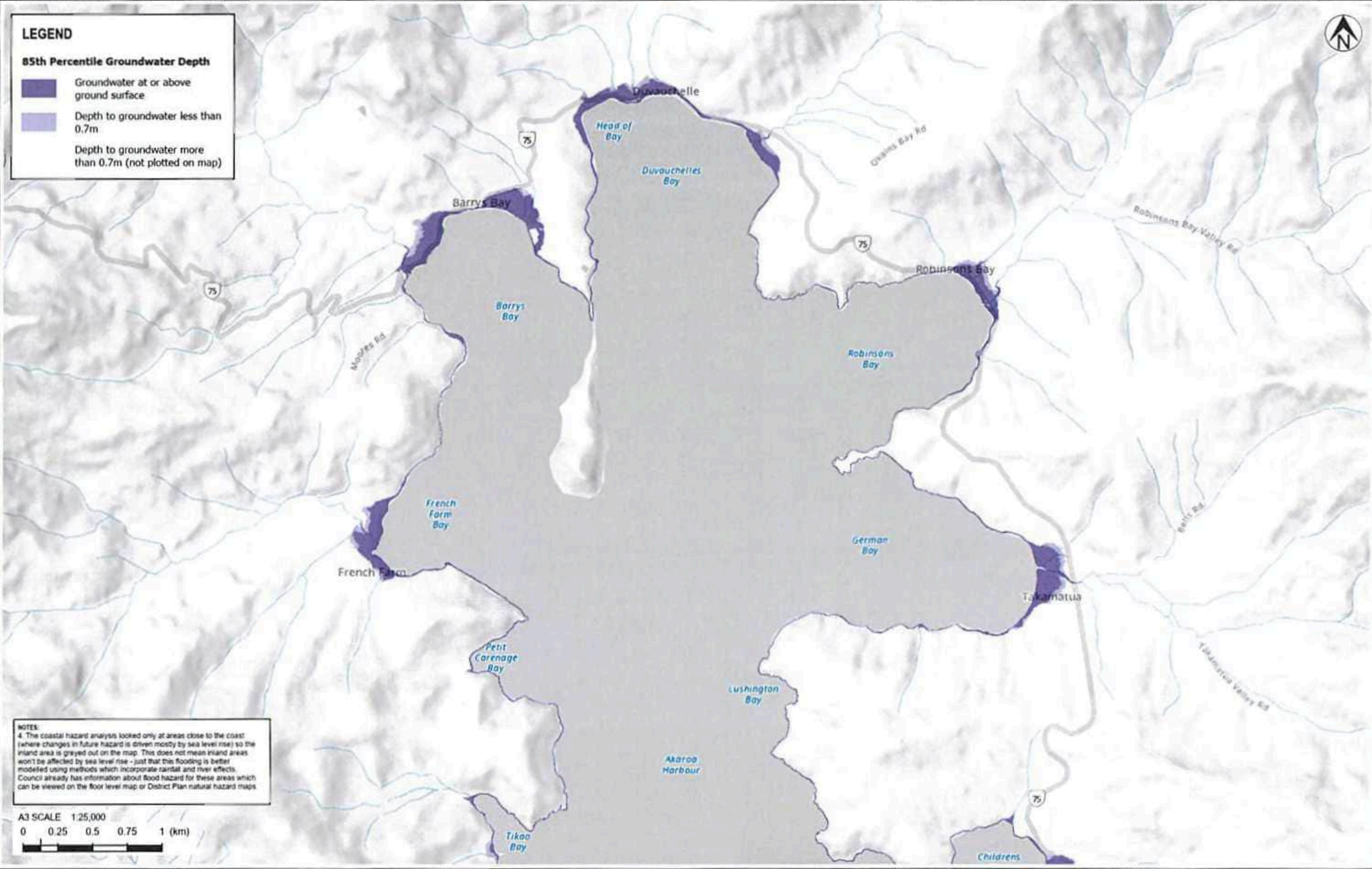


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3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ.

| REV | DESCRIPTION | GIS | CHK | DATE |
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| DESIGNED | MEJ | SEP.21 |
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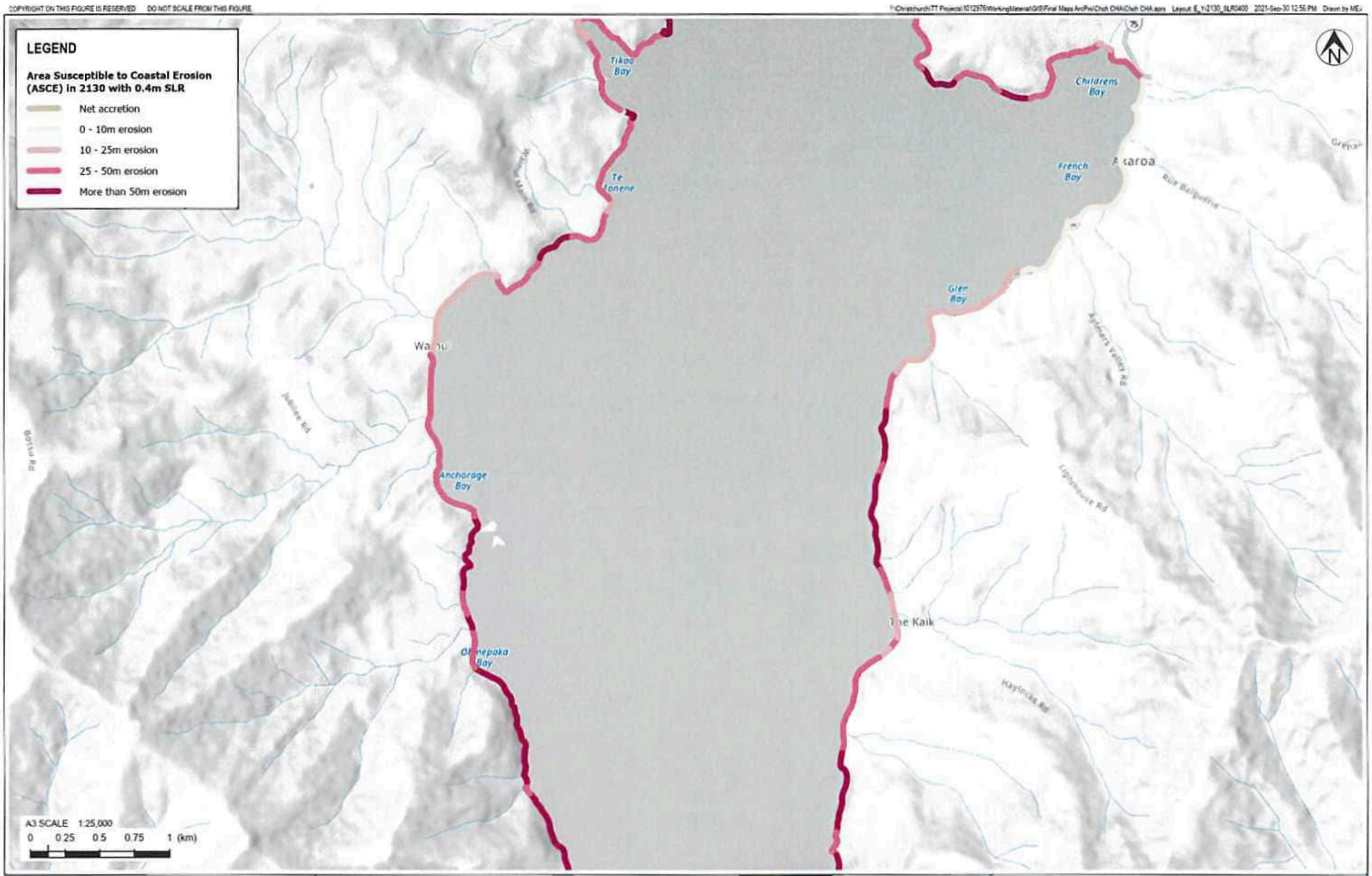
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3) 1:25,000 FIG No. FIGURE 8F REV 1

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**NOTES:**
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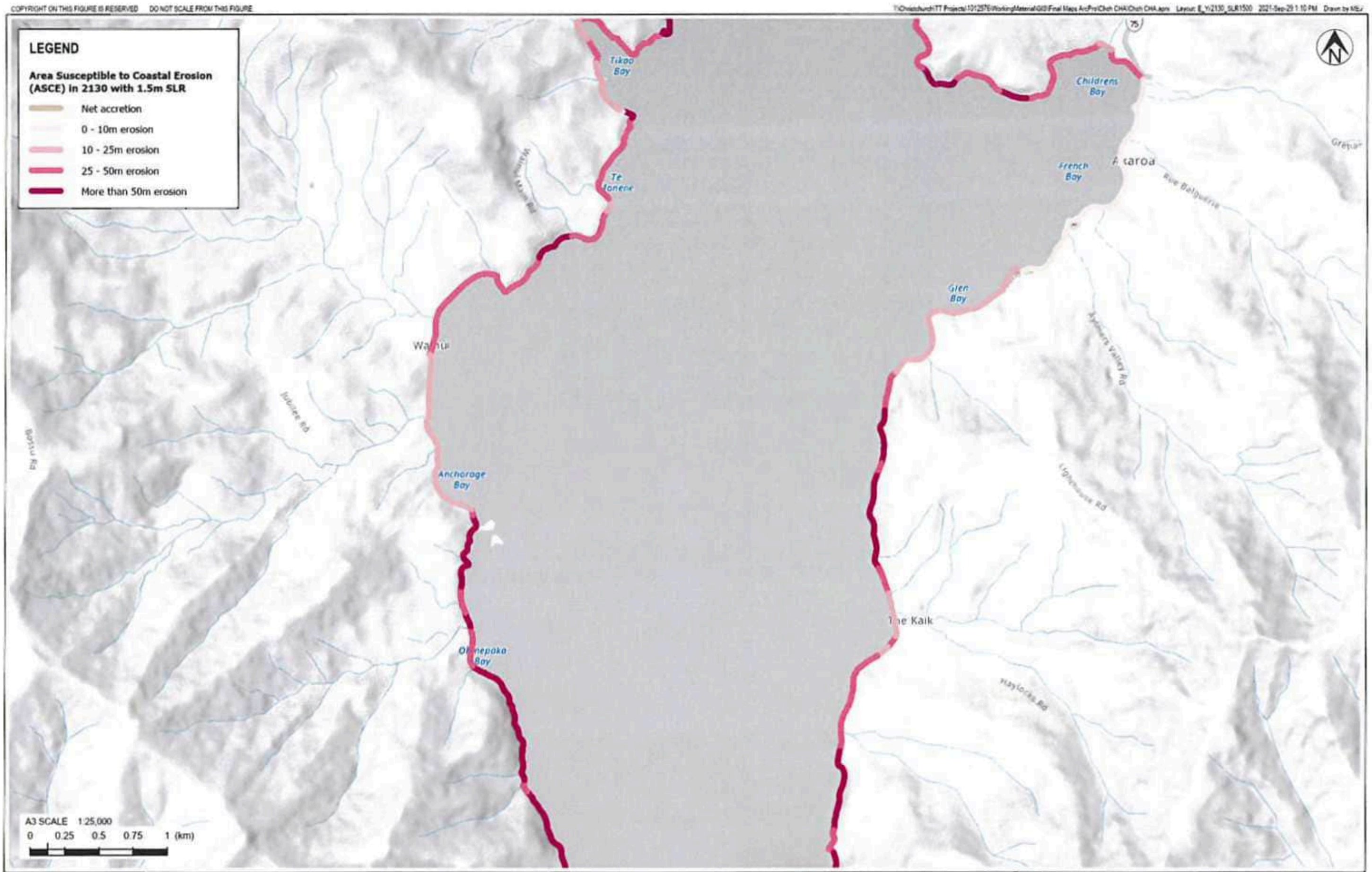
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**
PROJECT **COASTAL HAZARD ASSESSMENT**
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE
SCALE (A3) 1:25,000 FIG No. FIGURE 9A REV 1

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE
SCALE (A3) 1:25,000 FIG No. FIGURE 9B REV 1

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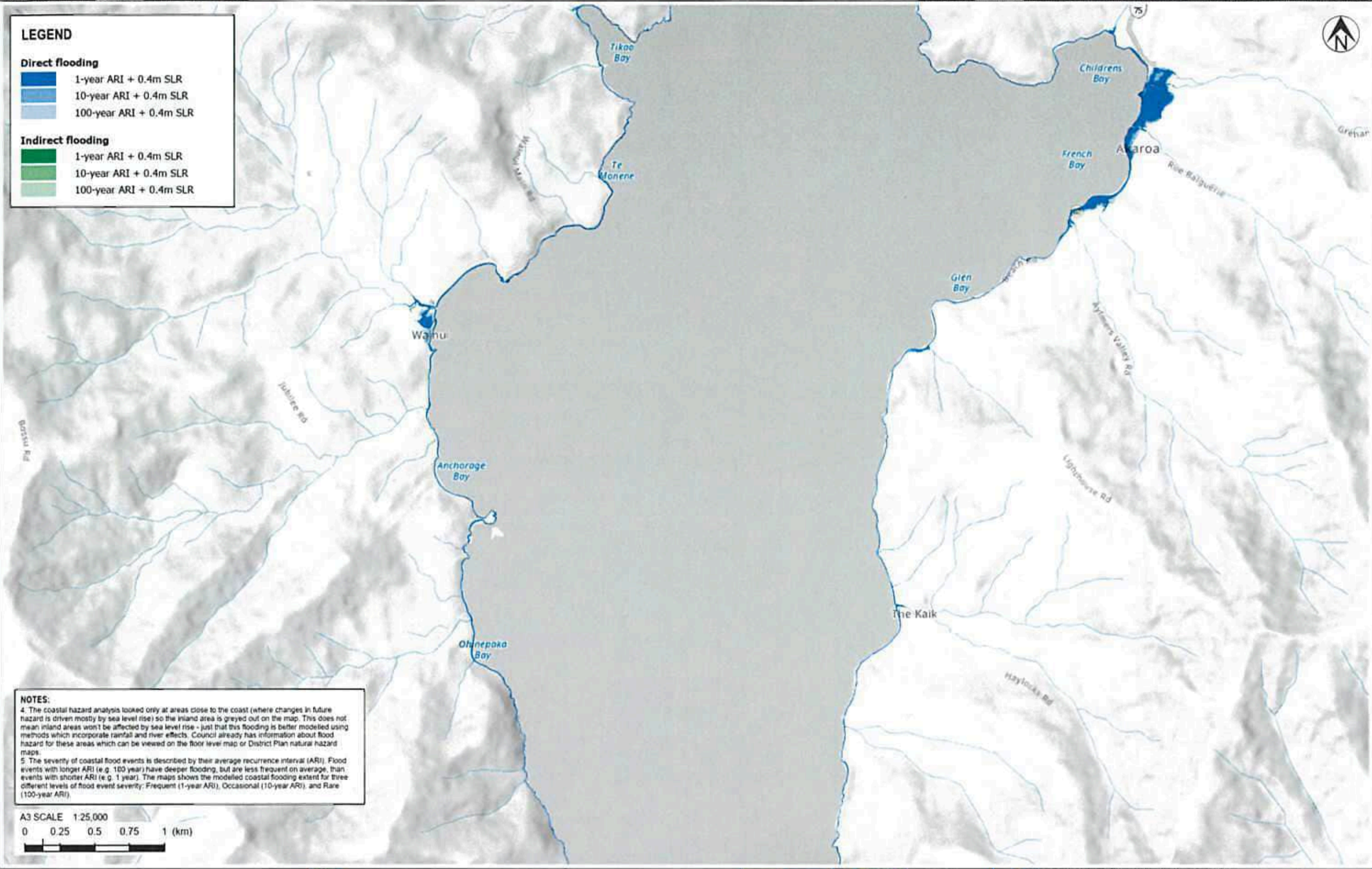


**LEGEND**

**Direct flooding**
- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

**Indirect flooding**
- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

**NOTES:**

4. The coastal hazard analysis looked only at areas close to the coast (where changes in future hazard is driven mostly by sea level rise) so the inland area is greyed out on the map. This does not mean inland areas won't be affected by sea level rise - just that this flooding is better modelled using methods which incorporate rainfall and river effects. Council already has information about flood hazard for these areas which can be viewed on the floor level map or District Plan natural hazard maps.
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A3 SCALE 1:25,000

0 0.25 0.5 0.75 1 (km)

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LOCATION PLAN

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
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| APPROVED | P COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:25,000 FIG No. FIGURE 9C REV 1

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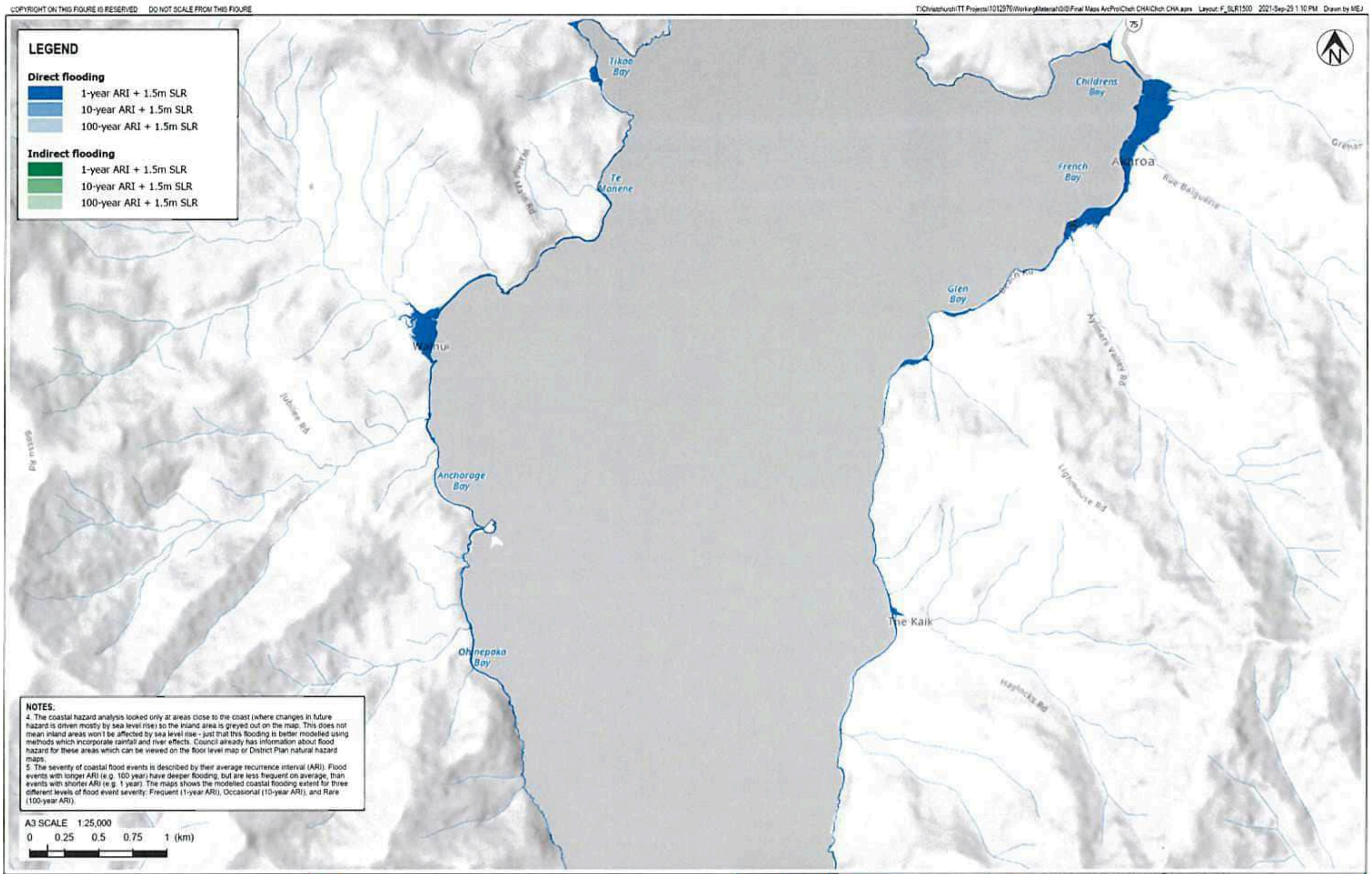


NOTES:
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A3 SCALE 1:25,000

0 0.25 0.5 0.75 1 (km)

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LOCATION PLAN

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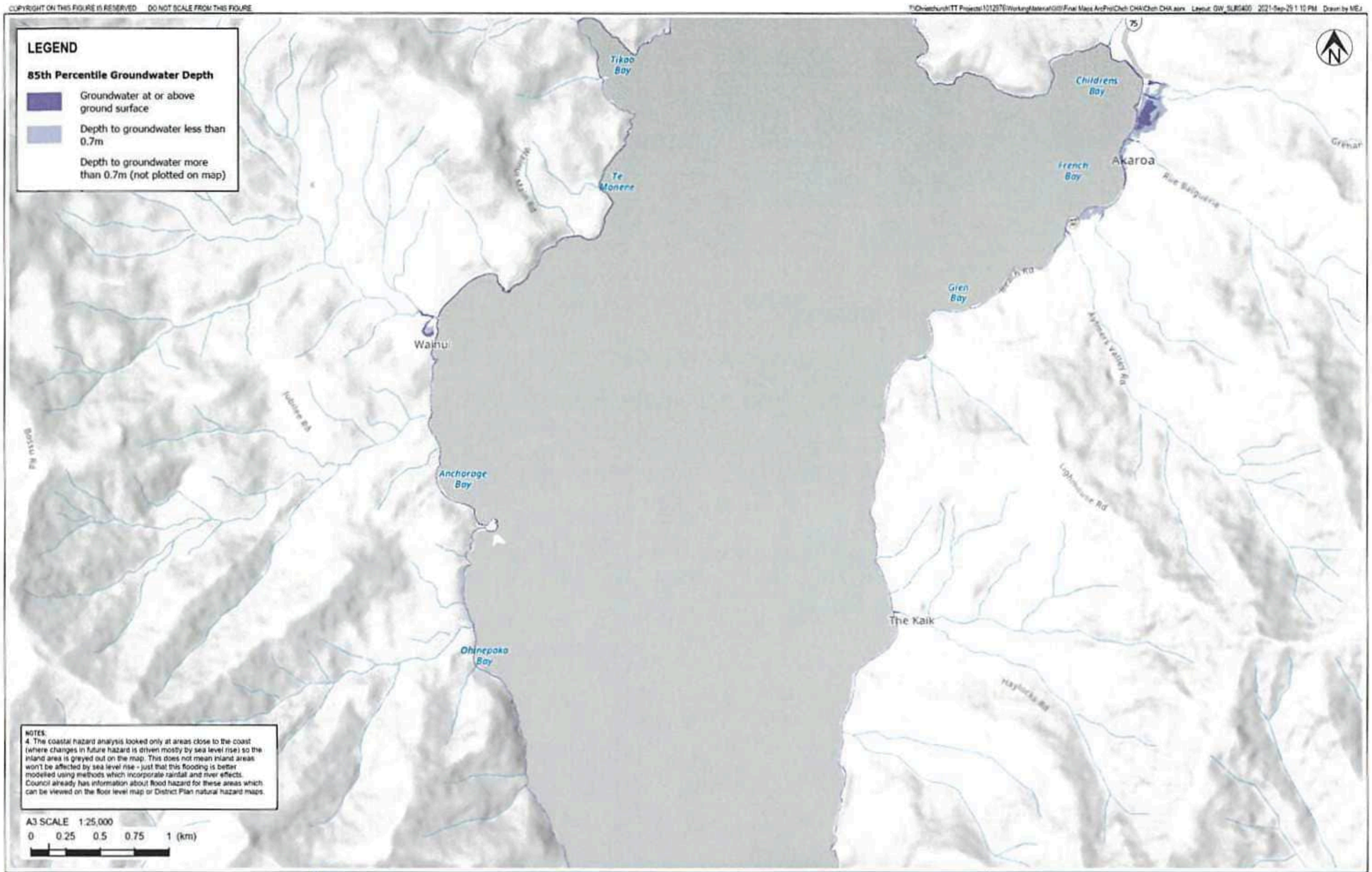
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:25,000 FIG No. FIGURE 9D REV 1

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NOTES
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3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ.

| REV | DESCRIPTION | GIS | CHK | DATE |
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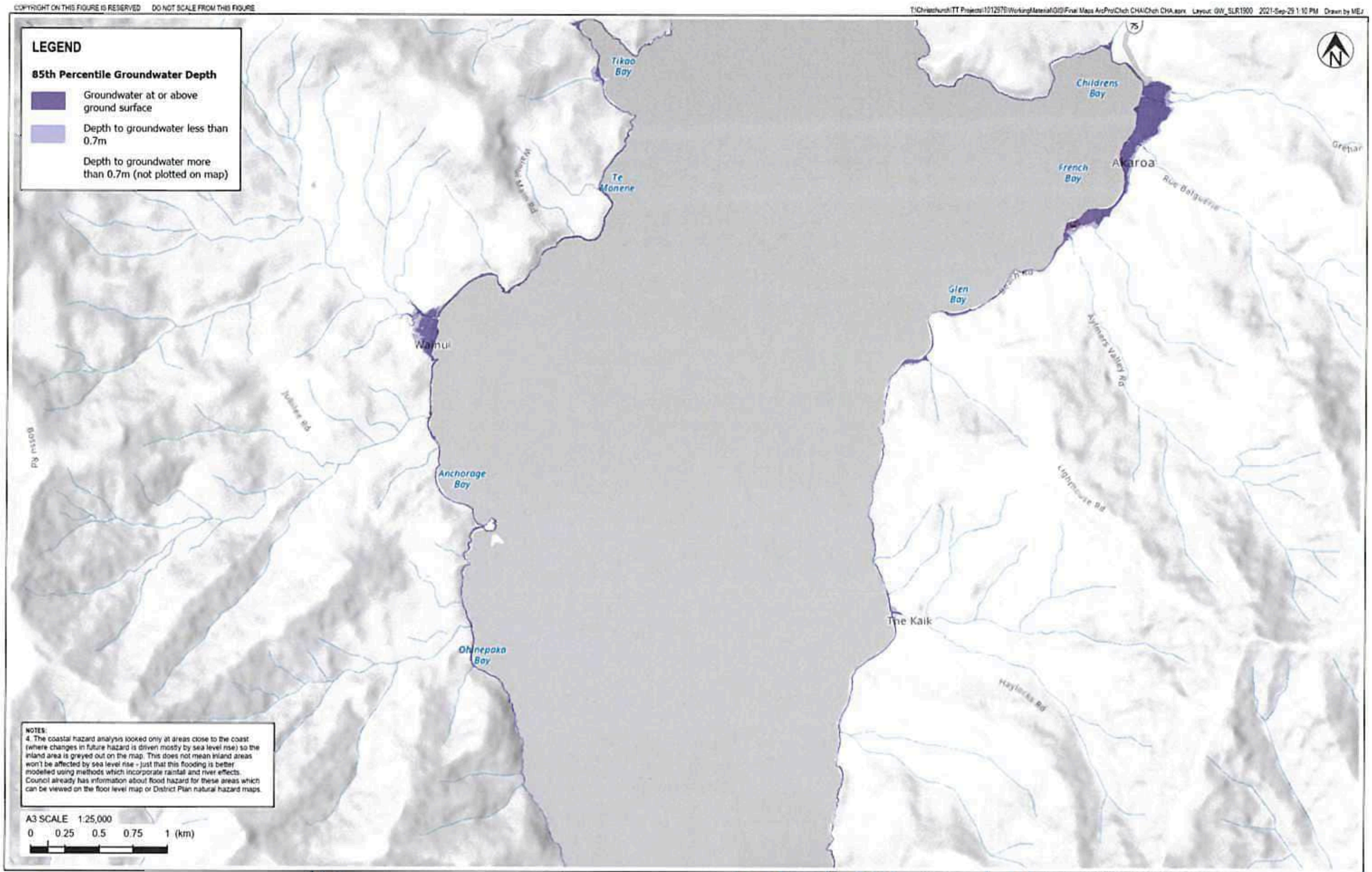
| CHECKED | PPK | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL GROUNDWATER ANALYSIS SCENARIO: 0.4M SEA LEVEL RISE
SCALE (A3) 1:25,000 FIG No. FIGURE 9E REV 1

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| REV | DESCRIPTION | GIS | CHK | DATE |
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LOCATION PLAN

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| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| P. COCHRANE | 29/09/21 | |
| APPROVED | DATE | |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3) 1:25,000 FIG No. FIGURE 9F REV 1

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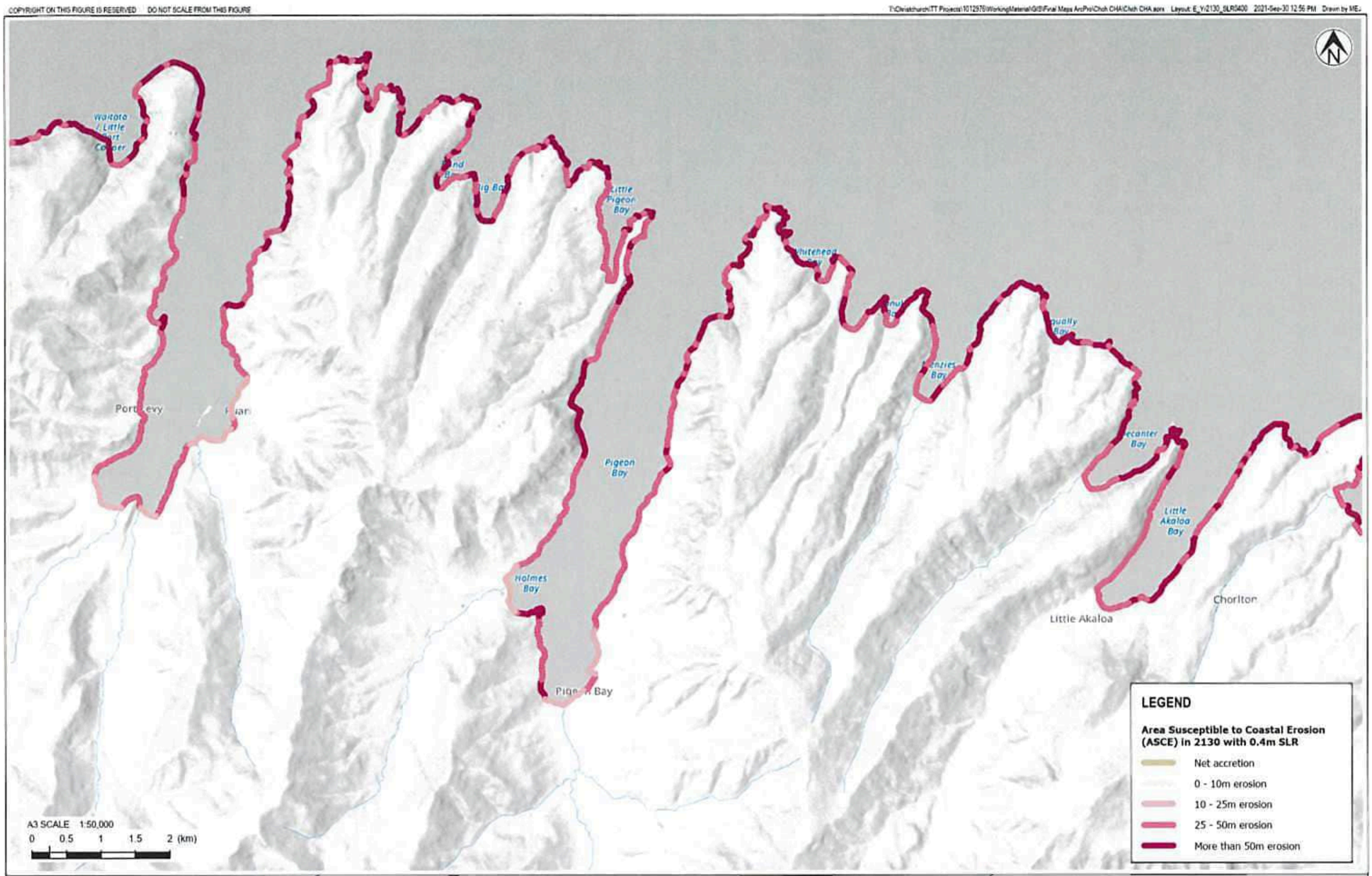


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| 1 | Report issued | MEJ | RHAU | 29/09/21 |

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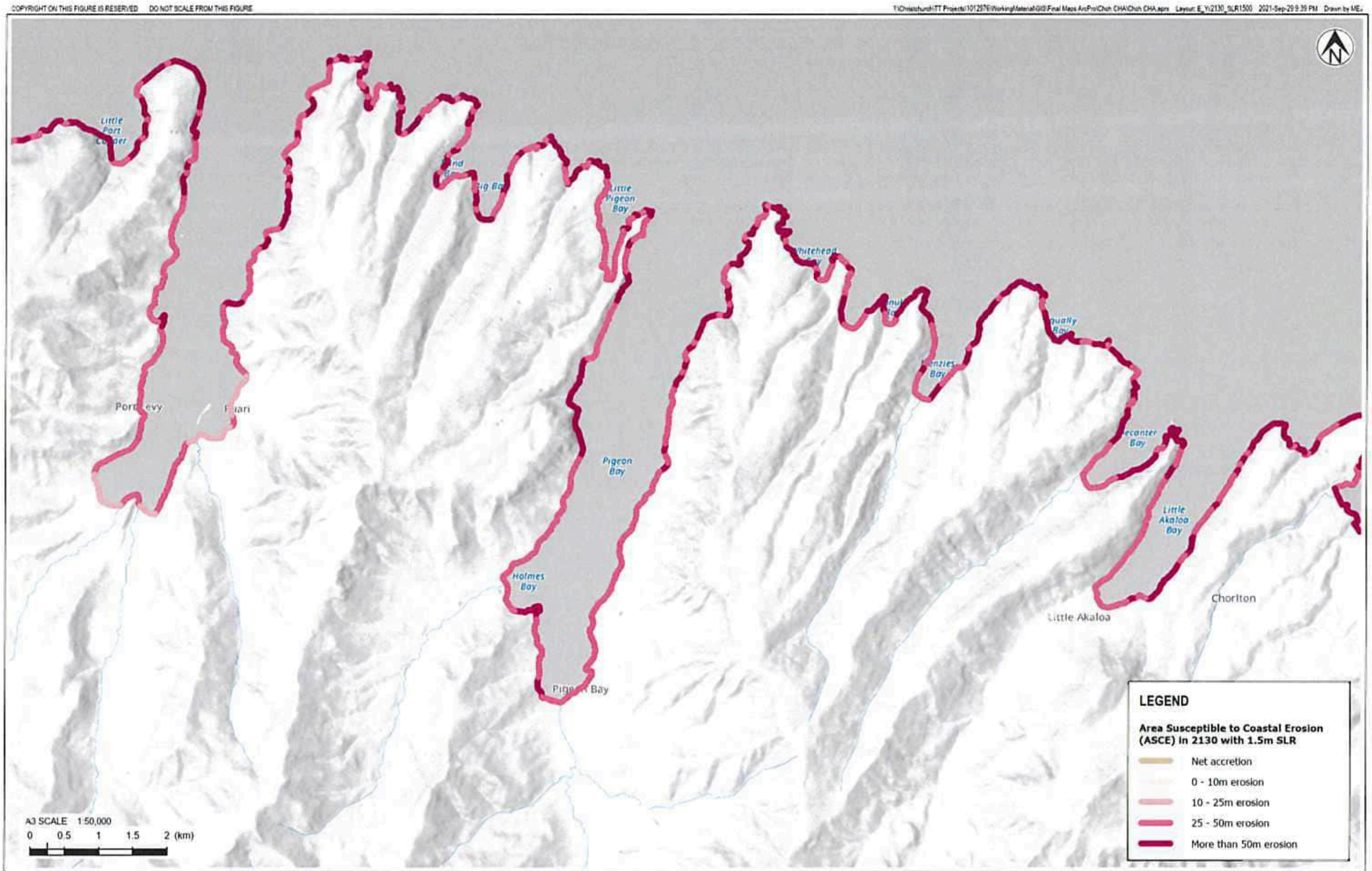
| DESIGNED | MEJ | SEP 21 |
| DRAWN | MEJ | SEP 21 |
| CHECKED | RHAU | SEP 21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 10A REV 1

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| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 10B REV 1

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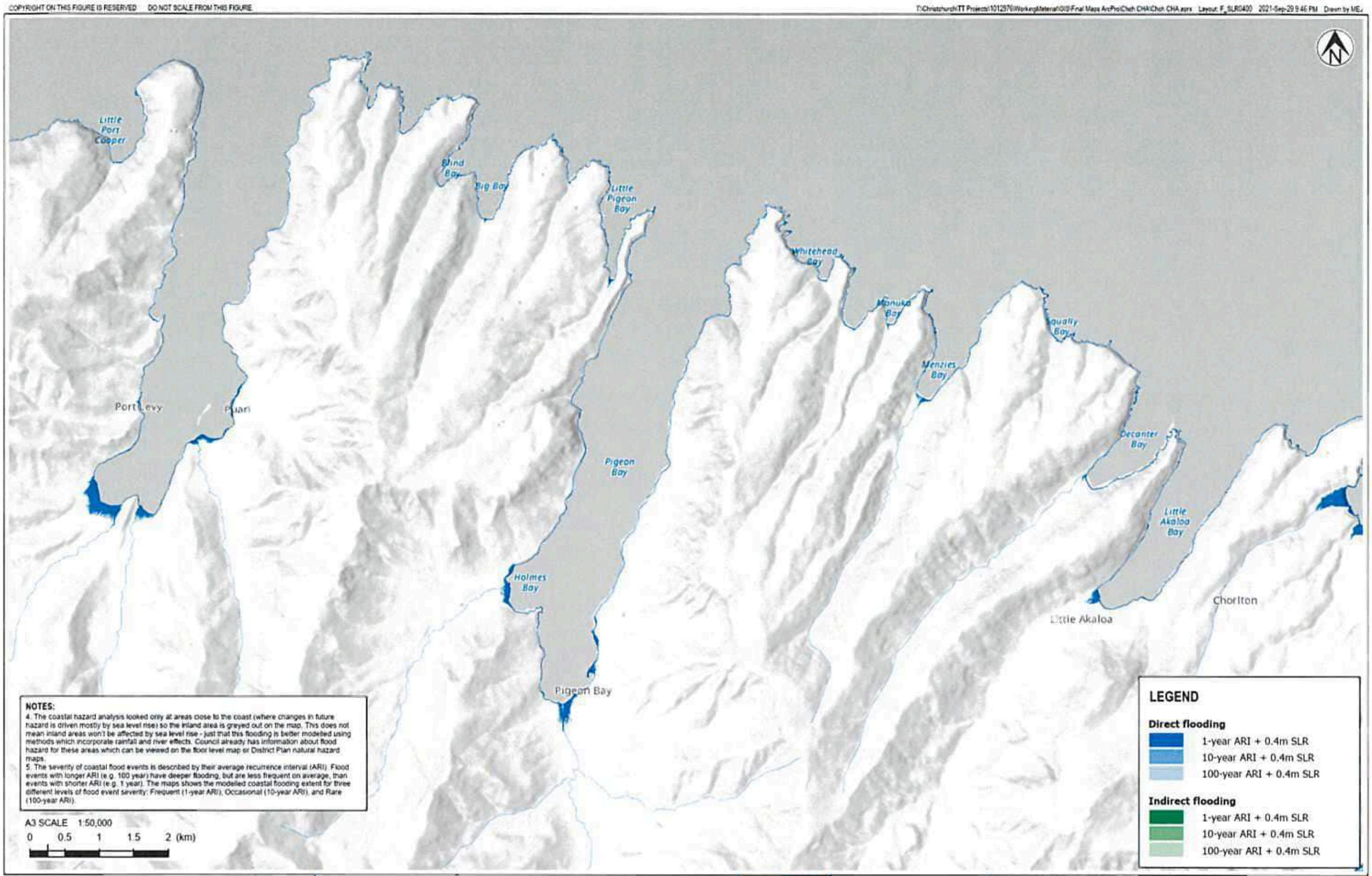


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A3 SCALE 1:50,000

0 0.5 1 1.5 2 (km)

**LEGEND**

**Direct flooding**

- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

**Indirect flooding**

- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

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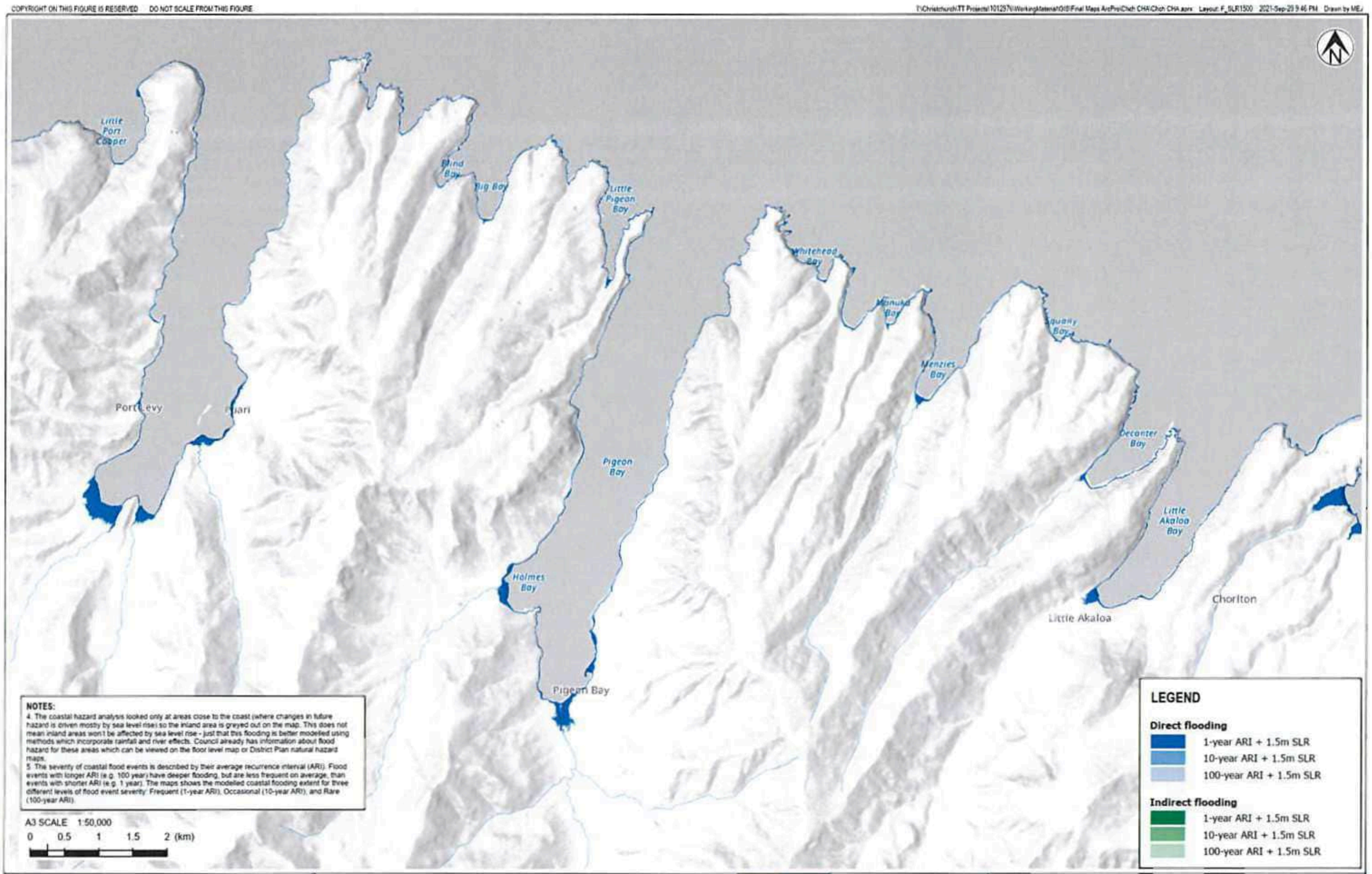
| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 10C REV 1




**NOTES:**

4. The coastal hazard analysis looked only at areas close to the coast (where changes in future hazard is driven mostly by sea level rise) so the inland area is greyed out on the map. This does not mean inland areas won't be affected by sea level rise - just that this flooding is better modelled using methods which incorporate rainfall and river effects. Council already has information about flood hazard for these areas which can be viewed on the floor level map or District Plan natural hazard maps.
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**NOTES:**

1. 'Direct flooding' is where there is a direct path for water to flow overland from the coast.
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3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.

| REV | DESCRIPTION | GIS | CHK | DATE |
|---|---|---|---|---|
| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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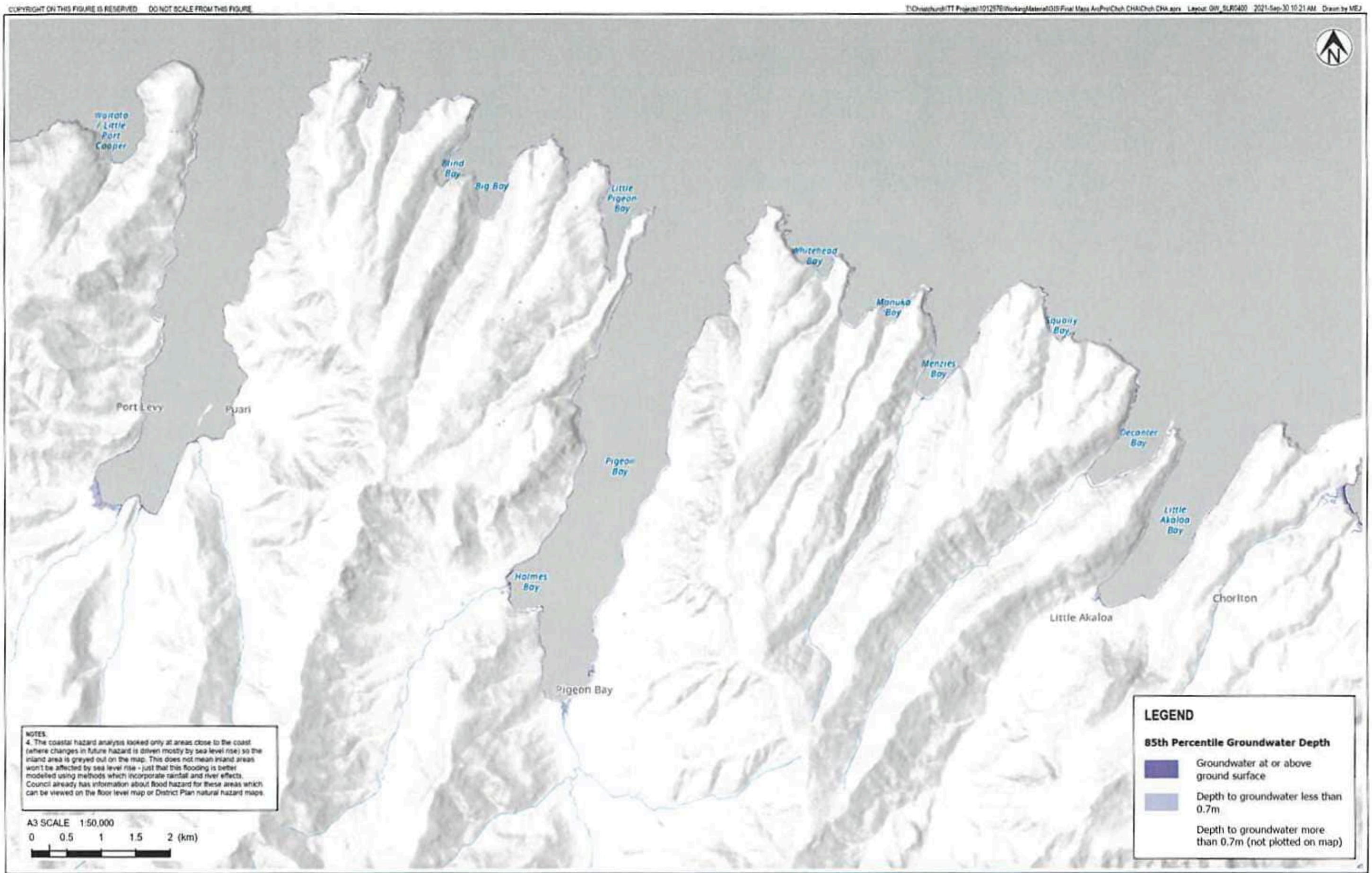
| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 10D REV 1

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NOTES:
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3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ.

| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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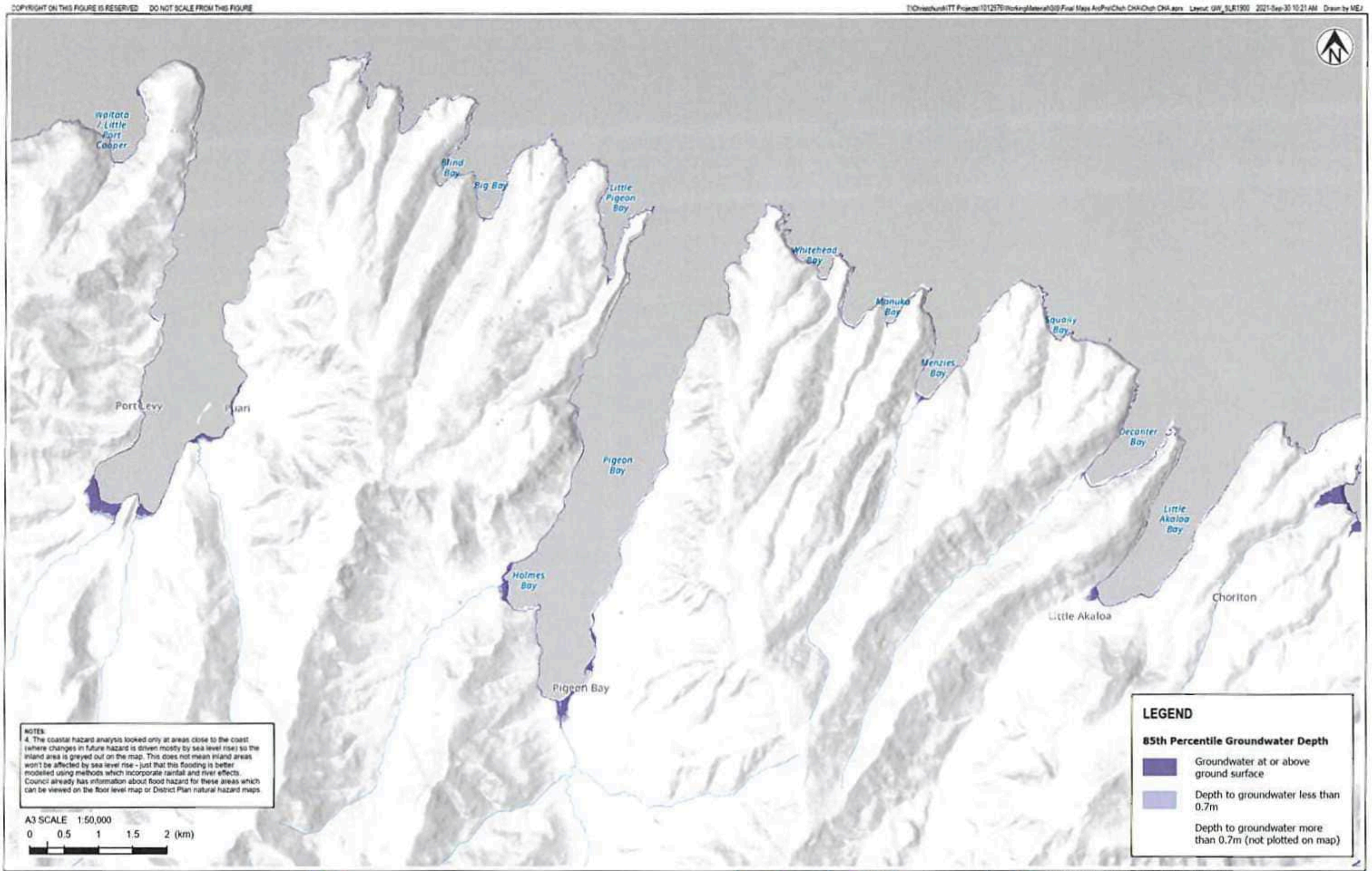
| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |

P. COCHRANE 29/09/21
APPROVED DATE

CLIENT **CHRISTCHURCH CITY COUNCIL**
PROJECT **COASTAL HAZARD ASSESSMENT**
TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 10E REV 1

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| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

| PROJECT No. | 1012976 | |
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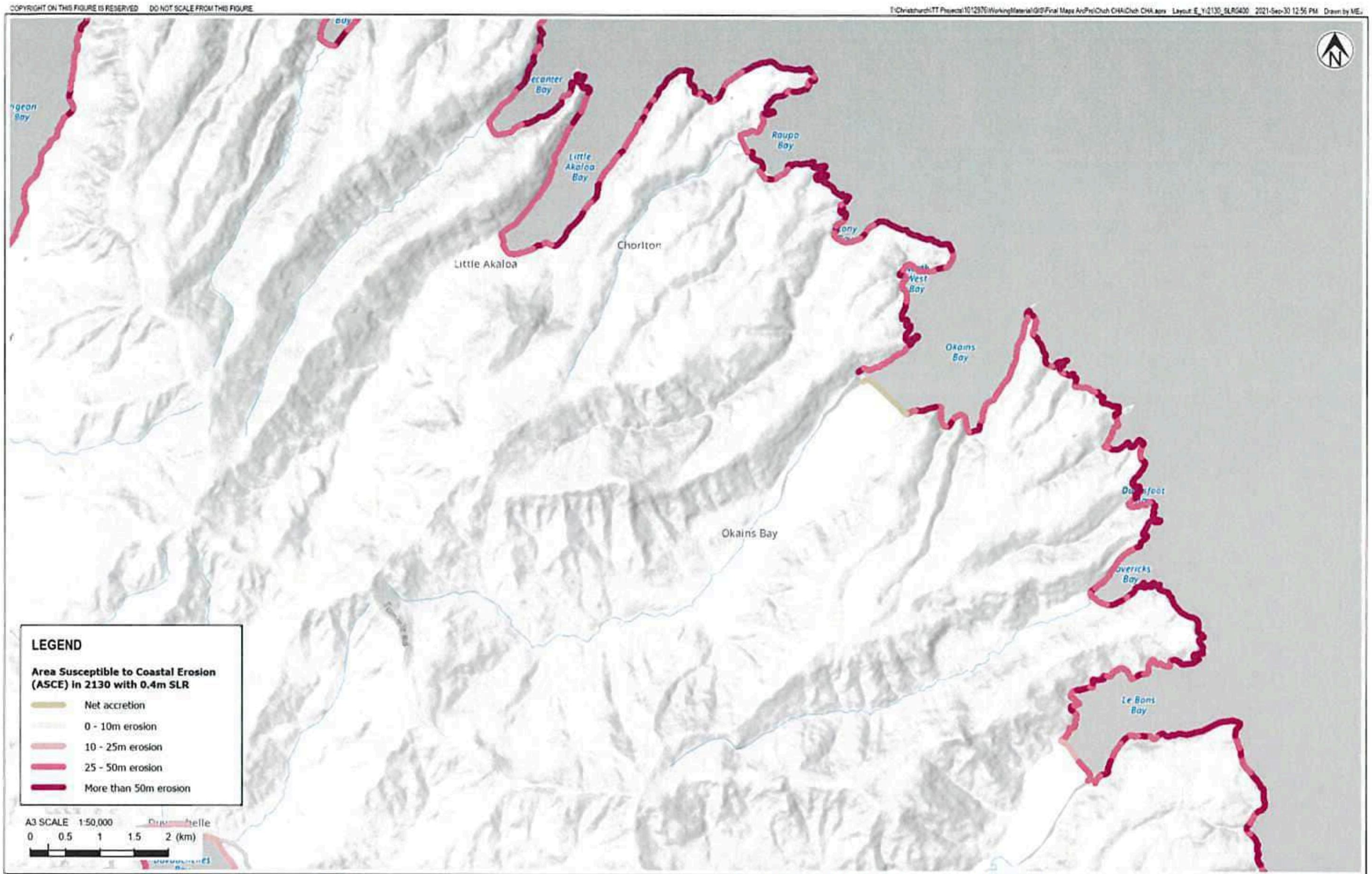
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| P COCHRANE | 29/09/21 | |
| APPROVED | DATE | |

CLIENT **CHRISTCHURCH CITY COUNCIL**
PROJECT **COASTAL HAZARD ASSESSMENT**
TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 10F REV 1

T:\Christchurch\TT Projects\1012976\WorkingMaterial\GIS\Final Maps ArcPro\Chch CHA\Chch CHA.aprx  Layout: E_Y2130_SLR0400  2021-Sep-30 12:56 PM  Drawn by MEJ

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NOTES:
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LOCATION PLAN

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT: CHRISTCHURCH CITY COUNCIL
PROJECT: COASTAL HAZARD ASSESSMENT
TITLE: COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE
SCALE (A3): 1:50,000  FIG No. FIGURE 11A  REV 1

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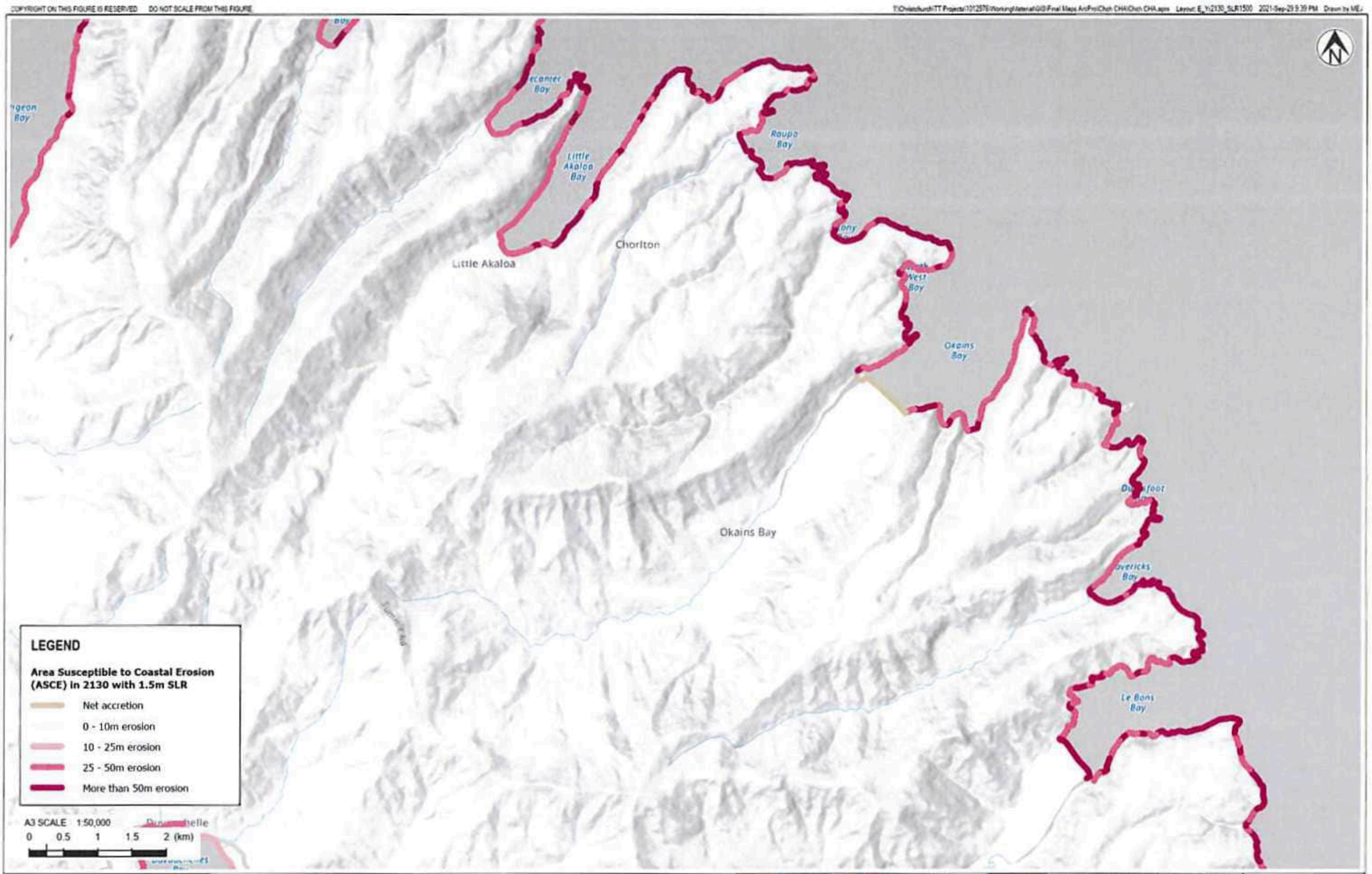


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| REV | DESCRIPTION | GIS | CHK | DATE |
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| PROJECT No. | 1012976 | |
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| CHECKED | RHAU | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 11B REV 1

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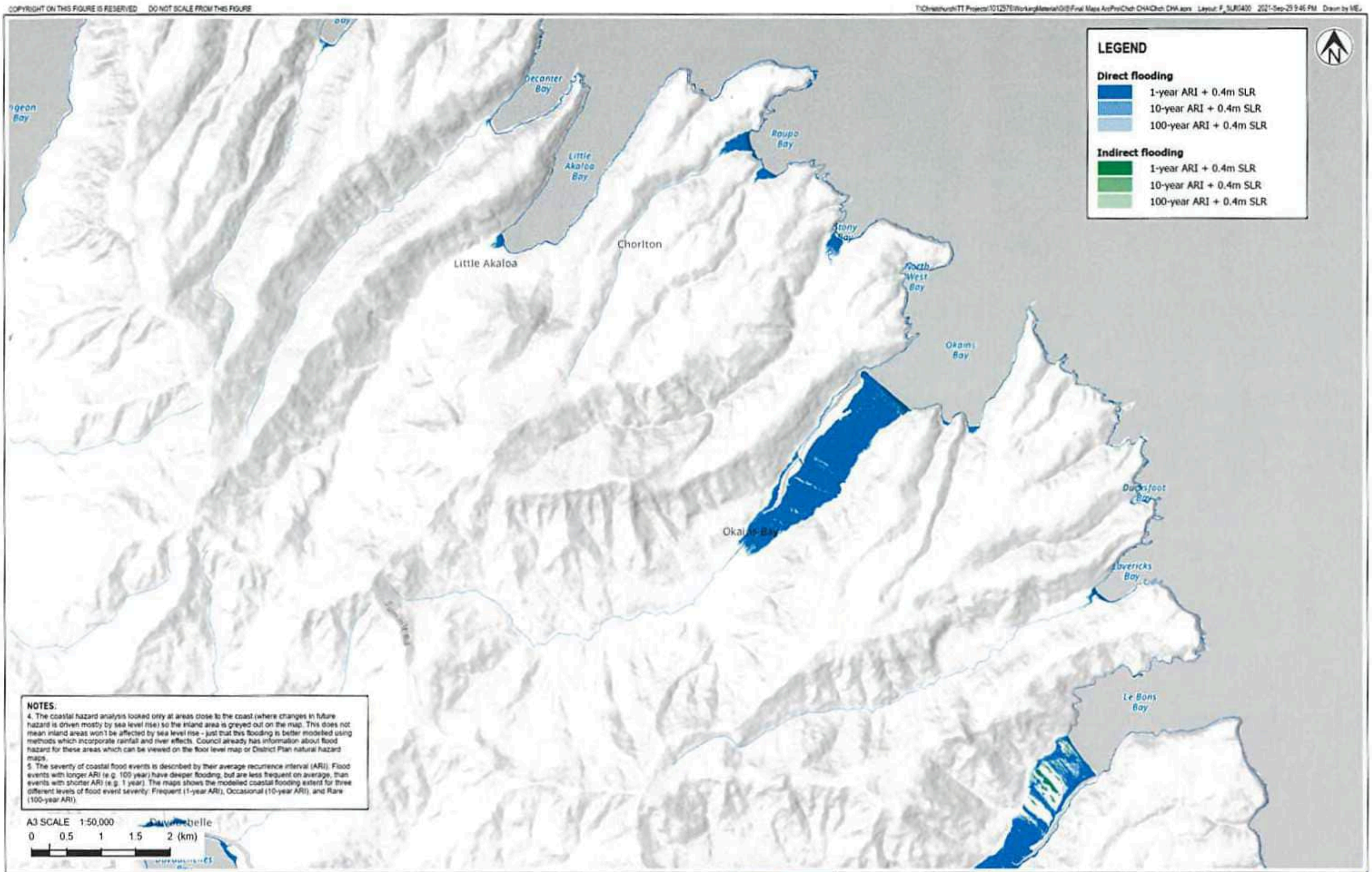


**NOTES:**

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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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| PROJECT No. | 1012976 | |
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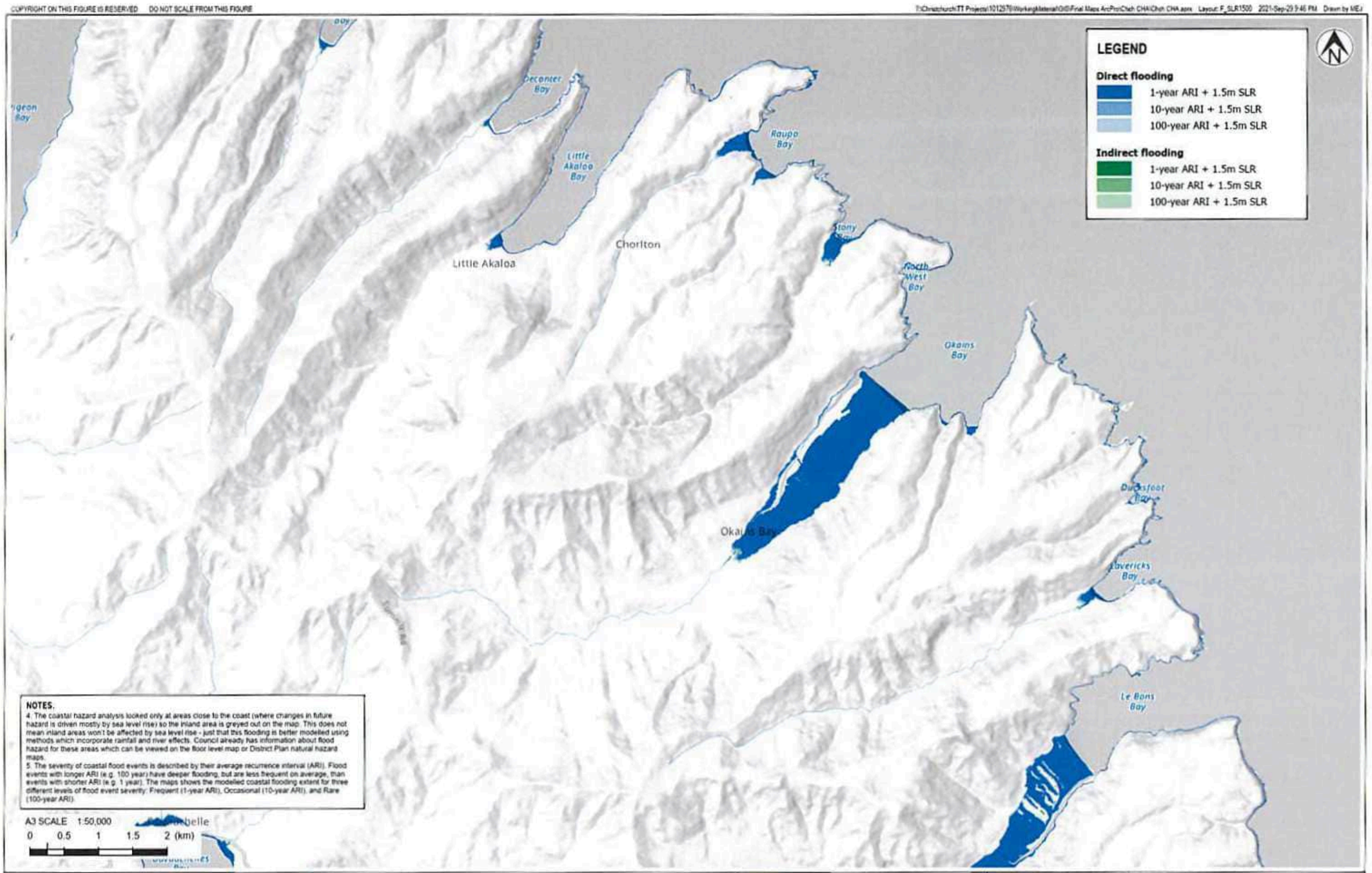
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**
PROJECT **COASTAL HAZARD ASSESSMENT**
TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 11C REV 1

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| REV | DESCRIPTION | GIS | CHK | DATE |
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LOCATION PLAN

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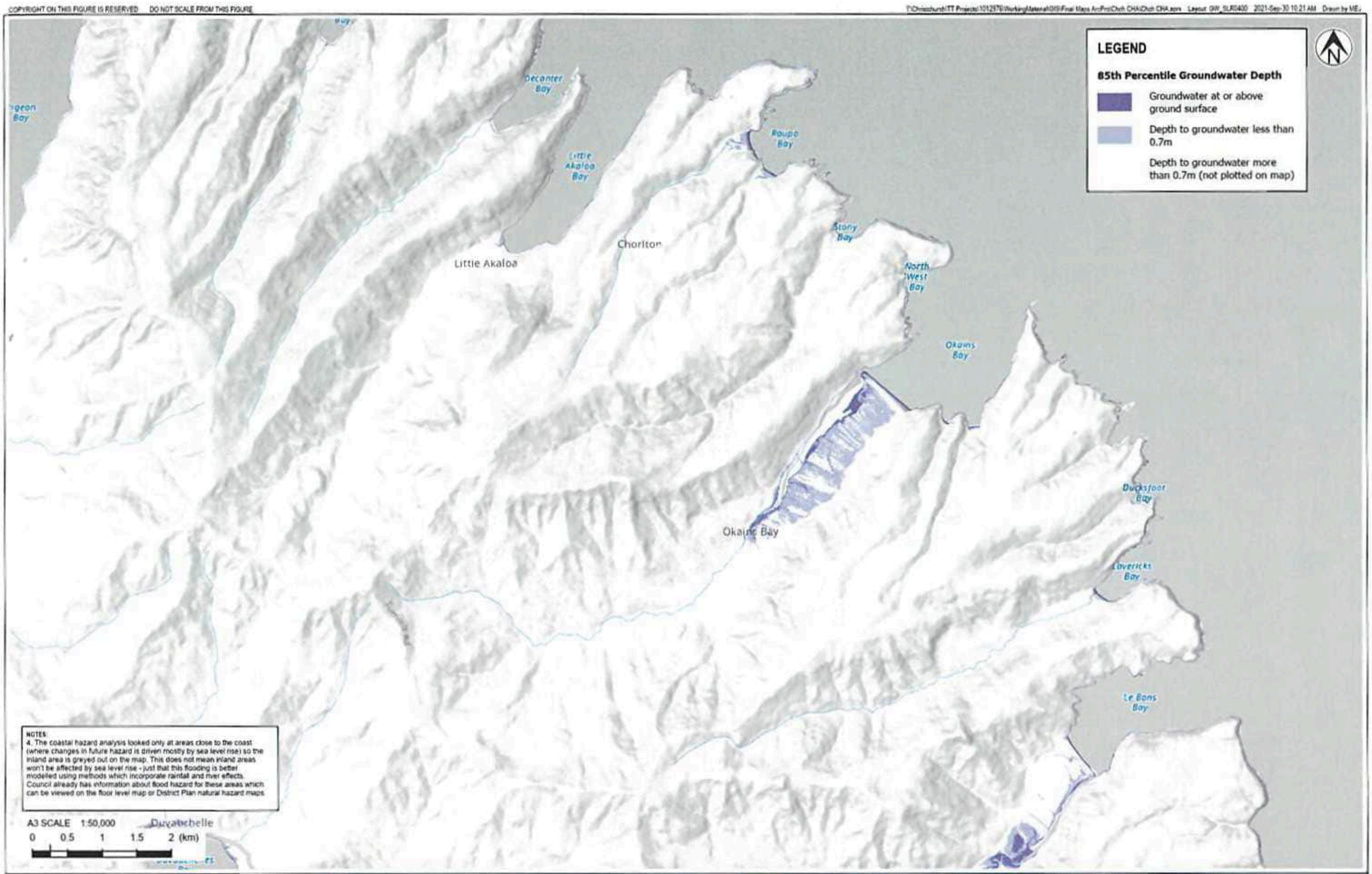
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT: CHRISTCHURCH CITY COUNCIL

PROJECT: COASTAL HAZARD ASSESSMENT

TITLE: COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 11D REV 1

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| REV | DESCRIPTION | GIS | CHK | DATE |
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LOCATION PLAN

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
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| CHECKED | PPK | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 11E REV 1

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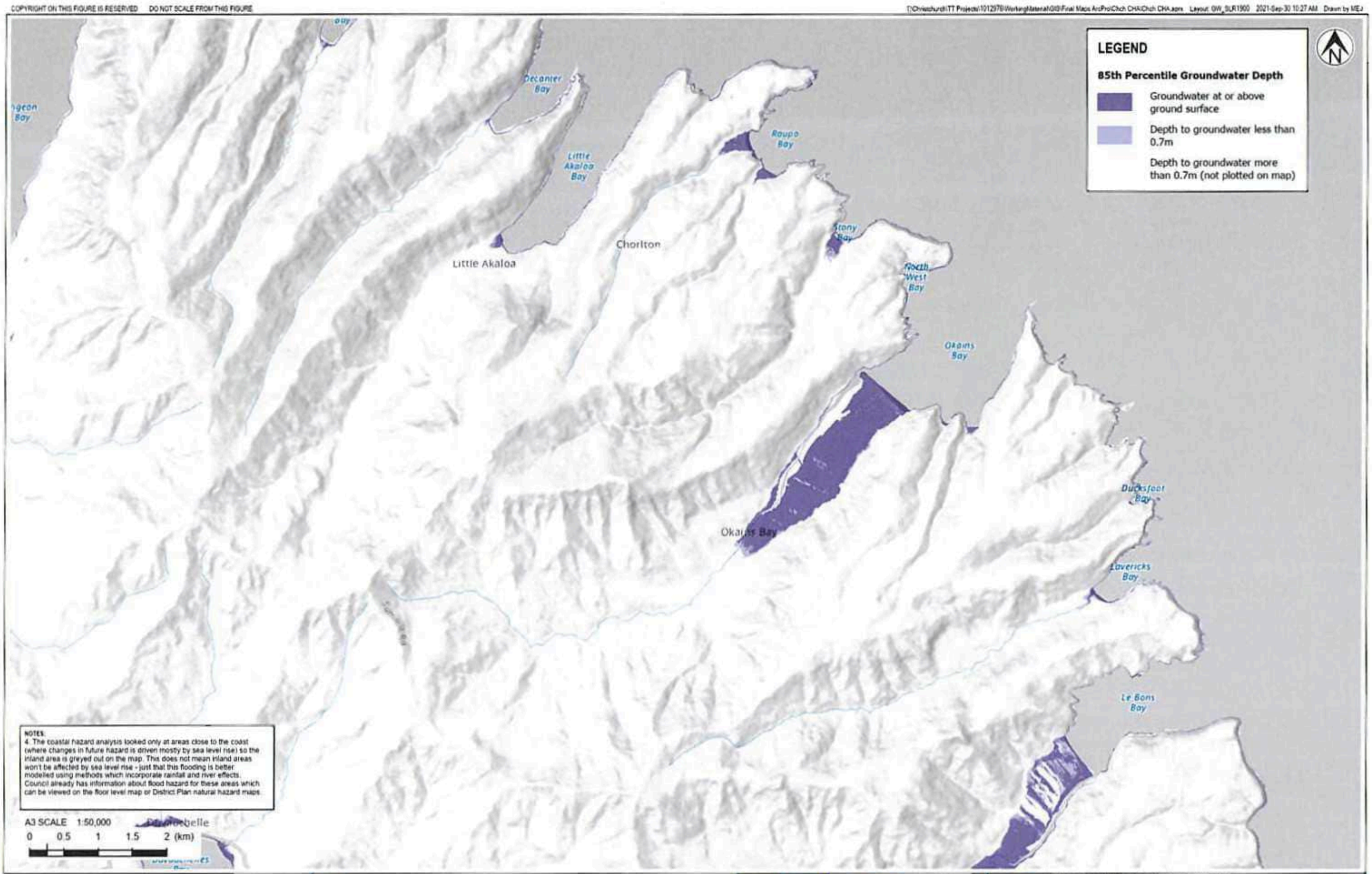


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A3 SCALE 1:50,000

0 0.5 1 1.5 2 (km)

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| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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| PROJECT No. | 1012976 | |
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| P. COCHRANE | 29/09/21 | |
| APPROVED | DATE | |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 11F REV 1

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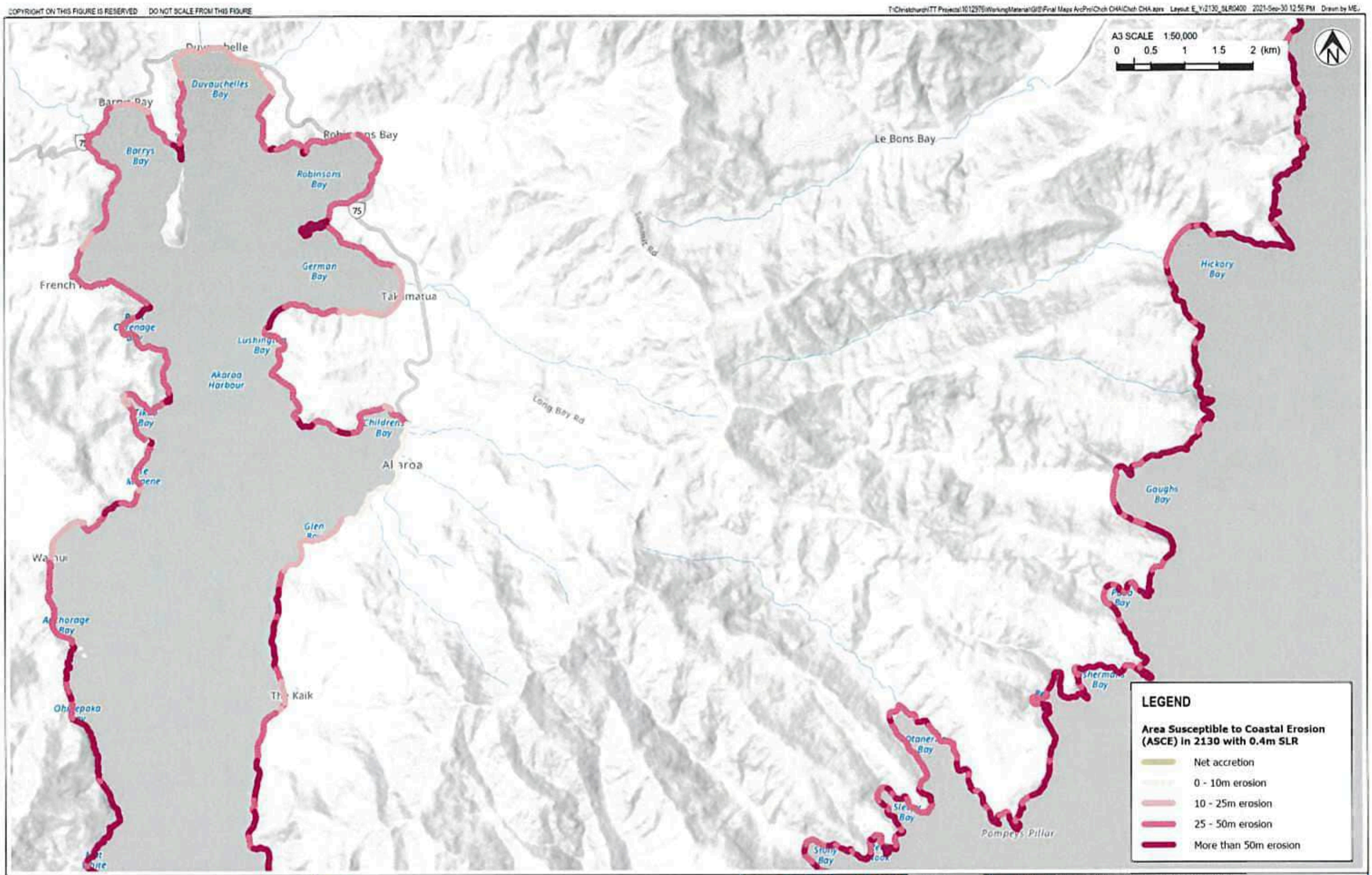


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NOTES:
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| 1 | Report issued | MEJ | RHAU | 29/09/21 |

LOCATION PLAN

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| PROJECT No. | 1012976 | |
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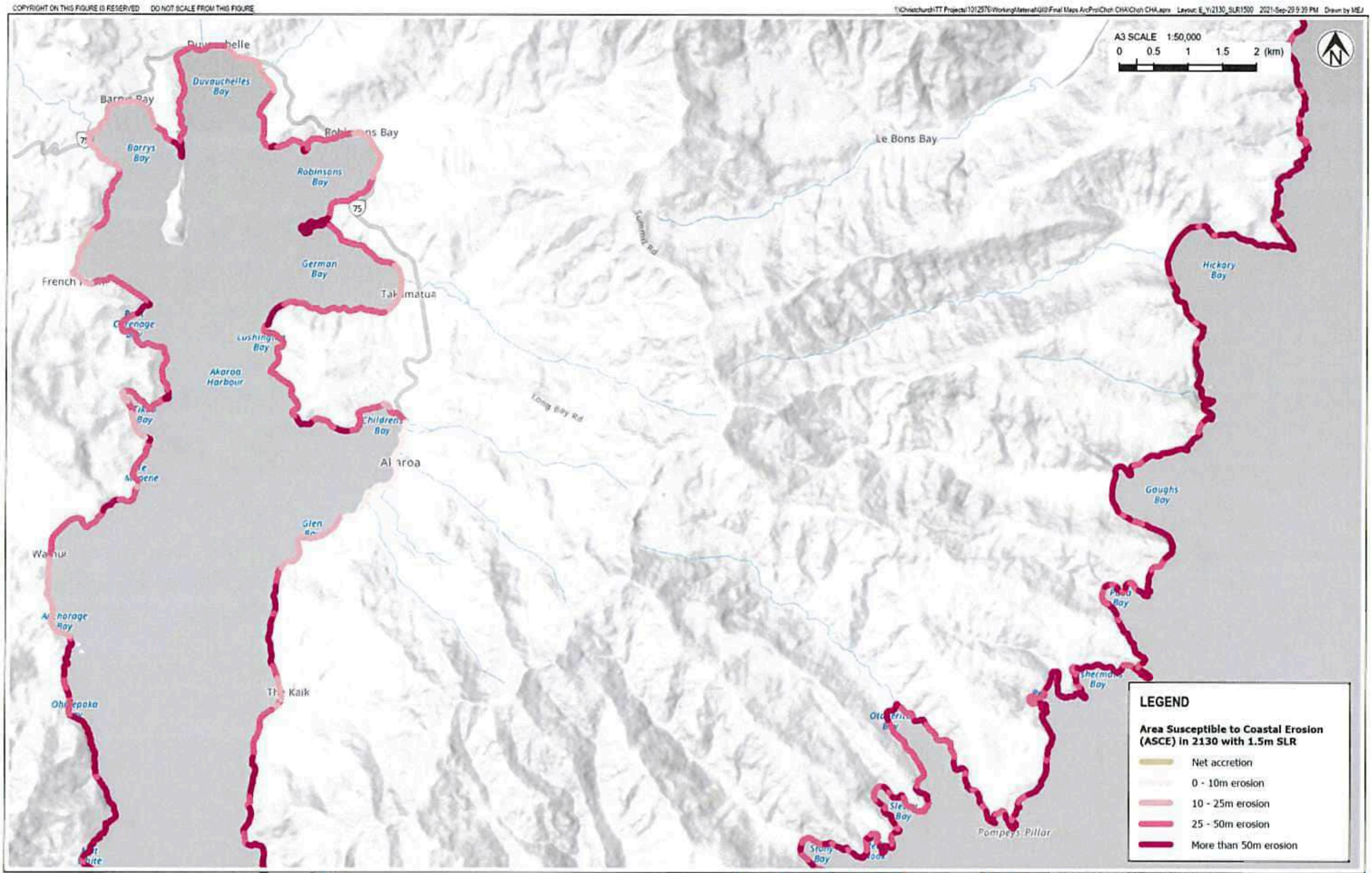
| CHECKED | RHAU | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 12A REV 1

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| PROJECT No. | 1012976 | |
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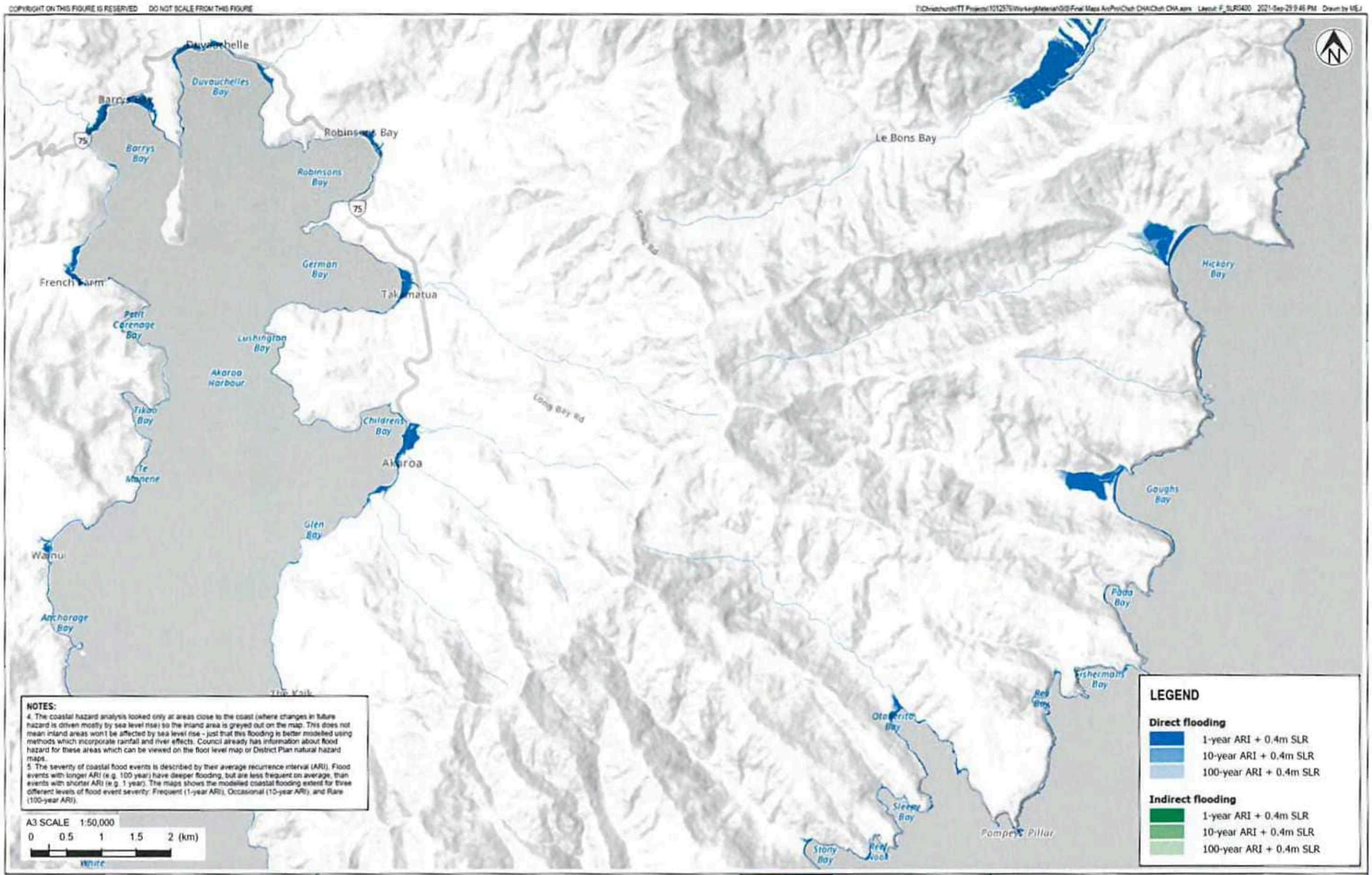
| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED: P. COCHRANE | DATE: 29/09/21 | |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 12B REV 1

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| REV | DESCRIPTION | GIS | CHK | DATE |
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LOCATION PLAN

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| PROJECT No. | 1012976 | |
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| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 12C REV 1

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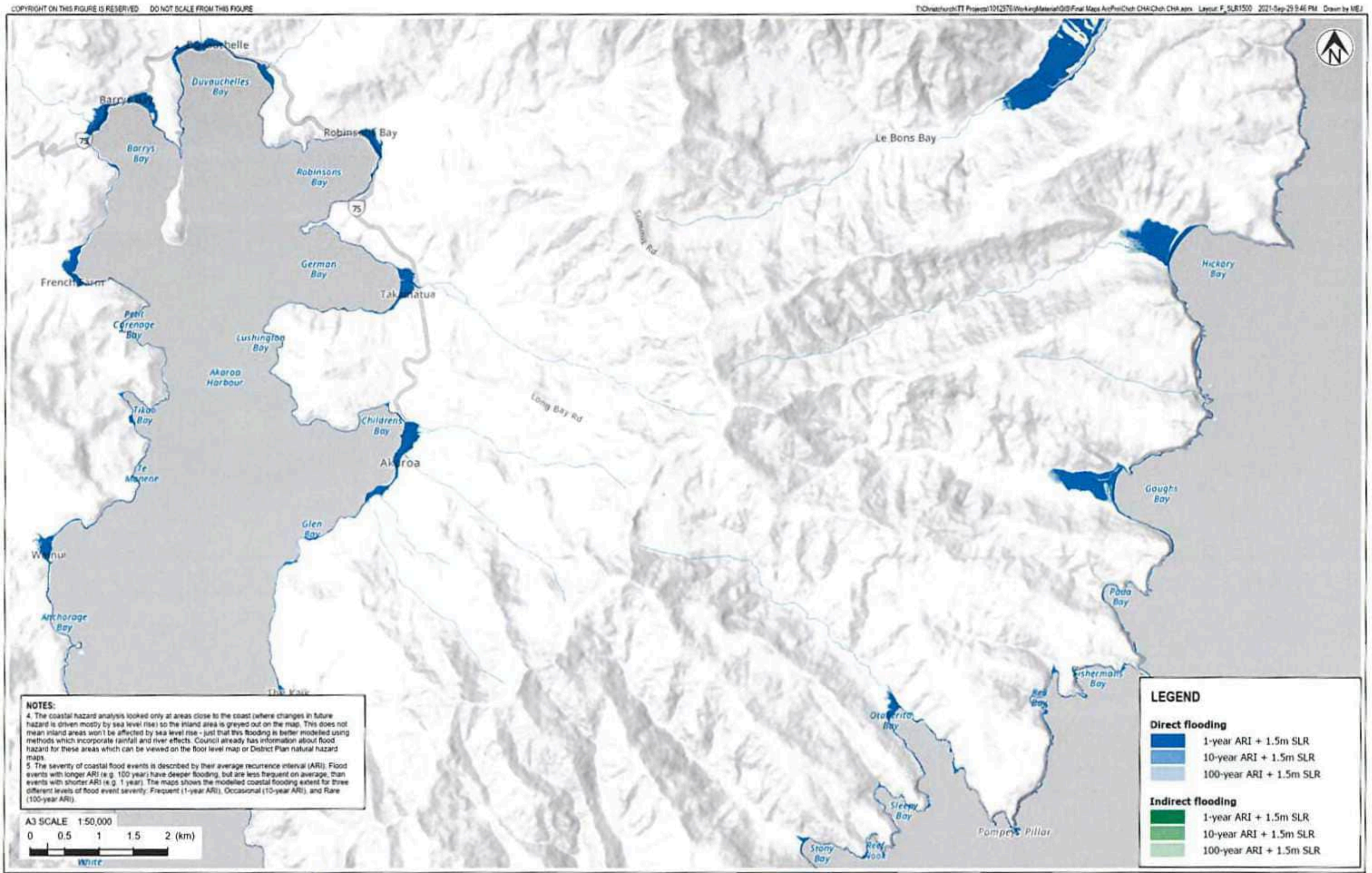


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A3 SCALE 1:50,000

0 0.5 1 1.5 2 (km)

**LEGEND**

**Direct flooding**
- 1-year ARI + 1.5m SLR
- 10-year ARI + 1.5m SLR
- 100-year ARI + 1.5m SLR

**Indirect flooding**
- 1-year ARI + 1.5m SLR
- 10-year ARI + 1.5m SLR
- 100-year ARI + 1.5m SLR

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| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 12D REV 1

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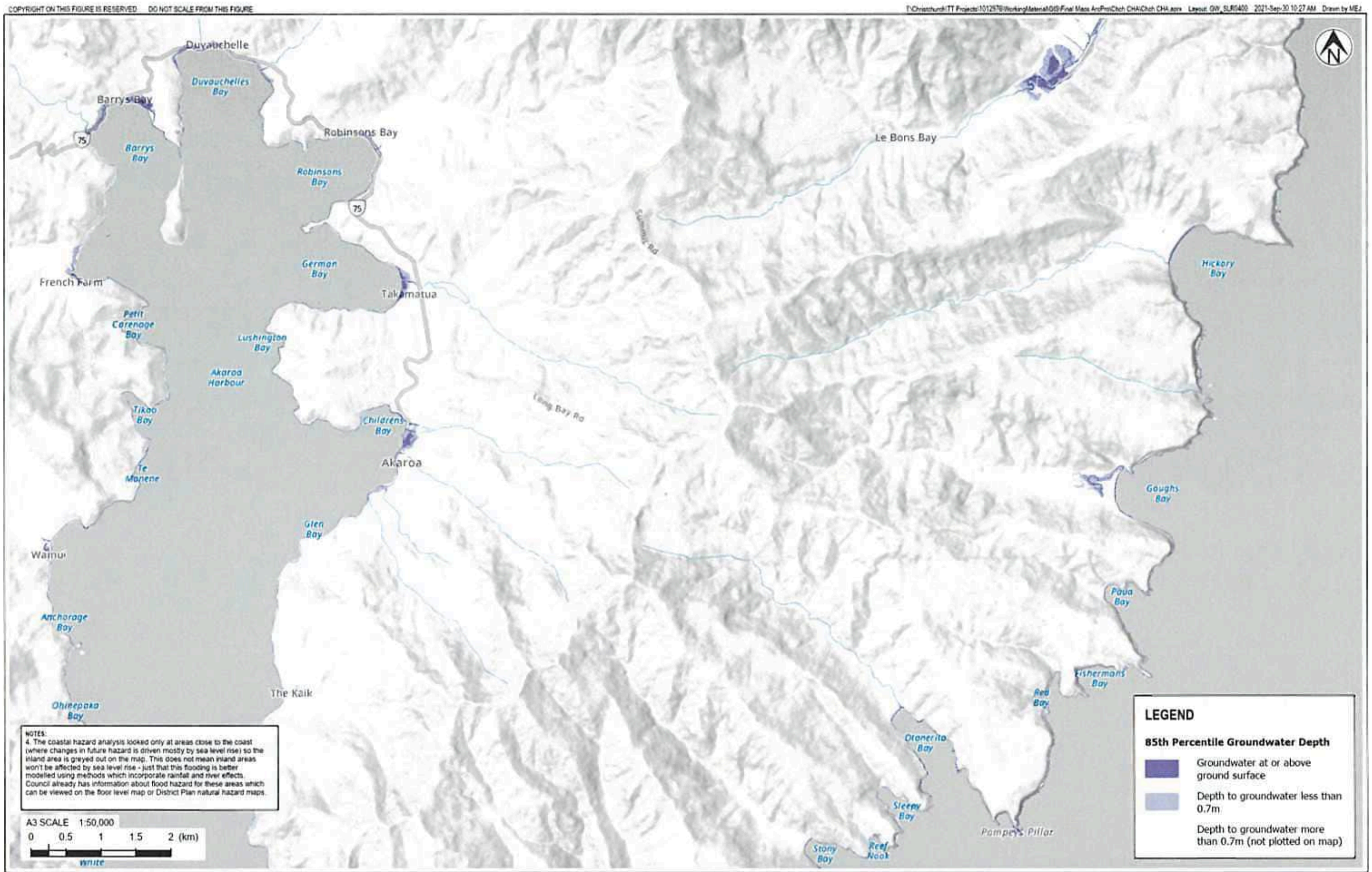


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| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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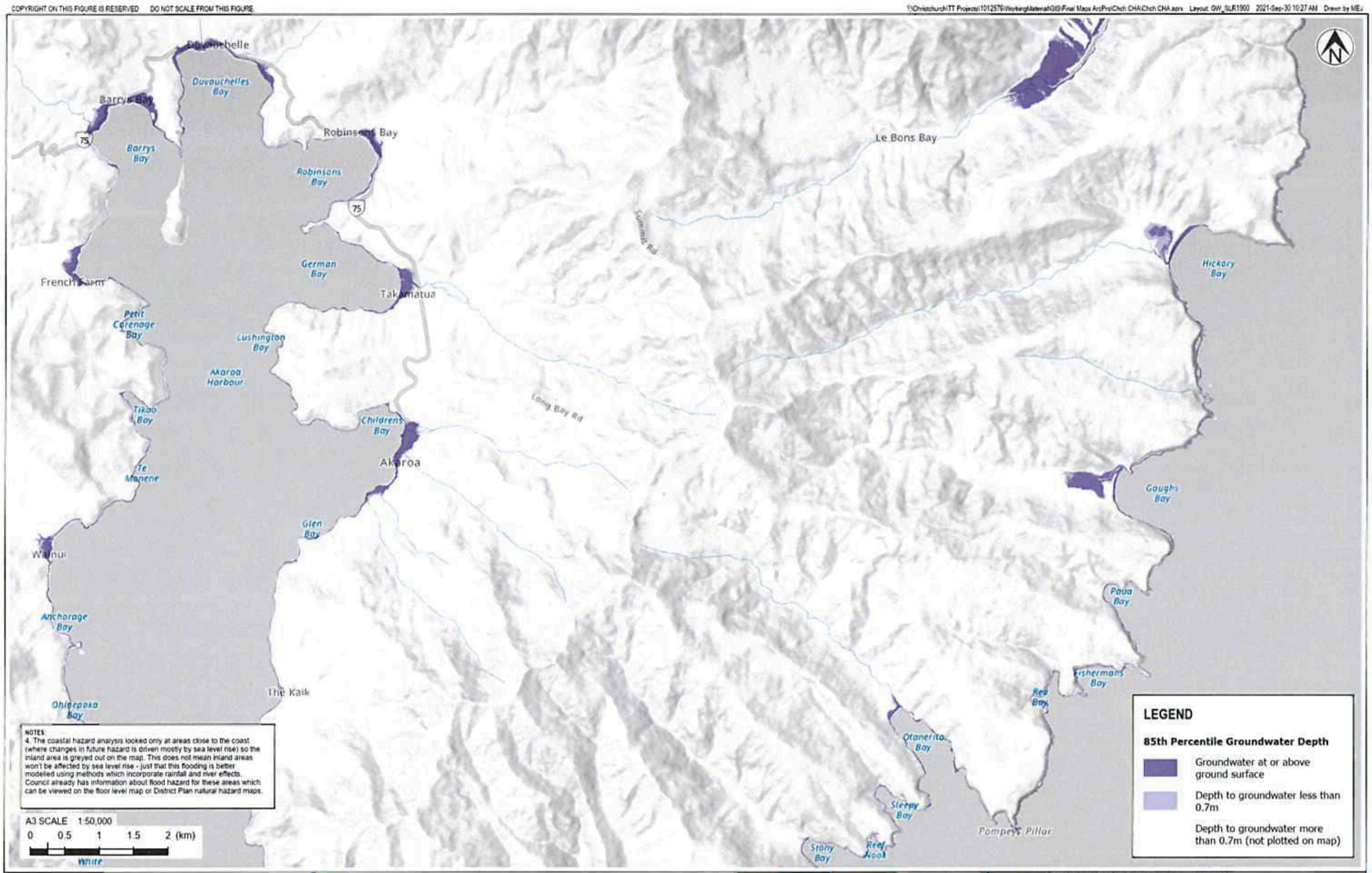
| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT: CHRISTCHURCH CITY COUNCIL

PROJECT: COASTAL HAZARD ASSESSMENT

TITLE: COASTAL GROUNDWATER ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000    FIG No. FIGURE 12E    REV 1

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**NOTES:**
1. For Christchurch urban flatland area, map shows 85th percentile groundwater model from Aqualinc (2020) "LDRP45: Impacts of earthquakes and sea level rise on shallow groundwater levels." Report prepared for Christchurch City Council, August 2020.
2. For Banks Peninsula, map assumes that 85th percentile groundwater level is approximately equal to MHWS high tide level.
3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology, NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ.

| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | PPK | 29/09/21 |

LOCATION PLAN

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | PPK | SEP.21 |
| APPROVED: P. COCHRANE | DATE: 29/09/21 | |

CLIENT **CHRISTCHURCH CITY COUNCIL**
PROJECT **COASTAL HAZARD ASSESSMENT**
TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3) 1:50,000   FIG No. FIGURE 12F   REV 1

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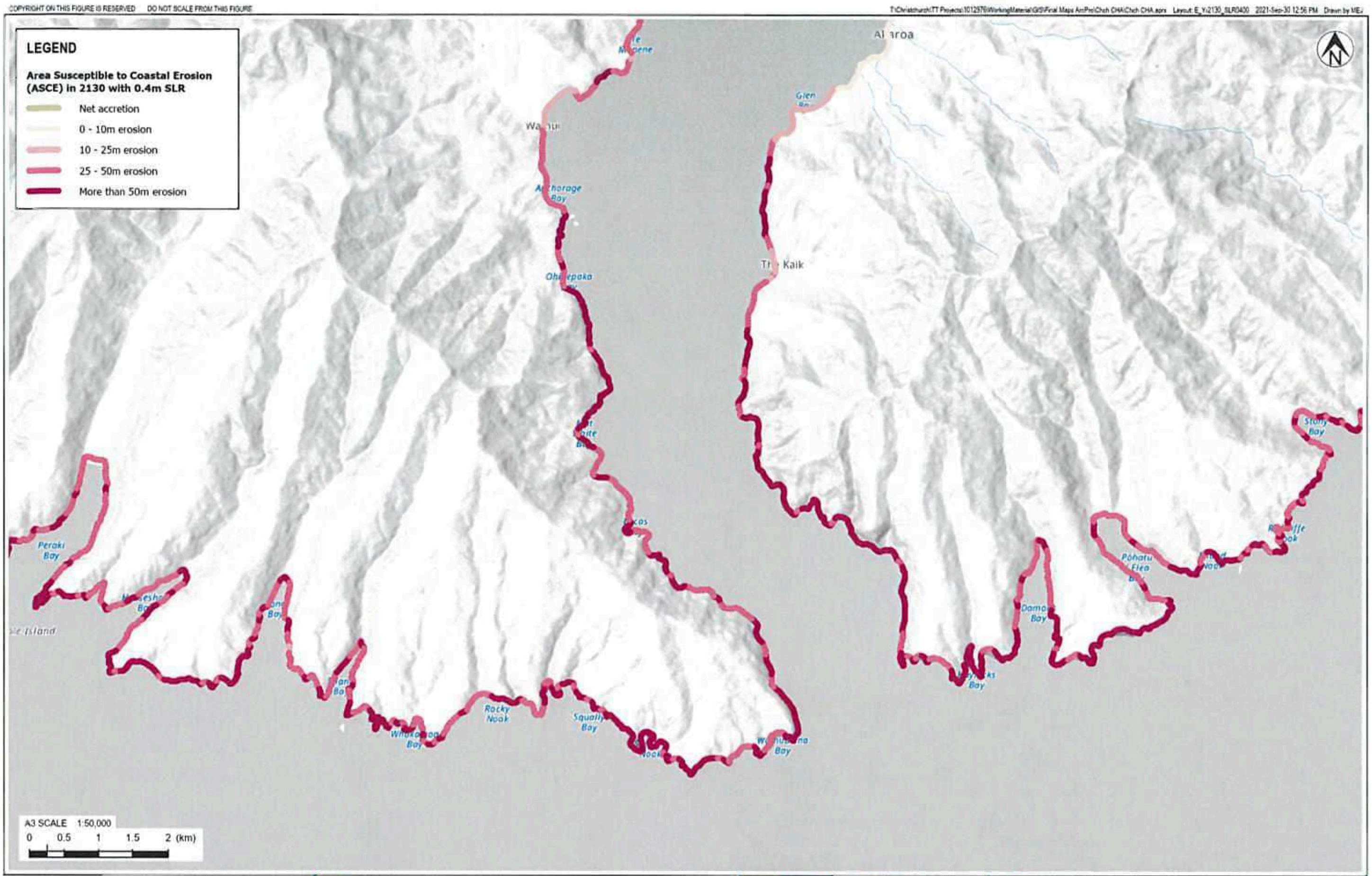


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NOTES:
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2. For regional screening analysis areas, this map shows the upper envelope erosion distance.
3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology, NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.

| REV | DESCRIPTION | GIS | CHK | DATE |
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| 1 | Report issued | MEJ | RHAU | 29/09/21 |

LOCATION PLAN

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| PROJECT No. | 1012976 | |
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 13A REV 1

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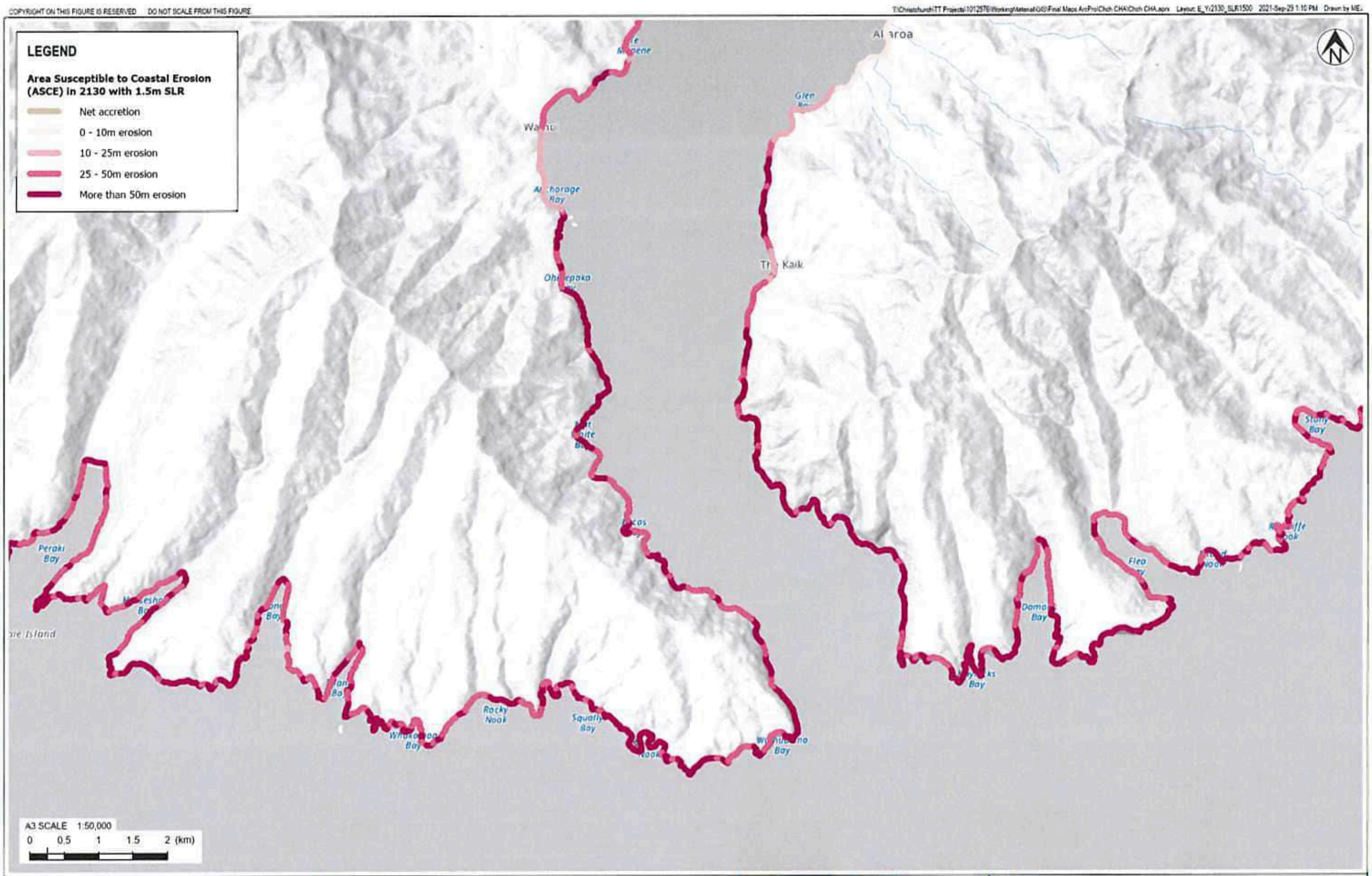


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3. Basemap NZ Hillshade (Alpha): LINZ, Eagle Technology. NZ Topographic Map for use with relief - Grey: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.

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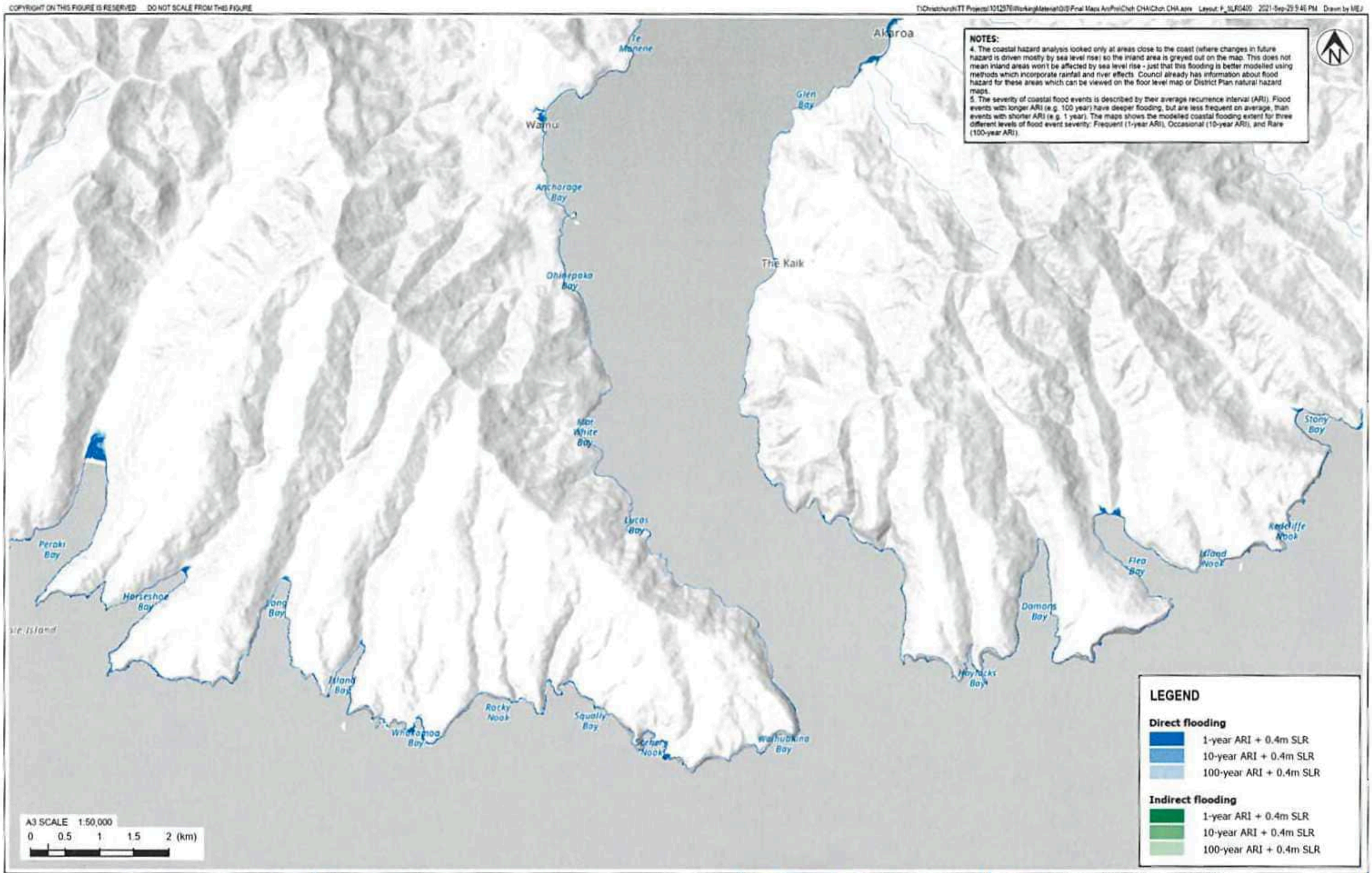
| DESIGNED | MEJ | SEP.21 |
| DRAWN | MEJ | SEP.21 |
| CHECKED | RHAU | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 13B REV 1




NOTES:

4. The coastal hazard analysis looked only at areas close to the coast (where changes in future hazard is driven mostly by sea level rise) so the inland area is greyed out on the map. This does not mean inland areas won't be affected by sea level rise - just that this flooding is better modelled using methods which incorporate rainfall and river effects. Council already has information about flood hazard for these areas which can be viewed on the floor level map or District Plan natural hazard maps.
5. The severity of coastal flood events is described by their average recurrence interval (ARI). Flood events with longer ARI (e.g. 100 year) have deeper flooding, but are less frequent on average, than events with shorter ARI (e.g. 1 year). The maps shows the modelled coastal flooding extent for three different levels of flood event severity: Frequent (1-year ARI), Occasional (10-year ARI), and Rare (100-year ARI).

**LEGEND**

**Direct flooding**
- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

**Indirect flooding**
- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

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| CHECKED | PPK | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 13C REV 1

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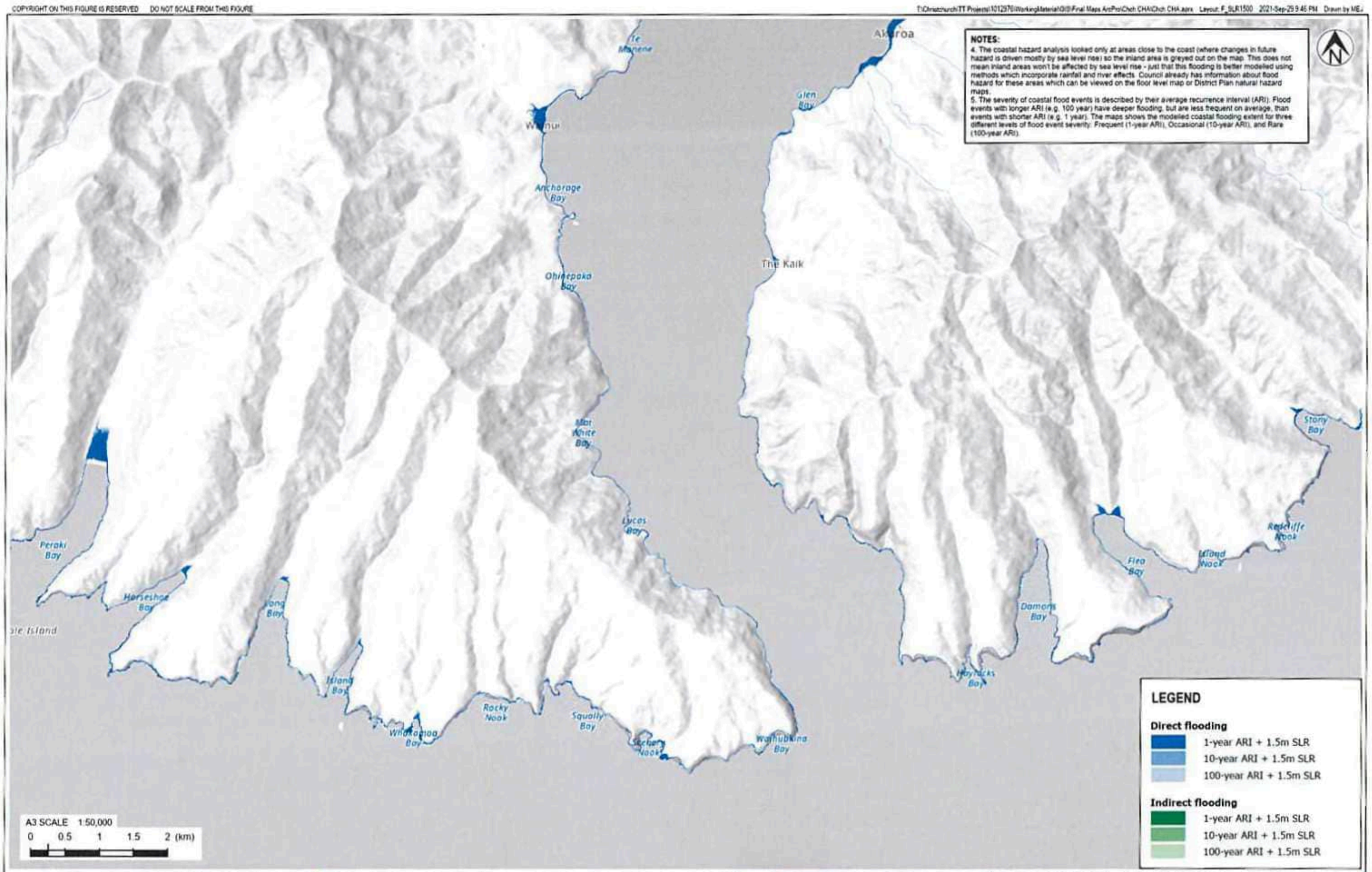


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| CHECKED | PPK | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000    FIG No. FIGURE 13D    REV 1

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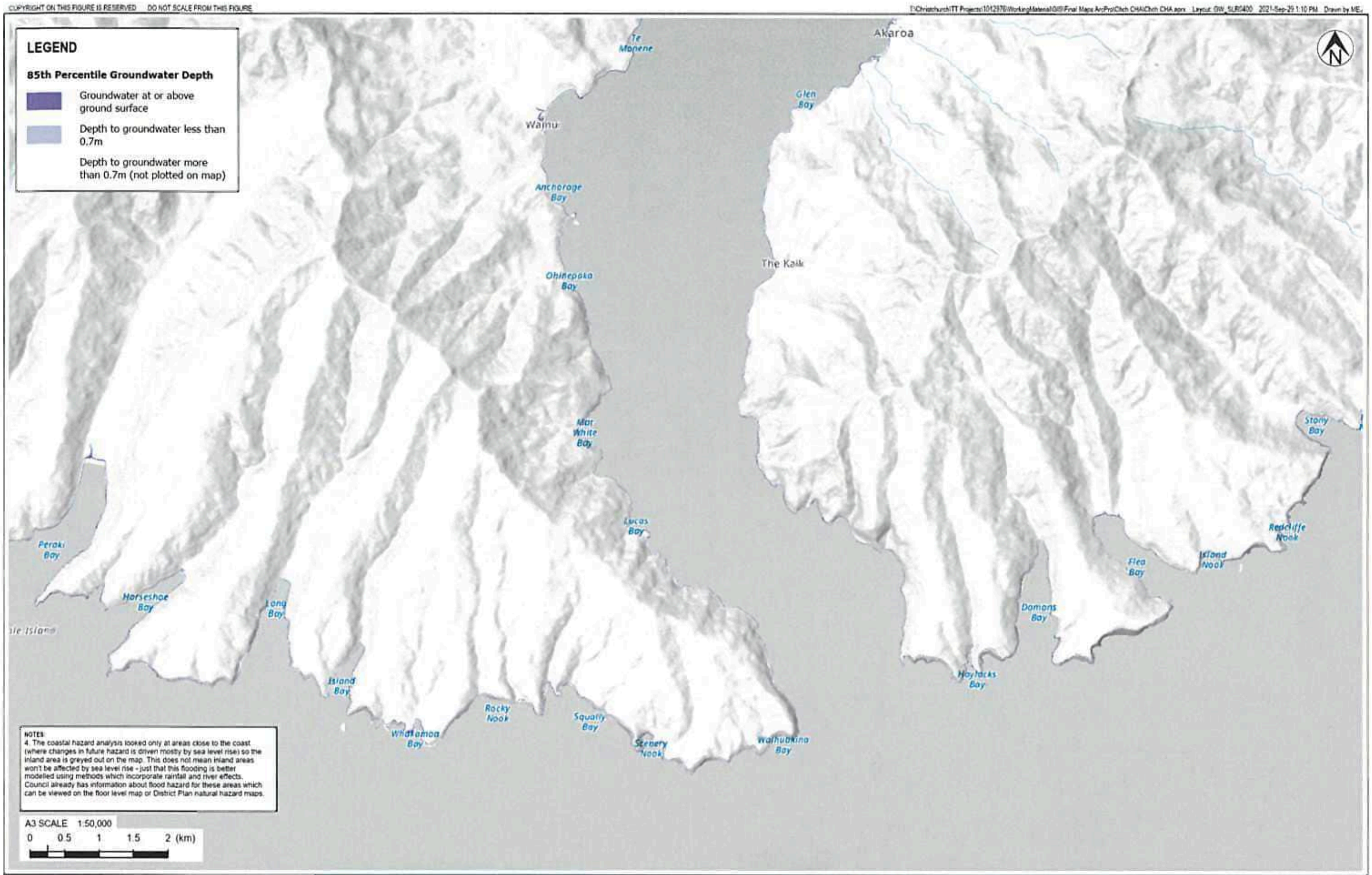


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| REV | DESCRIPTION | GIS | CHK | DATE |
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LOCATION PLAN

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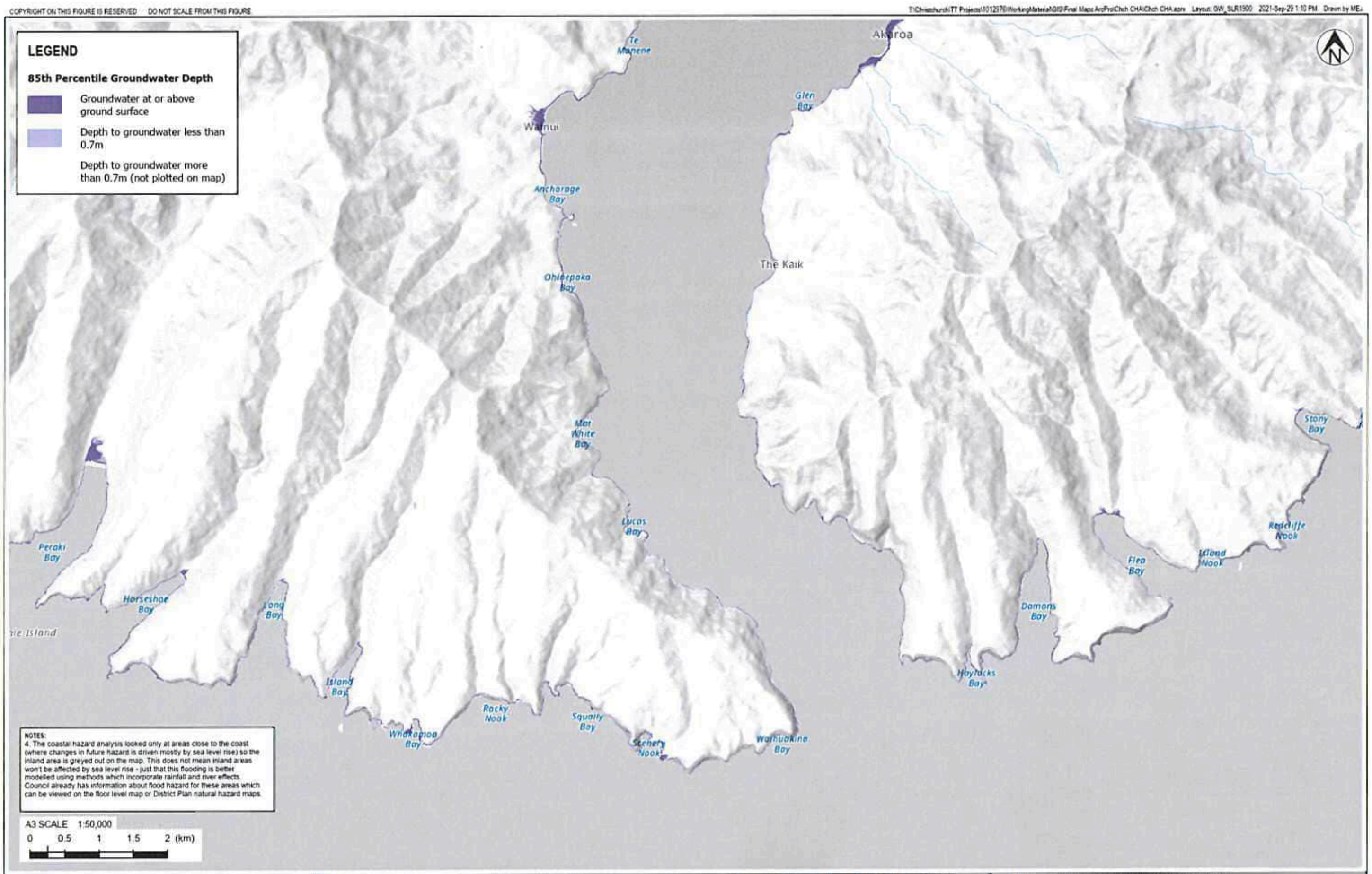
| | P COCHRANE | 29/09/21 |
| | APPROVED | DATE |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 13E REV 1

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| APPROVED | P COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 13F REV 1

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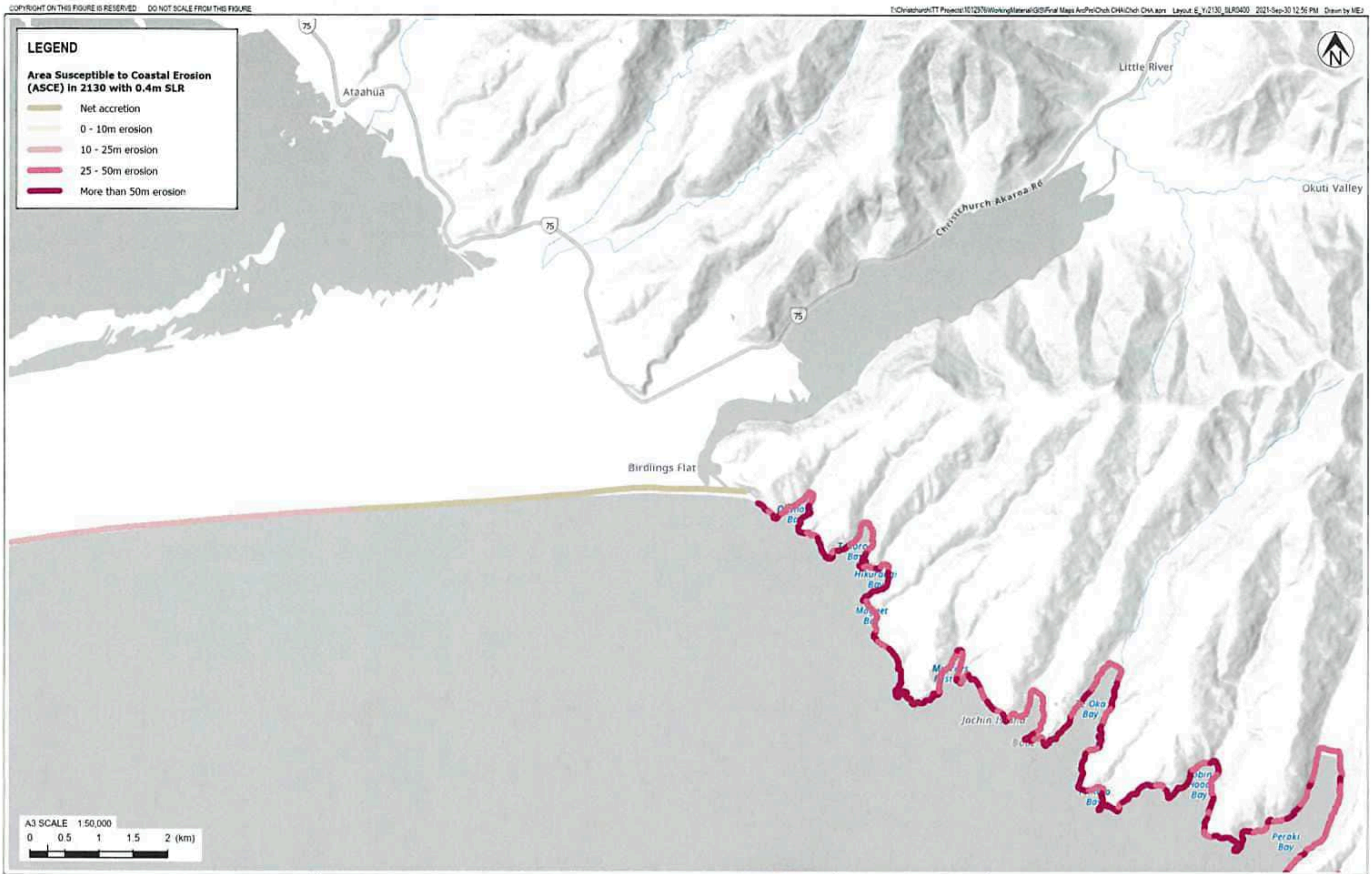


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NOTES:
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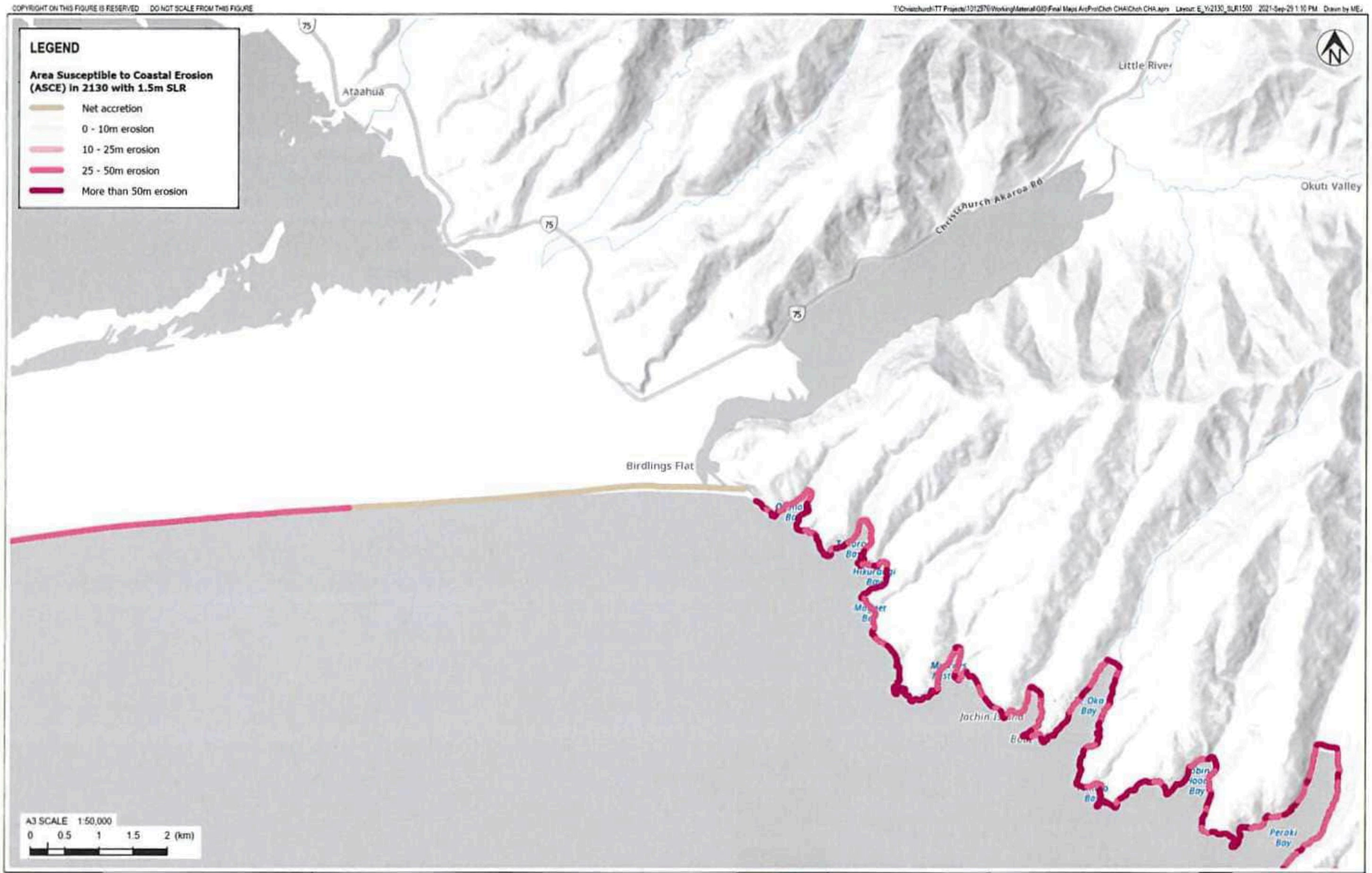
| CHECKED | RHAU | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 14A REV 1

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| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 14B REV 1

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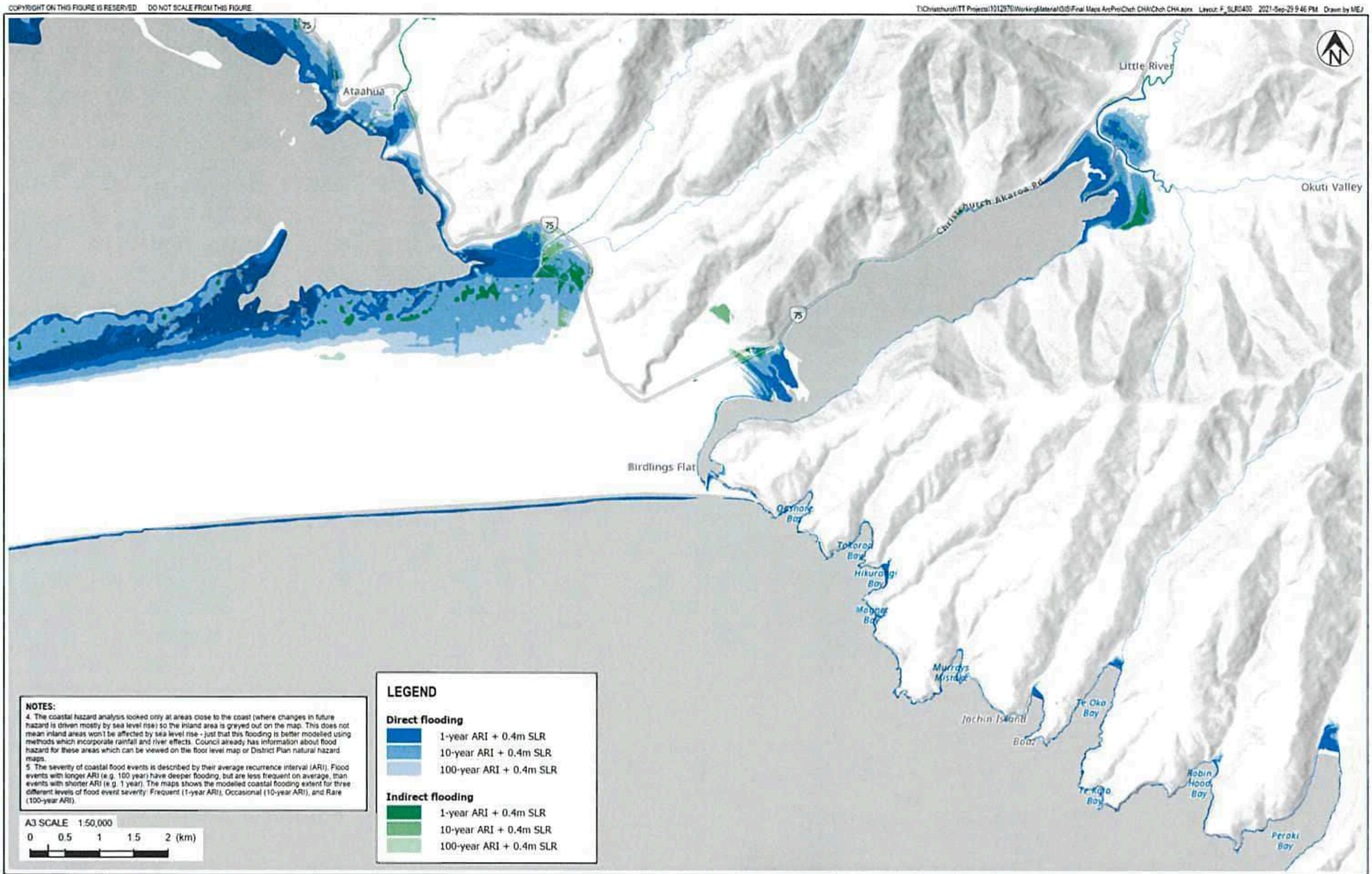


**NOTES:**

4. The coastal hazard analysis looked only at areas close to the coast (where changes in future hazard is driven mostly by sea level rise) so the inland area is greyed out on the map. This does not mean inland areas won't be affected by sea level rise - just that this flooding is better modelled using methods which incorporate rainfall and river effects. Council already has information about flood hazard for these areas which can be viewed on the floor level map or District Plan natural hazard maps.
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A3 SCALE 1:50,000

0 0.5 1 1.5 2 (km)

## LEGEND

**Direct flooding**

- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

**Indirect flooding**

- 1-year ARI + 0.4m SLR
- 10-year ARI + 0.4m SLR
- 100-year ARI + 0.4m SLR

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| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000    FIG No. FIGURE 14C    REV 1

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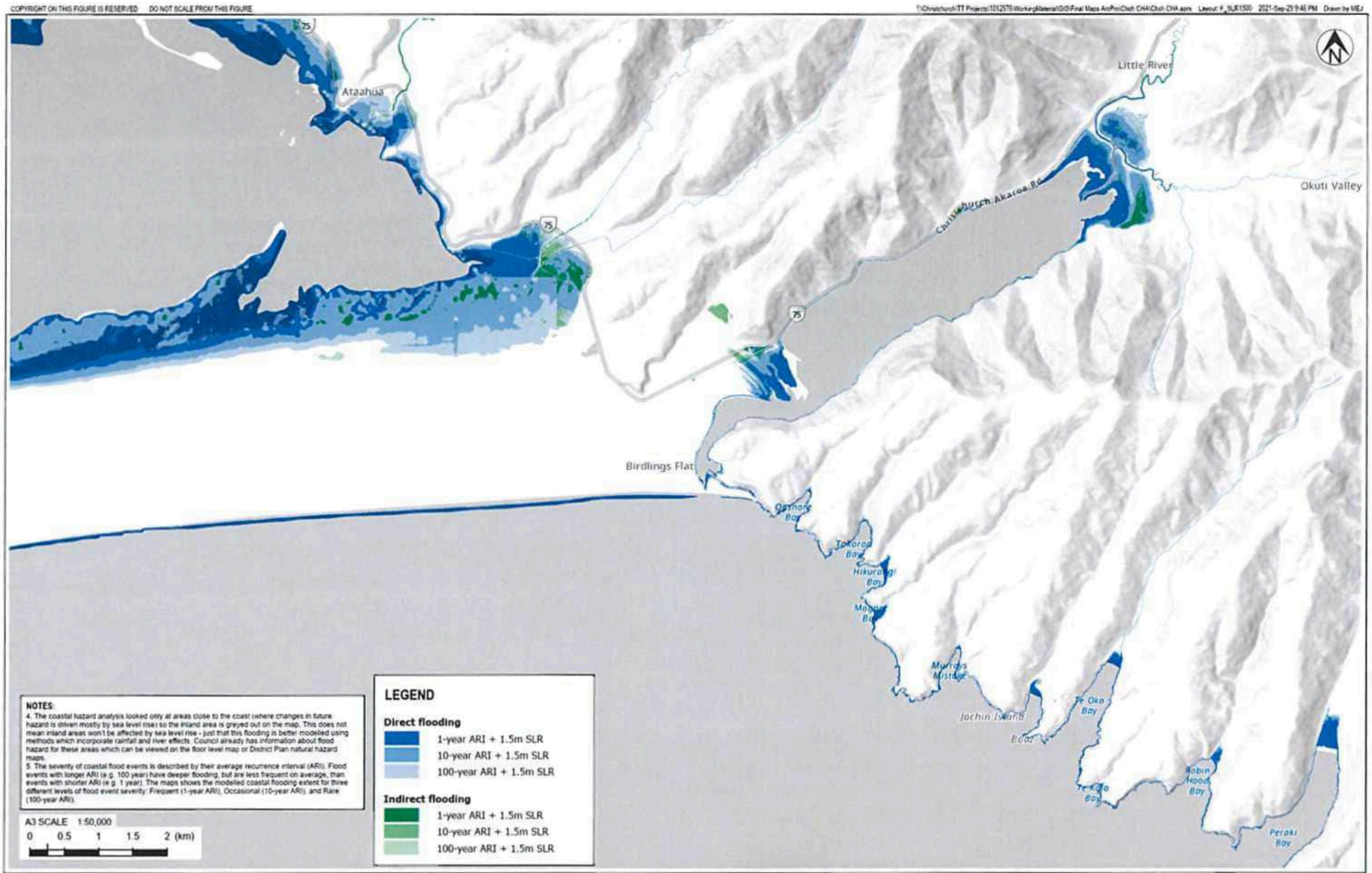


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A3 SCALE 1:50,000

0 0.5 1 1.5 2 (km)

**LEGEND**

**Direct flooding**

- 1-year ARI + 1.5m SLR
- 10-year ARI + 1.5m SLR
- 100-year ARI + 1.5m SLR

**Indirect flooding**

- 1-year ARI + 1.5m SLR
- 10-year ARI + 1.5m SLR
- 100-year ARI + 1.5m SLR

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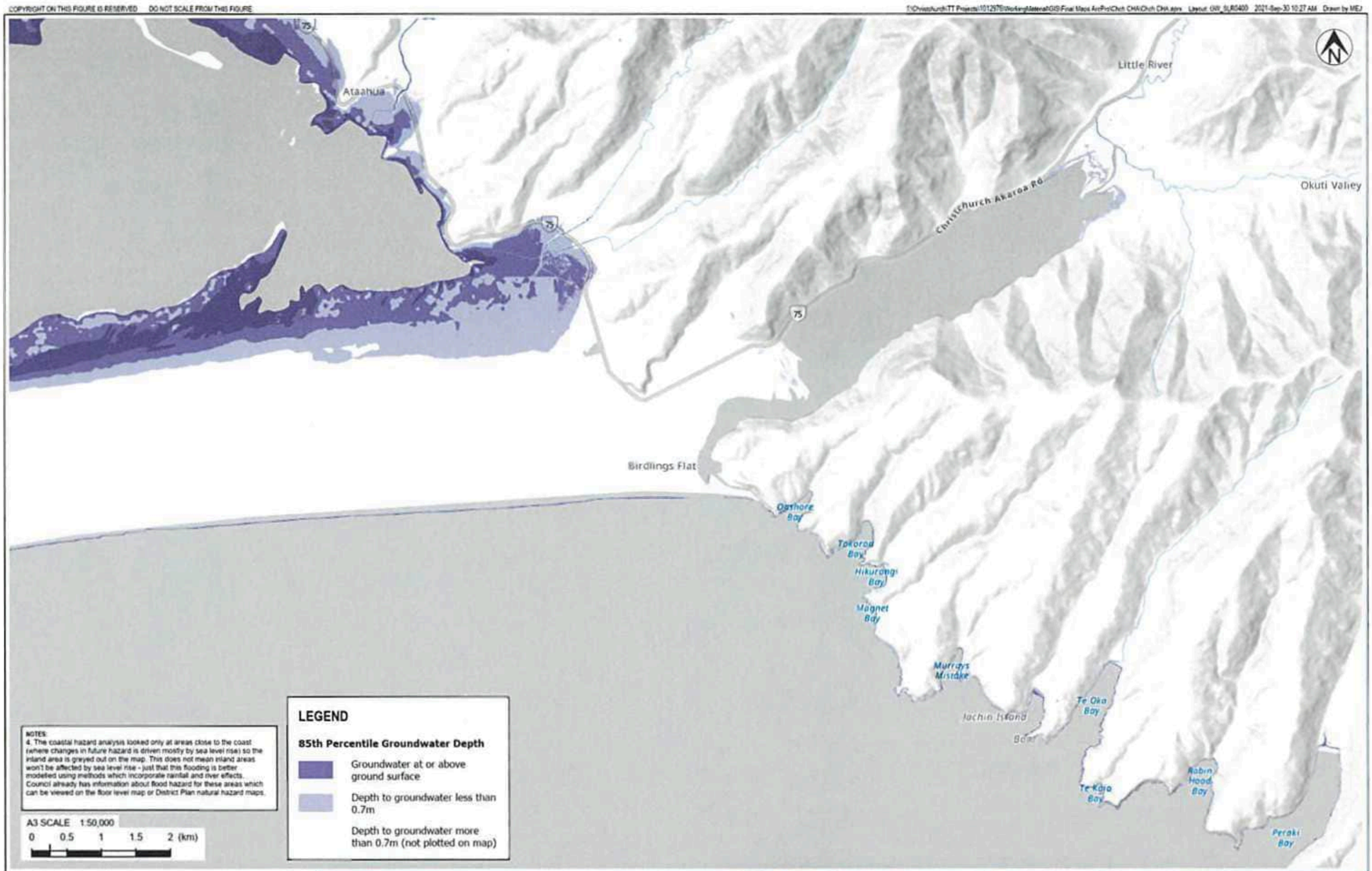
| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 14D REV 1

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A3 SCALE 1:50,000

0 0.5 1 1.5 2 (km)

## LEGEND

**85th Percentile Groundwater Depth**

- Groundwater at or above ground surface
- Depth to groundwater less than 0.7m
- Depth to groundwater more than 0.7m (not plotted on map)

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NOTES:
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| CHECKED | PPK | SEP 21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL GROUNDWATER ANALYSIS SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 14E REV 1

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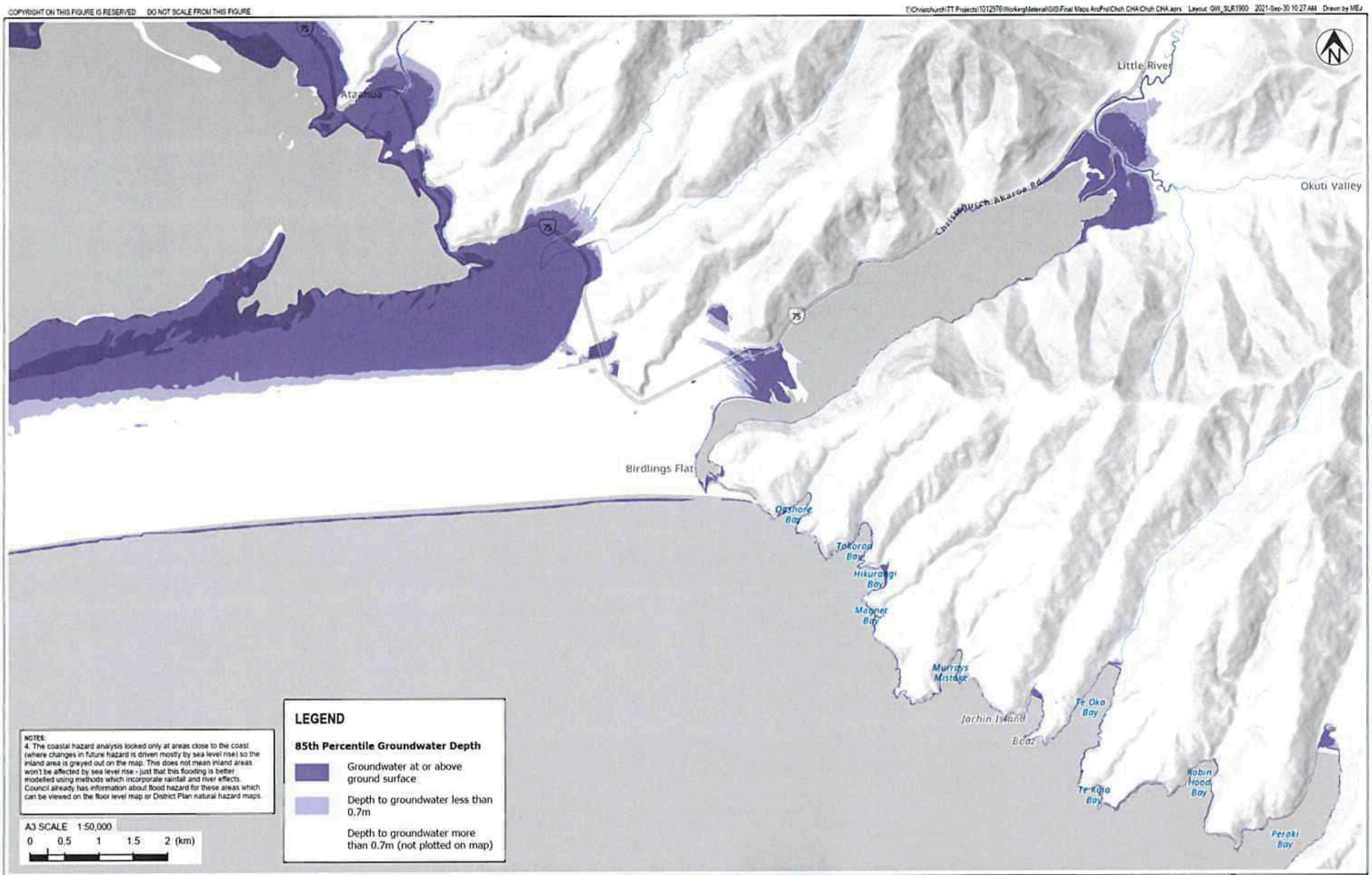


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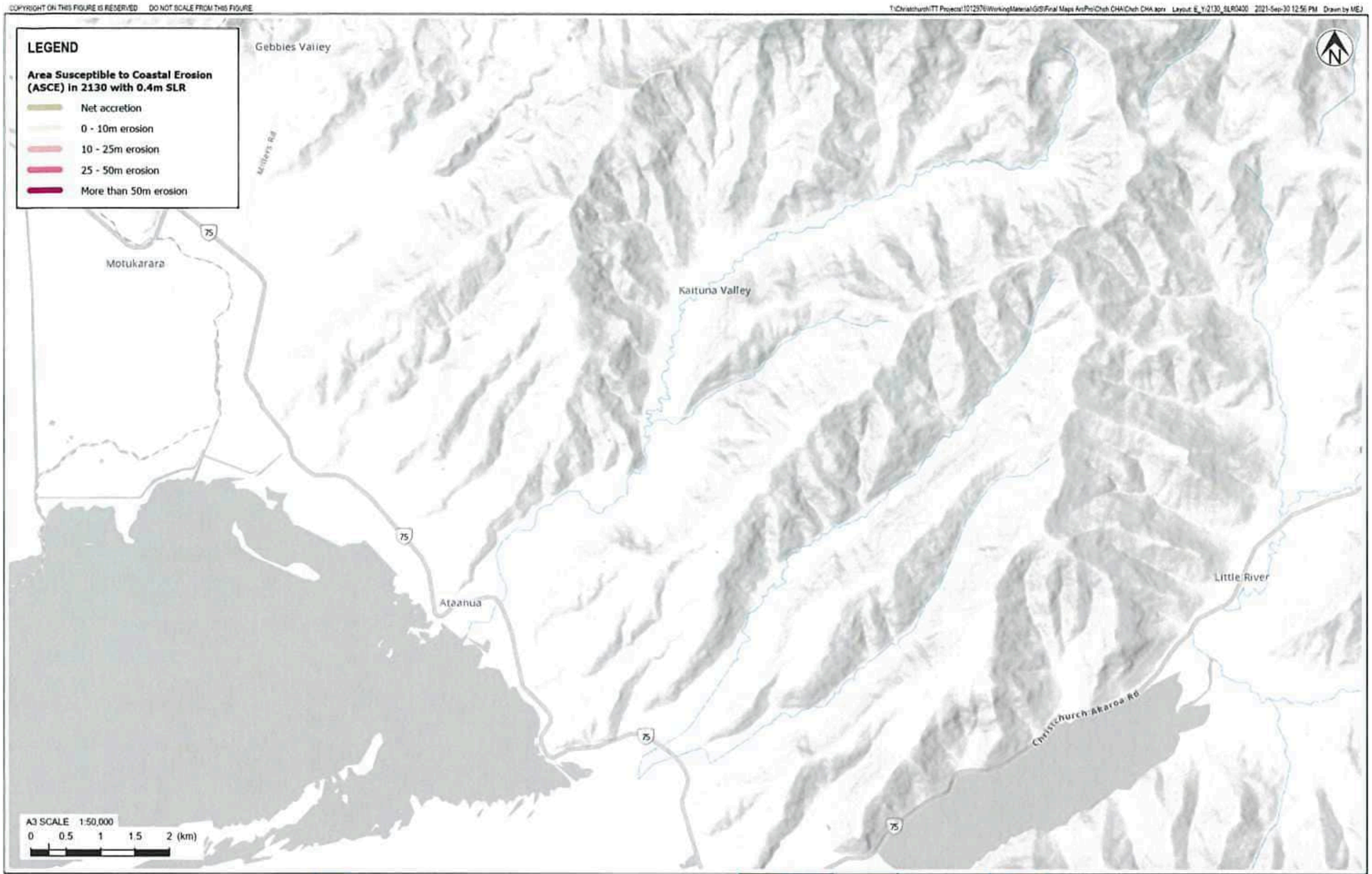
| APPROVED: P. COCHRANE | | 29/09/21 |

CLIENT: **CHRISTCHURCH CITY COUNCIL**

PROJECT: **COASTAL HAZARD ASSESSMENT**

TITLE: COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3): 1:50,000 FIG No. FIGURE 14F REV 1

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| PROJECT No. | 1012976 | |
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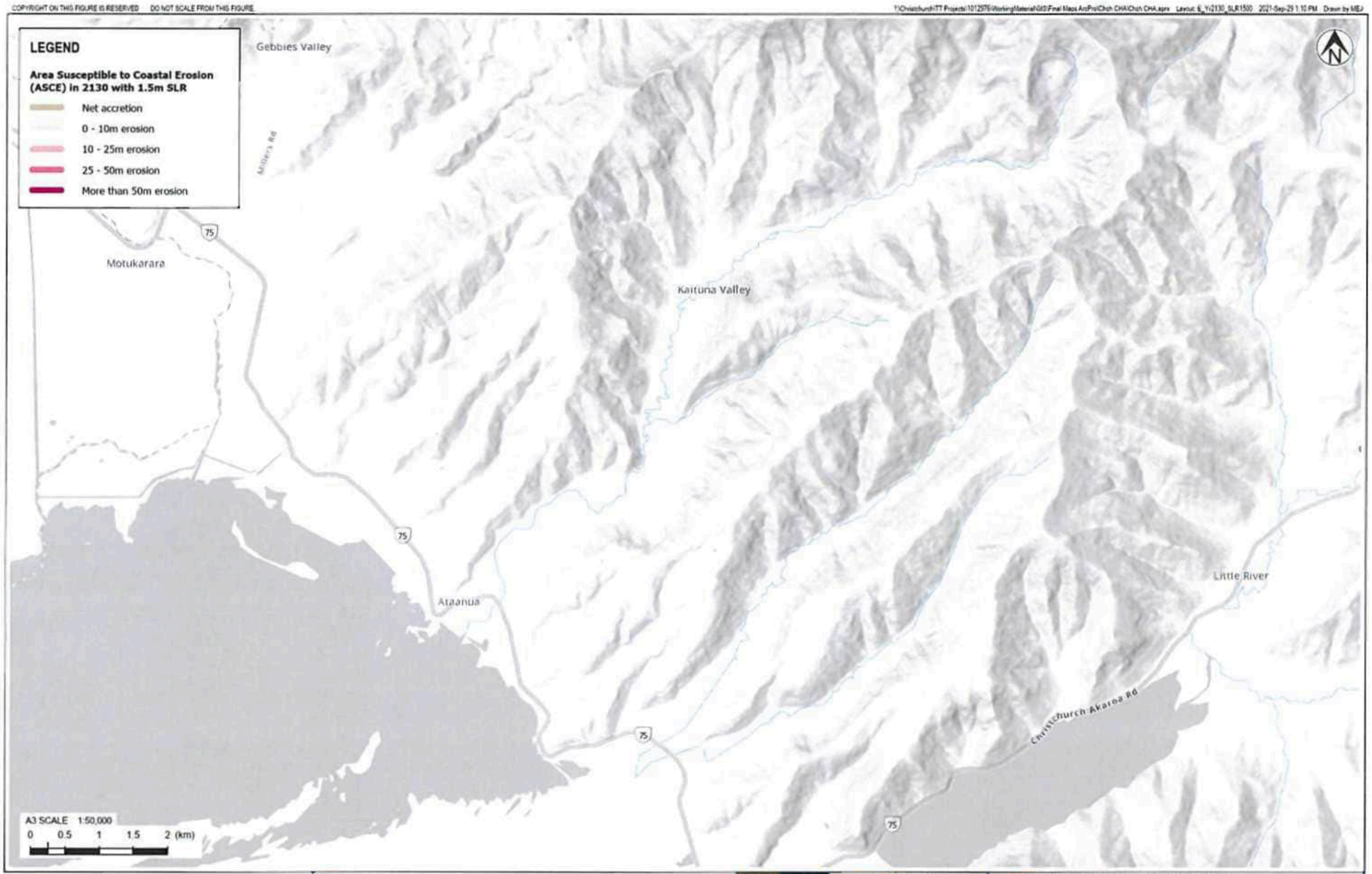
| CHECKED | RHAU | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 15A REV 1

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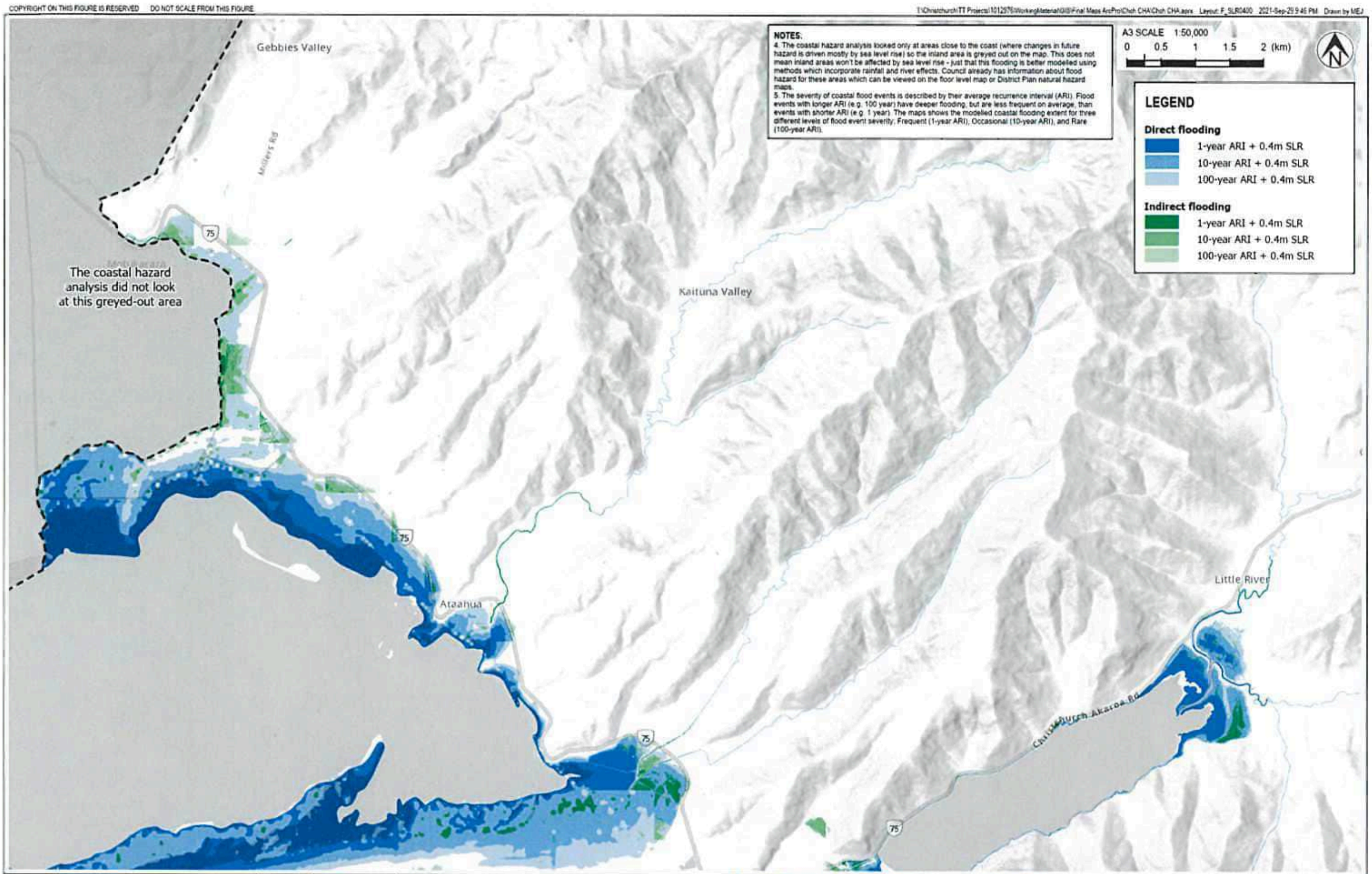
| CHECKED | RHAU | SEP.21 |
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 15B REV 1

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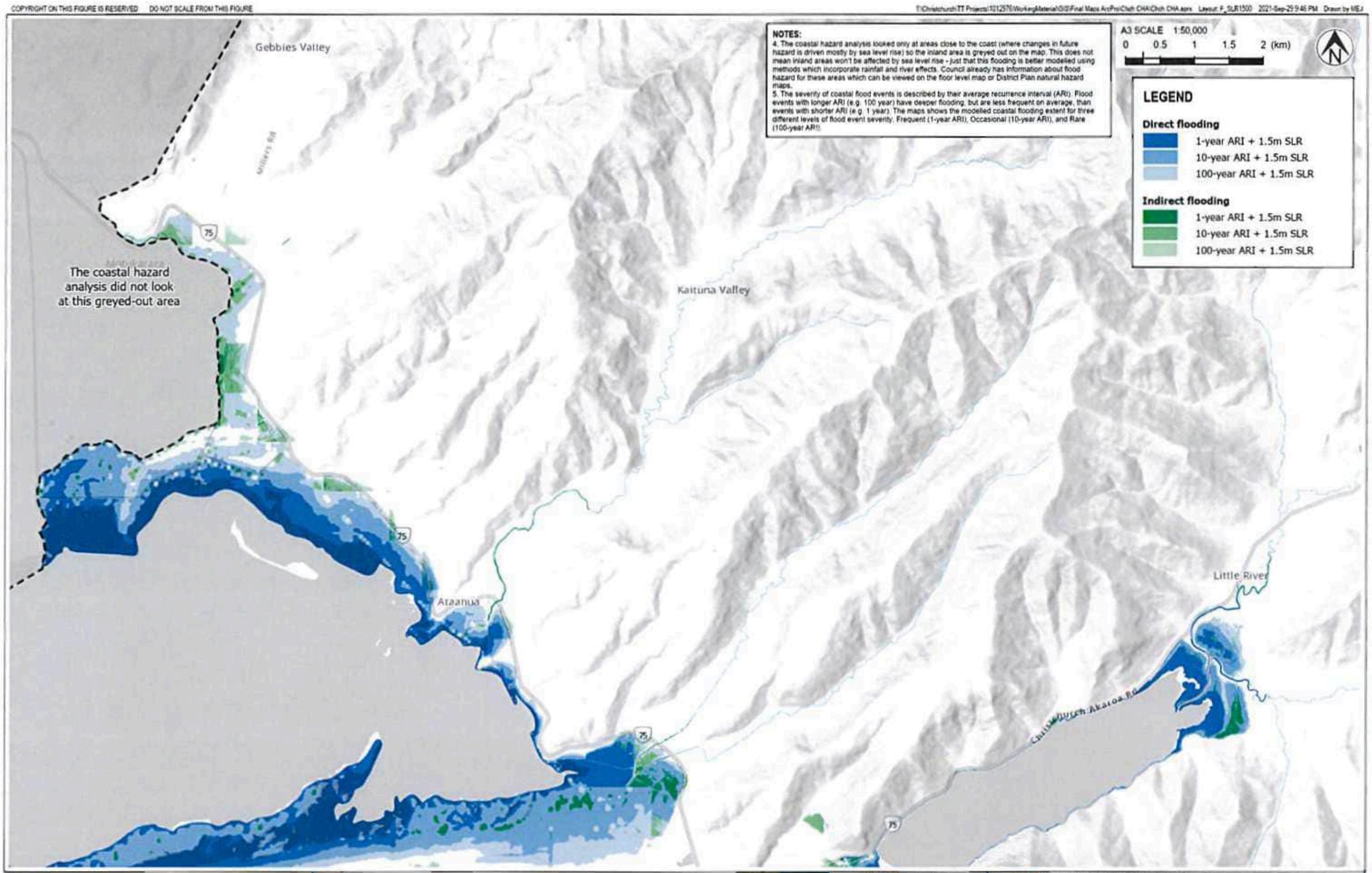
| APPROVED: P. COCHRANE | DATE: 29/09/21 | |

CLIENT: CHRISTCHURCH CITY COUNCIL
PROJECT: COASTAL HAZARD ASSESSMENT
TITLE: COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE
SCALE (A3): 1:50,000 FIG No. FIGURE 15C REV 1

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| CHECKED | PPK | SEP.21 |
| APPROVED | P. COCHRANE | 29/09/21 |

CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 15D REV 1

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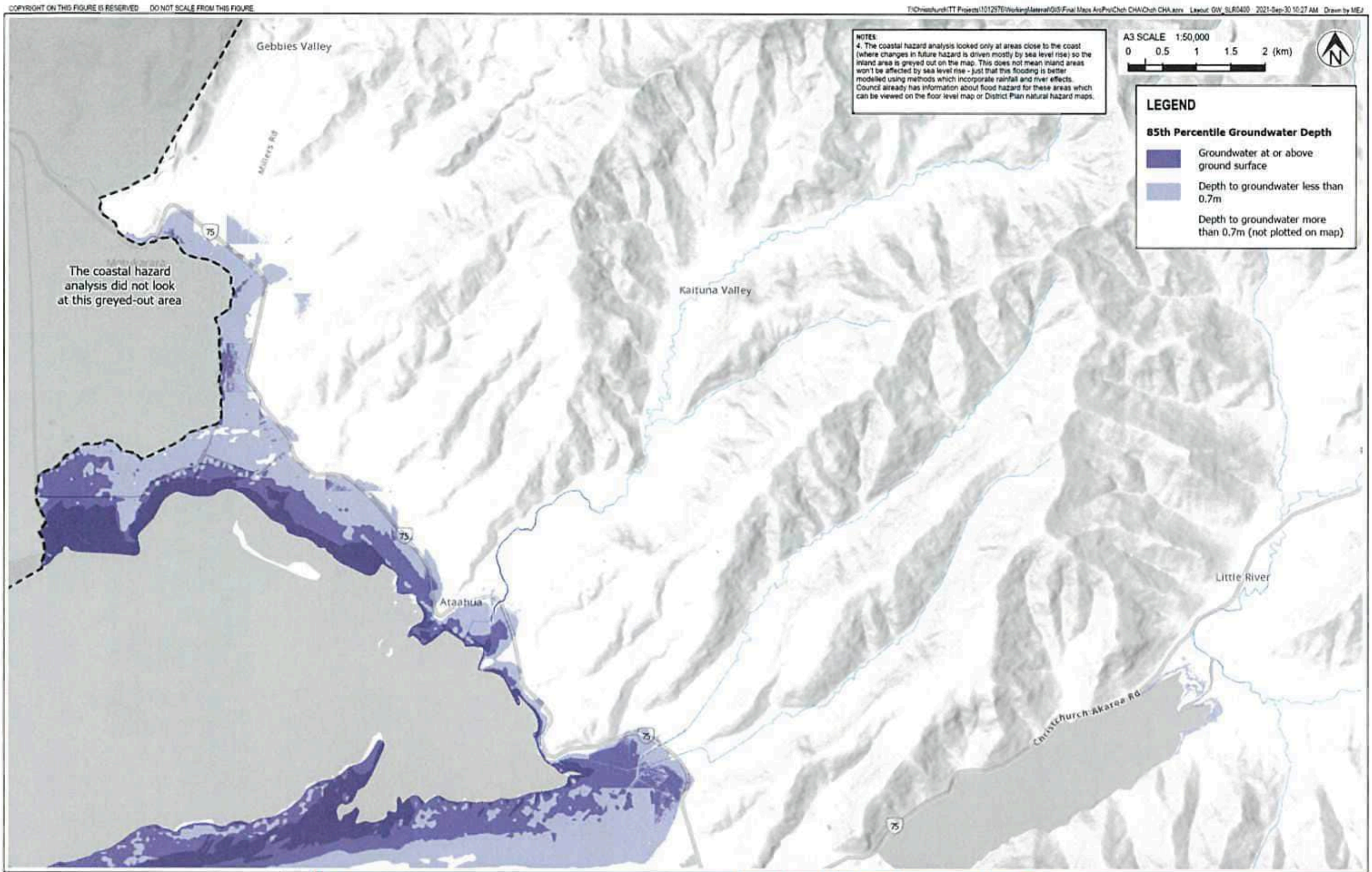


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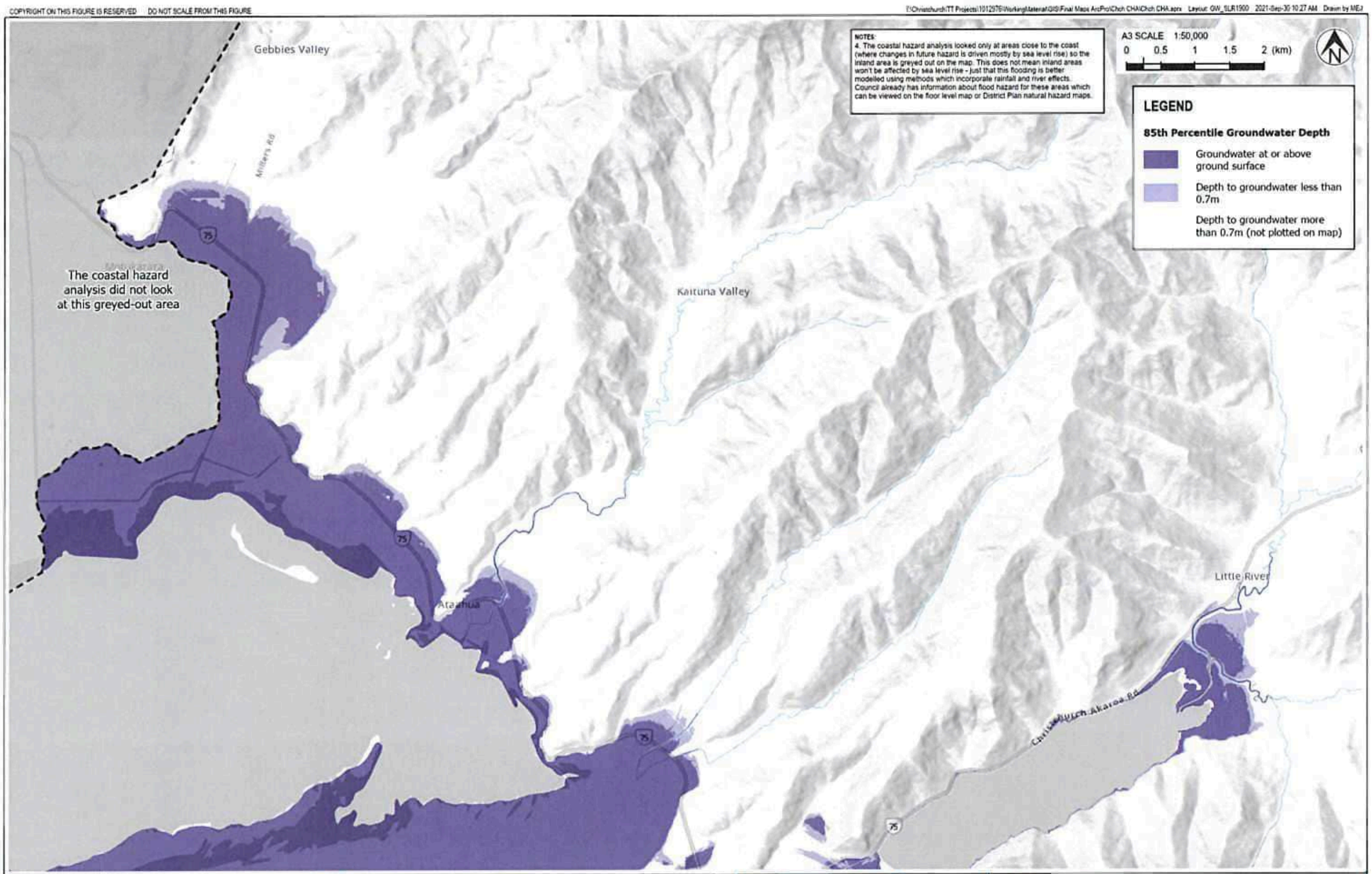
CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL GROUNDWATER ANALYSIS SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 15E REV 1

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CLIENT CHRISTCHURCH CITY COUNCIL

PROJECT COASTAL HAZARD ASSESSMENT

TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 15F REV 1

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**NOTES:**

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CLIENT **CHRISTCHURCH CITY COUNCIL**

PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000  FIG No. FIGURE 16A  REV 1

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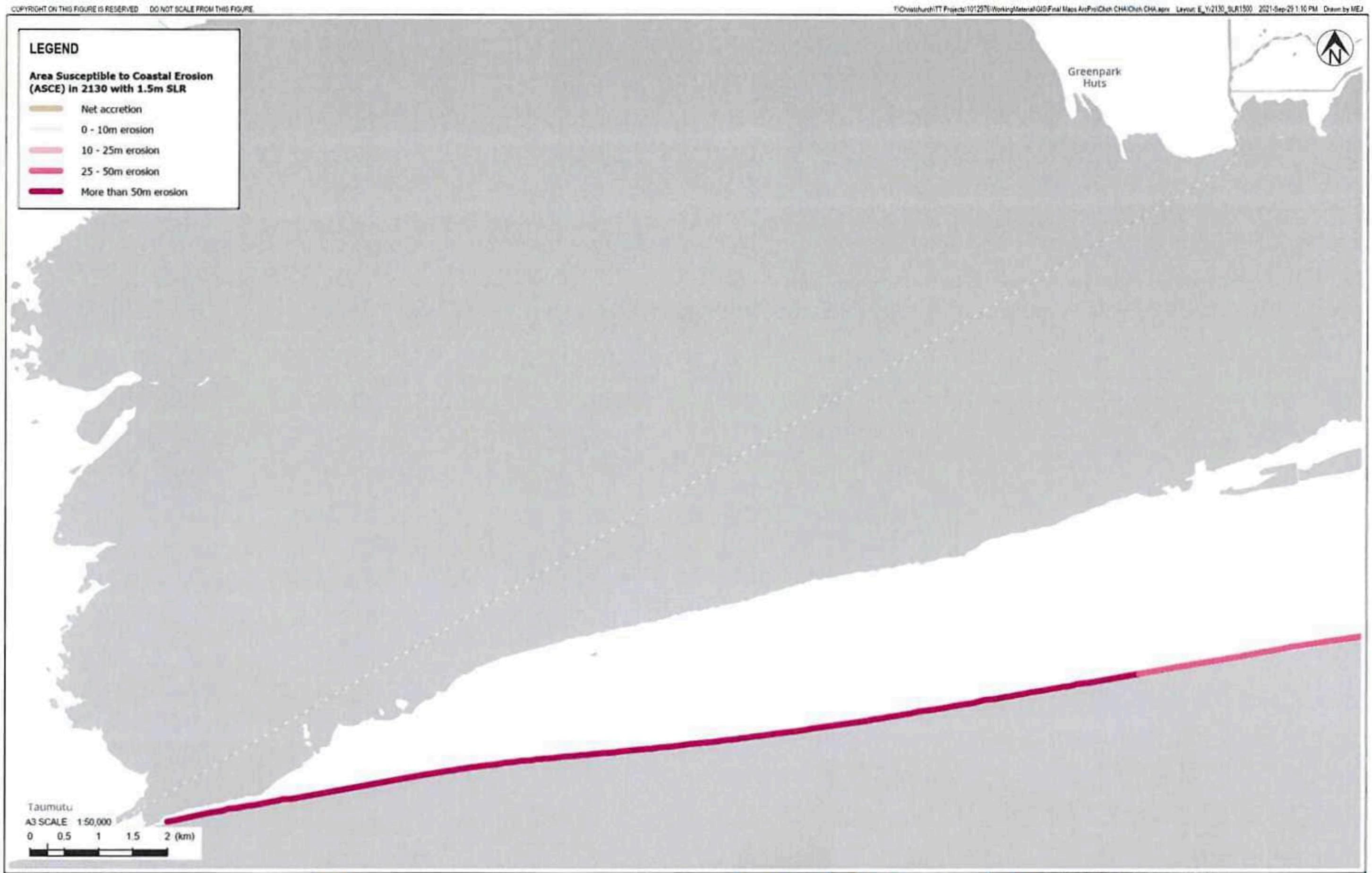


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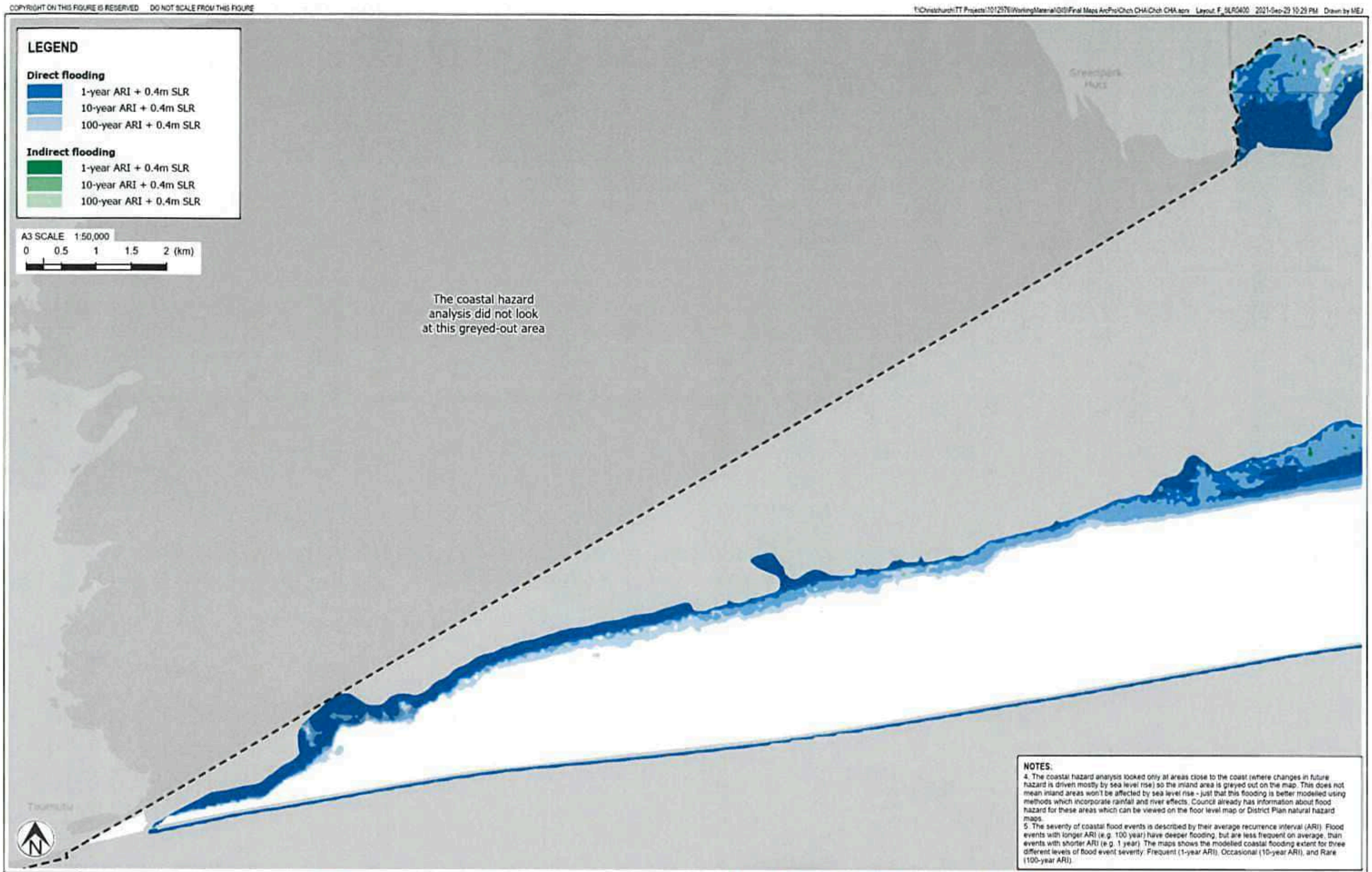
PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL EROSION ANALYSIS
SCENARIO: YEAR 2130 WITH 1.5M SEA LEVEL RISE

SCALE (A3) 1:50,000   FIG No. FIGURE 16B   REV 1




NOTES:
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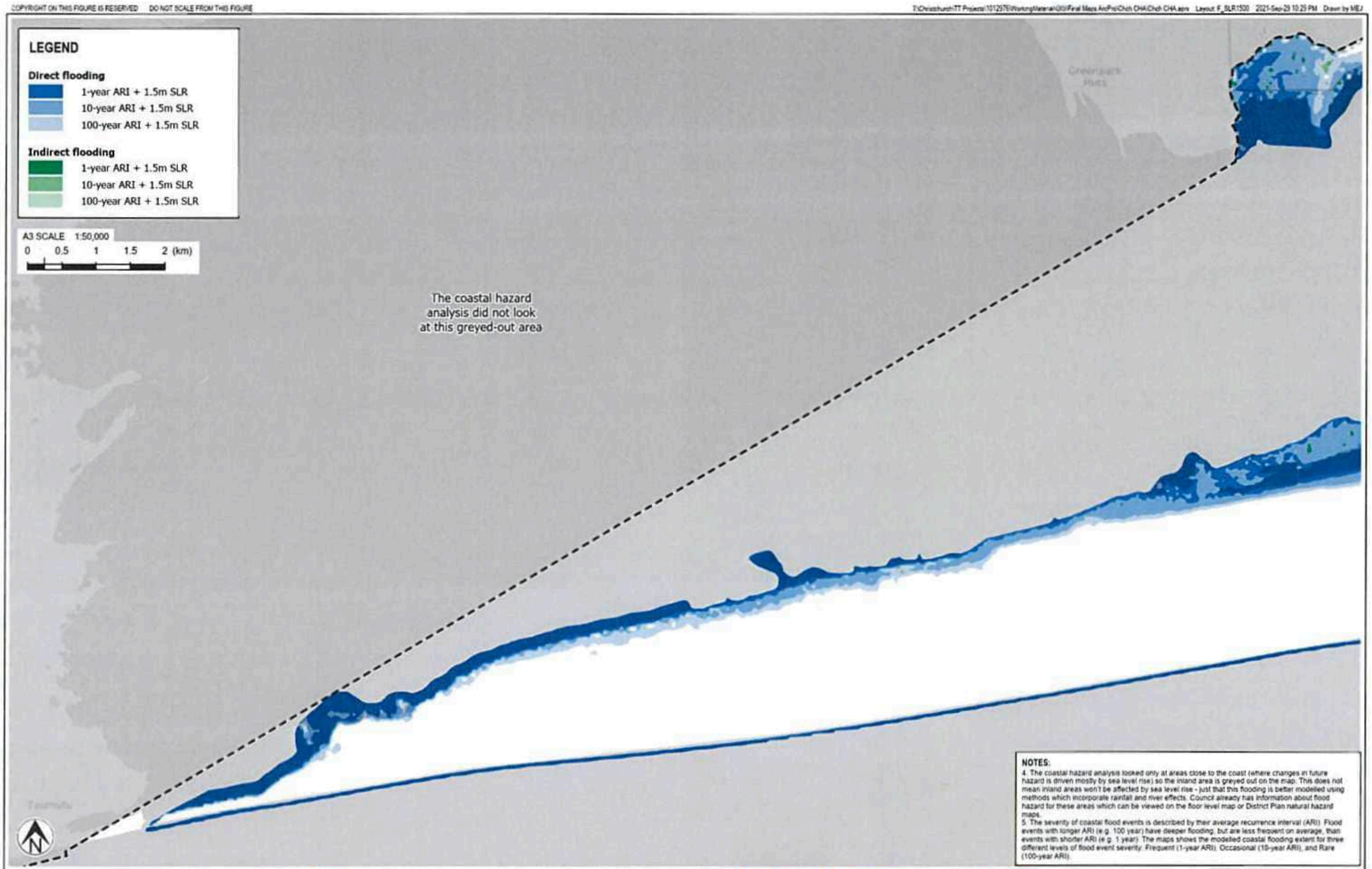
| APPROVED | P COCHRANE | 29/09/21 |

CLIENT CHRISTCHURCH CITY COUNCIL
PROJECT COASTAL HAZARD ASSESSMENT
TITLE COASTAL FLOODING ANALYSIS
SCENARIO: 0.4M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 16C REV 1

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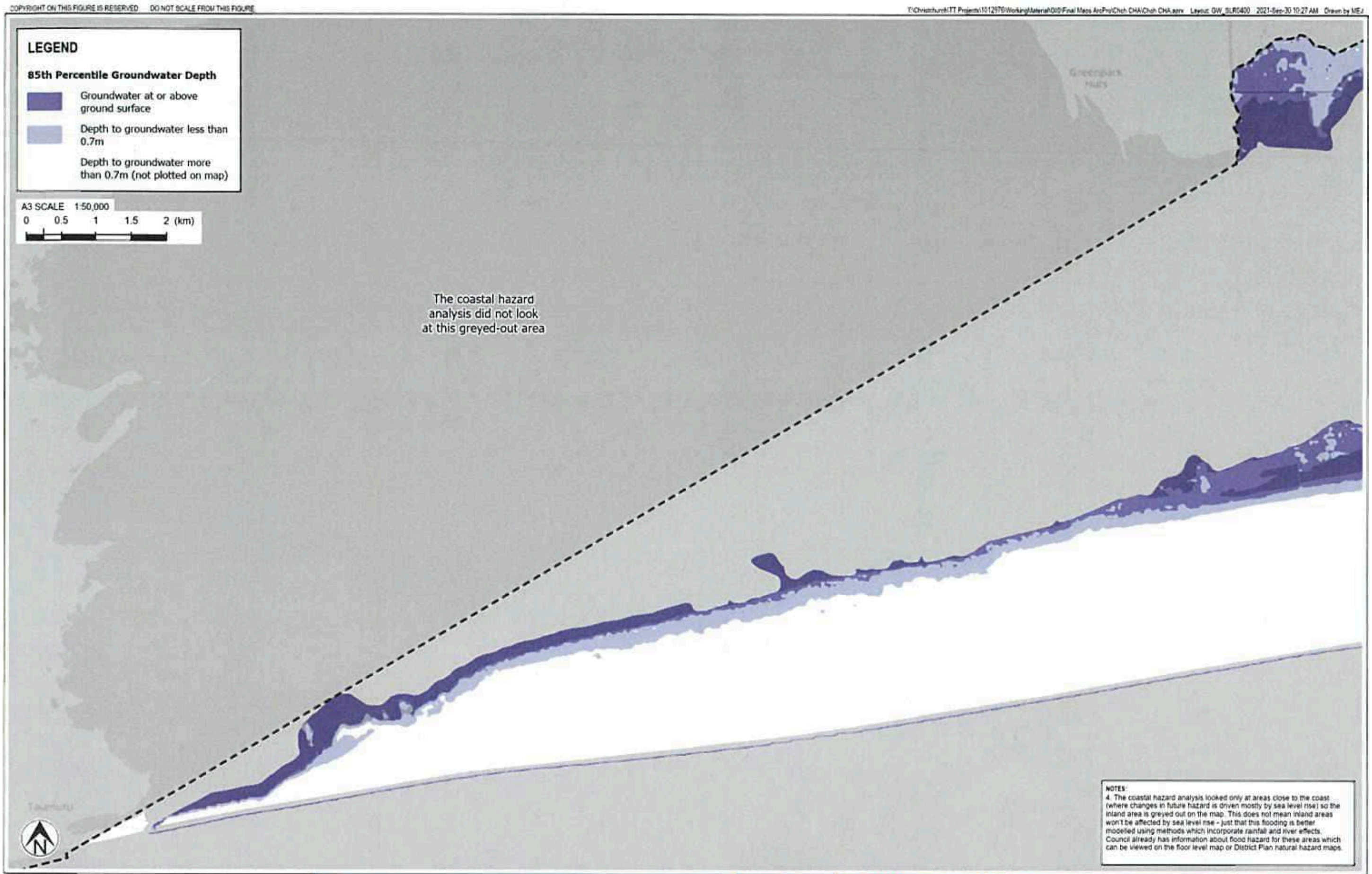
CLIENT: CHRISTCHURCH CITY COUNCIL
PROJECT: COASTAL HAZARD ASSESSMENT
TITLE: COASTAL FLOODING ANALYSIS
SCENARIO: 1.5M SEA LEVEL RISE

SCALE (A3): 1:50,000    FIG No. FIGURE 16D    REV 1

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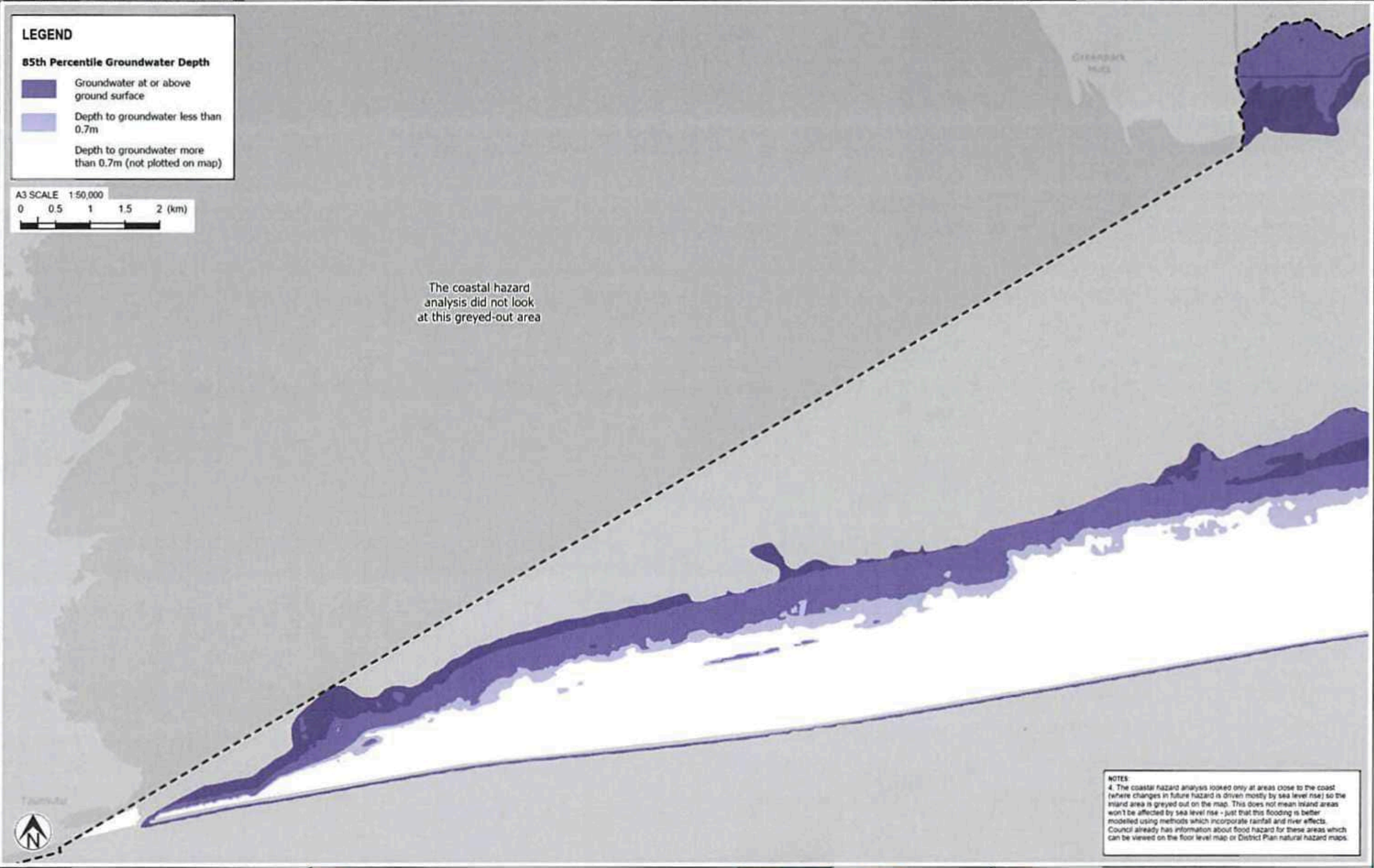
PROJECT **COASTAL HAZARD ASSESSMENT**

TITLE COASTAL GROUNDWATER ANALYSIS SCENARIO: 0.4M SEA LEVEL RISE

SCALE (A3) 1:50,000 FIG No. FIGURE 16E REV 1

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CLIENT **CHRISTCHURCH CITY COUNCIL**
PROJECT **COASTAL HAZARD ASSESSMENT**
TITLE COASTAL GROUNDWATER ANALYSIS
SCENARIO: 1.9M SEA LEVEL RISE
SCALE (A3) 1:50,000 FIG No. FIGURE 16F REV 1

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# Appendix 7

2021 Risk Based Coastal Hazard Analysis for Land-use Planning – Jacobs

# Coastal Hazards Plan Change - Analysis/Technical Advice

## Risk Based Coastal Hazard Analysis for Land-use Planning

IS391200-NP-RPT-0001 | Final

September 17, 2021

Christchurch City Council

# Coastal Hazards Plan Change - Analysis/Technical Advice

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|---|---|
| Project No: | IS391200 |
| Document Title: | Risk Based Coastal Hazard Analysis for Land-use Planning |
| Document No.: | IS391200-NP-RPT-0001 |
| Revision: | Final |
| Date: | September 17, 2021 |
| Client Name: | Christchurch City Council |
| Project Manager: | Ian Wiseman |
| Author: | D Todd, D Debski, J Jozaei, T Hegarty & E Scheffler |
| File Name: | IS391200-NP-RPT-0001 Risk Based Coastal Hazard Analysis - Final |

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## Document history and status

| Revision | Date | Description | Author | Reviewed | Approved |
|---|---|---|---|---|---|
| Draft A | 01/09/2021 | Draft for client comment | D Todd, D Debski, J Jozaei, T Hegarty, E Scheffler | R Hardy | I Wiseman |
| Final | 17/09/2021 | Final | D Todd, D Debski, J Jozaei, T Hegarty, E Scheffler | R Hardy | I Wiseman |
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## Contents

# Executive Summary

In July 2021, Christchurch City Council (CCC) commissioned Jacobs to conduct a risk-based coastal erosion and inundation hazard analysis for land-use planning. This sought to identify appropriate risk-based thresholds and scenarios for defining coastal hazard categories for use in land use planning.

New information on the coastal hazards was developed for CCC in the Coastal Hazard Assessment (CHA) by Tonkin and Taylor (Ltd). This data will inform public consultation about adaptation to coastal hazards. It is anticipated that a new Coastal Hazards Plan Change to the District Plan will be required to develop planning provision to address this new hazard information.

The objectives of our project were to:

a) Define a range of suitable hazard thresholds and applicable scenarios[1] to develop low, medium, and high hazard areas

b) Recommend a preferred approach to the categorising and mapping of hazards to inform the drafting of plan change provisions appropriate to the differing levels of risk.

A review of the approaches currently used in District and Regional Plans in New Zealand, non-statutory documents and consideration of international guidance was undertaken to inform the choice of risk thresholds and scenarios.

Thresholds were developed for the new erosion and inundation coastal hazard data which was in the form of bathtub modelling data for inundation and a range of methodologies for erosion along differing coastline types. A range of approaches to define areas of low, medium and high risk were developed and compared, from which a preferred approach was recommended.

To account for climate change and sea level rise (SLR) impacts on increasing hazard exposure, SLR scenarios of 0.6 m SLR by 2080 and 1.2 m SLR by 2130 were selected for both erosion and inundation hazards.

For inundation, the 1% annual exceedance probability - a reasonably foreseeable event and the smallest probability available in the T+T data – and the 1.2m SLR scenario were selected to define the overall extent of inundation hazards. This scenario ensures intergenerational needs, and a precautionary approach are applied to the planning framework.

Thresholds are based on the water depth for the 1% annual exceedance probability with 1.2m SLR and were developed by considering the hazard to people who need to access, egress, or use the buildings during a flood.

The depth threshold values were informed by published guidelines and used to define four coastal flood risk categories – high/medium/low/very low – which allow for a consideration of the change in the flood depth between the higher confidence SLR scenario (0.6m) and the lower confidence, further into the future (1.2m) scenario. The recommended flood risk categories are presented in Table 1.1.

Table 1.1: Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 1% annual exceedance probability)

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Very low | None (dry) | Low (d < 0.5m) |
| Low | Low (d < 0.5m) | Medium (0.5m < d < 1.1m) |

[1] "Scenario" refers to a combination of a future time period and climate change scenario (RCP) which together determine a projected rise in mean sea level (SLR) and consequent increase in hazard.

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Medium | Medium (0.5m < d < 1.1m) | High (d > 1.1m) |
| High | High (d > 1.1m) | High (d > 1.7m) |

For Erosion, based on the assumption that the permanent loss of land due to erosion is always high, likelihood was selected as the key determinant of erosion thresholds, being the statistical probability that a certain erosion distance will occur within a given timeframe.

Several thresholds across different SLR timeframe were tested to assess whether they can meet the requirements under the RMA of defining reasonable foreseeable hazards, and that the resulting hazard zones meet the needs of future generations. The analysis also took into account the various assessment methods applied by T+T in different areas of the District. The recommended combination of thresholds and scenarios are:

1) For the Christchurch City urban area open coast - two erosion zones compromising of:
    a) A High Hazard Coastal Erosion Zone covering the whole current beach-dune width, and
    b) Where required, A Low Hazard Coastal Erosion Zone to a lowland limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 and an additional area required for “future healthy beach factors”.
2) For the Avon-Heathcote Estuary; two erosion zones comprising of:
    a) A High-Medium Hazard Coastal Erosion Zone to a landward limit defined by the 66% probability erosion distance with 0.6 m SLR by 2080, with consideration of a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell under this scenario/threshold option, and
    b) A Low Hazard Coastal Erosion Zone to a landward limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 with consideration of a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell under this scenario/threshold option
3) For the beaches and bays of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour - a single Banks Peninsula Bays Coastal Erosion Hazard Zone, with the landward limit defined for:
    a) Probabilistic assessment cells, as the 10% probability of erosion distance for 1.2 m SLR by 2130, and
    b) Deterministic assessment cells, the limit of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.
4) For the coastal cliffs of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour - a single Banks Peninsula Cliff Erosion Zone of 20-30 m width as defined by the generic T+T cliff erosion setback.
5) For assessment cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where there are land reclamation and substantial hard protection structures - a single High Hazard Coastal Erosion Zone hazard zone with a generic width in the order of 20 m.

Maps have been created showing the hazard zones relating to the recommended inundation and erosion risk categories. These have been provided to CCC as a spatial layer. Maps of all the other options considered are provided in a spatial viewer accessible to the project team. It is recommended that CCC discuss proposed plan provisions and methods further with the authors to identify whether they are broadly consistent with the reasoning behind the definition of thresholds and choice of scenarios.

## Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to develop a risk-based approach to analysing coastal hazards to be used in land-use planning in accordance with the scope of services set out in the contract between Jacobs and Christchurch City Council ('the Client'). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full, and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

The coastal hazard data and information analysed in this assessment was developed by Tonkin and Taylor Ltd for Christchurch City Council and this information has been used as provided with no review of the accuracy of that information or its method of development.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Table 1.2: List of Acronyms and Abbreviations used in this report

| Acronyms and Abbreviations | Details |
|---|---|
| AEP | Annual Exceedance Probability |
| AR6 | Six Assessment Report |
| ASCE | future Areas Susceptible to Coastal Erosion |
| CCC | Christchurch City Council |
| CHPC | Coastal Hazards Plan Change |
| DEFRA | Department of Environment, Food and Rural Affair |
| DEM | Digital elevation Model |
| IPCC | Intergovernmental Panel on Climate Change |
| LiDAR | Light Detection And Ranging |
| LINZ | Land Information New Zealand |
| LVD (LTN37) | Local Vertical Datum (Lyttelton datum 1937) |
| MfE | Ministry for the Environment |
| NZCPS | New Zealand Coastal Policy Statement |
| NZVD2016 | New Zealand Vertical Datum 2016 |
| RCEP | Regional Coastal Environment Plan for the Canterbury Region |
| RCP | Representative Concentrations Pathways |
| RMA | Resource Management Act |
| RPS | Regional Policy Statement |
| SLR | Sea Level Rise |
| SSP | Shared Socio-economic Pathways |
| T+T | Tonkin & Taylor Ltd |

# 1. Introduction

## 1.1 Background

CCC are proposing to undertake a plan change to update Coastal Hazards aspects of the Christchurch District Plan. To inform consultation on adaptation to coastal hazards and a future Coastal Hazards Plan Change (CHPC) Tonkin and Taylor (Ltd) (T+T) generated updated coastal hazard assessment data and have provided this to CCC.

CCC propose to use a risk-based approach under which land use, development and subdivision in coastal areas of the district are managed according to the level of risk of coastal inundation and erosion. Under this approach there will be more restrictive controls in high hazard areas, while activities in low and medium hazard areas would be managed according to the level of risk and sensitivity of the activity to the risk.

Under a risk-based approach, there is a need to define appropriate sea level rise (SLR) scenarios and boundary thresholds between hazard levels or categories of risk for areas exposed to coastal inundation and erosion. CCC have commissioned Jacobs to investigate and recommend justifiable and appropriate scenarios and thresholds for defining the coastal hazard categories for land use planning over the whole of the Christchurch District (i.e. both the city urban area and Banks Peninsula).

The purpose of this report is to present the analysis undertaken to justify the recommended thresholds for the hazard categories and to present the spatial extent of the resulting hazard zones for both coastal inundation and erosion. It is understood that this analysis and recommendations will be used in Issues and Options consultation with communities and stakeholders on the CHPC in conjunction with consultation on the Coastal Hazards Adaptation Planning Programme also being undertaken by CCC.

The data provided by CCC to undertake this analysis is from the recent Coastal Hazard Assessment prepared by T+T, which is summarised in Section 3 of this report. It is recognised that the primary purpose of the T+T assessment was to inform the Coastal Hazards Adaptation Planning Programme, however, as explained in the Technical Reporting for the assessment "The results of the assessment could also inform a range of other purposes including review of the coastal hazards provisions in the Christchurch District Plan, provided the uncertainties and limitations are understood and appropriately managed".

## 1.2 Framing of Key Terms used in this Report

The scope of our work was to identify a range of high, medium, and low hazard exposure categories for coastal erosion and inundation hazards. Hazard category levels indicate the level at which a hazard factor, could adversely impact different phenomena, such as people's lives, properties and infrastructure, or cause harmful consequences to them. Hazard thresholds adopted in this study, refer to the boundaries between different hazard categories, where a hazard changes its consequence category level, for example, from medium to high.

Then, hazard exposure categories aimed to be applied to a range of "scenarios". These scenarios would then be mapped to show the spatial extent of the three hazard exposure category areas.

The application of hazard and risk terms in the literature has always been challenging and these terms have often been used interchangeably. It is therefore important to frame these key terms in this report to avoid further confusion.

We adopted the framing of hazard and risks concepts that is consistent with MfE 2017[2] and 2020[3] and more broadly, with Intergovernmental Panel on Climate Change (IPCC) discourse. This framing acknowledges a conceptual difference between hazard and risk where risk is the outcome of interactions between hazards, exposure, and vulnerability (Figure 1.1).

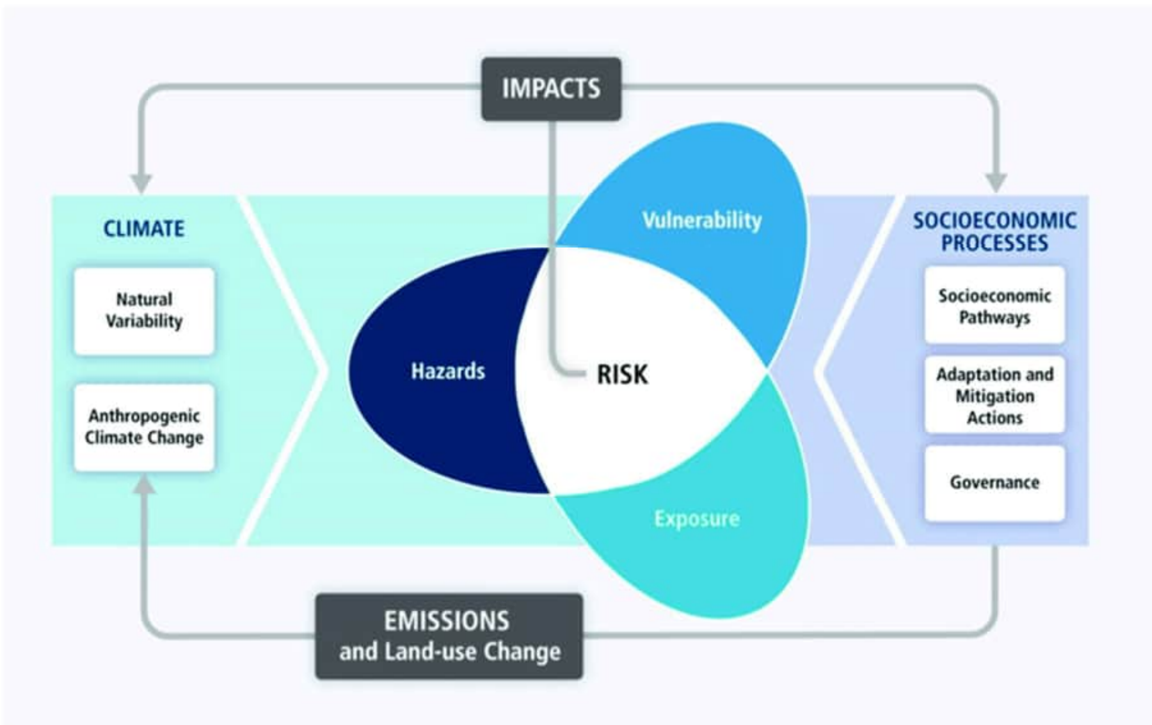


Figure 1.1: Interaction between hazard, exposure and vulnerability create risk (Source: IPCC, 2014) reproduced in (MfE 2020)

Hazard refers to the severity and magnitude of a natural or human or climate change induced driver or trend that causes harmful impacts (consequences) on natural, built environment, or social systems (MfE 2020). Accordingly, exposure is the lack of systems (i.e., property, infrastructure, human) protection against adversity (adverse hazard factors) in a hazard prone area, that could cause negative impacts.

In this report hazard addresses the physical extent at which erosion or inundation may interact with the land in the future. Therefore, for erosion it is the range of potential future coastline positions which could occur with differing amounts of future erosion. For inundation the hazard is the area potentially susceptible to inundation by water arising from coastal flooding. These hazard areas have been developed for CCC and this report by T+T.

Risk as noted above is typically considered as the interaction between the hazard, exposure of things to that hazard and the vulnerability of the things that are exposed. In this report we are identifying risk “thresholds” to apply broadly across the whole of the city and Banks Peninsula for District Planning purposes to control current and future land-use change and development. As such we are not seeking to consider the specific exposure/vulnerability of current activities to the hazard. For future activities that consideration will be addressed within the planning zoning, plan provisions and future consenting decisions on specific activities. We are however using existing risk categorisation guidelines that consider exposure and vulnerability when

[2] Ministry for the Environment. (2017) *Coastal Hazards and Climate Change: Guidance for Local Government*, ME1341, December 2017.
[3] Ministry for the Environment. 2020. *National Climate Change Risk Assessment for Aotearoa New Zealand: Main report – Arotakenga Tūraru mō te Huringa Āhuarangi o Āotearoa: Pūrongo whakatōpū*. Wellington: Ministry for the Environment.

developing our thresholds. As an example, international risk categories for flooding depth that are based on the vulnerability of specific age groups are used to underpin our recommendations

A "Threshold" was conceptually to be used in this work as a method of categorising between areas of differing level of risk. This was the method by which some characteristic of the hazard was to be used to determine between high, medium and low risk. "Scenarios" were the range of SLR curves under various RCP emission scenarios, timeframes and event return periods that were considered most suitable for use for District Planning purposes.

These threshold and scenario definitions are easier to consider for inundation hazard risk. As the threshold can be, for instance, a water depth that defines high hazard. Then the scenario is a particular sea level rise at a given point in time applied to a given return period of flood event. For erosion hazards this same distinction between threshold and scenario was not able to be made as the various factors being considered (sea level rise via RCP emission pathway, probability of erosion occurring and timeframe) have to be combined together into one combined risk threshold/scenario. This is further explained in Section 5.

The outcome of this report is therefore the identification and mapping of areas of high, medium, and low risk which we generally refer to as risk "Categories". A glossary of terms is provided in Appendix D.

## 1.3 Methods

To undertake this analysis of suitable risk based approaches to coastal hazard management for land use planning we had the following approach to the study:

- We assembled a team including coastal science, flood modelling, RMA planning, coastal adaptation and GIS data management skills to all provide input into the options.
- We started with a review of existing approaches to coastal erosion and inundation hazard management within New Zealand District and Regional Plans, guidance documents and also made reference to selected international literature. This information set the scene for our consideration for what may be suitable approaches.
- The new council coastal hazard data was provided by T+T and we developed a web viewer for the project to view this data plus the existing mapped extents of hazards from the existing RPS, District Plan and other flood modelling. This viewer was then used to view and consider our mapped threshold/scenario options. The T+T data was reviewed to consider its suitability for setting different types of thresholds.
- A set of thresholds were developed for inundation and erosion hazards. These were originally intended to be high, medium and low categories but have been modified to better suit the available data and environments. These thresholds were workshopped with CCC.
- Following the workshop, scenarios were developed in which these thresholds would apply, these were generally expected to be chosen ranges of SLR based on RCP emissions pathways and could also include timelines and event magnitudes. In delivery we blended the thresholds and scenarios together to get a better outcome. The identified thresholds and scenarios were mapped to allow an understanding to be made of the spatial extent of each risk category (high, medium and low) and allow comparison of the outcome between the various scenarios. This was used to determine the preferred thresholds and scenarios in a second workshop with CCC.
- Comparison of these thresholds/scenarios was also made to current hazard mapping and using alternative data sets to generate the hazard category maps.

The above work has then been written up in this report with the additional deliverable being a spatial layer of the maps of the preferred threshold/scenario approach.

## 1.4 Report Structure

The report is presented in the following sections:

- Section 2 documents a high-level overview of our review of other relevant approaches to defining erosion and inundation risk
- Section 3 sets out the planning context of the project, which is important to develop approaches for identifying thresholds and scenarios
- Section 4 discusses the T+T coastal hazard data provided t Jacobs and the processing methodology undertaken by Jacobs to be able to use this data to analyse and map potential thresholds as boundaries to hazard categories
- Section 5 presents a selection of the most appropriate SLR scenarios for use defining the hazard categories,
- Sections 6 presents the results of the analysis to define the thresholds for a risk-based approach to coastal inundation hazard planning
- Sections 7 presents the results of the analysis to define the thresholds for a risk-based approach to coastal erosion hazard planning
- Section 8 provide a brief conclusion and summary of the recommended scenarios- thresholds-categories for use in consultation with communities and stakeholders on the CHPC.

# 2. New Zealand and International Review of Risk Categorisation Approaches

A review was undertaken of the current range of approaches to assessing and categorising the risk of coastal erosion and inundation hazards within relevant New Zealand local government plans (e.g., District and Regional Plans), relevant New Zealand guidance (e.g., central government guidance and legislation) plus reference was also made to risk classification approaches from selected international hazard management documents. This section provides a high-level summary of the outcome of that review, the detail of the review is provided in Appendix B.

The findings suggest a variety of parameters for categorising hazards[4] and defining associated thresholds in New Zealand and internationally. For flooding and coastal inundation, velocity, depth and likelihood (in form of Annual Exceedance Probability (AEP[5])), were the most frequent parameters.[6]

By way of example, Waikato Regional Council (WRC) used depth as the only parameters for categorising flood hazard within the Waikato River zone (Figure A.3). However, WRC adopted a combination of depth and velocity for the hazard outside the River zone (Figure A.4). By comparison, Waimakariri District Council applied likelihood and depth for categorizing inundation hazard levels. According to these categories, for 0.5% (1 in 200) AEP flooding events, flood depth lower that 0.3 metre (m) is associated with low flood hazard, depth between 0.3 to 1m is associated with medium flood hazard, and more than 1m flood depth was associated with high hazard area. The Christchurch District Plan adopted Canterbury Regional Policy Statement (RPS) recommendations and selected a combination of flood likelihood, velocity and depth to define hazard categories and thresholds. The Plan defined a high flood hazard management area if the depth(m) x velocity(m/s) in a 0.2% (1 in 500) AEP flood is equal or greater than one.

From an international perspective, the Australian Disaster Resilience Handbook Collection 2017,[7] adopted a six-flood hazard vulnerability classification by combining flood depth and velocity (see Table A.1 in Appendix A for more information). DEFRA[8] developed a hazard matrix that accounts for a combination of velocity and depth in categorising flood hazard for people and buildings.

Compared with flood hazard, less information was found on categorizing erosion hazard. However, several documents address likelihood and consequence as useful parameters for categorising erosion hazard. For example, Auckland Unitary Plan adopted likelihood, magnitude and consequence as parameters to define erosion hazard categories. Canterbury Regional Policy Statement (RPS) address likelihood as the best representative of erosion hazard.

Table A.1, Appendix A summarises the findings of the literature review on available methodologies for categorising the hazards and associated thresholds. This review was used to underpin the approach developed within this document by seeking to understand the available relevant and recent approaches to risk categorisation and especially the approaches that are already being used within district or regional planning in New Zealand.

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[4] Some documents adopted hazard synonymously with risk, therefore, they used hazard and risk categories interchangeably

[5] The probability that an event will be exceeded in any one year. So, a 1 % AEP event, has 1% probability of being exceeded in any year.

[6] Some documents also included vulnerability and sensitivity as parameters in categorising hazard/risk. However, according to our framing, incorporation sensitivity and vulnerability require accounting for social, cultural and economic values, which fall beyond hazard assessment/categorisation process.

[7] Australian Government (2017) Supporting document for the implementation of Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (AIDR 2017), The Technical flood risk management guideline: Flood hazard Australian Disaster Resilience Handbook Collection 2017

[8] Framework and Guidance for Assessing and Managing Flood Risk for New Development, UK Defra/Environment Agency Flood and Coastal Defence R&D Programme FD2320/TR22

# 3. The New Zealand Planning Context

This assessment will provide information to inform consultation regarding the proposed CHPC to the Christchurch District Plan and is likely to inform any future plan change. As such, it is important to understand the statutory planning framework and its relevant to hazard assessment. The planning framework provides guidance on the relative importance of addressing hazard impacts, the types of hazard risks/effects that should be considered, and the timeframe for projections. Decisions made under the resource management and planning framework establish a baseline for future outcomes.

This section provides a high-level summary of relevant planning documents and related policies however, it does not provide a determination as to either preferred responses or the level of assessment commensurate with that undertake for a Section 32 assessment.

## 3.1 The Resource Management Act 1991

The current NZ planning framework has been established under the Resource Management Act 1991 (RMA). The RMA provides the overarching legislation for sustainable management at the national, regional and district/city levels and provides scope, content and outcomes sought in planning documents. A review of the NZ resource management system is currently underway, and an overhaul of the planning framework is proposed. For now, the RMA remains the relevant legislation under which this study has been undertaken.[9]

Part 2 of the RMA details its purpose and principles, with the principles following a hierarchy beneath the purpose (i.e. sections 5 – 8). Part 2 sets out with the purpose of the RMA:

> *(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
>
> *(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while –*
>
> *(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
>
> *(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

As can be seen from above, the purpose of the RMA is focused on the sustainable management of resources, as opposed to "sustainable development" which is more widely used internationally.[10] A key aspect of sustainable management is ensuring that community wellbeing is delivered in a manner which protects their health and safety. This is also linked to providing the reasonably foreseeable needs of future generations.

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[9] The NZ Government is currently in the process of replacing the RMA with three new Acts:
- Natural and Built Environments Act (NBA) to provide for land use and environmental regulation (this would be the primary replacement for the RMA).
- Strategic Planning Act (SPA) to integrate with other legislation relevant to development, and require long-term regional spatial strategies; and
- Climate Change Adaptation Act (CAA) to address complex issues associated with managed retreat and funding and financing adaptation.

[10] The key difference between 'sustainable development' and 'sustainable management' is that the latter removes the presumption that a portion of the environment (e.g. land) can be modified/used by humans as of right.

Also, Section 5 of part 2 indicates the ability of councils to take action to protect communities against hazards (i.e., protect their health and safety). When determining the risks of these hazards, councils should consider those hazards which are reasonably foreseeable. This wording implies that extreme or unlikely hazard scenarios should not be employed in the decision making under the RMA. Rather the application of SLR scenarios and hazard thresholds (e.g. frequency for flooding, probability of occurrence in timeframe for erosion) should be based on certainty and likelihood, the more certain or likely of which should then be employed to develop the content of a future plan change and/or other responses.

Section 4 of this report has detailed how "reasonably foreseeable" has been employed when considering the health and safety risks associated with coastal hazards.

Part 2 then proceeds to the "matters of national importance":

*In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:*

> *(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:*
>
> *(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:*
>
> *(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
>
> *(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:*
>
> *(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:*
>
> *(f) the protection of historic heritage from inappropriate subdivision, use, and development:*
>
> *(g) the protection of protected customary rights:*
>
> *(h) the management of significant risks from natural hazards.*

Section 6(h) gives direction to both recognise and provide for the management of significant risks from natural hazards. Furthermore, while section 6(h) does not restrict either the type or timeframes associated with natural hazard, it identifies that councils have a duty, at a minimum, to management risks that are significant. However, section 6(h) does not prevent councils from considering other risks (i.e. risks less than significant in scale or risks associated with other types of hazards). Significant risks are not defined within the RMA but are left to non-statutory guidance documents and planning authorities to define and determine (such as National Climate Change Risk Assessment for New Zealand 2020). Significant risk has not been specifically defined in this report however the determination of hazard categories based on thresholds and scenarios determines where the risk is significant and where it may choose to be managed by future Plan provisions.

Section 7 of the RMA details "other matters":

*In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to—*

*(a) kaitiakitanga:*

*(aa) the ethic of stewardship:*

*(b) the efficient use and development of natural and physical resources:*

*(ba) the efficiency of the end use of energy:*

*(c) the maintenance and enhancement of amenity values:*

*(d) intrinsic values of ecosystems:*

*(e)[Repealed]*

*(f) maintenance and enhancement of the quality of the environment:*

*(g) any finite characteristics of natural and physical resources:*

*(h) the protection of the habitat of trout and salmon:*

*(i) the effects of climate change:*

*(j) the benefits to be derived from the use and development of renewable energy*.

Section 7(i) provides useful guidance to councils, in that it directs them to have particular regard to the effects of climate change. Again, these effects are themselves undefined in the RMA and it is left to planning instruments (e.g. the NZCPS,[11] RPS's[12]) to determine the types and timeframes of such effects. This is discussed in further detail in Section 2.3. This provides further justification to the purpose of this analysis of appropriate scenarios and thresholds for use in risk based coastal hazard planning, bearing in mind that the "effects" should be driven in part by both whether these effects are reasonably foreseeable (RMA section 5) and that the risks are significant (RMA section 6(h)).

The last section (section 8) of RMA Part 2 relates to linking RMA decision-making to the Treaty of Waitangi. In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

Section 8 highlights the importance of engagement with local iwi to ensure that the full quantum of risk and effects of coastal hazards is complied. This is particularly important given the intrinsic nature of many cultural values which may not be clearly apparent when undertaking hazard assessments in a purely technical manner. It should be noted that this analysis of coastal hazard scenarios/thresholds for a risk based approach to land use planning has not considered effects on cultural values, both physical and intrinsic. Rather, we recommend that the consideration of such effects should be undertaken in direct consultation with the potentially affected hapu and other relevant mana whenua entities.

## 3.2 Plan Changes

Given this analysis relates to a potential change to the Christchurch District Plan, it is useful to consider the purpose of a district plan. Under section 31 of RMA details the functions of territorial authorities (like CCC):

[11] New Zealand Coastal Policy Statement, 2010
[12] Regional Policy Statements

*(1) Every territorial authority shall have the following functions for the purpose of giving effect to this Act in its district:*

*(a) the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the effects of the use, development, or protection of land and associated natural and physical resources of the district:*

*(aa) the establishment, implementation, and review of objectives, policies, and methods to ensure that there is sufficient development capacity in respect of housing and business land to meet the expected demands of the district:*

*(b) the control of any actual or potential effects of the use, development, or protection of land, including for the purpose of—*

*(i) the avoidance or mitigation of natural hazards; and*

*(ii) [Repealed]*

*(iia) the prevention or mitigation of any adverse effects of the development, subdivision, or use of contaminated land:*

*(iii) the maintenance of indigenous biological diversity:*

*(c) [Repealed]*

*(d) the control of the emission of noise and the mitigation of the effects of noise:*

*(e) the control of any actual or potential effects of activities in relation to the surface of water in rivers and lakes:*

*(f) any other functions specified in this Act.*

*(2) The methods used to carry out any functions under subsection (1) may include the control of subdivision.*

The above clauses demonstrate why the district plan will address coastal hazards, both through avoidance and mitigation. It also indicates a clear accountability of councils to restrict subdivision in those areas affected by natural hazards.

The assessment process for new district plans and plan changes is detailed in section 32 of the RMA, which requires an evaluation of the extent to which the objectives of the proposal are the most appropriate way to achieve the purpose of the Act (section 32(1)(a)). A plan change will contain the following:

- A description of the environmental issue(s) which are being addressed
- The proposed/altered objectives and policies (i.e. that will be incorporated into the district plan and relate to the outcomes sought)
- Details of the methods that will be employed to achieve the objectives and policies (these may include methods outside of the district plan/RMA)
- Any rules, standards and assessment criteria which will be incorporated into the district plan.

This analysis of potential coastal hazard scenarios and thresholds for a risk-based approach will directly input into consultation for the potential CHPC and its various components and may then be used to support the actual plan change. It is therefore relevant to understand what must be included in plan change reports (known as section 32 reports).

Section 32 of the RMA is broken down into several sub-sections, starting with section 32(1):

*(1) An evaluation report required under this Act must—*

> *(a) examine the extent to which the objectives of the proposal being evaluated are the most appropriate way to achieve the purpose of this Act; and*
>
> *(b) examine whether the provisions in the proposal are the most appropriate way to achieve the objectives by—*
>
> > *(i) identifying other reasonably practicable options for achieving the objectives; and*
> >
> > *(ii) assessing the efficiency and effectiveness of the provisions in achieving the objectives; and*
> >
> > *(iii) summarising the reasons for deciding on the provisions; and*
>
> *(c) contain a level of detail that corresponds to the scale and significance of the environmental, economic, social, and cultural effects that are anticipated from the implementation of the proposal.*

Section 32(1)(a) provides guidance as to the overall purpose of an evaluation report (section 32 report). It provides a clear link back to section 5 (the purpose of the RMA) by requiring any proposed objectives to be the most appropriate way to achieve the RMA's purpose.

Section 32(1)(b) then sets out how a plan change's provisions (i.e. policies, rules, standards and other methods) are the most appropriate way to achieve a plan change's stated objectives. The "appropriateness" of these provisions is further broken and required them to be reasonably practicable and efficient. There must also be clear and articulate argument provided for how the provisions are both reasonably practicable and efficient. While this analysis will not recommend specific adaptation responses, it does provide the justification of how the hazard categories were defined, and therefore the basis for spatial differences in adaptation responses or planning provisions.

Lastly, section 32(1)(c) requires reporting to be commensurate with the scale of the significance of the effects which may occur from the adoption of a plan change's provisions. This requirement has been considered in the analysis presented in Sections 5 and 6 of this report to define the most appropriate boundaries of different hazard categories.

Section 32(2) provides additional guidance as to how the efficiency and effectiveness of a plan change's provisions should be assessed (i.e. section32(b)(ii)):

*An assessment under subsection (1)(b)(ii) must—*

> *(a)identify and assess the benefits and costs of the environmental, economic, social, and cultural effects that are anticipated from the implementation of the provisions, including the opportunities for*
>
> > *(i) economic growth that are anticipated to be provided or reduced; and*
> >
> > *(ii) employment that are anticipated to be provided or reduced; and*

*(b) if practicable, quantify the benefits and costs referred to in paragraph (a); a(c) assess the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the provisions.*

Section 32 (2) places significant weight on the economic effects of a plan change and, the effects on economic growth and employment. While the analysis presented in this report does not include an economic impact assessment, the following discussion is included here to ensure that such an assessment is included in the CHPC. While the effects on environmental, social and cultural wellbeing are not excluded, the risk assessment should consider the economic effects, for example loss of development rights that may arise from a proposed plan change. As such, the removal of development rights and restrictions of land use activities needs to be balanced against the potential effects arising from reasonably foreseeable and significant natural hazards.

Section 32(3) is also relevant, given that the analysis presented in this report will be employed to support a plan change:

*If the proposal (an amending proposal) will amend … plan, or change that is already proposed or that already exists (an existing proposal), the examination under subsection (1)(b) must relate to—*

*(a) the provisions and objectives of the amending proposal; and*

*(b) the objectives of the existing proposal to the extent that those objectives—*

*(i) are relevant to the objectives of the amending proposal; and*

*(ii)would remain if the amending proposal were to take effect.*

In essence, the existing District Plan acts as a baseline when considering whether the effects of coastal hazards has been adequately addressed. This would include consideration as to whether the current District Plan has previously identified and addressed the relevant hazards (and associated significant risks). The objectives, policies and standards of the District Plan have been considered, as detailed below, with regard to the currently policy and regulatory framework for coastal hazards in Canterbury.

## 3.3 Existing Planning Framework

As previously stated, this analysis considered various statutory planning documents and guidance which are relevant to hazard assessment (including coastal hazards). While a detailed review of these documents is required in developing any future section 32 report, it is useful to address the planning framework for coastal hazards in New Zealand, as well as more specifically within Canterbury and Christchurch. The documents considered in this study include:

- New Zealand Coastal Policy Statement 2010 (the NZCPS)
- Canterbury Regional Policy Statement (the RPS)
- Regional Coastal Environment Plan for the Canterbury Region (RCEP)
- Christchurch District Plan
- MfE Guidance for Local Government “Preparing for Climate Change 2017.

These five documents are discussed briefly in turn with more detailed considerations provided in Appendix B.

### 3.3.1 New Zealand Coastal Policy Statement 2010 (NZCPS)

The NZCPS provides national direction for the management of, and adaption to coastal hazards via:

- *Objective 5: To ensure that coastal hazard risks taking account of climate change, are managed by*
  - *Locating new development away from areas prone to such risks*
  - *Considering responses, including managed retreat, for existing development in this situation; and*
  - *protecting or restoring natural defences to coastal hazards*
- Policy 3: Precautionary approach: (1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse. (2) In particular, adopt a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change
- Policy 24: The identification of coastal hazards (gives priority to the identification of areas at high risk of being affected over at least 100 years),
- Policy 25: Subdivision, use and development in areas of coastal hazard risk (avoid increasing the risk, encourage reducing the risk by locating outside areas of risk, and discourage hard protection)
- Policy 26: Natural defences against coastal hazards (recognise and provide for)
- Policy 27: Strategies for protecting significant existing development from coastal hazard risk (development of range of options).

### 3.3.2 Canterbury Regional Policy Statement (RPS)

The objectives and policies of the RPS Chapter 11 “Natural Hazards” are consistent with the direction set by the NZCPS - that land use activities should avoid increasing natural hazard risks. The framework also recognises and provides for the projected increases in sea levels and associated hazards. It sets out the types of risks to be considered, principally loss of life or significant damage to property. The policies are directive and set out specific requirements for building in inundation areas. This direction has been incorporated into this study’s identification of risks. The policy framework also set out the requirement for district and city councils to investigate, map and address natural hazards, with specific regard given to the effects of sea level rise and climate change.

RPS Policy 11.3.1 (Avoidance of inappropriate development in high hazard areas) provides a definition for “high hazard areas” which for the Christchurch District includes:

> *1) flood hazard areas subject to inundation events where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% AEP (1 in 500 year) flood event;*
>
> *3) land within greater Christchurch likely to be subject to coastal erosion including the cumulative effects of sea level rise over the next 100 This includes (but is not limited to) the land located within Hazard Zones 1 and 2 shown on Maps in Appendix 5 of this Regional Policy Statement that have been determined in accordance with Appendix 6; and*
>
> *4) land subject to sea water inundation (excluding tsunami) over the next 100 years. This includes (but is not limited to) the land located within the sea water inundation zone boundary shown on Maps in Appendix 5 of this Regional Policy Statement.*

### 3.3.3 Regional Coastal Environment Plan for the Canterbury Region (RCEP)

The RCEP recognises the dynamic and connected nature of the coastal environment and includes objectives, policies, and rules for coastal hazards on the landward of the Mean High Water Spring boundary of the Regional

Coastal Plans. The h RCEP pre-dates both the NZCPS and RPS and is less restrictive, however the same guidance as to the importance of identifying, mapping and assessing coastal hazards is included.

The RCEP includes the identification of coastal erosion hazard zones along the majority of the region's coastline which define the areas within which the hazard rules apply and are the hazard zones referred to in point 3 of the RPS definition of *high hazard*. These erosion hazard zones are defined as being:

- Erosion Hazard Zone 1:

  (a) For stable or accretionary shorelines: Where there is no evidence of shoreline erosion, the width of Hazard Zone 1 is the area landward of the Coastal Marine Area boundary to the landward limit of the active beach system. This position is determined either by ground survey, or from aerial photography.

  (b) For most eroding shorelines: The width of Hazard Zone 1 includes the active beach system and the area landward of this, which is likely to be part of the active beach system if contemporary erosion processes continue unaltered for the next 50 years. Hence, the landward limit of Hazard Zone 1 corresponds to the projected position of the landward toes of the active beach system.

The width of hazard zones has been determined by interpolating the rate of shoreline retreat between fixed determination points. For all determination points, except for some special situations listed below, there was no evidence of a change in the long-term rate of shoreline retreat. Therefore, the longest-term historical erosion rates have been used. These will include short term fluctuations.

- Erosion Hazard Zone 2:

  No Hazard Zone 2 is defined for stable or accreting shorelines.

  For eroding shorelines, Hazard Zone 2 is landward of Hazard Zone 1, and covers areas that could become part of the active beach system within 50 to 100 years if the erosion rates used to calculate Hazard Zone 1 were to continue unaltered for 100 years.

it is important to note that they do not include are consideration of the effect of SLR on future coastal erosion.

The RCEP also maps a sea water inundation zone, covering areas known to have been affected by coastal inundation the past, but does not include any policies or rules around this hazard.

#### 3.3.4 The Christchurch District Plan

The Christchurch District Plan includes several objectives and policies relevant to coastal hazards and replicates the language of higher order RMA documents in that hazards should be avoided where the risks generated by these hazards is unacceptable. Specific guidance and policy regarding flooding and sea level rise is provided in Policy 5.2.2.2 (Managing risk from flooding), which defines Flood Management Areas to be:

> *"(i) a modelled 0.5% AEP (1 in 200-year) rainfall event plus a 5% AEP (1 in 20-year) tide event plus 250mm freeboard; OR a modelled 5% AEP (1 in 20-year flood event) plus a 0.5% AEP (1 in 200-year) tide event plus 250mm freeboard; OR 11.9m above Christchurch City Council Datum (the maximum 200-year tidal contour) plus 250mm freeboard; whichever is the greater; and*
>
> *(ii)allowance for 1 metre of sea level rise and an increase in rainfall intensity by 16% through to 2115 as a result of climate change; and…"*

Flood Management Areas are included as a layer on the District Plan maps, as are the High Flood Hazard Management Areas as identified in the RPS. The District Plan does not identify or any Coastal Erosion Hazard

Management Areas and relies on the Erosion Zones and policies of the RPS and the relevant zone rules in the RCEP.

#### 3.3.5 Banks Peninsula District Plan

The Banks Peninsula District Plan (BPDP) also includes objectives and policies relating to natural hazards. While many elements of the BPDP have been superseded following the amalgamation of the Christchurch City and Banks Peninsula District Councils, its coastal hazard content is still operative. Its approach to these hazards is similar to that of the Christchurch District Plan, with a focus on minimising loss of life and property damage. However, its rules focus on surface flooding and not sea level rise, storm surges or coastal erosion.

#### 3.3.6 MfE Guidance for Local Government "Preparing for Climate Change" 2017.

This a non-statutory document provides the most practicable guidance on the methodology assessing and current and future coastal hazard susceptibility, exposure and vulnerability. The T+T Coastal Hazard Assessment use in this report follows the methodology of the MfE (2017) guidance.

# 4. Data Sources and Processing

This section sets out the data on coastal hazards that was used within this analysis. It notes the sources of data and how this has been processed to produce and map the hazard risk category areas.

All maps produced for this analysis are available in a webviewer accessible to the project team. Maps of the preferred approach has been provided to CCC as a spatial layer.

## 4.1 Bathtub Modelling Inundation Data

### 4.1.1 T+T Bathtub modelling data

The T+T coastal inundation data was acquired from their 'bathtub' model, covering the coastal land of the Christchurch City urban area, and Banks Peninsula. The inputs into the bathtub modelling include:

- Peak static water levels comprising storm tide and wave set-up for three water level AEPs: 63% (1 in 1 year), 10% (1 in 10 years), 1% (1 in 100 years) and nine SLR increments from a 2020 base, ranging from 0 m to 2m.
- Water level data provided in look-up tables for 11 discrete areas covering the district coastline as presented in Table 4.1 and mapped in 11 areas shown in Figure 4.1. It is noted that due to differences in the wave set-up values in each area (which depends on wave climate and beach slopes) there is some variation between the resulting water levels in each area for the same SLR increment and water level frequency.
- Ground levels from the 2018 LiDAR survey.

The bathtub modelling does not include dynamic water levels from the inclusion of wave run-up processes to the inundation depths and extents.

The assessment scenarios proposed by T+T to inform adaptation planning in relation to coastal inundation are presented in Table 4.2. Although an assessment of the potential effect of erosion on inundation was made, this was not included in the bathtub mapping.

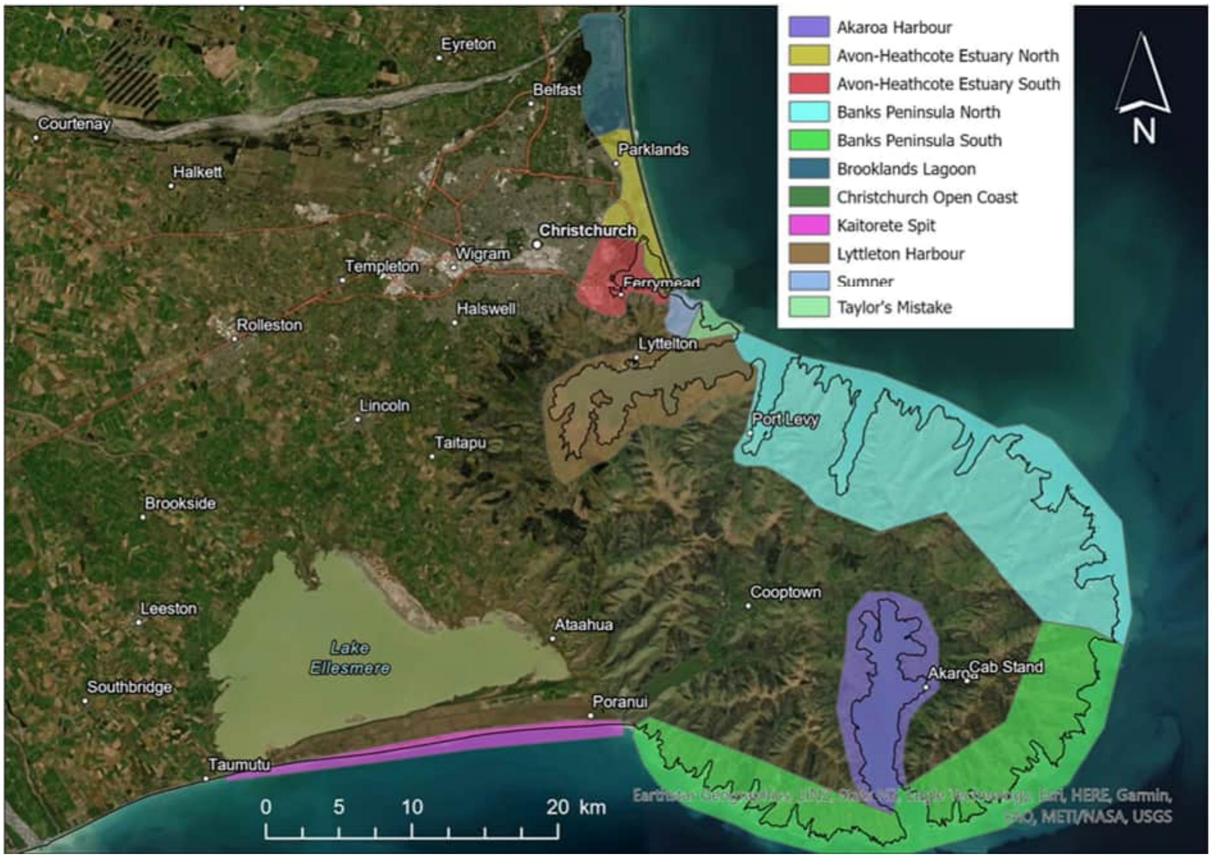



Figure 4.1: Discrete areas of extreme water levels from look-up Tables in Table 4.1

Table 4.1: Look up Table of extreme static sea levels supplied by T+T for combination of water level frequencies and SLR's. Levels in NZVD2016.

| Area | Water Level Frequency | | Sea Level Rise (SLR) (m) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % Annual Exceedance Probability (AEP) | Average Recurrence Interval (ARI) | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.2 | 1.4 | 1.5 | 2.0 |
| Christchurch Open Coast | 63% | 1 year | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 3.0 | 3.2 | 3.3 | 3.8 |
| | 10% | 10 year | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.2 | 3.4 | 3.5 | 4.0 |
| | 1% | 100 year | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.5 | 3.7 | 3.8 | 4.3 |
| Sumner | 63% | 1 year | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 3.0 | 3.2 | 3.3 | 3.8 |
| | 10% | 10 year | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.2 | 3.4 | 3.5 | 4.0 |
| | 1% | 100 year | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.5 | 3.7 | 3.8 | 4.3 |
| Taylor's Mistake | 63% | 1 year | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 3.0 | 3.2 | 3.3 | 3.8 |
| | 10% | 10 year | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.2 | 3.4 | 3.5 | 4.0 |
| | 1% | 100 year | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.5 | 3.7 | 3.8 | 4.3 |
| Brooklands Lagoon | 63% | 1 year | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.6 | 2.8 | 2.9 | 3.4 |
| | 10% | 10 year | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.8 | 3.0 | 3.1 | 3.6 |
| | 1% | 100 year | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 3.0 | 3.2 | 3.3 | 3.8 |
| Avon-Heathcote Estuary North | 63% | 1 year | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.7 | 2.9 | 3.0 | 3.5 |
| | 10% | 10 year | 1.7 | 1.9 | 2.1 | 2.3 | 2.5 | 2.9 | 3.1 | 3.2 | 3.7 |
| | 1% | 100 year | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.2 | 3.4 | 3.5 | 4.0 |
| Avon-Heathcote Estuary South | 63% | 1 year | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.7 | 2.9 | 3.0 | 3.5 |
| | 10% | 10 year | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.8 | 3.0 | 3.1 | 3.6 |
| | 1% | 100 year | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 3.0 | 3.2 | 3.3 | 3.8 |
| Lyttelton Harbour | 63% | 1 year | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.8 | 3.0 | 3.1 | 3.6 |
| | 10% | 10 year | 1.7 | 1.9 | 2.1 | 2.3 | 2.5 | 2.9 | 3.1 | 3.2 | 3.7 |
| | 1% | 100 year | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 3.0 | 3.2 | 3.3 | 3.8 |
| Akaroa Harbour | 63% | 1 year | 1.9 | 2.1 | 2.3 | 2.5 | 2.7 | 3.1 | 3.3 | 3.4 | 3.9 |
| | 10% | 10 year | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 3.3 | 3.5 | 3.6 | 4.1 |
| | 1% | 100 year | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.5 | 3.7 | 3.8 | 4.3 |
| Banks Peninsula North | 63% | 1 year | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.4 | 3.6 | 3.7 | 4.2 |
| | 10% | 10 year | 2.5 | 2.7 | 2.9 | 3.1 | 3.3 | 3.7 | 3.9 | 4.0 | 4.5 |

| Area | Water Level Frequency | | Sea Level Rise (SLR) (m) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % Annual Exceedance Probability (AEP) | Average Recurrence Interval (ARI) | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.2 | 1.4 | 1.5 | 2.0 |
| | 1% | 100 year | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 4.0 | 4.2 | 4.3 | 4.8 |
| Banks Peninsula South | 63% | 1 year | 2.9 | 3.1 | 3.3 | 3.5 | 3.7 | 4.1 | 4.3 | 4.4 | 4.9 |
| | 10% | 10 year | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 4.6 | 4.8 | 4.9 | 5.4 |
| | 1% | 100 year | 3.9 | 4.1 | 4.3 | 4.5 | 4.7 | 5.1 | 5.3 | 5.4 | 5.9 |
| Kaitorete Spit | 63% | 1 year | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.4 | 3.6 | 3.7 | 4.2 |
| | 10% | 10 year | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.8 | 4.0 | 4.1 | 4.6 |
| | 1% | 100 year | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 4.0 | 4.2 | 4.3 | 4.8 |

Table 4.2: Assessment scenarios proposed by T+T for inundation lookup tables

| Assessment | SLR (m) | Average Recurrence Interval (ARI) | Effect of erosion |
|---|---|---|---|
| Detailed assessment | 0<br>+0.2<br>+0.4<br>+0.6<br>+0.8<br>+1.0<br>+1.2<br>+1.5<br>+2.0 | 1 year<br>10 year<br>100 year | n/a |
| | +1.5 | 100 year | Future P5% and P50% erosion for same scenario |
| Regional screening assessment | 0<br>+0.4<br>+1.5 | 1 year<br>10 year<br>100 year | n/a |

For the Avon, Heathcote and Styx catchments within the Christchurch City urban area, the spatial extent of the bathtub modelling was limited to the area to the east of the modelling boundary shown in Figure 4.2. To the west of this boundary, T+T assessed that

*…extreme inundation level is increasingly influenced by river/stream flow, with lesser reliance on the sea level applied and that the bathtub model generally overestimates the extent of inundation because it applies a water level derived at the coast which is too high for the area further inland.*

T+T concluded that:

*...extreme inundation of areas upstream of these locations is best derived through joint probability modelling assessment, taking into account both sea level and river flow state*

The bathtub model outputs that were provided to Jacobs included the following:

- Polygons of the extents of the 11 discrete areas (Figure 4.1).
- Mask of the useable bathtub model area within the Christchurch City Urban area (Figure 4.2).
- Raster datasets representing inundation depth at a spatial ground resolution of 1x1m from water levels at 0.1 m intervals from 0.9 m to 6.0 m relative to NZVD2016 datum. The raster outputs were divided into 'connected' and 'disconnected' flooded areas, with disconnected areas not having a direct pathway of flooding to the coastline.

Determining the inundation extent and depth for a particular frequency and SLR scenario within a specified area required obtaining the resulting water level for that scenario and area from the look-up tables, then interrogating the appropriate raster for that water level to obtain the inundation extent and depths.

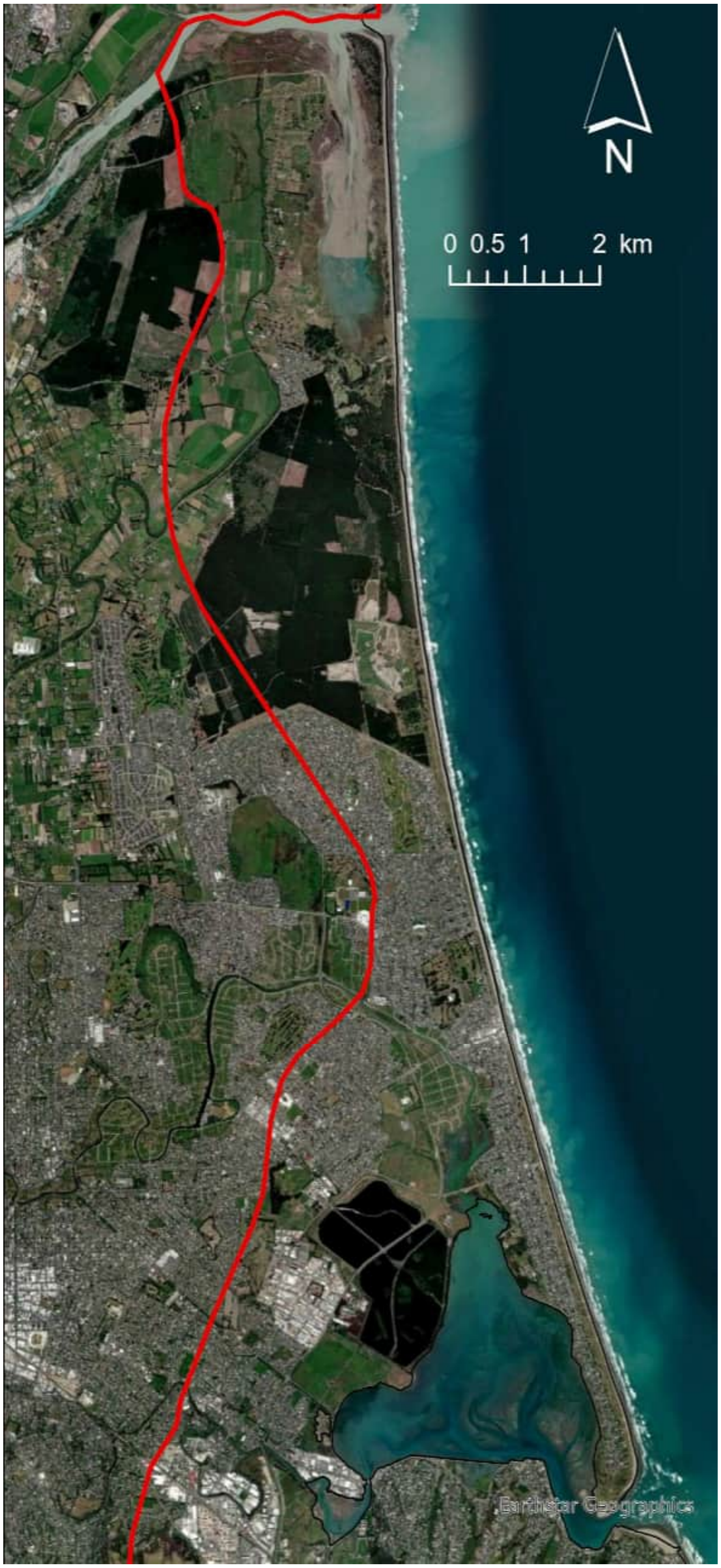



Figure 4.2: Bathtub modelling boundary position for Christchurch City urban area

#### 4.1.2 Inundation Data Processing

The raster data of the bathtub model outputs were combined based on the selected AEP, SLR, and for all 11 areas around Christchurch and Banks Peninsula. The required water flood level rasters were clipped to their relevant location extents, and all non-usable model area was removed using the provided polygons and mask. This included both 'connected' and 'disconnected' inundation areas from the static water levels. To test the different potential flood depth thresholds for setting planning categories, each resulting raster was classified to the desired flood depth intervals and dissolved into polygon areas.

#### 4.1.3 TUFLOW Model Inundation Data

We received outputs from T+T's TUFLOW model dated 2017, which covered the Christchurch City urban area. The model was run with zero rainfall to assess hydrodynamic response to storm tide applied at the seaward model boundary. Under this assumption, there was no flow in the waterways draining into the Avon-Heathcote Estuary and Brooklands Lagoon at the time of the extreme sea level event.

The flood level data have a ground resolution of 5x5m and are relative to the LVD37[13] datum. They were provided for two different flood scenarios as shown in Table 4.3. For the conversion of TUFLOW flood level data into flood depth data, we obtained the 2018 Canterbury, Christchurch and Ashley River LiDAR DEM with a spatial ground resolution of 1x1m[14] and the datum conversion grid from LVD37 to NZVD2016 datum.[15]

Table 4.3: Water Levels from T+T TUFLOW 2017 model

| Year | Water Level Frequency (ARI in years) | Representative Concentration Pathway (RCP) used to determine SLR | Peak water level within model (LVD37) | | |
|---|---|---|---|---|---|
| | | | Bridge St | Ferrymead Bridge | Styx tide gate |
| 2065 | 100 | RCP 4.5 | 2.52 | 2.53 | 2.54 |
| 2115 | 100 | RCP 8.5H+ | 3.0 | 3.18 | 3.1 |

For data processing and comparison to the bathtub data, we converted the TUFLOW flood level data from LVD37 to NZVD2016 datum using LINZ's conversion grid. For that purpose, an offset raster was calculated from the grid points by applying a surface triangulation in combination with a barycentric interpolation which was then used to convert the TUFLOW levels to NZVD2016. Flood depth was calculated against the 2018 LiDAR DEM.

### 4.2 Coastal Erosion Data

#### 4.2.1 T+T Erosion Modelling Data

The coastal erosion modelling undertaken by T+T involved calculating the current and future Areas Susceptible to Coastal Erosion (ASCE) across the beaches and coastal banks of the whole district from the following standard formula relevant to each coastal morphology:

$Current\ ASCE_{Beach} = ST + DS$, and

$Future\ ASCE_{Beach} = (LT \times T) + SL + ST + DS$

$Current\ ASCE_{Bank} = (H_C/tan\alpha)$

[13] Lyttelton Vertical Datum 1937
[14] (https://data.linz.govt.nz/layer/104497-canterbury-christchurch-and-ashley-river-lidar-1m-dem-2018-2019/)
[15] (https://data.linz.govt.nz/layer/53432-lyttelton-1937-to-nzvd2016-conversion/)

$$Future\ ASCE_{Bank} = (LT\ x\ T)\ x\ SL + (HC/tan\alpha)$$

Where;

ST is the short-term storm erosion in 100 year wave and water level event combined probability event,

DS is a dune stability factor for dune face collapse following over-steepening a storm event,

LT is the historical long-term rate of shoreline retreat or advance,

T is the time frame of the assessment,

SL is the erosion resulting from SLR within the time frame,

Hc is the height of the bank,

$\alpha$ is the characteristic stable angle of the bank in degrees

To account for the different coastal morphologies and erosion responses to coastal processes operating within the study area, the coastline was dividied into 100 cells, with the calculated ASCE being constant within each cell. For 52 of the cells covering, the Christchurch City urban area (30 cells), beach or bank shorelines along the existing larger settlements within Lyttelton (10) and Akaroa Harbours (12), a detailed probabilistic erosion assessment was carried out. These assessments involved calculating the full range of statistical probability of erosion distances resulting from a range of input parameter values for each of sixteen different combinations of time frame and SLR magnitude scenarios as presented in Table 4.4. The results were presented to Jacobs as raster data, representing erosion probabilities at a spatial ground resolution of 1x1m, with a gradual decrease of probability with increasing distance from the shoreline. These probability values can therefore be interpreted as being the probability that the erosion will reach or be greater than the calculated ASCE to that location.

Within the detailed assessment there are several cells where future erosion is not considered to be acceptable. This includes areas where there is land reclamation and substantial hard protection structures that protect critically important infrastructure or significant development. Therefore, the Future ASCE is assessed as the same as Current ASCE (e.g. erosion resulting from structure damage/failure before repair) and there is no change in ASCE with SLR scenario, and very little change in erosion distance with probability. These cells include the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township.

For the remaining 48 cells in other bays within Banks Peninsula, Lyttelton and Akaroa Harbours, and along Kaitorete Spit, a less detailed deterministic erosion hazard screening approach was taken due to insufficient data for a full probabilistic approach. For these cells single value input parameters were used with only five combinations of time frame and sea level rise magnitude as shown in Table 4.4. The resulting ASCE are assumed to be very conservative, with an assumed probability of being exceeded in the range of 1-5%. In these cells the ASCE results were presented to us as lines of the future shoreline position for each SLR scenario.

Table 4.4: SLR Scenarios used in the T+T coastal erosion modelling

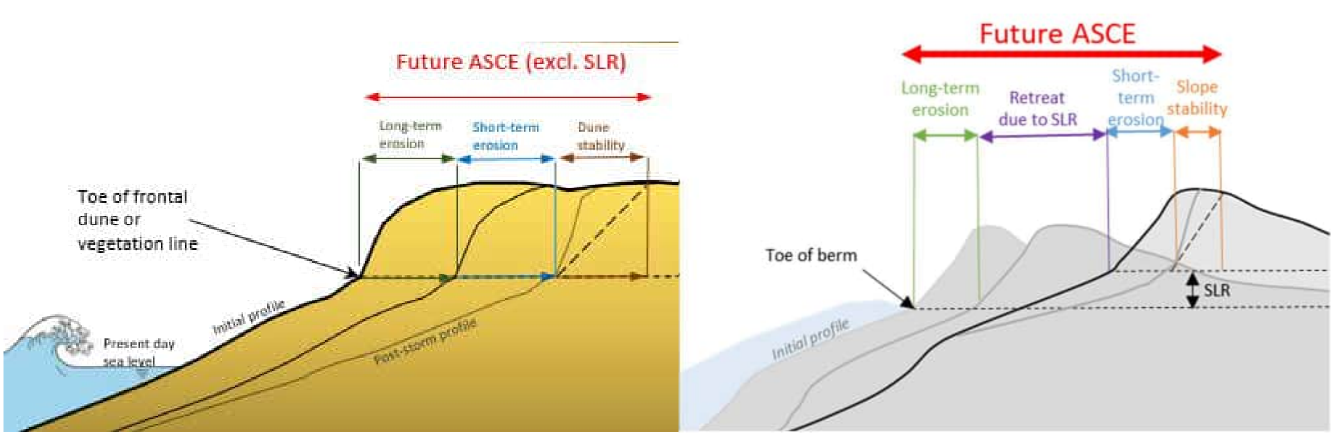
| Detailed Probabilistic Cells | | | | Deterministic Screening Cells | | |
|---|---|---|---|---|---|---|
| Year | SLR (m) | Probability | Sediment Supply | Year | SLR (m) | Probability |
| 2020 | 0.0 | | | 2020 | 0.0 | Assumed to be in range 1 -5 % probability |
| 2050 | 0.2 | | | 2080 | 0.4 | |
| | 0.4 | | | 2150 | 0.4 | |
| 2080 | 0.4 | | | | 1.5 | |
| | 0.6 | | | | | |
| | 0.8 | | | | | |
| 2130 | 0.4 | | No change | | | |
| | 0.6 | | | | | |
| | 0.8 | | | | | |
| | 1.0 | | | | | |
| | 1.2 | | | | | |
| | 1.5 | | | | | |
| 2150 | 2.0 | A range of probabilities mapped as a gradient from 99% to 1% | | | | |
| 2130 | 1.5 | | Reduced by 11% | | | |
| 2130 | 1.5 | | Increased by 28% | | | |

The origin position for the ASCE calculations for beaches and banks is the seaward toe of the dune, beach berm or bank as shown in Figure 4.3. Therefore, when interpreting these future erosion positions for determining setback distances for planning purposes, there is a need to allow for natural backshore environments (for example dunes and beach ridges), bank slopes, and potential protection works within the setback distance.

For cliff shorelines around the Banks Peninsula, the Future ASCE is defined as a generic setback distance, the width of which is dependent on the current cliff slope as follows:

- Where current cliff slope is equal or steeper than 1:1slope: Future ASCE $_{Cliff}$= 20 m set back from top of the cliff
- Where current cliff slope is flatter than 1:1slope: Future ASCE $_{Cliff}$ = 30 m set back from toe of the cliff.

The locations of Future ASCE $_{Cliff}$ were provided by T+T as a smoothed line offset by the appropriate distance from a mapped cliff baseline position, assumed to be the current toe of the cliff.



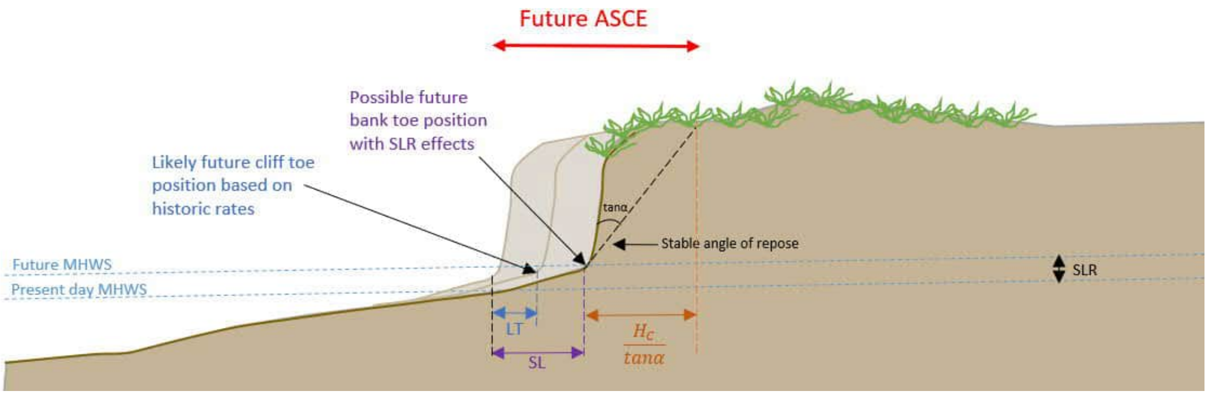



Figure 4.3: Position of origin position for ASCE on beach and bank profiles (Source T+T Technical Report)

### 4.2.2 Erosion Data Processing

For the detailed assessment of cells, lines of erosion probability were extracted from various scenarios provided as “probabilistic raster data”. Lines were created by tracing raster values of the probability of interest. Where rasters did not contain the exact probability value, a linear interpolation between raster cells was carried out, assuming that the probability location is represented by the centre of each raster cell.

As a result of the T+T cell wide approach to the ASCE calculations, there are discontinuities in the lines of equal probability for the same SLR scenario across the cell boundaries as shown in Figure 4.4.

For deterministic screening cells and cliff locations, no processing of the received erosion lines was requested. However, it is noted that there is potential inconsistency in the widths of the ASCE within the bays of Lyttelton and Akaroa Harbours compared to adjoining bays where the detailed probabilistic approach was used.

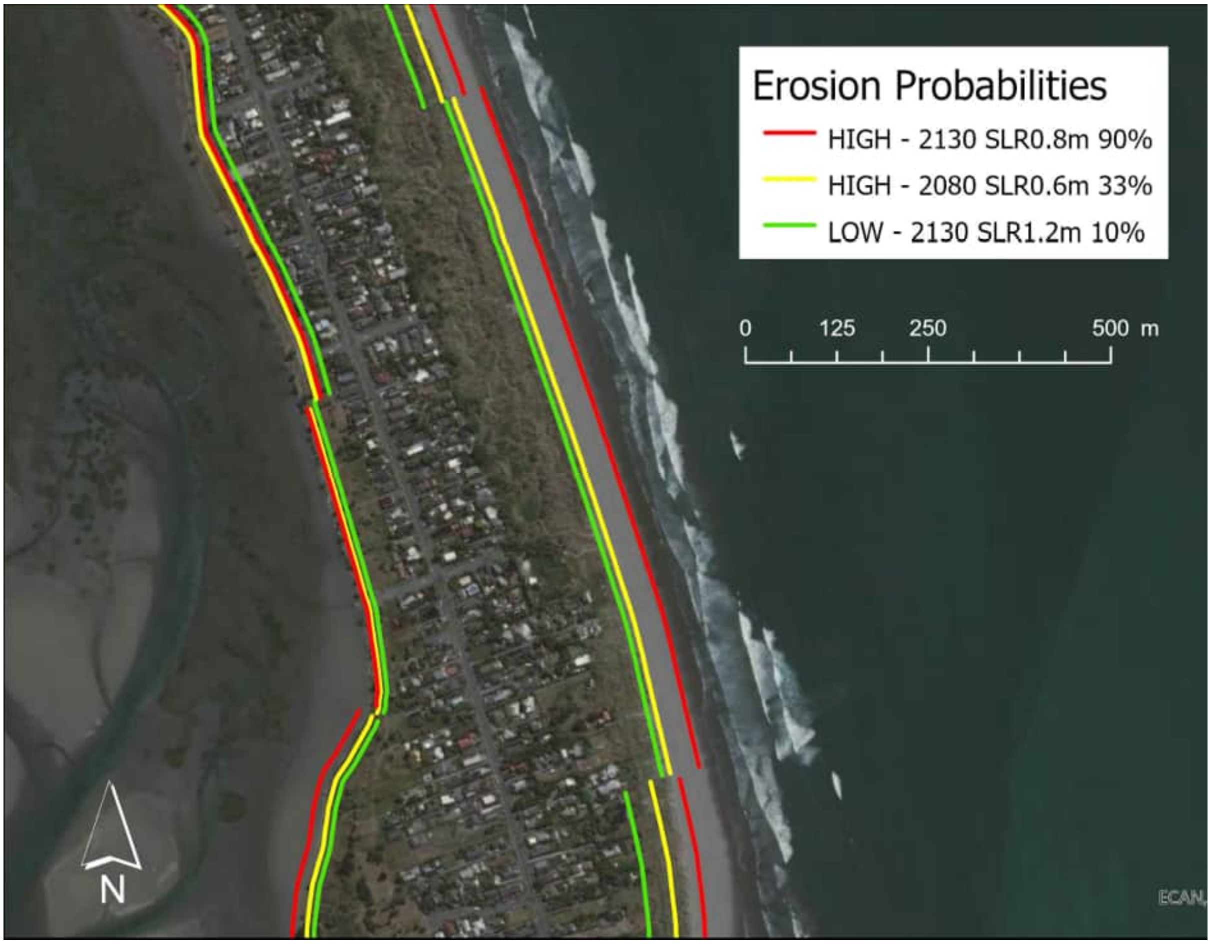



Figure 4.4: Inconsistencies in ASCE probability across cell boundaries

#### 4.2.3 RPS/RCEP Erosion Hazard Zone Data

The Coastal Erosion Hazard Zone data from the RPS was provided as polygons for a comparison to erosion hazard zones proposed in Section 7. As noted in Section 3.3.2, these erosion hazard data did not include any reference to future erosion from SLR. The RPS defines High Hazard areas within greater Christchurch to include land likely to be subject to coastal erosion including the cumulative effects of SLR over the next 100 years, which includes, but is not limited to, the land located within the Hazard Zones 1 and 2.

For the Christchurch City district these coastal erosion hazard zones only exist along the open coast of the Christchurch City urban area and along Kaitorete Spit, with no erosion zones beginning defined in the Avon-Heathcote Estuary or Banks Peninsula. Since the shoreline in both the Christchurch City open coast and along Kaitorete Spit are long-term accretionary, only Erosion Hazard Zone 1 is present. This is the width of the active beach, which is defined as back of the dune system in Christchurch city and the back of the beach ridge at Kaitorete Spit.

# 5. Sea Level Rise Scenario Selection

This section discusses the range of SLR scenarios that were available for consideration within this study and identifies is considered to be most applicable for use within this district plan risk analysis framework.

SLR projections, both globally and locally, are developed according to the scenarios of greenhouse gas (GHG) emissions in the future, and associated global temperature change. Under the previous IPCC assessment report(AR5 2014)[16] , each scenario represents the assumptions of GHG concentrations in the atmosphere for different future timeframes.[17] These scenarios are called 'Representative Concentrations Pathways' (RCPs), ranging from RCP2.6 (the lowest concentrations scenario), to RCP8.5 (the highest concentration scenario). RCP4.5 and RCP6.0 are the two mid-range RCPs.[18] Each scenario is considered plausible to at least 2100, but they do not have probabilities attached to them, so quantifying an overall likelihood distribution for SLR to a future date next century (e.g.2120 or 2130) is not possible. There is increasing uncertainty all the projections with time.

Within New Zealand, RCPs 2.6, 4.5 and 8.5 were adopted in central government guidance[19] to develop SLR scenarios.[20] A fourth higher projection, RCP8.5H+, was added to the scenarios, presenting the 83rd percentile of the RCP8.5. The guidance notes:

> *this higher scenario reflects the possibility of future surprises towards the upper range in SLR projections of an RCP8.5 scenario, being representative of a situation where more rapid rates of SLR could occur early next century due to dynamic ice sheet processes and instability thresholds that were not fully quantified in the IPCC AR5 projections*[21]

The MfE Coastal Hazards Guidance notes that RCP8.5 H+

> *should be used to stress-test dynamic adaptive pathways, policies and new greenfield and major infrastructure developments.*[22]

The guidance suggests that under RCP8.5H+ scenario, local/district planning instruments should consider SLR projections over longer periods than 100 years, to avoid or mitigate adverse hazard impacts to coastal subdivisions, greenfield developments and major new infrastructure. To account for regional factors, New Zealand's SLR scenarios applied in the guidance are 5cm higher than the IPCC global projections and were extended in time through to 2150 to provide a longer view over 130 years.

In the most recent IPCC assessment report (AR6 2021)[23], the scenarios were reshaped to integrate different levels of emissions and climate change against multiple socio-economic development pathways. These are referred to as SSP's (Shared Socio-economic Pathways). There are five SSP scenario families which IPCC assess a medium confidence of occurring. The last two numbers of each scenario refer to radiative forcing by 2100 in the same way as the RCP scenarios. Hence SSP5-8.5 could be associated with RCP 8.5, SSP2-4.5 with RCP4.5, and SSP1-2.6 with RCP2.6. The additional scenario from the AR6 assessment is SSP1-1.9, which is a lower carbon emission than SSP1-2.6. In addition, RCP 6.0 was replaced with the SSP3-7.0 scenario. There are also two

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[16] AR5, 2014
[17] Including 2030, 2050, 2100, etc.
[18] (for more information about RCPs, please refer to Intergovernmental Panel on Climate Chane. 2014. Long-term Climate Change: Projections, Commitments and Irreversibility, https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter12_FINAL.pdf
[19] Coastal Hazards and Climate Change: Guidance for local governments, 2017, Ministry for the Environment, Wellington 6143, New Zealand, Publication number: ME 1341
[20] RCP6.0 was dropped as it was close to the RCP4.5 projection.
[21] MFE. (2017) op. cit.
[22] MFE. Op cit. p104
[23] Climate Change 2021 The Physical Science Basis. Working Group I contribution to the sixth Assessment Report of the Intergovernmental Panel on Climate Change

additional low confidence scenarios, indicating the potential effect of low likelihood, high impact ice sheet processes that cannot be ruled out. For SLR, all the SSP projections are slightly higher than the corresponding RCP projection (Figure 5.1).

NASA developed a sea level change tool[24] which provides regional projections from the IPCC SSP global scenarios. The regional projections for New Zealand are presented at eight port sites around the country, including Lyttelton Harbour. For all the New Zealand sites, the regional SSP projections are also slightly above the global projections, but by less than the standard 5 cm as per MfE guidance for the RCP projections.

## 5.1 Comparison of T+T SLR Increments to RCP/SSP levels

The T+T assessment used increments of SLR at three timeframes (2050, 2080, 2130) as presented in Table 4.4 and covering the range of New Zealand RCP projections (including RCP8.5H+). As per the recommendation in MfE Guidance additional higher SLR projection over a longer time frame (2150) is also included.

The comparison of the T+T increments to the upper and lower range of the RCP and SSP projections is presented in Figure 5.1. The SSP scenarios have slightly higher magnitudes of SLR than the corresponding RCP scenarios, the 83rd percentile SSP5-8.5 values are higher than the RCP8.5H+ values. As can also be seen, the range of T+T increments are still relevant under the SSP scenarios, appropriately covering the full range of the scenarios. However, what is required for land use planning is the selection of the most applicable scenario for a risk-based approach.

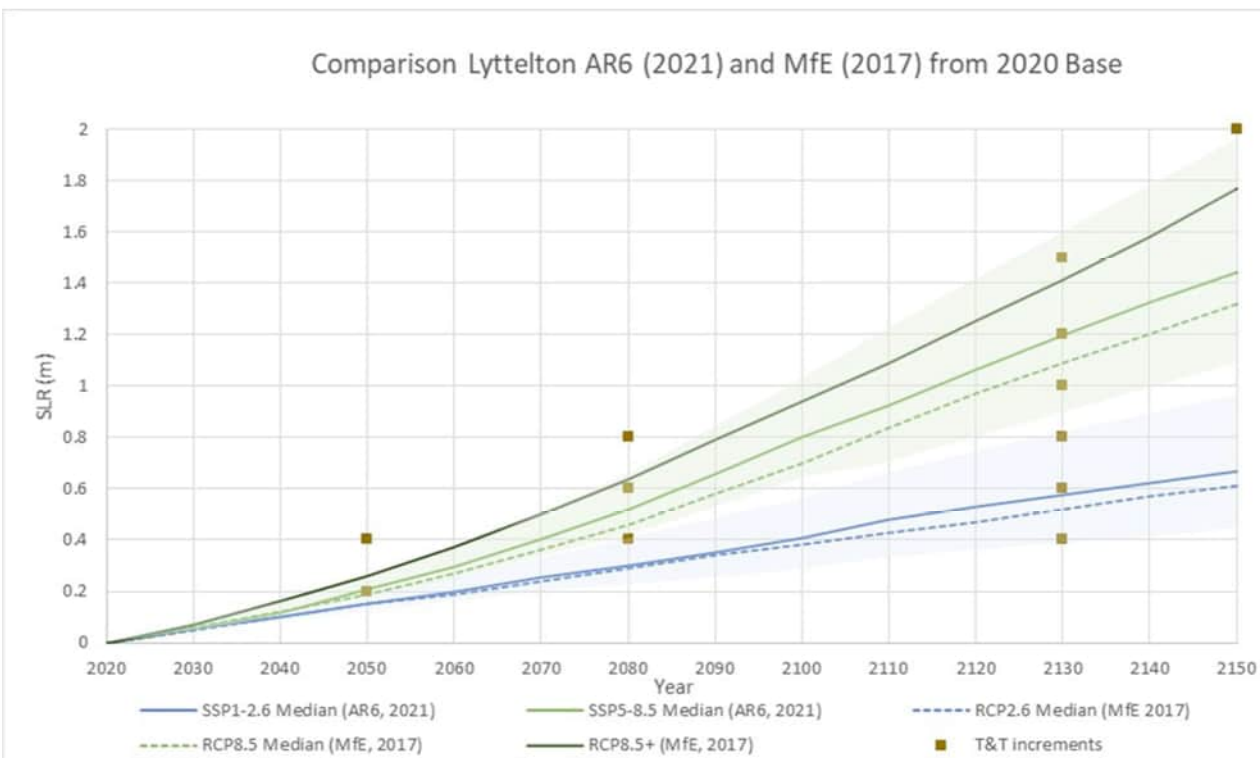



Figure 5.1: Comparison of T+T SLR increments to SSP and RCP scenarios. Note shaded areas represent the17th to 83rd Percentile of AR6 (2021) SSP1-2.6 (Blue) and SSP5-8.5 (Green) Projections.

[24] https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

## 5.2 Selection of SLR Increments for Planning Purposes Within this Study

The selection of an SLR scenario for use in this report, is limited to the increments presented by T+T shown in Table 4.4. The following underlying principles were applied to select the most appropriate T+T SLR increments for use in land-use planning:

1) There needs to be consistency between the selected scenarios for both inundation and erosion planning.
2) The scenarios need to reflect both timeframe and SLR magnitude, as it is the rate of SLR that is important in determining future erosion.
3) The timeframe is important as need to ensure that any land use activities allowed under the rules in various hazard categories have sufficient and reasonable time (for erosion), or lack of frequency of hazard (for inundation) for that activity to be carried out in an appropriate manner without the need for hazard mitigation measures.
4) Timeframes are also important for defining the ‘certainty’ of the magnitude of SLR. While all scenario pathways have the same assumed likelihood of occurrence, there is much greater certainty in the lower projected magnitudes occurring over the shorter timeframes.

Applying a risk-based approach to select a SLR magnitude is shown schematically in Figure 5.2. The upper pane shows that for a specified planning timeframe, there is a generalised probability distribution of possible SLR magnitudes, peaking with a ‘most likely’ SLR value and a skewed-tail distribution influenced by a wider range of process responses to climate change. The lower pane shows that a generalised SLR risk profile can also be obtained by multiplying the likelihood of SLR distribution curve by the consequences curve. This simplified example demonstrates that, in most cases, the peak of the risk curve within the specified timeframe will typically occur at a SLR above the mid-range SLR value.

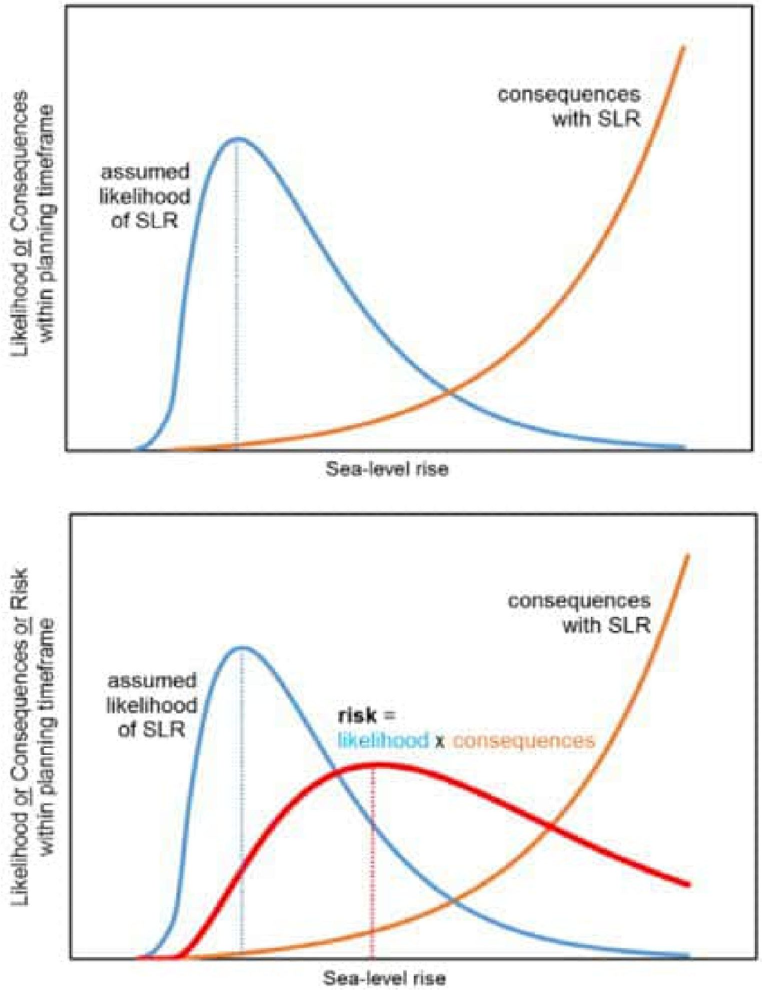



Figure 5.2: Generalised SLR probability and generic consequence curve (upper pane) resulting in the risk profile (lower pane). (From MfE, 2017).

Considering the above principles and discussion, it is recommended that the most appropriate T+T increments to use as SLR scenarios for a risk-based approach to land-use planning are:

- 0.6 m SLR by 2080, and
- 1.2 m SLR by 2130

As can be seen in Figure 5.1, both scenarios are located between the RCP 8.5 and 8.5H+ scenarios, and close or slightly above the SSP5-8.5 scenarios. The justifications for this recommendation include:

- Not taking the increments closest to lowest of the SSP-RCP scenarios is considered a precautionary approach to hazard planning, consistent with the principles of the RMA.
- Both scenarios are considered to be reasonable in terms of SSP-RCP scenarios, not taking the highest scenario (e.g RCP 8.5H+), but reflecting the slightly higher most recent SSP projections over the previous commonly used scenarios of planning (e.g. 1 m SLR in 100 years).and the recommends of the MfE (2017) coastal hazards guidance.

- Although it is recognised that globally there are likely to be more serious emission mitigation efforts in the future, both scenarios are not dependent on global political responses to reduce emissions.
- Both scenarios are unlikely to occur much before the specified time frame.
- We have a high degree of confidence that the lower magnitude of SLR (0.6 m) will occur at sometime within a reasonable planning timeframe, even if global emission reductions can be successfully implemented. From Figure 5.2., 0.6 m of SLR can be considered to be close to the likelihood peak of SLR over a 100 year timeframe.
- The use of a 60-year hazard time frame is not considered too conservative for restricting activities in high hazard area, while also being sufficient time for allowing other suitable activities with a degree of certainty around their occupancy and/or use,
- Although there is less certainly about the timing of the higher magnitude of SLR (1.2 m) and timing may be delayed beyond a beyond a reasonable planning timeframe if global emission reduction is successful, there is still a medium degree of confidence that this magnitude of rise will occur within the next 130 years. From Figure 5.2, this magnitude of SLR can be considered close to peak of risk of SLR over a 100-year timeframe and therefore some degree of planning controls is required for other activities that are most at risk.

The recommended scenarios are not available for the 48 deterministic erosion screening assessment cells for the bays and beaches of Banks Peninsula, Lyttleton and Akaroa Harbours. For these cells the scenario choices are limited to 0.4 m SLR by 2080, and 0.4 m or 1.5 m SLR by 2130. Being the upper and lower bounds of the scenario range these scenarios do not meet the above justifications or recommended scenarios. Therefore, it is recognised that the recommended scenarios would create an inconsistency in the hazard risk approach between the cells in Lyttelton and Akaroa Harbours where a probabilistic approach and those where a deterministic approach was taken. The effect of this different approach may be able to be negotiated using different thresholds for erosion risk categories in the different assessment cells and is considered further in Section 7.

In arriving at the above selections, we also considered several other SLR increments and timeframes from the T+T assessment in sensitivity testing with a range of thresholds to definite a risk-based approach to land use planning. Some of these increments are close to the RCP4.5 scenarios presented by MfE (2017), which in the absence of a NZ RCP6.0 scenario, are the next highest scenario to RCP8.5. The alternative increments considered included the following:

- 0.4 m SLR by 2050 – considered as a scenario for high erosion hazard areas. Discarded due to 30 year being considered too short a timeframe for land use activities having a certainty occupancy and/or use.
- 0.4 m SLR by 2080 (just above RCP4.5 scenario) – considered as it would allow consistency with the deterministic erosion assessment cells. Discarded due to high likelihood of being exceeded before 2080 therefore not providing the level of certainty in the protection to land-use afforded by the planning provisions.
- 0.8 m SLR by 2130 (approximately halfway between RCP 4.5 and RCP8.5) – considered as an alternative to a 1.2 SLR over the same period. Discarded due to high likelihood of being exceeded before 2130 therefore not providing the level of certainty in the protection to land-use afforded by the planning provisions.
- 1.0 m SLR by 2130 - considered as an alternative to a 1.2 SLR over the same period. Discarded as does not allow for recent increase in projections in IPCC AR6(2021), therefore could be considered to not reflect the most recently available science.
- 1.5 m SLR by 2130 – considered as would allow consistency with the deterministic erosion assessment cells. Discarded as being too conservative to be considered reasonable as is above the RCP 8.5+ magnitude but is suitable for use as an upper stress test for low erosion hazard categories.

- 2.0 m SLR y 2150 - as an upper stress test for low erosion hazard categories. Discarded as being too conservative and too uncertain that will occur even within this 130-year timeframe.

# 6. Coastal Inundation Hazard Thresholds

This section sets out our approach to developing appropriate thresholds for defining inundation hazards. Four flood risk categories are proposed: very low, low, medium and high. An overall summary of this recommended approach is provided in Section 6.1 followed by a discussion of the reasoning behind this recommendation and consideration of other thresholds and scenarios in Sections 6.3 to 6.5.

## 6.1 Summary of Recommended Approach

The main coastal processes which cause inundation are storm surge and wave setup, combined with the astronomical tide and SLR. Inundation has the potential to result in loss of, or damage to, properties, possessions, buildings, and infrastructure, and could cause injury to people or loss of life. The consequence of inundation depends on the nature of the flooding – primarily the depth of water and speed of flow – and the vulnerability of people and assets to flooding.

Land use planning seeks to limit these consequences through risk-based control of development termed effects and outcomes based under the RMA. Several methods for mapping coastal inundation to inform planning decisions have been considered. The purpose is to define a simple set of thresholds which

i. are consistent with the RMA requirements to consider only risks which are “reasonably foreseeable” and “significant” in effect

ii. can be applied to the ‘bathtub’ outputs of the 2021 Coastal Hazard Assessment for Christchurch District (“the CHA”).

This approach takes into account three main factors which define flood risk:

- likelihood of flooding
- consequence of flooding
- change in likelihood and consequence in the future with SLR

The recommended method for defining flood risk takes account of these factors and is set out in Table 6.1. Four categories of flood risk defined by thresholds of water depth are proposed.

Table 6.1: Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 1% annual exceedance probability)

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Very low | None (dry) | Low (d < 0.5m) |
| Low | Low (d < 0.5m) | Medium (0.5m < d < 1.1m) |
| Medium | Medium (0.5m < d < 1.1m) | High (d > 1.1m) |
| High | High (d > 1.1m) | High (d > 1.7m) |

The definitions in Table 6.1 were applied to the CHA inundation depth data to produce a map showing the four coastal flood risk areas for the entire district. Figure 6.1 below shows an example extract of the map in the area around the Avon-Heathcote estuary. Full inundation mapping outputs are available in the project webviewer.

Sections 6.2 to 6.5 discuss inundation factors and coastal inundation processes then describe and compare the flood mapping methods considered and present the basis for our recommended method in more detail. We also compare example results to the current District Plan and CCC flood layers.

As noted, the bathtub method used in the CHA to calculate flood depths does not take account of the hydrodynamic behaviour of inundation or the contribution to coastal inundation from coincident rainfall and river flow. We illustrate the difference between flood mapping using the CHA bathtub results and mapping using hydrodynamic model results.

In some locations there are gaps in the CHA data meaning the flood risk cannot be fully mapped using the available data. In Section 6.5 we discuss the implications of the limitations in the bathtub method, data uncertainties, application of freeboard and thresholds for ‘nuisance flooding’.

All maps produced for this assessment are available in a webviewer accessible to the project team. Maps of the preferred approach has been provided to CCC as a spatial layer.

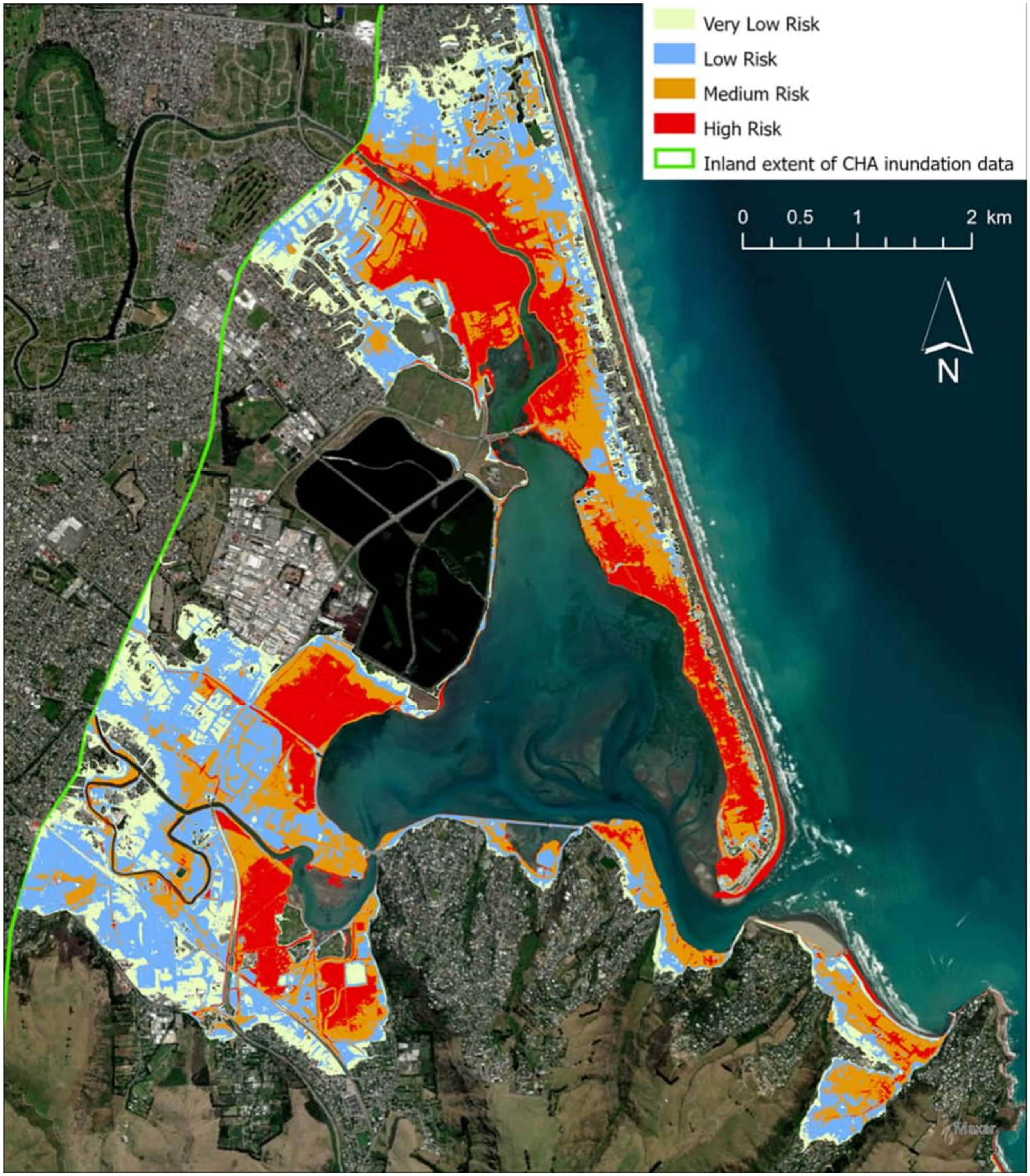



Figure 6.1: Coastal flood risk categories mapped using the CHA inundation data and recommended definitions of flood risk (example extract of mapping for the district)

## 6.2 Estimating the Extent and Depth of Coastal Inundation

Coastal inundation is usually understood to mean flooding from the sea caused by a ‘storm tide’. Storm tide is a combination of the astronomical high tide and ‘storm surge’ – the temporary rise in mean sea level during a storm caused by low atmospheric pressure, wind, and wave setup. The level of storm tides will increase in the future as the mean sea level rises in response to climate change.

A weather event that causes a storm tide can also result in heavy rainfall and high flow in rivers at the coast and coastal inundation is often a combination of flooding from different sources, arising from the same weather event. In any particular event, the individual probabilities of storm tide level and rainfall or river flow usually differ from each other and multiple combinations are possible for the same combined probability of occurrence. For example, the combined probability of a 1% AEP storm tide and 10% AEP river flow occurring together, or a 10% AEP storm tide and 1% AEP river flow occurring together may be 1% AEP in both cases. However, the maximum flood levels in each combination of events may be different. Nearer the coast, events with smaller probability storm tides are likely to result in higher flood levels. Further inland, flooding from events with a smaller probability fluvial flow is likely to be worse. Figure 6.2 illustrates conceptually how these sources of flooding usually combine in a coastal area for a given likelihood of occurrence.

To take account of combined sources of flooding, multiple combinations of storm tide and fluvial flow need to be considered so that a maximum “envelope” of flood extent can be produced. The relationship between the probability of storm tide and the probability of fluvial flow varies with location and depends on the correlation between the two conditions during a weather event. For example, the Flood Management Area in the current Christchurch District Plan is mapped as the maximum envelope of the 0.5% AEP storm tide combined with 5% AEP fluvial flow and the 5% AEP storm tide combined with 0.5% AEP fluvial flow.

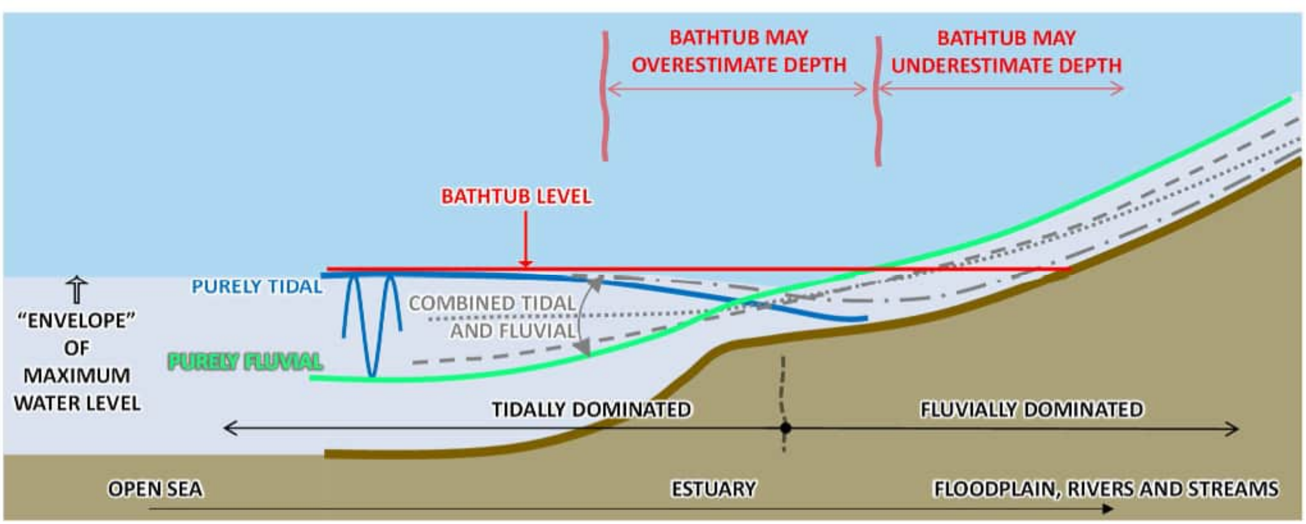



Figure 6.2: Conceptual cross-section of a coastal area comparing maximum flood levels for purely tidal events, purely fluvial events and a range of combined events, all of the same likelihoods of occurring. The bathtub level of maximum storm tide is shown for comparison.

Figure 6.2 also shows how the bathtub method compares to an envelope of maximum flood level derived from a range of combined events. In the bathtub method the storm tide level is projected across the entire coastal area to estimate the inundation depths. In the tidally dominated area, the flood level may fall inland, below the storm tide level, as water spreads out over the floodplain and up estuaries. The bathtub method tends to overestimate the flood level and depth in this area. Further inland, flood levels may be higher than the storm tide level due to the additional contribution to flooding from fluvial flow or rainfall and the bathtub method may underestimate the flood level and depth.

The coastal inundation processes and the interaction of the different sources of flooding during a storm event are naturally dynamic and accurate mapping of flood extents and depths usually requires hydrodynamic modelling of multiple combinations of events. However, the tendency of the storm tide to dominate flood level in areas closest to the coastline means that the difference between a simple bathtub approach and hydrodynamic modelling can be relatively small. In these areas the bathtub method also tends to be conservative and overestimates flood depth. In this way the method can be considered appropriate as a precautionary approach to defining flood risk for the purpose of land use planning at a district level. More detailed investigation of flooding may be appropriate for assessing individual developments or activities.

The uncertainty in flood depths using the bathtub method with a storm tide level generally increases the further inland it is applied. This is because in reality the storm tide level usually becomes increasingly attenuated as it travels inland due to frictional resistance and storage in the floodplain and river channels (although in some estuaries the tide level can increase due to “funnelling” of flow). Flooding from fluvial and pluvial events also starts to become more important than the tidal event of the same probability and these sources of flooding cannot be readily included in the bathtub method. The increase in uncertainty means there is a limit to how far inland the bathtub method is appropriate for planning purposes.

Figure 6.3 shows the difference between flood depths produced from a hydrodynamic model simulation of a storm tide event in the Avon-Heathcote estuary (Tonkin & Taylor, 2017: TUFLOW model simulation of 1% AEP storm tide and SLR to 2115, RCP8.5H+) and a bathtub projection of the peak storm tide level (inferred to be approximately 3.2m LVD37 inside the estuary mouth). The model simulation is for a purely tidal event, without any contribution from fluvial flow or rainfall. The map shows that inland from the main estuary the difference in depth between the two methods is generally negative in value i.e., the model depths are smaller than the bathtub depths– and the difference increases inland.

Figure 6.3 also shows the inland limit of the bathtub depth data produced for the CHA. The difference in depth at the bathtub data limit is around 0.3m, i.e., the bathtub depth is 0.3m greater than the hydrodynamic model for the same storm tide level at the mouth of the estuary, providing an indication of the likely range of uncertainty in the CHA inundation depth data for purely tidal events.

Since this dataset tends to be conservative within the area of coverage defined in the CHA, we consider it unnecessary to include an additional allowance for uncertainty in the depth data for mapping the inundation area or defining flood risk. However, in areas of higher flood risk, mitigation measures such as minimum floor level requirements should include an appropriate freeboard allowance above estimated flood level. More detailed assessment of flood level, including consideration of flooding from other sources, may be warranted for individual properties or developments to determine floor levels or other planning requirements.

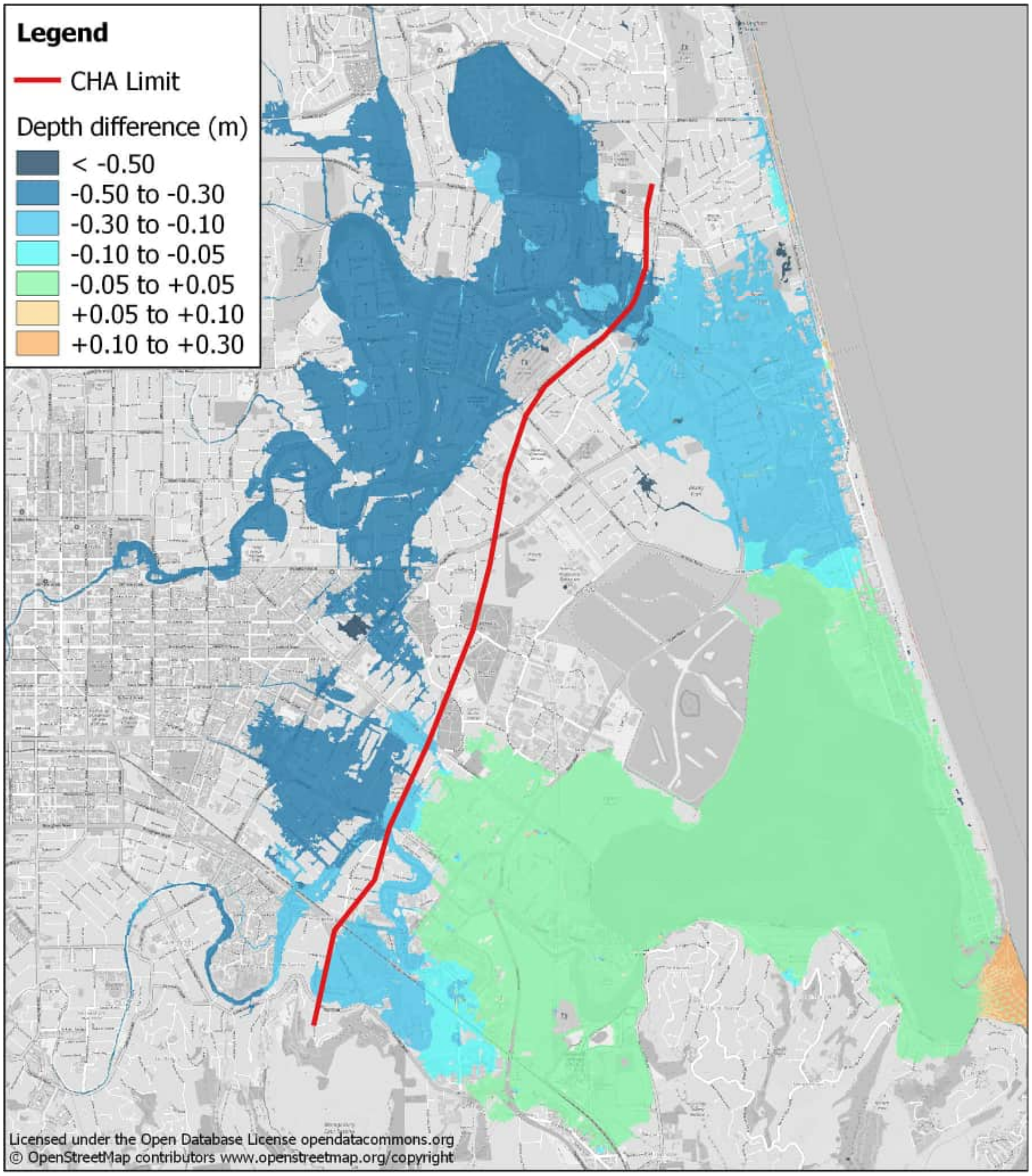



Figure 6.3: Map showing the difference between storm tide flood depths derived from a hydrodynamic model simulation and from a bathtub projection of the storm tide level (~3.2m LVD37). The difference is positive where the model depths are larger than the bathtub depths and vice versa. The maps also the limit of application of the bathtub method in the CHA.

## 6.3 Inundation Factors

### 6.3.1 Likelihood of Flooding

The likelihood of a given magnitude of flooding (water level or depth, for example) is usually measured by the Average Recurrence Interval (ARI) – how often, on average it occurs – or the Annual Exceedance Probability (AEP) – the chance it will happen in any one year.

The chance a given magnitude event will occur increases with the length of time considered, as summarised in Table 6.2.

Table 6.2: Likelihood of flooding over varying time periods

| Flood magnitude | ARI | AEP | Chance an event will occur during a period of | | |
|---|---|---|---|---|---|
| | | | 30 years | 60 years | 100 years |
| “Small” | 5 years | 20% | 100% | 100% | 100% |
| ↓ | 10 years | 10% | 96% | 100% | 100% |
| ↓ | 20 years | 5% | 79% | 95% | 99% |
| ↓ | 50 years | 2% | 45% | 70% | 87% |
| ↓ | 100 years | 1% | 26% | 45% | 63% |
| “Large” | 200 years | 0.5% | 14% | 26% | 39% |

The chance that a low probability event (such as the 1% or 0.5% AEP) will occur becomes relatively likely (a 40% to 50% chance) when considering a time period of 60 to 100 years. With reference to the requirements of Section 5 of the RMA, this chance of occurrence is considered to be consistent with being “reasonably foreseeable” and supports adopting a relatively low probability to define areas at risk of flooding. The smallest probability for which inundation data is provided in the CHA is the 1% AEP, which is considered a reasonably foreseeable event over the lifetime of a development.

Inundation mapping for planning and development control is often based on one or more likelihoods or probability of flooding. The Christchurch District Plan defines the Flood Management Area as the 0.5% AEP flood extent and the High Flood Hazard Management Area through the 0.2% AEP flood extent (with the inclusion of a water depth and velocity criterion). The Canterbury RPS defines areas subject to inundation as lying within the 0.5% AEP flood extent. By comparison, the UK Environment Agency’s Flood Map for Planning (Rivers and Sea) defines four Flood Zones according to three likelihoods of flooding (from any source or combination of sources) as shown in Figure 6.4.[25]

[25] Table 1 of Guidance - Flood risk and coastal change, Ministry of Housing, Communities & Local Government, www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables

| Flood Zone | Definition |
|---|---|
| Zone 1 Low Probability | Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3) |
| Zone 2 Medium Probability | Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map) |
| Zone 3a High Probability | Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.(Land shown in dark blue on the Flood Map) |
| Zone 3b The Functional Floodplain | This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map) |

Figure 6.4: Definition of Flood Zones in the UK Flood Map for Planning (Rivers and Sea)

### 6.3.2 Consequence of flooding

The consequence of flooding can be quantified in terms of financial costs for example, damages to property and assets, loss of possessions, disruption to services. This requires a detailed assessment of the value of properties and assets and calculation of damages for a range of flood probabilities and is usually applied to assessing protection of existing development rather than planning new development.

For planning purposes, the consequence is more usually quantified in terms of the 'flood hazard', a measure of the severity of the danger to people and vehicles and of damage to or failure of buildings during a flood. Methods for evaluating flood hazard, based on scientific research which includes full scale laboratory testing, are provided in Australian[26] ("the AR&R method") and UK[27] ("the DEFRA method") guidelines amongst others.

In these methods, flood hazard is generally defined as a function of the depth and velocity of the flood water. Additional factors such as the effects of debris in flood water are included in some methods. Figure 6.5 and Figure 6.6 show respectively the Combined Hazard Vulnerability Curves of the AR&R method and the Hazard to People Classification of the DEFRA method.

In the flood hazard curves in Figure 6.5, the thresholds for hazard to people are lower than for buildings, and the thresholds for hazard to vehicles are lower than for people. For lower velocities, less than 0.5 m/s, the hazard thresholds are independent of velocity and defined by water depth only. The hazard ratings in Figure 6.6 also depend on velocity for velocities below between 2.5 and 4.0 m/s, depending on water depth.

The CHA bathtub method does not determine velocity and so this data is not available for assessing hazard. From our experience of coastal inundation modelling using hydrodynamic models, for example in assessing coastal inundation hazards for Waimakariri District Council, velocities in floodplain areas are usually relatively low – below the 0.5 m/s value for inclusion in hazard definition in the AR&R method (Figure 6.5), for example. For these reasons we consider it appropriate to categorise flood hazard solely on depth and to use the "still water" depth thresholds from hazard guidelines to categorise flood hazard from the CHA bathtub depth data. We also note that the contribution of velocity to hazard was considered during the Christchurch Replacement District Plan

[26] Australian Rainfall and Runoff: A Guide to Flood Estimation, Book 6, Chapter 7 (Smith and Cox, 2019)
[27] Framework and Guidance for Assessing and Managing Flood Risk for New Development, UK Defra/Environment Agency Flood and Coastal Defence R&D Programme FD2320/TR22

review process[28] in relation to the definition of the High Flood Hazard Management Area. This area was found to be largely defined by the water depth criterion rather than the combined depth and velocity criterion since, away from the main river channels, velocity was generally low.

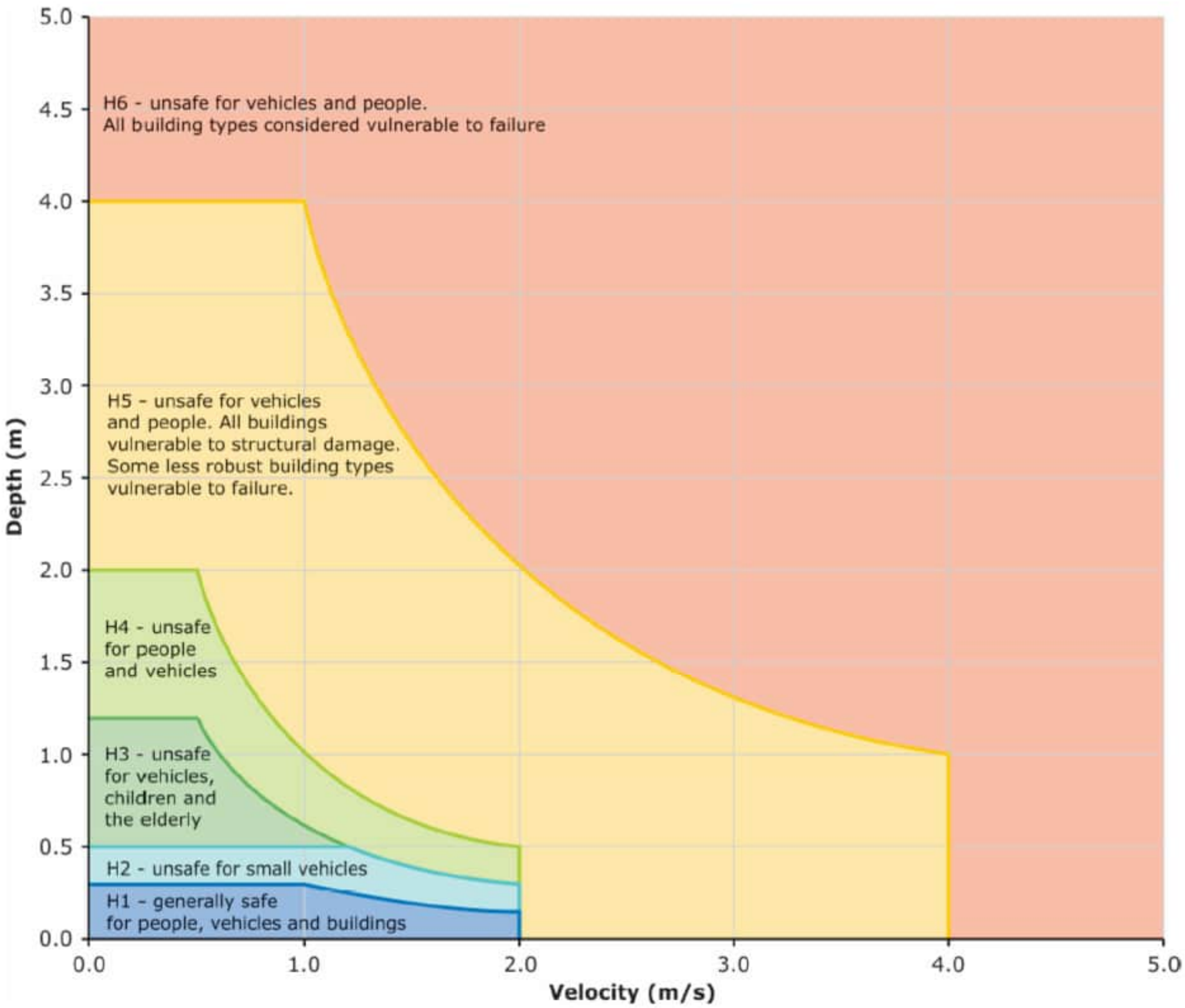



Figure 6.5: Combined flood hazard curves (Figure 6.7.9 of Australian Rainfall and Runoff: A Guide to Flood Estimation, Book 6, Chapter 7)

[28] Independent Hearings Panel, Christchurch Replacement District Plan, Decision 53, Chapter 5: Natural Hazards – Stage 3, 2016

| HR | Depth of flooding - d (m) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DF = 0.5 | | | | DF = 1 | | | | | | | | |
| Velocity v (m/s) | 0.05 | 0.10 | 0.20 | 0.25 | 0.30 | 0.40 | 0.50 | 0.60 | 0.80 | 1.00 | 1.50 | 2.00 | 2.50 |
| 0.0 | 0.03 + 0.5 = 0.53 | 0.05 + 0.5 = 0.55 | 0.10 + 0.5 = 0.60 | 0.13 + 0.5 = 0.63 | 0.15 + 1.0 = 1.15 | 0.20 + 1.0 = 1.20 | 0.25 + 1.0 = 1.25 | 0.30 + 1.0 = 1.30 | 0.40 + 1.0 = 1.40 | 0.50 + 1.0 = 1.50 | 0.75 + 1.0 = 1.75 | 1.00 + 1.0 = 2.00 | 1.25 + 1.0 = 2.25 |
| 0.1 | 0.03 + 0.5 = 0.53 | 0.06 + 0.5 = 0.56 | 0.12 + 0.5 = 0.62 | 0.15 + 0.5 = 0.65 | 0.18 + 1.0 = 1.18 | 0.24 + 1.0 = 1.24 | 0.30 + 1.0 = 1.30 | 0.36 + 1.0 = 1.36 | 0.48 + 1.0 = 1.48 | 0.60 + 1.0 = 1.60 | 0.90 + 1.0 = 1.90 | 1.20 + 1.0 = 2.20 | 1.50 + 1.0 = 2.55 |
| 0.3 | 0.04 + 0.5 = 0.54 | 0.08 + 0.5 = 0.58 | 0.15 + 0.5 = 0.65 | 0.19 + 0.5 = 0.69 | 0.23 + 1.0 = 1.23 | 0.30 + 1.0 = 1.30 | 0.38 + 1.0 = 1.38 | 0.45 + 1.0 = 1.45 | 0.60 + 1.0 = 1.60 | 0.75 + 1.0 = 1.75 | 1.13 + 1.0 = 2.13 | 1.50 + 1.0 = 2.50 | 1.88 + 1.0 = 2.88 |
| 0.5 | 0.05 + 0.5 = 0.55 | 0.10 + 0.5 = 0.60 | 0.20 + 0.5 = 0.70 | 0.25 + 0.5 = 0.75 | 0.30 + 1.0 = 1.30 | 0.40 + 1.0 = 1.40 | 0.50 + 1.0 = 1.50 | 0.60 + 1.0 = 1.60 | 0.80 + 1.0 = 1.80 | 1.00 + 1.0 = 2.00 | 1.50 + 1.0 = 2.50 | 2.00 + 1.0 = 3.00 | 2.50 + 1.0 = 3.50 |
| 1.0 | 0.08 + 0.5 = 0.58 | 0.15 + 0.5 = 0.65 | 0.30 + 0.5 = 0.80 | 0.38 + 0.5 = 0.88 | 0.45 + 1.0 = 1.45 | 0.60 + 1.0 = 1.60 | 0.75 + 1.0 = 1.75 | 0.90 + 1.0 = 1.90 | 1.20 + 1.0 = 2.20 | 1.50 + 1.0 = 2.50 | 2.25 + 1.0 = 3.25 | 3.00 + 1.0 = 4.00 | 3.75 + 1.0 = 4.75 |
| 1.5 | 0.10 + 0.5 = 0.60 | 0.20 + 0.5 = 0.70 | 0.40 + 0.5 = 0.90 | 0.50 + 0.5 = 1.00 | 0.60 + 1.0 = 1.60 | 0.80 + 1.0 = 1.80 | 1.00 + 1.0 = 2.00 | 1.20 + 1.0 = 2.20 | 1.60 + 1.0 = 2.60 | 2.00 + 1.0 = 3.00 | 3.00 + 1.0 = 4.00 | 4.00 + 1.0 = 5.00 | 5.00 + 1.0 = 6.00 |
| 2.0 | 0.13 + 0.5 = 0.63 | 0.25 + 0.5 = 0.75 | 0.50 + 0.5 = 1.00 | 0.63 + 0.5 = 1.13 | 0.75 + 1.0 = 1.75 | 1.00 + 1.0 = 2.00 | 1.25 + 1.0 = 2.25 | 1.50 + 1.0 = 2.50 | 2.00 + 1.0 = 3.00 | 3.50 | 4.75 | 6.00 | 7.25 |
| 2.5 | 0.15 + 0.5 = 0.65 | 0.30 + 0.5 = 0.80 | 0.60 + 0.5 = 1.10 | 0.75 + 0.5 = 1.25 | 0.90 + 1.0 = 1.90 | 1.20 + 1.0 = 2.20 | 1.50 + 1.0 = 2.50 | 1.80 + 1.0 = 2.80 | 3.40 | 4.00 | 5.50 | 7.00 | 8.50 |
| 3.0 | 0.18 + 0.5 = 0.68 | 0.35 + 0.5 = 0.85 | 0.70 + 0.5 = 1.20 | 0.88 + 0.5 = 1.38 | 1.05 + 1.0 = 2.05 | 1.40 + 1.0 = 2.40 | 1.75 + 1.0 = 2.75 | 3.10 | 3.80 | 4.50 | 6.25 | 8.00 | 9.75 |
| 3.5 | 0.20 + 0.5 = 0.70 | 0.40 + 0.5 = 0.90 | 0.80 + 0.5 = 1.30 | 1.00 + 0.5 = 1.50 | 1.20 + 1.0 = 2.20 | 1.60 + 1.0 = 2.60 | 3.00 | 3.40 | 4.20 | 5.00 | 7.00 | 9.00 | 11.00 |
| 4.0 | 0.23 + 0.5 = 0.73 | 0.45 + 0.5 = 0.95 | 0.90 + 0.5 = 1.40 | 1.13 + 0.5 = 1.63 | 1.35 + 1.0 = 2.35 | 1.80 + 1.0 = 2.80 | 3.25 | 3.70 | 4.60 | 5.50 | 7.75 | 10.00 | 12.25 |
| 4.5 | 0.25 + 0.5 = 0.75 | 0.50 + 0.5 = 1.00 | 1.00 + 0.5 = 1.50 | 1.25 + 0.5 = 1.75 | 1.50 + 1.0 = 2.50 | 2.00 + 1.0 = 3.00 | 3.50 | 4.00 | 5.00 | 6.00 | 8.50 | 11.00 | 13.50 |
| 5.0 | 0.28 + 0.5 = 0.78 | 0.60 + 0.5 = 1.10 | 1.10 + 0.5 = 1.60 | 1.38 + 0.5 = 1.88 | 1.65 + 1.0 = 2.65 | 3.20 | 3.75 | 4.30 | 5.40 | 6.50 | 9.25 | 12.00 | 14.75 |

| Flood Hazard Rating (HR) | Colour Code | Hazard to People Classification |
|---|---|---|
| Less than 0.75 | | Very low hazard - Caution |
| 0.75 to 1.25 | | Danger for some – includes children, the elderly and the infirm |
| 1.25 to 2.0 | | Danger for most – includes the general public |
| More than 2.0 | | Danger for all – includes the emergency services |

Figure 6.6: Hazard to People Classification using Hazard Rating (Table 13.1 from Framework and Guidance for Assessing and Managing Flood Risk for New Development, UK Defra/Environment Agency Flood and Coastal Defence R&D Programme FD2320/TR22– Extended version) – Hazard Rating (HR) = d x (v+0.5) + DF (d is water depth, v is velocity and DF is the Debris Factor)

The DEFRA method specifically considers the hazards to people while the AR&R method considers hazards to people, vehicles, and buildings. However, the lower flood depth thresholds in the AR&R method reflect hazard to people rather than hazard to buildings. The District Plan primarily controls the development of buildings and infrastructure, for which the depth of water for a given severity of hazard is higher than that for people. Although buildings and other infrastructure can be designed and constructed to perform safely in areas of relatively deep flooding, most development will be occupied or used by people who will need to access or egress buildings during a flood. The depth thresholds for the same category of hazard are lower for people than for buildings. We therefore consider it appropriate, and consistent with the requirements of Section 6(h) of the RMA to consider "significant risks", to define flood hazard depth thresholds based on hazards to people, considering the AR&R and DEFRA thresholds.

### 6.3.3 Change in Likelihood and Consequences in the Future

The likelihood and consequences of coastal inundation in the district will increase in the future due to sea level rise resulting from climate change, which will increase storm tide levels. Figure 6.7 shows how the frequency of the present day 100-year and 10-year storm tides in the Avon-Heathcote estuary, as defined in the CHA, will increase in the future based on MfE (2017) projections of sea level rise for the RCP8.5H+ scenario.

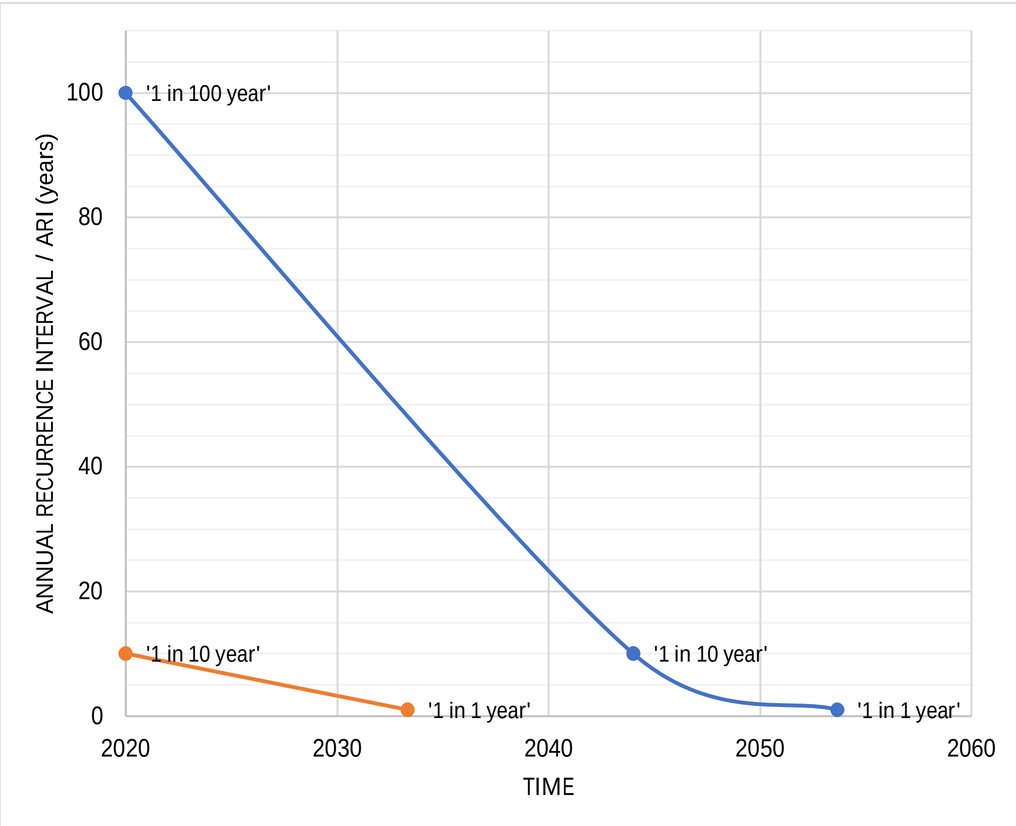



Figure 6.7: Change in Annual Recurrence Interval of present-day 100-year and 10-year ARI storm tides in the Avon-Heathcote estuary (RCP8.5H+ scenario of MfE 2017)

Land use planning should take account of reasonably foreseeable amounts of SLR in considering coastal inundation hazard. Figure 6.7 shows that based on current projections, the frequency of present-day extreme tides will increase rapidly over the next 20 to 40 years. The effect of SLR on inundation can be included by mapping inundation for representative scenarios of SLR values combined with the present-day storm tide level. We have selected SLR values of 0.6m and 1.2m as "lower" and "higher" SLR scenarios for inundation mapping as set out in Section 5 of this report.

The lower value SLR scenario is more likely to occur within the planning timeframe (it will occur sooner) than the higher value. There is less confidence in the timing of the higher value SLR scenario (it will occur later) but it can reasonably be expected to occur at some point in the future.

## 6.4 Mapping Methods

### 6.4.1 Methods

Two main methods for categorising and mapping coastal inundation for the district have been assessed as summarised below.

Method 1: Inundation categorised according to the likelihood or frequency of flooding, regardless of the depth of flood water. In this method we have used the CHA bathtub flood extent for the 10-year ARI and 100-year ARI (10% and 1% AEP) flood events as thresholds to define three inundation categories. Although the 1-year ARI (63% AEP) flood extent is also available from the T+T bathtub assessment, these areas are generally well known to be regularly inundated and there is little need for additional planning controls.

Method 2: Inundation categorised by hazard severity, defined by the maximum depth of flood water during a low frequency event. In this method we have used the CHA bathtub water depths for the 100-year ARI (1% AEP) storm tide event – the smallest probability considered in the CHA – to categorize flood hazard. Two different hazard classification systems were also tested:

> Method 2a: Water depth bands based on the AR&R method (Combined Hazard Vulnerability Curves of "Australian Rainfall and Runoff: A Guide to Flood Estimation", Book 6).
>
> Method 2b: Water depth thresholds based on the DEFRA method (Hazard to People Classification of "Framework and Guidance for Assessing and Managing Flood Risk for New Development", UK DEFRA R&D Technical Report FD2320/TR2).

Both the classification systems consider flood water velocity as a factor in categorising hazard. Since the bathtub method does not determine velocity, we have categorised hazard using the "still water" depth criteria, or zero velocity.

For both methods, we have produced separate maps for each of the two representative values of SLR selected – a lower value scenario of 0.6m and a higher value scenario of 1.2m – for mapping coastal inundation. Table 6.3 to Table 6.5 summarise the definitions of the inundation categories and SLR scenarios for each method.

Table 6.3: Definition of categories and scenarios for coastal inundation - Method 1 (likelihood)

| Scenario | | Probability of flooding | Rating | Likelihood description | Overall likelihood category |
|---|---|---|---|---|---|
| SLR | Timescale | | | | |
| 0.6 m | Likely to occur soon | Less than 1% AEP | Low | Less likely to flood (<39% chance over 50 years) | Low in the near future |
| | | Between 1% AEP and 10% AEP | Medium | Likely to flood (39% to 99% chance over 50 years) | Medium in the near future |
| | | 10% AEP or greater | High | Very likely to flood (more than 99% chance over 50 years) | High in the near future |
| 1.2m | Unlikely to occur soon, likely to occur later | Less than 1% AEP | Low | Less likely to flood (<39% chance over 50 years) | Low further in the future |
| | | Between 1% AEP and 10% AEP | Medium | Likely to flood (39% to 99% chance over 50 years) | Medium further in the future |
| | | 10% AEP or greater | High | Very likely to flood (more than 99% chance over 50 years) | High further in the future |

Table 6.4: Definition of categories and scenarios for coastal inundation - Method 2a (hazard/flood depth)

| Scenario | | "Bathtub" water depth (1% AEP) | Rating | Hazard description | Overall hazard Category |
|---|---|---|---|---|---|
| SLR | Timescale | | | | |
| 0.6 m | Likely to occur soon | 0 m to 0.5 m | Low | Generally safe for people | Low in the near future |
| | | 0.5 m to 1.2 m | Medium | Unsafe for children and the elderly and for vehicles | Medium in the near future |
| | | Over 1.2 m | High | Unsafe for people and vehicles | High in the near future |
| 1.2m | Unlikely to occur soon, likely to occur later | 0 m to 0.5 m | Low | Safe for people | Low further in the future |
| | | 0.5 m to 1.2 m | Medium | Unsafe for children and the elderly and for vehicles | Medium further in the future |
| | | Over 1.2 m | High | Unsafe for people and vehicles | High further in the future |

Table 6.5: Definition of categories and scenarios for coastal inundation - Method 2a (hazard/flood depth)

| Scenario | | "Bathtub" water depth (1% AEP) | Rating | Hazard description | Overall hazard Category |
|---|---|---|---|---|---|
| SLR | Timescale | | | | |
| 0.6 m | Likely to occur soon | 0 m to 0.3 m | Low | Very low hazard | Low in the near future |
| | | 0.3 m to 0.5 m | Medium | Danger for some (children, elderly, infirm) | Medium in the near future |
| | | Over 0.5 m | High | Danger for most (general public) | High in the near future |
| 1.2m | Unlikely to occur soon, likely to occur later | 0 m to 0.3 m | Low | Very low hazard | Low further in the future |
| | | 0.3 m to 0.5 m | Medium | Danger for some (children, elderly, infirm) | Medium further in the future |
| | | Over 0.5 m | High | Danger for most (generalpublic) | High further in the future |

### 6.4.2 Results

The overall inundation extent for the district, categorised by likelihood of inundation (Method 1) is presented in Figure 6.8.

The mapping shows that over most of Banks Peninsula the extent of inundation is generally small and the additional area inundated in the "medium" likelihood category is very small. This is because the ground level generally rises rapidly from the coastlines and the areas of lower ground are bounded by steeper slopes. The largest area of inundation is in the coastal plain between the mouth of the Avon-Heathcote estuary and the Waimakariri River.

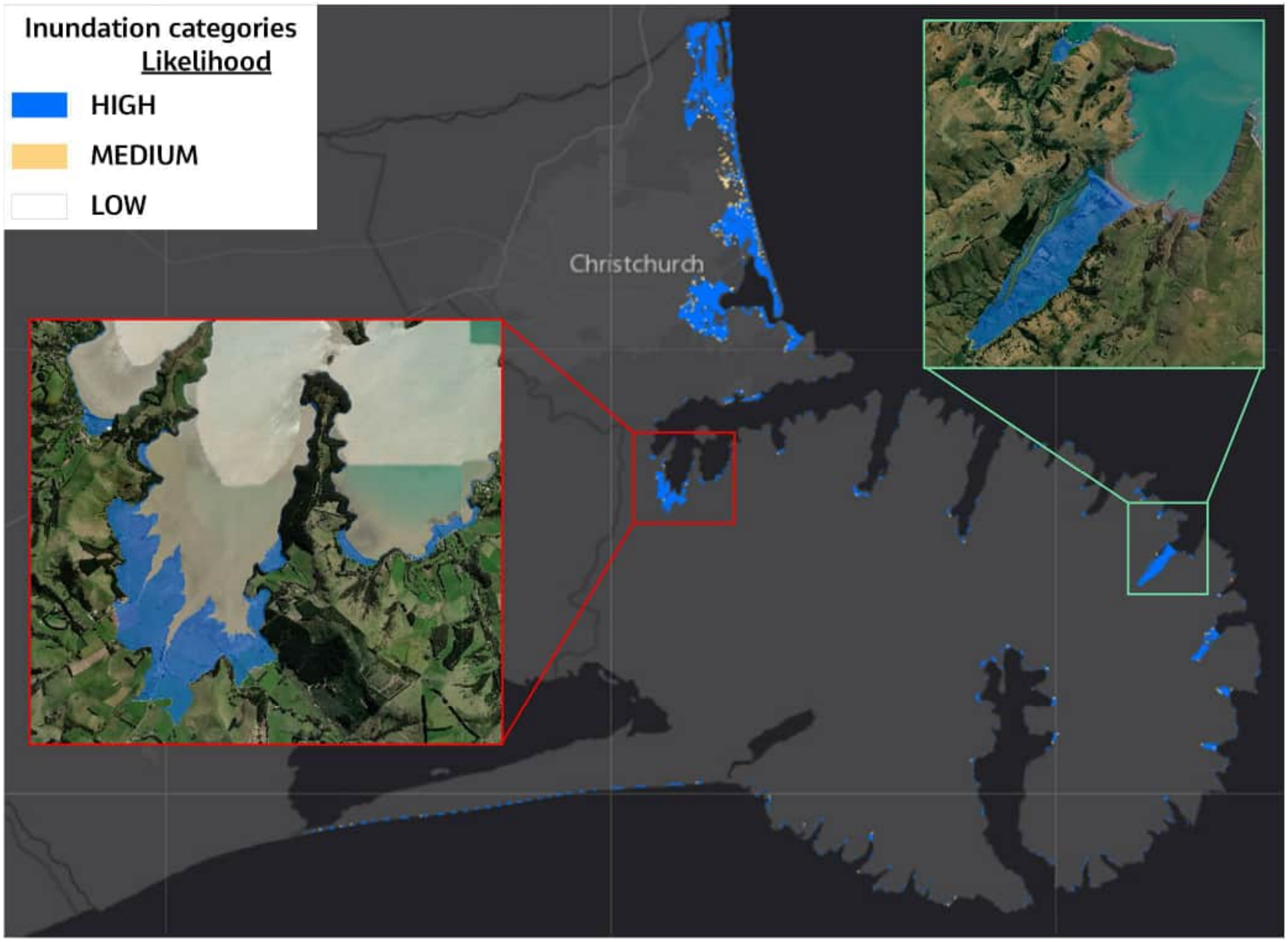



Figure 6.8: Inundation map for Method 1 (flood likelihood) – note that, for clarity, "low" likelihood has not been shaded on the map – it is defined as all land outside of "medium" and "low" likelihood.

*Method 1 Likelihood thresholds*

A sample extract of the inundation map for both SLR scenarios for Method 1 at the southern end of the Avon-Heathcote estuary is provided in Figure 6.9. All maps produced for this assessment are available in a webviewer accessible to the project team. Maps of the preferred approach has been provided to CCC as a spatial layer.

For both SLR scenarios the map shows that the extent of the "high" likelihood category (>10% AEP) is large and the extent of the "medium" likelihood category (1% to 10% AEP) is very small in comparison. This is because the variation in storm tide level for different likelihoods is relatively small (e.g. 0.2m between the 10% and 1% AEP for the southern Avon-Heathcote estuary) and the land is relatively flat and bounded by steeper ground. The difference in flood depth between the two likelihoods is also relatively small compared to typical hazard classification thresholds. Most of the inundated area is categorised as a "high" likelihood of flooding but the actual flood hazard will vary within it.

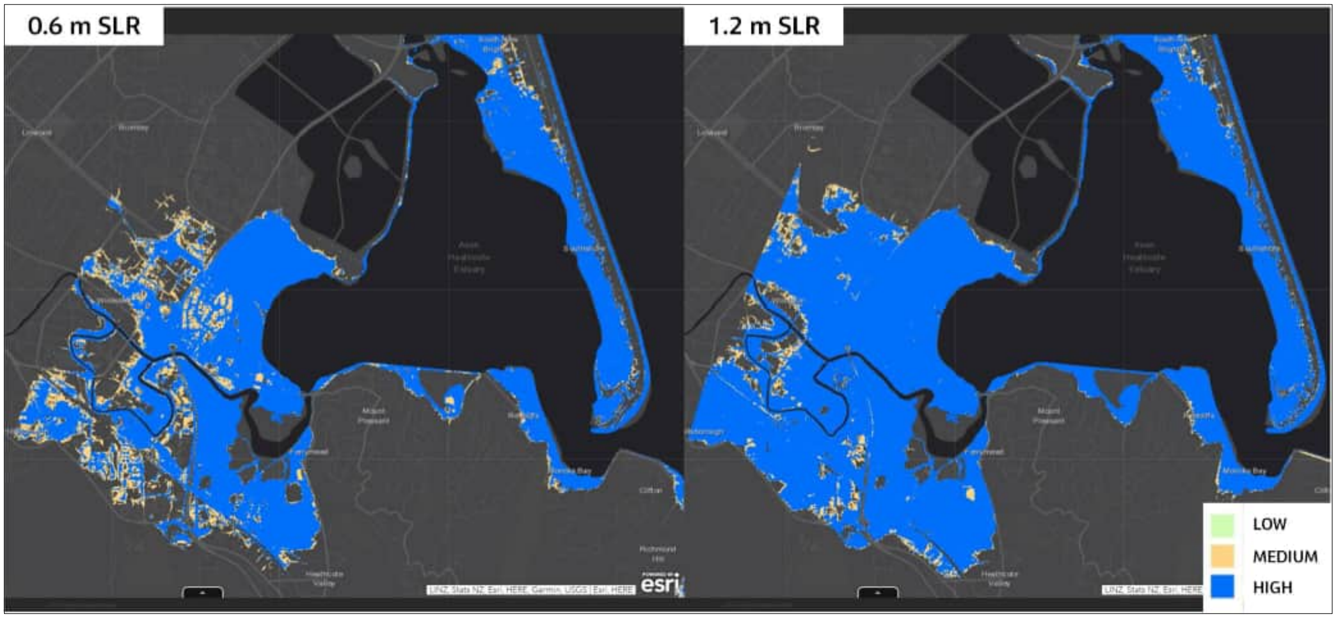



Figure 6.9: Inundation map for Method 1 (flood likelihood) – note that, for clarity, “low” likelihood has not been shaded in the map. It is defined as all land outside of “medium” and “low” likelihood.

Because the difference in inundation extent for different likelihoods is small and the method does not adequately differentiate between areas of higher and lower hazard, this method of categorising inundation is not recommended for planning purposes.

Given the small difference in extents, use of a single likelihood for mapping is appropriate and we recommend using the1% AEP, the smallest for which CHA data is available, for inundation mapping.

*Method 2a Hazard thresholds (AR&R categories)*

A sample extract of the inundation map for both SLR scenarios for Method 2a in show in Figure 6.10.

The map shows clear differentiation between the three categories of hazard for both SLR scenarios when using the AR&R hazard thresholds method applied to the 1% AEP flood depths. The likelihood of inundation is not explicitly taken into account in this method. However, the difference in depths between the 1% AEP and 10%AEP depths (generally between 0.1m and 0.3m) means that when the inundation thresholds are applied to the less likely 1% AEP water depth, they are equivalent to a lower depth threshold for the more likely 10% AEP depths. For example in the south of the Avon-Heathcote estuary the “medium” hazard depth threshold of 0.5m for the 1% AEP corresponds to a depth of 0.3m (similar to the more conservative DEFRA method threshold) for the 10% AEP. In this way the hazard thresholds reflect a lower depth threshold for more frequent events and a higher depth threshold for less frequent events. This is shown in Figure 6.11.

For these reasons this hazard threshold method is recommended as the basis for mapping inundation. However, to avoid the need for separate flood maps for each SLR scenario, it would be preferable to incorporate the effect of SLR on hazard within an overall method.

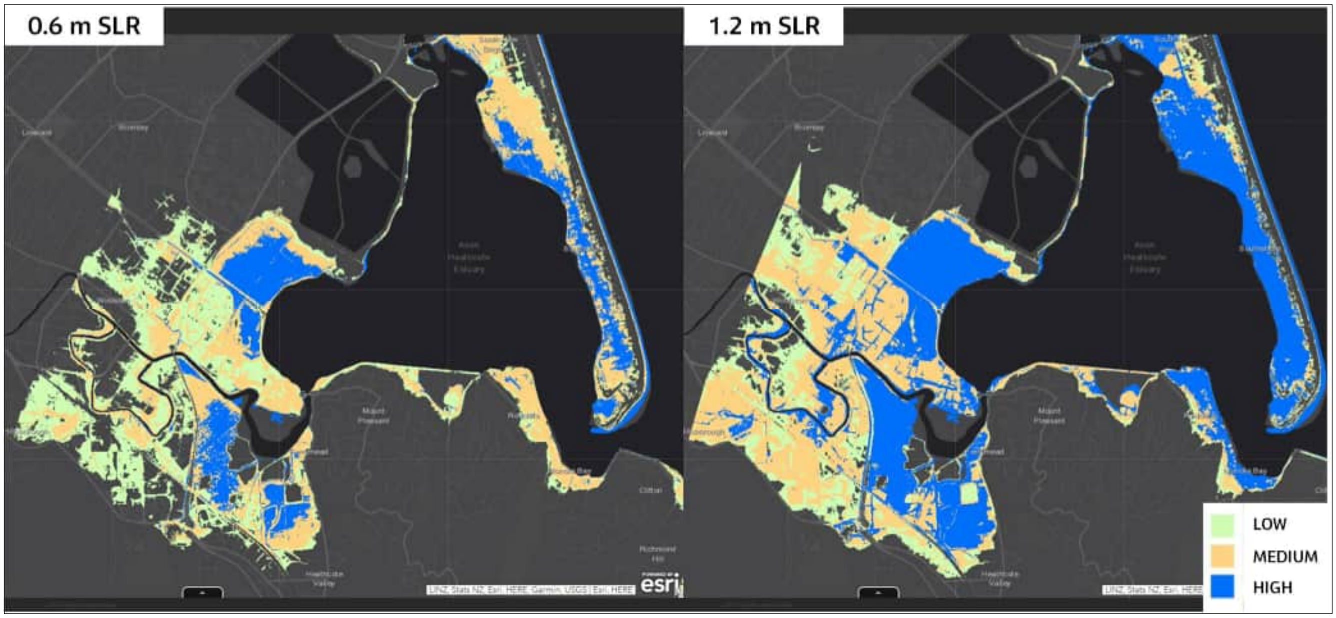



Figure 6.10: Inundation map for Method 2a (flood hazard – AR&R method)

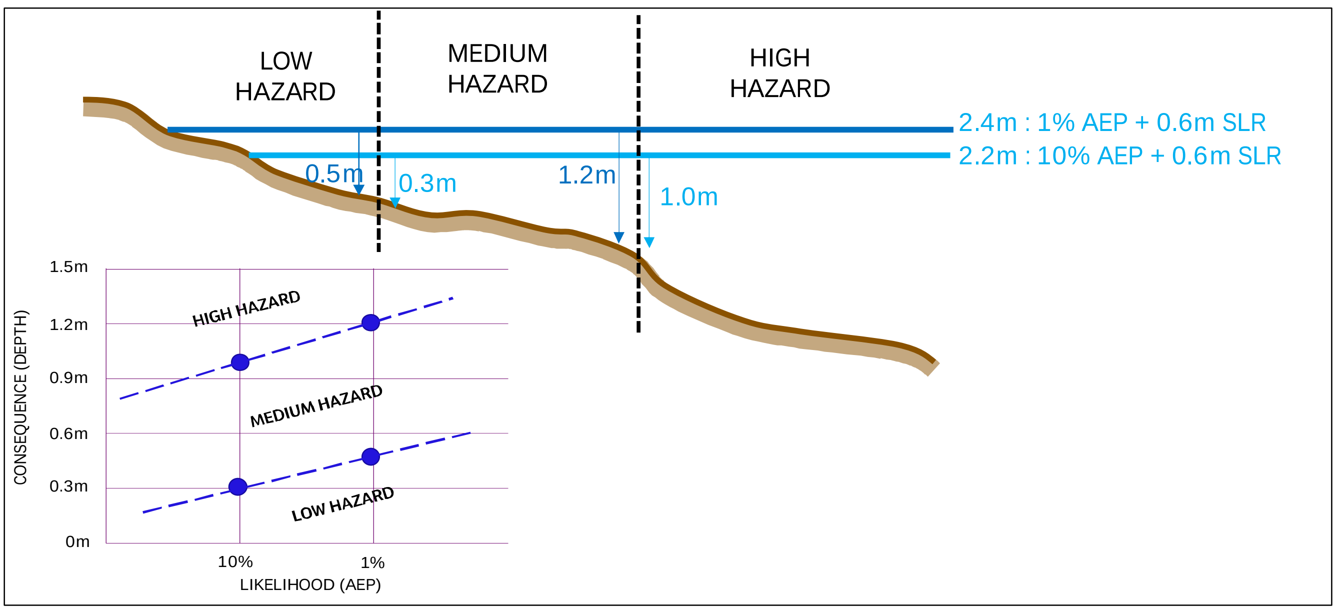



Figure 6.11: Example of the relationship between threshold values for 1% and 10% AEP flood depths using the AR&R method (Avon-Heathcote estuary south)

*Method 2b Hazard thresholds (DEFRA categories)*

A sample extract of the inundation map for both SLR scenarios for Method 2b is provided in Figure 6.12.

The map shows less differentiation between the three categories of hazard for both SLR scenarios when applied to the 1% AEP flood depths than when using the AR&R hazard thresholds method (Method 2a). This is because of the relatively small difference between the “medium” and “high” depth thresholds (0.3m and 0.5m respectively). The “medium” hazard depth threshold of 0.3m applied to the 1% AEP depths equates to a 0.1m or lower threshold when applied to the 10% AEP depths which is less appropriate than the equivalent depths using the AR&R thresholds.

For these reasons we recommend Method 2a (AR&R hazard thresholds) instead of Method 2b (DEFRA hazard thresholds) as the basis for inundation mapping.

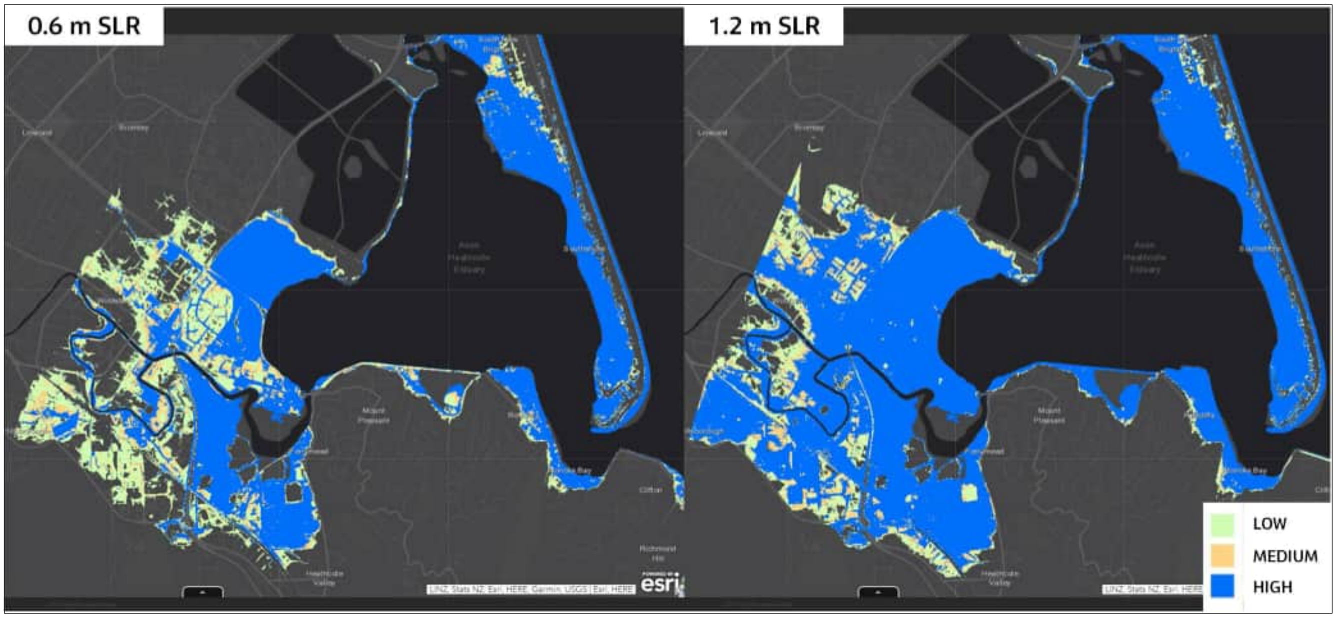



Figure 6.12: Inundation map for Method 2b (flood hazard – DEFRA method)

### 6.4.3 Comparison of Hazard Mapping from Bathtub and Hydrodynamic Model Data

Figure 6.13 compares hazard maps for the recommended thresholds of Method 2b, the AR&R method, using the CHA bathtub data and the hydrodynamic model results presented in Section 6.2.[29]. The storm tide in the model simulations is estimated to be approximately 3.2m LVD37, or around 2.84m NZVD2016, inside the estuary mouth. Figure 6.13 (a) shows the flood hazard categorised from the CHA bathtub data for a water level of 2.8m NZVD2016 (the closest value available in the dataset). Figure 6.13 (b) shows the flood hazard categorised from the TUFLOW model results.

The results show that there is generally little difference in the extents of the hazard categories mapped from the two datasets. This provides confidence in using the bathtub data for this purpose. Most of the differences are close to the inland boundary of the CHA dataset. This reflects the generally small differences in water depths produced by the two methods relative to the hazard category depth ranges and the tendency for larger differences close to the inland limit of the CHA dataset. The results suggest that, for hazard mapping, a minor adjustment of the inland limit of the bathtub mapping could reduce potential inconsistencies with flood mapping for inland areas derived from models.

The area in Aranui, between Pages Road and Breezes Road (circled in red) is connected via a drainage channel to the estuary. The capacity of the drain and the local stormwater network could limit the extent and depth of flooding in this area, as suggested in the TUFLOW model results. However, the model representation of this flow

[29] Tonkin & Taylor, 2017: TUFLOW model simulation of 1% AEP storm tide and SLR to 2115, RCP8.5H+

path may not be sufficiently detailed to accurately simulate inundation through this pathway. In such "disconnected" areas, further assessment of inundation pathways may be needed to reduce uncertainty in the mapped hazard.

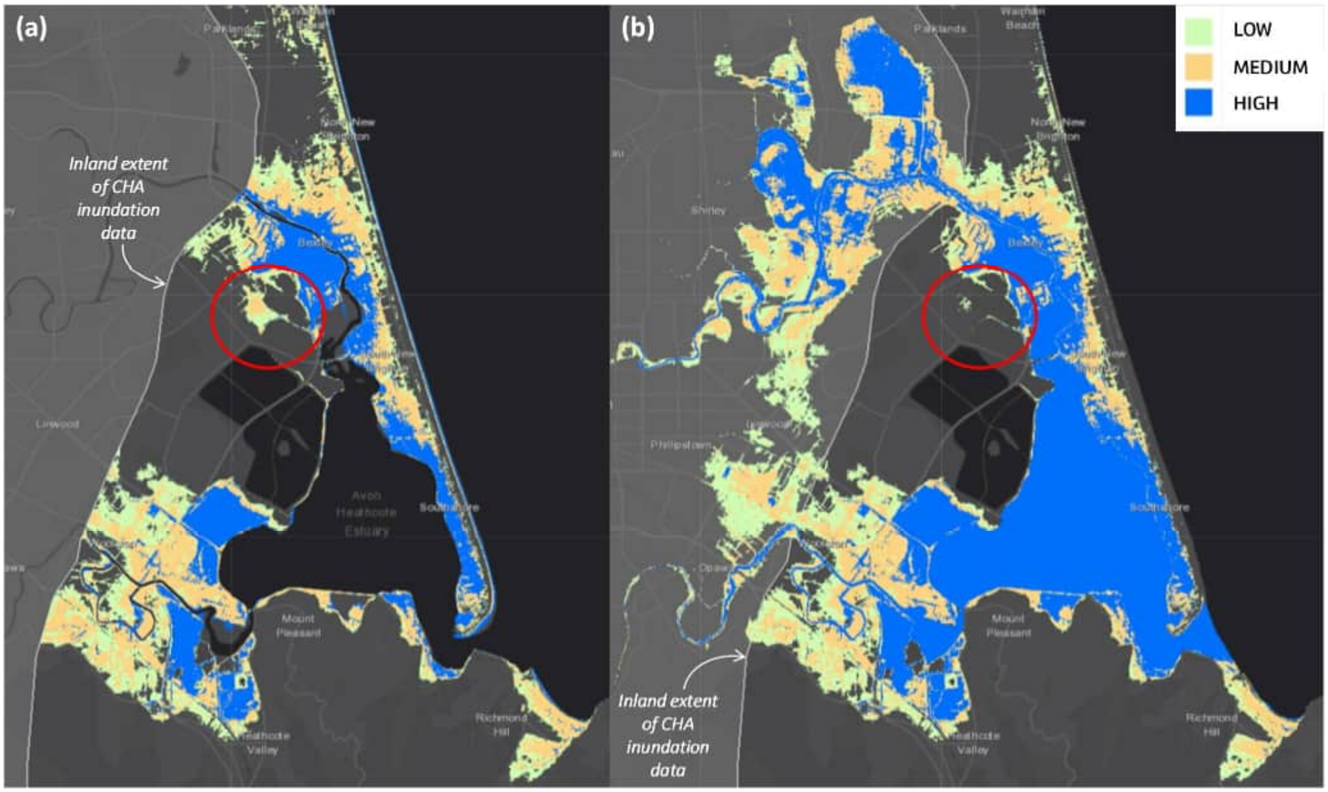



Figure 6.13: Comparison of hazard zones defined using Method 2a (AR&R hazard thresholds) and (a) CHA bathtub data for a water level of 2.8m NZVD201; and (b) T+T TUFLOW model simulations results for a storm tide of ~2.84 mNZVD2016. (Note that land within the estuary, below MHWS, is not mapped in the CHA data). Differences in Aranui circled in red.

## 6.5 Recommended Method and Thresholds

### 6.5.1 Method

From the results of our tests of applying alternative methods and thresholds to the CHA bathtub depth data, we recommend a mapping method which:

- uses a single likelihood of flooding,
- categorises hazard using still water depth thresholds informed by published scientific guidelines,
- includes the effect of SLR for two representative climate change scenarios.

The SLR value can be used as a measure of likelihood instead of the probability of flooding because:

i. it reflects both the degree of certainty of occurrence and the time period in which it is likely to occur

ii. the depth of flooding varies more with SLR than with AEP for a range of "reasonably foreseeable" and "significant" occurrences.

By combining measures of both likelihood and hazard our method defines thresholds and categories of flood risk.

### 6.5.2 Thresholds and Scenarios

We recommend categorising the inundation hazard using the 1% AEP depth data. This is the smallest AEP for which CHA data is available and we consider it is consistent with the purpose of the RMA to promote sustainable management of natural and physical resources, ensures that the District Planning framework considers intergenerational needs, and a precautionary approach is applied.

We recommend the H3 (“unsafe for vehicles, children and the elderly”) and H4 (“unsafe for vehicles and people”) hazard classification thresholds of the Australian Rainfall and Runoff guidelines as upper bounds to defining hazard threshold depths. This reflects the fact that most development will be occupied or used by people who will need to access and egress buildings during a flood and for whom the depth thresholds for the same category of hazard are lower than for buildings. We therefore consider it appropriate, and consistent with the requirements of Section 6(h) of the RMA to consider “significant risks”, to define flood hazard depth thresholds based primarily on hazards to people.

As indicated, our hazard categories we have incorporated SLR values of:

0.6m – a lower value, more certain to occur within the planning timescale and will occur sooner, and

1.2m – a higher value, less certain to occur within the planning timescale and will occur later, but can reasonably be expected to occur at some point in the future

We recommend that the inundation area is mapped using the 1% AEP depths with a SLR value of 1.2m (the higher value). This ensures that areas that may become at risk of flooding in the future are included in planning considerations.

Figure 6.14 shows our recommended values of depth thresholds applied to the 1% AEP flood depths with SLR of 1.2m. The corresponding depths for the 0.6m SLR scenario are shown for comparison. We have used the recommended H3 threshold value of 0.5m as the threshold for “medium hazard”. For the “high” hazard threshold we have used a value of 1.1m applied to the 1% AEP depth. This is slightly lower than the recommended H4 threshold value (1.2m) but corresponds to a depth of 0.5m in the lower SLR scenario, in line with the recommended H3 threshold value.

Table 6.6 presents the threshold values and Figure 6.15 illustrates the depths of water in each flood risk category for the two SLR scenarios.

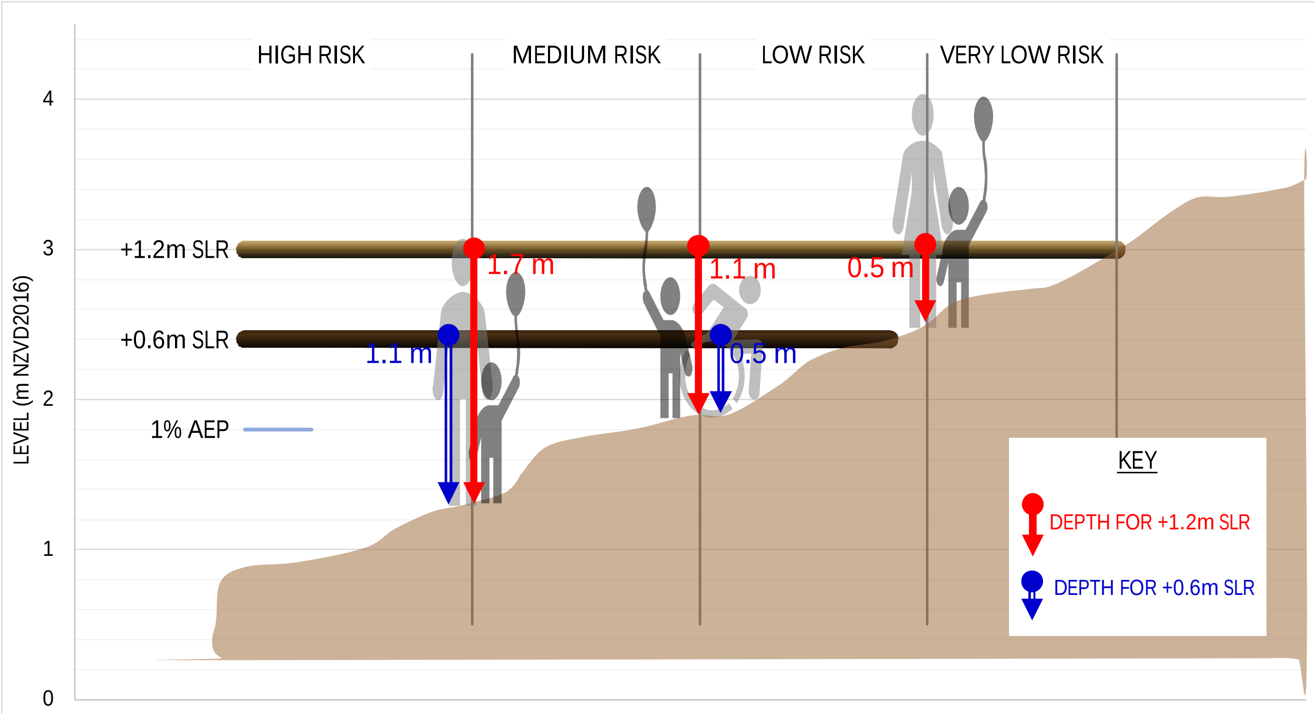



Figure 6.14: Recommended depth thresholds for defining flood risk based on the 1% AEP flood level and 1.2m SLR

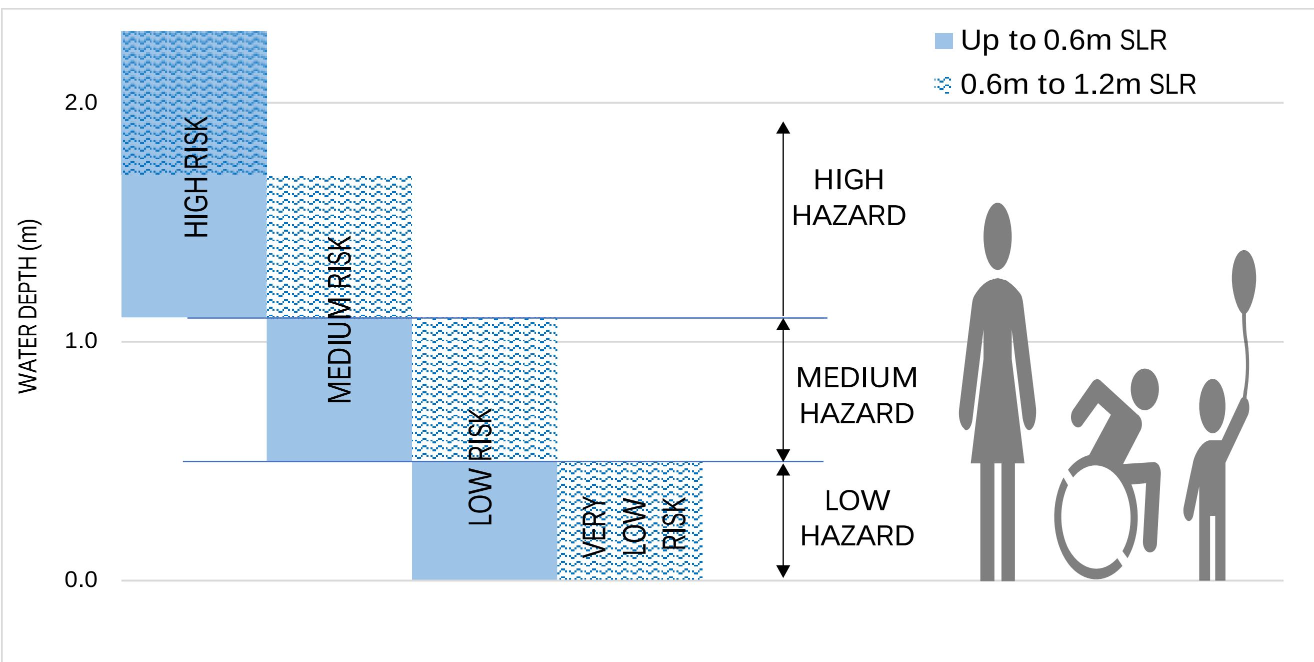



Figure 6.15: Flood risk categories based on the thresholds defined in Figure 6.14

Table 6.6: Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 1% AEP)

| Coastal flood risk category | Flood hazard with 0.6m SLR | | Flood hazard with 1.2m SLR | |
|---|---|---|---|---|
| Very low | None | (dry) | Low | (d < 0.5m) |
| Low | Low | (d < 0.5m) | Medium | (0.5m < d < 1.1m) |
| Medium | Medium | (0.5m < d < 1.1m) | High | (d > 1.1m) |
| High | High | (d > 1.1m) | High | (d > 1.7m) |

### 6.5.3 Comparison of Hazard Mapping with Current Flood Maps

The flood risk categories mapped using the CHA bathtub depth data at two sample locations – the Avon-Heathcote estuary and the Waimakariri River and Brooklands Lagoon area. These areas are shown in Figure 6.16, Figure 6.17 and Figure 6.18. The current District Plan mapping of the High Flood Hazard Management Area, the CCC 0.5% AEP flood extent and the current District Plan Flood Management Area are overlaid for comparison. The 0.5% AEP flood extent is similar to the Flood Management Area overlay of the Christchurch District Plan. However, that overlay also includes land where ground levels are within a height of 250mm above the 0.5% AEP flood level. These were derived from models considered appropriate for use at the time of development of the District Plan (around 2014) and tend to be more extensive than a modelled extent or a bathtub map for a similar storm tide level.

In both sample areas the mapped “high” flood risk area generally aligns with the existing High Flood Hazard Management Area. In the area along the Styx River (Figure 6.17) there are areas within the High Flood Hazard Management Area for which there are no depth values in the CHA bathtub data. These areas are generally bounded by “high” flood risk areas. These areas were masked out of the bathtub data in the CHA methodology because the ground levels are below the Mean High Water Springs (MHWS) tide level. All land below MHWS is excluded from the CHA data for presentation purposes at is regularly inundated without storm tide effects. Lower lying land, beyond the estuaries and shorelines is also excluded. This masking should be removed when applying the data for planning maps so that all land below storm tide level is mapped.

In the area around the Avon-Heathcote estuary, the existing 0.5% AEP flood extent is similar to the extent of the low flood risk area closer to estuary. Further inland the area of low flood risk outside the 0.5% AEP extent increases. The very low flood risk area generally lies beyond the 0.5% AEP extent. These differences are due to the different values of SLR adopted in the two maps (1.2m and 1m), differences in storm tide levels and the increasingly conservative nature of the bathtub map further inland. South of Brooklands lagoon, the bathtub hazard extent is significantly greater than the 0.5% AEP extent. This could be due to attenuation of storm tide in the lagoon and floodplain in the hydrodynamic model used to map the 0.5% AEP extent, or could be due to differences in the tidal boundary water level adopted in the two methods.

The existing Flood Management Area is generally very similar in overall extent to the flood risk area mapped from the CHA bathtub data around the Avon-Heathcote estuary, with generally only the “very low” risk area extending beyond the Flood Management Area.

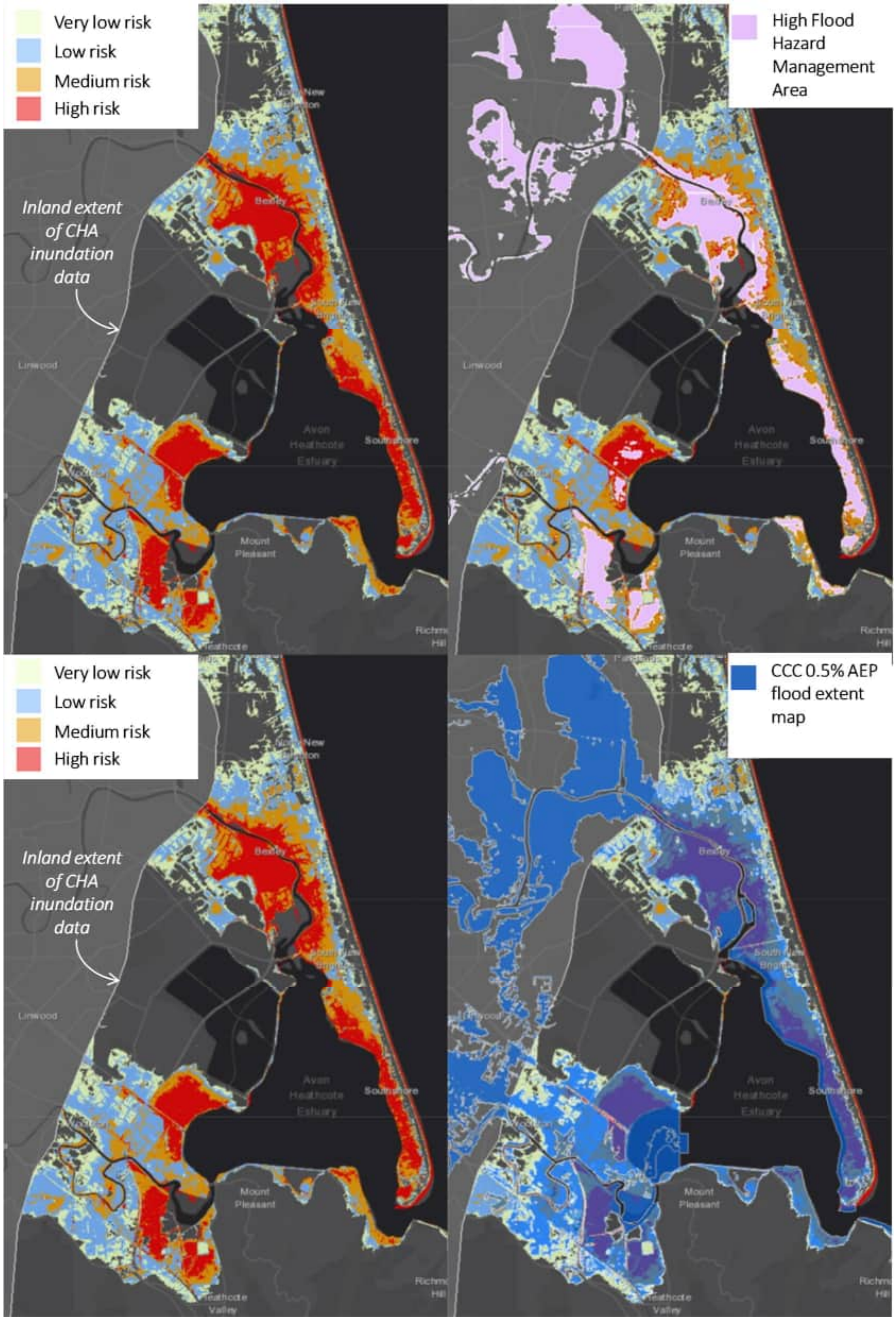



Figure 6.16: Recommended flood risk mapping of coastal inundation compared to current High Flood Hazard Management Area and CCC 0.5% AEP flood extent in the Avon-Heathcote estuary

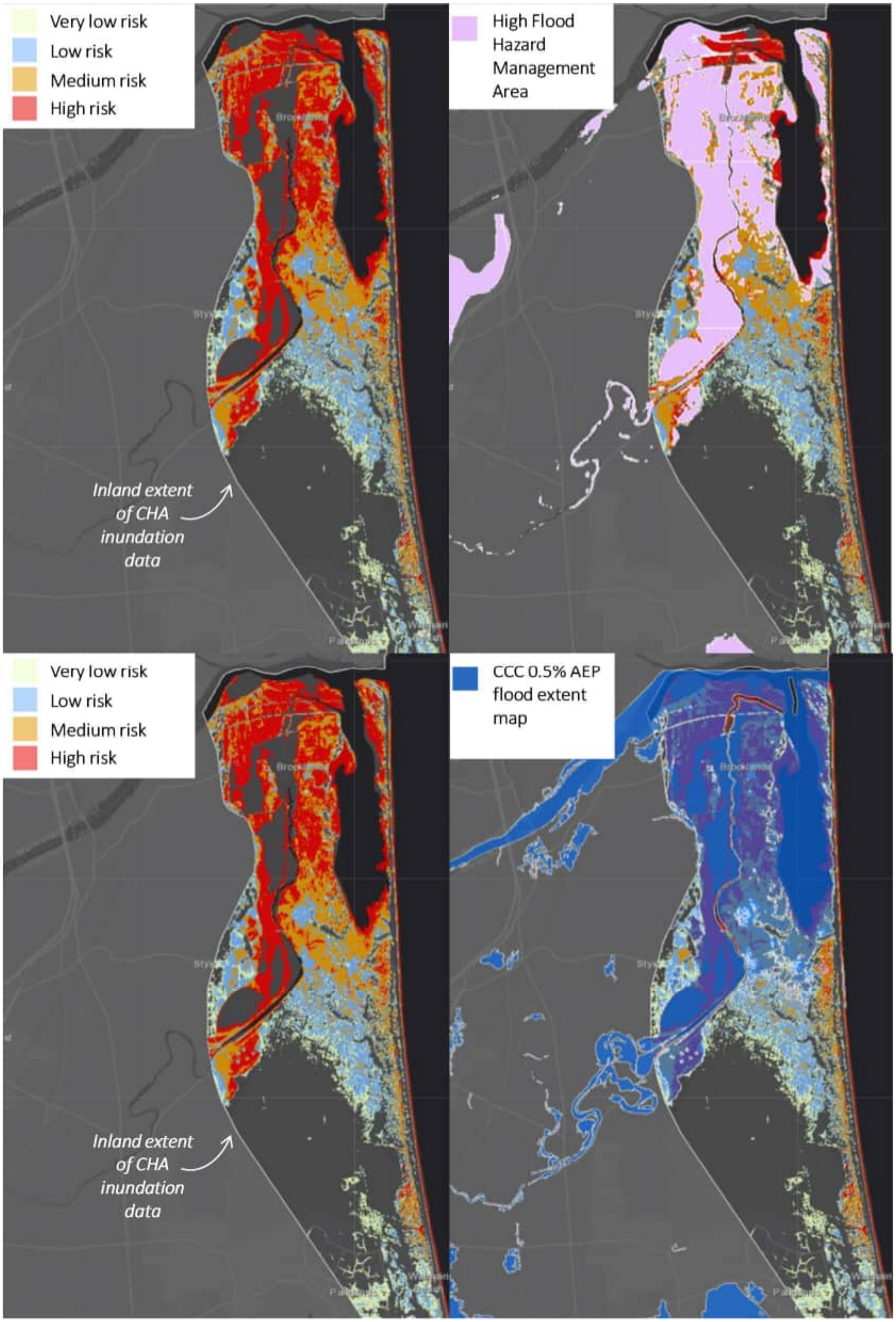



Figure 6.17: Recommended flood risk mapping of coastal inundation compared to current High Flood Hazard Management Area and CCC 0.5% flood extent at the Waimakariri River and Brooklands Lagoon

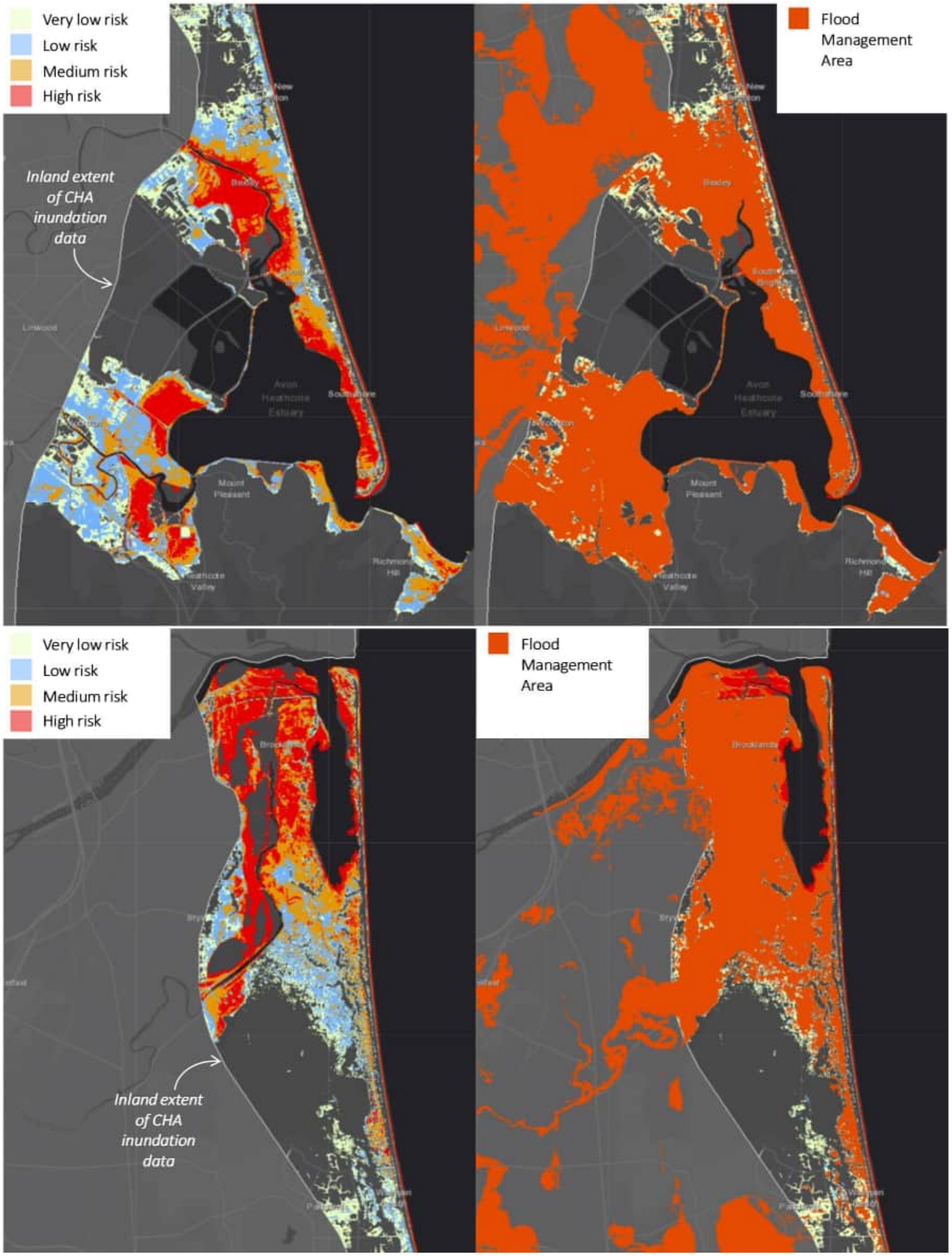



Figure 6.18: Recommended flood risk mapping of coastal inundation compared to current Flood Management Area in the Avon-Heathcote estuary and at the Waimakariri River and Brooklands Lagoon

### 6.5.4 Relationship to Tsunami Inundation

The Scope of Works included the requirement to cross reference the inundation hazard thresholds to tsunami inundation data, to advise on areas of hazard overlap or gaps, and to consider whether an integrated multi hazard approach should influence the risk categories. A number of hydrodynamic tsunami inundation modelling studies for the Christchurch district has been undertaken since 2011 primarily for Civil Defence purposes. The majority of these have involved worst case tsunami scenarios with return periods in the order of 2500 years and are not relevant for comparison with the coastal flood inundation data for this study. However, a 2018 model study[30] for the CCC LDRP multi-hazards study includes a 500 year tsunami scenario, which can be used for comparative assessment. This study involved modelling tsunami inundation depths for Christchurch city area from a South American earthquake source, which previous studies had shown to be the worst-case scenario for Christchurch. As well as present day sea levels, the modelling also included tsunami inundation with 1.06 m SLR by 2120. The modelling did not include Lyttelton or Akaroa Harbours.

The modelling results showed the inundation extent within the city to be 39 km2 for a 500 -year tsunami arriving at current mean sea level, with maximum depth of 5.4 m near the Waimakariri River mouth. The resulting inundation map is presented in Appendix C and shows the main inundation locations with depths in the range 1-5 to 2 m around Brooklands Lagoon, and the low-lying areas around the Avon-Heathcote Estuary and lower river channels. Some inundation was also predicted around the dune openings at New and North Brighton. Extremely high flow velocities (7- 8 m/s) were predicted at the mouth of the Estuary and the Waimakariri River, with high velocities (3-4 m/s) near the dune openings, Sumner and mouths of the Avon and Heathcote Rivers

The inundation maps for the same tsunami scenario arriving with 1.06 m SLR is also presented in Appendix C. The inundation extent is nearly doubled to 70 $km^2$ and reaches a maximum depth of 5.8 m. Depths in many areas around the Styx, Lower Avon and Lower Heathcote and the Estuary are predicted to be greater than 2m. The dunes along the coastal strip are overtopped at numerous locations causing nearly continuous inundation of the land along Marine Parade. Although flow velocities are similar to the current day scenario, the overtopping is likely to erode dunes and causing an increase in inundation that is not captured by the model.

The extent and depth of flooding for (a) the 500 year (0.2%) tsunami with 1.06m SLR and (b) the coastal inundation risk map is compared in Figure 6.19. This was developed using the recommended depth thresholds and the CHA bathtub data for the 1% AEP event with 1.2m SLR for a sample area around the Avon-Heathcote estuary. The maps show that inland from the estuary the overall area at risk from tsunami inundation aligns fairly closely to the CHA flood risk areas and the areas of highest water depth tending to lie within the “medium” and “high” risk areas for coastal inundation. However, tsunami flooding is more extensive and deeper due to the greater height and much greater duration and velocity of water arriving at the shore in a tsunami event.

[30] Passarella C., Arnold J., Lane E.; Land Drainage Recovery Programme: Tsunami Study. NIWA report 2018039CH Prepared for CCC.

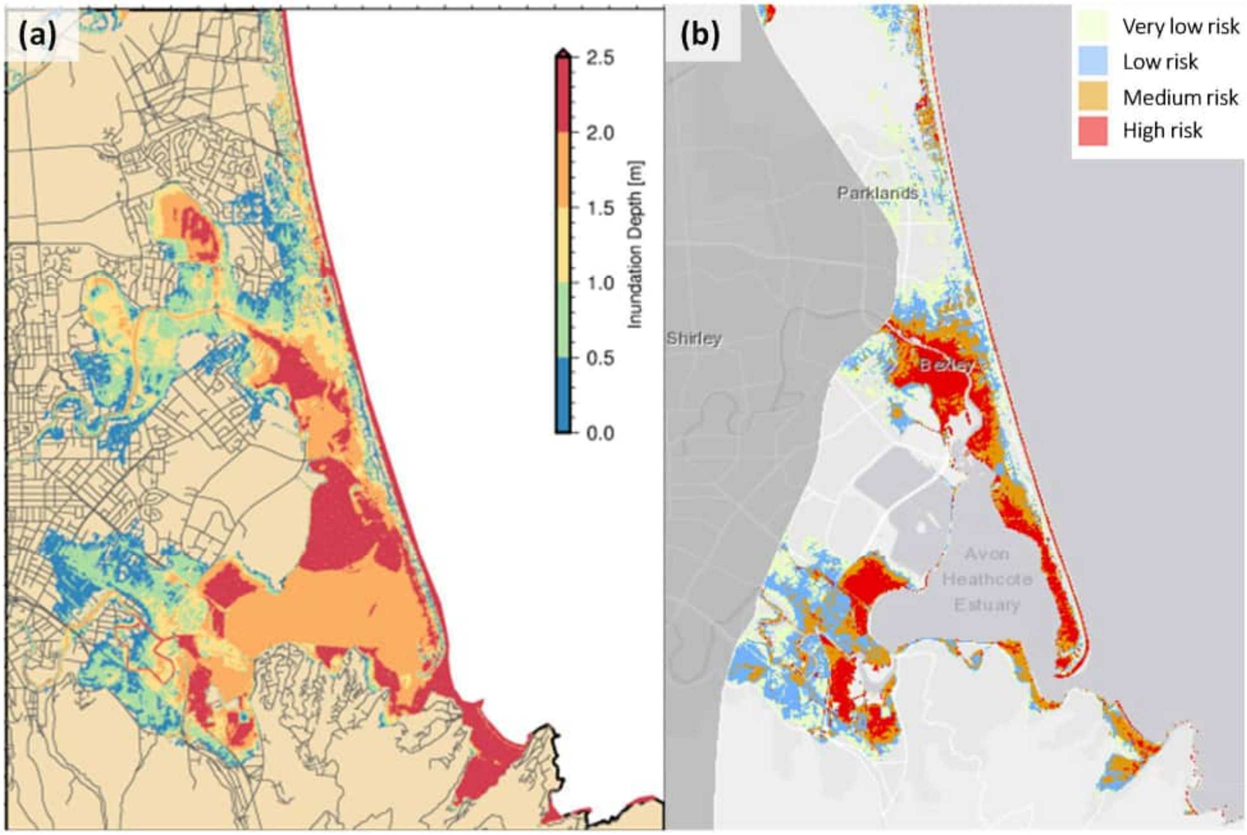



Figure 6.19: Comparison of (a) tsunami inundation map (500 year with 1.06m SLR) and (b) flood risk category map derived using recommended thresholds and the 1% AEP flood depths with 1.2m SLR from the CHA in the Avon-Heathcote estuary.

For the Banks Peninsula and Kaitorete coastline, Environment Canterbury commissioned GNS Science to undertake multiple tsunami source and magnitude modelling over 2019[31] and 2020,[32] which included scenarios from up to 20 Pacific sources that give wave heights in the order 3 m to 5 m along the Peninsula and Kaitorete coast. Although the probabilities of these tsunami events are not given, they are considered to be much more comparative to the flood probabilities than the 2500-year events used in other tsunami modelling. Although the maps presented from this modelling (reproduced in Appendix C) are small scale covering the whole peninsula, they indicate that maximum tsunami water depths in the head of Lyttelton Harbour and the north to NE facing bays could be up to 6 m for a 3 m tsunami wave, and up to 8 m for a 5 m tsunami wave. As such these tsunami water depths are considerably greater than the flood inundation depths therefore the proposed flood thresholds from this analysis are not appropriate for tsunami risk.

Any planning provisions and restrictions applied to the areas at risk from coastal inundation will also be of benefit in reducing the impacts of tsunamis. However, due to the very low probability of tsunami events, and the availability to have sufficient time for evacuation in the largest and potentially most damaging events (e.g. 12-16 hrs for South American tsunami source) the Civil Defence management response to them rather than a planning response is appropriate.

[31] Mueller, C., Wang, X., Power, W.L., Lukovic, B., 2019, Multiple scenario tsunami modelling for Canterbury. Report prepared for Environment Canterbury. GNS Science consultancy report; 2018/198, GNS Science, Lower Hutt, New Zealand.

[32] Mueller, C., Wang, X., Lukovic, B., 2020. Multiple scenario tsunami modelling for the Selwyn coastline, Kaitorete Barrier and Akaroa Harbour. Report prepared for Environment Canterbury. GNS Science consultancy report 2020/47, GNS Science, Lower Hutt, New Zealand.

### 6.5.5 Considerations in Applying the Risk Thresholds

*Uncertainties*

We have developed our recommended method for flood risk mapping for use with the CHA bathtub depth outputs. For inundation from purely tidal events, this dataset tends to be conservative within the area of coverage defined in the CHA. For this reason, we consider it unnecessary to include an additional allowance for uncertainty in the depth data for mapping the inundation area or defining flood risk. In areas of higher flood risk, mitigation measures such as minimum floor level requirements should include an appropriate freeboard allowance above estimated flood level. More detailed assessment of flood level, including consideration of flooding from other sources, may be warranted for individual developments to determine floor levels or other measures.

The bathtub method maps all land below the flood level without taking account of connectivity with the source of flooding or the hydraulic capacity of pathways connecting flooded areas. Some flood risk areas may be separated by higher ground from the source of flooding, which could prevent flooding in the “unconnected area”. In common with the CHA, we have included both “connected” and “potentially unconnected” areas when mapping flood risk using the proposed depth thresholds. In the CHA maps, potentially unconnected areas are highlighted through different colouring to help guide adaptation responses. These could include more detailed, case by case assessments to determine if pathways, such as culverts or sub-surface stormwater drains which are not represented in the terrain data, would connect such areas and if their capacity would allow significant inundation. Including all land which is below the source flood level in the inundation area also allows the residual risk from breaches of stopbanks or impedance of stormwater drainage in low-lying areas to be included in both sets of maps.

*Negligible risk*

The flood risk maps show all depths of water. Flood maps often exclude areas of very shallow water on the basis that the flooding constitutes a “nuisance” rather than a danger and additional controls are not needed. If a minimum depth of flooding is used to define the inundation area and the applicability of planning rules, such as minimum floor level, then this should be consistent with other development controls. For example, for housing outside of secondary flow paths the minimum floor height required under the Building Code is 150mm above the adjacent ground level. To avoid the risk of flooding above floor level, additional freeboard would be required where flood depths exceed 150mm as a minimum. We recommend that the minimum depth applied to inundation mapping should be no greater than 50mm. A negligible depth threshold could be included in the “very low risk” threshold of Table 6.6, i.e., as “0.05m < d < 0.5m”, for mapping the same CHA bathtub depth data.

*Data limitations*

As discussed in Section 6.4.3, the CHA depth data is masked so that any land below the MHWS tide level is excluded e.g. along the River Styx. This limits the coverage of the flood risk map since these areas are generally at risk. The bathtub method is simple to apply, and the flood levels used in the CHA could be readily applied to the same LiDAR ground level data to remove gaps in the coverage for preparation of planning maps.

The raster data used to produce the flood risk map results in a very complex topology due to the small grid size used. For planning purposes this should be simplified and smoothed. This could include removal of any areas at “indirect” risk of flooding if these are confirmed to be unconnected.

# 7. Coastal Erosion Hazard Thresholds

This section first presents the recommended coastal erosion thresholds and similarly to the inundation section then provides the discussion and reasoning behind this recommendation and the other approaches that were considered.

## 7.1 Summary of Erosion Recommendations

Based on the different coastal morphologies within the Christchurch district and the various assessment methods applied by T+T in different areas, the following are the recommended thresholds from the T+T data for determining coastal erosion hazard zones:

1) For the Christchurch City urban area open coast; two erosion zones compromising of
    a) A High Hazard Coastal Erosion Zone covering the whole current beach-dune width, and
    b) Where required, a Low Hazard Coastal Erosion Zone to a lowland limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 and an additional area required for "future healthy beach factors".
2) For the Avon-Heathcote Estuary; two erosion zones comprising of
    a) A High-Medium Hazard Coastal Erosion Zone to a landward limit defined by the 66% probability erosion distance with 0.6 m SLR by 2080, with consideration of a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell under this scenario/threshold option, and
    b) A Low Hazard Coastal Erosion Zone to a landward limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 with consideration of a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell under this scenario/threshold option
3) For the beaches and bays of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula Bays Coastal Erosion Hazard Zone, with the landward limit defined for:
    a) Probabilistic assessment cells, as the 10% probability of erosion distance for 1.2 m SLR by 2130, and
    b) Deterministic assessment cells, the limit of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.
4) For the coastal cliffs of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula Cliff Erosion Zone of 20-30 m width as defined by the generic T+T cliff erosion setback
5) For assessment cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where there are land reclamation and substantial hard protection structures; a single High Hazard Coastal Erosion Zone hazard zone with a generic width in the order of 20 m.

The following discussion provides the discussion and justifications behind these recommendations.

## 7.2 Critical Thinking

In applying a risk-based approach to land-use planning for coastal erosion hazards, the key determination is likelihood as the consequence is always high, for example land is eroded and therefore will be unusable after a certain time.

To define appropriate erosion likelihoods for different coastal erosion risk categories for land-use planning a combination of SLR scenario, time frames and probability of occurrence needs to be considered so risk can be expressed as:

"xxx probability that erosion will occur within yyy time frame under zzz SLR scenario".

As per Section 5, we have defined the most appropriate SLR scenarios and timeframes as being 0.6 m SLR by 2080, and 1.2 m SLR by 2130. So, the probabilities that a certain erosion distance will occur within these scenarios and timeframes can be used to define the thresholds for determining different categories of hazard risk. The critical thinking behind the selection of these thresholds includes:

1. The probabilities are a measure of the "Statistical Uncertainty" of resulting erosion distance based on distribution of certainty in the input data used for the erosion models and calculations. Most of the distributions applied are normal, triangular, or extreme event depending on the data availability. This has not addressed the "modelling uncertainty" covering how well the models and methods used can predict future erosion, or the "Scenario uncertainty", which is addressed in the choice of scenarios in Section 4.

   In the T+T assessment the probabilities are expressed as the likelihood that the erosion will reach or be greater than the calculated ASCE to that location. Therefore, the probabilities decrease with distance from the current shoreline position, as there is decreasing likelihood that erosion will reach or exceed this position with the specified magnitude of SLR within the specified timeframe. Hence for the same SLR magnitude and timeframe, we can be more certain that erosion will reach the positions with higher probabilities, and less certain it will reach the positions with lower probabilities.

   The probabilities used in the thresholds link to the quantitative likelihood ratings presented in MfE guidance) as shown in Figure 7.1. The most expected likelihood ratings to be used as thresholds include; very likely (⩾ 90%), likely (⩾66%), unlikely (⩽33%), and very unlikely (⩽10%). It is noted that T+T assessment presents results of a 5% probability, as the middle of the 'very unlikely' range (0-10%). The ASCE distance to this probability level is slightly greater than to the 10% probability (in the order of 5 m along the Christchurch open coast and 1-2 m in the Avon-Heathcote Estuary) and is less likely to occur. However, for consistency of approach of using the probability limit of each likelihood rating so that all of the proposed zone has a likelihood greater than 'very unlikely', we have used the 10% probability position for defining 'very unlikely' occurrence rather than the 5% middle position presented by T+T.

| Likelihood rating | Probability that a hazard event with a given annual exceedance probability will occur within the design life or planning timeframe (%) |
|---|---|
| Virtually certain: | ≥ 99% probability of occurrence |
| Very likely: | ≥ 90% probability of occurrence |
| Likely: | ≥ 66% probability of occurrence |
| About as likely as not: | 33–66% probability of occurrence |
| Unlikely: | ≤ 33% probability of occurrence |
| Very unlikely: | ≤ 10% probability of occurrence |
| Exceptionally unlikely: | ≤ 1% probability of occurrence |

Figure 7.1: Relationship between quantitative likelihood ratings and probabilities. (From MfE, 2017; Table F-3)

An example of how these likelihood ratings convert to a probability distribution of erosion distance is shown in Figure 7.2.

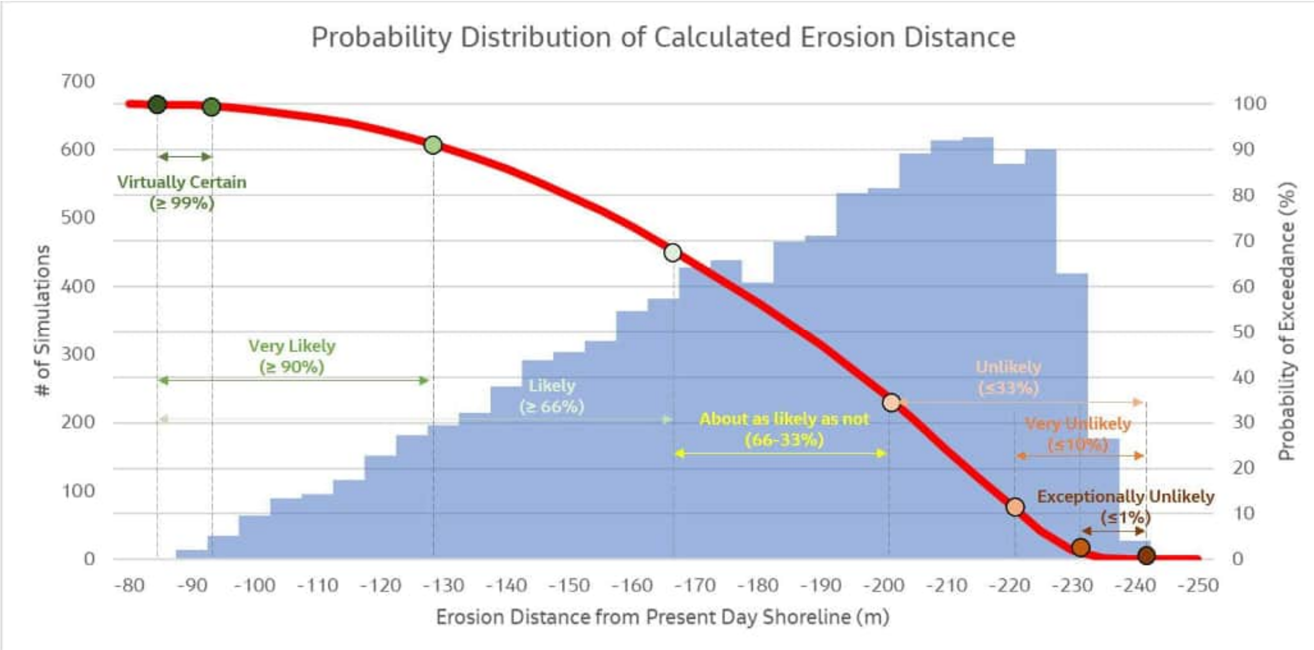



Figure 7.2: Example of probability distribution of erosion distances

2. For consistency of risk assessment, there needs to be a degree of consistency between the thresholds applied across the different assessment types: probabilistic, deterministic, cliffs and protection structures. While the above consideration of probabilities can be applied to the beach, bay and estuary cells where a probabilistic assessment was undertaken, it cannot be applied to cells and areas covered by the other assessment methods as the full range of probabilities is not available for these cells. Ways of addressing this inconsistency are considered in the testing of different threshold options under each of the assessment methods.

3. The distance between the thresholds defining different hazard risk categories needs to be sufficient for likely land-use activity to be reasonably able to be carried out in the zone between the thresholds. For example, it is considered that the use of thresholds which only produce 5 m wide hazard zones are not going to be acceptable. This raises the following two questions:

I. Where the distance between thresholds is too narrow for an acceptable planning zone width, should the position be shown just for information that there are hazards in the area (e.g. low risk of erosion for sea level rise over a100 year time frame) without associated planning provisions, or should a generic acceptance zone width be applied even though some (and possibly most) of the zone doesn't meet the risk threshold?

II. Whether the number of erosion hazard categories required can be reduced for some environments from the three originally envisaged for this study to one or two to provide suitable widths for land-use planning purposes.

4. For beach and bay environments, due to the ASCE distances being from the position of the dune/beach ridge/bank toe, the thresholds for planning set-backs need to also allow for natural backshore environments (e.g. dunes and beach ridges) within the set back distance. Therefore, the whole of the beach environment is considered to be in a high hazard category so that the full natural protection ability of the beach against coastal hazards is not compromised. This is consistent with NZCPS Policy 26 (natural defences against coastal hazards) as well as having a number of ecological, nature character, and landscape

reasons for being protected from inappropriate development which are consistent with objectives 1 and 2 of NZCPS. The inclusion of the whole active beach and dune environment with Coastal Erosion Hazard Zones is consistent with the approach taken in both the RPS and the RCEP.

5. In additional to the need to protect the current beach environment, there may also be a need to provide an additional width within erosion set-back zones for "future healthy beach factors". For example, once the ASCE positions reach beyond the current beach/bank position they do not include any consideration for the distance required to have a healthy dune or beach ridge environment, or stable bank slope. The absence of these natural hazard protection environments would result in an increase in the consequences of erosion in storm events and an increase in the frequency, extent, magnitude and consequence of inundation events, or result in the need for more engineered protected structures. In more layman terms this means allowing within district planning zones not only for where the erosion may be predicted to reach by the chosen scenario/threshold combination, but also allowing for the beach and dune systems to move inland as the front of these features erode so that they can still provide the same level of erosion protection. Hence the outcome may be mapped hazard areas and district planning controls further inland from the T+T mapped erosion extents. It is not possible in the timeframe of this analysis to recommend possible widths required for "future healthy beach factors".

6. The T+T approach of mapping ASCE's in cells creates a number of discontinuities in mapping of the potential thresholds across the cell boundaries, which creates difficulties for District Plan Erosion Hazard Zone mapping. It is possible to develop a process for smoothing these discontinuities across other cells involving consideration of the representativeness and certainty of the data used in the ASCE calculation as the cell boundary is approached from both longshore directions. Such a process would need to be well justified and documented as the largely subjective movement of the hazard zone is likely to be subject to challenge. This smoothing will be required to be done before the threshold mapping can be used for consultation on potential erosion hazard planning zones, however it is beyond the scope of this analysis to develop the details of the process to undertake this task.

## 7.3 Hazard Threshold Options

### 7.3.1 For Detailed Probabilistic Assessment Cells

As described in Section 4.2, detailed probabilistic assessments were undertaken for 52 cells covering the Christchurch City open coast, parts of the Avon-Heathcote Estuary, and beach or bank shorelines along the existing larger settlements within Lyttelton and Akaroa Harbours.

The analysis for these probabilistic assessment cells involved trialling two approaches to defining thresholds for erosion hazard categories. The preferred and alternative approach are discussed in turn below.

From the analysis, the Preferred approach involved reducing the probabilities and/or increase the SLR scenarios through time while descending the hazard categories from high to low to recognise different levels of certainty in the erosion calculations and that different land-uses may be appropriate over different timeframes. While there are multiple combinations of timeframes, scenarios and thresholds possible, the best two options chosen to be tested for sensitivity of resulting erosion distances are presented in Table 7.1. Note that although the 0.4 m SLR by 2050 and 2.0 m SLR by 2150 scenarios do not fit the recommended SLR scenarios from section 5 (e.g. 0.6 m by 2080 and 1.2 m by 2130), they are included in the sensitivity test for completeness of options.

Table 7.1: Threshold options for recommended probabilistic assessment approach to defining hazard categories

| Hazard Category | Option | Time Frame | SLR since 2020 | T+T Probability | Likelihood description (Statistical uncertainty) |
|---|---|---|---|---|---|
| High | (a) | 2050 | 0.4 m | 10% | Greater erosion is very unlikely, so very certain this erosion distance will occur in this short timeframe |
| | (b) | 2080 | 0.6 m | 66% | Erosion up to this distance is likely within this medium timeframe, so less certain than option (a) High Hazard |
| Medium | (a) | 2080 | 0.6 m | 33% | Greater erosion than this position is unlikely within this medium timeframe |
| | (b) | 2130 | 1.2 m | 66% | Erosion up to this distance is likely within this longer timeframe, but less certainty that SLR to this magnitude will occur within the timeframe |
| Low | (a or b) | 2130 | 1.2 m | 33% | Greater erosion than this position is unlikely within this longer timeframe, but less certainty that SLR to this magnitude will occur within the timeframe |
| | (a or b) | | | 10% | Greater erosion is very unlikely within this longer timeframe, but less certainty that SLR to this magnitude will occur within the timeframe |
| | (a or b) | 2150 | 2.0 m | 33% | Greater erosion than this position is unlikely within this much longer timeframe, but also much less certainty that SLR to this magnitude will occur within the timeframe |

The Alternative Approach involved applying a consistent time frame and SLR scenario across all hazard categories, with the decreasing probabilities being used to define the thresholds between hazard categories. From the T+T increments, the chosen SLR scenario to test was the 1.2 m by 2130, with the threshold options being as shown in Table 7.2. A second option under this approach of applying the 2.0 m SLR by 2150 scenario as the low hazard threshold was also included in the sensitivity testing.

Table 7.2: Threshold options for alternative probabilistic assessment approach to defining hazard categories

| Hazard Category | Option | Time Frame | SLR since 2020 | Probability | Likelihood description (Statistical uncertainty) |
|---|---|---|---|---|---|
| High | (a) | 2130 | 1.2 m | 90% | Erosion very likely up to this distance over this long timeframe. |
| | (b) | | | 66% | Erosion likely up to this distance over this long timeframe, so less certain than option (a) High Hazard |
| Medium | (a) | 2130 | 1.2 m | 66% | Erosion likely up to this distance over this long timeframe, |
| | (b) | | | 33% | Greater erosion than this position is unlikely within this longer timeframe. |
| Low (1a) | (a) | 2130 | 1.2 m | 33% | Greater erosion than this position is unlikely within this longer timeframe. |

| | | | | | |
|---|---|---|---|---|---|
| | (b) | | | 10% | Greater erosion than this position is very unlikely within this longer timeframe. |
| Low (1b) | (a or b) | 2150 | 2.0 m | 33% | Greater erosion is unlikely within this much longer timeframe, but also less certainty that SLR to this magnitude will occur within the timeframe |

Sensitivity testing of the erosion distances from each of the threshold options and consideration of the points raised above in section 7.2 around zone widths and relationship to whole beach widths are discussed below for each of coastal environments where T+T applied a probabilistic assessment approach.

Christchurch City open coast (T+T Cells 1-14)

Figure 7.3 shows examples on how the high, medium, and low hazard zones would look at North Brighton and Southshore from applying the possible threshold options under the preferred approach in Table 7.1. All maps produced for this assessment are available in a webviewer accessible to the project team. Maps of the preferred approach has been provided to CCC as a spatial layer.

As can be seen from Figure 7.3, the options for high and medium hazard categories are largely within the existing beach environment. This outcome is consistent along the whole of the Christchurch open coast, with the only locations where this doesn't occur being where the dunes have been removed at North Brighton and New Brighton. A similar result was obtained from the alternative approach.

It is therefore recommended that to ensure that the full natural protection ability of the dune system against coastal hazards is not compromised, the whole beach-dune width be treated as a High Hazard zone. The position of this zone is shown in Figure 7.4 for the same areas as presented in Figure 7.3 (e.g. North Brighton and Southshore). Note that the width of dune in Figure 7.4has subjectively been applied by the Jacobs team for the purpose of this mapping from vegetation patterns on aerial imagery and smoothed along Marine Parade. These dune positions would need to be confirmed before being used in District Planning Erosion Hazard Zoning.

This approach of including the whole beach-dune environment in the High-Hazard category is consistent with NZCPS Policy 26 and with the approach taken in defining Coastal Erosion Hazard Zone 1 in both the RPS and the RCEP. The position of Coastal Erosion Hazard Zone 1 is shown in Figure 7.4. As per section 7.2, there are also a number of ecological, nature character, and landscape reasons for protecting the whole beach/dune environment from inappropriate development.

It is noted that this whole beach/dune width approach to the High Hazard zone removes the issue with inconsistency zone boundaries across the assessment cell boundaries as shown at South Brighton Spit in the right pane for Figure 7.3. However, it is also noted that the width of the current dune system is variable due to spatial differences in width of the beach-dune buffer applied to past developments. Further work is required to define an optimum width required for healthy dune systems within the High Hazard Zone, as it is likely that in some places current width will be too narrow (e.g. North and New Brighton due to Marine Parade), and in others may be wider that required (e.g. South Brighton & Southshore).

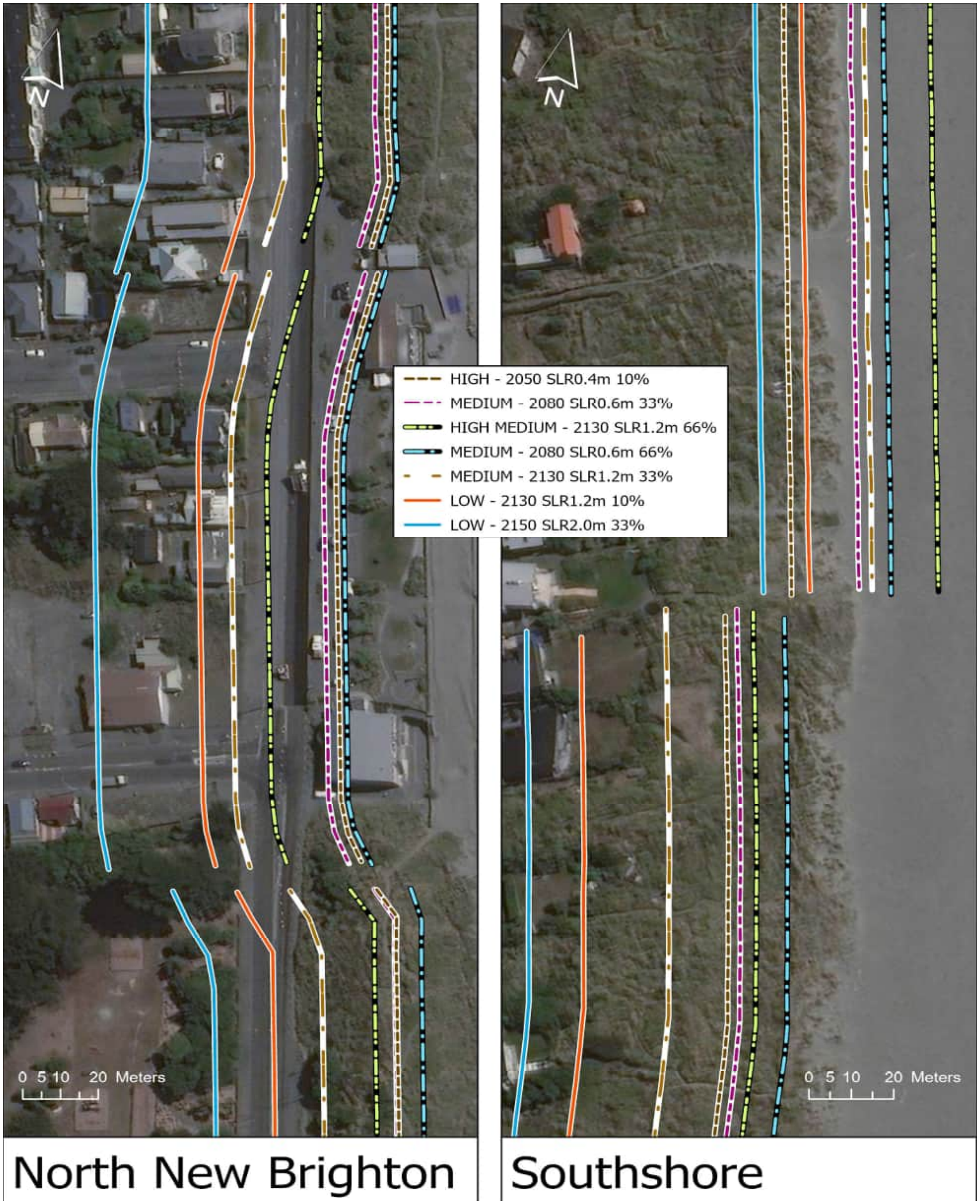



Figure 7.3: Possible options for High, Medium and Low Coastal Erosion Hazard Categories at North Brighton (left) and Southshore (right). Not recommended due to High and Medium zones being within the beach system

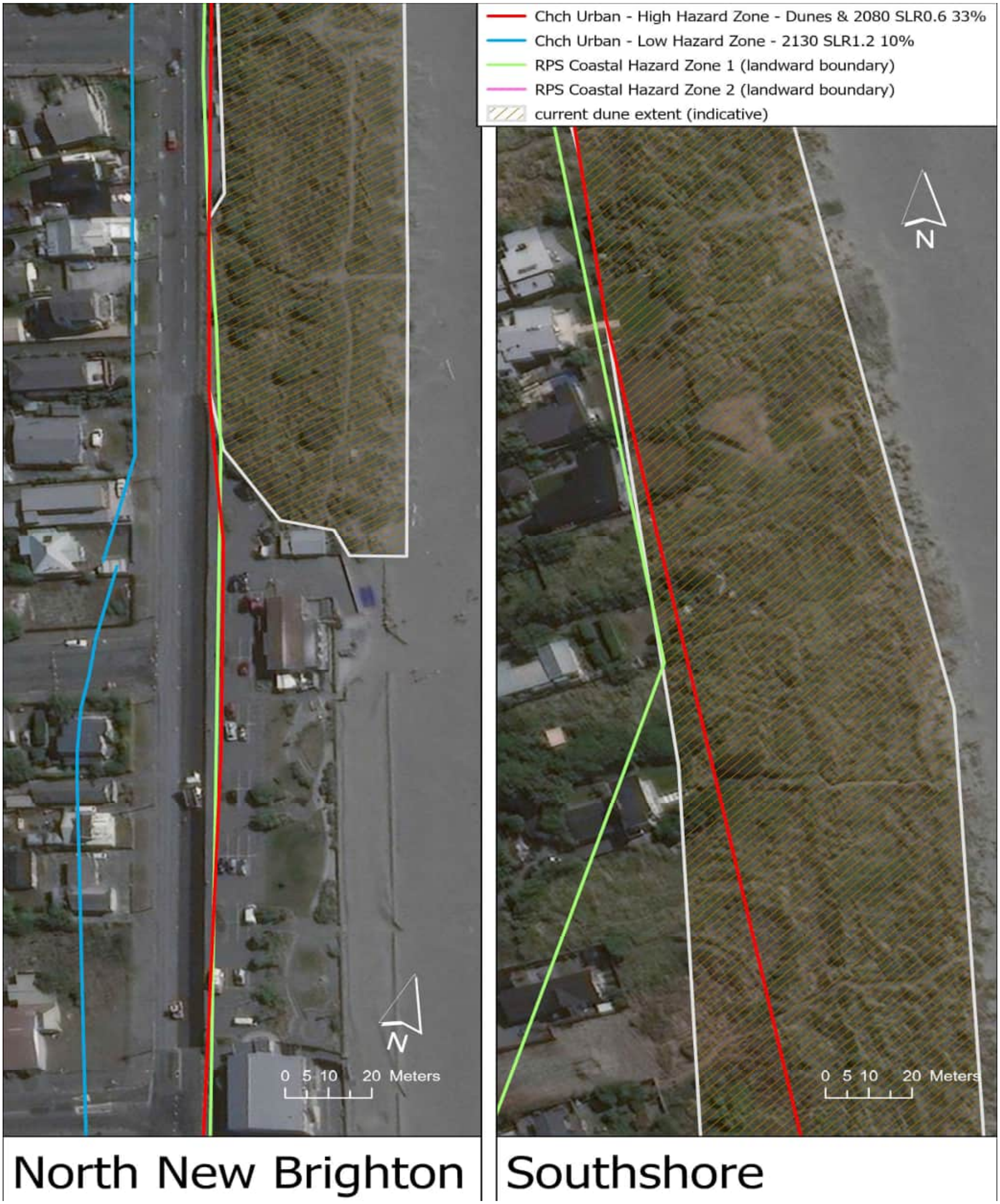



Figure 7.4: Recommended High Coastal Erosion Zone covering whole of the dune environment compared to the RPS/RCEP Hazard Zone 1 and recommended Low Coastal Erosion Hazard Category based directly from the T+T data at the same locations as shown in Figure 7.3 - North Brighton (left) and South Brighton Spit (right).

For the Low Hazard zone, Figure 7.3suggests that spatially the 33% probability with 1.5 m SLR by 2150 provides a more appropriate zone width for land use planning, however as stated in Section 5.2 this scenario is conservative and it is more uncertain whether this magnitude of SLR will occur within a reasonable time frame for land-use planning. Therefore the 10% probability with 1.2 m SLR by 2130 is considered more appropriate landward boundary for the low Hazard zone and has a higher degree of consistency with the maximum scenario from the deterministic assessment. However, as also noted in Section 7.2, further work is required to define the additional width required in the Low Hazard Coastal Erosion Zone for ‘future healthy beach factors’. This could result in the Low Hazard boundary being close to the position of the 33% probability with 1.5 m SLR by 2150.

The position of the recommended Low Hazard boundary based directly on the position of 10% probability with 1.2 m SLR by 2130 from the T+T data is shown in Figure 7.4. As can be seem from the right pane in Figure 7.4(Southshore), there are locations where this recommended Low Hazard Category is also totally contained within the current dune system that would be zoned as High Hazard Coastal Erosion, in which case it is recommended that no Low Hazard Coastal Erosion Zone is required.

An overview of where Low Hazard zones would be required based directly on the position of the 10% probability with 1.2 m SLR by 1230 from the T+T data (e.g. no consideration of ‘future healthy beach factors’ or minimum width) are shown in Figure 7.5, with fuller spatial details being available on the webviewer.


Figure 7.5: Locations where recommended Low Coastal Erosion Hazard Category based directly from the T+T data would be required along the Christchurch open coast - Brooklands Lagoon (left), North New Brighton (centre) and New Brighton (right).

Avon-Heathcote Estuary T+T Cells 15 to 24)

Figure 7.6 shows examples on how the high, medium, and low hazard zones would look at two locations in the Avon-Heathcote Estuary from applying the possible threshold options in Table 7.1 under the preferred approach.

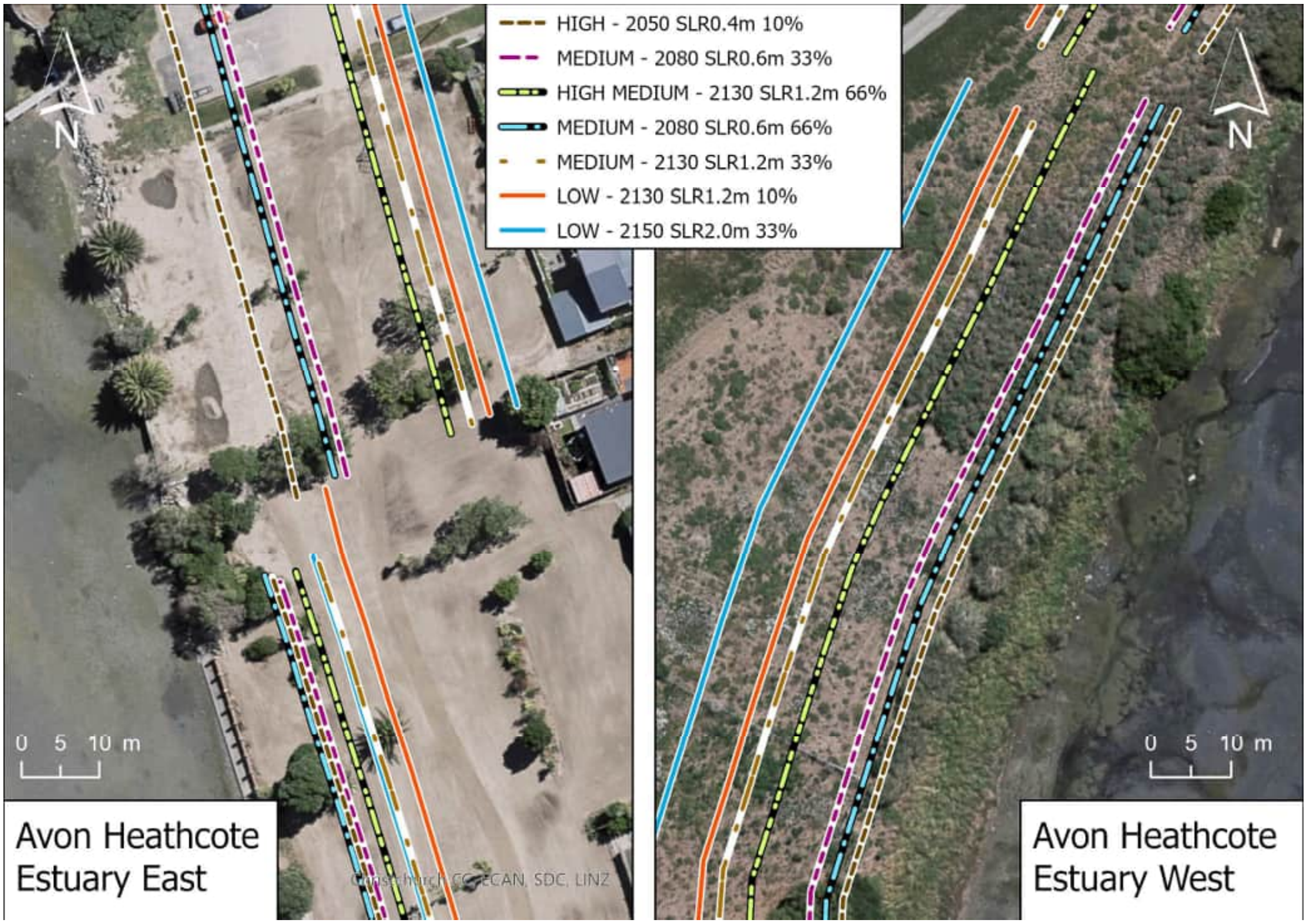



Figure 7.6: Possible options for High, Medium and Low Coastal Erosion Hazard Categories at Southshore (left) and Oxidation ponds (right) around the Avon-Heathcote Estuary. Not recommended due to zones being too narrow.

As can be seen from Figure 7.6, the resulting zones are narrow, being in the order of 10-20 m for the High Hazard options, 5 - 10 m width for the Medium zone options, and 5-20 m widths for the Low hazard zone depending on location around the estuary. These widths are considered to be too narrow for effective land-use planning provisions, so the following two zone approach is recommended.

- High-Medium Coastal Erosion Hazard Zone Boundary: 66% probability of erosion with 0.6 m SLR by 2080
- Low Coastal Erosion Hazard Boundary: 10% probability of erosion with 1.2 m SLR by 2130.

It is noticeable from the left pane of Figure 7.6 that these recommended thresholds would result in inconsistent erosion hazard zone widths within different cells around the estuary and there will need to be in some locations large adjustments and smoothing of the hazard zones across the cell boundaries. It is therefore further recommended that consideration should be given to applying consistent erosion hazard widths across all estuary assessment cells, with the generic width for the zones being equal to the largest ASCE in any cell under the recommended scenario/threshold option. Under this approach, the width of both the High-Medium and Low Coastal Erosion Hazard Zones being 20 m. The position of the recommended Coastal Erosion Hazard Zone boundaries under this approach for selected locations around the estuary is shown in Figure 7.7. More detailed spatial details of these recommended positions are available on the webviewer.

Figure 7.7: Recommended High-Medium and Low Coastal Erosion Hazard Categories at Southshore (left) and Oxidation ponds (right) around the Avon-Heathcote Estuary.

Bays of Banks Peninsula

The recommended threshold options for the Avon-Heathcote Estuary were applied to Charteris Bay and Wainui to see how the resulting zones would look for the bays in Lyttelton and Akaroa Harbours where the probabilistic approach was used. The resulting hazard zones at 10-20 m for the High-Medium hazard category and an additional 10 m for the Low Hazard category were considered too narrow to be practical for land-use planning zones.

It is therefore considered that there only be one hazard zone of these bays in the Harbours having the threshold boundary of:

- 10% probability of erosion with 1.2 m SLR by 2130. The zone has a width 20 -30 m depending on location, as shown in Figure 7.8for Charteris Bay and Wainui.

However, for consistency, this hazard zone also needs to be tested for compatibility with the those calculated in other bays of Lyttelton and Akaroa Harbours and outer Peninsula calculated by the deterministic approach. The results of this comparative testing are presented in the following section.

Figure 7.8: Possible single Coastal Erosion Hazard Zones for Charteris Bay, Lyttelton Harbour (left Pane) and Wainui, Akaroa Harbour (Right Pane), where probabilistic assessments were undertaken. Requires comparative testing against Deterministic assessments.

### 7.3.2 For Deterministic Screening Assessment Cells

There are 48 cells in the bays and beaches of Lyttelton and Akaroa Harbours and the outer bays of the Peninsula where the deterministic screening approach was used due to lack of data to undertake a probabilistic approach. For these cells different SLR scenarios were used and due to the conservativeness of the method, the statistical probability of erosion occurrence to the resulting ASCE distances are assumed to be 1-5%. However, for a risk based approach to land-use, it is considered important that for similar environments, the resulting risk categories and zone widths are similar regardless of method. Although this would best be achieved by re-running the deterministic assessment for a SLR of 1.2 m by 2130, the comparative testing of the following available thresholds was undertaken:

- Deterministic assumed 1-5% probability for 1.5 m SLR by 2130
- Probabilistic 5% probability for 1.5 m SLR by 2130 (for comparison to similar threshold/scenario as deterministic approach)
- Probabilistic 10% probability for 1.2 m SLR by 2130 (for comparison to best probabilistic single zone option from above)

The results of this comparative testing for Wainui, where there are adjoining probabilistic and deterministic assessment cells are shown in Figure 7.9, which shows the following important results:

1) There is very little difference in the width of a single hazard zone from using the different probabilistic thresholds (max 5 m), and
2) The position of the probabilistic and deterministic low hazard thresholds are very similar.

Therefore, based on this result, it recommended that a single coastal erosion hazard zone for Banks Peninsula bays and beaches is appropriate, and can be based on the following thresholds:

1) For Probabilistic assessment cells the 10% probability of erosion occurrence for 1.2 m SLR by 2130 to be consistent with the Low Hazard zones along the Christchurch Open Coast and the Avon-Heathcote Estuary.
2) For deterministic assessment cells the boundary of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.

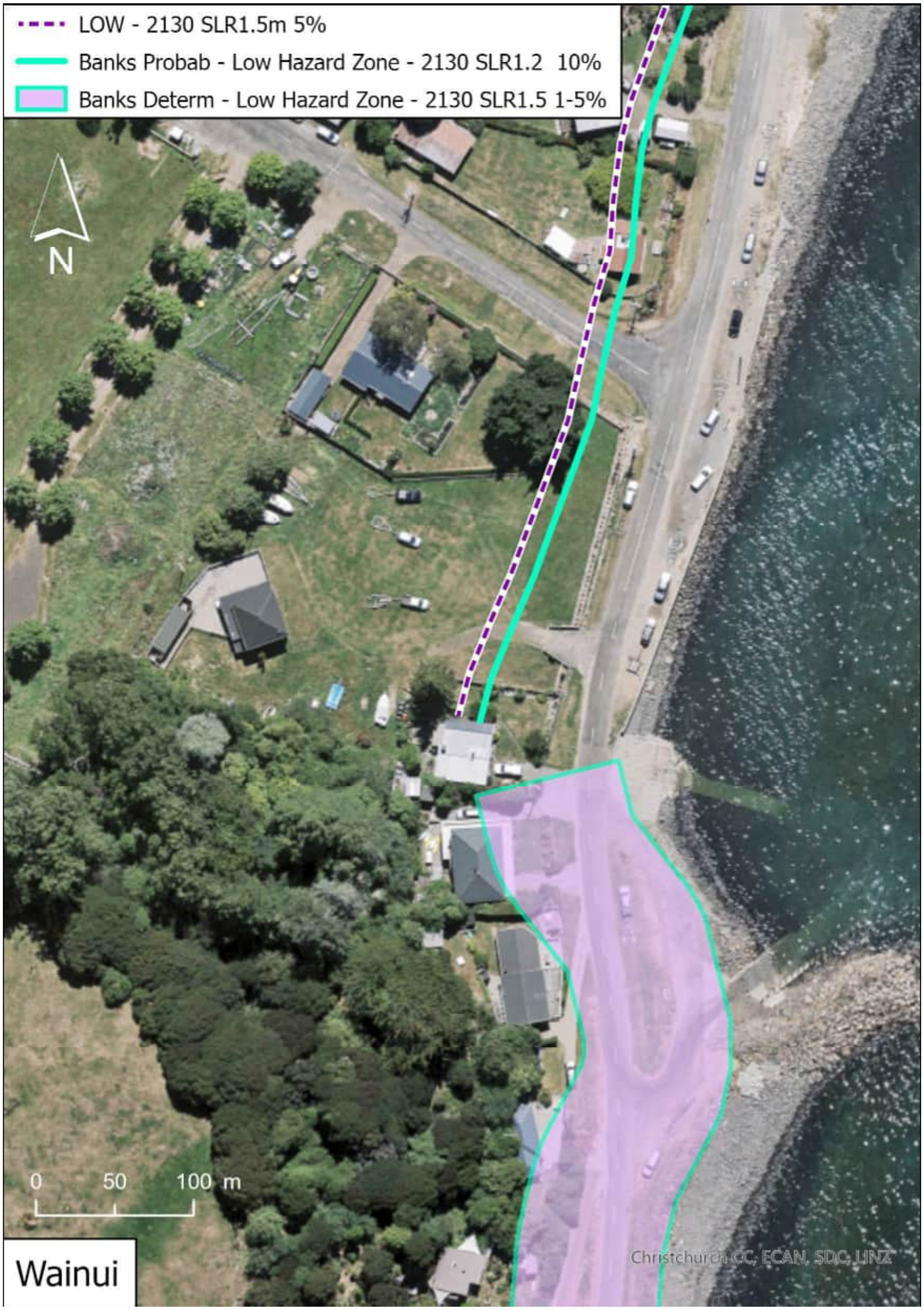



Figure 7.9: Comparative testing of Probabilistic and deterministic thresholds at Wainui, Akaroa Harbour

### 7.3.3 For Cliff Assessment Cells

As outlined in Section 4.2.1, the ASCE along the cliff shorelines of the Banks Peninsula is defined as a generic setback distance between 20-30 m. Examples of the comparative widths of these generic cliff hazard zones to the Banks Peninsula single hazard zone in adjoining bays are shown in Figure 7.10 (Charteris Bay) and Figure 7.11 (Wainui). As can be seen from these Figures, the widths of the respective zones are not dissimilar, hence it is considered that there is no significant inconsistency in using these generic cliff erosion setbacks as the boundary for a single erosion zone for land-use planning along the cliff environments of Banks Peninsula.

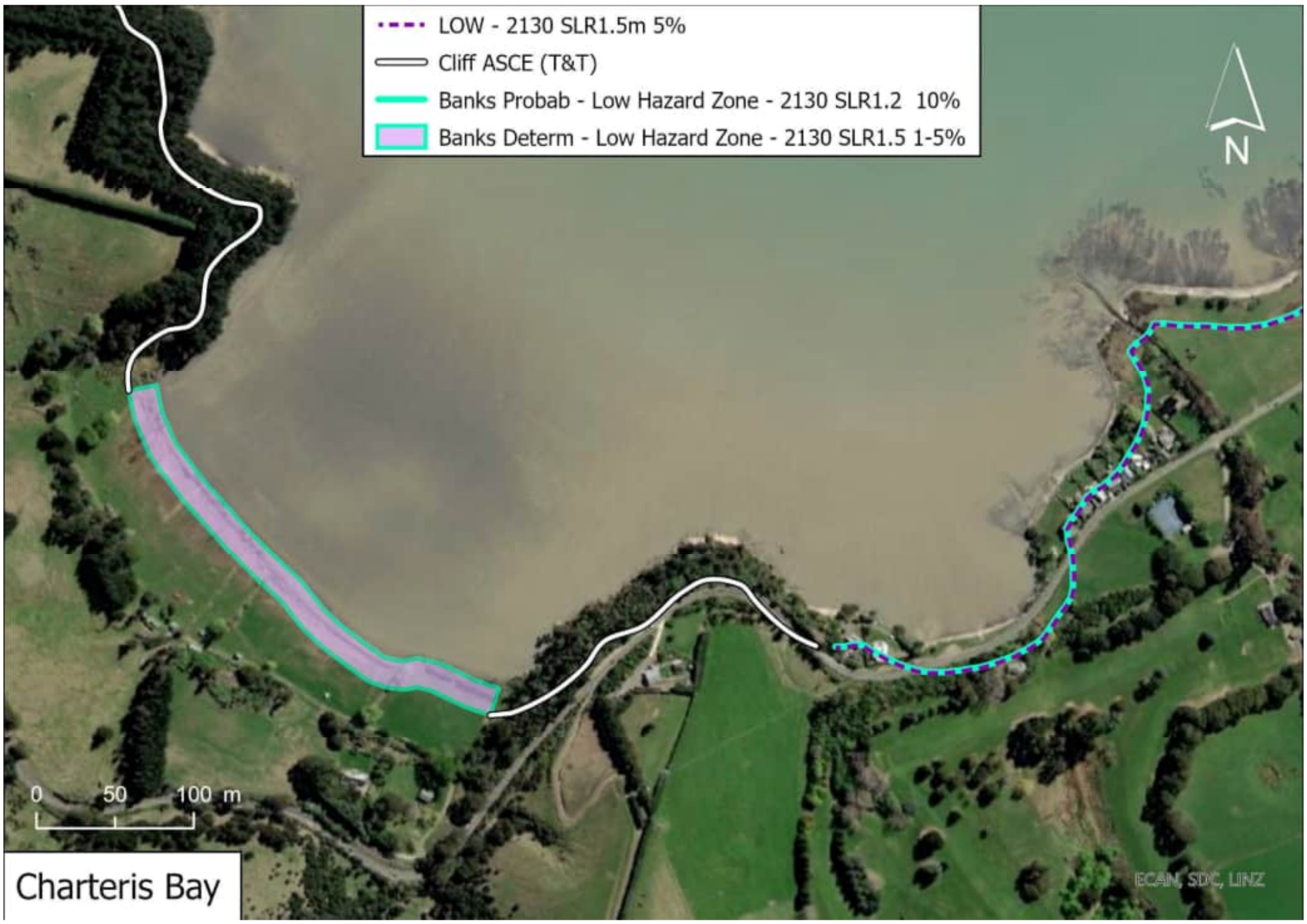



Figure 7.10: Comparative width of generic cliff erosion zone to adjoining probabilistic and deterministic single hazard zones at Charteris Bay, Lyttleton Harbour.


Figure 7.11: Comparative width of generic cliff erosion zone to adjoining probabilistic and deterministic single hazard zones at Wainui, Akaroa Harbour.

### 7.3.4 For Erosion Protection Cells

As indicated in Section 4.2 there are a number of cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where due to land reclamation and substantial hard protection structures, the future ASCE's have been assessed as being the same as Current ASCE (e.g. erosion resulting from structure damage/failure before repair). As such there is no change in ASCE with SLR scenario, and very little change in erosion distance with probability.

For these protection cells, it is recommended that a generic single erosion hazard zone width in the order of 20 m be applied as a High hazard Zone. This zone would reflect the consequences of erosion should the protection structures fail and allow for the control of activities in these areas.

It is recognised that inconsistencies in the erosion zone positions at the boundaries of these protection cells with the detailed assessment cells, will need to be addressed.

### 7.3.5 Considerations in Applying the Risk Thresholds

*Uncertainties*

Although the SLR scenarios have been chosen with regard to the uncertainties in the magnitude of rise, and the timeframes over which they will occur, and we have developed our recommended erosion thresholds based on the statistical uncertainty of the erosion occurring under these scenarios, there are other sources of uncertainty in the data used to create the thresholds. These include

- The modelling uncertainty, in that how well do the models used estimate future erosion? This is particularly relevant to;
  1) the extrapolation of past historical rates of shoreline movement, which is dependent on sand supply from the Waimakariri River and longshore transport by waves. The T+T assessment presents erosion data for both reductions and increases in sediment supply, and
  2) the accuracy of the Bruun Rule to calculate the erosional effects of SLR.

  There is nothing that can be done to reduce modelling uncertainty.
- The uncertainty in the appropriate erosion across the cell boundaries where the position of the same threshold values do not align. The recommended whole beach/dune environment approach to High Hazard Coastal Erosion Zones for all cells on the Christchurch open coast and the consideration of generic erosion hazard zone widths for Avon-Heathcote Estuary cells, will reduce the significance of this limitation. It is possible to develop a process for smoothing these discontinuities across other cells involving consideration of the representativeness and certainty of the data used in the ASCE calculation as the cell boundary is approached from both longshore directions.
- Uncertainty about the future effectiveness and lifetimes of current protection structures and any future erosion mitigation measures. This is addressed by the recommendation of a standard generic 20 m High Coastal Erosion Hazard zone in these areas.
- Uncertainty about the spatial footprint of the current dune and backshore environments, and how much width is required so that the full natural protection ability of the beach against coastal hazards is not compromised. This can be addressed with further analysis of dune responses to past storm events and modelling of potential future storm scenarios.
- Uncertainty around how dune environments will naturally grow and develop in the future, particularly once they begin to migrate beyond their current footprint, and how much additional area is required for “future healthy beach factors”. This can be addressed with further investigations into dune migration processes.

*Data limitations*

The analysis of possible scenario and threshold combinations is limited to the data provided from the T+T hazards assessment. These limitations include:

- Data common to all assessment methods being limited to only two timeframes (2080 and 2130). Our consideration of scenarios is therefore limited to these timeframes.
- Data in the deterministic assessment cells not being provided for the preferred scenarios (0.6 m by 2080 and 1.2 m by 2130), therefore limiting the ability for direct comparison with the probabilistic assessment cells.
- The deterministic data being limited to the upper probability bound, therefore potentially raising questions on whether this is a reasonable hazard likelihood over the timeframe to 2130.

# 8. Conclusions and Recommendations

A preferred approach to risk thresholds has been developed for recommended scenarios for both the erosion and inundation hazards. These have been mapped to show the resulting low, medium and high risk category areas. This mapping is available to the direct project team in a webviewer and the preferred approach will be mapped as pdf's in the final version of this report. These preferred approaches were compared to other scenarios and existing mapped hazards areas during the process of this analysis. The preferred approaches for each aspect are:

Inundation Table 8.1 provides the recommended definitions for coastal flood risk mapping and Figure 8.1 and Figure 8.2 provide graphical examples of these four flood risk categories.

Table 8.1: Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 1% AEP)

| Coastal flood risk category | Flood hazard with 0.6m SLR | | Flood hazard with 1.2m SLR | |
|---|---|---|---|---|
| Very low | None | (dry) | Low | (d < 0.5m) |
| Low | Low | (d < 0.5m) | Medium | (0.5m < d < 1.1m) |
| Medium | Medium | (0.5m < d < 1.1m) | High | (d > 1.1m) |
| High | High | (d > 1.1m) | High | (d > 1.7m) |

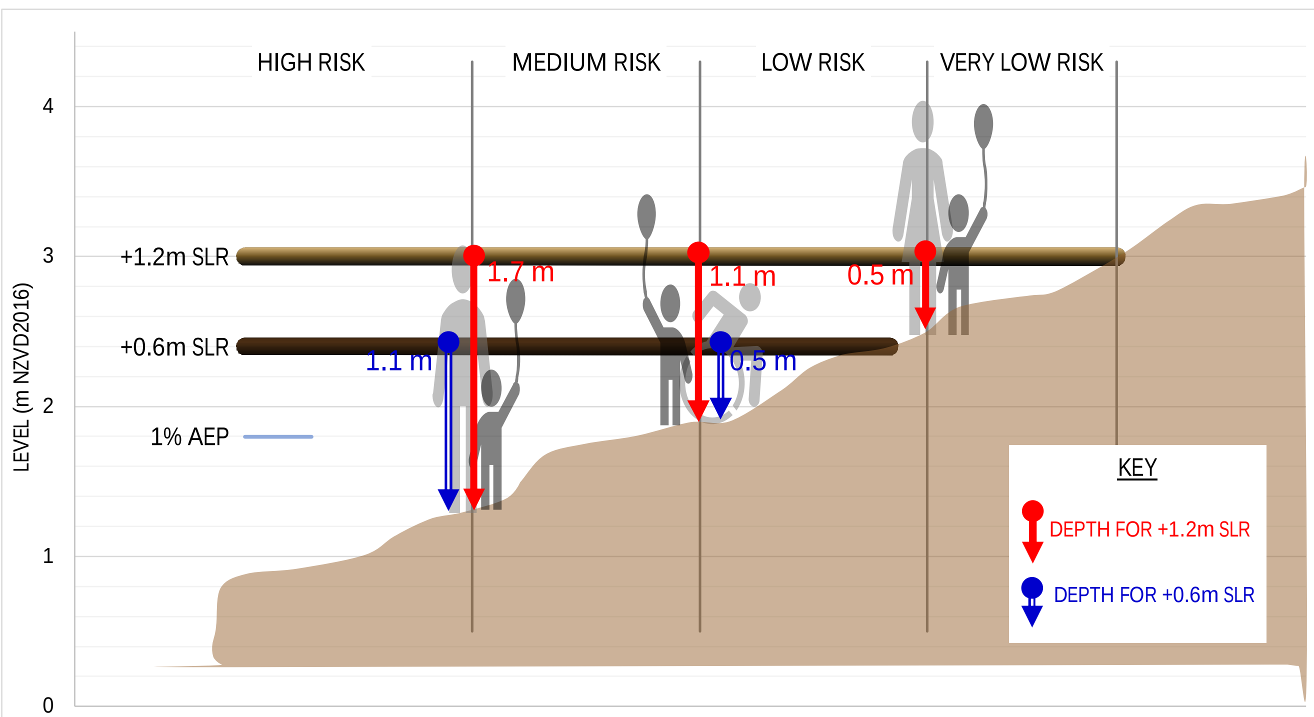



Figure 8.1: Recommended depth thresholds for defining flood risk based on the 1% AEP flood level and 1.2m SLR

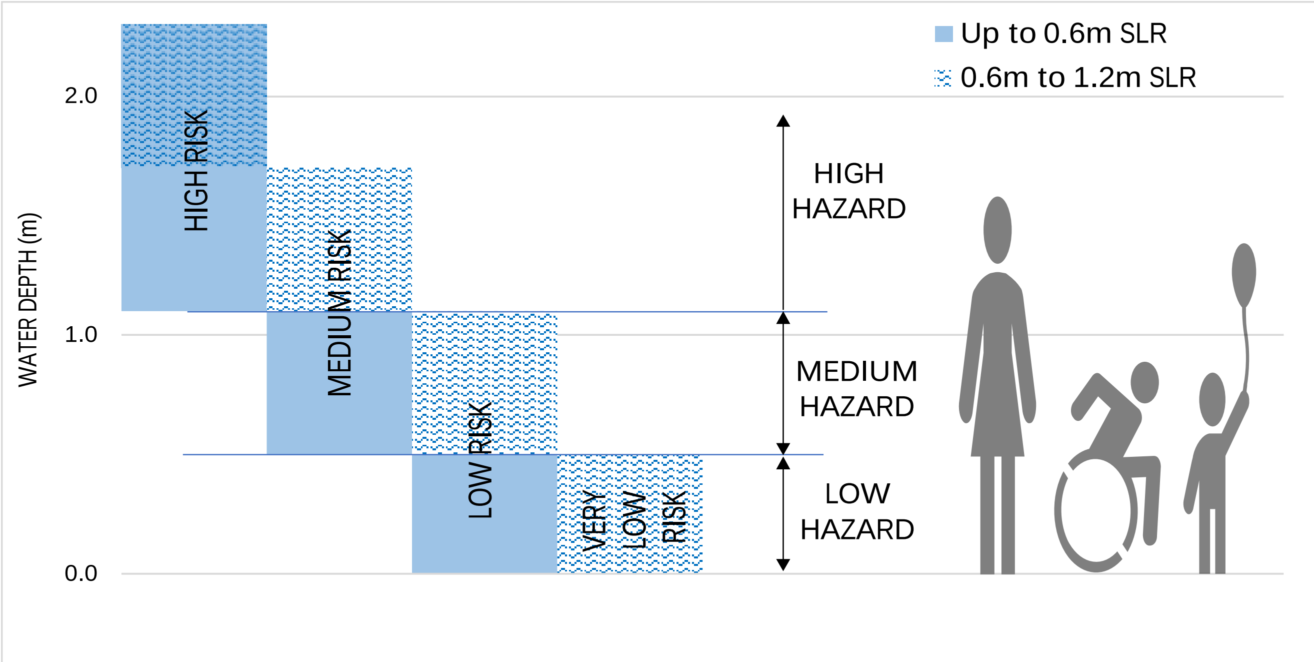



Figure 8.2: Flood risk categories based on the thresholds defined in Figure 8.1

Erosion - Based on the different coastal morphologies within the Christchurch district and the various assessment methods applied by T+T in different areas, the following are the recommended thresholds from the T+T data for determining coastal erosion hazard zones:

1) For the Christchurch City urban area open coast; two erosion zones compromising of
   a) A High Hazard Coastal Erosion Zone covering the whole current beach-dune width, and
   b) Where required, A Low Hazard Coastal Erosion Zone to a lowland limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 and an additional area required for “future healthy beach factors”.
2) For the Avon-Heathcote Estuary; two erosion zones comprising of
   a) A High-Medium Hazard Coastal Erosion Zone to a landward limit defined by the 66% probability erosion distance with 0.6 m SLR by 2080, with consideration of a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell under this scenario/threshold option, and
   b) A Low Hazard Coastal Erosion Zone to a landward limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 with consideration of a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell under this scenario/threshold option
3) For the beaches and bays of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula Bays Coastal Erosion Hazard Zone, with the landward limit defined for:
   a) Probabilistic assessment cells as the 10% probability of erosion distance for 1.2 m SLR by 2130, and
   b) Deterministic assessment cells as the limit of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.
4) For the coastal cliffs of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula Cliff Erosion Zone of 20-30 m width as defined by the generic T+T cliff erosion setback

5) For assessment cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where there are land reclamation and substantial hard protection structures; a single High Hazard Coastal Erosion Zone hazard zone with a generic width in the order of 20 m.

Recommendations

It is recommended that CCC discuss the draft plan change policies and other methods that are developed for these hazard areas with the author of this report to identify whether they are broadly consistent with the reasoning behind the definition of thresholds and choice of scenarios.

# Appendix A. Literature Review Summary Information

Table A.1: Summary of hazard categorising methodologies and associated thresholds in multiple documents

| Document | Flood hazard | Erosion hazard |
|---|---|---|
| Auckland Council: Natural Hazard Risk Communication<br>Toolbox Natural Hazard Risk Management Action Plan, 2014<br>https://www.civildefence.govt.nz/assets/Uploads/NHRCToolbox/NHRCToolbox-Auckland-Council.pdf | - Depth<br>- velocity<br>- Likelihood<br>- Consequence | |
| Auckland Unitary Plan, update 9 July 2021<br>https://unitaryplan.aucklandcouncil.govt.nz/pages/plan/Book.aspx?exhibit=AucklandUnitaryPlan_Print | - Depth<br>- Likelihood<br>- Consequence | - Likelihood<br>- Magnitude<br>- Consequenc e |
| Dunedin City Council 2020, 2nd Generation District Plan (2GP)<br>https://www.dunedin.govt.nz/council/district-plan/2nd-generation-district-plan | - Likelihood<br>- Velocity<br>- Consequence[33]<br>- Sensitivity[34]<br>Figure A.1 and Figure A.2 | |
| Waikato Regional Council: General info on website: Flood Hazard Information Questions and Answers<br>https://www.hamilton.govt.nz/our-council/council-publications/districtplans/flood/Pages/Flood-FAQ.aspx | - Depth (for both inside and outside the River zone Figure A.3)<br>- Velocity (just for OUTSIDE the | |

[33] The consequences of a natural hazard event occurring are considered in the context of health and safety, costs of damage to the built environment, and social and economic impacts on the wider community
[34] the sensitivity of land use activities is classified according to the health and safety implications of the land use. This helps to manage the consequences that may occur as a result of a natural hazard event. This sensitivity classification draws from, and broadly corresponds to, the building importance levels defined in the Building Regulations 1992 (Schedule 1: The building code).

| Document | Flood hazard | Erosion hazard |
|---|---|---|
| | River zone Figure A.4) | |
| Hamilton City council (2012 information)<br>https://www.hamilton.govt.nz/our-council/council-publications/districtplans/flood/Documents/GIS%20-%20Metadata%20for%20Flood%20Hazard%20Modelling%20(FHM)%20Data%20-%20City%20Waters.pdf | - Depth<br>- Velocity<br>Figure A.5 | |
| Waimakariri District Council<br>https://waimakariri.maps.arcgis.com/apps/MapSeries/index.html?appid=16d97d92a45f4b3081ffa3930b534553 | - Velocity<br>- Depth: (High Hazard depth >1 m, Medium Hazard – 0.3m <Depth< 1m, Low – Depth less than 0.3m) | |
| Thames Coromandel District Plan | - Depth<br>- Velocity<br>Figure A.6 | |
| Christchurch District Plan https://districtplan.ccc.govt.nz/pages/plan/book.aspx?exhibit=DistrictPlan<br>(based on Canterbury RPS Canterbury Regional Policy Statement \| Environment Canterbury (ecan.govt.nz) | - Depth<br>- Velocity<br>- Likelihood | -likelihood |
| Wellington city council<br>https://gis.wcc.govt.nz/LocalMaps/Viewer/?map=5c3d903dc4c043e0953410033c5c0b3e | - Depth<br>Figure A.7 | |

| Document | Flood hazard | Erosion hazard |
|---|---|---|
| Technical flood risk management guideline: Flood hazard Australian Disaster Resilience Handbook Collection 2012<br><br>https://knowledge.aidr.org.au/media/1891/guideline-7-3-technical-flood-risk-management.pdf | - Depth<br>- Velocity<br>Figure A.8 and Figure A.9 | |
| Department for Environment, Food & Rural Affairs (Defra) Flood Risks to People-Phase 2, 2006 | - Depth<br>- Velocity<br>Figure A.10 | |
| Managing natural hazard risk in New Zealand – towards more resilient communities 2014<br><br>https://www.lgnz.co.nz/assets/Publications/de504aaea2/Managing-natural-hazards-LGNZ-think-piece.pdf | - Likelihood<br>- Consequence | |
| The National Flood Risk Analysis for the Netherlands FINAL REPORT, 2017?<br><br>https://www.helpdeskwater.nl/onderwerpen/waterveiligheid/programma-projecten/veiligheid-nederland/english/flood-risk-the/ | - Likelihood<br>- Consequence | |
| World Meteorological Organization<br><br>https://public.wmo.int/en/resources/bulletin/chinas-implementation-of-impact-and-risk-based-early-warning | - Depth<br><br>Figure A.11 and Figure A.12 | |

| Likelihood | Minor consequences | Moderate consequences | Major consequences |
|---|---|---|---|
| Very likely (less than 1:50 (1 in 50 year event) or annual exceedance probability (AEP) 2% or more) | Low to Moderate risk | Moderate to High risk | High risk |
| Moderately likely[1] (1:50 - 1:200 or AEP range 0.5% to 2%) | Low risk | Moderate risk | High risk |
| Unlikely (1:200 - 1:500 or AEP range 0.2% to 0.5%) | Low risk | Low risk | Moderate risk |
| Very unlikely (1:500 to 1:2500 or AEP range 0.04% to 0.2%) | Very low risk | Low risk | Moderate risk |
| Extremely unlikely (more than 1: 2500 or AEP 0.04% or less) | Very low risk | Very low risk | Low risk |

[1] *Where likelihood is unknown or poorly established, use 'moderately likely'.*

Figure A.1: Dunedin Council

| Minor consequences | Moderate consequences | Major consequences |
|---|---|---|
| Includes:<br>- limited property damage that may be repairable without access to insurance, such as cracks in walls or wet foundations<br>- minor, non-life-threatening injuries<br>- localised (rather than district-wide) economic impact; and<br>- restricted site access to a site for no more than 2 days due to flood waters, but where safe access is still possible on foot. | At least 2 of the following outcomes:<br>- serious structural damage to property, which is costly, but still repairable, where access to insurance is almost always necessary to fix damage<br>- a potential for significant injury<br>- physical isolation on-site for more than 2 days at a time<br>- potential for economic impact that may be felt at a district-wide scale; and<br>- some reliance on civil defence. | At least 2 of the following outcomes:<br>- significant property or asset damage or loss, including structural damage that is extensive and so severe that it may lead to a property being abandoned or an asset requiring complete replacement<br>- a likely potential for long term displacement, deaths or serious injuries<br>- potential for significant effects to be felt over a wider area, including public health issues<br>- potential for economic impact to be felt at a regional scale; and<br>- significant civil defence assistance being required, including temporary shelter or evacuation. |

Figure A.2: Dunedin Council

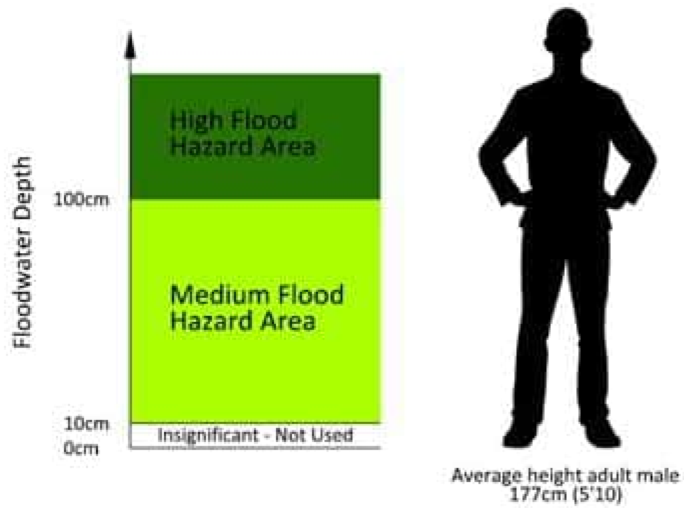



Figure A.3: Waikato River zone

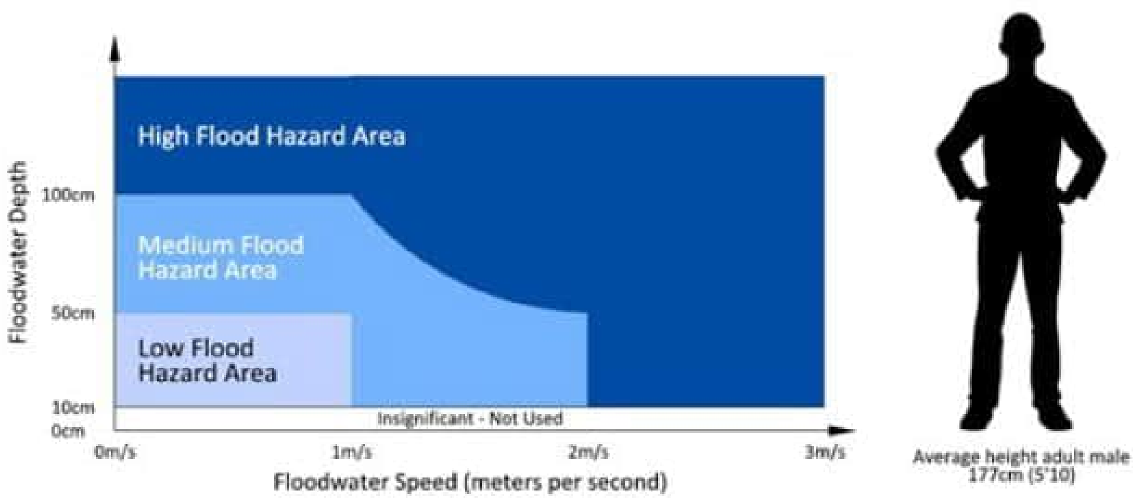



Figure A.4: Outside Waikato River zone

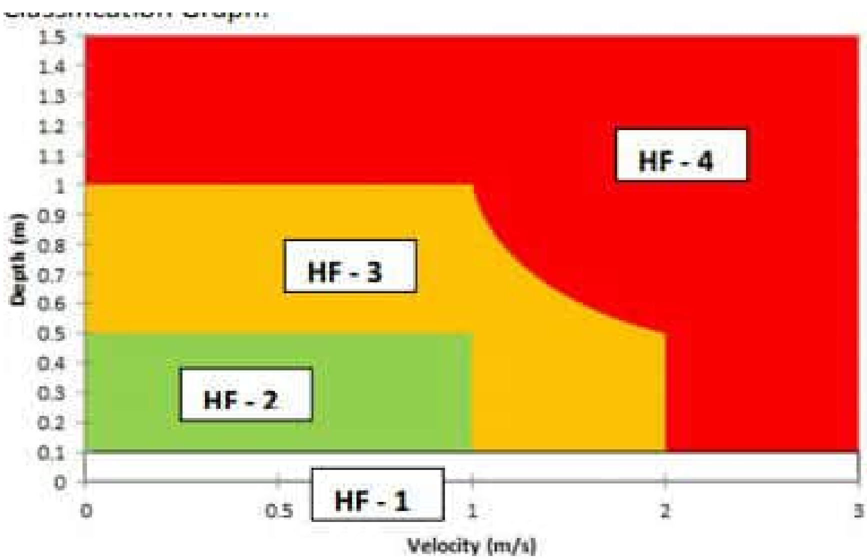



Figure A.5: Hamilton City Council

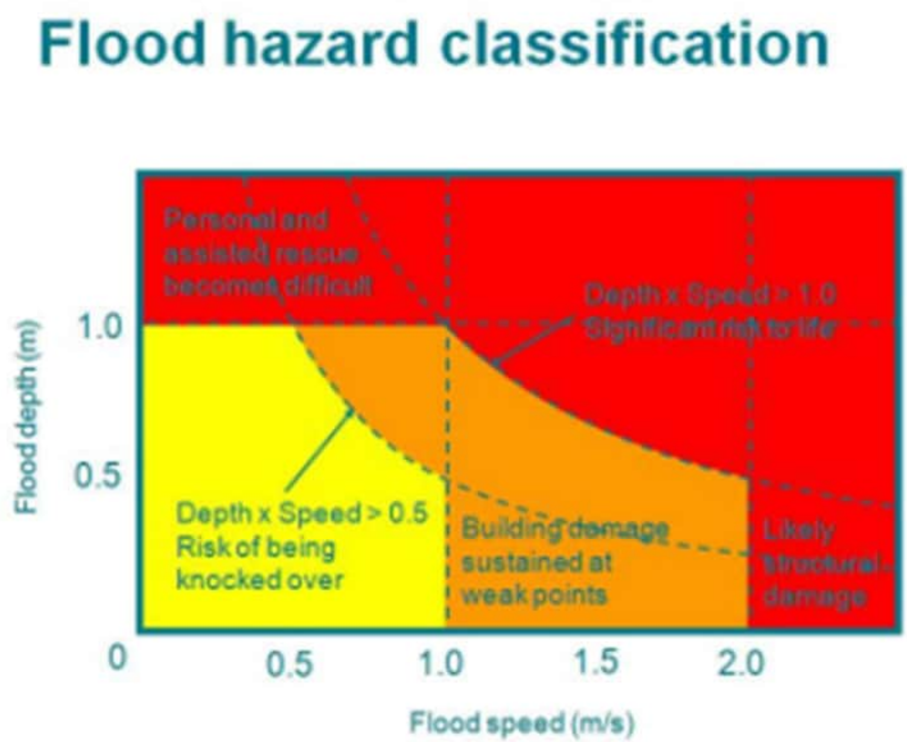



Figure A.6: Thames Coromandel

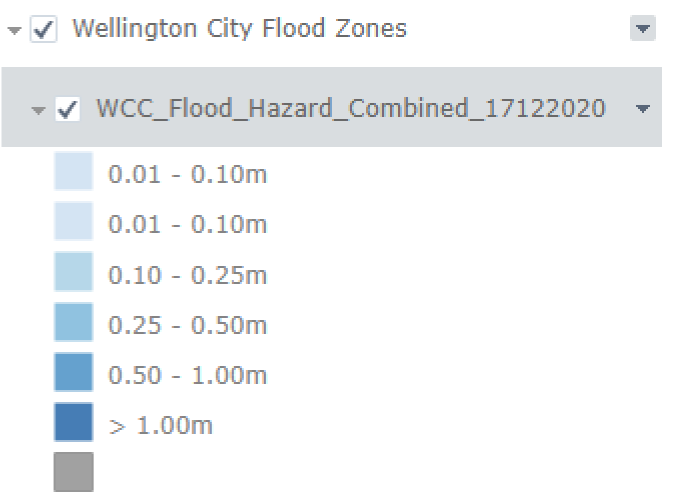



Figure A.7: Wellington City Flood Hazard

| Hazard Vulnerability Classification | Description |
|---|---|
| H1 | Generally safe for vehicles, people and buildings. |
| H2 | Unsafe for small vehicles. |
| H3 | Unsafe for vehicles. children and the elderly. |
| H4 | Unsafe for vehicles and people. |
| H5 | Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure. |
| H6 | Unsafe for vehicles and people. All building types considered vulnerable to failure. |

| Hazard Vulnerability Classification | Classification Limit (D and V in combination) | Limiting Still Water Depth (D) | Limiting Velocity (V) |
|---|---|---|---|
| H1 | $D*V \leq 0.3$ | 0.3 | 2.0 |
| H2 | $D*V \leq 0.6$ | 0.5 | 2.0 |
| H3 | $D*V \leq 0.6$ | 1.2 | 2.0 |
| H4 | $D*V \leq 1.0$ | 2.0 | 2.0 |
| H5 | $D*V \leq 4.0$ | 4.0 | 4.0 |
| H6 | $D*V > 4.0$ | - | - |

Figure A.8: Australian Disaster Resilience Handbook (thresholds)

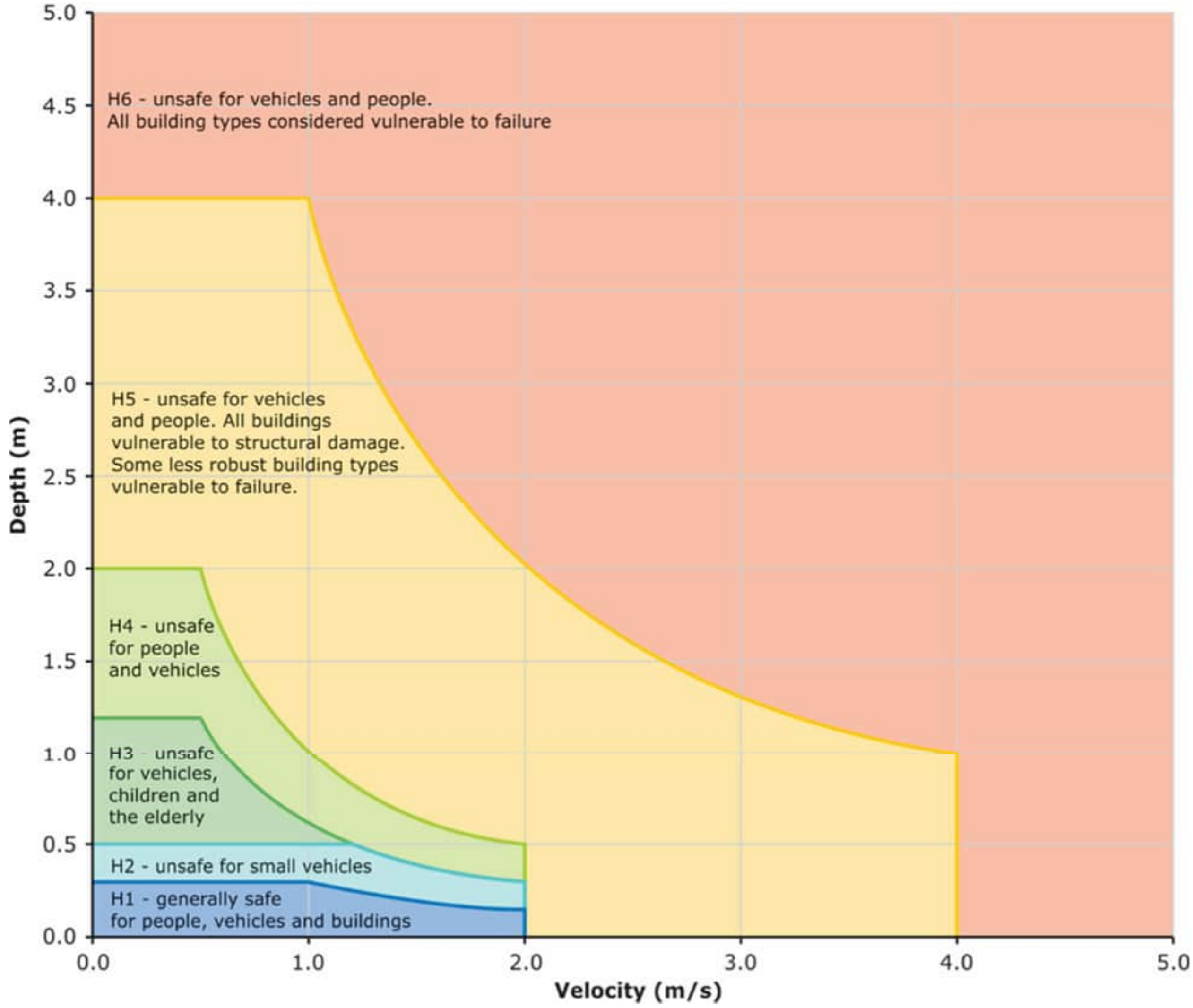



Figure A.9: Australian Disaster Resilience Handbook (categories)

| Velocity Coefficient C | 0.5 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (V+C) * D | Depth | | | | | | | | | |
| Velocity | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 |
| 0.00 | 0.13 | 0.25 | 0.38 | 0.50 | 0.63 | 0.75 | 0.88 | 1.00 | 1.13 | 1.25 |
| 0.50 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 | 2.50 |
| 1.00 | 0.38 | 0.75 | 1.13 | 1.50 | 1.88 | 2.25 | 2.63 | 3.00 | 3.38 | 3.75 |
| 1.50 | 0.50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 |
| 2.00 | 0.63 | 1.25 | 1.88 | 2.50 | 3.13 | 3.75 | 4.38 | 5.00 | 5.63 | 6.25 |
| 2.50 | 0.75 | 1.50 | 2.25 | 3.00 | 3.75 | 4.50 | 5.25 | 6.00 | 6.75 | 7.50 |
| 3.00 | 0.88 | 1.75 | 2.63 | 3.50 | 4.38 | 5.25 | 6.13 | 7.00 | 7.88 | 8.75 |
| 3.50 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 |
| 4.00 | 1.13 | 2.25 | 3.38 | 4.50 | 5.63 | 6.75 | 7.88 | 9.00 | 10.13 | 11.25 |
| 4.50 | 1.25 | 2.50 | 3.75 | 5.00 | 6.25 | 7.50 | 8.75 | 10.00 | 11.25 | 12.50 |
| 5.00 | 1.38 | 2.75 | 4.13 | 5.50 | 6.88 | 8.25 | 9.63 | 11.00 | 12.38 | 13.75 |

| | From | To | |
|---|---|---|---|
| Class 1 | 0.75 | 1.25 | Danger for some |
| Class 2 | 1.25 | 2.50 | Danger for most |
| Class 3 | 2.50 | 20.00 | Danger for all |

Figure A.10: Defra hazard matrix

| Depth X Velocity ($m^2$/sec) | Hazard | Description |
|---|---|---|
| < 0.75 | LOW | *Caution*<br>Shallow flood water or deep standing water |
| 0.75 < 1.5 | MODERATE | *Dangerous to vulnerable groups*<br>Deep or fast flowing water.<br>Fatalities concentrated in vulnerable groups or the result of human behaviour. |
| 1.5 < 2.5 | HIGH | *Dangerous to most people*<br>Deep or fast flowing water.<br>Fatalities due mainly to exposure to the hazard. |
| 2.5 > 7.0 | EXTREME | *Dangerous for all*<br>Extreme danger from deep, fast flowing water.<br>Fatalities due to hazard exposure. |
| > 7.0 | EXTREME | *Dangerous for all*<br>Extreme danger from deep, fast flowing water and risk of building collapse. |

Figure A.11: World Meteorological Organization

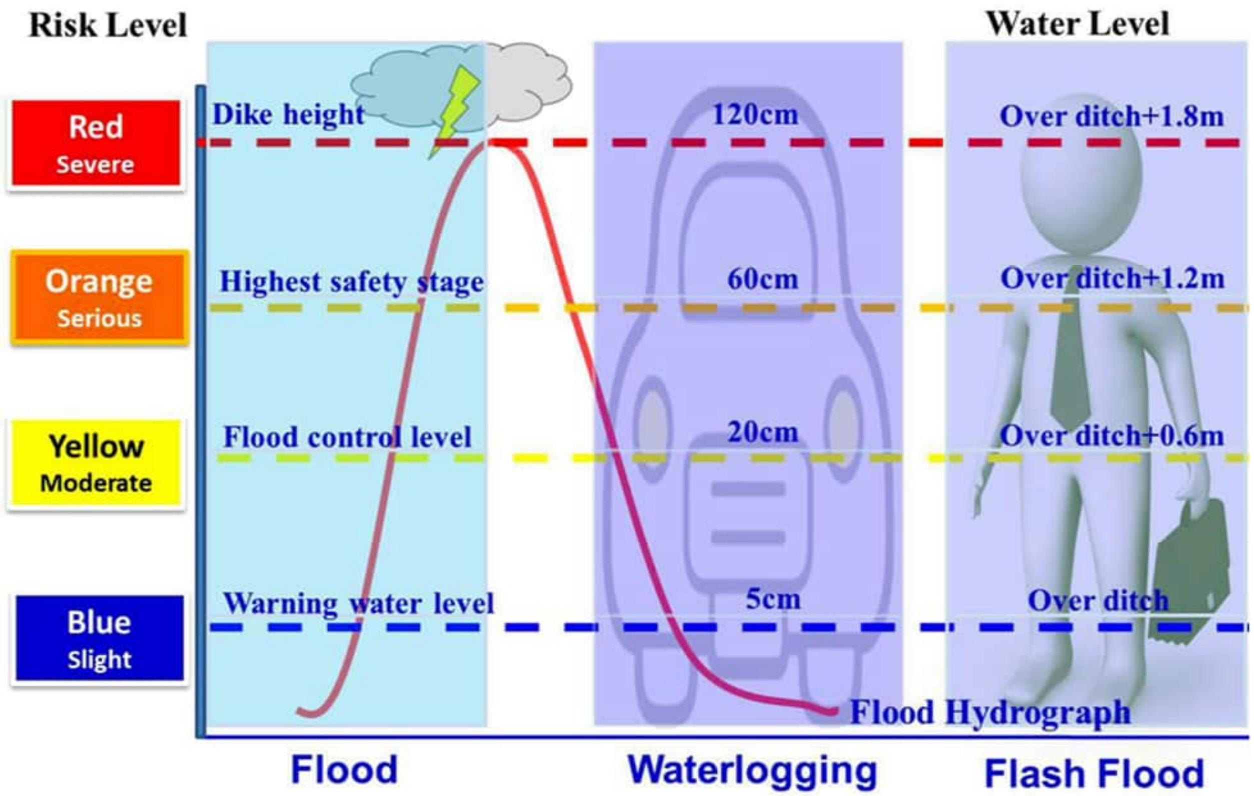



Figure A.12: World Meteorological Organization

# Appendix B. Detailed Planning Context

## B.1 New Zealand Coastal Policy Statement (NZCPS)

NZCPS provides national direction for the management of, and adaption to coastal hazards. Objective 5 of the NZCPS provides an overarching guidance regarding hazards and land uses:

*To ensure that coastal hazard risks taking account of climate change, are managed by:*

- locating new development away from areas prone to such risks;
- considering responses, including managed retreat, for existing development in this situation; and
- protecting or restoring natural defences to coastal hazards.

Policy 3: Precautionary approach:

*(1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse.*

*(2) In particular, adopt a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change, so that:*

> *(a) avoidable social and economic loss and harm to communities does not occur;*
>
> *(b) natural adjustments for coastal processes, natural defences, ecosystems, habitat and species are allowed to occur; and*
>
> *(c) the natural character, public access, amenity and other values of the coastal environment meet the needs of future generations.*

The means by which to identify coastal hazard risks is described by Policy 24:

*(1) Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:*

*(a) physical drivers and processes that cause coastal change including sea level rise;*

*(b) short-term and long-term natural dynamic fluctuations of erosion and accretion;*

*(c) geomorphological character;*

*(d) the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;*

*(e) cumulative effects of sea level rise, storm surge and wave height under storm conditions;*

*(f) influences that humans have had or are having on the coast;*

*(g) the extent and permanence of built development; and (h) the effects of climate change on:*

*(i) matters (a) to (g) above;*

*(ii) storm frequency, intensity and surges; and*

*(iii) coastal sediment dynamics; taking into account national guidance and the best available information on the likely effects of climate change on the region or district.*

These matters have been addressed by T+T in preparing the Coastal Hazard Assessment, which is the base data for the analysis of thresholds for defining the boundaries of coastal hazard categories in this report.

The NZCPS requires councils to utilise the information developed in Policy 24 to manage the risks, and wider effects of hazards on land uses. This approach is elaborated on by Policy 25:

- In areas potentially affected by coastal hazards over at least the next 100 years:
- avoid increasing the risk of social, environmental and economic harm from coastal hazards.
- avoid redevelopment, or change in land use, that would increase the risk of adverse effects from coastal hazards;
- encourage redevelopment, or change in land use, where that would reduce the risk of adverse effects from coastal hazards, including managed retreat by relocation or removal of existing structures or their abandonment in extreme circumstances, and designing for relocatability or recoverability from hazard events;
- encourage the location of infrastructure away from areas of hazard risk where practicable;
- discourage hard protection structures and promote the use of alternatives to them, including natural defences; and
- consider the potential effects of tsunami and how to avoid or mitigate them.

It should be noted that the language used in this policy is directive with the use of “avoid” in the first two sub-parts to the policy. RMA case law have established that avoiding or avoidance is of the highest order of responses, only surpassed by prohibiting. In Environmental Defence Society Inc v The New Zealand King Salmon Co Ltd [2014] NZSC 38, the New Zealand Supreme Court found that the use of the word avoid in the NZCPS means “not allowing" and "inappropriateness". As such, Policy 25 provides a clear direction as to the importance of preventing an increase in coastal hazard risks, as well as the potential for more restrictive controls on existing land uses. Policy 25 also provides clear direction as the duration that coastal hazard risks should be considered, that being 100 years.[35]

While this report does not recommend specific responses to coastal hazard, it is recognised that this analysis will be used in concert with other analysis and community engagement to confirm preferred regulatory responses to these risks. This process will also include the reporting required under s32 of the RMA, with the s32 reporting needing to address Policy 27 of the NZCPS:

*1 In areas of significant existing development likely to be affected by coastal hazards, the range of options for reducing coastal hazard risk that should be assessed includes:*

[35] The NZCPS describes risk as:
*“Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009).”*

It should be noted that exercises to identify and assess risks are not limited by the above description, given that it is only a description rather than a binding definition.

*a) promoting and identifying long-term sustainable risk reduction approaches including the relocation or removal of existing development or structures at risk;*

*b) identifying the consequences of potential strategic options relative to the option of "do-nothing";*

*c) recognising that hard protection structures may be the only practical means to protect existing infrastructure of national or regional importance, to sustain the potential of built physical resources to meet the reasonably foreseeable needs of future generations;*

*d) recognising and considering the environmental and social costs of permitting hard protection structures to protect private property; and*

*e) identifying and planning for transition mechanisms and timeframes for moving to more sustainable approaches.*

*2. In evaluating options under (1):*

*a) focus on approaches to risk management that reduce the need for hard protection structures and similar engineering interventions;*

*b) take into account the nature of the coastal hazard risk and how it might change over at least a 100-year timeframe, including the expected effects of climate change; and*

*c) evaluate the likely costs and benefits of any proposed coastal hazard risk reduction options.*

## B.2 Canterbury Regional Policy Statement (the RPS)

RPS Chapter 11 "Natural Hazards" policies provides some direction for assessing coastal hazards. The two relevant objectives of this chapter are:

*11.2.1 - Avoid new subdivision, use and development of land that increases risks associated with natural hazards.*

New subdivision, use and development of land which increases the risk of natural hazards to people, property and infrastructure is avoided or, where avoidance is not possible, mitigation measures minimise such risks.

*11.2.3 – Climate change and natural hazards*

The effects of climate change, and its influence on sea levels and the frequency and severity of natural hazards, are recognised and provided for.

These objectives are then detailed further by the following policies:

*11.3.1 - Avoidance of inappropriate development in high hazard areas*

To avoid new subdivision, use and development (except as provided for in Policy 11.3.4) of land in high hazard areas, unless the subdivision, use or development:

1. is not likely to result in loss of life or serious injuries in the event of a natural hazard occurrence; and
2. is not likely to suffer significant damage or loss in the event of a natural hazard occurrence; and

3. is not likely to require new or upgraded hazard mitigation works to mitigate or avoid the natural hazard; and

4. is not likely to exacerbate the effects of the natural hazard; or

5. Outside of greater Christchurch, is proposed to be located in an area zoned or identified in a district plan for urban residential, industrial or commercial use, at the date of notification of the CRPS, in which case the effects of the natural hazard must be mitigated; or

6. Within greater Christchurch, is proposed to be located in an area zoned in a district plan for urban residential, industrial or commercial use, or identified as a "Greenfield Priority Area" on Map A of Chapter 6, both at the date the Land Use Recovery Plan was notified in the Gazette, in which the effect of the natural hazard must be avoided or appropriately mitigated; or

7. Within greater Christchurch, relates to the maintenance and/or upgrading of existing critical or significance infrastructure.

*11.3.2 - Avoid development in areas subject to inundation*

In areas not subject to Policy 11.3.1 that are subject to inundation by a 0.5% AEP flood event; any new subdivision, use and development (excluding critical infrastructure) shall be avoided unless there is no increased risk to life, and the subdivision, use or development:

1. is of a type that is not likely to suffer material damage in an inundation event; or

2. is ancillary or incidental to the main development; or 3. meets all of the following criteria:

   a. new buildings have an appropriate floor level above the 0.5% AEP design flood level; and

   b. hazardous substances will not be inundated during a 0.5% AEP flood event; provided that a higher standard of management of inundation hazard events may be adopted where local catchment conditions warrant (as determined by a cost/benefit assessment). When determining areas subject to inundation, climate change projections including sea level rise are to be taken into account.

*11.3.4 - Critical infrastructure*

*New critical infrastructure will be located outside high hazard areas unless there is no reasonable alternative. In relation to all areas, critical infrastructure must be designed to maintain, as far as practicable, its integrity and function during natural hazard events.*

11.3.5 - General risk management approach

*For natural hazards and/or areas not addressed by policies 11.3.1, 11.3.2, and 11.3.3, subdivision, use or development of land shall be avoided if the risk from natural hazards is unacceptable. When determining whether risk is unacceptable, the following matters will be considered:*

*1. the likelihood of the natural hazard event; and*

*2. the potential consequence of the natural hazard event for: people and communities, property and infrastructure and the environment, and the emergency response organisations. Where there is uncertainty in the likelihood or consequences of a natural hazard event, the local authority shall adopt a precautionary* *approach. Formal risk management techniques should be used, such as the Risk Management Standard (AS/NZS ISO 31000:2009) or the Structural Design Action Standard (AS/NZS 1170.0:2002).*

11.3.6 - Role of natural features

The role of natural topographic (or geographic) and vegetation features which assist in avoiding or mitigating natural hazards should be recognised and the features maintained, protected and restored, where appropriate.

11.3.9 - Integrated management of, and preparedness for, natural hazards

To undertake natural hazard management and preparedness for natural hazard events in a coordinated and integrated manner by ensuring that the lead agencies have particular regard to:

1. the investigation and identification of natural hazards;

2. the analysis and mapping of the consequential effects of the natural hazards identified;

3. the effects of climate change and resulting sea level rise;

6. any other matters necessary to ensure the integrated management of natural hazards in the Canterbury region

These objectives and policies are consistent with the direction set by the NZCPS, in that decision making associated with land use activities should avoid increasing natural hazard risks. They also recognise and provide for the projected increases in sea levels and associated hazards and detail the types of risks to be considered, principally loss of life or significant damage to property. They also acknowledge the importance of critical infrastructure and its locational requirements (i.e. some infrastructure must be located within/through hazardous areas.

It is also noted that these policies are directive, in that they detail specific requirements for building in inundation areas and this direction has been incorporated into this study's identification of risks. The policy framework also set out the requirement for district and city councils to investigate, map and address natural hazards, with specific regard given to the effects of sea level rise and climate change.

Lastly, Policy 11.3.1 helpfully provides a definition of high hazard areas, which includes land subject to sea water inundation and coastal erosion:

"*High hazard areas*" are:

*1. flood hazard areas subject to inundation events where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% AEP flood event;*

*2. land outside of greater Christchurch subject to coastal erosion over the next 100 years; and*

*3. land within greater Christchurch likely to be subject to coastal erosion including the cumulative effects of sea level rise over the next 100 This includes (but is not limited to) the land located within Hazard Zones 1 and 2 shown on Maps in Appendix 5 of this Regional Policy Statement that have been determined in accordance with Appendix 6; and*

*4. land subject to sea water inundation (excluding tsunami) over the next 100 years. This includes (but is not limited to) the land located within the sea water inundation zone boundary shown on Maps in Appendix 5 of this Regional Policy Statement.*

## B.3 Regional Coastal Environment Plan for the Canterbury Region (RCEP)

The RCEP recognises the dynamic and connected nature of the coastal environment and therefore includes objectives, policies and rules for coastal hazards on the landward of the Mean High Water Spring boundary of mandatory Regional Coastal Plans. The following objective and related policies are considered relevant:

| *Objective 9.* | *a. To minimise the need for hazard protection works, and avoid or mitigate the actual or potential effects of coastal hazards by locating use and development away.* |
|---|---|
| *Policy 9.1* | *a. New habitable buildings should be located away from areas of the coastal environment that are, or have the potential to be, subject to sea water inundation or coastal erosion.*<br><br>*b. Any new development in the coastal environment should be designed or located in such a way that the need for coastal protection works, now and in the future, is minimised.*<br><br>*c. The continued use and protection of essential infrastructure and services should be provided for, where no reasonable alternative exists, in areas subject to coastal hazards, provided adverse effects on the coastal environment are avoided, remedied or mitigated.* |

The RCEP pre-dates both the NZCPS and RPS, and its language is less restrictive than the NZCPS (i.e. should rather than avoid), there is never-the-less the same clear guidance as to the importance of identifying, mapping and assessing coastal hazards. This includes the mapping of coastal erosion hazard zones along the majority of the region's coastline which form the areas for implementation of the rules under the above hazard objectives and policies.

These erosion hazard zones are defined as being:

- Erosion Hazard Zone 1:

  (a) For stable or accretionary shorelines: Where there is no evidence of shoreline erosion, the width of Hazard Zone 1 is the area landward of the Coastal Marine Area boundary to the landward limit of the active beach system. This position is determined either by ground survey, or from aerial photography.

  (b) For most eroding shorelines: The width of Hazard Zone 1 includes the active beach system and the area landward of this, which is likely to be part of the active beach system if contemporary erosion processes continue unaltered for the next 50 years. Hence, the landward limit of Hazard Zone 1 corresponds to the projected position of the landward toes of the active beach system.

  The width of hazard zones has been determined by interpolating the rate of shoreline retreat between fixed determination points. For all determination points, except for some special situations listed below, there was no evidence of a change in the long term rate of shoreline retreat. Therefore, the longest term historical erosion rates have been used. These will include short term fluctuations.

- Erosion Hazard Zone 2:

  No Hazard Zone 2 is defined for stable or accreting shorelines.

  For eroding shorelines, Hazard Zone 2 is landward of Hazard Zone 1, and covers areas that could become part of the active beach system within 50 to 100 years if the erosion rates used to calculate Hazard Zone 1 were to continue unaltered for 100 years.

The RCEP also maps a sea water inundation zone, covering areas known to have been affected by coastal inundation the past, but does not include any policies or rules around this hazard.

## B.4 The Christchurch District Plan

The Christchurch District Plan currently includes a number of objectives and policies relevant to coastal hazards. These would likely be reviewed and amended or replaced by a potential CHPC. Current objectives and policies include:

*Objective 3.6 – Natural Hazards*

*(a)New subdivision, use and development (other than new critical infrastructure or strategic infrastructure to which paragraph b. applies):*

*(i) is to be avoided in areas where the risks from natural hazards to people, property and infrastructure are assessed as being unacceptable; and*

*(ii) in all other areas, is undertaken in a manner that ensures the risks of natural hazards to people, property and infrastructure are appropriately mitigated.*

*(b) New critical infrastructure or strategic infrastructure may be located in areas where the risks of natural hazards to people, property and infrastructure are otherwise assessed as being unacceptable, but only where:*

*(i) there is no reasonable alternative; and*

*(ii) the strategic infrastructure or critical infrastructure has been designed to maintain, as far as practicable, its integrity and form during natural hazard events; and the natural hazard risks to people, property and infrastructure are appropriately mitigated.*

*(iii) There is increased public awareness of the range and scale of natural hazard events that can affect Christchurch District.*

*(iv) The repair of earthquake damaged land is facilitated as part of the recovery.*

*5.2.2.1.1 Policy - Avoid new development where there is unacceptable risk*

*(a) Avoid new subdivision, use and development, including new urban zonings, where the risk from a natural hazard is assessed as being unacceptable.*

*5.2.2.1.2 Policy -- Manage activities to address natural hazard risks*

*(a) Manage activities in all areas subject to natural hazards in a manner that is commensurate with the likelihood and consequences of a natural hazard event on life and property.*

*5.2.2.1.3 Policy -- Infrastructure*

*(a) Avoid locating new critical infrastructure where it is at risk of being significantly affected by a natural hazard unless, considering functional and operational requirements, there is no reasonable alternative location or method.*

*(b) Enable critical infrastructure to be designed, maintained and managed to function to the extent practicable during and after natural hazard events.*

*(c) Recognise the benefits of infrastructure and the need for its repair, maintenance and ongoing use in areas affected by natural hazards.*

*5.2.2.2 Policy for managing risk from flooding*

*(a)Map hazard risk for the Flood Management Area based on:*

*(i) a modelled 0.5% AEP (1 in 200-year) rainfall event plus a 5% AEP (1 in 20-year) tide event plus 250mm freeboard; OR a modelled 5% AEP (1 in 20-year flood event) plus a 0.5% AEP (1 in 200-year) tide event plus 250mm freeboard; OR 11.9m above Christchurch City Council Datum (the maximum 200-year tidal contour) plus 250mm freeboard; whichever is the greater; and*

*(ii)allowance for 1 metre of sea level rise and an increase in rainfall intensity by 16% through to 2115 as a result of climate change; and*

*(iii) a maximum buffer extension of the modelled rainfall event areas by 60 metres in a north/south and east/west direction.*

*(b) In the High Flood Hazard Management Area:*

*(i) provide for development of a residential unit on residentially zoned land where the flooding risk is predominantly influenced by sea-level rise and where appropriate mitigation can be provided that protects people's safety, well-being and property from unacceptable risk; and*

*(iii) in all other cases, avoid subdivision, use or development where it will increase the potential risk to people's safety, well-being and property.*

*(e)Except for filling required to meet minimum floor levels, ensure that filling in urban areas at risk of flooding in a major flood event does not transfer flooding risk to other people, property, infrastructure or the natural environment.*

*(f) Reduce potential flood damage by ensuring floor levels for new buildings or additions to buildings, except those unlikely to suffer material damage, are above flooding predicted to occur in a major flood event, including an allowance for appropriate freeboard.*

The above objective and policies provide a context regarding hazard identification and assessment, including specific guidance regarding flooding and sea level rise. In particular, the District Plan replicates the language of higher order RMA documents, in that hazards should be avoided where the risks generated by these hazards is unacceptable. This study has employed this policy approach and incorporates the concept of unacceptable risk into its methodology.

The District Plan also recognises the functional need for activities in hazard locations, principally infrastructure. Again, consideration of the risks to critical infrastructure has been incorporated into this study. Lastly, the District Plan also incorporates a set sea level rise figure as it relates to inundation risks. This current District Plan approach is acknowledged by this study and it is noted that the current sea level rise horizon and level will likely be replaced by any future plan change.

## B.5 The Banks Peninsula District Plan

The Banks Peninsula District Plan currently includes a number of objectives and policies relevant to coastal hazards. These would likely be reviewed and amended or replaced by a potential CHPC. Current objectives and policies include:

Chapter 38 – Objective 1

*To avoid or mitigate the costs resulting from natural hazards in terms of loss of life and loss or damage to property and the environment.*

Policy 1A

*New subdivision and development shall take into account any potential risks from natural hazards. The minimum protection aimed for is that there should be no damage:*

- *To new dwellings or their contents from flood events with a 1:500 probability of occurrence, or from events arising from slope instability.*
- *To existing dwellings or their contents from flood events with a 1:200 probability of occurrence, or from events arising from slope instability.*

Policy 1C

*Risk reduction measures shall be promoted where existing activities are located in areas of high existing or potential risk.*

Policy 1E

*Council data on natural hazard events will be updated progressively, and consideration given to any need for a review of natural hazards provisions in the Plan.*

Policy 1F

*No measure intended to remedy or mitigate a natural hazard should have a significant adverse effect on the environment.*

Policy 1G

*In flood-prone areas earthworks should only be undertaken in such a way that they do not cause or worsen flood risk elsewhere*

## B.6 Coastal Hazards and Climate Change: guidance for local Government

Provides non-statutory guidance to assist local governments for effective climate change adaptation planning in the face of increasing coastal hazard risks form climate change. The document adopts, and recommends, a 10-step decision cycle for-long term strategic planning and decision-making[36]. It also explains the relationship for coastal hazard management under RMA, policy and plans.[37] The guidance provide some useful recommendations in using climate change hazards information such as sea level rise (SLR) scenarios in the local planning context, discussed in Section 5 of this report.

[36] See page 14 of the document here https://environment.govt.nz/assets/Publications/Files/coastal-hazards-guide-final.pdf
[37] See page 218 of the document here https://environment.govt.nz/assets/Publications/Files/coastal-hazards-guide-final.pdf

# Appendix C. 500 year Return Period Tsunami Inundation Depths

From Bosserelle C., Arnold J., Lane E.; Land Drainage Recovery Programme: Tsunami Study. NIWA report 2018039CH Prepared for CCC.

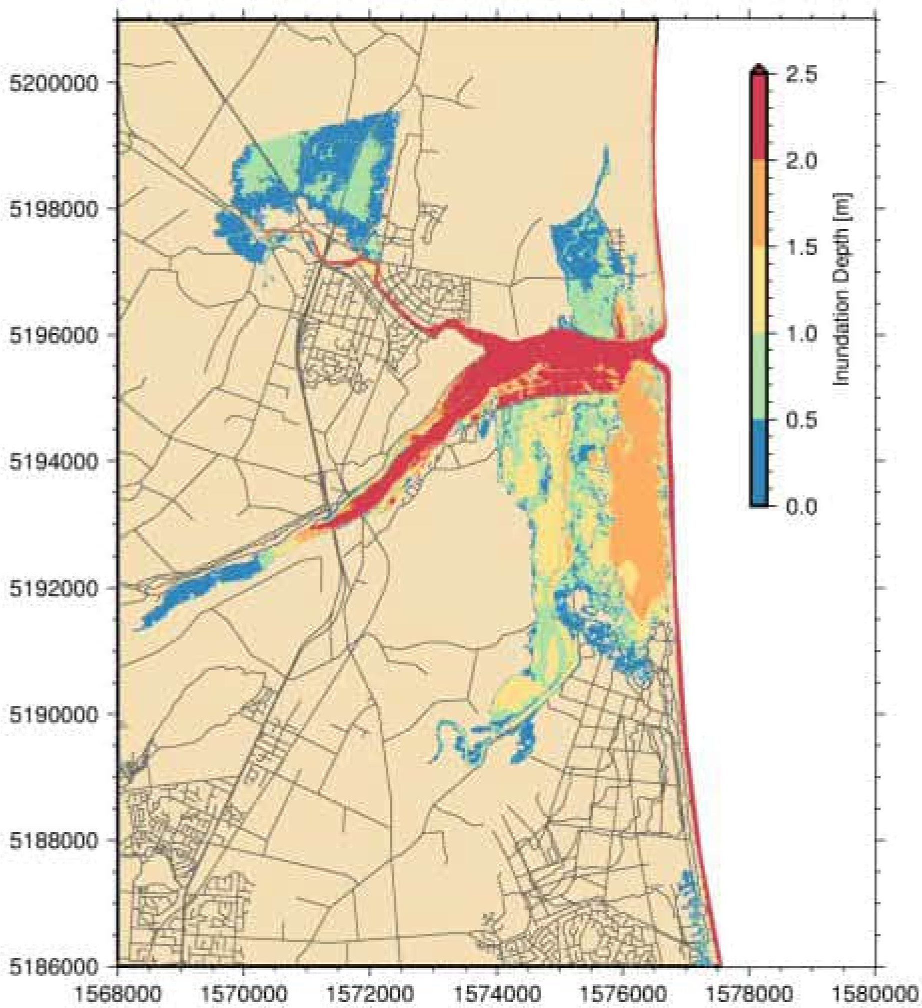



**Figure 3-21: Maximum inundation depth (i.e., height above ground) for 1:500-year return period event Current Sea Level - Northern Section.** Note that for the river channels the value given is the height above the pre-tsunami water level.

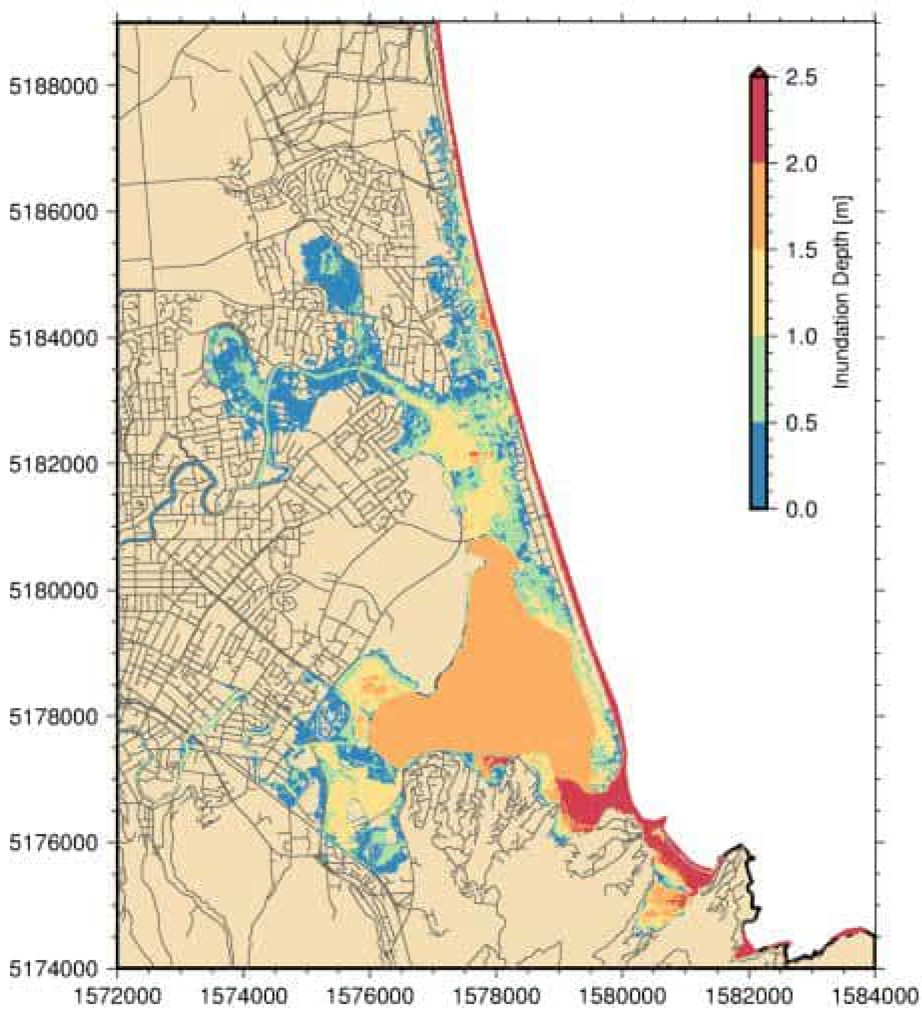



**Figure 3-23: Maximum inundation depth (i.e., height above ground) for 1:500-year return period event Current Sea Level - Southern Section.** Note that for the river channels the value given is the height above the pre-tsunami water level.

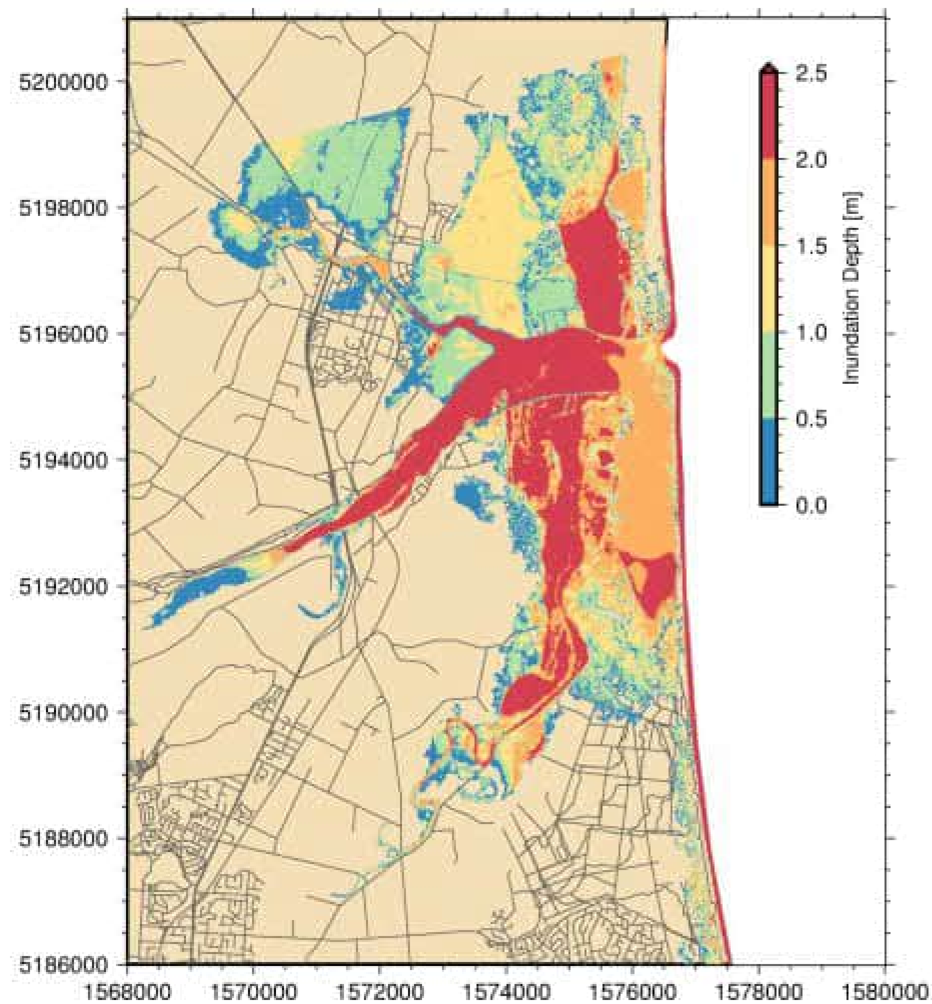



**Figure 3-33: Maximum inundation depth (i.e., height above ground) for 1:500-year return period event 2120 Sea Level Scenario – 1.06 m Sea Level Rise - Northern Section.** Note that for the river channels the value given is the height above the pre-tsunami water level.

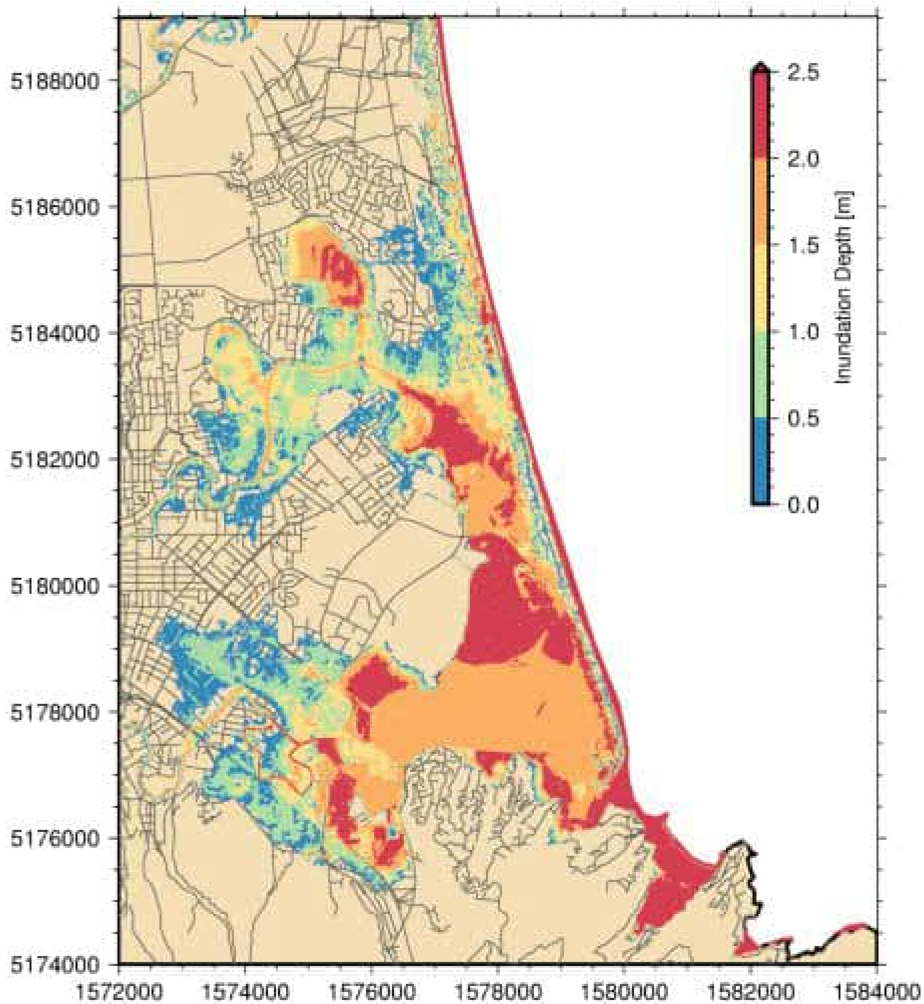



**Figure 3-35: Maximum inundation depth (i.e., height above ground) for 1:500-year return period event 2120 Sea Level Scenario – 1.06 m Sea Level Rise - Southern Section.** Note that for the river channels the value given is the height above the pre-tsunami water level.

From GNS Science 2019 & 2020 (as presented in ECan 2020 – Review of tsunami evacuation zones for Banks Peninsula and the Kaitorete coast)

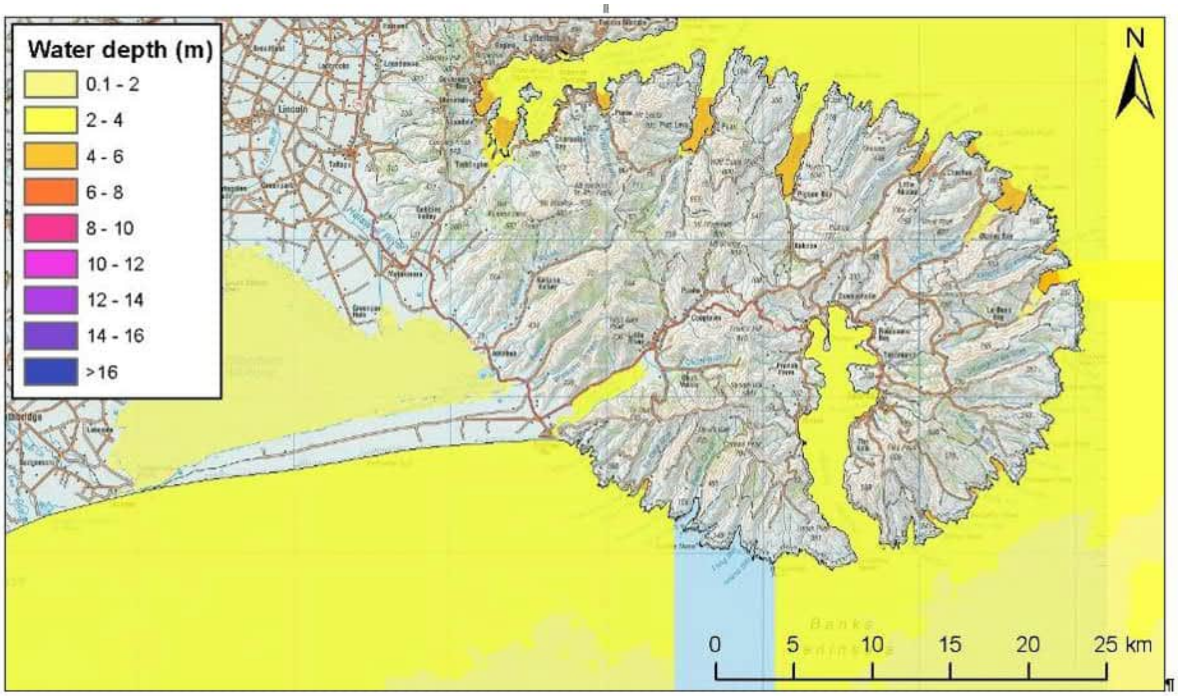



Figure 3-2: → **Maximum modelled inundation water depths for eighteen different tsunami sources around the Pacific Ocean that generate an ~ 3 metre wave height at coast. Note that each separate scenario inundates very slightly different areas within the total modelled inundation extent. Water depths in the ocean and coastal lakes are water height above mean sea level (the coastal lakes are is assumed to be full at the time of the tsunami). Water depths on land are water height above ground. From Mueller *et al,* 2020 and Roger *et al,* 2020.**

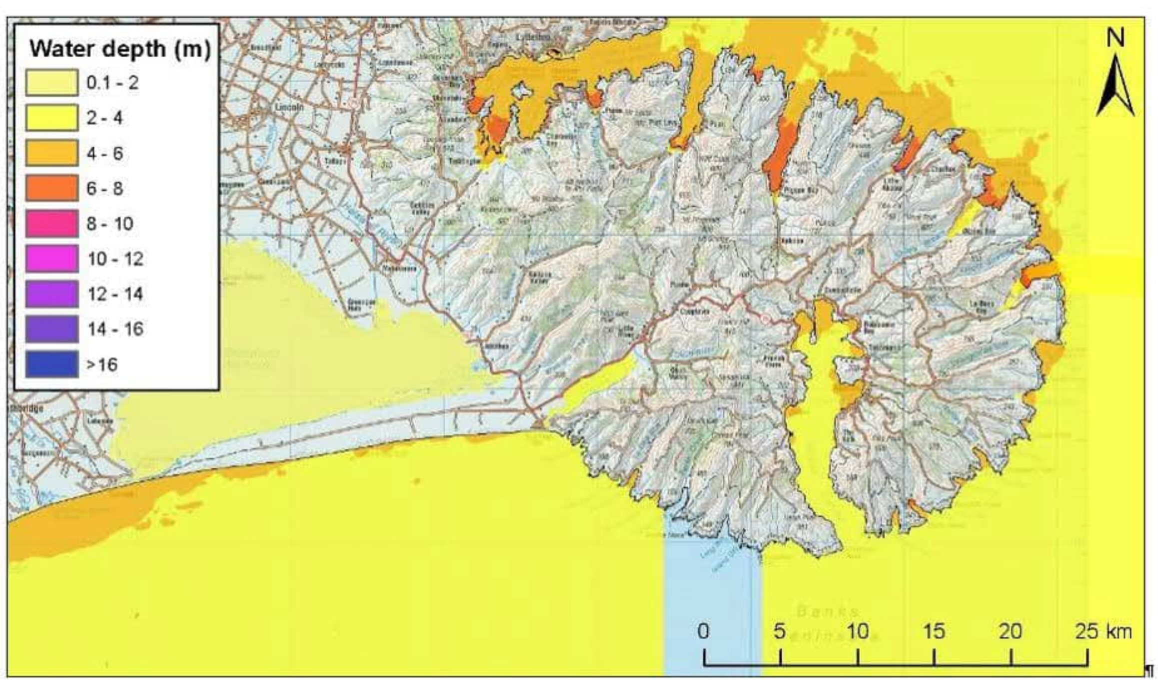



Figure 3-3: → **Maximum modelled inundation water depths for twenty different tsunami sources around the Pacific Ocean that generate an ~ 5 metre wave height at coast. Note that each separate scenario inundates very slightly different areas within the total modelled inundation extent. Water depths in the ocean and coastal lakes are water height above mean sea level (the coastal lakes are is assumed to be full at the time of the tsunami). Water depths on land are water height above ground. From Mueller *et al,* 2020 and Roger *et al,* 2020.**

# Appendix D. Glossary

| Risk-related terminologies | Definitions |
|---|---|
| Hazard | Severity and magnitude of a natural or human-induced event or trend that causes harmful impacts (consequences) on natural, built environment, or social systems (MfE 2020). |
| Exposure | The lack of systems (i.e., properties, infrastructures, human) protection against adversity (adverse hazard factors) in a hazard prone area, that could cause negative impacts. |
| Vulnerability | The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm, and lack of capacity to cope and adapt |
| Risk | The interaction between the hazard, exposure of things to that hazard and the vulnerability of the things that are exposed. |
| Scenarios | The range of SLR curves under various RCP emission scenarios, timeframes and event return periods that were considered most suitable for use for District Planning purposes. |
| Threshold | was conceptually to be used in this work as a method of categorising between areas of differing level of risk. So, it was the method by which some characteristic of the hazard was to be used to determine between high, medium and low risk |
| Representative Concentration Pathway (RCP) | A future assumptions of greenhouse gas concentration trajectory adopted by the Intergovernmental Panel on Climate Change |
| Shared Socioeconomic Pathways (SSPs) | Shared Socioeconomic Pathways (SSPs) are scenarios of projected socioeconomic global changes up to 2100. They are used to derive greenhouse gas emissions scenarios with different climate policies. |
| Scenarios | The combination of a future timeframe and climate change Representative Concentration Pathways (RCP), which together determine a projected SLR and consequent increase in hazard exposure, |

# Appendix 8

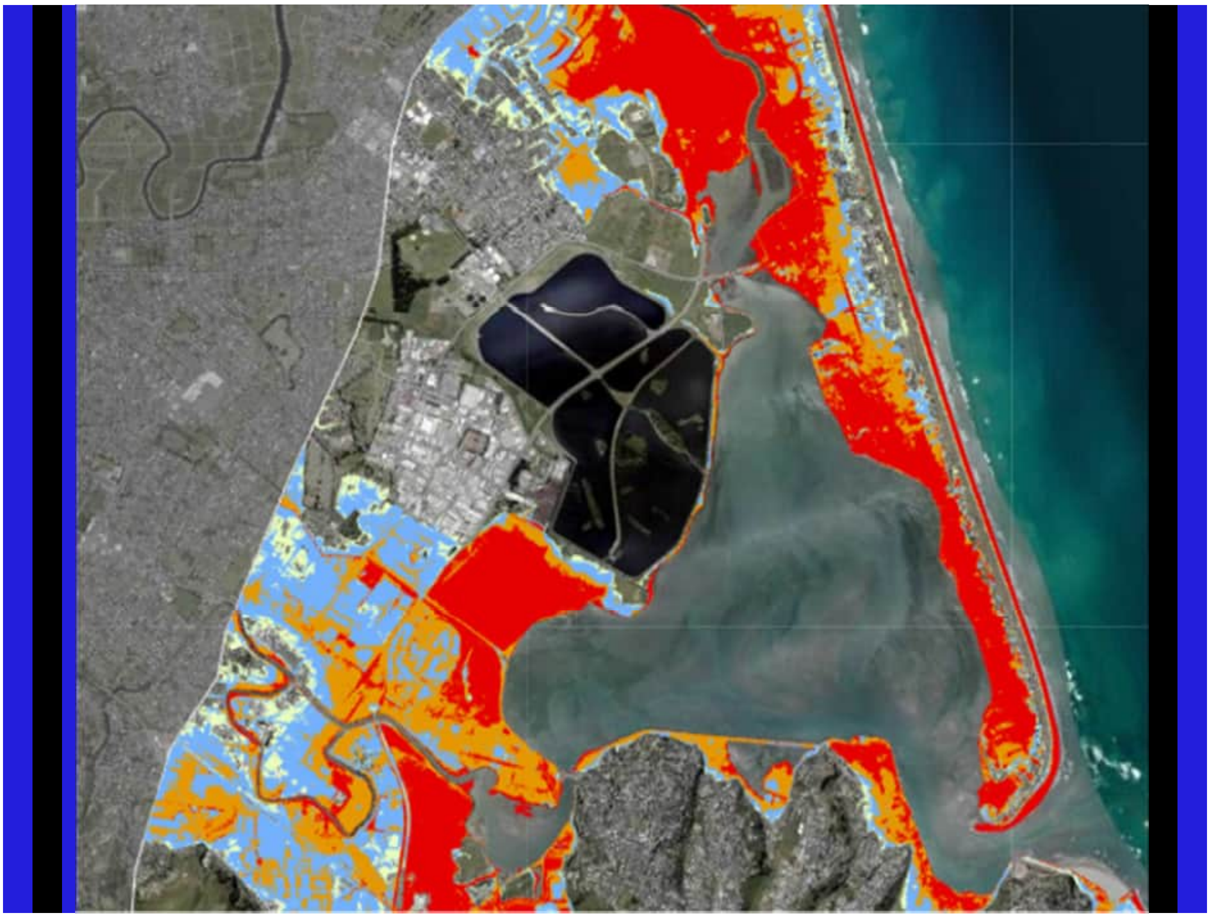
Qualifying Matter Addendum to the 2021 Risk Based Coastal Hazard Analysis for Land-use Planning – Jacobs

# Addendum Report to Risk Based Coastal Hazard Analysis for Land-use Planning Report

Document no: IS417100-NP-RPT-0003 Addendum Report to Risk Based Coastal Hazard Analysis for Land-use Planning Report
Revision no: Rev 0

Christchurch City Council

Coastal Hazard Plan Change - Analysis/Technical Advice
24 August 2022



# Addendum Report to Risk Based Coastal Hazard Analysis for Land-use Planning Report

| | | | |
|---|---|---|---|
| **Client name:** | Christchurch City Council | | |
| **Project name:** | Coastal Hazard Plan Change - Analysis/Technical Advice | | |
| | | **Project no:** | IS417100 |
| **Document no:** | IS417100-NP-RPT-0003 Addendum Report to Risk Based Coastal Hazard Analysis for Land-use Planning Report | **Project manager:** | N Malone |
| **Revision no:** | Rev 0 | **Prepared by:** | D Debski, E Scheffler & K MacDonald |
| **Date:** | 24 August 2022 | **File name:** | IS417100-NP-RPT-0003 Addendum Report to Risk Based Coastal Hazard Analysis for Land-use Planning Report |

## Document history and status

| Revision | Date | Description | Author | Reviewed | Approved |
|---|---|---|---|---|---|
| Draft A | 12/08/2022 | For client issue | D Debski, E Scheffler, K MacDonald | D Todd | I Wiseman |
| Rev 0 | 24/08/2022 | Final | D Debski, E Scheffler, K MacDonald | D Todd | I Wiseman |
| | | | | | |

## Distribution of copies

| Revision | Issue approved | Date issued | Issued to | Comments |
|---|---|---|---|---|
| Draft 0 | I Wiseman | 24/08/2022 | CCC | Final |
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# Executive summary

In July 2021, CCC commissioned Jacobs to conduct a risk-based coastal erosion and inundation hazard analysis for land-use planning. The recommendations from the study (Risk Based Coastal Hazard Analysis for Land-use Planning, Jacobs report IS391200-NP-RPT-0001, September 2021) were used by CCC in their Issues and Options paper for consultation with communities and stakeholders on the Coastal Hazards District Plan Change in conjunction with consultation on the Coastal Hazards Adaptation Planning Programme also being undertaken by CCC. The recommendations were externally peer reviewed by Beca. In light of community submissions and external peer review comments, we have updated our recommendations, which are presented in this addendum to the Jacobs (2021) report. The purpose of this addendum report is to present the analysis undertaken to justify the recommended thresholds for the hazard categories and to present the spatial extent of the resulting hazard zones for both coastal inundation and erosion.

Council intend to use this addendum report to support the identification of Qualifying Matters in Plan Change 14 – Housing and Business Choice which is anticipated to be notified in September 2022.

The objectives of our project were to:

a) Define a range of suitable hazard thresholds and applicable scenarios[1] to develop low, medium, and high erosion and inundation hazard areas

b) Recommend a preferred approach to the categorising and mapping of erosion and inundation hazards to inform the drafting of plan change provisions appropriate to the differing levels of risk.

A review of the approaches currently used in District and Regional Plans in New Zealand, non-statutory documents and consideration of international guidance was undertaken to inform the choice of risk thresholds and scenarios.

Thresholds were developed for the new erosion and inundation coastal hazard data from the CHA which was in the form of bathtub modelling data for inundation and a range of methodologies for erosion along differing coastline types. A range of approaches to define areas of low, medium and high risk were developed and compared, from which a preferred approach was recommended.

We have allowed for the increase in hazard exposure due to expected sea level rise (SLR) by assessing both the erosion and inundation hazards for two SLR scenarios - 0.6 m SLR by 2080 and 1.2 m SLR by 2130.

For Inundation, the 0.5% annual exceedance probability – a reasonably foreseeable event and consistent with definitions under the existing District Plan and Regional Policy Statement – and the 1.2 m SLR scenario were selected to define the overall extent of inundation hazard. This scenario ensures intergenerational needs, and a precautionary approach are applied to the planning framework.

Thresholds are based on the water depth for the 0.2% annual exceedance probability with 1.2m SLR and were developed by considering the hazard to people who need to access, egress, or use the buildings during a flood.

The depth threshold values were informed by published guidelines and used to define four coastal flood risk categories – high/medium/low/very low. These categories allow for a consideration of the change in the flood depth between the higher confidence SLR scenario (0.6 m) which is likely to occur sooner, and the lower confidence, but higher consequence, SLR scenario (1.2 m) which may occur further in the future. The recommended flood risk categories are presented in Table 1-1.

[1] "Scenario" refers to a combination of a future time period and climate change scenario (RCP) which together determine a projected rise in mean sea level (SLR) and consequent increase in hazard.

Table 1-1. Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 0.2% annual exceedance probability)

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Very low | None (dry) | Low (d < 0.4 m) |
| Low | Low (d < 0.4 m) | Medium (0.4 m < d < 1.0 m) |
| Medium | Medium (0.4 m < d < 1.0 m) | High (d > 1.0 m) |
| High | High (d > 1.0 m) | High (d > 1.6 m) |

For Erosion, based on the assumption that the permanent loss of land due to erosion is always high, likelihood was selected as the key determinant of erosion thresholds, being the statistical probability that a certain erosion distance will occur within a given timeframe.

Several thresholds across different SLR timeframes were tested to assess whether they can meet the requirements under the Resource Management Act 1991 (RMA) of defining reasonably foreseeable hazards, and that the resulting hazard zones meet the needs of future generations. The analysis also considered the various assessment methods applied by T+T in different areas of the District. The recommended combination of thresholds and scenarios are:

1) For the Christchurch City urban area open coast; two erosion zones compromising of
   a) A High Hazard Coastal Erosion Zone covering the current beach-primary dune width, and
   b) Where required, A Low Hazard Coastal Erosion Zone to a lowland limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 and an additional area required for “future dune resilience factor”.
2) For the Avon-Heathcote Estuary; two erosion zones comprising of
   a) A High-Medium Hazard Coastal Erosion Zone defined by a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell for the 66% probability erosion distance with 0.6 m SLR by 2080
   b) A Low Hazard Coastal Erosion Zone defined by a generic additional width of 20 m across all cells to be equal to the largest ASCE in any cell for the 10% probability erosion distance with 1.2 m SLR by 2130.
3) For the beaches and bays of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula Bays High-Medium Coastal Erosion Hazard Zone, with the landward limit defined for:
   a) Probabilistic assessment cells as the 10% probability of erosion distance for 1.2 m SLR by 2130, and
   b) Deterministic assessment cells as the limit of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.
4) For the coastal cliffs of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula High-Medium Cliff Erosion Zone of 20-30 m width as defined by the generic T+T cliff erosion setback
5) For assessment cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where there are land reclamation and substantial hard protection structures; a single High-Medium Hazard Coastal Erosion Zone hazard zone with a generic width in the order of 20 m based on the short-term erosion response if these reclamation and protection structures failed.

Maps have been created showing the hazard zones relating to the recommended inundation and erosion risk categories as shown in the sample extract in Figure 1-1. These have been provided to CCC as a spatial layer. Maps of all the other options considered are provided in a spatial viewer accessible to the project team.

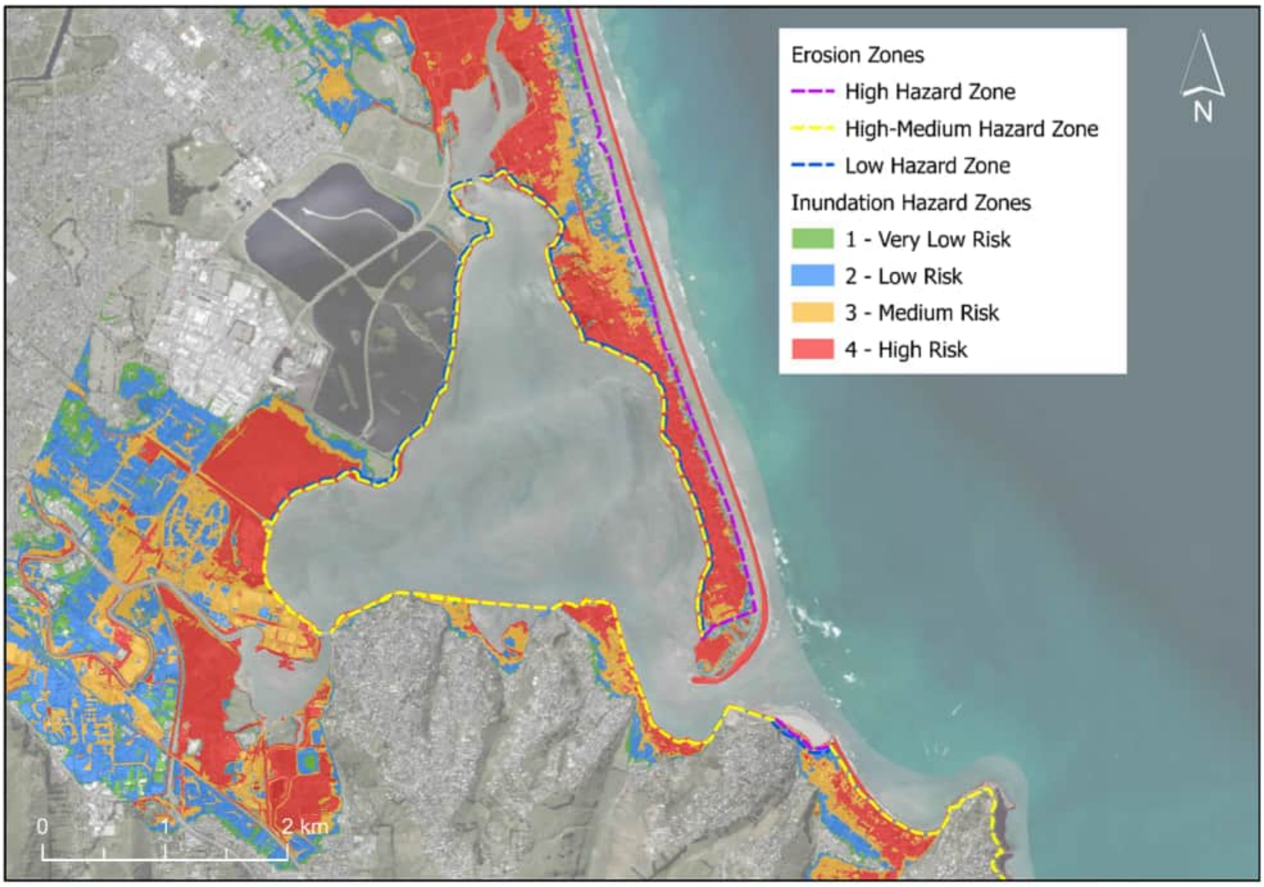


Figure 1-1. Sample extract of mapping of the recommended erosion and inundation zones

## *ⓘ Important note about your report*

*The sole purpose of this report and the associated services performed by Jacobs is to develop a risk-based approach to analysing coastal hazards to be used in land-use planning in accordance with the scope of services set out in the contract between Jacobs and Christchurch City Council ('the Client'). That scope of services, as described in this report, was developed with the Client.*

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*The coastal hazard data and information analysed in this assessment was developed by Tonkin and Taylor Ltd for Christchurch City Council and this information has been used as provided with no review of the accuracy of that information or its method of development.*

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# Contents



# Tables



# Figures

# Acronyms and abbreviations

| | |
|---|---|
| AEP | Annual Exceedance Probability |
| AR6 | Six Assessment Report |
| ASCE | future Areas Susceptible to Coastal Erosion |
| CCC | Christchurch City Council |
| DEM | Digital elevation Model |
| IPCC | Intergovernmental Panel on Climate Change |
| LiDAR | Light Detection and Ranging |
| LINZ | Land Information New Zealand |
| NZCPS | New Zealand Coastal Policy Statement |
| NZVD2016 | New Zealand Vertical Datum 2016 |
| RCEP | Regional Coastal Environment Plan for the Canterbury Region |
| RCP | Representative Concentrations Pathways |
| RMA | Resource Management Act |
| RPS | Regional Policy Statement |
| SLR | Sea Level Rise |
| SSP | Shared Socio-economic Pathways |
| T+T | Tonkin & Taylor Ltd |
| yr | year |

# 1. Introduction

This document is an addendum to the Jacobs report titled "Coastal Hazards Plan Change – Analysis/Technical Advice – Risk Based Coastal Hazard Analysis for Land-use Planning", document reference IS391200-NP-RPT-0001 Final, dated September 17 2021 (referred to in this document as Jacobs, 2021).

The Jacobs (2021) document detailed a range of options for using Council's coastal erosion and inundation hazard assessment data within land use planning. Specifically, it sought to develop a risk based approach to identify areas of high, medium and low risk and map extents of these across the city and Banks Peninsula.

Our recommendations from the Jacobs (2021) report were used by CCC in their Issues and Options paper for consultation with communities and stakeholders on the Coastal Hazards District Plan Change in conjunction with consultation on the Coastal Hazards Adaptation Planning Programme also being undertaken by CCC. The recommendations were externally peer reviewed by Beca. In light of community submissions and external peer review comments, we have updated our recommendations, which are presented in this report. The purpose of this report is to present the analysis undertaken to justify the recommended thresholds for the hazard categories and to present the spatial extent of the resulting hazard zones for both coastal inundation and erosion.

Council is initially proposing to use these mapped hazard areas for two purposes. The first is to support the identification of Qualifying Matters in Plan Change 14 – Housing and Business Choice which is anticipated to be notified in September 2022. The second is to support a Coastal Hazards Plan Change (plan change 12) anticipated to be developed further in 2023. It is likely that these two plan changes would use different subsets of the mapped hazard areas due to their different purposes with the later Coastal Hazards Plan Change being likely to include a wider range of hazard areas.

The addendum report presents the updated approaches to the coastal hazards plan change technical advice following the public submissions and peer review. It is specifically focused on providing an update to the Jacobs (2021) report to support the mapped hazard extents used in the Plan Change 14 Coastal Hazard Qualifying Matters.

It is noted that ongoing refinement of the methods may occur as a result of further developing the approach to the Coastal Hazards Plan Change. This may result in changes to the mapped hazard areas developed by using the approaches noted in this report.

# 2. Consideration of NZSeaRise Data

This section is an addendum to section 5 of the Jacobs (2021) report. It discusses the sea level rise scenarios selected in light of this more recent data on vertical land movement (VLM).

Data compiled by GNS and NIWA which considers the recent AR6 (2021) SLR projections and local VLM was released in 2022 as part of the NZSeaRise programme. The data shows relative sea level rise projections at 2 km intervals along the entire New Zealand coastline. The VLM was able to be captured at high resolution using InSAR – a satellite based technique which can measure ground deformation using radar images of the earth's surface.

For the NZSeaRise programme, information on VLM has been gathered from a relatively short 8-year period from 2003-2011. This data capture period lacks inclusion of data from the post Christchurch Earthquake Sequence (including instantaneous land movement in the earthquake sequence), which for some sites are contrary to the results of the pre-quake InSAR analysis. Therefore, there is little confidence at this time of including these rates to medium and long-term projections of sea level rise.

However, if the NZSeaRise data was to be included, it was considered that further analysis was required to determine(a) how the spatial variation in VLM across the district would influence the magnitude of projected SLR ; and (b) what the practical implications of that were on the mapping of hazards for planning purposes.

The NZSeaRise data shows that there is significant variation in the amount of vertical land movement that occurs around the Christchurch and Banks Peninsula coastline, as shown in Figure 2-1. Across the total area, the mean VLM is -1.508 mm/yr, with a maximum uplift of +1.917 mm/yr; and a maximum subsidence of -4.010 mm/yr. The variation in VLM is broader over the Banks Peninsula coastline compared to the Christchurch Metropolitan area, as can be seen in Figure 2-1, where the 50% of sites have VLM between -0.8 mm/yr to +0.225 mm/yr.

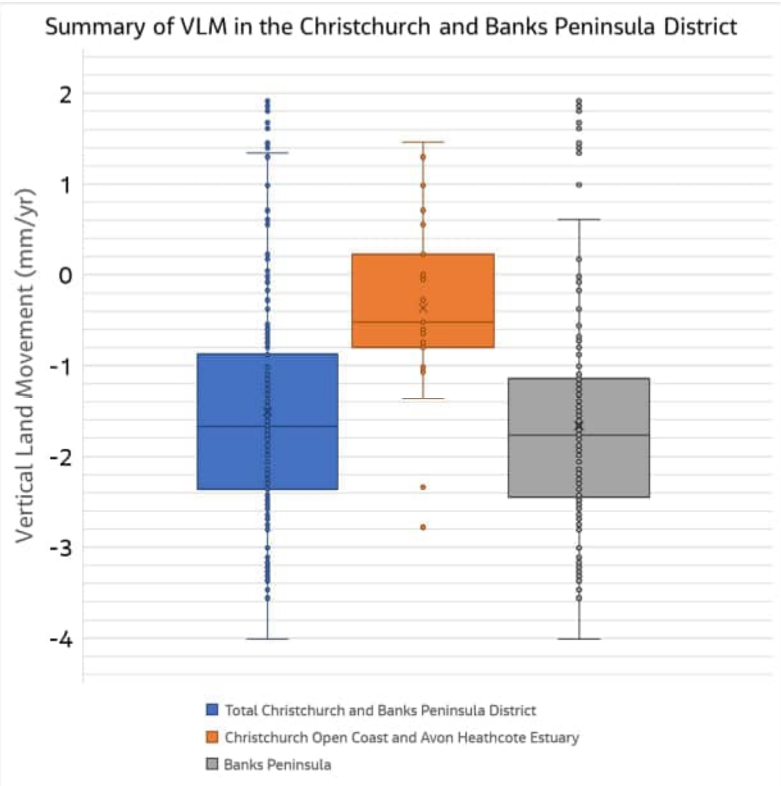



Figure 2-1. Summary of Vertical Land Movements (VLM) in the Christchurch and Banks Peninsula District from NZSeaRise.

*Boxplots show the interquartile range (middle 50%) within the box, the line within the box is the median and the whisker bars show the upper and lower quartiles. Outliers are shown as dots.*

When looking at the extreme VLMs in the Christchurch Open Coast/ Avon Heathcote Estuary, the implications of incorporating the VLM data into the planning assessment can be summarised as:

- For maximum subsidence of -2.78 mm/yr (Site 4303), the selected 0.6 m SLR by 2080 is 0.06 m below SSP5-8.5, and above the projection for SSP2-4.5. For 1.2 m SLR by 2130, the increment is below SSP5-8.5 by 0.27 m, above SSP2-4.5, and within the SSP5-8.5 17th – 83rd Percentile range. The impact of including VLM would:
  - be negligible on the high flood risk category (0.6 m SLR by 2080) due to the little difference between the increment and the SSP5-8.5 projection.
  - Increase the extent of the low flood risk categories (1.2 m SLR by 2130) due to the 0.27 m difference between the increment used and the SSP5-8.5 scenario.
  - Have no impact on the erosion risk categories.
- For maximum uplift of +1.46 mm/yr (Site 4320), the selected 0.6 m SLR by 2080 is at the SSP5-8.5 83rd percentile (essentially RCP8.5 H+), and is above SSP5-8.5 by 0.19 m. For 1.2 m SLR by 2130, the increment is above the SSP5-8.5 by 0.2 m, but below the SSP5-8.5 83rd percentile. The impact of including VLM would:
  - Reduce the extent of the high and low flood risk categories due to the increment being higher than the SSP5-8.5 projection.
  - Have no impact on the erosion risk categories.

Therefore, due to the lack of confidence in the applicability of the short pre-quake data set used to predict VLM, the difficulty of applying the spatial variations in VLM data on a district wide basis, and the negligible impact on the extent of the proposed risk areas from including the VLM effect on SLR, particularly for high risk areas, the inclusion of the VLM from NZSeaRise data is not justified for use in the plan change.

# 3. Coastal Inundation Hazard Thresholds

This section is an addendum to Section 6 of the Jacobs (2021) report.

This section sets out our approach to developing appropriate thresholds for defining inundation hazards and consequently our recommended approach to defining coastal flood risk.

An overall summary of the recommended approach is provided in Section 3.1.

A discussion of the reasoning behind this recommendation in light of submissions to an initial 'Issues and options discussion paper' presenting the proposed method, are provided in Sections 3.2 to 3.3.

## 3.1 Summary of Recommended Approach

The main coastal processes which cause inundation are storm surge and wave setup, combined with the astronomical tide and SLR. Inundation has the potential to result in loss of, or damage to, properties, possessions, buildings, and infrastructure, and could cause injury to people or loss of life. The consequence of inundation depends on the nature of the flooding – primarily the depth of water and speed of flow – and the vulnerability of people and assets to flooding.

Land use planning seeks to limit these consequences through risk-based control of development under the RMA. Several methods for mapping coastal inundation to inform planning decisions have been considered. The purpose is to define a simple set of thresholds which

1. are consistent with the RMA requirements to consider only risks which are 'reasonably foreseeable' and 'significant' in effect
2. can be applied to the 'bathtub' inundation depth outputs of the 2021 Coastal Hazard Assessment for Christchurch District ('the CHA').

The methods take into account three main factors which define flood risk:

- likelihood of flooding
- consequence of flooding
- change in likelihood and consequence in the future with SLR

The recommended method for defining flood risk takes account of these factors and is set out in Table 3-1. Four categories of flood risk, defined by thresholds of water depth, are proposed.

Table 3-1. Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 0.2% annual exceedance probability)

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Very low | None (dry) | Low (d < 0.4 m) |
| Low | Low (d < 0.4 m) | Medium (0.4 m < d < 1.0 m) |
| Medium | Medium (0.4 m < d < 1.0 m) | High (d > 1.0 m) |
| High | High (d > 1.0 m) | High (d > 1.6 m) |

The definitions in Table 3-1 have been applied to the CHA inundation depth data to produce a map showing the proposed four coastal flood risk categories along the entire coastline of the district. The CHA inundation maps also include the shorelines of Te Waihora (Lake Ellesmere) and Wairewa (Lake Forsyth). However, we have excluded these sites from our risk based coastal mapping because flooding from the lakes is not significantly influenced by coastal conditions, i.e., storm surge, waves, and sea level rise, for the range of scenarios we have adopted.

Figure 3-1 below shows an example extract of the map in the area around the Avon-Heathcote estuary.

Section 3.2 summarises the outcome of consultation on the proposed method and Sections 3.3 and 3.4 presents the recommended definitions of risk and the method we have used to map these areas.

As noted, the bathtub method used in the CHA to calculate flood depths does not take account of the hydrodynamic behaviour of inundation or the contribution to coastal inundation from coincident rainfall and river flow.

In the CHA data provided for our assessment, land lying below the Mean High Water Springs (MHWS) tide level was excluded for presentation purposes in order to differentiate areas which are regularly inundated without any storm tide effects. These areas are generally located within the river estuaries and along the shoreline of the sea. However, along the Styx River there are some areas of very low-lying land outside of the river channel and lagoons which have also been excluded. This means that the flood risk cannot be fully mapped using the data provided. In these areas we have directly mapped the risk areas using LiDAR ground level data and the coastal water level in order to capture all the land at risk of flooding. This masking has been removed from the low-lying land around the Styx River for the final CHA outputs.

In Section 6.5 of Jacobs (2021) we discuss the implications of the limitations in the bathtub method, data uncertainties, application of freeboard and thresholds for 'nuisance flooding' in more detail.

Maps of the recommended risk categories are available in a CCC webviewer and have been provided to CCC as a digital spatial layer.

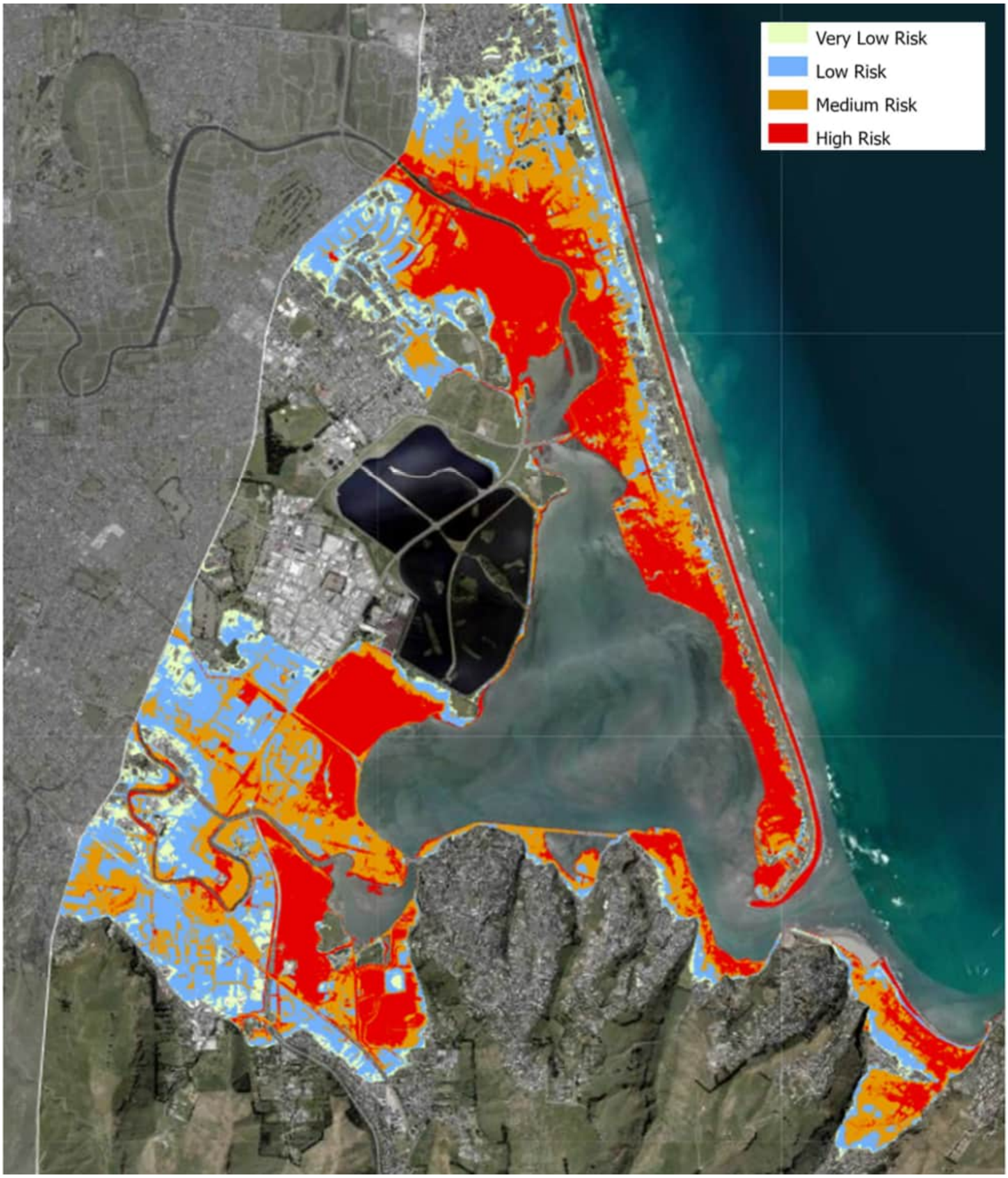



Figure 3-1. Coastal flood risk categories mapped using the CHA inundation data and recommended definitions of flood risk using the 0.2%/0.5% AEP approach (example extract of mapping for the district)

## 3.2 Review of proposed Coastal Hazards Plan Change method in Jacobs (2021)

The proposed method and thresholds set out in Sections 6.5 and 6.6 of Jacobs (2021) were presented in an Issues and Options Discussion Paper by Christchurch City Council in 2021 to support the Coastal Hazards District Plan Change.

We have considered the submissions received on this paper and the proposed Jacobs (2021) risk-based method to identify whether there are benefits in adapting the method in response to the submissions. We have also reviewed the compatibility of the proposed method with existing flood hazard mapping and planning approaches across coastal, fluvial and pluvial sources, including provisions and the thresholds for the levels of risk, to identify and resolve any differences in approach. In light of this review changes to the Jacobs (2021) method are proposed as outlined in Section 3.3.

### 3.2.1 Definitions of risk and hazard

The submissions generally support a risk-based approach – i.e., a planning framework where areas in which the flood hazard is less severe, or the hazard occurs only further in the future or is less certain to occur are classified as at a lower risk and activities are less restricted than areas where the hazard is higher or more immediate or more certain.

The submissions, and our review of the existing flood hazard overlays, identify the main differences in the Jacobs (2021) proposed risk-based approach in the coastal area and the existing overlays as being:

- that the existing overlays do not differentiate the differences in risk due to the timing of or uncertainty in sea level rise or differentiate hazard beyond a 'high hazard' area;
- that the likelihood of flooding used for mapping the existing overlays (0.5% and 0.2% AEP) differs from that in the Jacobs (2021) proposed risk-based approach (1% AEP);
- that the threshold values of water depth used to define the severity of hazard in the existing overlays (1 m for high hazard) differs to those in the proposed Jacobs (2021) risk-based approach (1.1 m for high hazard and 0.5 m for medium hazard).

In the submissions, consistency of approach between the coastal area and other areas is identified as important. The likelihoods of flooding (0.2% AEP)and high hazard (>1m) depth threshold which are currently adopted in the District Plan are consistent with the definitions of the Canterbury Regional Policy Statement (CRPS). The proposed risk-based approach can be adapted to align with current definitions in the District Plan and CRPS.

Submissions also highlight the need to consider all sources of flooding in the coastal zone, not just flooding from the sea. The 2021 CHA data does not address sources other than storm tides and groundwater. We have reviewed the CHA groundwater hazard outputs and do not consider the data appropriate for use with the bathtub coastal flooding data to take account of combined hazard.

### 3.2.2 Method of deriving the flood extent

Risk-based flood mapping of the entire coastal area of the district is needed for the Coastal Hazards Plan Change. New hydrodynamic modelling which is currently in progress will provide more detailed definitions of flood extents, depths and velocities, including within the coastal area, using up to date estimates of extreme tidal water levels. The model outputs will generally be used to update flood hazard overlays in the district and could be used as the basis for applying a risk-based approach in the coastal area. However, the model outputs will not cover the whole district.

The proposed approach will allow mapping of coastal risk over the whole coastal area within the timescale of the Coastal Hazards Plan Change. Adopting multi-hazard modelling of flooding in the coastal area when and where it becomes available should improve the level of detail in the mapping and will help to address those submissions expressing the need to consider all sources of flooding in the coastal area, even if this is dominated by flooding from the sea. If a risk-based approach is to be taken for the coastal area, then ideally the method for defining flood risk should be applicable to both the 2021 CHA bathtub data and future model outputs.

### 3.2.3 Sea level rise

The proposed method uses two values of sea level rise to allow the level of risk to reflect both the severity of the hazard and the certainty in or timing of the hazard occurring. This approach is supported by submissions expressing the need for greater weight to be placed on hazards which are more likely to occur and to occur soon, under lower values of sea level rise, over those which are less certain to occur and will occur further in the future, under higher values of sea level rise.

We consider the proposed upper value of sea level rise of 1.2 m to be appropriate and is consistent with our erosion risk assessment. This value is higher than the current District Plan allowance (1 m), but we consider this is justified. It is not clear if the current allowance for flood hazard in the District Plan will be reviewed.

### 3.2.4 Freeboard

There can be value in including an allowance for the effects of uncertainty in flood levels, ground levels and flooding mechanisms on the extent of the risk area by applying a freeboard to mapped water levels. The freeboard currently applied for mapping the Flood Management Area (250 mm as outlined in Policy 5.2.2.2.1.a.i of the District Plan) covers the likely combined uncertainties in storm tide level and LiDAR ground level data.

The benefit of applying freeboard to the mapped flood risk areas under a risk-based approach is considered further in Section 3.3.1.

### 3.2.5 Shallow flooding

It is not clear if or how areas of shallow flooding (e.g., water depth less than 50 mm or 100 mm) are excluded from the existing overlays in the District Plan. We do not see a need to exclude areas of shallow flooding under the risk-based approach since the depth of flooding (hazard) is one of the factors considered in defining the risk level.

## 3.3 Recommended definitions of inundation risk

### 3.3.1 Definitions of risk and freeboard

For consistency with the definitions in the current District Plan overlays, we recommend mapping the proposed coastal flood management area as the extent of the 0.5% AEP coastal water level.

We recommend using the two proposed SLR values of 0.6 m and 1.2 m to define a higher level of risk in areas where a hazard may occur sooner, in a more certain SLR scenario (0.6 m), than in areas where the same hazard is as likely to occur only further in the future, in a less certain SLR scenario (1.2 m). The overall extent of the flood management area is defined using the lower certainty SLR scenario (1.2 m) in recognition of the need to consider the significant consequences that could arise in less certain events.

For consistency with the Canterbury Regional Policy Statement (CRPS) definitions of hazard we recommend using:

i) water depths under the 0.2% AEP coastal water level to define the severity of flood hazard; and

ii) a water depth of 1 m to define ‘high’ hazard.

The threshold water depth of 1 m for ‘high hazard’ is slightly lower than both the value we proposed (1.1 m) and the H4 hazard vulnerability threshold depth for people and vehicles (1.2 m) in still water under the AR&R guidelines. Adopting a limiting depth of 1 m allows for the additional hazard of a water velocity of up to 0.6 m/s under these guidelines (refer to Figure 6.5 in Jacobs (2021)).

We also recommend adjusting the depth threshold for ‘medium’ hazard to 0.4 m so that the difference in hazard thresholds aligns with the difference in SLR values (0.6 m). This threshold is slightly lower than the value we proposed (0.5 m), which corresponded to the H3 hazard vulnerability threshold depth for large 4WD vehicles in still water and for velocities up to 1.2 m/s. A depth of 0.4 m corresponds to the vulnerability threshold for larger passenger vehicles in still water and for velocities up to 1.1 m/s. This depth also allows for the additional hazard of velocities up to 1.5 m/s for large 4WD vehicles.

The recommended definitions of coastal flood risk are shown in Table 3-2 and illustrated diagrammatically in Figure 3-2.

Table 3-2. Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 0.2% annual exceedance probability)

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Very low | None (dry) | Low (d < 0.4 m) |
| Low | Low (d < 0.4 m) | Medium (0.4 m < d < 1.0 m) |
| Medium | Medium (0.4 m < d < 1.0 m) | High (d > 1.0 m) |
| High | High (d > 1.0 m) | High (d > 1.6 m) |

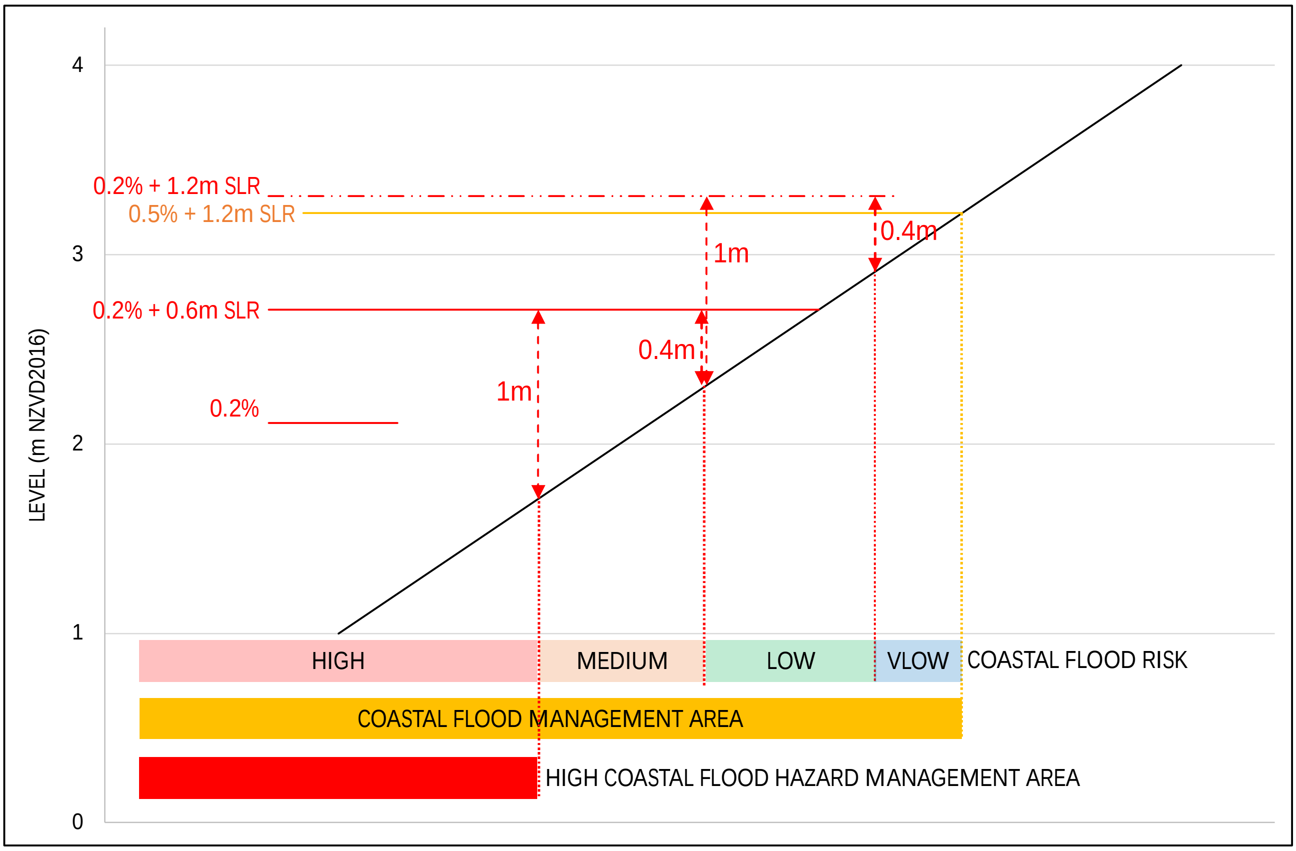



Figure 3-2. Recommended definitions of coastal flood risk.

*The coastal flood management area is defined by the 0.5% AEP coastal water level with 1.2 m of sea level rise (SLR). Flood hazards are defined by the water depth under the 0.2% AEP coastal water level. Flood risk is defined by the combination of hazard (water depth) and the certainty in and timing of sea level rise.*

The recommended definitions do not include a ‘freeboard’ to the water levels used to define hazard or the overall extent of the flood management area. This is consistent with the CRPS method of defining severity of hazard which does not include a freeboard allowance.

As shown in Section 3.3.2 the difference between 0.5% and 0.2% AEP water levels is no greater than 0.1 m in all but one of the CHA coastal areas and, overall, does not exceed 0.2 m. These differences in water levels are less than the value of freeboard that would typically be applied – e.g., 0.25 m on the 0.5% AEP water level as per the current District Plan overlays (Policy 5.2.2.2.1.a.i). Therefore, the additional area which would be mapped through the addition of a freeboard to the 0.5% AEP water level would be largely dry in the 0.2% AEP event with 1.2 m SLR scenario – which we use to define risk – with any water depths being less than 0.1 m to 0.2 m. As shown in Table 3-2 and Figure 3-2 this would correspond to a risk level less than 'very low' in most of the additional area mapped, noting that under the AR&R guidelines a still water depth of less than 0.3 m is classified as 'generally safe for vehicles, people and buildings'.

### 3.3.2 Derivation of coastal water levels

Estimates of the 0.5% AEP and 0.2% AEP coastal water levels are needed to map the flood risk management area and the flood risk categories as defined in Figure 3-2. The 2021 CHA does not generally report water levels for probabilities less than 1% AEP. The method used to derive the static water levels varies between the three types of inundation sites – open coast, harbours and estuaries, and regional hazard screening sites. For consistency with the CHA, we have derived water levels for each of the same coastal sites defined in the CHA, using the same methodology where the necessary source data are available and/or by extrapolating values from the CHA data where required.

It is acknowledged that by using different methods in the three groups of inundation sites there may be differing uncertainties and levels of confidence in the data. The uncertainties are also a result of the range of historical data available in each area relative to the small probabilities of the water levels required for mapping. Alternative methods of analysis using the same data may not therefore necessarily reduce the uncertainty in the estimated water levels.

- Open coast sites: Christchurch, Sumner, Taylors Mistake

In these areas the static water levels were derived in the CHA from a statistical analysis ('extreme value analysis') of a synthetic time series of historical tidal water level and wave setup. Figure 3-3 shows an example of the outputs of the extreme value analysis for one of the sites. It would be possible to obtain estimates of the 0.5% and 0.2% AEP water levels from the results of the analysis already undertaken - for example, the red circle in Figure 3-3 indicates the 0.5% AEP water level (2.4 m NZVD2016) in this cell. However, since the full results of the analyses are not available, we have estimated the required water levels by fitting a trendline to the reported values of the 1-year, 10-year and 100-year Average Recurrence Interval (ARI) water levels and using this to extrapolate the required values.

Figure 3-3 shows that the uncertainty in the water levels estimated through the CHA analysis, as indicated by the 90% confidence interval ('90% CI') lines, tends to increase with the value of ARI. The 90% confidence interval for the 1% AEP water level adopted in the CHA is approximately +/- 0.25 m. For the 0.5% AEP water level the corresponding confidence interval is a little larger, approximately +/- 0.30 m. The uncertainty in the estimates of the water levels proposed for mapping the coastal flood risk areas is therefore a little greater than that in the water levels adopted for mapping in the CHA but this is largely due to the inherent increase in uncertainty in estimating smaller probability water levels. Alternative methods are unlikely to significantly reduce the uncertainty in these estimates if using the same historical data.

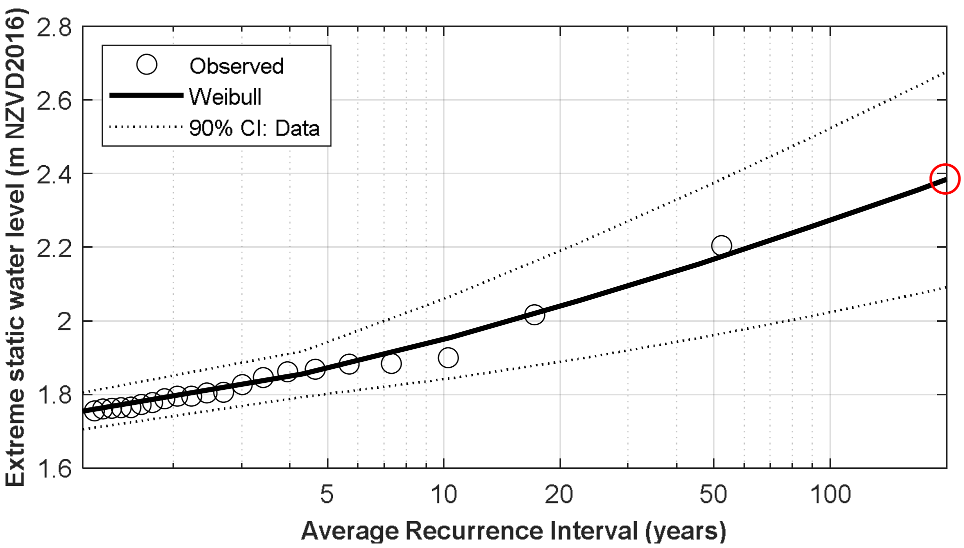


Figure 3-3. Example of extreme value analysis of static water level for open coast cells (Christchurch open coast cell) (Figure 7-6 of the 2021 CHA Technical Report).
*Red circle indicates the 0.5% AEP water level.*

The water levels for the three open coast sites are provided in Table 8.1 of the CHA Technical Report. Since the reported water levels for each ARI are the same at all three sites, we have used a single set of water levels to estimate the 0.5% and 0.2% AEP water levels for all three sites.

The CHA water levels, and our corresponding estimated water levels are compared in Table 3-3. The water levels and fitted trendline are plotted in Figure 3-4.

Table 3-3. Estimates of the 0.5% and 0.2% AEP coastal water levels at open coast sites.

| ARI (AEP) | Water level reported in Table 8.1 of CHA Technical Report (m NZVD2016) | Water level estimated from trendline to CHA data (see Figure 6.22) for risk-based coastal inundation mapping (m NZVD2106) |
|---|---|---|
| 1-year (63%) | 1.8 | 1.8 |
| 10-year (10%) | 2.0 | 2.0 |
| 100-year (1%) | 2.3 | 2.3 |
| 200-year (0.5%) | n/a | 2.4 |
| 500-year (0.2%) | n/a | 2.5 |

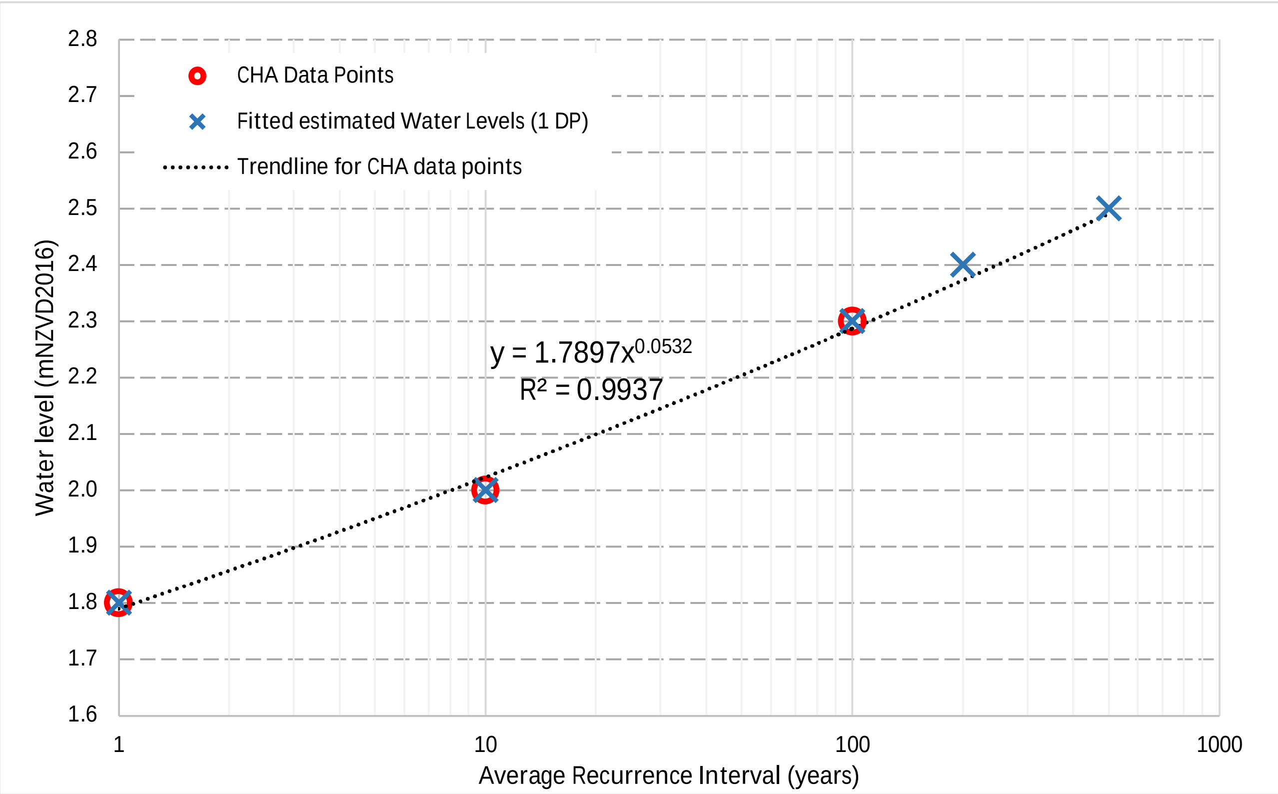



Figure 3-4. Estimates of 0.5% and 0.2% AEP (200-year and 500-year ARI) water levels using a trendline fitted to the CHA water levels for the 1-year, 10-year and 100-year ARI water levels for the open coast sites (Table 8.1 of the CHA Technical Report).

- Harbour and estuary sites: Avon-Heathcote, Akaroa, Lyttelton, Brooklands Lagoon

In these cells the static water levels were derived in the CHA using a statistical 'extreme value analysis' of water level records at gauges in the estuaries and harbours undertaken by GHD[2]. An estimate of the 1% AEP wave setup height at each site (Table 7.4 of the CHA Technical Report) was added to the extreme values for each probability considered in the CHA.

The GHD report includes values for the 0.5% and 0.2% AEP water levels at the gauges. We have used these water levels together with the wave setup values derived in the CHA to provide estimates of coastal water levels for these cells as shown in Table 3-4. For the Akaroa harbour site, we have used the method reported in the CHA Technical Report (Section 7.2.1) and used the extreme values derived for the Lyttelton gauge combined with an offset of +0.24 m to allow for the difference in astronomical tide levels between the two sites.

Table 3-4. Estimates of the 0.5% and 0.2% AEP coastal water levels at harbour and estuary sites.

| CHA site | Gauge location[1] | GHD extreme values[1] (m CDD) | | Conversion CDD to Lyttelton 1937 datum[2] (m) | Conversion Lyttelton 1937 to NZVD2016 datum[3] (m) | CHA Wave setup[4] (m) | Total coastal water level (m NZVD2016) | |
|---|---|---|---|---|---|---|---|---|
| | | 0.5% AEP | 0.2% AEP | | | | 0.5% AEP | 0.2% AEP |
| Brooklands Lagoon | Styx | 11.294 | 11.373 | -9.043 | -0.363 | 0 | 1.9 | 2.0 |
| Avon-Heathcote north | Bridge Street | 11.265 | 11.359 | -9.043 | -0.346 | 0.15 | 2.0 | 2.1 |
| Avon-Heathcote south | Ferrymead | 11.141 | 11.217 | -9.043 | -0.341 | 0.15 | 1.9 | 2.0 |
| Lyttelton | Lyttelton | 11.057 | 11.110 | -9.043 | -0.394 | 0.25 | 1.9 | 1.9 |
| Akaroa | Lyttelton (+0.24m offset as per CHA) | 11.297 | 11.350 | -9.043 | -0.365 | 0.25 | 2.1 | 2.2 |

*[1] Table 5 of Christchurch City Council LDRP097 Multi-Hazard Baseline Modelling, Joint Risks of Pluvial and Tidal Flooding, Rev 0 (GHD, February 2021); [2] Waterways, Wetlands and Drainage Guide - Part B: Design, Appendix I (Christchurch City Council, December 2011); [3] LINZ LTN37-NZVD2016 grid (https://data.linz.govt.nz/layer/53432-lyttelton-1937-to-nzvd2016-conversion/); [4]Table 7.4 of CHA Technical Report.*

- Regional hazard screening sites: Banks Peninsula, Kaitorete Spit, Te Waihora (Lake Ellesmere), Wairewa (Lake Forsyth)

For the coastal regional hazard screening sites at Banks Peninsula and Kaitorete Spit, the static water levels were derived in the CHA using the GHD extreme values for the Sumner gauge and estimates of the individual wave setup at each site for each probability considered. No correction is applied to the extreme values at the Sumner gauge for the difference in site locations since the astronomical tide levels at all sites are reported to

[2] Christchurch City Council LDRP097 Multi-Hazard Baseline Modelling, Joint Risks of Pluvial and Tidal Flooding, Rev 0 (GHD, February 2021)

be similar. The wave setup values were calculated by applying an empirical formula to extreme values of wave heights derived from a statistical analysis of hindcast wave time series records at these sites.

The GHD report includes values for the 0.5% and 0.2% AEP water levels at Sumner, both including and excluding the contributions of far infra-gravity (FIG) waves. The water levels quoted in Table 7.5 of the CHA for Banks Peninsula and Kaitorete Spit correspond to those in the GHD report for Sumner including the effects of FIG waves and we have therefore also adopted values for the 0.5% and 0.2% AEP which include FIG effects.

It would be possible to obtain estimates of the 0.5% and 0.2% AEP significant wave heights from the results of the analysis already undertaken for the CHA and hence estimate the corresponding wave setup values using the same empirical method. However, although the significant wave heights and corresponding wave setup values for the 1-year, 10-year and 100-year ARI are reported in the CHA (Tables 2.8 and 7.6 of the CHA Technical Report), full results of the analyses are not available. We have therefore estimated the required wave setup by fitting a trendline to the reported values of the 1-year, 10-year and 100-year ARI wave setup values and used this to extrapolate the required values as shown in Table 3-5 and Figure 3-5. We have then added the estimated wave setup values to the GHD extreme water levels at Sumner (including FIG wave allowance) to obtain the total water levels for the 0.5% and 0.2% AEP as shown in Table 3-6.

Table 3-5. Estimates of the 0.5% and 0.2% AEP wave setup at coastal regional hazard screening sites.

| ARI (AEP) | Wave setup reported in Table 7.6 of CHA Technical Report (m) | | | Wave setup estimated from trendline to CHA data (Figure 3-4) for risk-based coastal inundation mapping (m) | | |
|---|---|---|---|---|---|---|
| | Banks Peninsula - North | Banks Peninsula - South | Kaitorete Spit | Banks Peninsula - North | Banks Peninsula - South | Kaitorete Spit |
| 1-year (63%) | 0.84 | 1.54 | 1.24 | 0.85 | 1.55 | 1.24 |
| 10-year (10%) | 0.96 | 1.84 | 1.35 | 0.94 | 1.81 | 1.36 |
| 100-year (1%) | 1.02 | 2.08 | 1.5 | 1.03 | 2.10 | 1.49 |
| 200-year (0.5%) | n/a | n/a | n/a | 1.06 | 2.20 | 1.54 |
| 500-year (0.2%) | n/a | n/a | n/a | 1.11 | 2.33 | 1.60 |

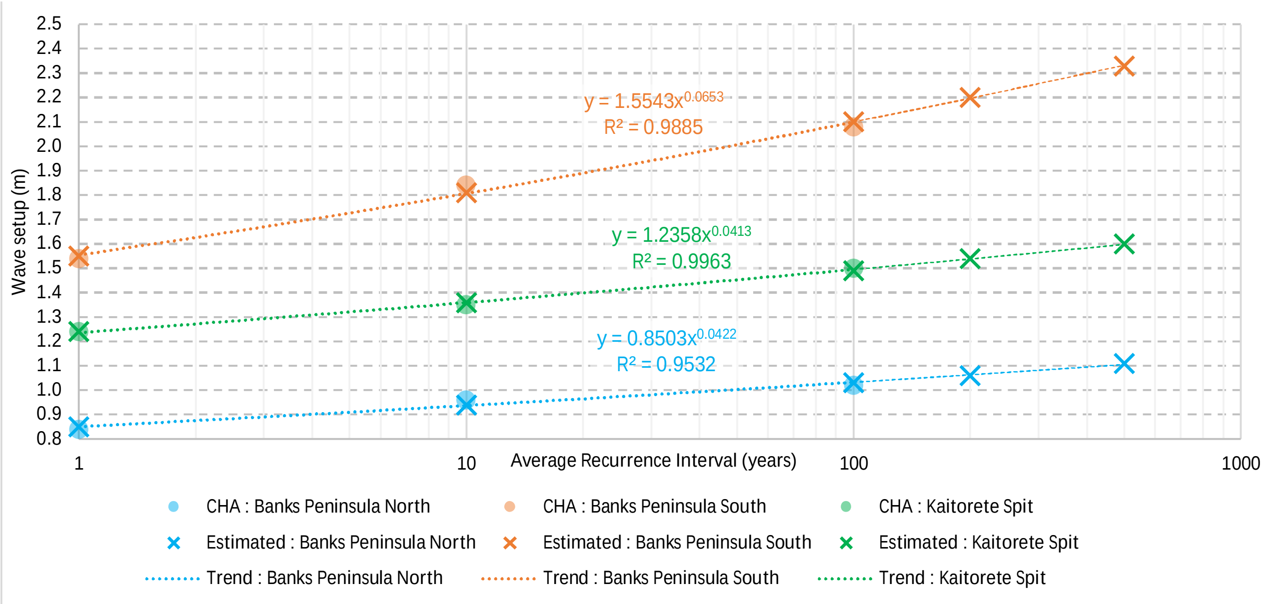



Figure 3-5. Estimates of 0.5% and 0.2% AEP (200-year and 500-year ARI) wave setup using a trendline fitted to the CHA estimates of the 1-year, 10-year and 100-year ARI wave setup for the coastal regional hazard screening sites (Table 7.6 of the CHA Technical Report).

Table 3-6. Estimates of the 0.5% and 0.2% AEP static water levels at coastal regional hazard screening sites.

| CHA site | Gauge location(1) | GHD extreme values(1) (m CDD) | | Conversion CDD to Lyttelton 1937 datum(2) | Conversion Lyttelton 1937 to NZVD2016 datum(3) | Estimated wave setup (Figure 3-4) (m) | | Total coastal water level (mNZVD2016) | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.5% AEP | 0.2% AEP | (m) | (m) | 0.5% AEP | 0.2% AEP | 0.5% AEP | 0.2% AEP |
| Banks Peninsula - North | Sumner incl. FIG | 11.289 | 11.374 | -9.043 | -0.388 | 1.06 | 1.11 | 2.9 | 3.0 |
| Banks Peninsula - South | Sumner incl. FIG | 11.289 | 11.374 | -9.043 | -0.388 | 2.20 | 2.33 | 4.1 | 4.3 |
| Kaitorete Spit | Sumner incl. FIG | 11.289 | 11.374 | -9.043 | -0.388 | 1.54 | 1.60 | 3.4 | 3.5 |

*(1) Table 5 of Christchurch City Council LDRP097 Multi-Hazard Baseline Modelling, Joint Risks of Pluvial and Tidal Flooding, Rev 0 (GHD, February 2021); (2) Waterways, Wetlands and Drainage Guide - Part B: Design, Appendix I (Christchurch City Council, December 2011); (3) LINZ LTN37-NZVD2016 grid (https://data.linz.govt.nz/layer/53432-lyttelton-1937-to-nzvd2016-conversion/)*

- Summary

The coastal water levels we have used for the risk-based coastal inundation maps are summarised in Table 3-7.

Table 3-7. Estimates of the 0.5% and 0.2% AEP static water levels at each of the CHA sites included in the risk-based coastal inundation maps.

| CHA Site | | Static coastal water level for risk-based mapping (m NZVD2016) | |
|---|---|---|---|
| | | 0.5% AEP | 0.2% AEP |
| Open coast | Christchurch Open Coast | 2.4 | 2.5 |
| | Sumner | 2.4 | 2.5 |
| | Taylor's Mistake | 2.4 | 2.5 |
| Harbour & estuary | Brooklands Lagoon | 1.9 | 2.0 |
| | Avon-Heathcote north | 2.0 | 2.1 |
| | Avon-Heathcote south | 1.9 | 2.0 |
| | Lyttelton | 1.9 | 1.9 |
| | Akaroa | 2.1 | 2.2 |
| Regional hazard screening | Banks Peninsula - North | 2.9 | 3.0 |
| | Banks Peninsula - South | 4.1 | 4.3 |
| | Kaitorete Spit | 3.4 | 3.5 |

## 3.4 Mapping of risk layers

### 3.4.1 Ground data

For consistency, we have used the water depth grids prepared for the CHA 'bathtub' coastal inundation maps to map the risk categories defined by the water levels in Table 3-7 and the depth classes in Table 3-1 for all CHA sites except the two lake sites (Te Waihora and Wairewa) and Brooklands Lagoon. These depth grids have a spatial resolution of 1 m.

We have excluded the lake sites from our mapping because flooding from the lakes is not significantly influenced by coastal conditions – storm surge, waves, and sea level rise.

In the bathtub depth grids originally provided from the CHA, large areas of Brooklands Lagoon were excluded from the grid where ground levels are lower than present day astronomical tide levels and are therefore potentially regularly submerged. To capture all the land at risk of flooding we have directly mapped the risk areas at this site using LiDAR ground level data[3] at 1m spatial resolution and the estimated coastal water level.

For all sites our mapping is limited to the inland limit of coastal inundation boundary defined in the CHA.

[3] Canterbury - Christchurch and Ashley River LiDAR 1m DEM (2018-2019), Environment Canterbury/Land Information New Zealand

### 3.4.2 Smoothing

We have smoothed the resulting boundaries of each flood risk area using ArcGIS Pro v2.8.1.

The raw flood risk area polygons have been smoothed with the ‘Smooth Polygon’ tool. The PAEK (Polynomial Approximation Exponential Kernel) algorithm has been used with a tolerance of 2 (twice the cell-size of the original dataset). This is a different algorithm than previously used by Christchurch City Council for the existing District Plan flood extents, but the results of the smoothing are quite comparable and retain a similar appearance.

A key part of the Council’s smoothing methodology was to ensure that no new parcels were inundated due to the smoothing approach. To ensure this the Council have applied a small negative buffer to shrink the final smoothed inundated area. Because the flood risk areas contain four separate classes, we could not directly apply a negative buffer, as this would introduce gaps between the classes.

Our approach to ensuring that no new parcels have been inundated due to the smoothing is a refinement of this method. We have dissolved the flood risk area data and created a smoothed output of just the extent. We have then applied a negative buffer to this smoothed extent and used this buffered extent to clip the original smoothed polygons. This approach has ensured no new parcels are inundated without creating gaps between the classes and retaining a similar appearance to the Council’s existing District Plan flood extents.

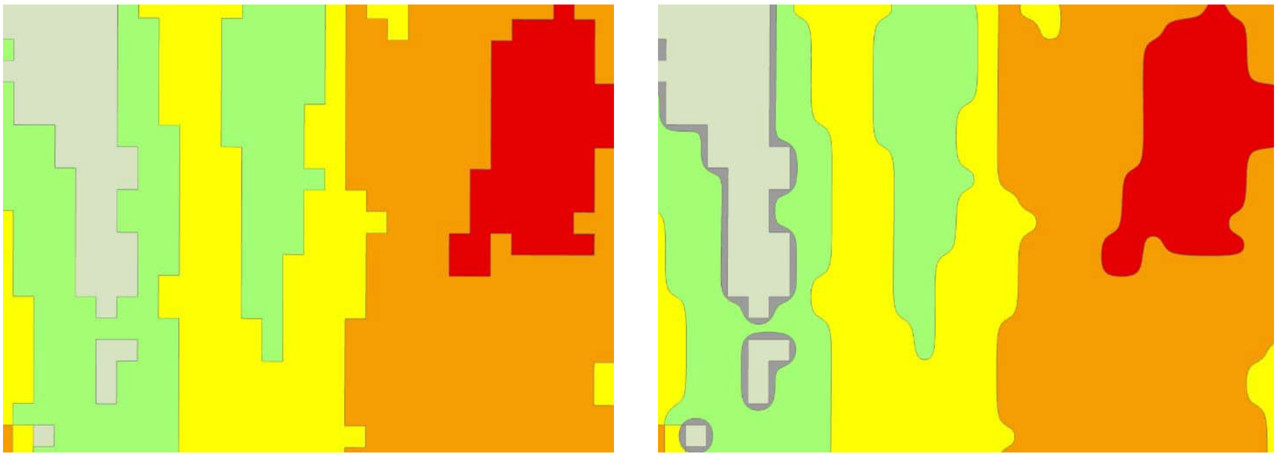


Figure 3-6. Comparison of the raw flood risk polygons on the left, and the smoothed result on the right. The original raw extent is shown in grey to illustrate that the smoothed result does not cross over it.

# 4. Coastal Erosion Hazard Thresholds

This section is an update to Section 7 of the Jacobs (2021) report. It has been updated to reflect updates and modifications based on submissions and peer review comments.

## 4.1 Summary of Erosion Recommendations

Based on the different coastal morphologies within the Christchurch district and the various assessment methods applied by T+T in different areas, the following are the recommended thresholds from the T+T data for determining coastal erosion hazard zones:

1) For the Christchurch City urban area open coast; two erosion zones compromising of

   a) A High Hazard Coastal Erosion Zone covering the current beach- primary dune width, and

   b) Where required, a Low Hazard Coastal Erosion Zone to a lowland limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 and an additional area required for “future dune resilience factor”.

2) For the Avon-Heathcote Estuary; two erosion zones comprising of

   a) A High-Medium Hazard Coastal Erosion Zone defined by a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell for the 66% probability erosion distance with 0.6 m SLR by 2080

   b) A Low Hazard Coastal Erosion Zone defined by a generic additional width of 20 m across all cells to be equal to the largest ASCE in any cell for the 10% probability erosion distance with 1.2 m SLR by 2130.

3) For the beaches and bays of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single High-Medium Banks Peninsula Bays Coastal Erosion Hazard Zone, with the landward limit defined for:

   a) Probabilistic assessment cells, as the 10% probability of erosion distance for 1.2 m SLR by 2130, and

   b) Deterministic assessment cells, the limit of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.

4) For the coastal cliffs of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single High-Medium Banks Peninsula Cliff Erosion Zone of 20-30 m width as defined by the generic T+T cliff erosion setback

5) For assessment cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where there are land reclamation and substantial hard protection structures; a single High Hazard Coastal Erosion Zone hazard zone with a generic width in the order of 20 m based on the short-term erosion response if these reclamation and protection structures failed.

The following provides the discussion and justifications behind these recommended addendums to the Jacobs (2021) report.

### 4.1.1 Critical thinking

As an addendum to point 5 of Section 7.2 “critical thinking” of the Jacobs (2021) report the following additional commentary on a “dune resilience factor” has been provided.

In addition to the need to protect the current open coast beach environments, there may also be a need to provide an additional width within erosion set-back zones for future dune resilience to hazards. For example, once the ASCE positions reach beyond the current beach/bank position they do not include any consideration for the distance required to have a resilient dune or beach ridge environment, or stable bank slope. The absence of these natural hazard protection environments would result in an increase in the consequences of erosion in storm events and an increase in the frequency, extent, magnitude and consequence of inundation events, or result in the need for more engineered protected structures. In more layman terms this means allowing within district planning zones not only for where the erosion of the seaward dune edge may be predicted to reach by the chosen scenario/threshold combination, but also allowing for the dune systems to also move inland as the front of these features erode so that they can still provide the same level of erosion protection. Hence the outcome may be mapped hazard areas and district planning controls further inland from the T+T mapped erosion extents. This additional factor has been termed the 'dune resilience factor'.

## 4.2 Christchurch City open coast (T+T Cells 1-14)

This section is an addendum to Section 7.3.1 of the Jacobs (2021) report, specifically the section titled "Christchurch City open coast (T+ Cells 1-14).

Figure 4-1 shows examples on how the high, medium, and low hazard zones would look at North Brighton and Southshore from applying the possible threshold options under the preferred approach in Jacobs (2021). Maps of the preferred approach has been provided to CCC as a spatial layer.

### 4.2.1 High Hazard Zone

As can be seen from Figure 4-1, the options for high and medium hazard categories are largely within the existing dune environment. This outcome is consistent along the whole of the Christchurch open coast, with the only locations where this doesn't occur being where the dunes have been removed at North Brighton and New Brighton. A similar result was obtained from the alternative approach.

It is therefore considered that to ensure that the full natural protection ability of the dune system against coastal hazards is not compromised, the High Hazard Zone include all or at least some component of the whole beach-dune width as a 'dune resilience factor', and a Medium Hazard Zone is not required.

There are two options for determining what component of the 'whole beach-primary dune' environment is included in the high hazard zone:

a) Inclusion of the primary dune only for hazard protection purposes; or

b) Inclusion of the whole of the total dune system, including primary and secondary dunes, up to where infrastructure starts to interact with the back of the dune, or where there is an obvious change in the vegetation type.

When assessing these two options against one another, it is clear that in some areas when using the whole of the dune system as the high hazard zone (e.g. option b) the width exceeds what is required for coastal hazard protection reasons. The primary dune has sufficient width to protect the integrity of the natural coastal dune system against activities that could reduce its ability to act as an effective buffer against erosion and inundation hazards, and to be consistent with the requirements of Policy 26 of the NZCPS. This approach is also consistent with Coastal Erosion Hazard Zone 1 in both the RPS and the RCEP. Protection of these areas beyond the primary dune are generally protected more appropriately through other planning mechanisms such as natural character and landscape controls.

It is therefore recommended that the high hazard zone be defined as a smoothed width of the primary dune environment.

The primary dune area is defined by the physical primary dune extent in 2018/2019 LiDAR. The landward extent was mapped in detail by analysing the change in backshore slope behind the dune. LiDAR was reclassified into 1 m elevation intervals, and where there was a flattening or reversal of the slope (which generally occurred around 3 m contour NZVD2016) this was determined to be the landward boundary of the primary dune.

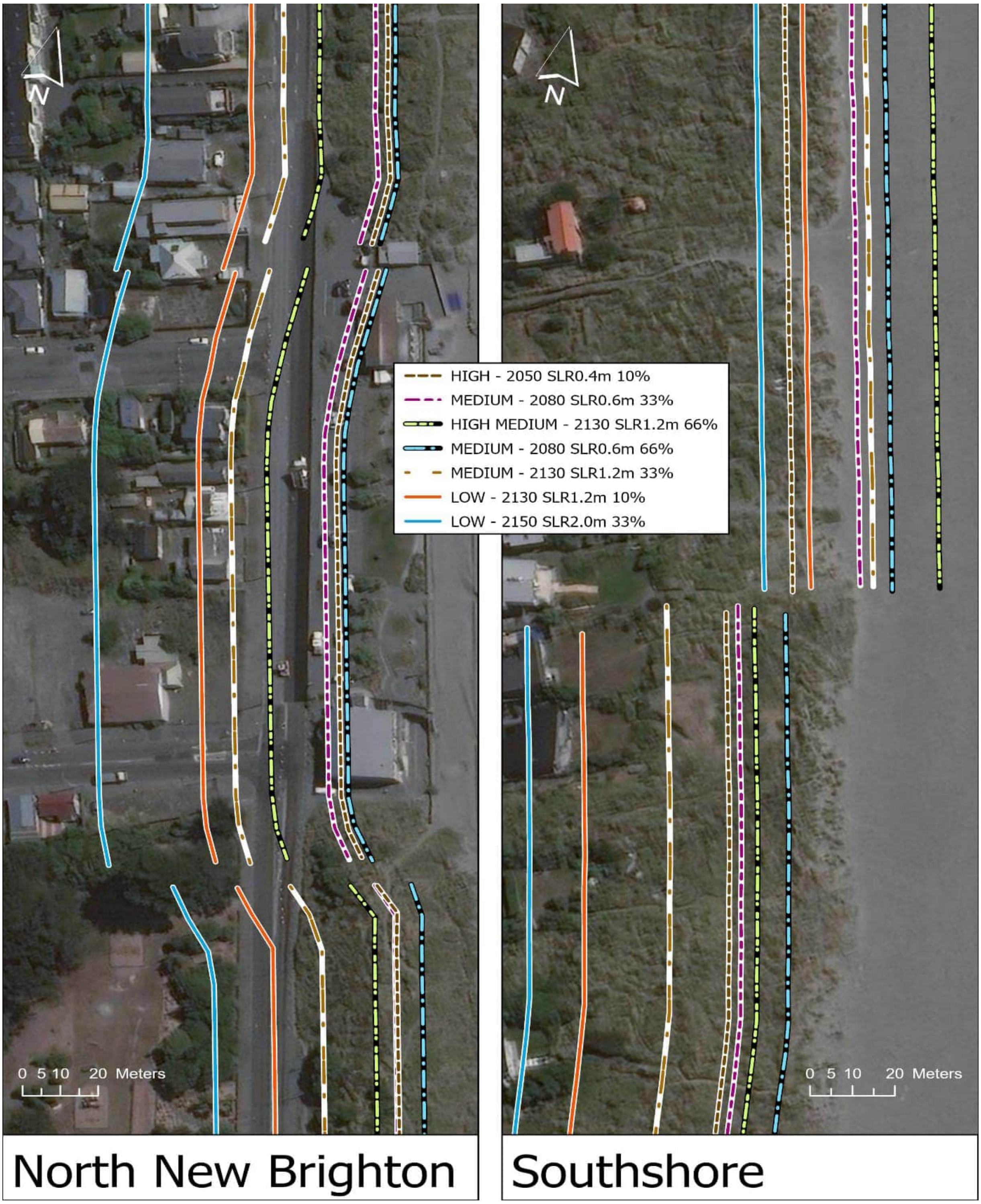



Figure 4-1. Possible options for High, Medium and Low Coastal Erosion Hazard Categories at North Brighton (left) and Southshore (right). Not recommended due to High and Medium zones being within the beach system

Where the dune system was not confined by roads, the primary dune was defined using this technique, as shown in the left example in Figure 4-2. Where the dune system was confined by roads, (e.g., Marine Parade) and the landward limit of the primary dune from the above technique was close to the position of the road, the extent of the dune system has been mapped up to the road edge. Where the primary dune has been removed for buildings (e.g., North New Brighton, New Brighton, South Brighton Surf Club) the landward boundary was extrapolated along the edge of Marine Parade.

For planning purposes, the mapped landward primary dune extent has been smoothed to removed local anomalies in the landward edge of the primary dune system, as shown in Figure 4-3. Further consideration of how the primary dune is defined and smoothed will be considered as part of the Coastal Hazards Plan Change.

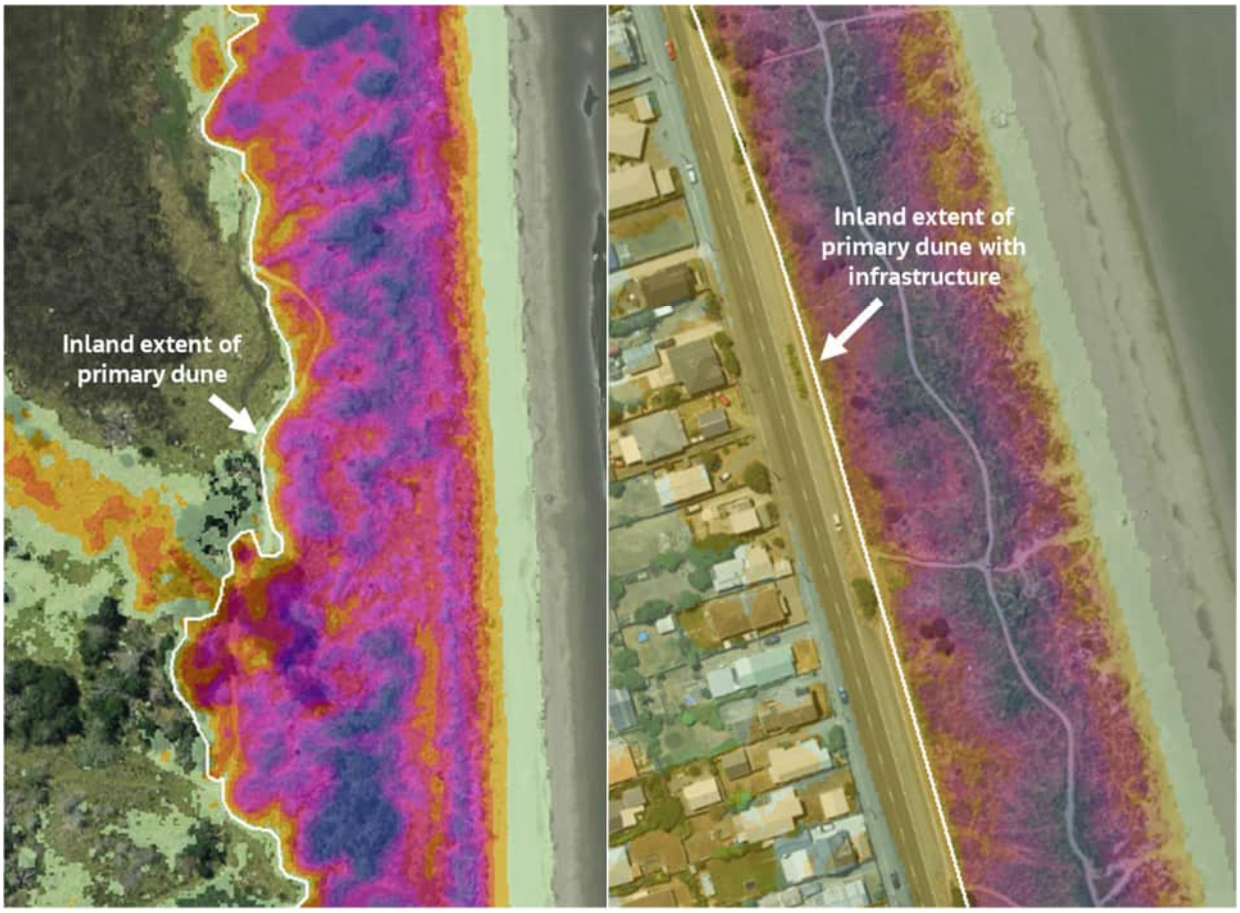



Figure 4-2. Example of reclassified lidar showing location of back of dune for dune system no confined by infrastructure (left) and confined by infrastructure (right).

When compared to the T&T (2021) CHA 0.6 m SLR by 2080 coastal erosion line of the seaward edge of the dune, the mapping of the current primary dune extent provides a sufficient buffer to still have at least some dune remaining if a 100 year ARI storm event as defined by the CHA occurred following the shoreline retreat to the 2080 position seaward dune edge.

It is noted that this beach/primary dune width approach to the High Hazard zone removes the issue with inconsistent zone boundaries across the assessment cell boundaries as shown at South Brighton Spit in the right pane in Figure 4-2.

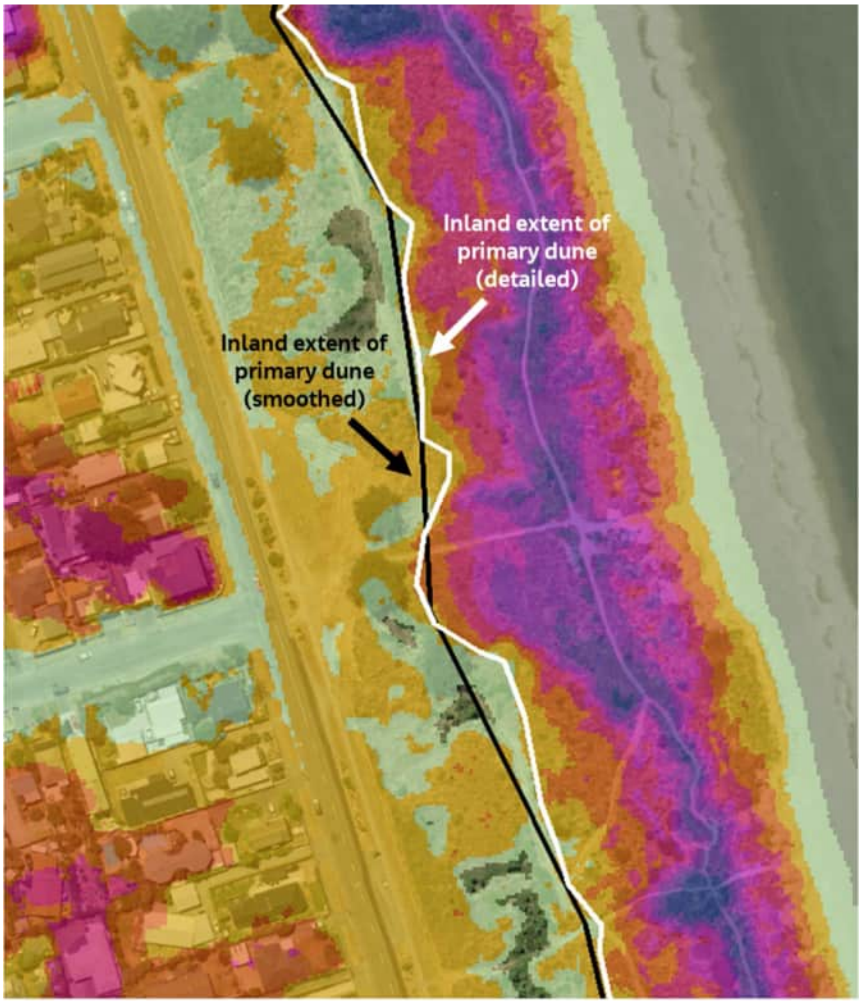



Figure 4-3. Example of area where smoothing has been undertaken along the landward extent of the dune.

The defined high hazard zone at the end of the Southshore spit is not related to the T&T (2021) CHA erosion lines or the existing primary dune extent. The T&T CHA (2021) coastal erosion lines assume that the current distal tip of the spit will be stable into the future. However, this is a dynamic environment where as recently as 1948 (74 years ago) the shoreline was located at the end of Rocking Horse Road (Figure 4-4). This extreme northward retreat of the spit occurred even after long periods of being at a more southern position (e.g., 1849, 99 years earlier). In these dynamic environments of sand spits at river mouths, we should anticipate that if the shoreline has been located there before, there is a high likelihood that it could retreat to there in the future, and therefore development and activity should be restricted across this reserve area.

As shown in Figure 4-5, the resulting high hazard zone at the Southshore Spit runs along the reserve boundary at the end of Rocking Horse Road to join the open coast primary dune area and the high hazard zone around the Avon Heathcote Estuary.

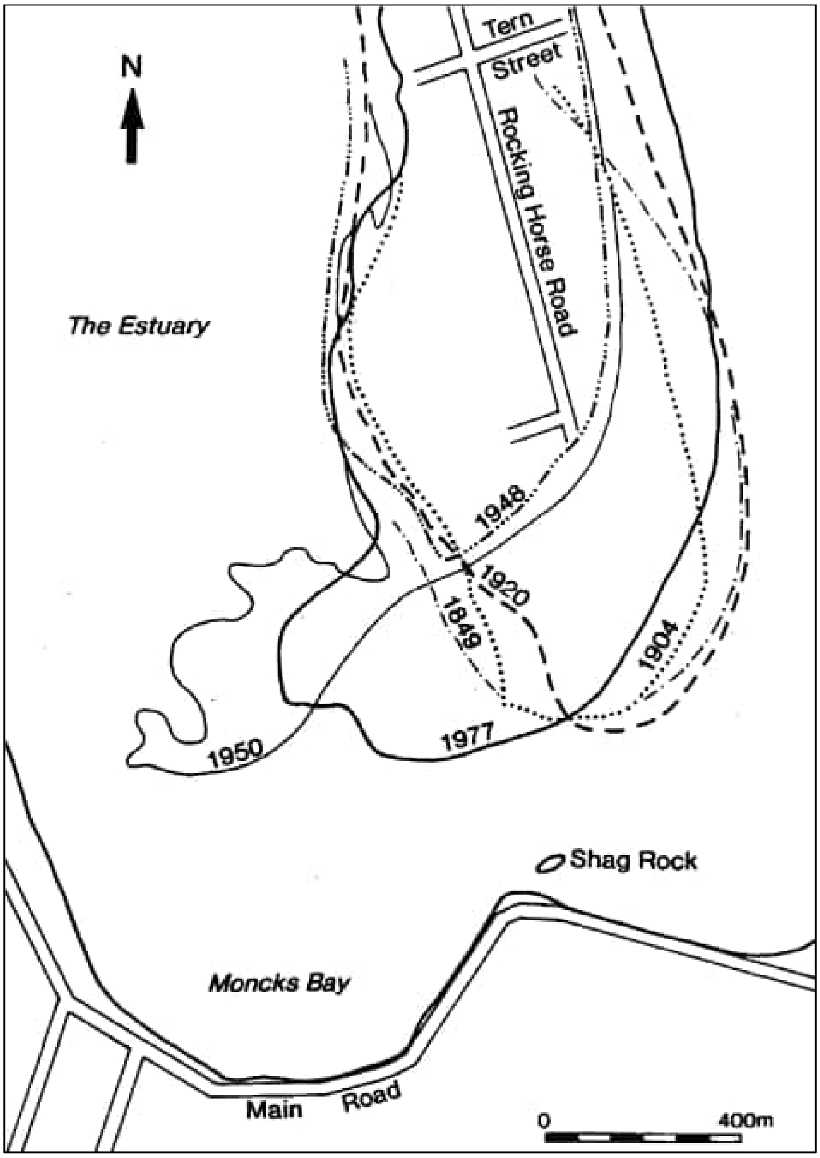



Figure 4-4. Morphological changes to the Southshore Spit from 1849-1950 (Kirk and Todd, 1994[4]).

[4] Kirk, R.M., and Todd, Derek, 1994, "Coastal Hazards", in Canterbury Regional Council (ed) Natural Hazards in Canterbury, Report 94(19), Christchurch, Canterbury Regional Council, pp 33-51


Figure 4-5. High hazard area at distal tip of Southshore Spit.

### 4.2.2 Low Hazard Zone

For the Low Hazard zone, Figure 4-1 suggests that spatially the 33% probability with 1.5 m SLR by 2150 provides a more appropriate zone width for land use planning, however as stated in Section 7.3.1 of Jacobs (2021) this scenario is conservative and it is more uncertain whether this magnitude of SLR will occur within a reasonable timeframe for land-use planning.

Therefore the 10% probability with 1.2 m SLR by 2130 is considered a more appropriate landward boundary for the Low Hazard Zone and has a higher degree of consistency with the maximum scenario from the deterministic assessment.

The position of the recommended Low Hazard boundary based directly on the position of 10% probability with 1.2 m SLR by 2130 from the T+T data is shown in Figure 4-1. As can be seem from the right pane in Figure 4-1 (Southshore), there are locations where this recommended Low Hazard Category is also totally contained within the current dune system that would be zoned as High Hazard Coastal Erosion, in which case it is recommended that no Low Hazard Coastal Erosion Zone is required.

However, it is noted that where the 1.2 m SLR by 2130 erosion line falls close to or landward of the high hazard zone, this represents a future shoreline where the entire primary dune system has been eroded as the erosion line produced by T+T represents the dune toe, not the back of the dune. If the dune was to erode back to this position, the risk profile in the area will increase due to the loss of hazard protection provided for by the dunes to both inundation and erosion. Therefore, it is recommended that the low hazard zone should include an allowance for dune migration in order for the dune system be maintained in the future to provide resilience to coastal hazards. This additional factor is termed the 'dune resilience factor' and should be offset from the 1.2 m SLR by 2130 erosion line. The purpose of applying this additional dune width is to ensure that there is sufficient dune form to provide hazard protection should a large storm with a return period of around 100 years occur following the end of the planning timeframe.

The dune resilience factor has been defined using the T&T (2021) CHA data for the open coast 'short term' (ST) and 'dune stability' (DS) factors. These two factors take into account the erosion which would occur in a 1 in 100 year storm event on the open coast. While these factors are included in the calculation of the CHA coastal erosion lines, the mapped T&T (2021) line shows where the seaward toe of the dune would be following such an event, with no consideration on whether there is sufficient dune to provide protection following the event. Due to the very high degree of dune vegetation cover, the landward toe of the primary dune is essentially locked in position and does not migrate with erosion of the front of the dune, resulting in long-term reduction in dune widths and ability to act as an effective buffer against coastal hazards. Failure to provide for this could result in the dune being totally breached in such an extreme storm event, leading to coastal inundation in areas not mapped for this to occur, and making it very difficult for natural dune rehabilitation to occur following the event. So, the intention of the dune resilience factor is to ensure that an additional dune area continues to exist following such a large event. Therefore, providing the possibility that the dune environment could still effectively provide a hazard protection function for the land behind, as well as provide an environment for the dune to recover and rebuild following the storm event.

The CHA shows that there is longshore variation in the ST and DS factors, with there being higher projected storm cuts at the southern end of the spit, and lower projected storm cuts at the northern end. The resulting dune resilience factor has been averaged across similar cell responses, as is seen below in Table 4-1. At the northern end of the open coast (cells 1-4) the dune resilience is calculated to be 25 m; through the central area (cells 5-13) the dune resilience factor is 32 m; and at the southern end of the spit (cell 14) the dune resilience factor is 43 m.

Table 4-1. Dune Stability (DS) and Short Term (ST) factors from T&T (2021) CHA with averaged Dune Resilience factors used for the low hazard zone is presented on the column on the right.

| Cell | DS (m) | ST (m) | Combined ST and DS (m) | Dune Resilience Factor (m) |
|---|---|---|---|---|
| 1 | 2 | 22 | 24 | 25 |
| 2 | 4 | 22 | 26 | |
| 3 | 3 | 22 | 25 | |
| 4 | 3 | 22 | 25 | |
| 5 | 4 | 29 | 33 | 32 |
| 6 | 4 | 29 | 33 | |
| 7 | 1 | 29 | 30 | |
| 8 | 4 | 29 | 33 | |
| 9 | 1 | 29 | 30 | |
| 10 | 4 | 29 | 33 | |
| 11 | 3 | 29 | 32 | |
| 12 | 2 | 29 | 31 | |
| 13 | 2 | 29 | 31 | |
| 14 | 2 | 41 | 43 | 43 |

The low hazard areas only exist where the current primary dune extent (e.g., the high hazard zone) is both (a) narrow; and (b) projected to erode through all or most of the existing primary dune area with 1.2 m SLR by 2130. A schematic of the way the low hazard area has been mapped relative to the high hazard zone and 1.2 m SLR 2130 shoreline is shown in Figure 4-6.

Due to the inclusion of the total primary dune in the high hazard area, and the small amount of projected erosion in some areas, the low hazard only occurs along the coast from around North New Brighton Surf Club to Waimairi Beach Surf Club, as can be seen in Figure 4-7. This is due to both (a) the narrow dune along Marine Parade at this location; and (b) the projected front of dune position for 1.2 m SLR by 2130 being located near the landward edge of the existing dune extent, and therefore should the dune be eroded to this position, there would be a significant change in the risk profile and exposure to coastal inundation and erosion hazards at this timeframe.

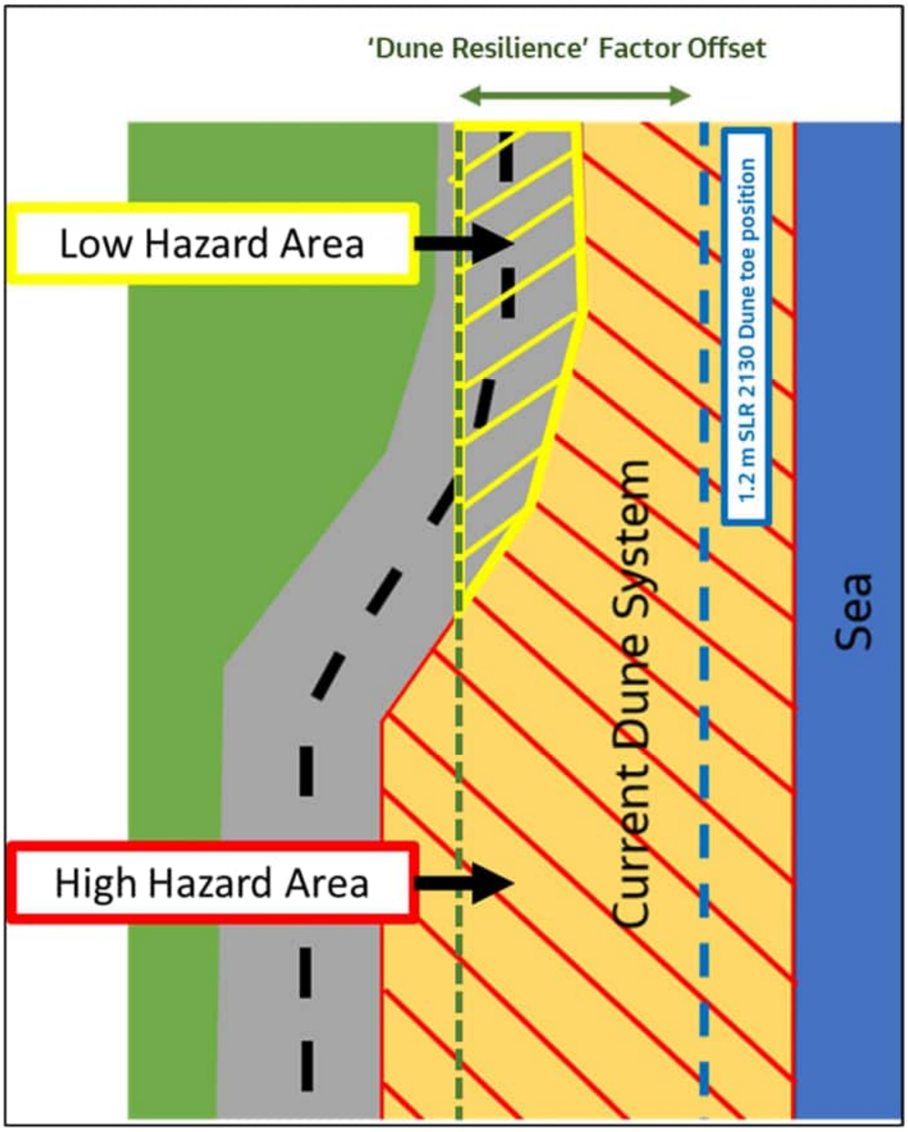



Figure 4-6. Schematic of where the high and low hazard areas are mapped in relation to the 1.2 m SLR (2130) dune toe position.


Figure 4-7. High and low hazard zones in North New Brighton/Waimairi Beach relative to the 1.2 m SLR 2130 erosion projection lines from T&T (2021).

#### 4.2.2.1 Avon-Heathcote Estuary (T+T Cells 15 to 24)

Figure 4-8 shows examples of how the high, medium, and low hazard zones would look at two locations in the Avon-Heathcote Estuary from applying the possible threshold options from Table 7.1 of Jacobs (2021).

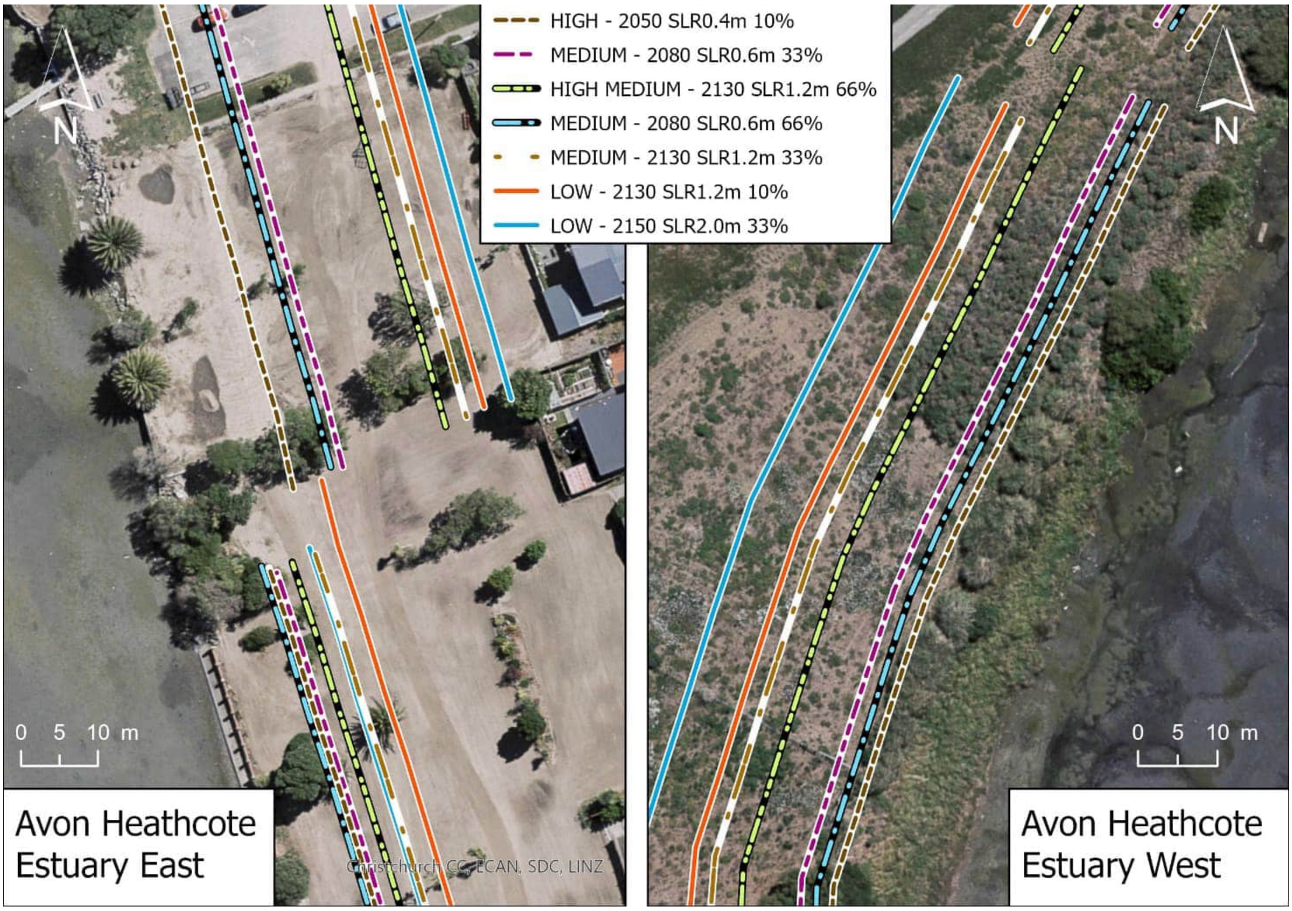



Figure 4-8. **Possible options for High, Medium and Low Coastal Erosion Hazard Categories at Southshore (left) and Oxidation ponds (right) around the Avon-Heathcote Estuary. Not recommended due to zones being too narrow.**

As can be seen from Figure 4-8, the resulting zones are narrow, being in the order of 10-20 m for the High Hazard options, 5-10 m width for the Medium zone options, and 5-20 m widths for the Low hazard zone depending on location around the estuary. These widths are considered to be too narrow for effective land-use planning provisions, so the following two zone approach is recommended.

- High-Medium Coastal Erosion Hazard Zone Boundary: 66% probability of erosion with 0.6 m SLR by 2080
- Low Coastal Erosion Hazard Boundary: 10% probability of erosion with 1.2 m SLR by 2130.

It is noticeable from the left pane of Figure 4-8 that these recommended thresholds would result in inconsistent erosion hazard zone widths within different cells around the estuary and there will need to be in some locations large adjustments and smoothing of the hazard zones across the cell boundaries.

Therefore, it was considered that applying a consistent erosion hazard width across all estuary assessment cells, with the generic width for the zones being equal to the largest ASCE in any cell under the recommended scenario/threshold option, was an appropriate approach to dealing with smoothing across cell boundaries. This also ensured that the distance between the thresholds defining different hazard risk categories is sufficient for likely land-use activity to be reasonably able to be carried out in the zone between the thresholds.

Under this approach, the width of the high-medium coastal erosion hazard zone is 20 m, and low coastal erosion hazard zone is an additional 20 m from the medium-high zone. The position of the recommended Coastal Erosion Hazard Zone boundaries under this approach for selected locations around the estuary is shown in Figure 4-9.


Figure 4-9. Recommended High-Medium and Low Coastal Erosion Hazard Categories at Southshore (left) and Oxidation ponds (right) around the Avon-Heathcote Estuary.

As seen in Figure 4-9, 20 m setbacks align closely to the ASCE lines in most areas of shoreline around the estuary. However, it is recognised that using this generic approach could be seen as precautionary at the southern end of Southshore Spit, where properties that were not identified as being included in the ASCE (due to low erosion projected erosion distances) could be included in a high-medium or low hazard zone as a result of the higher generic setback distances being used.

A sensitivity test was undertaken to identify how many additional properties could be included within the defined high-medium and low hazard zones, which were not included in the ASCE for the corresponding timeframes and SLR scenarios used. The results of this sensitivity testing showed:

- When comparing the high-medium hazard zone (e.g., 20 m setback) to the ASCE for 0.6 m SLR by 2080 (66th Percentile), the same land parcels are projected to be affected (51 land parcels) for both lines, and therefore the use of the 20 m setback for the high hazard does not intersect with any additional land parcels. This finding for the high hazard zone is a result of majority of the setback area being located through parks, reserves, and through the Southshore Residential Redzone where council now has ownership of the land
- For the low hazard zone (e.g., additional 20 m setback), there are an additional three land parcels which are projected to be in the low hazard zone but are not shown as being affected by projected erosion hazard in the ASCE for 1.2 m SLR by 2130, all of which are located at the southern end of the Southshore Spit (Figure 4-10).

For the additional three land parcels that are affected, the low hazard zone line only intersects with a very small portion of the land parcel:

- For one of the land parcels, the low hazard zone appears to intersect with a garden shed;
- For one of the land parcels, the low hazard zone appears to intersect with the main dwelling on the property; and
- For one of the land parcels the low hazard zone cuts the corner of an empty property with no dwellings

There are also two land parcels where the low hazard line intersects with an accessway, however these appear to be a shared accessway to properties that now form part of the red zone.

- The additional three land parcels affected by the 40 m low hazard set back are south of Tern Street at the southern end of Cell 16 from the CHA assessment. It is noted that these parcels occur around the southern limit of former private shoreline protection structures. Therefore, there is uncertainty in the CHA assessment results on the effect of the demolition of these structures on the future shoreline movements, and a precautionary approach is justified here to take into account these additional factors.


Figure 4-10. Three land parcels and two accessways intersect with the 40 m setback area and not with the 1.2 m SLR by 2130 CHA erosion line shown as the properties in red.

Therefore, as a result of this analysis, due to there being (a) no additional private properties effected by the use of the 20 m setback for the high hazard zone; and (b) only three additional properties being affected by the low hazard zone (and to a small extent), it is recommended that the generic approach in the Avon Heathcote Estuary for the high-medium and low hazard zones is used.

## 4.3 For Erosion Protection Cells

This section is an addendum to Section 7.3.4 of Jacobs (2021). As indicated in Section 4.2 of Jacobs (2021) there are a number of cells along the southern shore of the Avon-Heathcote Estuary, Sumner Beach, Lyttelton Port and Akaroa township where due to land reclamation and substantial hard protection structures, the future ASCE's have been assessed as being the same as Current ASCE (e.g., erosion resulting from structure damage/failure before repair). As such there is no change in ASCE with SLR scenario, and very little change in erosion distance with probability.

For these protection cells, it is recommended that a generic single erosion hazard zone width in the order of 20 m be applied as a High hazard Zone. This zone would reflect the consequences of erosion should the protection structures fail and allow for the control of activities in these areas.

Christchurch City Council planning staff confirmed that they were comfortable that the infrastructure protected by the listed protection structures meet the criteria of national and regional importance, and therefore the continued reliance and maintenance of these structures is consistent with the NZCPS. Therefore, no low hazard zone is required to be mapped along the length of these structures behind the generic 20 m high-medium hazard zone.

# 5. Conclusions and Recommendations

A preferred approach to risk thresholds has been developed for recommended scenarios for both the erosion and inundation hazards. These have been mapped to show the resulting low, medium and high risk category areas. This mapping is available in a webviewer and digital spatial datafiles. These preferred approaches were compared to other scenarios and existing mapped hazards areas during the process of this analysis. The preferred approaches for each aspect are:

## 5.1 Inundation

Table 5-1 provides the recommended definitions for coastal flood risk mapping and Figure 5-1and Figure 5-2 provide graphical examples of these four flood risk categories.

Table 5-1. Recommended definitions for coastal flood risk mapping using the CHA inundation depth data (d = water depth from the CHA for 0.2% annual exceedance probability)

| Coastal flood risk category | Flood hazard with 0.6m SLR | Flood hazard with 1.2m SLR |
|---|---|---|
| Very low | None (dry) | Low (d < 0.4 m) |
| Low | Low (d < 0.4 m) | Medium (0.4 m < d < 1.0 m) |
| Medium | Medium (0.4 m < d < 1.0 m) | High (d > 1.0 m) |
| High | High (d > 1.0 m) | High (d > 1.6 m) |

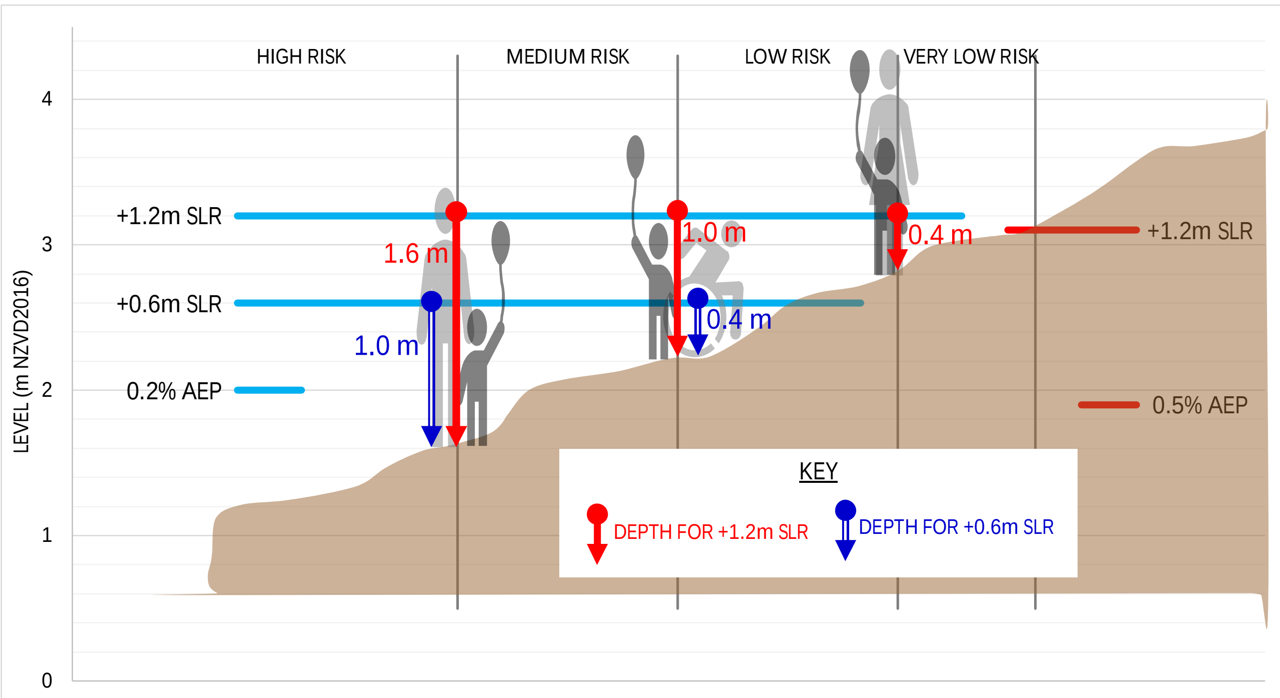



Figure 5-1. Recommended definitions of coastal flood risk. The coastal flood management area is defined by the 0.5% AEP coastal water level with 1.2 m of sea level rise (SLR). Flood hazards are defined by the water depth under the 0.2% AEP coastal water level. Flood risk is defined by the combination of hazard (water depth) and the certainty in and timing of sea level rise.

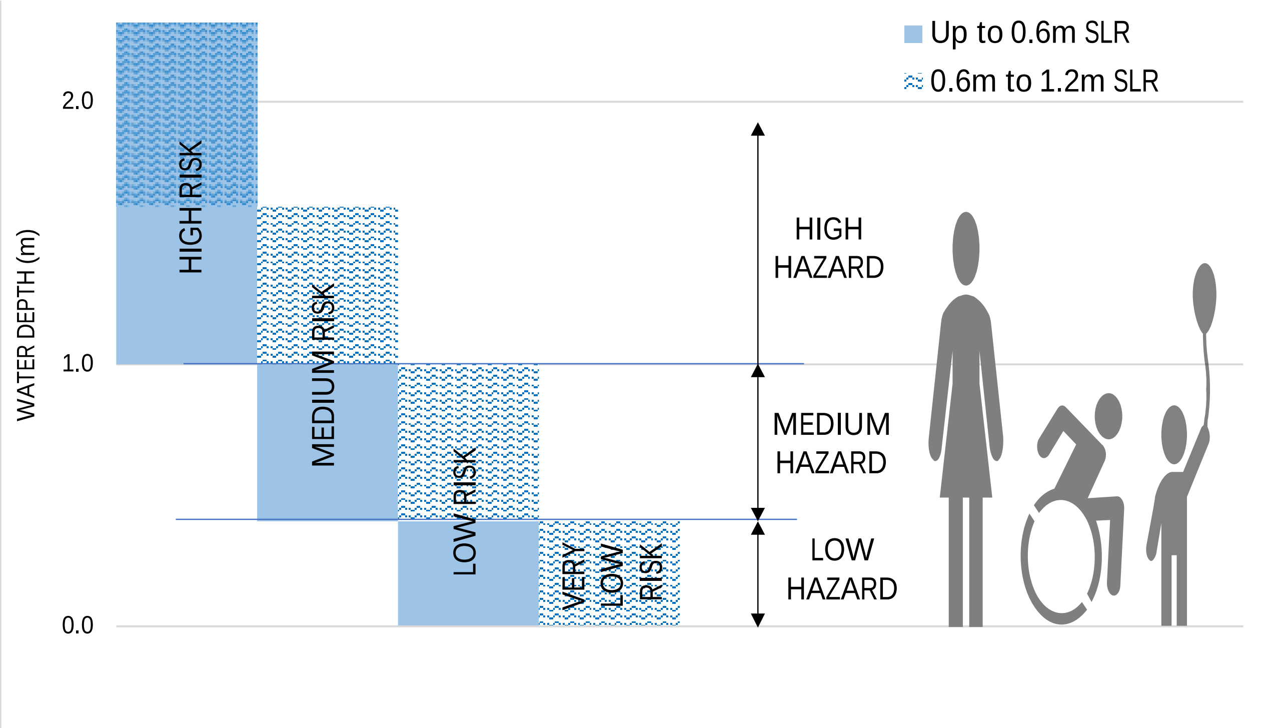



Figure 5-2. Flood risk categories based on the thresholds defined in Figure 5-1

## 5.2 Erosion

Based on the different coastal morphologies within the Christchurch district and the various assessment methods applied by T+T in different areas, the following are the recommended thresholds from the T+T data for determining coastal erosion hazard zones:

1) For the Christchurch City urban area open coast; two erosion zones compromising of

   a) A High Hazard Coastal Erosion Zone covering the current beach-primary dune width, and

   b) Where required, A Low Hazard Coastal Erosion Zone to a lowland limit defined by the 10% probability erosion distance with 1.2 m SLR by 2130 and an additional area required for “future dune resilience factor”.

2) For the Avon-Heathcote Estuary; two erosion zones comprising of

   a) A High-Medium Hazard Coastal Erosion Zone defined by a consistent generic width of 20 m across all cells to be equal to the largest ASCE in any cell for the 66% probability erosion distance with 0.6 m SLR by 2080

   b) A Low Hazard Coastal Erosion Zone defined by a generic additional width of 20 m across all cells to be equal to the largest ASCE in any cell for the 10% probability erosion distance with 1.2 m SLR by 2130.

3) For the beaches and bays of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula Bays High-Medium Coastal Erosion Hazard Zone, with the landward limit defined for:

   a) Probabilistic assessment cells as the 10% probability of erosion distance for 1.2 m SLR by 2130, and

   b) Deterministic assessment cells as the limit of the ASCE from the 1.5 m SLR by 2130 scenario, which has an assumed probability of 1-5%.

4) For the coastal cliffs of the Banks Peninsula, Lyttelton Harbour and Akaroa Harbour; a single Banks Peninsula High-Medium Cliff Erosion Zone of 20-30 m width as defined by the generic T+T cliff erosion setback

5) For assessment cells along the southern shore of the Avon-Heathcote estuary, Sumner Beach, Lyttelton Port and Akaroa township where there are land reclamation and substantial hard protection structures; a single High-Medium Hazard Coastal Erosion Zone hazard zone with a generic width in the order of 20 m.

# Appendix 9

Memorandum on the Qualifying Matters Relevant to Lyttelton Port Company Limited - Andrew Purves Planning and Resource Management (on behalf of Lyttelton Port Company Limited)

andrew purves
planning & resource management

# Christchurch City Council Draft Plan Change 14

## Memorandum on the Qualifying Matters Relevant to Lyttelton Port Company Limited

## 1. Background

1.1 The Christchurch City Council (*CCC*) will be required under the Resource Management Act, 1991 (*RMA*) to notify changes to the Christchurch District Plan (*CDP*) to enable the establishment of up to three residential units, each up to three storeys high on a site zoned Residential. These changes, otherwise known as "Medium Density Residential Standards" (*MDRS*) must be notified (and take effect) by the 20 August 2022.

1.2 CCC will, however, be able to notify changes that are less permissive than the MDRS in relation to specific areas within residential zones if specified qualifying matters are present. These include the need to give effect to the safe and efficient operation of nationally significant infrastructure. The definition of "nationally significant infrastructure" is contained in the National Policy Statement on Urban Development (*NPS UD*) and this definition includes port facilities of a port company. Therefore, LPC's port facilities are nationally significant infrastructure.

1.3 The CDP currently contains provisions to recognise and provide for the safe, efficient and effective operation and development of infrastructure, including strategic infrastructure such as port facilities, because of their benefits to the community.

1.4 One important means in achieving the above policy direction is protecting infrastructure from 'reverse sensitivity' effects. Reverse sensitivity is the vulnerability of an established land use (Lyttelton Port or the Inland Port in this instance) to complaint from a newly establishing, more sensitive land use such as new houses and other activities which might be disturbed by noise from the port or from the inland port for example.

1.5 Provisions to avoid reverse sensitivity in the CDP need to be carried over as a qualifying matter if the CDP is to continue to protect nationally significant infrastructure such as the port and inland port.

1.6 This is particularly so given the MDRS have immediate legal effect when the Intensification Planning Instrument (*IPI*) is notified, unless a qualifying matter applies. It is therefore important that the Council correctly identifies and notifies qualifying matters that prevent the construction of dwellings as-of-right where that would be inappropriate.

1.7 The purpose of the memorandum is to assist Council in the identification and drafting of existing and new qualifying matters for both the Lyttelton Port and the Inland Port (*CityDepot*) to include in its IPI.

## 2. Lyttelton Port

### Introduction

2.1 Lyttelton Port Company (*LPC*) was formed in 1988 with the introduction of the Port Companies Act which separated the commercial role and the non-trading (recreational and safety) roles of the former Lyttelton Harbour Board.

2.2 Lyttelton Port is the primary international gateway for the South Island with Christchurch being the major distribution centre for inbound goods. Export customers include a wide variety of dairy, meat, forestry, horticultural, and manufacturing businesses, as well as coal which is an important export for the west coast region.

2.3 Lyttelton Port is the most significant port in the South Island in terms of total tonnages of cargo and containers handled, as well as in the value of imports received and in the value of certain exports.

2.4 The importance of the Port is reflected in the various statutory documents prepared under the RMA. The New Zealand Coastal Policy Statement recognises that a sustainable transport system requires an efficient network of safe ports, servicing national and international shipping. Lyttelton Port is defined as a regionally significant infrastructure under the Canterbury Regional Policy Statement, and is also variously defined as a strategic, critical, and essential infrastructure in that document.

2.5 Lyttelton Port is a port facility of LPC and is therefore defined as Nationally Significant Infrastructure in the NPS UD.

**Existing provisions to manage port noise and reverse sensitivity effects at Lyttelton**

2.6 There is an integrated package of provisions relating to port noise in the CDP as follows:

a. Those on the management of port noise at source;

b. Those on the management of reverse sensitivity effects through an acoustic treatment programme for noise affected properties; and

c. Those on management of reverse sensitivity effects through controls on landuse within the "Lyttelton Port Influences Overlay" (*LPIO*) which is of particular relevance to this memorandum.

2.7 The Specific Purpose (Lyttelton Port) Zone permits "Port Activities" subject to a number of standards. There are, however, no short-term noise limits contained in the CDP. Rather, there are detailed methods that set out the requirements for a port noise management plan (along with a port liaison committee) and also a port noise mitigation plan.

2.8 The port noise management plan must at all times contain a map showing how much noise is generated from port activities (called port noise contours). These contours are developed from a model that is developed in accordance with NZ Standard NZS6809:1999, Acoustics - Port Noise Management and Land Use Planning.

2.9 The noise model is regularly reviewed to ensure any changes in intensity or character of port noise is captured, and which may result in the shifting of the noise contours.

2.10 Those properties that are located within the 65 dBA Ldn port noise contour become eligible for acoustic treatment that is funded by the LPC and administered by the port liaison Committee. The LPIO coincides with the 65dBA Ldn contour.

2.11 There are 38 residential sections within the LPIO (as shown in **Appendix 1**), and of those 29 are dwellings that are currently eligible for acoustic treatment, with 18 dwellings receiving acoustic treatment thus far. The LPIO includes all of the property no matter which part of the property falls within the contour.

2.12 The LPIO and associated rules were introduced at the same time to control activities that are sensitive to port noise.

2.13 If the 65 dBA Ldn contour shifts inland then any new noise affected property owners would become eligible for acoustic treatment. The intention would also be for the LPIO to be amended in due course to align with the new position of the 65 dBA Ldn contour through a Plan Change or the next review of the CDP.

2.14 On-going monitoring of noise has shown the model to be accurate and the position of the 65 dBA Ldn contour to be more or less unchanging.

2.15 The LPIO takes in parts of the:

a. Residential Banks Peninsula Zone;

b. Commercial Banks Peninsula Zone; and

c. The Industrial General Zone.

2.16 The Residential Banks Peninsula Zone within the LPIO permits up to $40m^2$ extensions to habitable rooms in existing dwellings provided that the subject rooms are acoustically treated so that they have an internal sound design level of 40 dBA Ldn (5-day). A replacement dwelling on a site is also permitted provided it is of a similar size and also meets an internal sound design level of 40 dBA Ldn (5-day).

2.17 This enables home owners to replace a house in the event of fire etc. or carry out reasonable extensions to habitable rooms of an existing house as-of-right provided any new habitable rooms or extensions exposed to port noise were acoustically treated down to the 40 dBA Ldn internal design sound level.

2.18 Extensions and replacement dwellings exceeding the $40m^2$ threshold are a restricted discretionary activity subject to ‘no-complaints covenant’ being signed by the applicant.

2.19 However, the intensification of residential use through multi-unit apartments are not contemplated within the LPIO, nor is the introduction of other sensitive activities, such as healthcare facilities.  Such proposals would be listed as non-complying activities.

2.20 The Commercial and Industrial Zone rules within the LPIO classify any residential housing a non-complying activity although LPC has given written approval to some dwellings or upstairs apartments of which there was some form of equivalent development prior to the earthquakes.  If the LPIO land use controls were rolled-back for the Residential Banks

Peninsula Zone, this could also be used as basis to argue for residential units (apartments) to be developed in Commercial Banks Peninsula Zone part of the LPIO which if successful would result in increased reverse sensitivity effects.

2.21 Subdivision within the LPIO is a non-complying activity unless a condition is proposed prohibiting noise sensitive activities on each allotment, to be complied with on a continuing basis, for the purpose of incorporation into a consent notice to be issued by the Council.

**How the Port Noise Provisions at Lyttelton were developed**

2.22 The planning framework was established in the former Banks Peninsula District Plan. Some parts of the former Council's decision on the District Plan was appealed by LPC and also by a resident.

2.23 In 2005, the parties to the appeals agreed to try to resolve the appeals by mediation and a Port Noise Working Party was established with former Environment Court Judge Peter Skelton appointed by the Court as the Mediator. The Court directed parties to carefully consider the agreement in the "Port Otago decisions."

2.24 LPC representatives and advisors (including myself) and the community group mediated regularly for just over a year to arrive at the agreed provisions summarised above. It was agreed in mediation that any acoustic control treatments and associated landuse controls be limited to inside the 65 dBA Ldn.

2.25 Although the agreement was outside the scope of the Appellant submissions, the Court determined that it should proceed to consider the changes by way of alteration under section 293 of the RMA. However, the Court concluded it should proceed cautiously by having the proposed agreed changes notified by the Council so that other members of the community could submit. Some did but the submissions were resolved by LPC and those submissions were withdrawn.

2.26 The Court, in its final decision, concluded that the new provisions represented the best opportunity for parties to seek a long-term resolution to the fairly intractable issues of noise in a port such as Lyttelton, where residential development is very close to the port.

2.27 The port liaison committee was established shortly after the Court decision and the port noise management and the port noise mitigation plans were prepared.

2.28 The land use controls relating to the Residential Banks Peninsula Zone were carried through into the Christchurch District Plan by the Hearing Panel after again hearing evidence on the matter. The provisions relating to the Commercial Zone were in fact tightened because the majority of the heritage buildings in the area were demolished and the exceptions applying to those buildings were no longer needed.

2.29 The above discussion highlights the fact that the CDP provisions manage port noise and reverse sensitivity effects in an integrated manner (including through restrictions on residential density and new development in the LPIO) that have been thoroughly considered by Councils and the Court and determined to be the best way to address these issues.

**Existing qualifying matter for Lyttelton Port**

2.30 Lyttelton Port is recognised as nationally significant infrastructure under the NPS UD and therefore LPC is relying on section 77I(e) of the RMA to include a qualifying matter: "*a matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure*."

2.31 I consider it appropriate that these existing controls in the CDP are carried through as existing qualifying matters in the IPI.

2.32 The existing provisions have been predicated on one residential unit per site, and; as noted earlier, subdivision within the LPIO is a non-complying activity unless a condition is proposed that prohibits noise sensitive activities on each allotment.

2.33 While the acoustic treatment of dwellings reduces the potential for reverse sensitivity effects from occurring, there can be a portion of dwelling owners that are particularly sensitive to noise and therefore consider their amenity compromised regardless. Therefore, I consider it important that the original density controls be retained as part of the package as a means to avoid reverse sensitivity effects as far as possible, consistent with the current policy direction in the CDP.

2.34 An assessment of this qualifying matter against section 77K of the RMA is included at **Appendix 2**.

## 3. CityDepot

3.1 CityDepot is an inland container hub that serves Lyttelton Port of Christchurch. The 17-hectare facility is located between Chapmans Road and Port Hills Road in Woolston. The facility is owned and operated by LPC.

3.2 The container facility provides the following services:

a. Handling and storage of up to approximately 10,000 TEU containers;

b. All-weather container repair facility;

c. Repair bays served by two 5-tonne and two 10-tonne overhead gantry cranes;

d. Container wash facilities; and

e. A mobile repair unit.

3.3 The facility operates 24 hours a day for five and a half days a week and has good access to the State Highway network and to the rail network via a 24 wagon rail siding.

3.4 CityDepot is an integral part of port operations because the facility enables LPC to better optimise container movements on and off the wharf for its key customers i.e. international shipping lines, freight forwarders and exporters and importers in the Canterbury region. As a port facility of LPC, CityDepot is Nationally Significant Infrastructure, as defined in the NPS UD.

**Managing noise and reverse sensitivity effects at CityDepot**

3.5 CityDepot is zoned Industrial Heavy apart from an approximately one hectare block at the western end of the property adjoining Port Hills Road, which is zoned Industrial General (refer to the map attached in **Appendix 3**.)

3.6 CityDepot has always been subject to the noise limits specified in the CDP. These noise limits are measured and set at the site receiving the noise. There is a Residential Hills Zone that is located on the opposite side of State Highway 76 (Port Hills Road) from CityDepot, which runs north towards Opawa Road.

3.7 The limits for any site zoned Residential Hills, located on the opposite side of Port Hills Road from CityDepot, are 50 dB $L_{AEq}$ and 40 $L_{AEq}$ for daytime and night-time noise respectively. A 65 $L_{Amax}$ limit also applies at night.

3.8 Prior to 2009, CityDepot was not well integrated with the cargo handling operations at Lyttelton Port. This was because the noise limits constrained night-time operations.

3.9 LPC needed to obtain a resource consent for the night-time operation so a reasonable level of activity associated with the receival and dispatch of containers could occur at night, including trains using the rail siding.

3.10 LPC was issued a resource consent from CCC (RMA92013975) for its night-time operations at CityDepot (and associated noise) but there are a range of conditions on the consent, including:

a. Requirement for a noise management plan and associated techniques to mitigate noise, including shielding;

b. Noise limits from CityDepot operations being applied at the boundary of eight properties in the Residential Port Hills Zone opposite CityDepot;

c. Noise limits from CityDepot operations being applied to existing residential units located in the adjoining Industrial General Zone;

d. Limits on container repair operations at night; and

e. Limits on the number of trains that could visit the site during any night.

3.11 There is no overlay associated with CityDepot currently in the CDP. This is a result of the history of the establishment of this site and also the fact that LPC has had limited opportunity to consider the matter, particularly given the focus in the last decade has been on the recovery of the Lyttelton Port after the earthquake sequence, including the promulgation of the Lyttelton Port Recovery Plan and the need to get major recovery-related consents.

3.12 The intensification of residential sites on Port Hills Road opposite CityDepot as a result of the MDRS would likely see an increase in the number of people subject to noise from CityDepot (and would also involve new residents coming to that noise). That would, accordingly, risk exposing additional residents to potentially undesirable amenity levels (particularly given port operations are 24/7 for five days a week) and thereby expose LPC to reverse sensitivity effects which could constrain the operation of CityDepot.

3.13 LPC has engaged acoustic expert Neville Hegley to provide advice on the likely implications of the MDRS on the noise effects of CityDepot that might be received from sensitive activities in proximity to CityDepot. In summary his advice provides:

a. The properties potentially affected are 311 – 321 Port Hills Road;

b. All other Residential Hills Zone properties will not have any potential adverse noise effect from an increase in height of those dwellings;

c. Noise screening is currently used at CityDepot but its current design assumes two storey dwellings being constructed in the residential zone;

d. Should the height of an existing dwelling be increased to three storeys then the current noise screening will not achieve the necessary noise screening to that third storey;

e. Noise screening at CityDepot cannot be practically achieved (due to the likely height of the noise screening barriers that would be required); and

f. An appropriate way to resolve this issue, and to achieve compliance with the required noise limits, would be to ensure third levels of buildings be designed to achieve a minimum façade reduction of 4 – 7dBA.

3.14 In addition, if a new dwelling was established on these sites on higher ground then potentially all floors could be exposed to noise generated from night-time activities at CityDepot. Therefore, on the basis of Mr Hegley's advice, I recommend an acoustic treatment standard should be inserted into the PC14 provisions in the manner set out in **Appendix 4**.

3.15 LPC has however decided not to seek a reduction in the number residential units allowed for each site under the MDRS provided proper acoustic treatment measures are put in place. This is because of the nature and history of the CityDepot site and operation, and the ability to screen night-time noise from activities at CityDeport to a reasonably large extent.

**Potential new qualifying matter for CityDepot**

3.16 CityDepot is recognised as nationally significant infrastructure under the NPS UD (noting that CityDepot constitutes 'port facilities' and not some other ancillary commercial activity).

3.17 I consider there is a way the plan could be amended such that the reverse sensitivity effects on CityDepot are managed, in a way that does not amend the density standards.

This is my preferred option for managing such effects, noting that the same approach has been taken in the CDP to manage reverse sensitivity effects from sensitive activities near roads and railways.

3.18 I note that the proposed drafting of this rule (see **Appendix 4**) would also require the introduction of two overlays shown in **Appendix 3** i.e.

a. The extent of the CityDepot, named "Inland Port Overlay"; and

b. The properties that are affected by CityDepot noise named "Inland Port Influences Overlay".

3.19 I consider this to be an appropriate method of managing these noise effects and that this should be included in the Council's IPI as a 'related provision' under section 80E(1)(b)(iii) of the RMA. Noting that 'related provisions' under that section can include rules or standards that support or are consequential on the MDRS, including provisions that relate to infrastructure and/or qualifying matters.

3.20 However, should the Council be of the view that management of noise effects from CityDepot would be more appropriately dealt with as a qualifying matter under section 77J of the RMA, then I have provided an assessment of this at **Appendix 5**.

## 4. Conclusion

4.1 Lyttelton Port and the Inland Port (CityDepot) is nationally significant infrastructure in terms of s77I (e) of the RMA.

4.2 Lyttelton has a package of well-established and tested provisions to manage port noise.

4.3 The package includes an Overlay to the Residential Banks Peninsula Zone that regulates sensitive activities that could otherwise cause reverse sensitivity effects on the Lyttelton Port. This is the Lyttelton Port Influences Overlay.

4.4 The existing provisions that apply to Lyttelton Port Influences Overlay, including the underlying density controls that currently apply to the Residential Zone, need to be retained and therefore included as a qualifying matter.

4.5 Absence of the Lyttelton Port Influences Overlay and associated provisions being a qualifying matter would undermine the efficient operation of Lyttelton Port by enabling significant development of residential activity that could constrain port operations due to the reverse sensitivity effects.

4.6 There are no currently Overlays to manage reverse sensitivity effects on CityDepot from sensitive activities residing in the nearby Residential Hills Zone.

4.7 An “Inland Port Influences Overlay” is recommended to be introduced to cover seven properties in the nearby Residential Hills Zone and a new standard be introduced to require acoustic treatment of dwellings within the Overlay.

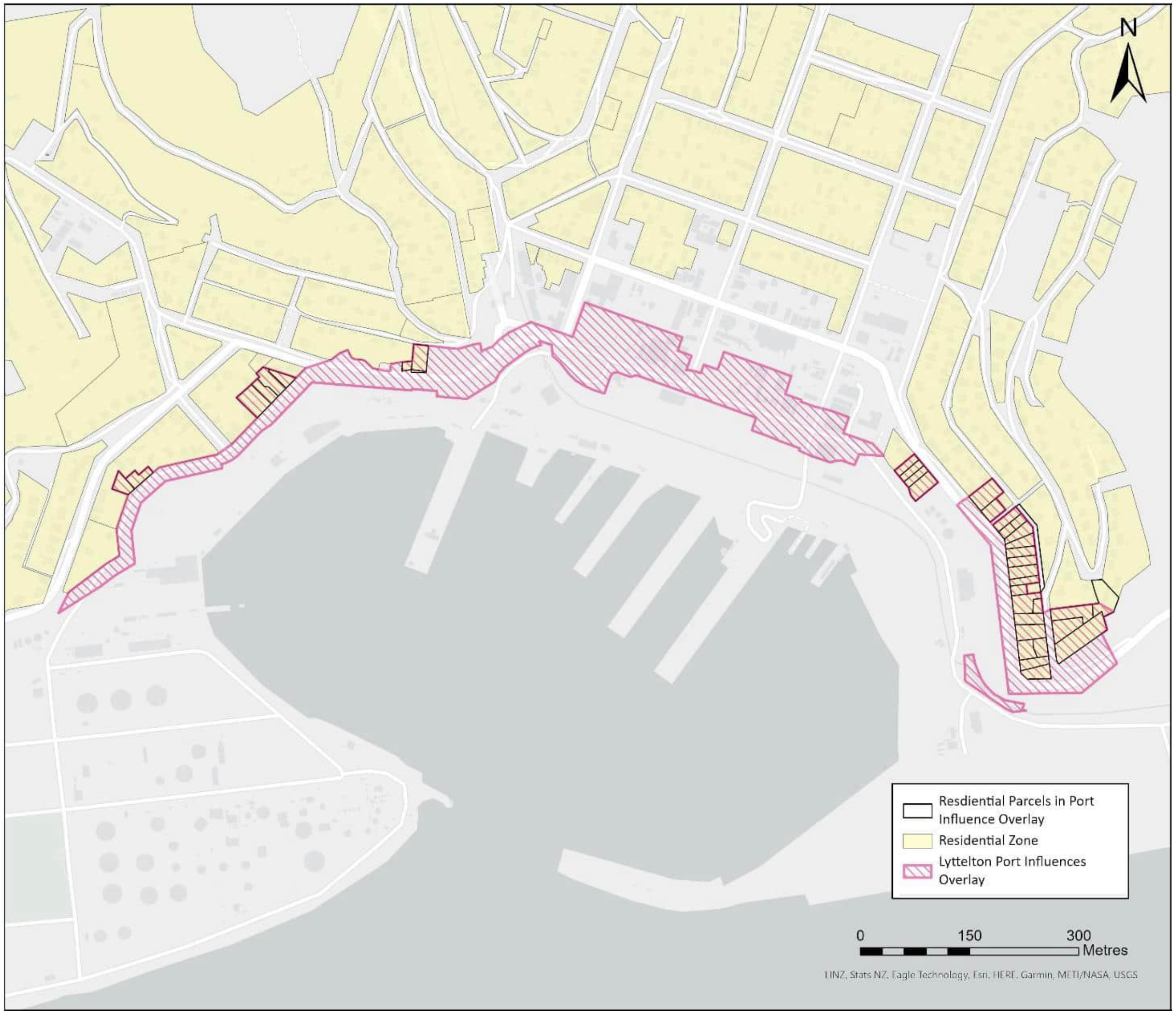
4.8 CityDepot already screens noise from existing dwellings but if a third floor is added to an existing dwelling, or a new dwelling is located on higher ground, then the noise cannot be practically screened.

4.9 The new standard would be presumably be introduced under s80E(1)(b)(iii) of the RMA but Council may wish to introduce it as a new qualifying matter under s77J of the RMA.

**Andrew Purves**

May 2022

**Appendix 1: Location of residential parcels within the Lyttelton Port Influences Overlay**



**Appendix 2: Assessment of existing qualifying matter for Lyttelton Port - The Lyttelton port influences overlay**

Below is an assessment against the relevant sections of the RMA. Section 77K(1) RMA sets out the process for considering existing qualifying matters.

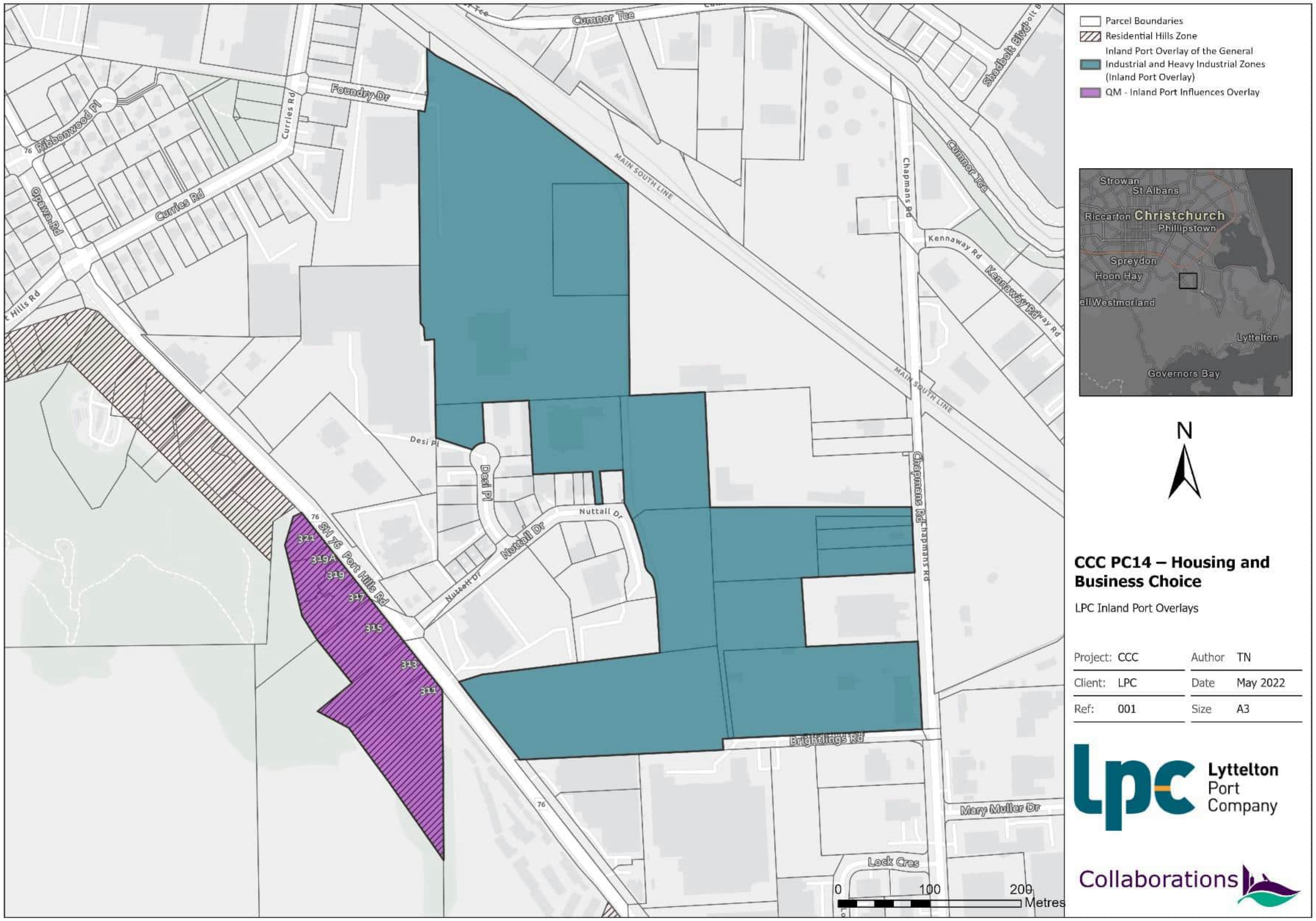
| Section | Analysis |
|---|---|
| S77K(1)(a)<br>Identify the location (for example, by mapping) where an existing qualifying matte applies | The area over which this qualifying matter applies is the Lyttelton Port Influences Overlay (LPIO), as marked in the CDP and shown at **Appendix 1** of this memorandum. For completeness, the LPIO in **Appendix 1** shows the full extent of the Overlay that currently exists in the CDP, covering the Banks Peninsula Commercial Zone and General Industrial Zone in Lyttelton as well as the Banks Peninsula Residential Zone. |
| S77K(1)(b)<br>Specify the alternative density standards proposed for those areas identified | The provisions contained in the CDP should remain unchanged within the LPIO. This means the following alternative density standards should apply to the LPIO as consistent with the current CDP drafting for the Banks Peninsula Residential Zone:<br>• One residential unit per site (Rule 14.8.2.1(a));<br>• Each residential unit shall be contained on a site with a minimum net site density of 400m$^2$ (Rule 14.8.2.1(a)(i));<br>• The maximum height of any building shall be 7m, and the maximum height of any accessory building shall be 4.5m (Rule 14.8.2.2);<br>• The maximum percentage of the net site area of any site covered by buildings shall be 35% (Rule 14.8.2.3).<br>I am not otherwise concerned with the other provisions of the MDRS (i.e. those not detailed above as altering the density standards) being incorporated into the Residential Banks Peninsula Zone located within the LPIO.<br>Further, I also agree with the Draft PC14: that is the other provisions relevant to residential units developing within the LPIO of the Residential Banks Peninsula Zone continue to apply:<br>• Strategic Objective 3.3.12 and the associated definition of reverse sensitivity in the Plan; and<br>• Objective 14.2.3 contained in Chapter 14 (Residential); and<br>• All the area specific rules for the Residential Banks Peninsula Zone contained in Rule 14.8.3, any relevant definitions, and the requirement to comply with Rule 14.8.3.2.1; and<br>• All references to the LPIO, as they apply to residential units, under Rule 14.8.1.1 (permitted activities); and<br>• Subdivision Rule 8.5.1.5 (NC3) applying to the Lyttelton Port Influences Overlay. |

| | |
|---|---|
| S77K(1)(c)<br>Identify why the existing qualifying matters apply to those areas | This has been explained in the above memorandum, however, in summary:<br>a. The CDP has an integrated package of provisions relating to port noise that:<br>• Manages port noise at source;<br>• Manages of reverse sensitivity effects through an acoustic treatment programme for noise affected properties funded by the Lyttelton Port Company and managed by a Port Liaison Committee; and<br>• Avoids as far as reasonable, reverse sensitivity effects by controlling landuse within the Lyttelton Port Influences Overlay (which was defined by a 65 dBA Ldn port noise contour).<br>b. Removing LPIO as a qualifying matter would act to unravel this package of provisions as well as undermining the efficient operation of Lyttelton Port by enabling significant development of residential activity that could constrain port operations due to reverse sensitivity effects. |
| S77K(1)(d)<br>Describe in general terms for a typical site in those areas identified the level of development that would be prevented by accommodating the qualifying matter, in comparison with the level of development that would have been permitted by the MDRS. | The existing qualifying matter includes the density provisions of the underlying zone, which of themselves provide for a level of development that is suitable for managing reverse sensitivity effects on the port. The below table compares the theoretical level of development (on a typical site) that would occur if the MDRS were permitted, and the level of development proposed accounting for the qualifying matter (being a retention of the density allowed under the Residential Banks Peninsula Zone.<br><br>The amount of feasible development however is considerably less because of the size of existing allotments, the generally difficult terrain, and consequently difficult access onto sites and on narrow roads to the sites. There are also a number of dwellings have a heritage classification under the CDP which may limit development potential. |

| Provision | Typical site if MDRS enabled | Typical site if LPIO qualifying matter applies |
|---|---|---|
| Number of residential units per site | 3 residential units | 1 residential unit |
| Building height | Not exceeding 14m in height | Not exceeding 7m in height, and 4.5m for accessory buildings |
| Site density | No minimums provided other MDRS can be met | Minimum net site area of 400m$^2$ |
| Extension to an existing habitable space | Could occur as of right provided MDRS are complied with | Subject to limitations in the increase of gross floor area under Rule 14.8.3.1.1 and |

| | | | |
|---|---|---|---|
| | | | requires resource consent if compliance with Rule 14.8.3.2.1 (internal sound design levels) is not met. |
| | Replacement of residential unit | Could occur as of right provided MDRS are complied with | Subject to limitations in the increase of gross floor area under Rule 14.8.3.1.1 and requires resource consent if compliance with Rule 14.8.3.2.1 (internal sound design levels) is not met. |

**Appendix 3: Location of proposed Overlays to Planning Map 47 (Inland Port Overlay of the Industrial Heavy and Industrial General Zone) and the Inland Port Influences Overlay of the Residential Hills Zone**



**Appendix 4: Recommended new acoustic treatment standard**

## 6.1.7.1 Activity status tables

### 6.1.7.1.1 Permitted activities

1. The activities listed below are permitted activities, if they meet the activity specific standards set out in the following table.
2. Activities may also be controlled, restricted discretionary, discretionary, non-complying or prohibited as specified in Rules 6.1.7.1.2, 6.1.7.1.3, 6.1.7.1.4, 6.1.7.1.5 and 6.1.7.1.6.

| Activity | | Activity specific standards |
|---|---|---|
| **P1** | Any activity listed in:<br>1. Rule 6.1.7.2.1 (Sensitive activities near roads and railways); or<br>2. Rule 6.1.7.2.2 (Activities near Christchurch Airport)<br>3. Rule 6.1.7.2.3 (Sensitive activities near the Inland Port) | 1. The activities shall meet the activity standards in the following rules<br>i. Rule 6.1.7.2.1 (Sensitive activities near roads and railways); or<br>ii. Rule 6.1.7.2.2 (Activities near Christchurch Airport); or<br>iii. Rule 6.1.7.2.3 (Sensitive activities near the Inland Port) |

**[New Activity standard proposed – shown in italics]**

Rule 6.1.7.2.3 – Habitable space near the Inland Port

a. Any new or extensions to existing habitable space of any development located within the Inland Port Influences Overlay shall be designed and constructed so that noise in any habitable space from the Inland Port will not exceed internal sound design level of 30dB $L_{Aeq}$ with ventilating windows or doors open or with windows or doors closed and mechanical ventilation installed and operating.

b. Determination of the internal design sound levels required under Clause (a), including any calculations, shall be based on noise from the Inland Port as follows:

   i. 50dB $L_{Aeq}$ on any façade facing north to north-east towards the Inland Port Overlay shown on Planning Map 47;

   ii. 47dB $L_{Aeq}$ on any façade within 90 degrees of facing north to north-east and has partial line of sight to any part of Inland Port Overlay shown on Planning Map 47;

c. Compliance with this rule shall be demonstrated by providing the Council with a design report prior to the issue of the building consent, which is prepared by a suitably qualified acoustics specialist, stating that the design proposed will meet the required internal noise levels.

**Appendix 5: Assessment of new qualifying matter for CityDepot - The Inland Port Influences Overlay**

Below is an assessment against the relevant sections of the RMA. Section 77J(3) RMA sets out the process for considering new qualifying matters.

| Section | Analysis |
|---|---|
| S77J(3)(a)(i)<br><br>Demonstrate why the area is subject to a qualifying matter | Sites within the proposed "Inland Port Influences Overlay" are subject to noise effects from CityDepot that need to be managed. CityDepot is integral to the effective and efficient operation of Lyttelton Port generally and is recognised as nationally significant infrastructure under the NPS UD (noting that CityDepot constitutes 'port facilities' and not some other ancillary commercial activity).<br><br>As such, this is a qualifying matter relying on section 77I(e) of the RMA, being: "a matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure." |
| S77J(3)(a)(ii)<br><br>Demonstrate why the qualifying matter is incompatible with the level of development permitted by the MDRS | The MDRS would enable existing residential units to be constructed three storeys high (or greater) or enable new dwellings on the same site to be established on higher ground. Without acoustic treatment being introduced in these circumstances noise levels from CityDepot could cause reverse sensitivity effects on CityDepot and thereby constrain its operation. |
| S77J(3)(b)<br><br>Assess the impact that limiting development capacity, building height, or density (as relevant) will have on the provision of development capacity | The proposed qualifying matter would only limit development if an owner of a residential unit decided not incorporate acoustic treatment in accordance with the proposed standard and was refused a resource consent as a consequence. Furthermore, the standard only applies to seven properties as shown on the proposed "Inland Port Influences Overlay." The level of acoustic treatment to address the noise that cannot be reasonably screened from CityDepot would not be substantial and is likely to be achieved through standard building design subject to appropriate mechanical ventilation.<br><br>LPC does not seek any limits on density for the "Inland Port Influences Overlay". |
| S77J(3)(c) | The cost of the acoustic treatment to the developer that would be required would be insubstantial in the context of a build and is likely to be with standard building design subject to mechanical ventilation. There will a transaction cost associated with a consenting process although for the reasons described above any owner seeking a resource consent is highly unlikely. |

| | |
|---|---|
| Assess the costs and broader impacts of imposing those limits | Conversely, LPC cannot practically screen noise generated by activities at CityDepot noise from three storey high dwellings or dwellings located on higher ground in the Inland Port Influences Overlay. Without acoustic treatment there is a risk of reverse sensitivity effects and any curtailment of the night-time activities at City Deport would, in effect, impact on its ability to integrate into the handling operations at the port. Ultimately, such an impact leads to a less efficient operation of the port with increased costs or importers and therefore the wider community. |

# Appendix 10

Airport Related Qualifying Matters in the Christchurch District Plan - Section 77K RMA Assessment - 11 July 2022

rmg
Resource Management Group Ltd.

# Airport Related Qualifying Matters in the Christchurch District Plan

## Section 77K RMA Assessment

## Date: 11th July 2022

| Document Control | | | | |
|---|---|---|---|---|
| **Report Title** | Airport Controls as Qualifying Matters in the Christchurch District Plan | | | |
| **Client** | **Christchurch International Airport Limited** | | **Client Contact/Approver** | Felicity Blackmore Environmental and Planning Manager |
| **Rev** | **Date** | **Status** | **RMG Author/s** | **RMG Reviewer** |
| 1 | 8 July 2022 | Draft for Client Approval | Darryl Millar – Principal | Teresa Walton - Principal |
| 2 | 11 July 2022 | Final | Darryl Millar – Principal | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| **Current Version** | | Final 11th July 2022 | | |

## Executive Summary

1. This report considers the inclusion of the operative District Plan planning regime managing residential density and intensification within the 50dB Ldn Air Noise Contour for Christchurch International Airport as an existing qualifying matter under section 77K of the Resource Management Act 1991 (RMA) within the Christchurch City Council's (the Council) proposed Plan Change 14. The area in which this qualifying matter applies is the recently remodelled 50 dB Annual Average Outer Control Boundary (AAOCB). The spatial extent of the AAOCB as it relates to the land covered by Plan Change 14 is shown on a map attached as **Appendix One**.

2. The operative Christchurch District Plan contains land use objectives, policies and rules that have been developed to manage residential and other sensitive activities in such a manner that adverse effects from aircraft noise are avoided in the receiving environment and, moreover, to avoid adverse reverse sensitivity effects on Christchurch International Airport (the Airport). The effect of the operative District Plan provisions is to manage the scale and extent of residential (and other sensitive activities) on land which is exposed to aircraft noise levels of 50dB Ldn or higher.

3. Exposure of people and communities to the adverse effects of aircraft noise can then result in complaints and pressure to reduce airport operations (for example, via imposition of a night-time curfew) and other adverse reverse sensitivity effects on Airport operations. Those reverse sensitivity effects could significantly impact upon the efficient operation of the Airport. This is a matter which is largely tied to residential density, as allowing more people to establish homes or other sensitive activities within the Contours will increase the number of people exposed to aircraft noise. This would correspondingly increase the risk of adverse reverse sensitivity effects which inhibit Airport operations.

4. The Council has commenced a planning process (draft Plan Change 14) to respond to its obligations under the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 (the Enabling Housing Act) and the National Policy Statement on Urban Development 2020 (NPSUD). In summary, the Enabling Housing Act requires Council to apply medium density residential standards (MDRS) to relevant residential zones in order to enable residential intensification.[1]

5. The proposal under draft Plan Change 14 to rezone land and apply medium density standards introduces the potential for significant further residential intensification. This has the potential to enable increased development on land within the AAOCB, beyond that currently provided for in the District Plan.

6. The Airport operates 24/7, and this availability provides a significant operational advantage for the Airport's users and its ability to connect to the rest of the world. Any reduction in that capacity would have notable consequences in the Airport's ability to deliver its operational outcomes, and the regional, national and international benefits that arise from that.

7. The assessments and attached reports confirm that:
    a. Christchurch Airport is nationally significant infrastructure and fulfils an important role in domestic, national and international passenger and freight services;

[1] Resource Management Act 1991, s77G: inserted by Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021, s9.

b. The timing and frequency of international air services are often beyond the control of the Airport; being dictated by other parties (slot taker restrictions);
c. As the Airport operates 24/7 without curfew or capacity constraint, it is a significant contributor to the national and regional economy;
d. The attached reports (Airbiz, Paling Consulting):
   - note the significance and importance of Christchurch Airport in international and domestic passenger travel and freight movements, and the interconnectivity between domestic and international networks;
   - highlight the commercial international passenger "slot taker" restrictions and the significance of the domestic multi modal night-time freight network
   - identify the risk to Airport operations from reverse sensitivity effects that could lead to constraints on Airport operations. This includes 5 international case studies illustrating the adverse results arising from a lack of or late adoption of safeguarding principles;
e. The Property Economics report identifies the risks that constraints on Airport operations poses to the economic wellbeing of Canterbury and the South Island;
f. Tying these themes together, the Marshall Day Acoustics (MDA) report identifies the amenity impacts that arise from noise exposure for sensitive activities within the 50dB Ldn Air Noise Contour, and the increasing annoyance level trend for those living in such locations;
g. In particular, MDA assess the issue of whether it is appropriate, from an acoustic perspective, to retain a 50 dB outer control boundary contour, or replace it with a 55 OCB. Overall, MDA conclude that adopting a 55dB contour, with no planning controls in the 50 to 55 space, would lead to poor environmental outcomes for sensitive activities in those locations.
h. The current regional and district planning regime provides a clear and coherent policy platform built on the above, and seeks to avoid sensitive activities within the 50dB Ldn contour as this:
   - recognises the social and economic importance of the Airport, and the need to integrate land use development with infrastructure;
   - seeks to avoid incompatible activities within the 50dB contour which may result in reverse sensitivity effects on the Airport;
   - recognises that it should not compromised by urban growth and intensification; and
   - enables the Airport's safe, efficient and effective operation and development.
i. Caselaw supports the current planning approach.

8. Given the above, the proposed MDRS can be considered as the antithesis of the provisions that unpin the current planning regime designed to achieve appropriate amenity outcomes for residents beneath the contours and to ensure effective and efficient operation of the Airport. As a result, it is appropriate to make the MDRS less enabling within the AAOCB to provide for the airport noise qualifying matter.

9. An assessment undertaken under s32 of the RMA is attached as **Appendix Eight.** The assessment finds that:
   a. the proposal to amend the MDRS provisions on land within the AAOCB to make it less enabling is the most appropriate objective for achieving the purpose of the RMA as it:
      - is necessary to accommodate a valid qualifying matter in respect of s77I(e);
      - does not unreasonably frustrate the Council's implementation of its obligations under the NPSUD, RPS and in turn, the purpose of the Act and the intent of recent

amendments to the Act to improve housing supply and enable residential intensification; and

- best aligns with the existing District Plan policy framework relating to health, amenity and Airport operational outcomes, which PC14 does not propose to alter.

10. Furthermore, the s32 report considers the relative advantages and disadvantages of:
    a. retaining the current residential zoning and related provisions applying to land within the AAOCB; or
    b. 'rehousing' the relevant provisions land beneath within the Medium Density Residential Zones.

11. In this respect the s32 report finds that option a. above is the most appropriate means of implementing the objective associated with the proposal, as it:
    a. involves the least degree of change to the current zoning and planning framework; and
    b. consequently, entails the least risk of unintended consequences or errors (e.g., anomalies) arising.

12. In addition to the above, the report also considers, from a s32 perspective, whether it is appropriate to retain a 50 dB outer control boundary contour, or replace it with a 55 OCB. The assessment concludes that retaining the 50 dB OCB has direct environmental, economic and social benefits, and minimal economic and social costs. Moreover, it is both effective and efficient.

13. Consequential to the above, proposed Plan Change 14 should make the MDRS less enabling to accommodate the airport noise qualifying matter, with the existing zonings beneath the AAOCB, and with the operative density standards, development controls and policy frameworks remaining in place. Specifically, this should include the following provisions of the District Plan:
    a. Strategic Objectives 3.3.1, 3.3.4, 3.3.7, 3.3.12 and 3.3.14;
    b. Objective 6.1.2.1 and Policies 6.1.2.1.1 and 6.1.2.1.5;
    c. Objective 7.2.1 and Policy 7.2.1.8;
    d. Objective 7.2.2 and Policies 7.2.2.1 and 7.2.2.3;
    e. Objective 8.2.3 and Policy 8.2.3.5, and the relevant subdivision standards for the RS, RSDT and RNN zones;
    f. Objective 14.2.1 and Policy 14.2.1.1;
    g. Objective 14.2.2 and Policy 14.2.2.2;
    h. Objective 14.2.3 and Policy 14.2.3.1;
    i. Objective 14.2.4 and Policies 14.2.4.1 and 14.2.4.2;
    j. Objective 15.2.4 and Policy 15.2.4.5;
    k. Rules 6.1.7.1 and 6.1.7.2; and
    l. Rules 14.4.1.4 RD34 and 14.12.1.3 RD26, and the relevant permitted and controlled activity standards applicable in Residential Suburban, Residential Suburban Density Transition, and Residential New Neighbourhood zones.

14. In addition, it will also be necessary to:
    a. Delineate the AAOCB on the relevant zones in the Planning Maps to show the extent of the qualifying matter in the District; and
    b. include an additional non-complying activity rule for sensitive activities within the new Commercial Mixed-Use zone beneath the AAOCB (Memorial Avenue).

## Introduction

1. This report considers the rationale for making MDRS less enabling in order to accommodate a qualifying matter for the protection of amenity in the area affected by aircraft noise levels of 50dB Ldn and above, and consequential protection of Christchurch International Airport's operations from reverse sensitivity effects within the Christchurch City Council's (the Council) proposed Plan Change 14. This is an existing qualifying matter under section 77K of the Resource Management Act 1991 (RMA). This report and recommendations only relate to the residential and commercially zoned land of the District Plan subject to Plan Change 14.

2. Noise contours have been in various planning documents in the greater Christchurch area since the early 1990's. At a general level the contours are linked to a suite of objectives, policies and rules which manage the development of sensitive land uses in areas exposed to aircraft noise levels of 50dB Ldn and above. The Christchurch District Plan (the District Plan) planning maps currently contain Air Noise Contours[2] and Engine Testing Contours[3]. The Contours identify land that will be subject to aircraft and engine testing noise at levels which have been shown to cause adverse community health and amenity effects. These provisions manage residential and other sensitive activities in such a manner that adverse effects are avoided in the receiving environment and, moreover, avoid adverse reverse sensitivity effects on Christchurch International Airport (the Airport). The general effect of the existing planning provisions is to manage the scale and extent of residential (and other sensitive activities) within the contours.

3. In residential zones, operative District Plan rules trigger additional scrutiny and notification requirements if a proposed development within the 50dB Ldn Air Noise Contour exceeds permitted or controlled density standards and scale. Some development may be accommodated in existing residential zones within the 50dB Ldn Air Noise Contour (in recognition of the residential zoning and historical development), but medium or high density residential development is not anticipated in these areas.

4. Exposure of people and communities to adverse aircraft noise effects can then result in complaints and pressure to reduce or alter airport operations (for example, via imposition of a night-time curfew) and other adverse reverse sensitivity effects on Airport operations. Those reverse sensitivity effects could significantly impact upon the efficient operation of the Airport. This is a matter which is largely tied to residential density, as allowing more people to establish homes or other sensitive activities within the contours will increase the number of people exposed to aircraft noise. This would correspondingly increase the risk of adverse reverse sensitivity effects which inhibit Airport operations. This is the key reason for determining whether the airport noise contour should be considered as a qualifying matter.

5. Examples of such operational restrictions being applied at other airports in New Zealand, where residential development has been allowed to establish (or was already established) in close proximity, can be seen in Wellington and Queenstown, both of which are now subject to a night-time curfew in order to manage noise impacts on residential communities near the airport.

[2] 50dB Ldn Air Noise Contour, 55dB Ldn Air Noise Contour, and Air Noise Boundary.

[3] 50dB Ldn Engine Testing Contour, 55dB Ldn Engine Testing Contour, and 65dB Ldn Engine Testing Contour.

6. In the case of the current contours[4], an expert Panel last reviewed and confirmed the inputs and assumptions in January 2008. At that time, the Panel recommended that the contours be remodelled every ten years. Within this context, policy 6.3.11 of the Canterbury Regional Policy Statement (CRPS) establishes monitoring requirements relating to the development of Greater Christchurch. Specifically, Environment Canterbury (ECan) may request the Airport to undertake a remodelling of the contours. ECan issued that request in September 2021. Christchurch Airport's independent experts (the Independent Experts) have now completed that task and the remodelled contours are with ECan awaiting review by a peer review panel (the ECan Review Panel). The review is expected to be completed in August 2022.

7. The Independent Experts confirmed the appropriateness of retaining the 50dB Outer Control Contour (OCB), but provided ECan with two recommended options for consideration; being:
   a. A contour based on the busiest three-month period of use on each runway (the Outer Envelope); and
   b. A contour based on the annual average runway use (the Annual Average).

8. For the purpose of this report, and to assist with the Council's response to the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 (the Enabling Housing Act) and the subsequent Intensification Planning Instrument (IPI) process that will follow, the Annual Average Outer Control Boundary (AAOCB) has been chosen as the qualifying matter for assessment. The spatial extent of the AAOCB as it relates to the land covered by Plan Change 14 is shown on a map attached as **Appendix One**.

9. While it is acknowledged that at this point in time the remodelled contours are yet to be assessed by the ECan Review Panel, they currently represent the most up to date research and data on this issue and have been prepared by a panel of independent experts.

10. The reasons for seeking to include the AAOCB to identify where the airport noise qualifying matter applies within the IPI process are as follows[5]:
    a. any rule in a proposed IPI which authorises a residential activity as a permitted activity in accordance with the Medium Density Residential Standards (MDRS) will have immediate effect upon notification;
    b. this would allow building to commence or certificates of compliance to be obtained at the time the MDRS are notified; and
    c. if the Annual Average contours are not accurately identified on the planning maps and included as a qualifying matter, this would allow residential intensification to inappropriately occur in areas exposed to noise levels of 50dB Ldn or greater.

11. It needs to be acknowledged, however, that should the ECan Review Panel recommend the Outer Envelope contour be used for land use planning, or a combination of the Outer Envelope and Annual Average, then a submission on Plan Change 14 will be required in order to give the Hearings Panel scope to confirm the correct contour and qualifying matter within the District Plan. It is accepted that this it is not an ideal situation, but it is, unfortunately, a product of the programming of both Plan Change 14 (as directed by legislation) and the timing of the review of the contours.

[4] 50dB Ldn Air Noise Contour, 55dB Ldn Air Noise Contour, and Air Noise Boundary. 50dB Ldn Engine Testing Contour, 55dB Ldn Engine Testing Contour, and 65dB Ldn Engine Testing Contour.
[5] And as largely outlined in letters prepared by Chapman Tripp dated and supplied to the Council on the 14th and 27th April 2022.

12. For completeness it is noted that The Engine Testing Contours do not extend over any land that is zoned residential and so provisions relating to engine testing noise will, therefore, be unaffected by the intensification plan change. Accordingly, the aircraft noise qualifying matter is the existing qualifying matter related to the Airport which is most relevant to the intensification plan change.

13. This report is in three parts:
    a. **Part A** provides background information about the Air Noise Contours, provides a summary of technical reports which consider the significance of the Airport in an operational, economic and acoustic context, and assesses the planning frameworks.
    b. Given the information and assessments provided in Part A above, **Part B** considers the proposal to include the Air Noise Contours as a qualifying matter within the assessment framework of section 77K(1) of the RMA. This also includes consideration, at a broad level, as to whether the 50dB metric should remain, or whether it should be replaced with a 55dB contour.
    c. **Part C** provides overall conclusions and recommendations.

# PART A: THE AIR NOISE CONTOURS

## Context

### Draft Plan Change 14

14. The Christchurch City Council (the Council) has commenced a planning process (draft Plan Change 14) to respond to its obligations under the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 (the Enabling Housing Act) and the National Policy Statement on Urban Development 2020 (NPSUD). The Plan Change will be notified in August 2022. In summary, the Enabling Housing Act requires Council to apply medium density residential standards (MDRS) to relevant residential zones in order to enable residential intensification.[6] This has the potential to enable increased density of development on land under the AAOCB, beyond that currently provided for in the District Plan. In many ways, the proposed MDRS are the antithesis of the provisions that unpin the current planning regime designed to achieve appropriate amenity outcomes for residents beneath the contours and to ensure effective and efficient operation of the Airport.

15. Given this, the Council may make the standards less enabling of development (i.e. provide for density at a level lower than anticipated in the MDRS) in a particular area if necessary to accommodate a "qualifying matter". In this case, the protection of residential amenity and airport operations can be considered as an existing qualifying matter[7] required to ensure the safe or efficient operation of the Airport as nationally significant infrastructure for the "effects" reasons summarised above and discussed in more detail below.[8] The location where this qualifying matter applies is the AAOCB.

16. This report provides further analysis to support that position and specifically considers the evaluation requirements of section 77K(1).

### Report Outline

17. The balance of this report addresses:

Part A

a. The Role and Significance of the Airport
   - Airport Operations and Safeguarding – Airbiz
   - Airport International and Domestic Freight Tends – Paling Consulting
   - Economic Significance and Vulnerability – Property Economics

b. Aircraft Noise:
   - Aircraft Noise Effects – Marshall Day Acoustics
   - Land Use Planning - Marshall Day Acoustics

c. The Planning Framework:
   - Canterbury Regional Policy Statement
   - History of the District Plan rules

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6 Resource Management Act 1991, s77G: inserted by Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021, s9.

7 An existing qualifying matter is a qualifying matter referred to in section 77I(a) to (i) that is operative in the relevant district plan – s77K(3)

8 Resource Management Act 1991, s77I(e): inserted by Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021, s9.

- Operative Christchurch District Plan – the policy framework and provisions
- Caselaw – the importance of density controls

d. Draft Plan Change 14
e. Conclusions and the planning issues

Part B
f. S77K(I) Assessment, including a section 32 assessment required under section 77K(1)(c)

Part C
g. Recommendations

## The Role and Significance of the Airport

### Introduction

18. The existing planning framework in the Canterbury Regional Policy Statement (CRPS) and the District Plan recognise the national and regional significance of the Airport.

19. The Airport is essential for transporting people and freight to, from, and around, the South Island. It is an intergenerational asset which connects Canterbury businesses and communities with the rest of the country and the rest of the world. CIA is the largest airport in the South Island and second largest in the country with high volumes of passengers and goods passing through daily.

20. The Airport operates 24/7, and this availability provides a significant operational advantage for the Airport's users and its ability to connect to the rest of the world. Any reduction in that capacity or flexibility would have notable consequences in the Airport's ability to deliver its operational outcomes, and the regional, national and international benefits that arise from that. To a large extent, this is one of the key principles underlying the existing planning framework.

21. To illustrate the significance of the Airport attached, as **Appendix Two,** is a report prepared by Airbiz. The Airbiz report outlines, amongst other things, the general role and key functions of the Airport, and considers the potential impacts of capacity constraints on Airport operations. **Appendix Three** contains a report prepared by Paling Consulting assessing international and domestic freight trends, and **Appendix Four** includes a report from Property Economics that provides the most up to date information on the economic significance of the Airport. The key findings of each report are summarised below.

### The Airbiz Report – Safeguarding the Airport (Appendix Two)

**Airport Safeguarding Principles**

22. Safeguarding an airport and its operations is critical to protect its current and future ability to function efficiently and competitively, and to enable it to continue to serve local and national roles as essential transport infrastructure connecting communities.

23. Urban development encroachment into areas required for airport safeguarding is a "lose-lose" situation (for the airport and community it serves) and is irreversible. It is very expensive, if not impossible to recover land for safeguarding purposes once it has been developed for urban purposes. A consistent conservative long-term approach is therefore justified and essential.

24. Long term planning frameworks are the key to preserving the economic importance of the Airport and the amenity of residents that live beneath flight paths. Any loosening or gap in airport safeguarding through deficiencies or relaxation of land-use controls will be irreversible. It will result in populations living in areas affected by noise from aircraft operations, or alternatively potential pressure for restrictions on airport operations and prejudice regional and national economic opportunities.

**ICAO Balance Approach to Aircraft Noise**

25. The International Civil Aviation Organisation (ICAO) establishes policy on aircraft noise, amongst other things. New Zealand is a signatory state to the ICAO. The main policy[9] on aircraft noise consists of four principal elements (pillars), as follows:
    a. Reduction of noise at source;
    b. Land use planning and management;
    c. Noise abatement operational procedures; and
    d. Operating Restrictions.

26. Table 1 on page 5 of the Airbiz report notes that the severity of impact on airport operations increases as options a-d are implemented; noting in particular that operational restrictions can have "high" impacts due to the use of measures that result in capacity restrictions and airline connectivity options. Airbiz notes that:
    a. Potential noise impacts on communities should be avoided by use of the noise reduction and then land use planning and management pillars;
    b. Where these pillars are unsuccessful, or not implemented, then noise abatement operational procedures may need to be implemented through techniques such as preferential runway modes and flight path rotation; and
    c. Operating restrictions are the "last resort" and can include limits on the type of aircraft, quotas for aircraft movements or night movements, or curfews.

27. Airbiz note that the Outer Control Boundary (OCB) regulatory framework described in the NZS 6805 (paragraph 99 below) fits into the land use planning and management pillar and should be considered as a "prevention is better than cure" option.

**General Consequences of Inadequate Land Use Protection**

28. Throughout New Zealand, the OCB is generally set at 55 Ldn. Airbiz note, however, that NZS6805 allows for greater levels of protection – which has been found appropriate by decision makers in Christchurch to date. With reference to the Marshall Day Acoustics reports (**Appendices Five and Six**) and discussed below, Airbiz highlight that evidence demonstrates that significant proportions of populations consider themselves highly or moderately annoyed at exposure levels below 55 dB Ldn.

29. Inadequate land use protection, or the relaxation of existing noise controls, allows noise sensitive activities and urban development/intensification to encroach under flight paths, with associated reverse sensitivity risks to the airport. At section 4 of the report[10], Airbiz provide a summary of five case studies to illustrate the risk. The case studies are:

[9] Balanced Approach to Aircraft Noise Management – paragraphs 24 – 38 Airbiz report
[10] And in full in an Appendix to the report.

a. Melbourne Airport;
b. Calgary Airport;
c. Brisbane Airport;
d. Schiphol Airport; and
e. Toronto Airport.

30. The key findings of the case studies are:
a. Whatever the metric selected and the position of a noise contour for planning purposes, there are linkages between urban encroachment and pressures to mitigate actual or perceived, current or future aircraft noise impacts through operational restrictions;
b. No cases were found where regulatory authorities relaxed protection in terms of an OCB equivalent level(e.g. reducing an OCB from 50 to 55Ldn);
c. Significantly, shrinkage of contours does occur due to periodic modelling updates[11], but subsequent urban encroachment has clearly shown increased pressure for airport operational restrictions; and
d. Specifically, at each airport:
   - Melbourne – the late introduction of appropriate safeguards allowed urban encroachment around the airport. This has resulted in pressures for operational restrictions. Given this, long-term safeguarding through land use controls needs to be in place early and consistently protected;
   - Calgary – provides an example where effective and conservative land use planning controls and adequate safeguarding principles enabled flexibility for necessary changes to airport operations associated with a new runway and limited reverse sensitivity impacts;
   - Brisbane – despite increasing already substantial buffer zones, the development and operation of subsequent parallel runway and associated flight path changes has lead to adverse community reaction. In response three trial noise-reducing initiatives are underway – two of which could reduce long-term runway capacity;
   - Schiphol – Due to urban encroachment near the Airport, operating restrictions are in place restricting total annual aircraft movements and at night (movement quota). In 2017 this resulted in Singapore Airlines relocating half of their freight operations to another airport; and
   - Toronto – Attempts to retrospectively establish appropriate safeguarding areas around the airport have been difficult to effect, due to lack of early and conservative land use planning controls.

**<u>Airport Importance and Potential Impacts of Relaxed Protection</u>**

31. The Airbiz assessments highlight the significance of maintaining appropriate airport safeguarding techniques through land use planning provisions. At section 5 of their report, Airbiz assess the potential impacts to the Airport and wider community that could arise from reverse sensitivity effects leading to operating constraints on the Airport. As background to this assessment, Airbiz documents the general role and importance of the Airport, its operations and dynamics, and then considers the potential range of operational constraints that could be imposed and the impacts that arise from that.

32. Christchurch Airport is of significant importance to New Zealand, the South Island, the Canterbury region and Christchurch City as an essential transportation connectivity hub and base for all types of aviation activity now and in the future. The Airport has no curfew and is

[11] For example introduction of quieter aircraft at Brisbane or flight paths at Calgary.

operationally available 24 hours a day, seven days a week. Its 24/7 availability is a significant operational advantage for the airport's users and the communities they serve.

33. The Airbiz report notes:
   a. the importance of the Airport in international air services – passenger and freight;
   b. given its proximity to Antarctica, it has international significance in facilitating scientific exploration;
   c. the Airport is a nominated "alternate" for Auckland International Airport, able to accommodate wide body aircraft – noting that this is a limitation for other Airports;
   d. As the gateway to the South Island, the Airport serves as a regional hub, connecting international and domestic passengers and freight across the South Island;
   e. Christchurch Airport provides critical air connectivity for the movement of international air freight into and out of the South Island and New Zealand, linking into international freight hubs in Australia, Singapore, China and the United States;
   f. The main runway at Christchurch Airport is the second longest runway in New Zealand at 3,287m, allowing air services by new generation aircraft such as the Airbus A350 and Boeing 787, and the world's largest passenger aircraft, the Airbus A380. These aircraft types are critical to passenger capacity and the supply of capacity for international air freight which travels in the belly-hold of these aircraft or on dedicated freight aircraft;
   g. The main runway at Christchurch is the only runway in the South Island capable of servicing these large wide body aircraft types without restrictions. If this runway is consistently not available for use, widebody international aircraft (passenger and dedicated freighters) would need to use runways in the North Island. Therefore, Christchurch International Airport is an essential piece of transport infrastructure for the South Island;
   h. In 2019 Christchurch Airport recorded:
      - 5,164,504 domestic passenger movements[12] making it the third busiest airport in New Zealand[13] for domestic passengers;
      - 105,000 Domestic to International transferring passengers and 245,000 domestic-to-domestic transferring passengers[14], illustrating its key role in regional connectivity for the lower South Island and as a hub for Air New Zealand in the South Island;
      - 1,766,937 international passenger movements[15] making it the second busiest airport in New Zealand[16] for international passengers
   i. Air freight, small parcels and mail is carried into and out of Christchurch Airport in the belly-hold of commercial passenger operations or on dedicated air freight services;
   j. Dedicated air freight or mail services typically occur during the night to enable overnight national delivery of freight and mail;
   k. Additionally, there is currently (2022) some domestic heavy freight being carried between Christchurch and Auckland on Air New Zealand's dedicated international freighter operations conducted under the Government's MIAC programme (described later);[17]

[12] Christchurch Airport 2019 Financial Statements
[13] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR004
[14] CIAL data
[15] Christchurch Airport 2019 Financial Statements
[16] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR006
[17] Domestic "heavy freight" (heavy freight generally excludes non-perishables or small parcels and mail) is usually carried on trucks over the road network.

l. Christchurch Airport facilitates the transfer of domestic and regional air freight onto international services, supporting industries such as salmon farming from Nelson/Tasman onto international services;

m. In 2019 Christchurch Airport recorded approximately 120,000 international tonnes of air freight and mail. In terms of volume and value, the airport accounts for 14% of all New Zealand's international air freight, making it the second busiest airport [18] in New Zealand for freight and mail;

n. 70% of international air freight and mail was carried in the belly-hold of passenger aircraft and 30% on dedicated international freight aircraft[19]; and

o. Christchurch Airport plays an essential role in local, regional and national disaster management, and is a designated 'Lifeline Utility' in the New Zealand Civil Defence Emergency Management Act 2016.

34. A significant feature of the international services at the Airport is that they arrive from long haul destinations in Asia and short haul destinations in Australia and the Pacific. The arrival and departure times of mid- and long-haul services at the airport are primarily dictated by available slot times, the network schedules and onward connectivity to major destinations at the hub airport overseas.

35. Within this context the Airport can be described as a "slot-taker" in that the scheduled times of arrival and departure at the Airport are often not able to be set to ideally suit local requirements, but rather are dictated by the network operation of the carrier overseas and timing (slot) availability at major overseas destinations.

36. With respect to international freight:

a. the Airport plays a significant role in freight exports, with nearly a quarter (23%) of New Zealand's air freight export value[20] being exported directly from Christchurch Airport;

b. with much of the passenger traffic being discretionary and price sensitive, the ability to access the freight market is important, to contribute to overall air route economics and make international services sustainable for airlines across multiple revenue streams;

c. the Airport plays a significant role in facilitating the supply chain for the export of high-value, perishable and seasonal produce direct from the South Island to international markets. Without the ability to export direct from Christchurch, speed to market would be impacted by the necessity to connect over other export gateways;

d. Due to the reduced belly-hold capacity resulting from the Covid-19 pandemic, capacity constraints have limited air freight supply;

e. recognising its importance, the New Zealand Government has supported international air freight market through the Maintaining International Air Connectivity (MIAC) subsidy scheme, essentially replacing the lost belly-hold air freight capacity with dedicated air freight operations; and

f. MIAC flights operate a triangular routing, coming into Christchurch Airport from Auckland Airport and then out to their overseas destination and back into Auckland, supporting exports from the South Island to international markets. This includes night-time freight operations.

37. While the above generally describes scheduled operations, the Airport also caters for non-scheduled operations, including:

a. aircraft repositioning – this usually occurs at night;

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[18] Airbiz analysis of New Zealand Ministry of Transport website Air Freight statistics for FY18

[19] CIAL data

[20] Airbiz analysis of New Zealand Ministry of Transport website Air Freight statistics for FY18

b. aircraft maintenance at the Air New Zealand maintenance base;
c. military, government, and Antarctic operations;
d. air ambulances, charters, business jets and small commercial operators;
e. flight training schools; and
f. helicopters – regional rescue helicopters, training providers, maintenance facilities and tourism and agricultural services.

38. Airbiz have identified a range of potential capacity/timing constraints that could be imposed on the Airport should communities within the AAOCB successfully lobby for operational restrictions. This includes:

a. at the higher end of restrictions are night-time curfews to all or specific operations (typically between the hours of 11pm and 6am);
b. annual aircraft movement quotas or caps;
c. daily or hourly aircraft movement caps restricting the number of arrivals or departures;
d. preferential runway regimes (rotating use of runways and associated flight paths to "share" the noise burden) which are often "sub-optimal" in terms of runway or airspace capacity;
e. development of additional runways to cater for air traffic growth, to ensure no additional noise burden is placed on current flight paths; and
f. other noise abatement and mitigation (noise charges, aircraft auxiliary power unit restrictions etc).

39. Overall, Airbiz state that if the above examples are imposed, it will reduce operating efficiency at the airport and impose restrictions (several extremely serious) on the existing operations. At section D of the report, Airbiz provide some practical examples of how these constraints could manifest at the Airport for <u>commercial scheduled passenger flights</u>, as follows:

a. Night-Time Curfew:
   - Its role as a nominated alternate airport would possibly change;
   - Reduced overall runway capacity;
   - Restrictions on future opportunities for international services;
   - Impacts on the viability of mid to long haul routes;
   - Impacts on the scheduled China Southern flight from Christchurch to Guangzhou;
   - Possible reductions, rescheduling or cancellation of early morning trans-Tasman departures; and
   - Possible reductions, rescheduling or cancellation of late-night trans-Tasman arrivals.

b. Annual Movement Quota:
   - Constraints on airlines volume of frequencies, resulting in sub-optimal outcomes such as requiring a more complex fleet with higher seating-density aircraft, which may not be economic to operate.

c. Daily or Hourly Movement Quota:
   - An hourly movement quota, if reached, would impact air services if airlines were not able to schedule aircraft to meet passenger demand. An example of the impacts of an hourly quota occurs at Sydney Airport. The quota includes an allocation to accommodate regional services, which then restricts the number of services which can operate on interstate and international routes. This has partly lead to the need for a new airport in the region.

d. Preferential Runway Regimes (PRR):
   - PRR distribute air traffic across an airport's runways and associated flight paths in order to "share" noise. This often results in sub-optimal use of runways and/or airspace capacity, and increased operational costs on ground.

40. For **Airfreight and Mail**, Airbiz note the following:

a. Night-Time Curfew:

- As domestic freight services fly overnight, linking domestic ports nationwide, the entire national air freight network would be impacted if Christchurch was effectively removed;
- The entire air freight supply chain utilising Christchurch is linked to intermodal road and rail connections, which facilitates next day delivery. A curfew would be highly detrimental to the freight supply chain;
- Domestic "just in time" (e.g. flowers and seafood) impacts would arise for multiple industries if they could not be freighted in overnight for early morning distribution;
- The export market for high-value, perishable produce may be impacted; and
- Potential constraints on incoming new/seasonal freight services in the future.

b. Annual Movement Quota

- The domestic air freight network is successful because it connects multiple ports, generating multiple movements. A cap on annual movements creates pressure between scheduled passenger flights and freight operators as they compete for movement allocations – the Schiphol example given above; and
- International air freight at Christchurch airport is seasonal – being the export of summer fruit on dedicated freighter services from December to February. On an annual basis, the flight volume is small, however, the economic significance is high in facilitating direct export of South Island produce. Airbiz note that examples at other airports globally have been detrimental to such freighter services.

41. For **Fixed Base Operation (FBO) and Small Commercial**:

a. Night-Time Curfew:

- Air service activities for air ambulance and medivac purposes are critical, and would be compromised by a curfew even if they were able to land or take off at Christchurch with a dispensation; and
- Small commercial air operators and FBO's have a degree of inter-dependence and benefit from clustering. Some businesses would be compromised by a curfew and may choose to relocate and that may impact on the economic viability of those not impacted by a curfew.

b. Annual Movement Quota:

- Flying schools and helicopter operations generate high volumes of movements. A quota may put pressure on these businesses to move away as they compete for movement allocations with scheduled passenger and freight services.

c. Daily or Hourly Movement Quota:

- As above.

42. **Airline Repositioning and Maintenance**:

a. Night-Time Curfew:

- Late night repositioning of aircraft for maintenance or repositioning would be restricted, meaning aircraft may have to be repositioned earlier in the day, potentially removing an aircraft rotation over the day and reducing passenger flight choice.

43. **Military, Government and Antarctic**:

a. Night-Time Curfew:

- These services are critical. Overnight and early morning operations would be stopped, reducing flexibility for Antarctic operations, reducing opportunities to operate to avoid unsuitable weather and meaning that services could not arrive early in the morning.

**Overall Conclusions**

44. Airbiz notes the significance and importance of Christchurch Airport in international and domestic passenger travel and freight movements, and the interconnectivity between domestic and international networks. In particular, Airbiz highlights the commercial international passenger “slot taker” restrictions and the significance of the domestic multi modal night-time freight network. Airbiz also outlines the importance of Christchurch Airport in aircraft repositioning, aircraft maintenance, military, government and Antarctic operations, air ambulance, medivac and small commercial operators, and with flight training services.

45. Given the significance of those networks and the extent of some of the operational limitations, Airbiz highlights that “safeguarding” is a critical concept in protecting airport functionality and efficiency; not only in terms of current operational capacity, but also for the future. Within this context Airbiz notes the main policy of the ICAO and the four “pillars” for addressing aircraft noise, and notes that addressing noise at source and land use planning tools are preferred to noise abatement operational procedures and operating restrictions. In particular, operating restrictions should be viewed as the “last resort” as they will impact on the functionality of the airport and have adverse downstream economic, passenger, freight and other outcomes.

46. Robust planning provisions are, therefore, viewed as the least risk outcome for airport operations and the community as a whole, providing certainty and long-term risk avoidance.

47. To illustrate the risks to airports and communities sitting beneath flight paths in real world terms, Airbiz provides 5 case studies illustrating the adverse results arising from a lack of or late adoption of safeguarding principles. From this, Airbiz illustrates a range of operational restrictions that could be imposed following community pressure to manage the effects of overflying aircraft, including curfews, quotas or caps and preferential runway regimes. The direct potential impact of such restrictions on Christchurch Airport are then outlined in the last section of the Airbiz report.

48. Overall, the Airbiz assessment and findings support the application of the AAOCB as a qualifying matter within the Christchurch District Plan.

## The Paling Report – International and Domestic Freight Trends (Appendix Three)

**Introduction**

49. The Richard Paling Consulting (RPC) report provides an overview of the economic role of the airfreight operation at the airport, including consideration of past trends, implications of the Covid-19 pandemic, and future projected trends. The key points and findings of this report are summarised below.

**Role of the Airport in freight**

50. CIA is the second largest international airfreight gateway in New Zealand, and the only one providing direct links to overseas destinations for those wishing to ship goods by air to or from the South Island. Both the value and volume of airfreight is focussed on in the RCP report, with the key aspect of airfreight being that this is primarily used for smaller goods with high

values. Air freight through CIA makes up around 0.2% of the volume of freight entering the South Island, with the remaining volume transported by sea.

51. The total value of goods (almost $3 billion in 2021) makes the Airport the second largest South Island import gateway after the Port of Lyttleton, and the third largest South Island export gateway after Lyttelton and Port Chalmers.

52. The Airport provides for both international and national airfreight, with those streams focussed as follows:
   a. **International Airfreight:**
      - Export of <u>time sensitive premium agricultural products</u>[21] from South Island producers to a range of international markets (especially in Australia, China, South East Asia and the US). Alternative transit modes would prevent or severely limit the sale of these products; and
      - Exports/Imports of <u>high value manufactured goods</u> supporting local industries both for exports and imports of time-critical materials (including Hamilton Jet engines and parts) and also the movements of goods to consumers from overseas suppliers.

   b. **Domestic Airfreight**
      - An important staging point for e-commerce, courier movements and mail, acting as a distribution centre for items delivered to South Island destinations and also as a consolidation point for those moving to North Island destinations.

**<u>Growth of International Airfreight</u>**

53. The RPC report (section 2) summarises the growth in the period up to 2019, where the total value of international trade carried by airfreight had been increasing strongly. Between 2014 and 2019, international trade imports had increased from $0.6bn to $1.5bn (a 150% increase), and exports doubled from $1.5bn to almost $3bn.

54. Up to 2019, the trends regarding the contribution of airfreight through the Airport included a domination by export traffic (both by value and volume), increase in value of exports and imports, and an increase in proportion of freight within the South Island. After growing for much of the period from 2015, export and import volumes declined slightly in 2019, indicating a switch to the carriage of higher value commodities.

55. Section 3 of the RPC report reviews the airfreight during 2019. This was the last normal year prior to the Covid-19 pandemic and represents the most recent position from which to consider future trends. The general position of the Airport's international trade at the time is summarised as follows:
   a. The <u>value</u> of international trade was around $4.4bn, or 17% of total international trade into the South Island. Of this figure, imports comprised around $1.47bn (19%), and exports around $2.7bn (16%). Imports therefore represent 33% of the value of freight, and exports dominant with 67% of value;
   b. The <u>volume</u> of exports was around 20,000 tonnes, with imports of around 9,000 tonnes;
   c. The dominance of exports is attributed to the nature of the South Island economy with its focus on producing goods (primarily agricultural commodities) for overseas markets;

[21] These products include fresh and live fish, horticultural products such as cherries and other stone fruits and fresh and chilled meat.

d. Airfreight has a high share of the value of international trade, and this highlights its importance in supporting economic activity, getting time-sensitive high value goods to overseas markets and bringing in supplies for local industries and consumers;
e. When individual commodities are grouped, exports comprised of 74% agricultural products[22] followed by manufactured goods[23] (19%), basic materials (6%) and precious metals (1.3%). Imports comprised of 57% manufactured goods, followed by basic materials (24%), agricultural products (19%) and precious metals (0.3%); and
f. In terms of the destinations and origins for international airfreight by volume through the Airport, Australia is the most important destination for exports followed by China, and the US.

56. Overall, exports are considerably larger than imports in terms of volume and value. Exports are more likely to be constrained by the absolute volume of airfreight capacity that may be available. Imports are less likely to be affected by a lack of total capacity.

57. Section 4 of the RPC report discusses the Covid-19 impacted years of 2020 and 2021, noting the associated restrictions and lockdowns affecting economic activity and trade, and resultant changes in patterns of aircraft activity through CIA. This included a:
a. Downturn in international passenger flights departing;
b. Increase in freight flights, from 261 (in 2019), to 290 then 535 in 2020/2021;
c. Overall, the reductions in passenger flight frequency resulted in less flexibility for airfreight, and connections constrained to particular days (passenger flights) or freight only aircraft;
d. The corresponding increase in freight flights (in part government subsidised) assisted with maintaining the service, however frequency (overall) fell sharply; and
e. Volumes of exports initially reduced in 2020 by around 20%, however then increased in 2021 to 95% of 2019 volumes. Imports increased by around 55% in 2020, with a very small increase from that in 2021. Value dropped by around a third from 2019 to 2020, with a slight increase in 2021. The patterns of change to the volumes and values of exports suggest significant changes in the unit values of commodities exported by air. Import volumes/values indicated a more consistent price.

58. The reduction in the range of services experienced during 2020 and 2021 appears to have limited the ability for both exporters and importers of high value manufactured goods to take advantage of the time savings achievable with air freight, with declines in both the volumes and values of these commodities. This decline has occurred despite the growth of the regional economy and highlights the importance of a wide range of air services capable of carrying freight to support this part of the airfreight market.

## Future Projected Growth

59. The RPC report highlights that there might be two main components to supporting air freight services, as follows:
a. Supporting agricultural production in the region by providing enhanced access for premium products to the key markets in Australia, Asia, the US and Europe. Of particular importance is the high volume of agricultural products looking to access premium markets around the world where the timing of services and speed of delivery are critical; and
b. Providing for the rapid movement of manufactured and other inputs for industries in New Zealand and overseas and also providing facilities for the movement of consumer

[22] Fish, meat, processed food, horticultural items and dairy
[23] Including pharmaceuticals, vehicles and textiles.

goods for consumers in New Zealand. This component dominates where access to and from a wide range of origins and destinations is the important factor.

60. Other key aspects of forecast growth that are outlined in section 5 of the RPS report include:
    a. The Airport provides the main direct access to international markets for manufactured goods, with the airport providing 70-80% of the combined volume of manufactured goods exports from both the Airport and Lyttelton Port. This proportion was increasing steadily up to 2020. The overall share of freight undertaken via the Airport is lower at 25-35%;
    b. A 2018 study[24] provided a detailed snapshot of freight in NZ for the main domestic modes and provided data for a 'MOT Freight Futures Model' allowing forecasts for growth of freight for a range of commodities, and international freight flows through Port of Lyttelton;
    c. Although the model focusses on domestic transport in New Zealand and the role of the Port of Lyttelton, and not small volumes of freight via airfreight, the forecasted growth at Port of Lyttelton is likely to be linked within increased demand for international airfreight to and from the Airport;
    d. As well as gaining from the general growth of overseas markets, airfreight provides opportunities for increasing value-added elements within commodities; and
    e. Commodities exported by air have a significantly higher value than the value of those exported by sea – primarily for perishable products. The growth of the value of airfreight to 2019 reinforces that finding.

**<u>The future role of Christchurch International Airport</u>**

61. Section 6 of the RPC report discusses the likely future role of CIA with regard to international airfreight, on the basis of recent and forecast trends for imports and exports. Of note is:
    a. there is likely to be growing demand for airfreight as the regional and South Island economies continue to grow following the COVID-19 pandemic, and as the use of airfreight becomes increasingly attractive for the transport of the growing share of premium agricultural products. The latter will often require flight timings that allow the products, in many cases fresh or chilled, to be brought to markets in the destination countries at a time that meets the patterns of consumer demand;
    b. The supply of airfreight capacity through Christchurch is broadly in line with the longer-term trends in demand, especially for exports. However, this reflects the current support provided by the New Zealand government which is likely to be withdrawn as passenger flights become more frequent. Any constraints on passenger services providing airfreight capacity could affect the agricultural sector adversely;
    c. Air freight also needs to meet the broader demands for the movement of manufactured goods both exported from and imported to New Zealand. These products are typically of high value, which reflects their importance to manufacturing and retail activities, and make up a large part of the inward and outward airfreight market;
    d. Issues with capacity and the specific timing of services is probably not such an issue for manufactured goods, however services to and from a range of overseas locations at a variety of times would be important; and
    e. CIAL's observed and forecast international aircraft movements (both passenger and freight) through CIA indicates that by 2027, the numbers of international flights could have recovered to pre-pandemic levels. With reasonable route coverage at sufficient frequencies, this would facilitate the growing demands for airfreight to and from the area, allowing the local and wider economy to receive the full benefits by the later part

[24] 2018 National Freight Demand Study

of the decade, and provide the basis for the forecast continuing growth over the longer term.

**Domestic Freight**

62. The RPC report notes that Christchurch is an important staging point for e-commerce, courier movements, and mail within NZ, acting as a distribution centre for items delivered to South Island destinations and also as a consolidation point for those moving to North Island destinations. There is a large proportion of goods requiring overnight deliveries, with goods despatched from businesses at the end of the working day and delivery to major centres by the next morning.

63. The rapid growth of e-commerce also includes increasing volumes of goods being delivered directly to customers, with expansion both before and during the Covid outbreak. In New Zealand the retail expenditure via e-commerce is around 11% of total retail sales, with figures of over 20% in the US and UK. This indicates the potential scope for expansion if NZ were to align with trends in comparable countries.

64. The figures in Table 7.1 in the RPC report indicate that total volumes of manufactured and retail goods transported into and out of the Lower South Island are expected to increase substantially over the period to 2052. The future growth in e-commerce is likely to be sustained and substantial.

65. Parcelair provides the freight service for domestic e-commerce market in the South Island, supporting NZ Post and Freightways, providing a consolidation of operations. This service operates overnight with a snapshot of an overnight period in March 2022, where the Airport provided for 16 arrivals/departures between 17.30hrs and 8.10hrs. The flights are spread over a wide period to meet the main demand from clients and allows for the volumes of goods to be sorted, contributing to an efficient supply chain. Of note is that 9 arrivals/departures occurred between 2305 hours and 0330 hours.

**Summary**

66. The RCP report concludes that the Airport plays an important role in the movement of both international and domestic airfreight, which is important to the local, regional and South Island economy. The demand for airfreight is projected to grow, as conditions recover from the pandemic challenges during 2020 and 2021.

67. International air freight capacity will largely be addressed with the increased range and frequency of passenger services, however as the Airport is a service taker for these operations, it is important that there are as few constraints as possible placed on these services, if the full benefit to the local and wider economy are to be achieved. This may include:
   a. Flights arriving and departing within night-time hours, for both international and internal freight;
   b. A wider range of services to a range of destinations for imports and exports of high-value manufactured goods, and for international e-commerce for NZ consumers; and
   c. Careful timing of the flights would provide suitable avenues for the export of time-sensitive agricultural products, allowing goods to reach markets at appropriate times.

68. Christchurch is located in a strategic position, at the centre of the South Island and at the junction of road and rail links to the north, south and west. Christchurch also acts as the major distribution centre for the South Island as a whole, supporting businesses and consumers in

general with the efficient moment of goods, and simplification of supply chains. This may reduce the amount of handling between supplier and customer, compared to what would be required if airfreight had to be routed through alternative locations.

69. For both international and domestic airfreight movements, the ability to work with as few constraints as possible through the night is important. This would help ensure that the maximum benefits are obtained from the movement of airfreight and its support for local industries and consumers.

**Overall Conclusions**

70. The RCP report demonstrates that there needs to be flexibility for CIA's operation in the future, to ensure that airfreight services can expand as necessary in response to projected future increases in demand. This may arise from increase in the use of e-commerce or from the export of (for example) manufactured goods, and agricultural and horticultural goods, including value-added commodities within that sector.

71. Passenger services play a key role in the distribution of freight, and the timing of such services is often determined by others (the international "slot taker" issue discussed earlier). Such services are anticipated to increase to pre-covid levels by the end of the 2020's. Freight-only flights are presently subsidised and may initially reduce once the government subsidy is removed. Freight only flights may be an option for the expansion of freight operations in the future.

72. Strategic timing for the departure of flights is key for the international freight of time-sensitive agricultural products, which are then able to quickly enter overseas markets, and ideally departure times can tie to the required arrival time at the appropriate part of the day for the receiving market. High value manufactured goods do not have the same time pressure. It is, however, important that those are able to be received and distributed widely, and reasonably rapidly.

73. The RCP report highlights that freight passing through the Airport is typically of high value per volume, and this complements the Port of Lyttelton operations, where volume of freight is substantially higher, however the value per volume is lower. This highlights the importance of airfreight as a valued option for the distribution of high value goods, for both import and export operations.

74. Overall, it is necessary for airfreight services to have the option to expand to meet potential future demands, thereby supporting the economy.

## The Property Economics Report – Economic Impacts of Operational Constraints (Appendix Four)

**Introduction**

75. The Property Economics (PE) report provides an assessment of the potential economic impacts associated with enabling noise sensitive activities within the noise contours. The key points are summarised below.

76. Christchurch Airport:

a. is the second largest airport in New Zealand and represents nationally and strategically significant infrastructure supporting national accessibility for passengers and business that supports economic well-being well beyond the borders of the Canterbury Region;
b. it fulfils an extremely important and unique role for the Canterbury regional community. It serves not only as a significant employer for the region but also as a conduit for visitors and commerce into the region. This importance goes beyond national and international passenger transportation and includes air freight, Antarctic operations, disaster response and recovery, helicopter operations, flight training, maintenance, is a significant business location, and provides for flights that are unable to land elsewhere in New Zealand due to delays and other operational restrictions; and
c. its function goes beyond its own direct operations and includes safeguarding other airports, such as Auckland, when acting as an alternate if aircraft are unable to land there. This provides improved competitiveness and resilience for the New Zealand air transport market.

**Freight**

77. In terms of freight:
   a. the Airport plays a fundamental role in the shipping of goods and, therefore, is critical to the economic and social well-being of all residents within the South Island;
   b. in 2019 the Airport moved (imports and exports) approximately 5,952 tonnes of manufactured goods (20% of the total moved in New Zealand) valued at over $3.5b;
   c. in 2019 the Airport was responsible for exporting over $3b of cargo to other ports; and
   d. this has huge positive flow-on effects through the rest of Canterbury's economy with 'off' airport jobs such as storage and transportation directly linked to these volumes. The ability of CIA to move these large valuable cargos is vital for Canterbury, and in fact the South Island, to remain competitive in the location of large, high value exporters and manufacturers.

**Passengers**

78. With respect to passengers:
   a. in 2019 the Airport catered for over 10,800 international passenger flights;
   b. following COVID-19 and by 2027 these numbers are expected to re-establish;
   c. in 2019 there were 7 million international passengers, and this is expected to increase to nearly 9 million passengers per annum by 2031;
   d. visitors originating at the Airport bring with them over $1b to the region with, significant flow on effects from this spending; and
   e. the current and future functionality of the Airport is key to not only the Canterbury economy but to that of the whole South Island.

**Employment**

79. The Airport directly employs over 200 people, generating $187m in revenue. While this alone would identify the Airport among Canterbury’s largest business contributors, the economic activity facilitated makes it one of the largest single contributing strategic assets in the South Island.

80. Additionally, over 7,000 jobs[25] are accommodated within the Airport campus, making it one of, if not, the largest employment centres in the South Island.

**Regional and District Prosperity and Economic Wellbeing**

81. The level of both passenger and freight numbers have fallen sharply over the last two years (with Covid). The numbers are, however, expected to rebound strongly. Given this, the ability for the Airport to meet future growth demands is critical to attracting and locating to the region many national and international businesses that would not otherwise situate themselves in Canterbury. Within this context it is imperative that the ability for the Airport to grow efficiently is protected, as safeguarding growth is not just in the interest of the Airport but has a vital flow-on benefit for the whole community.

82. In terms of the Airport's economic contribution:
    a. in 2012 it was estimated the Airport contributed $2.13b to the regional economy;
    b. by 2017 this figure had risen to $2.62b;
    c. over the next 3 years (the pre-COVID-19 year ended March 2020) this figure is estimated at $3.02b per annum; and
    d. the Airport supports 28,625 jobs within the region (10% of Canterbury's employment) and contributes $4.76b (7%) to South Island GDP.

**Potential Impacts on Airport Operations and Economic Contribution**

83. There is a direct link between management through land use planning and the level of economic contribution provided by efficient operations at the Airport. Ultimately the Airport is vulnerable to operational constraints that would reduce its flexibility. When considering the potential application of a curfew, PE note that:
    a. recent assessments of Perth Airport found that a night-time curfew could cost the Western Australian economy $46.1b and 27,000 jobs by 2040; and
    b. more extreme noise management constraints such as those at Rotterdam Airport have decreased passenger numbers by over 60%.

**Potential Economic Risks to Airport Operations and the South Island Economy**

84. PE note that the imposition of a curfew has potential notable impacts; including:
    a. post COVID recovery – the potential for reduced connectivity through the Airport is likely to hamper freight and passenger movements resulting in increased costs and reduced economic benefits;
    b. given the Airport's role as a "slot taker", a curfew could reduce the range of destinations connecting to Christchurch and thereby reduce the markets from which Christchurch can attract tourists as well as trade and business development;
    c. airlines may also choose to locate aircraft elsewhere given the reduced competitiveness at CIA. Limitations of night-time movements on aircraft can limit the crafts ability to be prepared for use. This would reduce the number of flights and the overall utilisation of aircraft;
    d. The limitation of night-time air freight movements is also likely to reduce craft utilisation, increasing costs and route profitability. The impact on freight is not limited to volumes but also around time-critical or 'just in time' operations;
    e. Long term loss of investment and business. Long term effects on investment could further reduce the ability of CIA to undertake current or future levels of operation; and

[25] Statistic New Zealand Employment Count

f. In terms of the wider impact on business investment, the reduction in transportation options is likely to impact upon businesses locational decisions, at this point the loss to the region is likely to be materialised as a loss to the whole South Island.

85. It is estimated that with the proportional increase in freight and the increased passenger numbers the contribution to regional GDP made by CIA has the potential to exceed $3.87b by 2031. This level of contribution at the South Island level would constitute economic activity circa $6b per annum. Based on a number of stated assumptions[26] relating to constrained operations under a night-time curfew it is estimated that were the region to forgo the economic activity generated from the state assumptions alone by 2031 this would equate to:
   a. $610m annually, and $835m per annum in forgone economic activity for the South Island;
   b. approximately 4,000 jobs regionally and 4,600 throughout the South Island; and
   c. Given this value is based on an annualised figure, the overall impact to 2031 (from 2022) would be in excess of $4.8b.

## Aircraft Noise

### Introduction

86. Airport operations create unavoidable noise. Control of noise sensitive land uses (including residential activity) within the AAOCB is important to:
   a. ensure people are protected from establishing sensitive land uses in areas that are exposed to levels of aircraft noise which might disturb them or affect their quality of life resulting in adverse amenity and health outcomes; and
   b. protect the Airport from reverse sensitivity effects, enabling airport operations to continue to support and benefit communities.

87. Density control is a key planning tool used in the District Plan to achieve the above outcomes. Residential density rules directly affect the intensity and development of new residential land use. The proposed MDRS focus on achieving densification through the application of more flexible development standards. By way of example, the standards described below are relevant to Airport noise issues:
   a. the number of units (and therefore the number of households) allowed per site;
   b. the height of residential units (which affects the number of storeys and therefore number of people who may be accommodated in each residential unit); and
   c. building coverage (which affects practically how easy it is to realise the number of units allowed per site).

88. Within this context, it is appropriate to ensure that District Plan standards applying to development beneath the AAOCB do not give rise to increased density that would lead to adverse amenity outcomes or reverse sensitivity impacts on the Airport. To explain this further, attached, as **Appendix Five**, is a Memorandum dated 8 July 2022 prepared by Marshall Day Acoustics (MDA) which explains the key acoustic reasons for controlling density beneath the contours. Related to this, the report outlines the research undertaken regarding community responses to airport noise. **Appendix Six** contains an additional report from MDA that examines what level of aircraft noise exposure is reasonable (50 or 55 as an outer control boundary). There is some cross-over in the effects related discussions in each report.

[26] Page 15 of the PE report

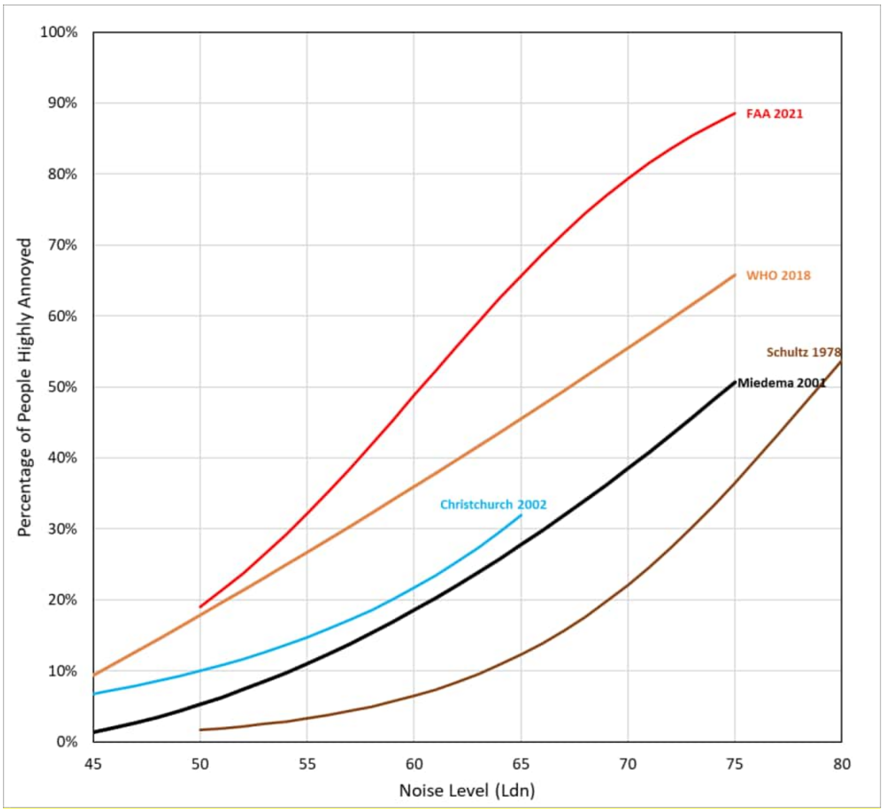
## Marshall Day Acoustics – Noise Effects (Appendix Five)

89. MDA note the relationship between residential density and exposure to aircraft noise and how this leads to adverse health and amenity impacts on communities. MDA highlight that with increased density comes the risk of complaints and community pressure to curtail airport operations. To illustrate this point MDA provide data from Boeing that illustrates an increase in airport operational constraints over time, despite the fact that aircraft have become quieter due to advances in technology.

90. To avoid this occurrence, MDA promote the use of a 50dB outer control boundary contour (and related provisions) as the most effective and efficient planning tool and note the existing regional and district planning framework (discussed below) to avoid sensitive activities within the Contour. Notably, MDA are of the view that (emphasis added):

*Aircraft noise inside the 50 dB $L_{dn}$ contour causes adverse effects on people and this is not a desirable noise environment in which to increase residential density. Accordingly, it is preferable to avoid noise sensitive activities from locating in areas where they will experience adverse effects from aircraft noise from the outset. Sound insulation or other types of mitigation will not fully avoid adverse effects of noise on occupants. Where there is alternative land outside of the noise contours available to locate residential intensification, this should be preferred.*

91. Within this context MDA note the long-term reliance on the Miedema and Oudshoorn 2001 dose-response curve and a 2002 Taylor Baines and Christchurch City Council study which illustrates "high annoyance" levels for communities between the 50 and 55dB Ldn ranging between 5%-11% and 10%-15% respectively. More recent research undertaken by the World Health Organisation (2017) and the FAA (2021) found higher levels of such annoyance ranging from 18% to 32% for communities receiving aircraft noise levels between 50 and 55dB Ldn. This is illustrated in a graph (Figure 2) contained in page 3 of the MDA report and reproduced below.



92. MDA argue that the more recent studies suggest that *"in order to minimise the number of highly annoyed people, a level of 45 dB $L_{dn}$ is required which is 10 dB lower than recommended by the Standard, and 5 dB lower than the current OCB that exists at Christchurch."*

93. Furthermore, MDA are of the view that (emphasis added):
*Both the Christchurch data and the latest overseas data confirm that, at 50 dB $L_{dn}$ and above, some of the population will be highly annoyed by aircraft noise. This is not a desirable noise environment in which to locate additional residential development (or intensification) if it can be easily avoided. The latest overseas studies confirm that community tolerance to aircraft noise is likely reducing, not increasing.*

94. MDA note that:
*If greater levels of intensification than permitted in the operative District Plan were allowed to occur in the residentially zoned areas inside the 50 dB Ldn Air Noise Contour, then an increase in the number of people highly annoyed would be expected to occur. Planning rules that allow for high density residential activity to establish as of right … will then expose more people to adverse effects from aircraft noise.*
*It is therefore appropriate, from an acoustics perspective, to prevent development and intensification within the 50 dB $L_{dn}$ Air Noise Contour in order to protect the health and amenity of the community, as well as the operations of CIA.*

95. To place this in some context, the Airport examined GIS data to determine the number of land parcels under the AAOCB. This assessment found:
   a. There are 5,438 parcels under the AAOCB;
   b. Assuming that a conservative 20% of these parcels are developed to accommodate three residential units per site, this could translate to 2,175 additional residential dwellings;
   c. Using an average occupancy of 2.5 persons/dwelling, this translates to an additional 5,437 people exposed to the effects of aircraft noise;
   d. Using the World Health Organisation community annoyance results (figure two MDA report), suggests an additional 1087 people are likely to be highly annoyed by aircraft noise; and
   e. if the uptake is higher, then clearly the number of households (and people) beneath the AAOCB increases.

## Marshall Day Acoustics - Land Use Planning (Appendix Six)

**Introduction**

96. Marshall Day Acoustics (MDA) have prepared an overview report of the land use planning framework influencing noise contours. As noted earlier, there is some cross over in the material contained in this report and the July Memorandum summarised above.

97. A key aspect of this report is MDA's assessment of what level of aircraft noise exposure is reasonable.

98. By way of introductory comment, MDA note that:
   a. World-wide, the lack of appropriate land use planning around airports has historically caused significant numbers of people to be exposed to airport noise and subsequent community action has initiated operational constraints on airports;

b. The adverse noise effects experienced around the Airport include annoyance, speech interference, sleep disturbance and potentially health effects associated with annoyance;
c. If land is available elsewhere for new residential (or other sensitive activities) development or intensification, this should be preferred to land within the 50 Ldn contour; and
d. Specifying sound insulation for activities between the 50 and 55 contour will not eliminate all the adverse effects of noise, due to open windows and an unsatisfactory noise environment.

**New Zealand Standard NZ6805**

99. In 1992, the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning" with a view to providing a consistent approach to noise around New Zealand airports. MDA note the following key points:
a. The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to:
- "Establish compatible land use planning" around an airport; and
- "Set noise limits for the management of aircraft noise at airports"

b. The Noise Boundary concept involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Air Noise Boundary (ANB) around the airport;
c. Between the ANB and the OCB new noise sensitive uses should also ideally be prohibited (and of those that are required, all should be provided with sound insulation);
d. The location of the OCB is generally based on the projected 55 dB $L_{dn}$ contour;
e. The Standard does however state that the local authority may show "the contours in a position further from or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case";
f. The Canterbury Regional Council, and therefore Christchurch, Waimakariri and Selwyn Councils have used the 50 dB $L_{dn}$ contour for the location of the OCB;
g. The Standard recommends that a "minimum of a 10-year period be used as the basis of the projected contours"; and
h. It is important for a major international airport to plan for a period significantly longer than 10 years

100. Overall, MDA note that Land Use Planning can be an effective way to minimise population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not be sufficient alone to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive uses around an airport can unnecessarily expose additional people to high levels of noise and can constrain, by public pressure as a response to noise, the operation of the airport.

**What Level of Aircraft Noise is Reasonable – 50 or 55**

101. MDA note that community response to aircraft noise is a "grey scale" and that annoyance does not start or stop at a specified noise level (or contour boundary). For planning controls, however, it is necessary to establish a specific noise level. MDA are of the view that a 50dB Ldn control is appropriate as:
a. 50dB Ldn has historically been used at Christchurch since 1975, including within the 2008 review;
b. NZS 6805 recommends that existing noise controls should not be downgraded:

- Clause 1.1.4 of NZS 6805 states that "This Standard shall not be used as a mechanism for downgrading existing or future noise controls…";
- NZS 6805 is very much recommending a <u>minimum</u> level of protection with its use of Ldn 55 dBA as the Outer Control Boundary. The Standard states in clause 1.4.3.8 that the local authority may show "the contours in a position further from, or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case";
- Christchurch Airport is a unique situation where the Council and the Airport Company have diligently maintained a 'buffer' around the airport through the implementation of appropriate land use planning over a significant period of time;
- Other airports have not been as fortunate due to severe shortages of residential land and, as a consequence, have implemented less stringent land use planning rules during the adoption of NZS 6805 into their district plans. This is because in most cases the Standard arrived too late (1992) to prevent residential encroachment; and
- The NZ Standard clearly envisages that a better standard of protection than the 'minimum standard' may be implemented somewhere in New Zealand – otherwise it would not have these words in clause 1.4.3.8 of the Standard.

c. World-wide, community annoyance from aircraft noise has increased significantly since these controls were first introduced:
   - Establishing a link between aircraft noise effects and how a community may respond to that is important, as without that relationship it may be difficult to conclude that pressure may be applied to limit capacity and operations at an airport;
   - In the 1970s, the Schultz curve was developed from a number of studies in general transportation noise (included air, road and rail). Later analysis by Bradley of airport studies indicated that community response is greater than the Schultz curve predicts by a factor of approximately two. The Schultz and Bradley results were used during the preparation of New Zealand Standard NZS 6805;
   - A comprehensive amalgamation of the various airport noise studies was carried out by Miedema and Oudshoorn in 2001[27] and the dose-response curve from this study has been used internationally and in New Zealand since then;
   - In 2002, Taylor Baines & Associates and Marshall Day Acoustics[28] conducted a noise annoyance survey in Christchurch. The study was conducted to investigate how the Christchurch community responded to environmental noise when compared to the previous overseas studies (Schultz, Bradley and Miedema);
   - There have also been a number of international studies that have been undertaken more recently in the 21st century. MDA has recently completed a literature review of 45 of the latest studies. A summary of the 14 most significant studies shows:
     - 6 reported an increase in noise annoyance over time (FAA, Guski x3, WHO, Janssen and Vos)
     - 1 reported a decrease (Vietnam)
     - 4 reported no change (Gjestland x 2, Fidell, Gelderblom)
     - 3 did not report on a change (NZTA, Brink, Gjestland 2021)

[27] Miedema and Oudshoorn (2001); "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals"
[28] See summary in paragraph 91 above

- The two largest studies in this set of studies, were the World Health Organisation (WHO) study in 2018 and the Federal Aviation Administration (FAA)[29] study in the US in 2021 – both show a significantly higher level of annoyance than the Meidema 2001 dose response curve. The dose response curves from these studies are shown the figure above at paragraph 91, along with the Miedema and 2002 Christchurch study for comparison.
- The clear conclusion from these recent studies, is that community annoyance from aircraft noise is significantly higher today than the results 20 to 40 years – which were used to develop the recommendations in NZS 6805 and adopted as the basis for airport controls in previous Christchurch District Plans; and
- Based on these results it would not be sensible to relax the planning controls to enable residential intensification in closer proximity to the Airport (for example, by setting the OCB to 55 dB $L_{dn}$) when the level of annoyance is trending the other way.

d. Planning Controls at other Airports generally experience significant complaints from residents located outside 55 dB $L_{dn}$:

- MDA argue that there is no validity in the argument that other airports do not use 50 dB for planning controls so why should Christchurch;
- The key reasons for this position are:
  - Other airports have failed to implement adequate planning controls;
  - As a result, a large number have operational restrictions;
  - MDA reference the Airbiz international case studies (summarised above);
  - To augment this, MDA examined Auckland, Wellington and Queenstown airports and found:
    - Auckland Airport has moderate land use controls (no equivalent to the Christchurch 50 dB contour). There are significant areas for new development in these moderate noise areas 55 to 65 dB $L_{dn}$. A community liaison group (the ANCCG) meet on a bi-monthly basis and provides an opportunity for the community to interact with Auckland International Airport Limited and Airways on noise issues. The majority of noise complaints at Auckland come from the relatively low aircraft noise areas – 45 to 55 dB $L_{dn}$.
    - Wellington International Airport was built in 1959 in the middle of an existing residential area. Since then, it has been compromised in terms of a curfew on airport operations and there are a significant number of people exposed to aircraft noise. NZS 6805 was implemented for Wellington International Airport in the 1990s but with a considerably 'watered down' version of the Standard's land use planning recommendations. There is no OCB included in the District Plan and thus no land use controls in the moderate noise areas. As a result, there have been further increases in the number of people exposed to aircraft noise over the years. This is an excellent example of how land use planning has caused a significant number of people to be exposed to the adverse effects of airport noise and for consequential restrictions on airport operations.
    - Queenstown Airport - The Queenstown noise boundaries are largely consistent with NZS 6805, in that an ANB based on the 65 dB $L_{dn}$ contour, and an OCB based on the 55 dB $L_{dn}$ contour. Due to the close proximity of houses to the runway, night operations are not permitted between 10pm and 6am. Noise is further restricted at Queenstown

[29] ibid

for practical reasons as the runway and surrounding topography cannot accommodate larger wide-bodied aircraft.

e. District Plan noise limits for general noise sources are set around 50 dB $L_{dn}$;
   - In addition to the above, MDA note that the use of a 50 dB may be seen by some as "unusual" or highly conservative. It is important to note, however, that:
     - the Christchurch District Plan sets the residential zone noise limits as 50 dB $L_{Aeq}$ daytime and 40 dB $L_{Aeq}$ night-time[30];
     - This gives an indication of what local Councils view as a reasonable 'receiving noise level' for the protection for residential amenity in the wider Christchurch context;
     - On this basis, as it is reasonable that residential uses should be protected to a level of 50 dB $L_{dn}$ from general noise sources, it is therefore equally reasonable that residential uses should not be allowed to establish next to an existing noisy activity (such as an airport) at levels higher than 50 dB $L_{dn}$.
   - MDA note that it is common at hearings or in planning processes for questions to arise which seek to draw conclusions based on the number of complaints received;
   - There are several reasons for the lack of complaints about aircraft operational noise from Christchurch International Airport. Firstly, the historic land use planning has meant that there are relatively few people exposed to aircraft noise in Christchurch. Secondly, people do not complain if they assume their complaints are likely to have no effect. If the airport is operating in its normal mode and they are annoyed, they know nothing can be done about the noise.
   - To illustrate the second point, MDA note an example of a 2017 trial in Auckland of alternative arrival procedures caused the number of complaints to jump from 2 per month to around 500 per month. These complaints came from a relatively low aircraft noise area.

f. Providing sound insulation to affected dwellings does not solve all the annoyance issues from aircraft noise:
   - Some advocates for residential development in areas affected by aircraft noise have submitted that sound insulation fitted to proposed dwellings is sufficient on its own to avoid the adverse effect of noise and to protect the interests of the Airport. MDA argue that this is incorrect as:
     - Firstly, the level of sound insulation required in the 50 to 60 dB $L_{dn}$ area is provided by a standard house. No additional construction techniques or materials are required;
     - However, 18% to 37% (WHO graph) of the population is still typically highly annoyed by aircraft noise in this environment, even though they have the opportunity to close their windows and achieve 'WHO satisfactory noise levels' inside;
     - Secondly, houses exposed to aircraft noise, are likely to operate with their windows closed to reduce internal noise levels, particularly at night. Three scenarios are then likely:
       - o the windows are kept closed resulting in an unsatisfactory level of fresh air; or
       - o a ventilation system or air-conditioning system is installed to improve air quality at significant cost; or,
       - o the windows are left open resulting in an unsatisfactory noise environment.

[30] MDA state that these controls are effectively the same as 50 dB $L_{dn}$.

    - Each of these scenarios is likely to result in annoyance and possible complaints from the residents;
    - The third difficulty with sound insulation is that it does not deal with the outdoor noise environment.
- This is why sound insulation, on its own, is insufficient and land use controls in the form of density restrictions are the only real form of mitigation available in this case.

## The Planning Framework

### The Canterbury Regional Policy Statement

102. The Airport is defined, and specifically listed, as "regionally significant infrastructure" and "strategic infrastructure" in the CRPS. The definition of "strategic infrastructure" notes that it includes "facilities, services and installations which are greater than local importance, and can include infrastructure that is nationally significant". Given the earlier assessment of the significant role of the Airport, it is clearly nationally significant.

103. Chapters 5 and 6 of the CRPS establish a policy framework recognising this importance and the need to ensure appropriate integration of new development with infrastructure and the avoidance of reverse sensitivity effects.

104. Chapter 5 deals with land use and infrastructure. **Objective 5.2.1(f)** and **(g)** requires that development is located and designed so that it functions in a way that:
*enables people and communities, including future generations, to provide for their social, economic and cultural well-being and health and safety; and which:*
*f. is compatible with, and will result in the continued safe, efficient and effective use of regionally significant infrastructure;*
*g. avoids adverse effects on significant natural and physical resources including regionally significant infrastructure, and where avoidance is impracticable, remedies or mitigates those effects on those resources and infrastructure…*

105. **Objective 6.2.1** (Recovery Framework) reads, in part:
*Recovery, rebuilding and development are enabled within Greater Christchurch through a land use and infrastructure framework that:*
*10. achieves development that does not adversely affect the efficient operation, use, development, appropriate upgrade, and future planning of strategic infrastructure and freight hubs;*
*11. optimises use of existing infrastructure…*

106. The CRPS includes the 50dB Ldn Air Noise Contour on its maps. **Policy 6.3.5(4)**, which implements **Objective 6.2.1**, requires that new development should only be provided for if it does not affect the efficient operation, use, development, upgrading and safety of existing strategic infrastructure, "*including by avoiding noise sensitive activities within the 50dBA Ldn airport noise contour for Christchurch International Airport, unless the activity is within an existing residentially zoned urban area…;*".

107. **Policy 6.3.5(5)**, similarly, reads:
*Managing the effects of land use activities on infrastructure, including avoiding activities that have the potential to limit the efficient and effective, provision, operation, maintenance or upgrade of strategic infrastructure and freight hubs.*

108. The 'Principal reasons and explanation' for **Policy 6.3.5** states: "*Strategic infrastructure represents an important regional and sometimes national asset that should not be compromised by urban growth and intensification… The operation of strategic infrastructure can affect the liveability of residential developments in their vicinity, despite the application of practicable mitigation measures to address effects… It is better to instead select development options … where such reverse sensitivity constraints do not exist*."

109. The policy thrust of the CRPS is clear, as it:
   a. recognises the social and economic importance of the Airport, and the need to integrate land use development with infrastructure;
   b. seeks to avoid incompatible activities within the 50dBA contour which may result in reverse sensitivity effects on the Airport;
   c. recognises that the Airport should not be compromised by urban growth and intensification; and
   d. enables the Airport's safe, efficient and effective operation and development.

## Brief history of the District Plan rules for land use within the 50dB Ldn Air Noise Contour in residential zones

110. The planning framework in Canterbury has responded to NZS 6805, the CRPS, the Airport significance, acoustic and economic issues discussed above by using 50dB Ldn Air Noise Contours consistently in the relevant district plan documents. The contours and related district plan provisions mark the starting point for controls on land use, including density controls.

111. There is a level of residential development that has already occurred within the 50dB Ldn Air Noise Contour and cannot be 'wound back'.

112. However, further intensification in existing residential zones above what is currently allowed can, and should, be prevented and directed to locations where people will not be exposed to noise of 50dB Ldn or greater.

113. For Christchurch District, the Independent Hearings Panel (the Panel) appointed to consider the proposed District Plan was required to consider and interpret the relevant policies of the CRPS (discussed above). Overall, the Panel determined that, although there is no absolute direction in the CRPS to avoid any further noise sensitive activities in existing residentially zoned land within the 50 dB Ldn Air Noise Contour, there is still a need to evaluate whether such activities should be avoided or restricted so as to give proper effect to **Policy 6.3.5** and related CRPS objectives and policies.[31] The Panel recognised the need for an ongoing capacity to assess relevant reverse sensitivity and noise mitigation matters for residential intensification above a certain scale.[32]

114. Ultimately the Panel determined that, for residential zones in the Christchurch District that sit within the 50dB Ldn Air Noise Contour, residential activities which do not meet permitted zone standards should have restricted discretionary activity status.[33] Applications would be limited notified to the Airport, in recognition of the fact that it is the Airport owner and may

[31] Decision 10 Residential (Part), Independent Hearings Panel, 10 December 2015, at [195].
[32] Ibid, at [235].
[33] Ibid, at [237].

have relevant information for the purposes of the assessment.[34] These provisions are discussed in more detail below.

## Operative Christchurch District Plan

**<u>The Policy Framework</u>**

115. The operative Christchurch District Plan contains a suite of provisions which aim to strike a balance between facilitating residential development and protecting the operations of the Airport as nationally significant infrastructure. A complete list is contained in **Appendix Eight** – Section 32 Assessment).

<u>Chapter 3 Strategic Directions</u>

116. Chapter 3 (Strategic Directions) establishes the overarching direction for the District Plan and establish objectives that set the outcomes sought for the district. **Strategic Objective 3.3.12** (Infrastructure) recognises the benefits of strategic infrastructure, which is defined in the District Plan to include the Airport, and seeks to enable the Airport's efficient and effective development, upgrade, maintenance and operation. To achieve this, the objective identifies the need to protect Infrastructure from incompatible development and activities, including reverse sensitivity effects. Specifically, **Objective 3.3.12 (b)(iii)** directs that new noise sensitive activities should be avoided within the 50dB Ldn Air Noise Contour, except within existing residentially zoned areas and other locations specified in subclauses B-D.

117. **Objective 3.3.12** reads, in part:

*3.3.12 Objective – Infrastructure*

*a. The social, economic, environmental and cultural benefits of infrastructure, including strategic infrastructure, are recognised and provided for, and its safe, efficient and effective development, upgrade, maintenance and operation is enabled; and*

*b. Strategic infrastructure, including its role and function, is protected from incompatible development and activities by avoiding adverse effects from them, including reverse sensitivity effects. This includes:*

*i. …*

*ii. …; and*

*iii. avoiding new noise sensitive activities within the 50dB Ldn Air Noise Contour and the 50dB Ldn Engine Testing Contour for Christchurch International Airport, except:*

*A. within an existing residentially zoned urban area; or*

*B. within a Residential Greenfield Priority Area identified in the Canterbury Regional Policy Statement Chapter 6, Map A; or*

*C. for permitted activities within the Specific Purpose (Golf Resort) Zone of the District Plan, or activities authorised by a resource consent granted on or before 6 December 2013; and*

*D. for permitted, controlled, restricted discretionary and discretionary activities within the Specific Purpose (Tertiary Education) Zone at the University of Canterbury; and …*

118. Related to this, **Objective 3.3.14** (Incompatible activities) recognises the need to control the location of activities to minimise conflicts, and to avoid conflicts where there may be significant adverse health, safety and amenity effects.

[34] Ibid, at [239].

Residential Chapter

119. Similar to the discussion above (paragraph 108) on CRPS policy 6.3.5, there is no prescription within Strategic **Objective 3.3.12** to avoid any further noise sensitive activities in existing residentially zoned land within the 50 dB Ldn Air Noise Contour. That said, the District Plan residential zone policy framework that gives effect to the CRPS and the Strategic Directions chapter of the District Plan, recognises the need to protect strategic infrastructure from reverse sensitivity effects. Specifically, the following Objective and policies are relevant:

*14.2.3 Objective - Strategic infrastructure*

*a. Development of sensitive activities does not adversely affect the efficient operation, use, and development of Christchurch International Airport and Port of Lyttelton, the rail network, the National Grid and the identified 66kV and 33kV electricity distribution lines and the Heathcote to Lyttelton 11kV electricity distribution line, the state highway network, and other strategic infrastructure.*

*14.2.3.1 Policy - Avoidance of adverse effects on strategic infrastructure*

*a. Avoid reverse sensitivity effects on strategic infrastructure including:*

*i. Christchurch International Airport;*

*ii. …*

*14.2.2.2 Policy - Recovery housing - higher density comprehensive redevelopment*

*a. Enable and incentivise higher density comprehensive development of suitably sized and located sites within existing residential areas, through an Enhanced development mechanism which provides:*

*i. high quality urban design and onsite amenity;*

*ii. appropriate access to local services and facilities;*

*iii. development that is integrated with, and sympathetic to, the amenity of existing neighbourhoods and adjoining sites; and*

*iv. a range of housing types;*

*v. and which does not promote land banking, by being completed in accordance with a plan for the staging of the development.*

*b. To avoid comprehensive development under the Enhanced development mechanism in areas that are not suitable for intensification for reasons of:*

*i. vulnerability to natural hazards;*

*ii. inadequate infrastructure capacity;*

*iii. adverse effects on Character Areas; or*

*iv. reverse sensitivity effects on existing heavy industrial areas, Christchurch International Airport, arterial traffic routes, and railway lines.*

120. **Policy 14.2.2.2** (relating to housing recovery and higher density development) directs that higher density comprehensive development should be avoided in areas that are not suitable for intensification for reasons of reverse sensitivity effects on Christchurch International Airport.[35] **Objective 14.2.3** and associated **Policy 14.2.3.1** also generally direct that development of sensitive activities should not adversely affect the efficient operation, use and development of the Airport and that, accordingly, reverse sensitivity effects in particular are to be avoided.

Subdivision Chapter

[35] Policy 14.2.2.2(b)(iv).

121. Objective 8.2.3 (Infrastructure and transport) recognises the need for subdivision design and development to promote efficient provision and use of transport. Related policy 8.2.3.5 deals with adverse effects on infrastructure and requires that subdivision design recognises their ongoing operation, development and maintenance, including the potential for reverse sensitivity effects.

Commercial Chapter

122. The commercial zones anticipate a range of sensitive activities, including residential activities. Within this context, and as a range of commercial zones site beneath the Contours, the policy framework[36] of the District Plan recognise the need to avoid sensitive activities in such locations.

123. Specifically, Policy 15.2.4.5(b) reads:
*Provide for the effective development, operation, maintenance and upgrade of strategic infrastructure and avoid adverse effects of development on strategic infrastructure through managing the location of activities and the design of stormwater areas. This includes but is not limited to, avoiding sensitive activities within commercial zones located within the 50 dB Ldn Air Noise Contour and within the Lyttelton Port Influences Overlay Area.*

**The Zone and Rule Framework**

Residential Chapter

124. The District Plan rule regime that flows from the policy framework within the Air Noise Contours control the extent to which residential activity can intensify.

125. The residential zones which sit within the 50dB Ldn Air Noise Contour and which are subject to density controls are Residential Suburban (RS) and Residential Suburban Density Transition Zones (RSDT)[37] and Residential New Neighbourhood Zone (RNN).[38]

126. There are portions of residentially zoned land which fall within the 55dB Ldn Air Noise Contour and within the ANB. Additional rules[39] apply to the land in those locations, which set out insulation standards for new buildings (or extensions to existing buildings) and prohibit new noise sensitive activities within the Air Noise Boundary, consistent with NZ6805 and the CRPS.[40]

127. Within the RS, RSDT and RNN zones in the 50dB Ldn Air Noise Contour, residential activities which do not meet the permitted or controlled activity density standards trigger a restricted discretionary rule related to airport noise issues. [41] In determining applications, the Council must consider "*The extent to which effects, as a result of the sensitivity of activities to current and future noise generation from aircraft, are proposed to be managed, including avoidance of any effect that may limit the operation, maintenance or upgrade of Christchurch International Airport.*"

[36] Objective 15.2.4
[37] Rule 14.4.1.3.
[38] Rule 14.12.1.3.
[39] And Objective 6.1.2.1, and policies 6.1.2.1.1 and 6.1.2.1.5
[40] Section 6.1.7.1 and 6.1.7.2
[41] Rule 14.4.1.3, RD34 and Rule 14.12.1.3 RD26.

128. Any applications triggering that rule are limited notified to the Airport (as a party identified as being adversely affected). This process is crucial as the Airport is able to more closely consider reverse sensitivity effects and, where these will impact Airport operations, the Airport takes an active role by lodging submissions and/or working with landowners. Notification serves a broader purpose than simply bringing residential activity applications to the attention of the Airport.

129. There is a small portion of land within the 50dB Ldn Air Noise Contour (on the north side of Buchanans Road) which is zoned Residential Medium Density (RMD). This area is part of a comprehensive development that took place under the former Christchurch City Plan, which allowed for a mixture of densities at that location.[42] When considering appropriate zonings and airport noise rules within the 50dB Ldn Air Noise Contour for the operative Christchurch District Plan, the hearings panel regarded this area of RMD as "*so small as to be insignificant for our purposes on this matter*".[43] This current, and only, area of RMD zoning under the Contour therefore reflects historic land use, and was not an area which was newly-identified as appropriate for increased residential development.

130. There are two areas of land within the 50dB Ldn Contour zoned RNN. However, both are subject to Outline Development Plans (ODP) which were considered and approved by the Independent Hearings Panel for the Christchurch District Plan. These areas were also initially zoned for residential development via the former Christchurch City Plan: the North West Belfast ODP,[44] and Yaldhurst ODP.[45]

Subdivision

131. The District Plan has minimum allotment size standards for subdivision in the RS, RSDT and RNN zones which is a direct control on density. In general terms this requires, as a controlled activity, the following minimums (net site area):
a. Residential Suburban – 450m$^2$ (rule 8.6.1 Table 1.a);
b. Residential Suburban Density Transition – 330m$^2$ (rule 8.6.1 Table 1.e); and
c. Residential New Neighbourhood – Density standards specified in rule 8.6.11, Table 8 and the relevant ODP (Yaldhurst – Appendix 8.10.28, Belfast – Appendix 8.10.23).

Commercial

132. The District Plan provides for residential activities within the commercial areas of the district as permitted activities, under stated conditions[46]. The AAOCB covers land zoned Commercial Office (CO), Commercial Core (CC) and Commercial Local (CL). Given the policy framework discussed above (paragraphs 122-123), sensitive activities located within these zones require resource consent as a non-complying activity via rules 15.8.1.5, 15.4.1.5 and 15.5.1.5. Under draft PC14 it is proposed to rezone the Residential Guest Accommodation Zone to Commercial Mixed Use (CMU). There is no equivalent non-complying rule for sensitive activities in this zone. Given this, a new provision needs to be inserted into the CMU (15.9.1.5).

[42] Christchurch City Plan 2005, Part 2 Living Zones, 1.12 Living G (Yaldhurst) Zone and associated appendices.
[43] Decision 10 Residential (Part), Independent Hearings Panel, 10 December 2015, at [215] and [216].
[44] Christchurch District Plan, Chapter 8, Appendix 8.10.23 North West Belfast Outline Development Plan and Christchurch City Plan 2005, Appendix 8.6.23.
[45] Christchurch District Plan, Chapter 8, Appendix 8.10.28 Yaldhurst Outline Development Plan and Christchurch City Plan 2005, Appendix 8.10.28.
[46] Acknowledging that Plan Change 5B is in process

### Caselaw

133. The principle that density controls are important land use planning controls for managing sensitive activities in proximity to airports has been well established before the Courts.

134. Attached, as **Appendix Seven**, is a summary and extracts of relevant decisions in which the Environment Court has articulated the importance of density controls. These cases confirm that density controls are essential for an effective planning framework that manages airport noise effects on the community whilst also safeguarding airport operations.

135. In summary:

a. The benefits of an airport future-proofing its operation have local, regional and national significance;[47]

b. There are likely to be a percentage of persons highly annoyed by airport operations even below the 50 dB Ldn noise contour, and there is likely to be an adverse effect on their amenity.[48] A greater number of dwellings between the 50 and 55 dB Ldn contours will lead to an increased number of persons highly annoyed by aircraft traffic;[49]

c. When weighing up conflicting policies and objectives, the Court has stated that density of dwellings around the Christchurch International Airport is a dominant factor.[50] Airport policies have been considered more significant than those which seek higher densities when the Court was asked to weigh these competing matters; [51] and

d. The NZS 6805 provides for a two-pronged approach with both noise management controls and land use planning controls. The two need to be considered as a composite package.[52]

## Draft Plan Change 14

### Residential

136. The Council has consulted on draft Plan Change 14, which will be publicly notified in August 2022. Plan Change 14 is the Council's response to its obligations under the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 (the Enabling Housing Act) and the National Policy Statement on Urban Development 2020 (NPSUD). In summary, the Enabling Housing Act requires Council to apply medium density residential standards (MDRS) to relevant residential zones to enable residential intensification. Table One below identifies the current District Plan zones and proposed new zonings of land that sit beneath the operative Air Noise Contours and the AAOCB.

[47] *Robinsons Bay Trust v Christchurch City Council* C 60/2004, 13 May 2004, at [24].
[48] Ibid at [58] and [59].
[49] Ibid at [59].
[50] *BD Gargiulo v Christchurch* CC, C 137/2000, 17 August 2000, at [51] and [63].
[51] *National Investment Trust v Christchurch CC*, C 41/2005, 30 March 2005, at [109].
[52] *Independent News Auckland Ltd & Anor v Manukau City Council,* (2003) 10 ELRNZ 16 at [111].

Table One: Residential zones currently and proposed to be located within the Airport Noise Contours in Christchurch City

| Operative Plan | As proposed in Plan Change 14 (operative contours) | As proposed in Plan Change 14 (AAOCB) |
|---|---|---|
| Residential Guest Accommodation Zone | N/A<br>MDRS do not apply as this is considered commercial. Note, however, that it is proposed to rezone to Commercial Mixed Use under PC14 | N/A<br>MDRS do not apply as this is considered commercial. Note, however, that it is proposed to rezone to Commercial Mixed Use under PC14 |
| Residential Medium Density Zone (NB: rules differ from MDRS) | Medium Density Residential Zone | Medium Density Residential Zone |
| Residential New Neighbourhood Zone | Medium Density Residential Zone | Medium Density Residential Zone |
| Residential Suburban Zone | Medium Density Residential Zone | Medium Density Residential Zone |
| Residential Suburban Density Transition Zone | Medium Density Residential Zone | Medium Density Residential Zone |

137. The establishment of the new medium density zones will potentially enable increased permitted density of development across large areas of Christchurch City, as anticipated by the NPSUD and the Enabling Housing Act. This includes land beneath the AAOCB, unless it is identified as a qualifying matter which makes less enabling development more appropriate.

138. The proposed MDRS planning tools to be inserted in the District Plan to achieve this outcome include, amongst other things, increased density standards (3 units per site), increased height (11m, plus roof intrusions up to 1m), more flexible recession plane standards, reduced building setback standards, increased site coverage rules (50%) and reduced subdivision standards. Developments that comply with these more enabling standards, and are not subject to a qualifying matter, can proceed without resource consent. It is further proposed that four or more residential units on a site would require resource consent as a restricted discretionary activity, with discretion limited to stated design principles. Similarly, buildings exceeding 11m in height, and breaches of the recession plane, setback, site coverage and other built form standards would also be assessed as restricted discretionary activities. There are no discretionary or non-complying activities.

139. Overall, these provisions provide a significantly more enabling residential development regime and thus a notable increase in potential development density and built form compared to the operative District Plan rules.

140. While the draft PC14 documentation also includes changes proposed to the District Plan objective and policy framework (Chapter 3 Strategic Directions and Chapter 14 Residential), it currently proposes no changes to the following objectives and policies (discussed above). This is appropriate as they are pivotal in recognising the strategic importance of the Airport, the need to protect its security and operations from incompatible activities and reverse sensitivity

effects, and to achieve appropriate health and amenity outcomes for the sensitive activities beneath the corridors:

a. Strategic Objective 3.3.12
b. Strategic Objective 3.3.14
c. Residential Objective 14.2.3
d. Policy 14.2.3.1
e. Policy 14.2.2.2

141. It is assumed that this is deliberate, given the Council's stated position that the Air Noise Contours should be considered as a qualifying matter and, that as a consequence, no changes to the aforementioned District Plan objectives and policies will be made.

142. As the Council is proposing to rezone the existing residential land beneath the AAOCB medium density, it is understood that it is proposed to "re-house" the existing District Plan residential rules into the new zone chapters. This would need to include all the relevant built form standards for the existing RS, RSDT and RNN[53] zones under the AAOCB, as non-compliance with those provisions are the trigger points for RDA status, and the density permitted by the operative District Plan provisions in those locations is more appropriate and should be retained.[54]

143. For completeness, it is also noted that the relevant provisions of Chapter 6.1.7 (Rules – Activities near infrastructure) should remain intact.

144. While the Council has signalled this "rehousing" approach, an alternate strategy would be to leave the current zoning (and related provisions) on land beneath the AAOCB intact. This would therefore provide a standalone package of provisions applying to the contour qualifying matter and should avoid:

a. complex Plan interpretation requirements; and
b. the potential for Plan drafting errors to arise from incorporating existing provisions into the new medium density and high-density zone chapters, which could lead to unanticipated outcomes

145. There appears to be no mandatory requirement in the legislation that requires the Council to undertake a blanket rezoning across all relevant residential zones, such that the only residential zone in the city is MDR Zone:

a. The obligation under s77G is to incorporate the MDRS into every relevant residential zone.
b. Under s77I the Council may make the MDRS and the relevant building height or density requirements under policy 3 less enabling of development in relation to an area within a relevant residential zone only to the extent necessary to accommodate 1 or more of the following qualifying matters. Again, the legislation does not prescribe the zoning that is to be used.
c. Section 77J talks about requirements for the evaluation report and asks for "a description of how the provisions of the district plan allow the same or greater level of development than the MDRS". This further reinforces the point that Councils can work out how they incorporate MDRS, they must then just explain what they have done and how it meets the duty in s77I.

[53] 14.4.2, 14.12.2
[54] 14.4.1.3 RD34, 14.12.1 RD26

d. The Council retains discretion as to how it incorporates the MDRS into relevant residential zones. The legislation does not require councils to rezone all of the relevant residential zones MDR.

e. It follows, therefore, that Council also has discretion in terms of the zoning and adjustments to the MDRS in areas where a qualifying matter applies.

### Residential Subdivision

146. Draft PC14 signals that subdivision of land that is vacant will require lots with a minimum of 400m$^2$ in the Medium Density Zone. In other respects, there will be no minimum allotment size. This represents a step change in potential density outcomes.

### Commercial

147. Draft PC14 proposes to align the current commercial zones with the National Planning Standards nomenclature. It is also proposed to enable greater building form. With respect to the Airport Contours, the only relevant issue is the extent to which any changes may enable residential development beneath the contours.

148. Table Two below identifies the current District Plan zones and proposed new zonings of land that sit beneath the operative Air Noise Contours and the remodelled AAOCB.

Table Two: Residential zones currently and proposed to be located within the Airport Noise Contours in Christchurch City

| Operative Plan | As proposed in Plan Change 14 (operative contours) | As proposed in Plan Change 14 (AAOCB) |
|---|---|---|
| Commercial Office Zone (Sir WP Drive) | Commercial Zone | Commercial Zone |
| Commercial Local Zone (example – Wentworth Street | Neighbourhood Centre Zone | Neighbourhood Centre Zone |
| Commercial Core Zone (Yaldhurst) | Local Centre Zone | Local Centre Zone |
| Residential Guest Accommodation Zone | Commercial Mixed-Use Zone – Memorial Avenue | Commercial Mixed-Use Zone – Memorial Avenue |

149. As noted in the discussion above, sensitive activities in the commercial zones and on land within the contours require resource consent as a non-complying activity (rules 15.9.1.5, 15.5.1.5, 15.6.1.5 and 15.4.1.5[55]). Currently the one exception to this is the Commercial Mixed-Use zone. The reason for this is that the operative Contours within the District Plan do not cover such zones. Land zoned Commercial Mixed Use is, however, included within the remodelled contours and given this a new non-complying activity rule will need to be inserted into chapter 15.10. No change to the policy framework is required, as it is covered by Policy 15.2.4.5(b). It is noted, for completeness, that the Commercial Mixed-Use zones will also replace land currently zoned Residential Guest Accommodation Zone in the operative District Plan.

[55] As renumbered in draft PC14

## Conclusions and the Planning Issues that arise

150. The proposal under draft Plan Change 14 to rezone land and apply medium density standards introduces the potential for significant further residential intensification. The draft Plan Change also proposes to align commercial zonings with the National Planning Standards nomenclature and the assessment above has identified the absence of a planning rule addressing sensitive activities within the CMU zone; albeit an existing policy applies.

151. The remodelled AAOCB, as it relates to urban areas, is illustrated in the map attached as **Appendix One**.

152. The preceding assessments and attached reports confirm that:
    a. Christchurch Airport is nationally significant infrastructure and fulfils an important role in domestic, national and international passenger and freight services;
    b. The timing and frequency of international air services are often beyond the control of the Airport; being dictated by other parties (slot taker restrictions);
    c. As the Airport operates 24/7 without curfew or capacity constraint, it is a significant contributor to the national and regional economy;
    d. The MDA report identifies the amenity impacts that arise from noise exposure for sensitive activities within the 50dB Ldn Air Noise Contour, and the increasing annoyance level trend for those living in such locations;
    e. The MDA report confirms that it is appropriate to continue to use the 50dB metric for the outer control boundary, rather than applying a 55 dB contour;
    f. The attached reports identify the risk to Airport operations from reverse sensitivity effects that could lead to constraints on Airport operations;
    g. The Property Economics and Airbiz reports identify the risks that constraints on the Airport poses operationally and to the economic wellbeing of Canterbury and the South Island;
    h. The current regional and district planning regime provides a clear and coherent policy platform built on the above, and seeks to avoid sensitive activities within the 50dB Ldn contour as this:
        - recognises the social and economic importance of the Airport, and the need to integrate land use development with infrastructure;
        - seeks to avoid incompatible activities within the 50dBA contour which may result in reverse sensitivity effects on the Airport;
        - recognises that it should not be compromised by urban growth and intensification; and
        - enables the Airport's safe, efficient and effective operation and development.
    i. Caselaw supports the current planning approach and there have been no material changes in evidence since most cases where decided.

153. Draft Plan Change 14 and the application of the MDRS has the potential to enable increased density of development on land under the AAOCB, beyond that currently provided for in the District Plan. In many ways, the proposed MDRS are the antithesis of the provisions that unpin the current planning regime designed to achieve appropriate amenity outcomes for residents beneath the contours and to ensure effective and efficient operation of the Airport.

154. Within this context it is appropriate to consider whether the MDRS should be made less enabling within the AAOCB to provide for the airport noise as a qualifying matter and, thus, whether the current policy framework and density/development rules should continue to apply, including the retention of the current notification requirements for proposals to exceed

the permitted and controlled activity standards. Moreover, it is necessary also to consider whether additional provisions are required given the amendments proposed to the commercial zones under draft Plan Change 14. These issues are addressed below in Part B and in the report attached as **Appendix Eight.**

155. Two additional matters require consideration:

a. The Council has signalled that it proposes to rezone the residential land beneath the AAOCB and "rehouse" the relevant provisions into the new zone provisions. This option, and an option that retains the existing zones and provisions are assessed within a section 32 framework; and

b. The impact on potential housing supply that would result from applying the AAOCB as a qualifying matter.

156. These matters are addressed in the Part B assessment below.

# PART B SECTION 77K ASSESSMENT

## Introduction

157. Section 77K(1) of the RMA establishes a process for considering existing qualifying matters. An existing qualifying matter is described in section 77K(3) as a qualifying matter referred to in section 77I(a) to (i) that is operative in the relevant district plan. Relevant to this issue, this includes[56]:

*(e) a matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure*

158. The term nationally significant infrastructure is not defined in the RMA, but is defined in the NPS UD[57], as follows:
*any airport (but not its ancillary commercial activities) used for regular air transport services by aeroplanes capable of carrying more than 30 passengers*

159. Section 77I allows the territorial authority to make the MDRS and the relevant building height or density standards <u>less enabling</u> within a relevant residential zone where a qualifying matter is present.

160. The alternate process for existing qualifying matters prescribed under section 77K(1) requires the territorial authority to:

*(a) identify by location (for example, by mapping) where an existing qualifying matter applies:*

*(b) specify the alternative density standards proposed for those areas identified under paragraph (a):*

*(c) identify in the report prepared under section 32 why the territorial authority considers that 1 or more existing qualifying matters apply to those areas identified under paragraph (a):*

*(d) describe in general terms for a typical site in those areas identified under paragraph (a) the level of development that would be prevented by accommodating the qualifying matter, in comparison with the level of development that would have been permitted by the MDRS and policy 3*

161. The following sections address these matters.

## Section 77K(1)(a) - Identify by location where an existing qualifying matter applies

162. A map attached as **Appendix One** shows the spatial extent of the AAOCB. Within a residential zoning context, the contours extend over land proposed to be zoned medium density residential. The proposed medium density residential zone will replace land currently zoned residential medium density, residential new neighbourhood, residential suburban, and residential suburban density transition within the operative District Plan.

## Section 77K(1)(b) – Specify the alternate density standards proposed for those areas

163. It is proposed that there should be no change to the density standards set out in the operative District Plan for the existing residential zones within the AAOCB (including the retention of the current notification requirement for proposals that exceed the permitted and controlled

[56] And in section 3.32(1)(c) NPSUD
[57] NPS UD – Section 1.4 Interpretation

activity standards). The density enabled in those locations should remain as it is in the operative Plan, and should not increase in line with MDRS.

164. The District Plan density standards enable a reasonable level of development on sites which have historically been zoned for residential land use, but which fall within the 50 dB Ldn contour. It would not be appropriate to increase the existing residential density in these locations for the reasons outlined in the Part A assessment.

### Section 77K(1)(c) – Identify in a section 32 report why the qualifying matter applies

165. **Appendix Eight** contains a section 32 assessment ('the s32 report'). The key finding of the s32 report is that the proposal to provide for the airport noise qualifying matter by amending MDRS provisions on land within the AAOCB is the most appropriate objective for achieving the purpose of the RMA as it:
   a. is necessary to accommodate a valid qualifying matter in respect of s77I(e);
   b. does not unreasonably frustrate the Council's implementation of its obligations under the NPSUD, RPS and in turn, the purpose of the Act and the intent of recent amendments to the Act to improve housing supply and enable residential intensification; and
   c. best aligns with the existing District Plan policy framework relating to health, amenity and Airport operational outcomes, which PC14 does not propose to alter.

166. Further, having settled the above, the s32 report considers the relative advantages and disadvantages of:
   a. retaining the current residential zoning and related provisions applying to land beneath the AAOCB; or
   b. 'rehousing' land beneath the AAOCB within Medium and Residential Zones.

167. In this respect the s32 report finds that option a. above is the most appropriate means of implementing the objective associated with the proposal, as it:
   a. involves the least degree of change to the current zoning and planning framework; and
   b. consequently, entails the least risk of unintended consequences or errors (e.g., anomalies) arising.

168. Consequential to the above, proposed Plan Change 14 should include alterations to the MDRS to accommodate the airport noise qualifying matter, with the existing zonings beneath the AAOCB, and with the operative density standards, development controls and policy frameworks remaining in place. Specifically, this should include the following provisions of the District Plan:
   a. Strategic Objectives 3.3.1, 3.3.4, 3.3.7, 3.3.12 and 3.3.14;
   b. Objective 6.1.2.1 and Policies 6.1.2.1.1 and 6.1.2.1.5;
   c. Objective 7.2.1 and Policy 7.2.1.8;
   d. Objective 7.2.2 and Policies 7.2.2.1 and 7.2.2.3;
   e. Objective 8.2.3 and Policy 8.2.3.5, and the relevant subdivision standards for the RS, RSDT and RNN zones;
   f. Objective 14.2.1 and Policy 14.2.1.1;
   g. Objective 14.2.2 and Policy 14.2.2.2;
   h. Objective 14.2.3 and Policy 14.2.3.1;
   i. Objective 14.2.4 and Policies 14.2.4.1 and 14.2.4.2;
   j. Objective 15.2.4 and Policy 15.2.4.5;
   k. Rules 6.1.7.1 and 6.1.7.2; and

l. Rules 14.4.1.4 RD34 and 14.12.1.3 RD26, and the relevant permitted and controlled activity standards applicable in Residential Suburban, Residential Suburban Density Transition, and Residential New Neighbourhood zones.

169. In addition, it will also be necessary to:
   a. Delineate the AAOCB on the relevant zones in the Planning Maps to show the extent of the qualifying matters in the District; and
   b. include an additional non-complying activity rule for sensitive activities within the new Commercial Mixed-Use zone beneath the AAOCB (Memorial Avenue).

**<u>50 v 55 Contours</u>**

170. Following the preparation of the s32 report, further consideration has also been given to whether, in principle, the 50 dB metric should continue to be used, or whether a change to a 55 dB contour is appropriate. Such an assessment does not fit neatly within a s32 assessment, as no change is proposed to the concept of retaining a 50 dB contour within the District Plan. Moreover, no changes are proposed to the policy framework or the rule provisions that relate to the contour. Rather, the issue that this report assesses is whether the remodelled contour should be a qualifying matter.

171. That said, given that it is proposed to include the AAOCB as the qualifying matter, rather than the 50 dB noise contour that presently exists within the District Plan, it is appropriate to assess from a planning perspective whether the 50 dB contour (the AAOCB) will achieve the preferred objective evaluated and adopted in section 6 of the attached s32 report (**Appendix Eight**); being:
*To achieve a balance in enabling housing supply and residential intensification, while protecting strategic infrastructure including the Airport from reverse sensitivity effects, and maintaining the health, safety and amenity of residents, through the imposition of the remodelled AAOCB as a qualifying matter over areas subject to MDRS provisions.*

172. The purpose of an air noise contour is to
   a. ensure people are protected from establishing sensitive land uses in areas that are exposed to levels of aircraft noise which might disturb them or affect their quality of life resulting in adverse amenity and health outcomes; and
   b. protect the Airport from reverse sensitivity effects, enabling airport operations to continue to support and benefit communities.

173. Given this effects focus, the preceding assessments of MDA and Airbiz are particularly relevant in determining which metric best achieves the above outcomes.

174. MDA promote the use of a 50dB Contour (and related provisions) as the most effective and efficient planning tool and note:
   a. Airport operations create unavoidable noise;
   b. Community response to aircraft noise is a “grey scale” and that annoyance does not start or stop at a specified noise level (or contour boundary);
   c. Research confirms:
      - high annoyance rates for communities between 50 and 55dB Ldn, and that the latest research confirms the rates are increasing; and
      - the latest overseas studies confirm that community tolerance to aircraft noise is likely reducing, not increasing;

d. If land is available elsewhere for new residential (or other sensitive activities) development or intensification, this should be preferred to land within the 50 Ldn contour; and

e. Specifying sound insulation for activities between the 50 and 55 contour will not eliminate all the adverse effects of noise, due to open windows and an unsatisfactory noise environment.

175. From a review of the Airbiz international case studies, and their own review of Auckland, Wellington and Queenstown Airports, MDA argue that there is no validity in the argument that other airports do not use 50 dB for planning controls so why should Christchurch. The key reasons for this position are:

a. Other airports have failed to implement adequate planning controls; and

b. As a result, a large number have operational restrictions.

176. From a broader perspective, MDA also note that the District Plan sets the residential zone noise limits as 50 dB $L_{Aeq}$ daytime and 40 dB $L_{Aeq}$ night-time[58]. This gives an indication of what local Councils view as a reasonable 'receiving noise level' for the protection for residential amenity in the wider Christchurch context. On this basis, as it is reasonable that residential uses should be protected to a level of 50 dB $L_{dn}$ from general noise sources, it is therefore equally reasonable that residential uses should not be allowed to establish next to an existing noisy activity (such as an airport) at levels higher than 50 dB $L_{dn}$.

177. Overall, it would not be sensible to relax the planning controls to enable residential intensification in closer proximity to the Airport (for example, by setting the OCB to 55 dB $L_{dn}$) when the level of annoyance is trending the other way.

178. The Airbiz report also highlights case studies which show:

a. significant proportions of populations consider themselves highly or moderately annoyed at exposure levels below 55 Ldn;

b. Whatever the metric selected and the position of a noise contour for planning purposes, there are linkages between urban encroachment and pressures to mitigate actual or perceived, current or future aircraft noise impacts through operational restrictions; and

c. No cases were found where regulatory authorities relaxed protection in terms of an OCB equivalent level(e.g. reducing an OCB from 50 to 55Ldn).

179. In summary, Airbiz conclude that:

*A relaxation of the CIA OCB from 50dBA Ldn to 55dBA Ldn would provide a framework to enable new noise sensitive activity such as residential, schools, hospitals etc to be developed closer to Christchurch Airport. The risk of negative amenity impacts on those new occupants, and reverse sensitivities then impacting airport operations and efficiency is real. This risk is demonstrated by global examples documented in previous sections of this report.*

180. Adopting a 55dB contour, with no planning controls in the 50 to 55 space, would lead to poor environmental outcomes for sensitive activities in those locations. On balance, and from a noise amenity perspective alone, it is essential to retain a 50 dB contour.

181. It is notable also, that the application of a 50 dB contour is entirely aligned with the existing policy framework of the CRPS and the Christchurch District Plan as assessed earlier in this report.

[58] MDA state that these controls are effectively the same as 50 dB $L_{dn}$.

182. It needs to be recognised, however, that the application of a 50dB contour places constraints on development over a larger spatial area, compared to the 55dB contour. The rules in the District Plan, however, strike a reasonable balance between development opportunity and effects outcomes. This is because within a residential context, for example, the RDA rules[59] are only triggered when a residential activity is not a permitted or controlled activity, or when certain other specified sensitive activities are proposed. In addition, from a housing capacity perspective, it is clear from the Colliers report (**Appendix Nine**) that sufficient capacity will exist, despite the application of the 50 dB contour as a qualifying matter.

183. The Airbiz report (**Appendix Two**) outlines the risks to Airport operations from poor planning controls and inadequate safeguarding. The Property Economics report highlights the economic value of the Airport's operations, the contribution it makes to the South Island GDP and the potential loss of economic activity and downstream employment opportunities should operational constraints apply as a result of community annoyance levels. The evidence demonstrates that the risk of such outcomes is reduced through the retention of a 50 dB contour as the outer control boundary.

184. In summary, and from a s32 perspective, the retention of a 50 dB contour:

a. Has direct environmental, economic and social <u>benefits</u>. There are no cultural benefits;

b. Has minimal economic and social <u>costs</u>, given the largely permissive rule framework attached to the contour and the findings of the housing capacity study. It should be noted, however, that there are potentially significant environmental, social and economic costs should the 50 dB contour be removed. There are no cultural costs;

c. Is <u>effective</u> as it will ensure that the protection of the Airport from reverse sensitivity effects, and the maintenance of the health, safety and amenity of residents will continue to be achieved; and

d. Is <u>efficient</u> given that the benefits will far outweigh the costs. In addition, the relevant District Plan provisions will remain intact.

185. Section 32(2) requires an assessment of the risk of acting or not acting if "there is uncertain or insufficient information about the subject matter of the provisions". Given the lengthy history of the planning provisions relating to Airport contours, the recent IHP examination of these issues, the substance of the remodelling exercise and supporting reports and assessments, and the assessments and investigations supporting this analysis, it is considered that there is certain and sufficient information on which to act.

186. Overall, it is considered that the proposal to retain 50dB as the outer control boundary is the most appropriate method for achieving the objectives and policies of the District Plan and the objective stated in paragraph 171 above. Moreover, the benefits will outweigh the costs. Given this, the proposal will achieve the purpose of the RMA.

### Section 77K(1)(d) - Describe in general terms the level of development that be prevented by accommodating the qualifying matter

187. For the relevant residential zones, the operative Christchurch District Plan provides for (generally speaking) a single residential unit per lot (with some limited ability to convert existing houses into two units in certain circumstances), and an additional minor residential unit on a site with a single residential unit. The maximum height standards are 8m and

[59] for example, RD34 in the RS and RSDT zone

maximum site coverage is 35%. There are also minimum lot sizes of 450m$^2$ (Residential Suburban zone) and 330m$^2$ (Residential Suburban Density Transition), and as mentioned requirements to notify CIAL where breach of built form standards triggers the need for consent[60].

188. Therefore, the level of development theoretically prevented by accommodating Air Noise Contours as a qualifying matter can be understood as, approximately:
   a. 1 fewer residential unit per site (accounting for the present ability to establish both a residential unit and minor residential unit per site);
   b. 1 fewer storey on each residential unit, and more size restrictions applicable to minor residential units; and
   c. 15% less site coverage allowed.

189. For completeness, it is not realistic to assume for the purpose of this assessment that every RS or RSDT zoned site within the Air Noise Contours would take up the opportunity to develop to the extent enabled through the MDRS. Many sites in residential zones have been recently re-developed and contain newly built dwellings that are unlikely to be further modified or re-built in line with MDRS. Some sites may contain additional practical constraints which limit the ability to take up MDRS.

190. Viewed as a proportion of the whole area of residentially zoned land in Christchurch City, the area covered by the AAOCB is comparatively small. It is appropriate to maintain less enabling density standards for this limited area to protect airport operations and avoid unreasonable amenity outcomes.

191. In order to quantify this, Colliers have prepared a report (**Appendix Nine**) assessing the impact on development capacity as a result of the increased spatial area occupied by the remodelled Outer Envelope (OE) contour. It is essential to note that this assessment uses the OE, rather than the AAOCB. Given that the AAOCB is spatially less extensive that the OE, conclusions drawn in the Colliers report will overestimate the impact on housing capacity.

192. As part of Colliers' assessments, they reviewed The Property Group (TPG) report[61] prepared for the Christchurch City Council which assessed theoretical and feasible development capacity arising from the application of the MDRS. The purpose of TPG's feasibility assessment was to place a real-world lens on development potential, rather than simply relying on a Plan enabled analysis. As part of this assessment, TPG correctly identified where development constraints may exist and excluded them from the capacity analysis. This included "noise boundaries" and areas "within flight path restrictions…given in the Operative District Plan"[62]. This is assumed to be the operative Air Noise Contours. It is notable that the number of exclusions within the feasible development capacity assessment is extensive and thus it is possible to conclude that a high degree of confidence can be applied to the TPG assessment when compared to the theoretical Plan enabled assessment. That said, it is important to note that Colliers have commented that a more detailed analysis of the Avonhead/Ilam, Burnside/Russley and Bush Inn/Ilam areas could reveal an increase in capacity.

193. Overall, TPG assessed the feasible development capacity at 58,188 dwellings. In Colliers' view this represents an adequate housing capacity.

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[60] Noting that there are some variations on this for the RNN and RMD zones which are to be rezoned RMD
[61] New Medium Density Residential Standards (MDRS) – Assessment of Housing Enabled dated January 2022
[62] TPG report page 30

194. Colliers took this work one step further to account for the OE, including the area that is proposed to be rezoned High Density Residential. In their assessment, the inclusion of the additional residential land under the remodelled contours as a qualifying matter would reduce the feasible development capacity by some 4000 households. Noting this reduction, Colliers concluded that it was relatively minor, and that the remaining capacity was "adequate when considered in the conjunction with the housing capacity in zoned greenfield areas of the city."[63]

195. While this reduces TPG's estimate feasible development capacity to something in the order of 54,000 dwellings, this only represents a 7% reduction in feasible capacity. As noted above, however, the Colliers assessment was based on the larger OE contour rather than the AAOCB and, as a consequence, the reduction in feasible capacity will be less than 7%. Given this, Colliers conclusions with respect to the adequacy of the housing capacity remains valid.

196. Also, while it is arguable that any reduction in development opportunities resulting from the application of the AAOCB as a qualifying matter is potentially undesirable, it is essential to consider two matters:

a. the legislation deliberately and purposefully provides for qualifying matters and thus recognises there will be circumstances where the development potential of the MDRS can not and ought not be realised; and

b. it is clear, for all the reasons outlined in the Part A assessment above, and in the section 32 assessment (**Appendix Eight**), that such circumstances exist here.

[63] Colliers report, page 5

# PART C: RECOMMENDATIONS

197. Given the above, it is recommended that proposed Plan Change 14 should include alterations to the MDRS to accommodate the airport noise qualifying matter, with the existing zonings beneath the AAOCB, and with the operative density standards, development controls and policy frameworks remaining in place. Specifically, this should include the following provisions of the District Plan:
   i. Strategic Objectives 3.3.1, 3.3.4, 3.3.7, 3.3.12 and 3.3.14;
   ii. Objective 6.1.2.1 and Policies 6.1.2.1.1 and 6.1.2.1.5;
   iii. Objective 7.2.1 and Policy 7.2.1.8;
   iv. Objective 7.2.2 and Policies 7.2.2.1 and 7.2.2.3;
   v. Objective 8.2.3 and Policy 8.2.3.5, and the relevant subdivision standards for the RS, RSDT and RNN zones;
   vi. Objective 14.2.1 and Policy 14.2.1.1;
   vii. Objective 14.2.2 and Policy 14.2.2.2;
   viii. Objective 14.2.3 and Policy 14.2.3.1;
   ix. Objective 14.2.4 and Policies 14.2.4.1 and 14.2.4.2;
   x. Objective 15.2.4 and Policy 15.2.4.5;
   xi. Rules 6.1.7.1 and 6.1.7.2; and
   xii. Rules 14.4.1.4 RD34 and 14.12.1.3 RD26, and the relevant permitted and controlled activity standards applicable in Residential Suburban, Residential Suburban Density Transition, and Residential New Neighbourhood zones.

198. In addition, it will also be necessary to:
   a. Delineate the AAOCB on the relevant zones in the Planning Maps to show the extent of the qualifying matter in the District; and
   b. include an additional non-complying activity rule for sensitive activities within the new Commercial Mixed-Use zone beneath the AAOCB (Memorial Avenue).

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# **Appendices** – attached separately

**Appendix One: AAOCB Contour**

**Appendix Two: Airbiz Report – Airport Operations and Safeguarding**

**Appendix Three: Paling Consulting Report – Freight Tends**

**Appendix Four: Property Economics Report – Economic Significance and Vulnerability**

**Appendix Five: Marshall Day Acoustics Report – Noise Effects**

**Appendix Six: Marshall Day Acoustics Report – Land Use Planning**

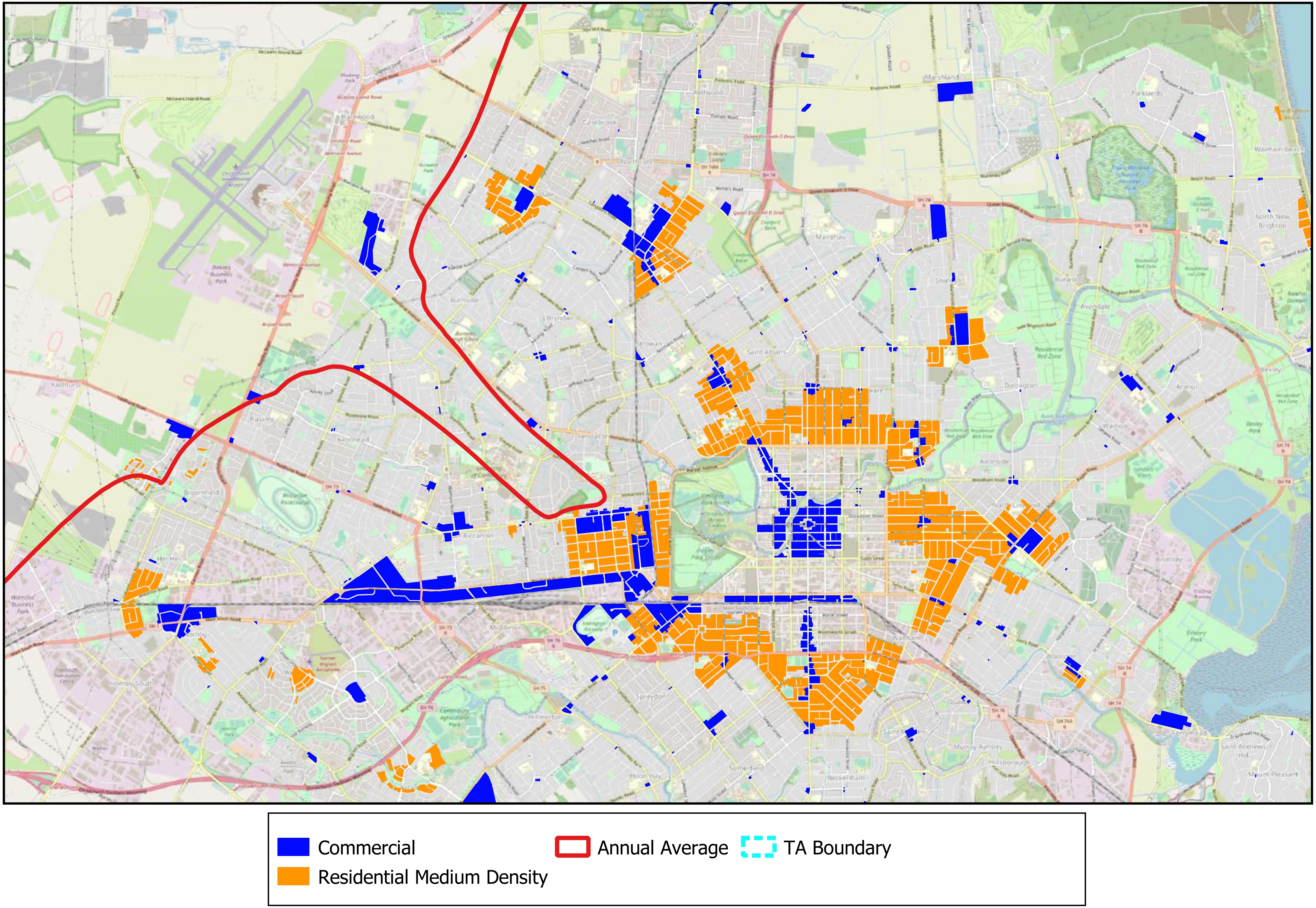
**Appendix Seven: Caselaw Extracts**

**Appendix Eight: Section 32 Report**

**Appendix Nine: Colliers Report**

# Appendix 11

Airport Contour s77K Appendix One: AAOCB Contour



Commercial
Residential Medium Density
Annual Average
TA Boundary

# Appendix 12

Airport Contour s77K Appendix Two: Airbiz Report – Airport Operations and Safeguarding

# CHRISTCHURCH INTERNATIONAL AIRPORT

## Air Noise Contours: Outer Control Boundary and Airport Safeguarding at Christchurch International Airport

14 June 2022

Final
Legally Privileged

AIRBIZ

# Introduction

1. Christchurch International Airport Limited (*CIAL*) is currently undertaking a review and update of the Christchurch International Airport (*CIA*) air noise contours which were last updated in 2008.

2. As part of this process Environment Canterbury (*ECan*) are peer reviewing the proposed updated contours, which were prepared by a group of independent noise and aviation experts.[1] In addition, ECan is undertaking a specific review of the basis for the Outer Control Boundary (*OCB*).

3. As will be explained in more detail in the following sections, all around the developed world, land use planning in the vicinity of airports is an essential tool to ensure compatibility with exposure from aircraft noise on arrival and departure from the runways. Land development outside the airport boundary is not prohibited, but zoning recommendations and regulations protect amenity values accordingly. For example, land in the vicinity of airports may be zoned for uses such as industrial and commercial (less sensitive to aircraft noise) more so than residential, hospitals, schools (more sensitive to high levels of exposure from aircraft noise).

4. Internationally the generic planning regime relies on a "noise-dose" response curve, correlating exposure to increased levels of aircraft noise with increased annoyance. In the New Zealand context this is described and regulated based on the New Zealand Standard NZS 6805, which defines two boundaries based on projected cumulative average daily noise exposure levels (in New Zealand based on the Ldn metric). The first boundary which relates to limiting residential and similar noise sensitive development is called the **Outer Control Boundary (*OCB*)**. The other, closer to the runways and with higher levels of noise exposure, is the **Air Noise Boundary (*ANB*)** which is also used to check airport compliance.

5. The OCB is a key tool in airport safeguarding, providing land use protection from *'incompatible land uses'*[2] around an airport, such as *'new residential, schools, hospitals or other sensitive uses'*[2]. For Christchurch Airport, the OCB is set at 50dB Ldn. We understand that the policy underpinning this is a specific focus of the OCB review by ECan.

6. The New Zealand Airport Noise Management and Land Use Planning Standard NZS 6805 provides recommendations for the *'minimum requirement needed to protect people from the adverse effect of airport noise'*[2] and defines a minimum requirement for an OCB at *'55dB Ldn'*[2].

7. It goes on to note that *'a local authority may determine that a higher level of protection is required in a particular locality'*[2] and *'This Standard shall not be used as a mechanism for downgrading existing or future noise controls designed to ensure a high standard of environmental health and amenity values'*[2].

[1] *Including representatives from Marshall Day Acoustics, Airbiz and Airways.*
[2] *NZS6805-1992 Airport Noise Management and Land Use Planning*

8. CIA's OCB at 50dB Ldn currently provides a higher level of protection for the community and airport operations than the minimum level noted in NZS 6805 of 55dB Ldn.

9. A change to the basis of the OCB from 50dB Ldn to 55dB Ldn around Christchurch Airport would effectively shift the OCB closer to the airport campus and provide opportunities for new noise sensitive uses such as residential, schools or hospitals to be exposed to levels of aircraft noise that they are currently protected from. This would downgrade existing protection to the minimum level recommended and reduce airport land-use protections or safeguards.

10. As well as exposing communities to additional aircraft noise, reduced land-use protection often results in reverse sensitivity issues that can impact the ability to operate an airport efficiently, often leading to operating restrictions at the airport and significant impacts on airport users and the communities they serve.

11. To specifically highlight this risk, this report includes an explanation of how the potential loss of existing levels of land-use protection could lead to restrictions on the airport, a reduced ability to operate the airport efficiently and negative impacts on existing operations.

12. In addition, this report examines international examples of approaches to land-use protection in the vicinity of airports and considers how, when these have not been implemented appropriately, they have resulted in constraints to airport operations.

13. This report sets out:
    1. **Airport Safeguarding Principles**
    2. **ICAO Balanced Approach to Aircraft Noise:** ICAOs recommended approach to noise management around airports.
    3. **Approaches to Land-Use Planning and Management Safeguards:** a brief survey of the variety of Land Use Controls in use internationally.
    4. **General Consequence of Inadequate Land use Protection**
    5. **CIA Importance and Potential Impacts of Relaxed Protection**
    6. **Appendix – Case Studies.**

# 1. Airport Safeguarding Principles

14. Safeguarding an airport and its operations is critical to protect its current and future ability to function efficiently and competitively, and to enable it to continue to serve local and national roles as essential transport infrastructure connecting communities.

15. Urban development encroachment into areas required for airport safeguarding is a "lose-lose" situation (for the airport and community it serves) and is irreversible. It is very expensive, if not impossible, to recover land for safeguarding purposes once it has been developed for urban purposes. A consistent conservative long-term approach is therefore justified and essential.

16. Inadequate protection can, and will often, lead to the creation of reverse sensitivity issues and constraints on air services operations, capacity and creation of hazards which could pose a risk to operational safety. Carefully considered and appropriate land-use planning is the most effective means to protect the airport and the community against adverse impacts. The New Zealand National Airspace Policy 2012 notes :

> *"To avoid or mitigate incompatible land uses or activities and potential obstacles or hazards that will impact, or have the potential to impact on the safe and efficient operation of aircraft, regional and district plans should have regard to applicable Civil Aviation Rules. Airport authorities and local authorities should work together in a strategic, cooperative and integrated way to ensure that planning documents (including those under the Resource Management Act) appropriately reflect the required noise contours and/or controls and approach and departure paths that take account of current and projected traffic flows.*
> ***Resource Management Act planning tools (including plan rules and designations) should as far as practicable seek to avoid the establishment of land uses or activities and potential obstacles or hazards that are incompatible with aerodrome operations or create adverse effects**."*

17. The New Zealand Airports Association (NZ Airports) is the industry association for New Zealand's airports. It represents the national network of 42 airports. In its 14 February 2020 submission on the Urban Development Bill[i] NZ Airports notes:

> *"Most airports in New Zealand rely heavily on district planning controls around airports to avoid or manage adverse effects on their operations due to incompatible (e.g. sensitive) activities locating in proximity to airports…… It is critical that the effects areas surrounding many of New Zealand's airports are well understood and maintained and their effectiveness is not undermined through inappropriate development. **The location of urban development within airports' effects areas without due consideration to the potential effects of such development on airports, and vice versa, has the potential to undermine the protections these areas provide for ongoing airport operations**."*

18. NZ Airports has adopted the Airport Master Planning Good Practice Guide February 2017[ii] which sets out good practice guidelines for development of airport master plans. This was developed in conjunction with the Australian Airports Association (AAA) and uses the Australian National Airports Safeguarding Framework to inform it. Section 3.2 - Off Airport Planning Objectives, notes that:

> *"Off-airport planning is often an area overlooked or inadequately addressed by airport Master Plans. Nevertheless this is a critical issue for the long term safeguarding of any airport and it should be addressed.*

19. It goes on to note:

> *"Outside the airport site, appropriate planning controls should be in place to protect the ongoing operation of the airport. …Local Government is not necessarily aware of the importance to the air transport network (and consequently national and regional economies) of safeguarding airports to enable them to meet current and future capacity requirements. It is therefore imperative that airports work with Local Government to provide the basis for safeguarding the ongoing capacity of the airport."*

20. Relaxation of existing airport safeguards, or insufficient safeguarding itself, can lead to 'reverse sensitivities' where effected populations lobby to restrict current or future operations at the airport.

21. Christchurch Airport, through consistent long term protection by planning authorities, has limited urban encroachment within areas that may be impacted by aircraft noise. Compared with the other primary New Zealand airports of Auckland and Wellington, there is very little conflicting land-use. The number of people within current and projected noise impacted areas in Christchurch is low when compared to these and other similar airports overseas.

22. To ensure that CIA's primary purpose as an important economic and community asset and that the amenity of the residents of Christchurch, Selwyn and Waimakariri is preserved, it is vital that long-term land use planning in the vicinity does not compromise CIA or the community. Any loosening or gap in airport safeguarding through deficiencies or relaxation of land-use controls will be irreversible. It will result in populations living in areas affected by noise from aircraft operations, or alternatively potential pressure for restrictions on airport operations and prejudice regional and national economic opportunities.

23. While there is pressure on Local Government to find areas for further development of new residential, schools, hospitals etc., the clear preference is to locate development outside of those neighbourhoods directly under flight paths. If development was permitted in those locations it would expose these sensitive populations to aircraft noise impacts.

# 2. ICAO Balanced Approach to Aircraft Noise

24. The United Nations agency setting international policy and regulation for civil aviation is the International Civil Aviation Organisation (*ICAO*), to which New Zealand is a signatory state. The main overarching ICAO policy on aircraft noise is the **Balanced Approach to Aircraft Noise Management**. It consists of four principal elements (pillars). The goal is to address local noise issues and identify the measures that most cost effectively achieve the maximum environmental benefit.

25. The four pillars of the balanced approach are:
    - **a.** Reduction of Noise at Source (Technology Standards);
    - **b.** Land-Use Planning and Management;
    - **c.** Noise Abatement Operational Procedures; and
    - **d.** Operating Restrictions.

26. The four pillars are summarised below with the author's added commentary indicating their relative severity on airport operations if not implemented properly:

| ICAO Balanced Approach Pillar | Pillar Role and Process | Potential Significance of Impact on Airport Operations |
|---|---|---|
| Reduction of Noise at the Source | Technology-driven and dependant on airlines introduction of new technologies. | Low |
| Land-Use Planning and Management | Pro-active safeguarding of the airport and community in order to have the most significant and lasting benefits over the long term. It is important to prevent sensitive areas against the adverse impacts of aircraft noise through land use controls around the airport, despite changes in operations/growth.<br><br>Compatible land-use planning and management is also a vital instrument in ensuring that the gains achieved by the reduced noise of the latest generation of aircraft are not offset by further residential development around airports [3] | Med |
| Noise Abatement Operating Procedures | Reactive mitigation of aircraft noise impacts through the modification of operating procedures to minimize aircraft noise over residential areas. | |
| Operating Restrictions | The final remedy if the other measures are not effective or not available. May include curfews, caps or other restrictions. These almost inevitably restrict capacity and airline connectivity options. Restrictions can be self-imposed or be the result of community/political pressure forcing regulatory restrictions. | High |

*Table 1*

[3] https://www.icao.int/environmental-protection/pages/Land-use-Planning-and-Management-.aspx

27. ICAO notes that:
*"it was important to consider equally all of these elements, and they agreed to the principle that operating restrictions should not be applied as a first resort, but only after consideration of the benefits to be gained from other elements in a manner that is consistent with the Balanced Approach"* [4]

28. Airbiz professional experience supports the ICAO statement, as impacts on airport operations are expected to be greater when using the Noise Abatement Operational Procedures and/or Operating Restrictions pillars. Therefore, potential noise impacts on communities in the vicinity of airports should be avoided by Reduction of Noise at Source and then Land-use Planning and Management pillars, before moving to Noise Abatement Operating Procedures or Operating Restrictions to mitigate residual impacts.

29. Where the first two pillars fail to deliver adequate safeguarding and community amenity values are compromised, reverse sensitivity issues may require that the other pillars are brought into play, with resulting limitations on airport operations and efficiency.

30. To be more specific, where long-term <u>Land-Use Planning and Management</u> fails to limit residential or similar sensitive uses in areas of highest aircraft noise exposure, then <u>Noise Abatement Operational Procedures</u> will inevitably need to be investigated and implemented where feasible. Examples include preferential runway modes and rotation of flight path usage to provide respite or "share the noise".

31. The "last line of defence" relies on <u>Operating Restrictions</u> at an airport which can include:
    - Limits on the type of aircraft operating
    - Quotas for overall aircraft movements or for aircraft particular types, or for night movements
    - Curfews.

32. <u>Operating Restrictions</u> should be considered as a "last resort" as they will have the most significant impact on airport efficiency, capacity and flexibility of airlines to schedule flights to meet demand and fit in with global networks, with an economic and financial cost to various stakeholders and the travelling public.

33. The OCB regulatory framework described in the New Zealand Standard NZS 6805 fits into the <u>Land-Use Planning and Management</u> pillar. It can be considered as "prevention is better than cure". Currently, through appropriate use of this pillar in the OCB context, CIA has not had to resort to significant Noise Abatement Operating Procedures or Operating Restrictions. Although there are procedures in place to manage noise for cross-wind runway operations. CIAL is also required to ensure aircraft noise is complies with the noise limits set in the District Plan(s) related to the Air Noise Boundary (ANB) through and annual reporting process.

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[4] Guidance on the Balanced Approach to Aircraft Noise Management, Second Edition, 2008, International Civil Aviation Organisation (ICAO)

34. Subsequent sections of this report illustrate the impacts of failing to provide adequate Land-Use Planning and Management safeguards (pillar 2) around an airport. They show how the mitigation of resulting reverse sensitivity impacts must then rely on the last two pillars, Operational Procedures to Mitigate Noise and/or Operating Restrictions, with associated negative impacts on an airport and the community and economy it serves.

35. The accepted method to develop Land-Use Planning and Management safeguards around an airport is to use noise contours, such as an Outer Control Boundary (OCB, the 55dB Ldn contour at a minimum, in New Zealand), or a Noise Exposure Forecast (ANEF 20 in Australia) to prevent noise sensitive uses such as residential developments and other sensitive-uses i.e. age-care centres, schools, hospitals, locating in areas adversely affected by aircraft noise.

36. The specific metrics used to define similar boundaries may vary around the world, but are typically based on a correlation between:

    **a.** a cumulative aircraft noise exposure level;
    **b.** the proportion of the community likely to be annoyed by the aircraft noise (noise-dose response curves); and
    **c.** level of annoyance (moderately or seriously affected).

37. Some provincial governments in Canada have their own land use planning instruments to manage development around an airport, such as an Airport Operational Area (AOA) and Airport Vicinity Protection Area (AVPA) for safeguarding like the OCB in New Zealand.

38. These various controls are discussed in the following section.

# 3. Approaches to Land-Use Planning and Management Safeguards

39. Aircraft noise related land-use safeguards, such as an OCB, are determined based on noise exposure metrics which correlate noise exposure to a self-reported level of annoyance or response from the community (moderately or seriously affected).

40. The mathematical calculation of noise exposure metrics vary but the compatible land use tables used to guide zoning are then correlated with community annoyance (at the societal rather than the individual level, based on literature or, where available, local surveys). Assumptions that determine the extent of the area within land-use planning control boundaries include:
    - Definition of a demand design day (e.g. average, 95$^{th}$ percentile, average of the 3 busiest months, etc).
    - Definition of a night movement (7pm-7am, 10pm-7am, 11pm-7am, etc.).
    - Definition of a night movement weighting factor (10 dB, 12 dB, etc.). Further explanation is included in Table 2 on the following page.
    - The air traffic forecast horizon (10 or 20 years, or airport/runway capacity).

41. Noise exposure contours used to limit residential and other sensitive uses such as schools, hospitals etc. in the vicinity of an airport vary in different jurisdictions – there is no universal contour or metric. However, the general principle of protecting the community from the adverse effects of aircraft noise and the airport from reverse sensitivity issues is a common goal. For example, in Australia the contour used to limit residential developments is the 20 ANEF and in Canada the 30 NEF is used.

42. Other noise metrics are used around the world for transparent communication with the community, and complement cumulative noise exposure contours which are generally adopted to support land-use planning compatibility tables. Other metrics include single event noise contours (SEL, LAmax) which have been used to research sleep disturbance, and 'number-above' (e.g. N70) contours to reflect the annoyance that may be associated with the number of perceptible noise events rather than the cumulative noise level of those events. This is now becoming more generally accepted to inform individuals in environmental studies (including evaluation of flight path changes) as they experience noise, rather than the more technically complex, community aggregated response, which guide land use policy decisions.

43. Whatever the metric used, noise does not stop at the contour boundary. There will still be significant numbers of individuals who will consider themselves annoyed, even at lower levels of noise exposure. Other acoustic and non-acoustic factors will influence how an individual will react to aircraft noise from individual and multiple events, during the day and at night.

44. Some airports have developed land-use planning controls based on a composite (i.e. worst case) of multiple operational scenarios and a combination of metrics (daytime cumulative, night-time cumulative etc.) to ensure future growth of airport operations is accounted for.

Examples of this are Melbourne and Perth which are protecting for future enhancements such as new or extended runways.

45. In New Zealand, as described in NZS6805-1992, the OCB is based on:
   - Average demand of the 3 consecutive busiest months ("or other such period as agreed between the operator and the local authority");
   - Ldn metric using night weighting factor of 10 dB for movements between 11pm and 7am; and
   - Composite of Ldn contours with a SEL single-event contour for the infrequent use of a critical aircraft or pattern, especially at night.

46. A comparison of New Zealand's OCB to other residential land-use controls around the world is provided below.

| **Metric** | **Region/Airport** | | | | |
|---|---|---|---|---|---|
| | **NZ** | **AUS** | **CAD** | **VIE** | **AMS** |
| **Control boundary for residential development** | OCB (55dB, Ldn) | 20 ANEF | 30 NEF | 54 dB(A) Lday<br>45 dB(A) Lnight | 48 dB(A) Lden<br>40 dB(A) Lnight |
| **Demand Day** | Average demand of the 3 consecutive busiest months | Average Day | 95th percentile day for the year | Average Day based on busiest 6 months | Average Day based on cumulative annual traffic |
| **Night Movement** | 11pm to 7am | 7pm to 7am | 10pm to 7am | 10pm to 6am[5] | 7pm to 11 pm (Evening)<br>11pm to 7 am (Night) |
| **Night Movement weighting** | 10 dB | x4, or<br>6 dB | X16.7, or<br>12.2 dB | n/a | 5 dB – evening<br>10 dB - night |
| **Other Factors** | SEL single-event contour for the infrequent use of a critical aircraft | | Use of Composite contours | N65 contours | Cap based on number of people living within contours |

*Table 2*

47. The commonality across all metrics in Table 2 is that they all use an equal energy/cumulative type metric averaged over a period (busy day, average day etc.), with a night weighting to account for increased sensitivity at night and sleep disturbance.

[5] https://www.dialogforum.at/jart/prj3/df/uploads/data-uploads/Publikationen/ergebnisse_eng_lo.pdf

# 4. General Consequences of Inadequate Land Use Protection

48. Prudent land use planning in Christchurch has achieved a level of safeguarding of community amenity that would be the envy of other similar urban and lifestyle communities. It has also safeguarded future operations of Christchurch Airport for the benefit of the community that it serves. Throughout New Zealand the OCB is generally at the 55 Ldn, as also mentioned in the New Zealand standard[6] (1.1.4). The Standard does allow for greater levels of protection, but this only seems to have been achieved at Christchurch. Internationally the equivalents of the OCB are at levels higher than Ldn 50 equivalent. This does not mean that in these jurisdictions a higher level of protection of community amenity would not be desirable.

49. Literature reviews of noise-dose response research and surveys show that there are still significant proportions of a population near airport flight paths that consider themselves high or moderately annoyed at exposure levels below 55 Ldn. This is discussed in the Marshall Day Acoustics '*Christchurch International Airport Land Use Planning*' report dated 23 May 2022.

50. Generally, with increased affluence and environmental awareness at the societal level, communities continue to increase their amenity expectations even if land use controls have not or cannot be implemented post-facto at lower levels, or where this cannot be achieved due to political pressure for expansion of urban areas around growing cities.

51. The case studies demonstrate that, whatever the actual metric selected and the position of a noise contour for planning purposes, there are linkages between urban encroachment and pressures to mitigate actual or perceived, current or future aircraft noise impacts through operational restrictions.

52. No cases were found where regulatory authorities relax protection in terms of an OCB equivalent level. Shrinkage of contours does occur due to periodic update of modelling of noise boundaries due to introduction of quieter aircraft (Brisbane) or flight paths (Calgary), but subsequent urban encroachment has clearly shown increased pressure for airport operational restrictions.

53. Inadequate land use protection in the vicinity of an airport, or the relaxation of existing controls, enables noise sensitive uses and urban development/intensification to encroach under flight paths, with associated reverse sensitivity risks to the airport.

54. To illustrate this risk, we have reviewed several international airports below where land use controls have proved ineffective and identified the consequences. Full case studies are included in the Appendix, and summaries of the case studies are discussed throughout the section below where relevant.

[6] NZS 6805-1992 Airport Noise Management and Land Use Planning

55. At Melbourne Airport, the late introduction of appropriate safeguards allowed urban encroachment around what was originally developed as a new "greenfield" airport. This encroachment has resulted in pressures for operational restrictions. This is outlined in Case Study 1 below.

### CASE STUDY 1 SUMMARY: MELBOURNE AIRPORT

#### Airport Introduction and Context

Melbourne Airport is Australia's second largest airport, serving approximately 37 million annual passengers before the COVID-19 pandemic. The location was selected due to its proximity to the city, whilst still being far enough away from urban development to allow the airport to operate unconstrained.

When the airport was designed and built (1970), noise buffer zones were established in the surrounding area and along proposed flight paths. However, special protective land-use controls on the areas surrounding the airport weren't introduced until 1992 (in the form of the Melbourne Airport Environs Area), by which time significant urban encroachment had occurred through rezoning and development of land in the buffer zones. [7]

#### Constraint Imposed

Urban encroachment on Melbourne Airport has become a major factor in shaping and defining the proposed plans for a 3rd runway and its flight tracks. To mitigate noise impacts, Melbourne Airport are having to propose a range of operating controls (operating in segregated modes, SODPROPS (simultaneous opposite direction parallel runway operations) etc.), all limiting airport capacity. Despite these compromises, the airport still faces calls for a curfew from residents living far outside the current equivalent of an Outer Control Boundary. [8]

#### Key Findings

- Long-term safeguarding through land use controls needs to be in place early and consistently protected. The control buffers must be conservative enough to minimise noise impacts of unforeseen changes outside of the airport and community's control.
- Once controls are relaxed, development will occur and urban encroachment cannot be reversed.
- As a result of tardy implementation of regulated buffers against urban encroachment, the airport now faces calls for a curfew from residents in the vicinity of the airport and its arrival and departure flight paths.

[7] Michael Buxton & Arun Chandu (2016) When growth collides: conflict between urban and airport growth in Melbourne, Australia, Australian Planner, 53:4, 310-320, DOI: 10.1080/07293682.2016.1275718

[8] https://brimbanknorthwest.starweekly.com.au/news/runway-concerns-mount/

56. Calgary Airport provides an example where effective and conservative land-use planning controls enabled flexibility for necessary changes to airport operations associated with a new runway and limited the impacts of reverse sensitivities.

## CASE STUDY 2 SUMMARY: Calgary Airport

### Airport Introduction and Context

Calgary Airport is the 4th busiest airport in Canada with 18 million passengers in 2019. It was planned as a multiple runway system with a parallel runway commissioned in 2014. The airport is located 19km from downtown Calgary. In 1979 the Alberta provincial government enacted the Airport Vicinity Protection Area (AVPA) regulation to govern development close to the airport. Noise Exposure Forecast (NEF) contours were used to define the AVPA and protect for a future parallel runway which was finally commissioned 35 years later. Because the AVPA was enacted before significant urban encroachment occurred, the airport had appropriate long term protection in place to enable such a significant development and operational change.

### Constraint Imposed

Despite this, in 2014, the commissioning of the new parallel runway triggered a negative response in the community.  Detailed airspace design for the runway led to the implementation of flight tracks that weren't considered in modelling assumptions that formed the basis of the earlier AVPA.

Provisions for parallel operations were published in 1995, followed in 2004 by the first edition of the Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR), including the need for 15 degrees divergence in circumstances when it is intended to use two instrument departure procedures from parallel runways simultaneously.

Hence, when the need to construct the parallel runway and finalise operational flight paths for the Calgary Airport arose, detailed flight path design rules based on operational safety were already in place and differed to those in the early AVPA assumptions. Communities under the new flight tracks were exposed to aircraft noise and flight tracks had to be altered (to 10 degrees rather than 15) to mitigate impacts and alleviate concerns. Because the NEF contours were implemented conservatively and to protect a future parallel runway, the airport retained flexibility when implementing the new runway. Without pro-active land-use controls, such a solution would not have been possible and more constraining operating restrictions may have been required.

### Key Finding

Land-use protection based on conservative assumptions (e.g. protection of existing and future airfield layout) around the airport provided a degree of flexibility for changes to future operational assumptions and led to the adjustment of operations on the new runway and subsequent AVPA review reflecting a new airport operational outcome (parallel runway operations). The airport did not need to move to operating restrictions, in part, due to adequate land use safeguarding.

57. Brisbane Airport, with a long-term vision for a new parallel runway, prior to its development adjusted airport master planning to reduce the impact of future aircraft noise impacts on the community by increasing already substantial buffer zones. Even with this, since the development and operational commissioning of the new parallel runway and associated flight path changes, adverse community reaction has led to a trial of 3 three noise-reducing initiatives, two of which could reduce the long-term runway capacity. It could negate any gains from the substantial investment in the new parallel runway at substantial financial and economic cost to the region.

## CASE STUDY 3: Brisbane Airport

### Airport Introduction and Context

Like Melbourne, Brisbane was built as a greenfield airport in 1988 with a main and cross-wind runway, and an Airport Master Plan with associated reservation and protections for a future parallel runway when required. It's Australia's 3rd busiest airport, handling approximately 24 million passengers in 2019. The airport is located 13km from the CBD.
Over the years since its opening, the equivalent of the Outer Control Boundary for Brisbane Airport (the ANEF 20 within which new residential development is only conditionally acceptable (requires noise insulation) has significantly shrunk due to changes in technology (largely between 1983 and 1998) reducing noise of aircraft at the source, despite annual movements increasing.

### Constraint Imposed

During the years leading up to the runway opening, including meeting requirements for regulatory approvals processes, Brisbane Airport undertook extensive community consultation on the expected noise impacts from the new runway and associated flight path changes in the vicinity of the airport. A number of noise abatement procedures were implemented, including a preference for operations over the bay when safe, and recommended flap settings to reduce airframe noise. However, despite these mitigation efforts and extensive community consultation, Brisbane Airport is now facing substantial political pressure from residents groups for operational restrictions to be imposed due to noise since the runway opened in 2020.

Despite the airport responding to community concern with additional noise mitigation initiatives, in February 2022 the Green party announced their plan to introduce a new bill to the Australian parliament to impose a curfew from 10pm to 6am and hourly flight caps of 45 movements per hour on the airport.[9] If this bill passes, it will have a very serious impact on the capacity of the airport, effectively rendering the development of the new parallel runway of no value since the airport was operating at around 50 movements per hour before its opening.

### Key Findings

- Noise contours shrunk over the years due to changes in technology, allowing some urban development towards the airport.
- Brisbane Airport undertook a number of mitigative measures to reduce the impact of noise on the community including increasing an already substantial buffer zone, shifting the location of the new runway further from residents and implementing several noise abatements procedures.
- Even with a substantial buffer zone community reaction has led to a trial of three noise-reducing initiatives, two of which could significantly reduce runway capacity.
- Despite responsive actions to address community concerns, community lobby groups and political parties are still pushing for a curfew and hourly movement caps.

[9] https://australianaviation.com.au/2022/02/greens-push-to-introduce-brisbane-airport-curfew/

58. When land use planning tools are not effective, reverse sensitivity issues may require approaches to noise mitigation that rely on Noise Abatement Operating Procedures and/or Operating Restrictions.

59. Several different Noise Abatement Procedures and Operating Restrictions are used around the world to minimise the impact of aircraft noise on the community, impacting airport and aircraft operations. Most people are aware of curfews, but there are many other measures that are currently in place.

60. The table below lists some of those measures, including examples of airports with those measures imposed.[10] Measures 1-4 are Noise Abatement Operating Procedures, which have some impact on airport operations. Measures 5-10 are Operating Restrictions and have a greater impact on airport operations.

| # | Noise Mitigation Measure | ICAO Balanced Approach Pillar | Description | Example Airports[11] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MEL | BNE | AMS | YYC | YYZ | VIE | YTZ | YWG |
| 1 | Noise Abatement Procedures | Noise Abatement Operating Procedures | Changes to arrival/flight tracks and/or flying techniques (eg. Reduced thrust, limits on reverse thrust, increased climb) | X | X | X | X | X | X | X | X |
| 2 | Preferential Runways | Noise Abatement Operating Procedures | Prioritise use of a particular runway when possible to minimise overflight of urban areas, or rotation of runway modes to share noise over different communities. | X | X | X | X | X | X | | X |
| 3 | APU Operating Restrictions | Noise Abatement Operating Procedures | Prohibition of the APU (Auxiliary Power Unit) while the aircraft is on the ground and recommends the use of fixed or mobile GPU (Ground Power Units) | | | X | | | X | | |
| 4 | Airport Curfews | Operating Restrictions | Time intervals in which take-off or landing is not permitted for some or all aircraft types | | | X | | X | X | X | |
| 5 | Noise Charges | Operating Restrictions | Additional charge to airlines whose aircraft exceed the allowable values of noise as well as additional charge to companies using older (louder) aircraft types. Charges can vary with time of day, weight of aircraft etc. | | X | X | | X | X | | |

[10] Emir M. Ganic, Fedja Netjasov, Obrad Babic, Analysis of noise abatement measures on European airports, Applied Acoustics, Volume 92, 2015, Pages 115-123, ISSN 0003-682X
[11] https://www.boeing.com/commercial/noise/list.page

| # | Noise Mitigation Measure | ICAO Balanced Approach Pillar | Description | Example Airports[11] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MEL | BNE | AMS | YYC | YYZ | VIE | YTZ | YWG |
| 6 | Noise Level Limits | Operating Restrictions | Permitted noise values in certain points of the noise monitoring system (usually per operation), the excess of which leads to additional charges (or fines) applied to airlines | | | X | | | | | |
| 7 | ICAO Annex 16 Chapter 3/Chapter 2 Restrictions | Operating Restrictions | Prohibition of flying for aircraft that are certified in accordance with Chapters 2 and 3 of ICAO Annex 16, Volume 1 (noise certification levels) | X | X | X | X | X | X | | X |
| 8 | Operating Quotas | Operating Restrictions | Limit of the number of commercial operations at the annual or seasonal level as well as the limited number of arrivals and departures during peak hours | | | X | | X | | X | |
| 9 | Noise Budget Restrictions | Operating Restrictions | The process of slot allocation in order to meet the defined criteria (e.g. the annual number of operations) and approved overall noise level (noise total volume) | | | X | | X | | | |

*Table 3*

61. Whilst there's a variety of measures applied around the world, some are much more commonly used. Ganic et al. (2015) analysed 248 European airports with noise mitigation measures in place and found that curfews were applied more often than any other operating restrictions, being implemented at approximately 50% of the airports surveyed.

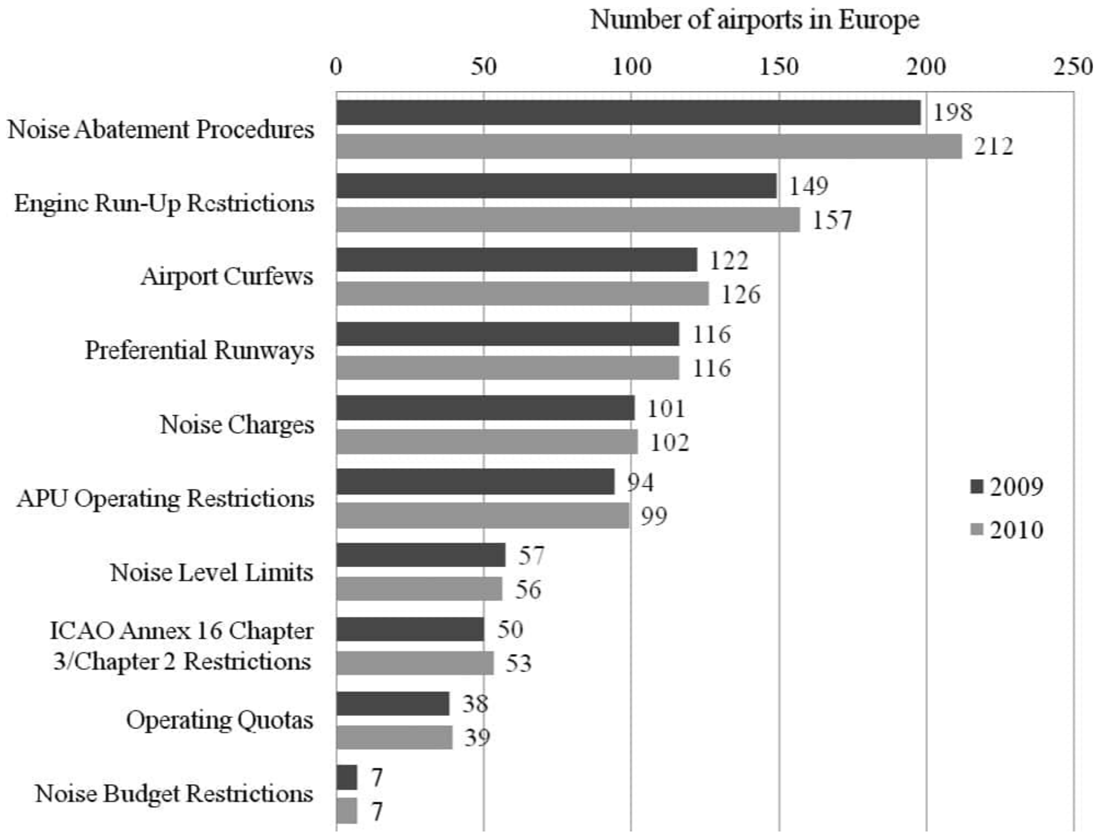



*Figure 1 Distribution of number of airports in Europe that introduced Noise Mitigation Measures in years 2009 and 2010* [10]

62. At CIA the impacts of these types of restrictions could be significant for passenger and freight aircraft operations.

63. Passenger services are highly tuned towards operating at optimum times that maximise passenger volumes across services and networks. Noise mitigation measures that restrict operational flexibility for airlines such as curfews or movement quotas (annual/daily/hourly) reduce airline flexibility to operate at optimum times, potentially impacting the viability of existing services. More detailed examples of these types of impacts are included in Section 5 of this report.

64. Airfreight services are also highly tuned towards commercial drivers. In New Zealand, domestic airfreight typically operates overnight to enable parcels and mail to be distributed the next morning. Again, noise mitigation measures that restrict operational flexibility for airfreight services such as curfews or movement quotas (annual/daily/hourly) reduce flexibility to operate at optimum times. In fact, such restrictions may force air freight operations to other airports that can continue to enable overnight delivery services or where freight services do not have to compete for 'slots' that may be forced by movement quotas. More detailed examples of these types of impacts are included in Section 5 of this report.

65. To support the above explanation around the risk of operational controls resulting from reverse sensitivities, we have reviewed several international examples below.

### CASE STUDY 4 SUMMARY: SCHIPHOL AIRPORT

#### Airport Introduction and Context

Schiphol is the busiest airport in the Netherlands (and one of the busiest in the world) with over 80 million passengers per year before the COVID-19 pandemic. The airport is located 15km from the downtown area of Amsterdam. In the 1970's a new town, Hoofddorp, was built right next door to Schiphol, and in the 1980's and 90's neighbouring cities like Amsterdam and Amstelveen built new areas expanding towards the airport.[12]

#### Constraint Imposed

Although aircraft noise has been an ongoing issue, following commissioning of a new runway, a 'consultation table' was setup by the government to provide advice on the development of Schiphol. This group was tasked with establishing the constraints that now define how the airport can grow and operate. Negotiations produced a new system to control aviation noise with operating constraints imposed based on the number of aircraft movements as well as exposure noise levels. Total numbers of aircraft movements per year and at night are now restricted (movement quota). In the years leading up to the pandemic, Schiphol were consistently operating at or close to the movement quota capacity.

These 'environmental constraints' limit runway capacity, potentially requiring slot allocation rules to be developed and pushing some operations to other airports. In 2017, Singapore Airlines relocated half of their freight operations to Brussels Airport due to a significant reduction in freighter slots at Schiphol because of the movement cap.[13]

#### Key Findings

- Growing encroachment leads to an increased need for community engagement to maintain buy-in. However, operating restrictions may be required to maintain community support.
- Operating restrictions can result in loss of flights to other airports.

[12] M, Wijk & Brattinga, Kes & Bontje, Marco. (2010). Exploit or Protect Airport Regions from Urbanization? Assessment of Land-use Restrictions in Amsterdam-Schiphol. European Planning Studies. 19. 261-277. 10.1080/09654313.2011.532671.

[13] https://www.lloydsloadinglist.com/freight-directory/news/SQ-to-transfer-half-its-Schiphol-freighter-flights-to-Brussels/70526.htm#.Yo3lx6hByUk

## CASE STUDY 5 SUMMARY: TORONTO AIRPORT

### Airport Introduction and Context

Toronto Pearson International Airport is Canada's busiest hub at over 50 million passengers per year prior to the COVID-19 pandemic. The airport is located 30km from downtown Toronto. Despite being opened in 1938, it was only in 1959 that land use development policies using noise contours were considered, ahead of a significant phase of expansion. By that time, urban encroachment was already present. An Airport Operating Area (AOA) was eventually implemented in official city plans to control residential development in the vicinity of the airport.

### Constraint Imposed

In February 2012, NAV CANADA implemented flight track changes in the Toronto-Ottawa-Montreal corridor (the main flight route between these centres), triggering negative community reactions. This led to a significant community consultation process to better disclose the impacts from airspace changes and to identify means to mitigate the impacts of aircraft noise primarily through noise abatement procedures. Interestingly many of the community responses came from locations outside the revised contours. This highlights how noise and associated impacts do not stop at a specific contour boundary.

### Key Finding

- Community annoyance can occur outside the designated noise contours and in places where communities were previously exposed to less frequent aircraft noise.
- Attempts to retrospectively establish appropriate safeguarding areas around the airport have been difficult to effect, due to lack of early and conservative land use planning controls

66. The case studies have illustrated that land use protections are generally changed when there is a trigger to update them such as an operational change, change to regulatory requirements, or a demand/capacity driver. These may be caused by systemic change to the airport's usage such as a change in airfield layout (e.g. new runway) or technology advances in air navigation for aircraft operations (e.g. RNP). Conservative land-use protection is required to limit the impact of these changes on the airport and community when they do occur.

67. Our research did not find any instances where airports or local governments actively reduced land use planning protections (e.g. reduced an OCB from 50 to 55Ldn). Rather, that airports actively aim to retain noise related safeguards and contours that provide conservative land-use protection where possible in order to protect from current and future reverse sensitivities and potential operational restrictions. Any changes in contours were a result of changes in inputs (e.g. fleet mix, flight tracks) rather than a change in the contour level used as the outer control boundary.

68. In the CIA OCB context, while the trigger to change this land use planning control may differ (triggers do differ in most cases surveyed), the risk of reverse sensitivities is the same and the potential range of operational impacts is the same.

# 5. CIA Importance and Potential Impacts of Relaxed Protection

69. A relaxation of the CIA OCB from 50dBA Ldn to 55dBA Ldn would provide a framework to enable new noise sensitive activity such as residential, schools, hospitals etc to be developed closer to Christchurch Airport. The risk of negative amenity impacts on those new occupants, and reverse sensitivities then impacting airport operations and efficiency is real. This risk is demonstrated by global examples documented in previous sections of this report.

70. This section documents the specific risks to CIA and the wider Canterbury community if reverse sensitivity issues result in noise abatement procedures and/or operating restrictions at CIA.

71. Below we set out the following:

    A: General Role and Importance of CIA;

    B: Operations and Dynamics at CIA;

    C: Generic Operating Constraints that could be imposed due to Aircraft Noise Sensitivities (reverse sensitivities); and

    D: Potential Impacts of Constraints to Operations

## A: General Role and Importance

### *General*

72. Christchurch Airport is of significant importance to New Zealand, the South Island, the Canterbury region and Christchurch City as an essential transportation connectivity hub and base for all types of aviation activity now and in the future. CIA has no curfew and is operationally available 24 hours a day, seven days a week. Its 24/7 availability is a significant operational advantage for the CIA's users and the communities it serves.

73. Prior to the COVID-19 pandemic there were direct air service connections from CIA to ten international destinations including Sydney, Melbourne, Brisbane, Perth, Gold Coast, Singapore, Guangzhou, Hong Kong, Rarotonga and Nadi, with nine international airlines represented. Scheduled traffic in the financial year 2019 comprised 92,345 domestic and 11,593 international aircraft movements[14] carrying 6.3 million annual passengers[15] and making CIA the second busiest commercial passenger airport in New Zealand[16].

74. Christchurch Airport is also of international importance, due to its proximity to Antarctica and its role in facilitating scientific exploration of the continent.

75. CIA is a nominated "alternate" for Auckland International Airport. If aircraft bound for Auckland are not able to land there for reasons such as poor weather, an accident blocking the runway or other operational reasons, they can be diverted to Christchurch Airport. Other "alternate" options for Auckland Airport diversions include;

    - Wellington Airport, however the runway is not suitable for most large wide body aircraft, and
    - the Ohakea Royal New Zealand Air Force Base in Palmerston North, however this does not have suitable passenger processing facilities, the runway is shorter than Christchurch and the Airport does not have other scheduled services making it slower for passengers to be processed and sent on to final destinations.

76. As the gateway to the South Island, CIA serves as a regional hub, connecting international and domestic passengers across the South Island. Christchurch Airport also provides critical air connectivity for the movement of international air freight into and out of the South Island and New Zealand, linking into international freight hubs in Australia, Singapore, China and the United States.

77. Statistics New Zealand notes that Christchurch Airport is the second ranking airport for air freight imports and exports in New Zealand (after Auckland), accounting for $3.14 billion New Zealand dollars' worth of air freight in 2017/18[17]. Statistics New Zealand also notes that: *"Air freight carries less than 1% of our trade by volume, but about 16% of our exports and 22% of our imports by dollar value.[iii]"* Christchurch International Airport plays a key role in this trade.

[14] A "movement" of an aircraft (or a passenger) is counted for each arrival, departure or transit/transfer
[15] Christchurch Airport 2019 Annual Report and CIAL data
[16] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR005
[17] https://www.transport.govt.nz/statistics-and-insights/air-and-sea-transport/sheet/air-freight

78. Infrastructure at CIA, such as the runways, taxiways and aprons, provide the basis for air service operators to connect Christchurch, the wider region and the South Island to the rest of New Zealand and the world.

79. The main runway at Christchurch Airport is the second longest runway in New Zealand at 3,287m, allowing air services by new generation aircraft such as the Airbus A350 and Boeing 787, and the world's largest passenger aircraft, the Airbus A380. These aircraft types are critical to passenger capacity and the supply of capacity for international air freight which travels in the belly-hold of these aircraft or on dedicated freight aircraft.

80. The main runway at Christchurch is the only runway in the South Island capable of servicing these large wide body aircraft types without restrictions. If this runway is consistently not available for use, widebody international aircraft (passenger and dedicated freighters) would need to use runways in the North Island. Therefore, Christchurch International Airport it is an essential piece of transport infrastructure for the South Island.

81. The COVID-19 pandemic dramatically altered the aviation landscape as borders were closed and most aviation activity ceased or was severely curtailed. In New Zealand there was a relatively rapid recovery of domestic traffic towards the end of 2020, although international borders were still closed to passengers. CIAL has updated passenger growth projections which considered scenarios for the short, medium and long term air traffic recovery. These updated projections identified that growth in International and Domestic passengers would be reached some 5 years later than in earlier projections due to COVID related impacts i.e. originally forecasted traffic levels for 2025 were identified in the updated forecast to now be reached in 2030.

82. In a press release[18] dated 1st March 2022 the International Air Transport Association (*IATA*) has set out its forecast for air passenger recovery from the pandemic. This notes that air traffic is expected to reach generally 2019 levels by 2024 globally and 2025 in the Asia-Pacific:

    a. *"The International Air Transport Association (IATA) expects overall traveller numbers to reach 4.0 billion in 2024 (counting multi-sector connecting trips as one passenger), exceeding pre-COVID-19 levels (103% of the 2019 total)."*
    b. *"Asia-Pacific: The slow removal of international travel restrictions, and the likelihood of renewed domestic restrictions during COVID outbreaks, mean that traffic to/from/within Asia Pacific will only reach 68% of 2019 levels in 2022, the weakest outcome of the main regions. 2019 levels should be recovered in 2025 (109%) due to a slow recovery on international traffic in the region."*[19]

83. General descriptions of Christchurch Airport's role and operational profiles are provided in this document based on 2019 operations, with some specific references to current (2022) operations where required. 2019 is representative of typical non-pandemic operations at

[18] https://www.iata.org/en/pressroom/2022-releases/2022-03-01-01/

CIA and the associated volume and profile of traffic at Christchurch Airport is expected to generally recover to 2019 levels in the medium term (approximately 5 years). \

## Commercial Scheduled Passenger Services

### *Domestic*

84. In 2019 Christchurch Airport recorded 5,164,504 domestic passenger movements[20] making it the third busiest airport in New Zealand[21] for domestic passengers.

85. In 2019 Christchurch Airport had 105,000 domestic-to-international transferring passengers and 245,000 domestic-to-domestic transferring passengers[22], illustrating its key role in regional connectivity for the lower South Island and as a hub for Air New Zealand in the South Island, distributing and collecting passengers onto trunk domestic services.

86. Domestic data recording reasons for travel is not generally collected other than in periodic sample surveys, however it is generally understood that CIA facilitates travel for leisure, business, visiting friends and relatives (*VFR*), education and medical reasons amongst others.

87. In 2019 Christchurch Airport was serviced domestically[23] by Air New Zealand, Jetstar, Air Chathams and Sounds Air on trunk and regional routes.

### *International*

88. In 2019 Christchurch Airport recorded 1,766,937 international passenger movements[24] making it the second busiest airport in New Zealand[25] for international passengers.

89. CIA provides a key role across a range of social and economic needs and is important in delivering tourists directly to the South Island. In 2019 the main reasons for travel for international passengers arriving at Christchurch Airport were holiday/leisure (63%) and VFR (24%). Discretionary travel is therefore highly significant for Christchurch Airport, with 6 in 7 international visitors arriving for the purpose of holiday or VFR.[26]

90. In 2019 Christchurch Airport was serviced internationally[27] by Air New Zealand, Emirates, Qantas, Jetstar, Virgin Australia, Singapore Airlines, China Southern Airlines, Cathay Pacific Airlines and Fiji Airways.

[20] Christchurch Airport 2019 Financial Statements
[21] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR004
[22] CIAL data
[23] Source: Airbiz analysis of Flight Global Diio 2019 domestic schedules for Christchurch Airport
[24] Christchurch Airport 2019 Financial Statements
[25] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR006
[26] Airbiz analysis of NZ Stats Infoshare International Travel and Migration data for Christchurch Airport international visitor arrivals for the year to June 2019
[27] Source: Airbiz analysis of Flight Global Diio 2019 international schedules for Christchurch Airport

## Air Freight and Mail

### *Domestic*

91. Air freight, small parcels and mail is carried into and out of Christchurch Airport in the belly-hold of commercial passenger operations or on dedicated air freight services.

92. Christchurch Airport is one of three South Island locations for Air New Zealand's domestic air freight operation 'Air New Zealand Cargo' (the others are Nelson and Queenstown). The airline's air freight products tend to focus on general and perishable goods and pets, and are principally transported on their scheduled passenger aircraft services which operate through the day and early evening.

93. Additionally, there is currently (2022) some domestic heavy freight being carried between Christchurch and Auckland on Air New Zealand's dedicated international freighter operations conducted under the Government's MIAC programme (described later in this report at point 130). Domestic "heavy freight" (heavy freight generally excludes non-perishables or small parcels and mail) is usually carried on trucks over the road network.

94. Air freight is also carried in the belly-hold of other domestic commercial airlines such as Jetstar and Air Chathams; this is handled by a ground handler at CIA such as Menzies where it is consolidated for air transport or distributed via freight forwarding companies such as Mainfreight onto the road network.

95. Christchurch Airport is a critical component in New Zealand's small parcel and mail distribution infrastructure, serving as the South Island hub in Parcelair's network, connecting to Auckland for the upper North Island and Palmerston North for the lower North Island.

96. Parcelair is a joint venture between Fieldair Holdings (a subsidiary of Freightways) and Airwork, and services the overnight air freight, courier and mail connectivity needs for principal clients Freightways and NZ Post.

97. Christchurch Airport facilitates the transfer of domestic and regional air freight onto international services, supporting industries such as salmon farming from Nelson/Tasman onto international services.

### *International*

98. In 2019 Christchurch Airport recorded approximately 120,000 international tonnes of air freight and mail. In terms of volume and value, CIA accounts for 14% of all New Zealand's international air freight, making it the second busiest airport [28]in New Zealand for freight and mail.

99. In 2019 at Christchurch Airport, 70% of international air freight and mail was carried in the belly-hold of passenger aircraft and 30% on dedicated international freight aircraft[29].

[28] Airbiz analysis of New Zealand Ministry of Transport website Air Freight statistics for FY18
[29] CIAL data

100. DHL, Qantas and Air New Zealand have used Christchurch Airport for their dedicated international air freight operations, linking into their individual distribution centres located at CIA.

101. During and prior to the Covid-19 pandemic, Christchurch Airport had a typical 5 day a week dedicated freighter service (with some weekly variations) on a B767 freighter taking freight from the Christchurch to Sydney. This is a triangular AKL-CHC-SYD flight operating year-round. On top of this, Christchurch occasionally have freighters going to Brisbane and Melbourne, especially during the summer peak export season.

102. International heavy air freight is screened at Christchurch Airport before being imported or exported on dedicated freighters or in the belly-hold of commercial passenger services.

## Antarctic Operations

103. Christchurch Airport is New Zealand's gateway to Antarctica, with a well-established International Antarctic Centre[iv]. This includes a dedicated Antarctic aircraft apron where cargo is airlifted, with its own airport departure terminal for personnel travelling to and from Antarctica during the summer season. It serves as a base for the United States, New Zealand and Italian[v] Antarctic Programs.

104. Christchurch Airport also provides key emergency access to the continent as recently illustrated by an emergency medical evacuation. Stuff.co.nz quotes:

> *"A military aeroplane was called in to carry out a medical evacuation of a member of the United States Antarctic Program who had been injured in Antarctica. A Royal New Zealand Air Force C-130 Hercules left Christchurch at 10.25pm on Sunday for the seven-hour, 3920km flight to the US-run McMurdo Station on Ross Island."*[30]

This further illustrates the essential role Christchurch Airport in Antarctic operations.

## Airport Campus Role

105. Aviation servicing infrastructure on CIA's campus is intrinsically linked to the air service operations and passenger, baggage and freight flows that Christchurch Airport facilitates. There are a range of businesses located at CIA that provide ancillary support to the air service operations, as well as commercial and service-related offerings.

## Covid-19 Pandemic Role

106. During the current Covid-19 pandemic, Christchurch Airport has played a key role maintaining international and domestic passenger connectivity, whilst meeting health requirements through specific operational protocols enabled within CIA's terminal infrastructure.

107. During the pandemic, the importance of air freight has been further emphasised. Christchurch Airport enables direct and large capacity freighter movements and belly-hold freight and forms part of a connected and diversified freight transport network to and from New Zealand. This helps ensure the availability of key goods in New Zealand that require

[30] https://www.stuff.co.nz/national/125725259/air-force-carries-out-nighttime-medical-evacuation-from-antarcticas-mcmurdo-station

movement by air, and helps mitigate the worst impacts of supply chain constraints to freight movements via shipping brought on by the pandemic.

## Disaster Recovery

108. Airports are critical links in disaster response and recovery, providing critical staging areas for disaster management, enabling fast medical evacuations and transport and providing important resilience to the overall transport network when roads, rail and maritime transport are compromised.

109. CIAL is a designated 'Lifeline Utility' in the New Zealand Civil Defence Emergency Management Act 2016. Section 60 of that Act notes that Lifeline Utilities must:

> *"… ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency and participate in the development of the national civil defence emergency management strategy and civil defence emergency management plans."*

110. Christchurch Airport plays an essential role in local, regional and national disaster management. This places a range of requirements on CIA and confirms its importance as a key asset for Canterbury and the wider South Island following any large-scale incident. The following are examples of Christchurch Airport's role in Disaster Recovery.
    a. 2011 Christchurch Earthquakes – Christchurch Airport was the main arrival and departure point for a wide range of local and international rescue teams. Emergency supplies were airlifted into Christchurch and many of the critically injured were evacuated out. Christchurch Airport was credited with contributing to helping save dozens of lives due to the ability to reopen the facility so quickly and keep it open 24/7. In the seven days following the initial earthquake, more than 45,000 passengers were moved out of Christchurch utilising a 'shuttle service' to Auckland.
    b. 2016 Kaikoura Earthquake – Due to Kaikoura being essentially cut off from all other towns by road and rail, air transport into and out of Kaikoura was vital. Christchurch Airport was the initial staging point for military and private air response. Large aircraft with supplies would arrive at Christchurch Airport and be helicoptered out to Kaikoura. Those evacuated from Kaikoura would often be airlifted back to Christchurch.
    c. 2017 Port Hills Fires – Christchurch Airport quickly became the staging point for all fixed wing and many helicopter aerial assault aircraft fighting the Port Hills fires. Christchurch Airport hosted on site the various aircraft and crews, making sure they had water available to refill aircraft as well as resting facilities for crews. In addition, over a period of 10 days, Christchurch Airport provided over 20 skilled staff to assist in the Emergency Operations Centre in Rolleston supporting the response effort.
    d. 2020 COVID-19 Repatriation Evacuations – In April and May 2020, thousands of stranded tourists visiting the South Island were evacuated to their home countries through Christchurch Airport. Visitors from Germany, the Netherlands, the UK, France and a range of other European countries all boarded repatriation flights at Christchurch Airport in a desperate attempt to get home as international borders shut. At the same time, hundreds of Kiwis were repatriated back to NZ on charter flights due to the disruption to commercial flights and border restriction.
    e. 2019 Rangitata Floods – This affected many international tourists and there were many general aviation fixed wing and helicopter operators ferrying passengers

between Timaru and Christchurch to enable them to continue their journey or catch international flights which would otherwise have not occurred due to road and rail outages.

## B: Operations and Dynamics

111. This section presents an overview of the different types of aeronautical (or related) operations that use Christchurch Airport and describes the dynamics (operational characteristics) of each operation.

112. All operations and dynamics discussed in this section refer to pre-COVID 2019 operations unless otherwise stated.

113. Air services that use Christchurch Airport can be categorised as follows:
    a. Commercial scheduled passenger flights;
    b. Dedicated air freight and mail;
    c. Non-scheduled operations (airline repositioning and maintenance; Fixed base operations and small commercial including flight training; medivac, military, helicopters government and Antarctic flights)

### Commercial Scheduled Passenger Flights

*Domestic*

114. Domestic aircraft services are split into trunk (i.e. major, usually jet operated, routes) and regional services. Both types generally operate during the day and late evening with minor operations (aircraft repositioning) occurring between midnight and 6am.

115. Domestic jet services only operate on the trunk routes of Auckland (AKL) and sometimes Wellington (WLG). Busy periods are early morning, around the middle of the day and in the evening and typically on narrowbody jets (165-214 seats), with periodic widebody (275-302 seats) services.

116. In addition to local domestic passengers travelling for the purpose of business, leisure and VFR, domestic services are also important as a transfer service for international passengers landing at Auckland or Wellington and transferring to/from the South Island via Christchurch Airport.

117. Turboprop services operate on trunk (WLG) and regional routes. Busy periods are early morning, around lunchtime and in the evening and occur typically on 50-70 seat turboprop aircraft and smaller piston engine aircraft types.

118. Regional services are generally timed to link into trunk services, using Christchurch Airport as a hub to collect and distribute passengers from around the South Island to and from the North Island trunk destinations.

119. There are several smaller airline operators, such as Sounds Air, which service thinner routes and smaller centres, playing a key role in distributing passengers around the South Island via the Christchurch Airport hub.

*International*

120. International services arrive from long haul destinations in Asia and short haul destinations in Australia and the Pacific.

121. The arrival and departure times of mid- and long-haul services at CIA are primarily dictated by available slot times, the network schedules and onward connectivity to major destinations at the hub airport overseas.

122. CIA can be described as a “slot-taker” in that the scheduled times of arrival and departure at Christchurch Airport are often not able to be tailored to local requirements, but rather are dictated by the network operation of overseas carriers and timing (slot) availability at major overseas destinations. An example of slot-taking is the timing of CIA’s China Southern flight from Guangzhou (pre-COVID). The aircraft leaves Guangzhou at just before 1am (local), arriving in Christchurch at 1720 (local). By leaving at 1am, the aircraft load benefitted from the connecting traffic coming into Guangzhou from the rest of the China Southern network across Asia. The aircraft was then on the ground for four hours in Christchurch, before departing at 2230, arriving back in Guangzhou at 0530. The benefit of arriving in Guangzhou at 0530 is the ability for passengers to then connect on to the first wave of aircraft departing Guangzhou to the rest of the China Southern network across Asia. Passengers are able to sleep on the returning aircraft as it is scheduled to operate through the night. This demonstrates that the scheduling of the aircraft is dictated by commercial and operational imperatives in Guangzhou and maximising the hub potential of the China Southern network.

123. Long haul services typically arrive and depart on wide body aircraft types such as the A359 and B789.

124. Long haul Asian services typically originate from Asian hub airports (Hong Kong, Guangzhou and Singapore) with the timing of departures from these airports typically aligned to maximise connecting passengers onto the point-to-point service to Christchurch. In 2019 arrivals into Christchurch from these destinations are typically during the daytime, turning and departing again during daylight hours.

125. Pacific services are generally leisure based and operate during daylight hours on narrowbody or widebody aircraft.

126. Trans-Tasman operations occur throughout the day on a range of narrowbody and widebody aircraft types. New Zealand-based aircraft typically operate two return services across the Tasman each day to maximise utilisation of the aircraft, typically starting from a New Zealand airport, including Christchurch, departing from 0545 onwards and arriving in eastern Australian seaboard destinations for the start of their work day, returning to New Zealand early afternoon (local), then departing again for Australia, offering an end of workday departure back to NZ, arriving back into New Zealand (CHC) around midnight or a little later.

127. Christchurch Airport plays a critical role in international airline disruption recovery and as an alternate to Auckland Airport. The availability of round the clock air services at Christchurch is critical in the event of aircraft emergencies, weather disruptions and critical incidents at Auckland which would necessitate large scale diversions.

## Air Freight and Mail

### *Domestic*

128. Domestic air freight and mail is carried into and out of Christchurch Airport in the belly-hold of passenger aircraft and also by dedicated air freight or airmail operators such as those described earlier. These operators deliver freight and mail to distribution centres located on CIA's campus (i.e. NZ Post and Freightways distribution centre).

129. Parcelair operates four B737-400 aircraft in an overnight operation 7 days a week between the three airport hubs. On weekdays, there are typically 9-12 aircraft movements during the night by Parcelair aircraft at Christchurch Airport, connecting to and from a road and rail distribution network serving the needs of the entire South Island. An example schedule for the 7th -8th March 2022 is presented below, illustrating the significance of night time (highlighted yellow) operations:

| Arrive/ Depart | Flight number | Aircraft type | Date | Time | To/from |
|---|---|---|---|---|---|
| D | 80 | 73F | 7/03/2022 | 1730 | AKL |
| D | 72 | 73F | 7/03/2022 | 2010 | AKL |
| A | 71 | 73F | 7/03/2022 | 2030 | AKL |
| D | 62 | 73F | 7/03/2022 | 2115 | PMR |
| A | 73 | 73F | 7/03/2022 | 2150 | AKL |
| D | 74 | 73F | 7/03/2022 | 2235 | AKL |
| A | 75 | 73F | 7/03/2022 | 2305 | AKL |
| A | 63 | 73F | 7/03/2022 | 2345 | PMR |
| A | 31 | 73F | 8/03/2022 | 0005 | AKL |
| D | 76 | 73F | 8/03/2022 | 0005 | AKL |
| D | 64 | 73F | 8/03/2022 | 0055 | PMR |
| D | 32 | 73F | 8/03/2022 | 0125 | AKL |
| A | 77 | 73F | 8/03/2022 | 0200 | AKL |
| D | 78 | 73F | 8/03/2022 | 0240 | AKL |
| A | 65 | 73F | 8/03/2022 | 0330 | PMR |
| A | 83 | 73F | 8/03/2022 | 0810 | AKL |

130. Christchurch Airport is the main distribution and consolidation centre for air freight and mail into and out of the South Island.

131. Dedicated air freight or mail services typically occur during the night to enable overnight national delivery of freight and mail.

*International*

132. International air freight moves in a similar way to domestic services, with freight and mail moving the belly-hold of passenger aircraft or on dedicated air freight or airmail operators such as DHL.

133. Christchurch Airport plays a significant role in freight exports, with nearly a quarter (23%) of New Zealand's air freight export value[31] being exported directly from Christchurch Airport. With much of the passenger traffic being discretionary and price sensitive, the ability to access the freight market is important to contribute to overall air route economics and make international services sustainable for airlines across multiple revenue streams.

134. CIA plays a significant role in facilitating the supply chain for the export of high-value, perishable and seasonal produce direct from the South Island to international markets. The value of some produce (e.g. aquaculture) is directly linked to freshness and the speed from farm to market is critical in attracting the highest price. Without the ability to export direct from Christchurch, speed to market would be impacted by the necessity to connect over other export gateways.

135. Air freight exports and imports are screened through Customs and Ministry of Primary Industries (*MPI*) screening facilities, with imports sent to a distribution centre where cleared imports are sorted and sent for delivery and exports are loaded onto departing aircraft.

136. Recently (2021/22) Christchurch Airport continues to play a key role in the South Island's international air freight system. Due to the reduced belly-hold capacity resulting from the COVID-19 pandemic, capacity constraints have limited air freight supply. Recognising its importance, the New Zealand Government has supported the international air freight market through the Maintaining International Air Connectivity (*MIAC*) subsidy scheme, essentially replacing the lost belly-hold air freight capacity with dedicated air freight operations. MIAC flights operate a triangular routing, coming into Christchurch Airport from Auckland Airport and then out to their overseas destination and back into Auckland, supporting exports from the South Island to international markets. Currently night-time freight operations run by Air New Zealand under this scheme are:

- Guangzhou (CAN), departing 2130 (2x week);
- Shanghai Pudong (PVG), departing 2330 (3x week); and
- Los Angeles (LAX), departing 2355 (2x week).

## Non-Scheduled Operations

137. The following describes typical non-scheduled operations at Christchurch Airport.

[31] Airbiz analysis of New Zealand Ministry of Transport website Air Freight statistics for FY18

*Airline Repositioning and Maintenance*

138. Airlines may need to reposition aircraft, typically as a result of operational delays accrued across the day, so they can return to a home port for the next day's scheduled departures. This usually occurs at night.

139. Further, Christchurch Airport hosts a major maintenance base for Air New Zealand.

> *"Air New Zealand is a major supplier of aircraft, and component MRO (maintenance, repair and overhaul) services with customers in New Zealand, Australia, Asia, the Americas and Europe"*[32]

There are associated maintenance movements of aircraft for this operation.

*Military, Government and Antarctic*

140. Christchurch Airport facilitates military and government aircraft, as well as Antarctic operations (both military and non-military).

*Fixed Base Operation (FBO) and Small Commercial*

141. Most of these movements are air ambulances, but they also include charters, business jets and other small commercial operators. However, jet aircraft movements are anticipated to increase at a greater rate as FBO operations continue to grow and air ambulance fleets are upgraded from turboprops. Air Ambulance operations are time critical and require a 24/7 operating environment.

142. Christchurch Airport facilitates flight training schools including the International Aviation Academy of New Zealand and the Canterbury Aero-Club. Flight training schools are valuable to airport communities in that they create multiple economic benefits for the region. Students often come from overseas and spend extended periods in the region. Schools create valuable, higher-worth jobs for flight training personnel. The competitive attraction of a flight training school is enhanced when it is located on or near an international airport with services from regional aircraft up to widebody jets. The level of experience for student pilots in studying in the operating environment is enhanced, for example, compared to studying at an aerodrome in a small country town away from an existing international airport.

*Helicopters*

143. Helicopter operations at Christchurch Airport cater for a wide range of operations and facilities, being a hub for the regional rescue helicopters, two training providers, maintenance operators as well as tourism and agricultural services.

144. The current operators have long-term commitments to their facilities, some of which are purpose-built, making relocation to other facilities unlikely. With the presence of helicopter maintenance facilities, many non-Christchurch Airport based operators regularly visit CIA.

145. There is a rescue helicopter base at Christchurch Airport, Canterbury West Coast Air Rescue Trust Inc. This is a time critical operation requiring a 24/7 operational capability.

[32] https://www.airnewzealand.co.nz/engineering-and-maintenance

146. There are also occasional military helicopter operations that use Christchurch Airport.

## C: Generic Capacity Constraints due to Aircraft Noise Sensitivities

147. In the event that Noise Abatement Procedures and/or Operating Restrictions are imposed on CIA, with operational capacity or timings explicitly restricted due to aircraft noise sensitivities, the following consequences may result:
    a. At the higher end, night-time curfews to all or specific operations (typically between the hours of 11pm and 6am);
    b. Annual aircraft movement quotas or caps;
    c. Daily or hourly aircraft movement caps restricting the number of arrivals or departures;
    d. Preferential runway regimes (rotating use of runways and associated flight paths to "share" the noise burden) which are often "sub-optimal" in terms of runway or airspace capacity;
    e. Development of additional runways to cater for air traffic growth, to ensure no additional noise burden is placed on current flight paths;
    f. Other noise abatement and mitigation (noise charges, aircraft auxiliary power unit restrictions etc).

148. The above examples, if imposed, will reduce operating efficiency at Christchurch Airport and impose restrictions (several being extremely serious) on the existing operations detailed in this report.

## D: Potential Impacts of Capacity Constraints to Operations

149. This section provides examples of how some of the capacity constraints noted above could conceivably manifest at Christchurch Airport, should reverse sensitivities result in restrictions being imposed, for each of the operations and dynamics described.

### Commercial Scheduled Passenger Flights Impacts

*- From a Night-Time Curfew*

150. Christchurch Airport's **role as a nominated alternative airport would possibly change,** due to its unavailability at night time. This would reduce New Zealand's resilience for unexpected disruptions to the aviation network resulting from weather, schedule disruptions or emergency situations.

151. **Reduced overall runway capacity** through reductions in available runway operating times. As a generic example, in a pure capacity sense, assuming a fictional runway could handle 10 aircraft movements (arrivals and departures) per hour across a 24hr operational day, capacity would be approximately 240 movements per day. If this operational day was reduced to 17hrs for example, the capacity of the runway would drop to approximately 170 movements per day.

152. **Restrictions on future opportunities for international services** from hub airports seeking to arrive/depart during an imposed curfew.

153. **Impacts on the viability of mid- to long-haul routes** established prior to COVID-19 if restricted hours of operation were in place, e.g. a flight with a delay may not be able to depart from an overseas hub if its estimated arrival time in Christchurch falls after a curfew starts. In such a case, that air service would either be cancelled or diverted to a curfew-free airport, inconveniencing the passengers and creating complexity for the airline in recovering from the disruption. Over time, the operational risk of a curfew would be noted by airlines and ultimately the competitiveness of Christchurch Airport would be damaged.

154. **The scheduled China Southern flight from Christchurch to Guangzhou** historically departed at 2230. An airline would be cautious of operating this flight under a curfew scenario (should a curfew commence at 2300). If there was a delay to the departure of greater than 30 minutes, it is likely the flight would be unable to depart due to the curfew. The airline would then face a complex scenario of accommodating the passengers in hotels and checking them in again for departure the next day, plus the loss of a day's operation for the aircraft which would not be able to operate its planned schedule the next day. If a curfew commenced at 2200, this flight would have to be cancelled or retimed, which may not be possible or viable for the airline.

155. It is possible that **early morning trans-Tasman departures may need to be reduced, retimed, or cancelled** (depending on curfew times), reducing choice for business travellers to arrive in Australia for the start of the working day.

156. It is possible that **late night trans-Tasman arrivals may need to be reduced, retimed, or cancelled,** reducing choice for business travellers to leave Australia late in the day. For example, with a 2300 curfew in Christchurch, a flight leaving Melbourne would have to depart by 1730 MEL, meaning passengers would need to be at the airport by approximately 1530. This would effectively reduce the business day by nearly half, considering travel time from the Melbourne CBD to Melbourne Airport.

*- From an Annual Movement Quota*

157. The creation of an **annual movement quota would detrimentally impact Christchurch Airport**, as the Airport's growth approaches the quota number. Airlines are constrained by the volume of frequencies they can fly (i.e. the number of flights an aircraft can be used for over an operational day). For example, for a 3hr sector (assuming a 24hr operational day) the aircraft flying that sector might be able to make approximately 5 frequencies per day (assuming a 1.5hr on-ground time between frequencies).To accommodate growth in demand, they can only resort to up-gauging aircraft to greater seating density, rather than increasing frequency of services. This is sub-optimal for both the consumer and the airline, particularly domestically, as it is the frequency of service that the consumer market values. For the airline, it requires a more complex fleet with higher seating-density aircraft, which may not be economic to operate on other "thinner" routes in their network.

*- From a Daily or Hourly Movement Quota*

158. During the course of the day, there are peak periods of demand when more air services operate compared to other times. Domestically, these periods are typically morning and evening, book-ending the business day. For the trans-Tasman market, the scheduling is in two distinct waves, creating peak demand and dictated by the practicalities of the time difference and passenger flows. **An hourly movement quota, if reached, would adversely**

**impact air services if the airlines were not able to schedule aircraft to meet passenger demand for services.**

159. An example of hourly movement quotas overseas is at Sydney Airport, where there is an allocation of 80 hourly movements. Within the quota is an allocation to accommodate regional services, which then restricts the number of services which can operate on interstate and international routes. **The airport's growth and competitiveness is constrained by the quota.** This has partly led to the need for a new airport in the region, Western Sydney Airport, which is currently being designed.

### *- From Preferential Runway Regimes*

160. Preferential runway regimes are interventionist measures utilised to distribute air traffic across an airport's runways and associated flight paths in order to "share" the noise burden. While this solution is often seen as equitable to residents, it often results in **sub-optimal use of runways and/or airspace capacity, and increased costs of operation on the ground**. For example, longer taxiing time for aircraft on the airfield, resulting in increased time and fuel burn. Any impact on operational costs for airlines is significant, however in a port such as Christchurch, which has a higher than average discretionary passenger mix[33], increased costs negatively impact the economic viability of marginal routes, making the operation less competitive.

## Air Freight and Mail Impacts

### *- From a Night-Time Curfew*

161. Domestic freight services fly overnight, linking domestic ports nationwide. **The entire national air freight network would be impacted if Christchurch was effectively removed**. It would not be economically viable nor logistically possible for domestic air freight services to operate during the day, just to service Christchurch.

162. The entire air freight supply chain has been developed and optimised to work overnight, utilising the hub of Christchurch and the intermodal connectivity to road and rail, which facilitates next day delivery. **A curfew would be highly detrimental to the freight supply chain**. Substitution of air freight services into other South Island airports is unrealistic, particularly given other airports lack Christchurch's geographic advantage and critical mass (and Queenstown is already curfewed).

163. Should a curfew be imposed, a consequence would be **slower distribution of freight and mail and possibly reduced overnight collection and delivery services** i.e. a package picked up in AKL during the day may be required to be air freighted to the South Island the following day (not overnight) missing early morning distribution of packages and arriving late in the day or the following day (2 or 3 day delivery not overnight).

*[33] The passenger market splits over people travelling for 1. Business 2. Leisure and 3. Visiting family/friends. The latter two categories are generally self-funded and discretionary. As such, travel competes for the consumer's share of wallet with other discretionary expenditure and is significantly more price sensitive than business travel. Airlines offer baskets of air fares to capture different demand segments, having business class seats and higher fares that offer greater flexibility and service levels versus lower fares to attract discretionary travellers with reduced flexibility and service levels. Previous work by Airbiz highlighted that international visitors to the South Island gateway airports differ substantially to other airports in terms of reasons for travel. The vast majority of international visitors arriving at Christchurch have been visiting for leisure. Long-haul visitors will be facing destination competition in their home source markets. If costs rise and fares on trips to Christchurch/the South Island increase, then the destination's appeal may decline in the face of other competing destinations.*

164. **Domestic just-in-time impacts would arise** in multiple industries, e.g. potential impacts on the just-in-time industries such as flowers and seafood if these are not able to be freighted in overnight for early morning distribution to retail outlets across the South Island.

165. The **export market for high-value, perishable produce may be impacted** if direct export was not available from the South Island to international markets. The value of some produce (e.g. molluscs and crayfish) is directly linked to freshness and the speed of delivery from producer to market is critical in attracting the highest price. Without the ability to export direct from Christchurch, speed to market would be impacted by the necessity to connect over other export gateways.

166. Opportunities for freight and goods entering New Zealand and the South Island during a **pandemic** may be restricted.

167. Opportunities for **new/seasonal Asian freight services in the future, which may wish to arrive during curfew hours, may be constrained**.

*- From an Annual Movement Quota*

168. The domestic air freight network is successful because it connects multiple ports, generating multiple movements. An overall cap on annual movements creates pressure between the scheduled passenger airlines and the freight operators as they compete for movement allocations. This was experienced at Schiphol as documented in the earlier Case Studies (see Appendix).

169. An element of the international air freight activity at CIA is seasonal, being the export of summer fruit (e.g. cherries and nectarines) on dedicated freighter services from December to February. On an annual basis, the flight volume is small and appears insignificant against year-round scheduled movements, however the economic significance of those flights is high in facilitating direct export of South Island produce. Examples of the implementation of movement caps at other airports globally have been detrimental to such freighter services, because of the small number of movements and the metrics established to allocate movements, meaning freight services have been deemed lower priority and pushed out.

## Fixed Base Operation (FBO) and Small Commercial Impacts

*- From a Night-Time Curfew*

170. Air service activities for air ambulance (LifeFlight etc) and medivac purposes are critical. Medivac services would be compromised by a curfew even if they were able to land or take-off at Christchurch with a dispensation. No other South Island airport/hospital combination would be as efficient as Christchurch. The key to Christchurch's success as a medivac hub is the ability to develop a fixed base at CIA, use of the runways for fixed wing operations, the extent of medical expertise and specialisms available at the hospitals and proximity to the city from CIA. By comparison, the airport at Dunedin is located 30km from the hospital, necessitating a lengthy ambulance transfer.

171. The small commercial air operator businesses and FBOs have a degree of inter-dependence, benefitting from "clustering" and relying on each other for a degree of commercial viability. Some businesses would be compromised by a night-time curfew and, if those businesses choose to relocate, that may then impact the economic viability of others not directly impacted by the imposition of a curfew. Ultimately, a curfew would be detrimental to the health of the whole non-scheduled community based on Christchurch Airport.

*- From an Annual Movement Quota*

172. Businesses such as flying schools and helicopter operations generate high volumes of movements. The addition of an annual movement quota would put pressure on these businesses to be relocated away from Christchurch, as they utilise valuable movements which could otherwise be allocated to scheduled passenger and freight services likely deemed of greater social and economic benefit to the region.

*- From a Daily or Hourly Movement Quota*

173. As with annual caps, FBO and small commercial businesses would be a lower priority in the allocation of daily or hourly movement caps when compared to scheduled passenger and medivac services likely deemed of greater social and economic benefit to the region. The prioritisation of air services at peak hours may have a negative impact on the operation of FBO and small commercial businesses. These flights may be restricted to flying in hours of lower demand, impacting the overall viability of their businesses.

## Airline Repositioning and Maintenance Impacts

*- From a Night-Time Curfew*

174. Late night repositioning of aircraft for maintenance or repositioning would be restricted, meaning aircraft may have to be repositioned earlier in the day, potentially removing an aircraft rotation over the day and reducing passenger choice for flights.

## Military, Government and Antarctic Impacts

*- From a Night-Time Curfew*

175. Air service activities for military, government and Antarctic purposes are critical and should be factored into any interventionist measures.

176. Overnight and early morning operations would be stopped, reducing flexibility for Antarctic operations, reducing opportunities to operate to avoid unsuitable weather and meaning services could not arrive early in the morning. Assuming a 5hr flight time, an aircraft departing for the Antarctic at 7am would not return until the evening.

## Helicopter Impacts

*- From a Night-Time Curfew*

177. Rescue operators might potentially require relocation to another airport to ensure 24/7 capability.

# Appendix

This Appendix presents the following Case Studies which were summarised in the report.

1. Melbourne Airport
2. Calgary Airport
3. Brisbane Airport
4. Schiphol Airport
5. Toronto Airport

## CASE STUDY 1: MELBOURNE AIRPORT

### Airport Introduction

Melbourne Airport is Australia's second largest airport, serving approximately 37 million annual passengers before the COVID-19 pandemic. It was built as a greenfield airport and opened to commercial flights in 1970 as a 2-runway (crossing) system. The location was selected due to its proximity to the city, whilst still being far enough away from urban development to allow the airport to operate unconstrained without a curfew unlike its main competitor, Sydney Airport. Ultimate plans for a 4-runway system have been in place since the airport's conception, with the 3rd runway now being required to meet demand. The airport is located 23km from the Melbourne CBD.

### Context

When the airport was designed, noise buffer zones were established in the surrounding area and along proposed flight paths. They were implemented through land acquisition and land-use zoning to minimise the impact of noise on the community. At the time of opening, the land acquired for the buffer zones was the most extensive of any Australian airport. These buffer zones were designed based on the ultimate 4-runway configuration so that the flight tracks for all runways would be over open areas and the effect of noise on the community would be kept to a minimum. However, special protective land-use controls on the areas surrounding the airport weren't introduced until 1992 (in the form of the Melbourne Airport Environs Area), by which time significant urban encroachment had occurred through rezoning and development of land in the buffer zones. [34]

In 1970, the Commonwealth advised that land-use zoning should "not be subject to uncoordinated change by local authorities" and it advocated legislation for Tullamarine to "ensure avoidance of later change to incompatible use". In the 1970's, councils and State Government went against this advice, approving the rezoning of several plots of land from rural to residential inside the airport buffer zones and surrounding areas. This included substantial residential developments less that 100m away from the proposed new runway locations and under the existing east-west runway flight paths.[7]

In the 1980's, the proposed location of the new north-south runway had to be relocated from the south-east of the airport site to the west of the existing north-south runway. This was a result of the decision that Essendon Airport would remain open, whereas original plans had assumed it would close.[35] Buffer zones had been aligned with the original airfield configuration, so development was able to occur unrestricted under what is now the proposed flight paths for the 3rd runway.

By the time more stringent protections were introduced in the early 90's, a lot of the land surrounding the airport had already been developed. Despite increased protection, rezoning of land under flight paths and surrounding the airport has continued over the last 30 years, with the airport often not hearing about the developments until they have already been approved by councils.[36] Residential growth continues around the airport, with the Hume local government area (where Melbourne Airport is located) being identified as a potential "growth area" in a planning strategy for 2030.[37]

### Trigger for Constraint

The need to build the 3rd runway now demonstrates the impact on the airport of not properly protecting the land around an airport and allowing urban encroachment over 50 years. The proposed new runway has been a trigger for a community already impacted by aircraft noise to call for increased operating restrictions.

### Constraint Imposed

With current stakeholder and community consultations as part of statutory approval process, the urban encroachment on Melbourne Airport has become a major factor in shaping and defining the proposed plans for the 3rd runway and its flight tracks. To mitigate noise impacts, Melbourne Airport are proposing operating in segregated modes, like Heathrow Airport, where one runway is for arrivals only and the other for departures. This is expected to reduce the number of houses exposed to night-time noise by between 15,550 to 24,795 when the new runway opens.[38] However, segregated modes operate at a lower capacity than mixed mode operations (arrivals and departures permitted on both runways). They are also proposing to operate SODPROPS (simultaneous opposite direction parallel runway operations) when possible, which is a reduced capacity mode that will allow traffic to both depart and arrive to the north to reduce noise impacts on residents to the south. Despite these compromises, the airport still faces calls for a curfew from residents living far outside the current Outer Control Boundary complaining of sleep disturbance. [39]

### Key Findings

- Even with well published plans for noise corridors or buffer zones, over the years urban encroachment can occur if the proper protections are not correctly enforced.
- Legislative protection needs to be in place as early as possible, as once development has occurred it is very difficult to reverse it.
- Protections need to be conservative enough to minimise noise impacts of unforeseen changes outside of the airport and community's control.
- As a result of poor protection against urban encroachment, the airport now faces calls for a curfew from residential developments in locations incompatible with airport activities.

[34] Michael Buxton & Arun Chandu (2016) When growth collides: conflict between urban and airport growth in Melbourne, Australia, Australian Planner, 53:4, 310-320, DOI: 10.1080/07293682.2016.1275718
[35] https://www.melbourneairport.com.au/getmedia/9faa35c0-7b47-4ff8-9e86-28e50dfc97de/Q_A_Online_Event_Health___Social_FINAL.pdf.aspx
[36] https://www.theage.com.au/politics/victoria/melbourne-airport-asks-for-powers-to-stop-development-underneath-flight-paths-20210115-p56uid.html
[37] https://www.planning.vic.gov.au/policy-and-strategy/planning-for-melbourne/melbournes-strategic-planning-history/melbourne-2030-a-planning-update-melbourne-@-5-million/docs/DPC051_M5M_A4Bro_FA_WEB-1.pdf
[38] https://caportal.com.au/melair/virtual?hview=modalAirportAirspace
[39] https://brimbanknorthwest.starweekly.com.au/news/runway-concerns-mount/

Balanced Approach to Noise Management – Review of Key Pillars in respect of Melbourne Airport

| | Balanced Approach Pillar | Pillar Role and Process |
|---|---|---|
| 1 | Reduction of Noise at the Source | Enhanced technology but increased demand is justifying the need for a parallel runway. Larger aircraft as international services grow. |
| 2 | Land-Use Planning and Management | Buffer zones of rural land-use zoning based on original 4-runway configuration when airport built in 1970, but no legislative protection until 1990's. |
| 3 | Noise Abatement Operating Procedures | Preferential use of runway 16 and aircraft routed to avoid residential centres when possible. [40]<br>Proposed noise-mitigating operating modes with the new runway. |
| 4 | Operating Restrictions | Current stakeholder and community consultations include calls for a curfew. |
| | Triggers | Proposed parallel runway project & urban encroachment into noise-affected areas |

[40] http://www.bom.gov.au/aviation/data/education/reference-card-ymml.pdf

## CASE STUDY 2: Calgary Airport

### Airport Introduction

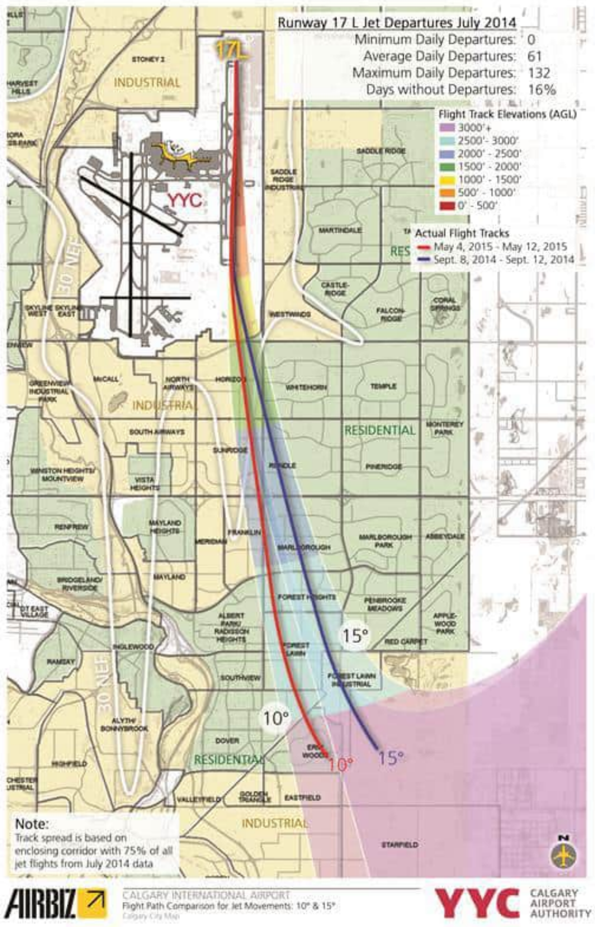
Calgary Airport is the 4th busiest airport in Canada with 18 million passengers in 2019. It was planned as a multiple runway system with a parallel runway commissioned in 2014. The airport is located 19km from downtown Calgary.

### Context

The Alberta provincial government enacted the Airport Vicinity Protection Area (AVPA) regulation in 1979 to govern development close to the Calgary International Airport. This prevents land from being developed near the airport that will negatively affect airport operations, including its runway arrival and departure areas. The Noise Exposure Forecast (NEF) contours used to define the AVPA were based on the existing airfield layout, as well as a scenario with a future parallel runway which was finally commissioned 35 years later. Because the AVPA was enacted before significant urban encroachment occurred, appropriate land-use controls were implemented to protect conservatively a future parallel runway.

### Trigger for Constraint

Despite this, in 2014, the commissioning of the new parallel runway triggered a negative response in the community. Detailed airspace design for the runway led to the implementation of flight tracks that weren't considered in modelling assumptions that formed the basis of the earlier AVPA. Provisions for parallel operations were published in 1995, followed in 2004 by the first edition of the Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (*SOIR*), including the need for 15 degrees divergence when it intends to use two instrument departure procedures from parallel runways simultaneously. Hence, when the need to construct the parallel runway and finalise operational flight paths for the Calgary Airport detailed flight path design rules based on operational safety were in place and differed to those in the early AVPA assumptions, communities under the new flight tracks were exposed to aircraft noise and flight tracks had to be altered to mitigate impacts and alleviate concerns. Divergence for take-off towards the south was subsequently reduced to 10 degrees (rather than 15 degrees) to mitigate those impacts. Without pro-active land-use controls, such a solution would not have been possible and more constraining operating restrictions may have been required.




## Constraint Imposed

While there was community engagement to discuss concerns following commissioning of the parallel runway, a revised take-off procedure was allowed to reduce the impact on communities towards the south. Without conservative land-use controls, such a solution would not have been possible and more constraining operating restrictions may have been required.

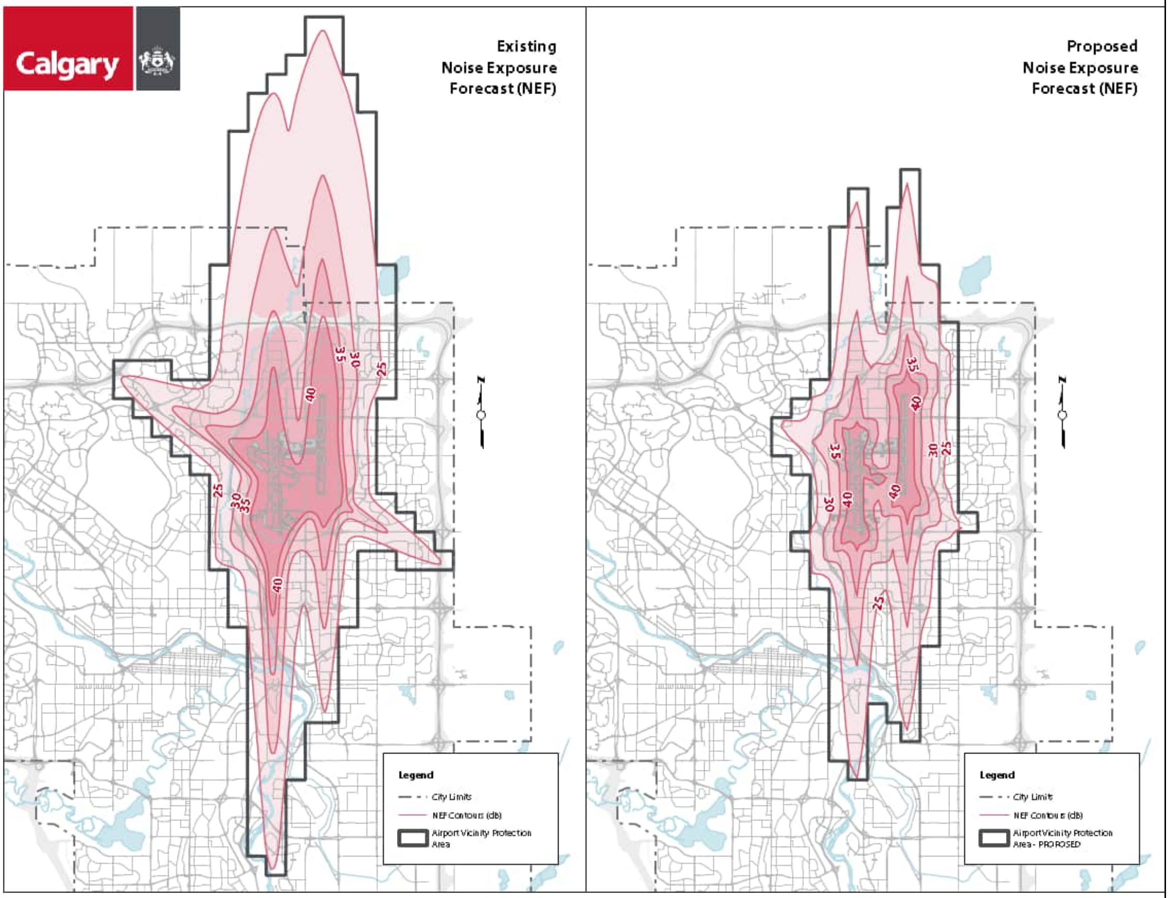
Future of Land-Use Planning approach at Calgary:
Following introduction of the new runway, a revised AVPA was developed to reflect the increased reliance on the N-S parallel runways and quieter fleet mix. This led to a reduction of the AVPA area (land-use control), especially benefitting existing urban areas which could not previously densify because of current restrictions on land development. While it is too early to assess the impacts of that reduction in land-use controls, it is worth noting how this modification was triggered by a significant change to prevailing modes of operation.

## Key Finding

Conservative land-use protection around the airport (i.e. protection of existing and future airfield layout) provided flexibility for changes to future operational assumptions and led to the successful development of a new runway and subsequent AVPA review, reflecting a new airport operational outcome (parallel runway operations). The airport did not need to move to operating restrictions, partly due to adequate land use safeguarding.

A new runway is consistently a key trigger as it exposes new areas to aircraft noise with permanent changes to airport runway operations. However, proactively implementing land-use controls to protect for a new runway mitigates the impacts of new noise and to provides flexibility for future modes of operations.

Some airports may review the level of land-use controls following a significant permanent change to operations.




Existing and Revised AVPA Contours (2021)

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Balanced Approach to Noise Management – Review of Key Pillars in Respect of Calgary Airport

| | Balanced Approach Pillar | Pillar Role and Process |
|---|---|---|
| 1 | Reduction of Noise at the Source | Enhanced technology but more larger aircraft |
| 2 | Land-Use Planning and Management | NEF Contours. AVPA recently updated with reduced protection due to new operating model. |
| 3 | Noise Abatement Operating Procedures | Preferential runways. Turn upon reaching a minimum altitude. |
| 4 | Operating Restrictions | None |
| | Triggers | New Runway (2014) |

## CASE STUDY 3: Brisbane Airport

### Airport Introduction

Like Melbourne, Brisbane was built as a greenfield airport in 1988, with a Master Plan reserving land and safeguarding for a future parallel runway when required. It's Australia's 3rd busiest airport, handling approximately 24 million passengers in 2019. The airport is located 13km from the CBD.

### Context

Over the years since its opening, the equivalent of the Outer Control Boundary for Brisbane Airport (the ANEF 20 contour) has significantly shrunk due to changes in technology (largely between 1983 and 1998) reducing noise of aircraft at the source, despite annual movements increasing. The images below illustrate the evolution of future noise contours used for land use planning purposes around Brisbane Airport at various stages.

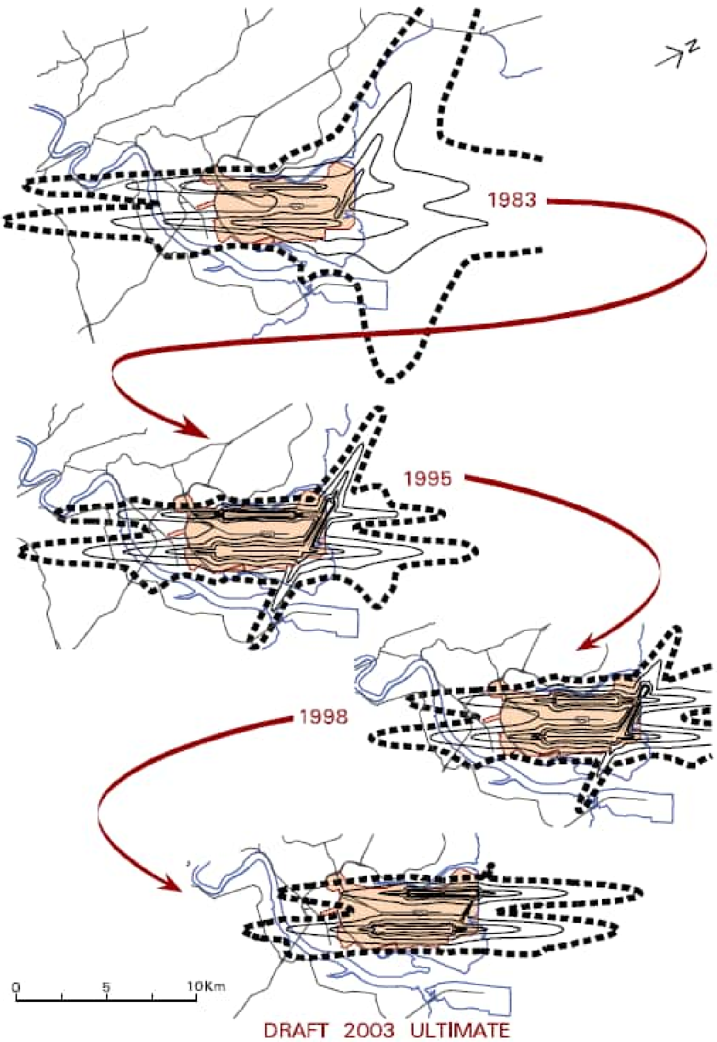



*Figure 2 Contours shrinking over time[41]*

### Trigger for Constraint

Community concern over noise from the new parallel runway. In 1998 Brisbane Airport pushed the proposed location of the new parallel runway 950m towards Moreton Bay in response to community concern over aircraft noise. As a result of community feedback, this was slipped a further 1,300m in the 2003 Master Plan. The resulting location ensured the largest noise buffer zone for any Australian capital city airport.[42]

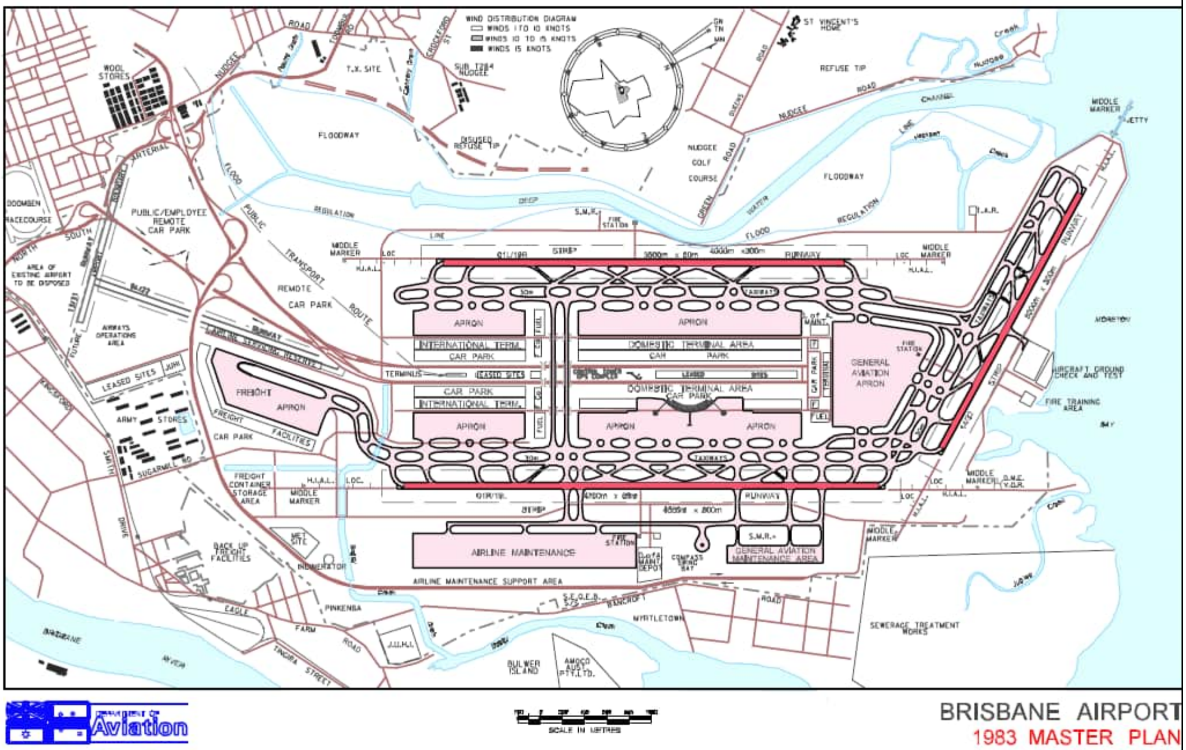



*Figure 3 Original Airfield Layout from the 1983 Master Plan*[43]

### Constraint Imposed

During the years leading up to the runway opening, Brisbane Airport undertook extensive community consultation on the expected noise impacts from the new runway opening. A number of noise abatement procedures were implemented, including a preference for operations over the bay when safe, and recommended flap settings to reduce airframe noise. However, despite these mitigation efforts and extensive community consultation, Brisbane Airport is now facing substantial pressure from residents for operational restrictions to be imposed due to impacts from changes to flight paths and noise redistribution since the new parallel runway opened in 2020.

[41] Brisbane Airport 2003 Master Plan
[42] Brisbane Airport 2003 Noise Management Strategies
[43] Brisbane Airport 2003 Master Plan

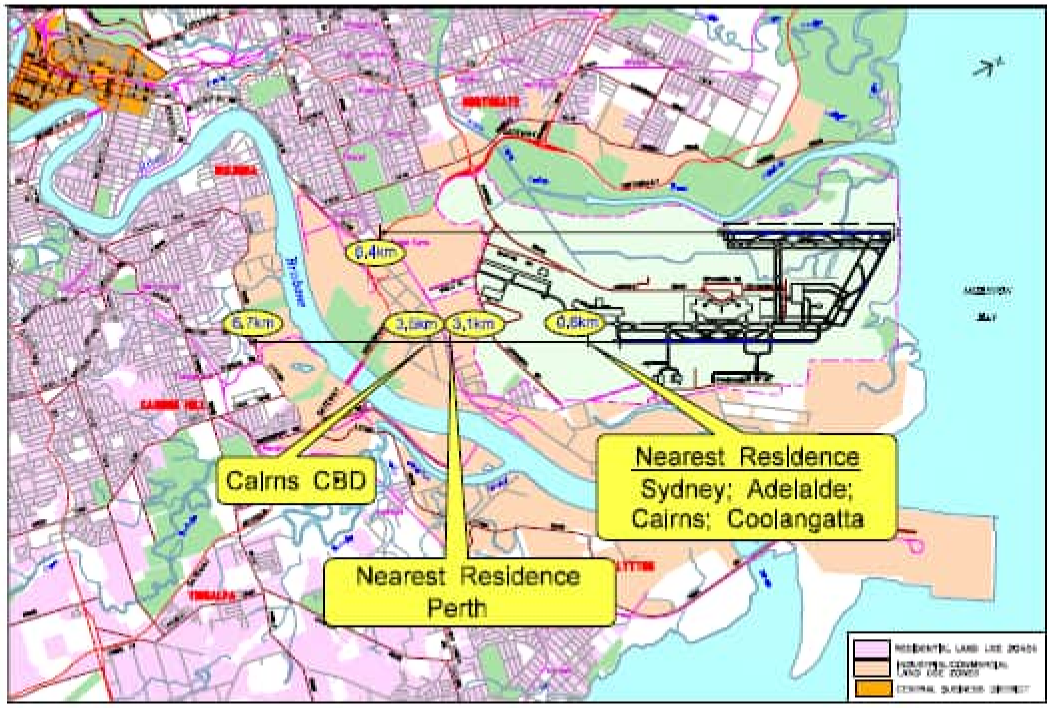



*Figure 4 Brisbane Airport Noise Buffer Zones*Error! Bookmark not defined.

In response to community concern, the airport announced in January 2022 that it would be running a 12-month trial of 3 initiatives to reduce noise[44]:

1. Extended use of SODPROPS (simultaneous opposite direction parallel runway operations);
2. Removal of intersection departures on the parallel runway; and
3. Introduction of a noise abatement procedure requiring jet aircraft to fly on standard flight paths until they reach 10,000-12,000ft.

Despite the airport responding to community concern with these noise mitigation initiatives, in February 2022 the Green party announced their plan to introduce a new bill in the Australian parliament to impose a curfew from 10pm to 6am and hourly flight caps of 45 movements per hour on the airport.[45] If this bill passes, it will have a very serious impact on the capacity of the airport, effectively rendering the development of the new parallel runway of no value since the airport was operating at around 50 movements per hour before its opening.

## Key Findings

- Noise contours shrunk over the years due to changes in technology, allowing some urban development towards the airport.
- Brisbane Airport undertook a number of mitigative measures to reduce the impact of noise on the community including providing a substantial buffer zone, shifting the location of the new runway further from residents and implementing several noise abatements procedures.

[44] https://australianaviation.com.au/2022/01/brisbane-airport-to-trial-new-tactics-to-reduce-aircraft-noise/
[45] https://australianaviation.com.au/2022/02/greens-push-to-introduce-brisbane-airport-curfew/

- Even with a substantia buffer zone community outcry has led to a trial of three noise-reducing initiatives, two of which could reduce the capacity of the airport if kept in the long-term.
- Despite responsive actions to allay community concerns, community lobby groups and political parties are still pushing for a curfew and hourly movement caps.

Balanced Approach to Noise Management – Review of Key Pillars in Respect of Brisbane Airport

| | **Balanced Approach Pillar** | **Pillar Role and Process** |
|---|---|---|
| 1 | Reduction of Noise at the Source | Enhanced technology but increased demand led to the need for parallel runway. Larger aircraft as international services grow. |
| 2 | Land-Use Planning and Management | Parallel runway location shifted towards Moreton Bay to reduce impacts on growing residential encroachment near the new runway. |
| 3 | Noise Abatement Operating Procedures | Opening of the new runway came with a number of noise abatement procedures to reduce noise impact on community, including increased operations over the bay. |
| 4 | Operating Restrictions | Trial of increased SODPROPS use and removal of intersection departures. Threats of curfew and hourly movement caps. |
| | Triggers | Changes to flight paths and redistribution of traffic on opening of new parallel runway |

## CASE STUDY 4: SCHIPHOL AIRPORT

### Airport Introduction

Schiphol is the busiest airport in the Netherlands with over 80 million passengers per year before the COVID-19 pandemic. It has a mature runway system, with a 6$^{th}$ runway built in 2003 (known as the Polderbaan). The airport is located 15km from the downtown area of Amsterdam.

### Context

In the 1970's a new town, Hoofddorp, was built right next door to Schiphol and, in the 1980's and 90's, neighbouring cities like Amsterdam and Amstelveen built new areas expanding towards the airport.[46]

Schiphol has had capacity limitations due to noise since the 1960's, but the extent to which noise has constrained the airport has changed over time.[47]

The new runway was constructed to increase capacity and to mitigate existing noise impacts in the vicinity of the airport. While it led to a reduction in the total number of people exposed to aircraft noise, new areas were exposed to aircraft noise that previously weren't.

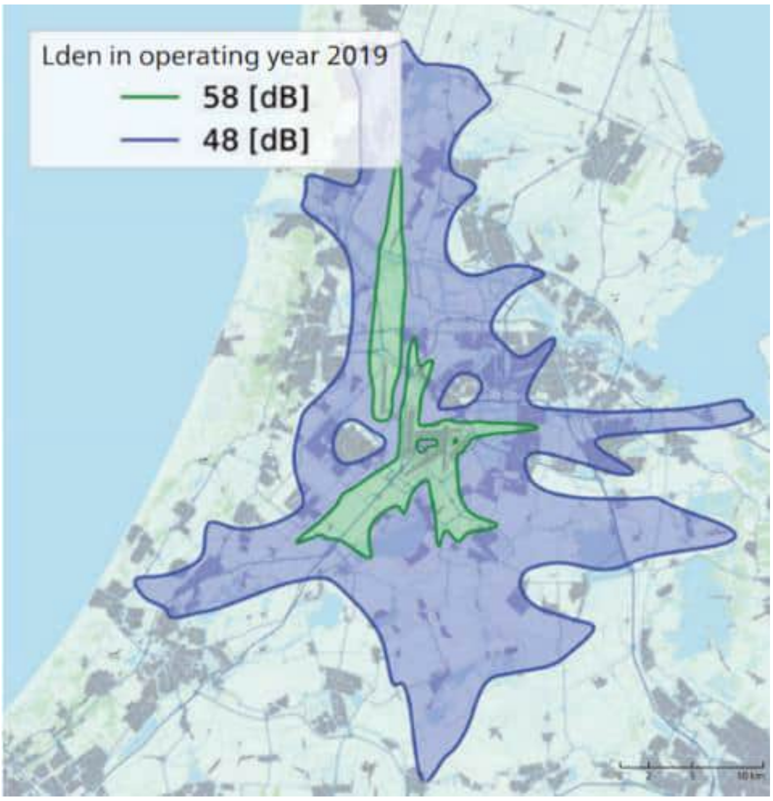
### Trigger for Constraint

Although aircraft noise has been an ongoing issue, following commissioning of the new runway, a 'consultation table' (developed during the 'Alderstafel' negotiations) was setup by the government in 2006 to provide advice on the development of Schiphol and other Dutch airports. This group was tasked with establishing the constraints that now define how the airport can grow and operate.

### Constraint Imposed

The Alderstafel negotiations produced a new system to control aviation noise. Constraints are now imposed based on the number of aircraft movements as well as exposure noise levels. Limits are for the total number of aircraft movements per year (500,000) and between 23:00 and 07:00 (32,000)[48]. The sound exposure allows up to 12,800 hours within the 58 Lden contours and 180,000 people within the 48 Lden contours. These legal maximum values are supposed to produce an equivalent protection against noise, existing in an older legal noise protection system before the reference year 2005. In the years leading up to the pandemic, Schiphol were consistently operating at or close to the 500,000 capacity, reaching 499,466 movements in 2018. In 2017, Singapore Airlines relocated half of their freight operations to Brussels Airport due to a significant reduction in freighter slots as a result of the movement cap.[49]

[46] M, Wijk & Brattinga, Kes & Bontje, Marco. (2010). Exploit or Protect Airport Regions from Urbanization? Assessment of Land-use Restrictions in Amsterdam-Schiphol. European Planning Studies. 19. 261-277. 10.1080/09654313.2011.532671.
[47] https://www.itf-oecd.org/sites/default/files/docs/airport-restricted-capacity-analysis.pdf
[48] https://slotcoordination.nl/wp-content/uploads/2021/09/Capacity-declaration-Amsterdam-Airport-Schiphol_Summer-2022.pdf
[49] https://www.lloydsloadinglist.com/freight-directory/news/SQ-to-transfer-half-its-Schiphol-freighter-flights-to-Brussels/70526.htm#.Yo3lx6hByUk




The system consists of 35 points around Schiphol, where the actual noise of passing planes is physically measured, and added up to annual totals per point. If a total at a certain point will exceed its legal maximum, the relating runway can no longer be used and traffic should be diverted to alternative runways.[50] This adds complexity for air traffic control and impacts on the capacity of the airport.

Environmental constraints, rather than operational constraints, limit runway capacity. This limits the number of slots available and potentially requires slot allocation rules to be developed to ensure the air traffic movement quota is not exceeded. As slots become scarce, there may be conflict between potential users and uses of the airport on who gets a slot at this airport and who must shift to secondary and commercially less desirable airports.

There has been a proposal for overflow traffic (beyond environmental capacity limit) to be shed to neighbouring airports, although it is now perceived that this just shifts the problem (shares the noise) and leads to NIMBY (not in my back yard) resistance.

Operational capacity is also limited by a preferential runway system to share the noise, which introduces complexity to runway operations and air traffic control.

### Key Findings

- Noise contours are a means to cap movements;
- Growing encroachment leads to an increased need for community engagement to maintain buy-in. However, operating restrictions may be required to maintain community support;
- The airport was reaching the imposed movement limits before the COVID-19 pandemic and is needing to find ways to continue to grow under existing constraints without shifting the noise to other communities.

[50] https://hacan.org.uk/blog/wp-content/uploads/2015/04/Noise-reduction-Schiphol-.pdf

Balanced Approach to Noise Management – Review of Key Pillars in Respect of Schiphol Airport

| | **Balanced Approach Pillar** | **Pillar Role and Process** |
|---|---|---|
| 1 | Reduction of Noise at the Source | Enhanced technology but more larger aircraft |
| 2 | Land-Use Planning and Management | Noise contours of 58 dB(A)Lden ("inner area") and 48 dB(A)Lden ("outer area"). Legally binding limits. |
| 3 | Noise Abatement Operating Procedures | NADP2 could help increase AC movements cap. |
| 4 | Operating Restrictions | Maximum amount of noise is legally determined by maximum values for numbers of houses and people seriously hindered by aircraft noise. Far lower maximum noise values are applicable for night flights.<br>Annual movement caps for all movements and separate nightly restrictions. |
| | Triggers | 2008 Schiphol Table of Hans Alders (Alderstafel) |

## CASE STUDY 5: Toronto Pearson International Airport

### Airport Introduction

Toronto Pearson International Airport is Canada's largest hub at over 50 million passengers per year prior to the COVID-19 pandemic. It currently has 5 runways, with Runway 15R/33L added in 1997 and Runway 06R/24L completed in 2002. The airport is located 30km from downtown Toronto.

### Context

Despite being opened in 1938, it was only in 1959 that land use development policies using noise contours were considered, ahead of a significant phase of expansion. By that time, urban encroachment was already present and the airport was expanding beyond its original boundaries. While noise contours were used to inform growth plans, it was only after privatization that an Airport Operating Area (AOA) was implemented in official city plans to control residential development in the vicinity of the airport, albeit with some exemptions. The AOA was developed using composite contours (i.e. multiple scenario envelopes based on prevailing winds for the 95th percentile day).[51]

### Trigger for Constraint

Constraints on aircraft movements were initially triggered by the privatization of the airport in 1997. Furthermore, in February 2012, NAV CANADA implemented changes in the Toronto-Ottawa-Montreal corridor (the main flight route between these centres) and the relocation of the downwind arrival flight paths 1.8 km south, triggering negative community reactions and operational constraints. Interestingly many of the community responses came from locations outside the revised contours which highlights how noise does not stop at the NEF contour's boundary and residential areas outside of defined contours can influence airport operational constraints.[52]

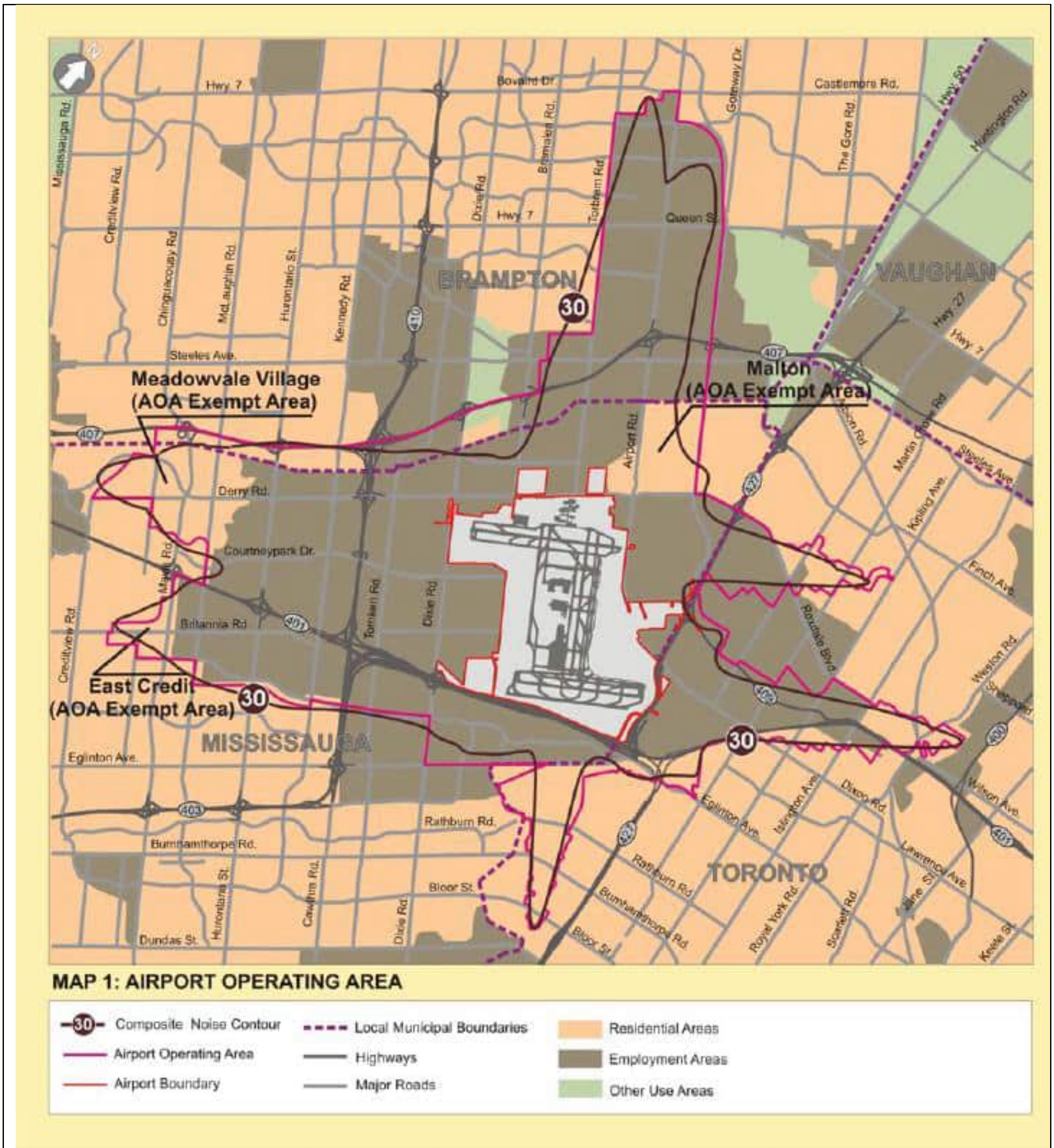
### Constraint Imposed

The main constraint is a night flight "budget" which is the maximum number of movements per year to operate between 12:30am and 6:30am. It can be increased by a percentage equivalent to the growth in passenger movements although a 10% bump up is allowed if 95% of the night cap is reached.

Attempts to introduce noise sharing were thwarted by the community, feeling that they were being forced to decide who would get exposed to noise rather than how everyone could be better off.

### Key Finding

Community reaction can occur well outside the contours, where communities are not normally exposed to aircraft noise. In the case of Toronto-Pearson, contours are used to minimise further encroachment rather than to prevent it altogether. Attempts to establish proper safeguarding areas around the airport have been difficult to effect due to lack of land use planning controls, leading to various development concessions within the AOA and exposing more people to aircraft noise. Mitigation options are therefore limited if the noise contours cannot enable flexible operational changes (e.g. preferential runways) without impacting residents living within the contours.




YYZ Airport Operating Area (AOA)

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[52] https://cdn.torontopearson.com/-/media/project/pearson/content/community/noise-management/pdfs/annual-noise-reports/2013-annual-noise-report.pdf?modified=20190426200044&rev=c29fe5c549754a8eb536954b8f9f11b8&hash=31AC0267C3FACB2F64CAB4BCEC3C4411

Balanced Approach to Noise Management – Review of Key Pillars in Respect of Toronto Airport

| | Balanced Approach Pillar | Pillar Role and Process |
|---|---|---|
| 1 | Reduction of Noise at the Source | Enhanced technology but more larger aircraft. |
| 2 | Land-Use Planning and Management | NEF Contours. AOA based on multiple scenarios. |
| 3 | Noise Abatement Operating Procedures | Preferential Runways. |
| 4 | Operating Restrictions | Night noise budget. |
| | Triggers | Privatization<br>Airspace Redesign (2012) |

[i] https://www.nzairports.co.nz/assets/Files/public/NZ-Airports-Submission-on-the-Urban-Development-Bill2.pdf (accessed 14/07/2021)

[ii] https://www.nzairports.co.nz/assets/Files/public/Airport-Master-Planning-NZ-Airports-Feb-2017-FINAL2.pdf (accessed 14/07/2021)

[iii] https://www.infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/index.aspx

[iii] https://www.transport.govt.nz/statistics-and-insights/air-and-sea-transport/sheet/air-freight (accessed 14/07/2021)

[iv] https://www.christchurchairport.co.nz/about-us/who-we-are/gateway-to-antarctica/ (accessed 14/07/2021)

[v] https://www.comnap.aq/our-members/programma-nazionale-di-ricerche-in-antartidepnra/ (accessed 14/07/2021)

# Appendix 13

Airport Contour s77K Appendix Three: International and Domestic Airfreight Assessment Paling Consultants

# Review of international and domestic freight trends through Christchurch International Airport

## Final Report

submitted by

## Richard Paling Consulting

June 2022

Richard Paling Consulting

# Review of international and domestic freight trends through Christchurch International Airport

## 1 Introduction

Christchurch International Airport (the Airport / Christchurch Airport) is the second largest international airfreight gateway in New Zealand and the only one providing direct links to overseas destinations for those wishing to ship goods by air to or from the South Island. While the volumes of goods handled are small, the total value of these (at almost $3 billion in 2021) makes the Airport the second largest South Island import gateway after the port of Lyttelton and the third largest South Island export gateway after Lyttelton and Port Chalmers.

A number of studies have indicated the value of international airfreight services to the domestic economy. For example, a study in the UK[1] estimated that these services contributed up to about 9 per cent of regional gross value added. Christchurch Airport similarly has an important role in encouraging and supporting economic development in the South Island.

International airfreight through Christchurch Airport has two major focusses:-

- The provision of a facility for export of a range of time sensitive premium agricultural products from South Island producers to a range of international markets, especially in Australia, China, South East Asia and the US, for which the transit times by alternative modes would prevent or severely limit the sale of these products. These products include fresh and live fish, horticultural products such as cherries and other stone fruits and fresh and chilled meat.
- The movements of high value manufactured goods supporting local industries both for exports and imports of time-critical materials examples of which include Hamilton Jet engines and parts and also the movements of goods to consumers from overseas suppliers.

Up to 2019 this role had been growing, with the share by value of Christchurch Airport in total South Island trade reaching 16 per cent for exports and 19 per cent for imports. The advent of COVID-19 and the reduction in services through the Airport has, however, halted or reversed this trend. This report looks at the extent of these changes before looking further into the role that the flows of freight through Christchurch Airport may play in supporting economic activity in Canterbury and the South Island as a whole in the future.

In addition to serving international trade, Christchurch is an important staging point for e-commerce, other courier movements and mail within New Zealand, acting as a distribution centre for items delivered to South Island destinations and also as a consolidation point for those moving to North Island destinations. A very large proportion of this inter-island traffic passes through Christchurch Airport and the report also considers the importance of accommodating this traffic.

The structure of this report is as follows:-

- Section 2 examines the general growth of air traffic through Christchurch Airport up to 2019.
- Section 3 focuses on the airfreight position in 2019, as it demonstrates the most recent data unaffected by the Covid-19 pandemic.

[1] Steer (2018) Assessment of the value of air freight services to the UK economy

- Section 4 looks at the changes over the period between 2019 and 2021.
- Section 5 considers predicted future trends
- Section 6 considers the role of Christchurch Airport in the increases in international air-freight demand anticipated in the future.
- Section 7 considers domestic airfreight issues
- The main findings are summarised in Section 8.

There are two dimensions of airfreight which this report considers particularly in relation to international movements –

- the volume of goods transported, which is related to the capacity available; and
- the value of the goods transported, which reflects their impacts on the economy of the areas served by Christchurch Airport.

## 2 Growth in the period before 2019

### 2.1 Changes up to 2019

Up to the end of 2019, the total value of international trade carried by airfreight both in terms of the total value of the goods transported and its share of total South Island trade had been increasing strongly, as can be seen in Figure 2.1 and Figure 2.2.

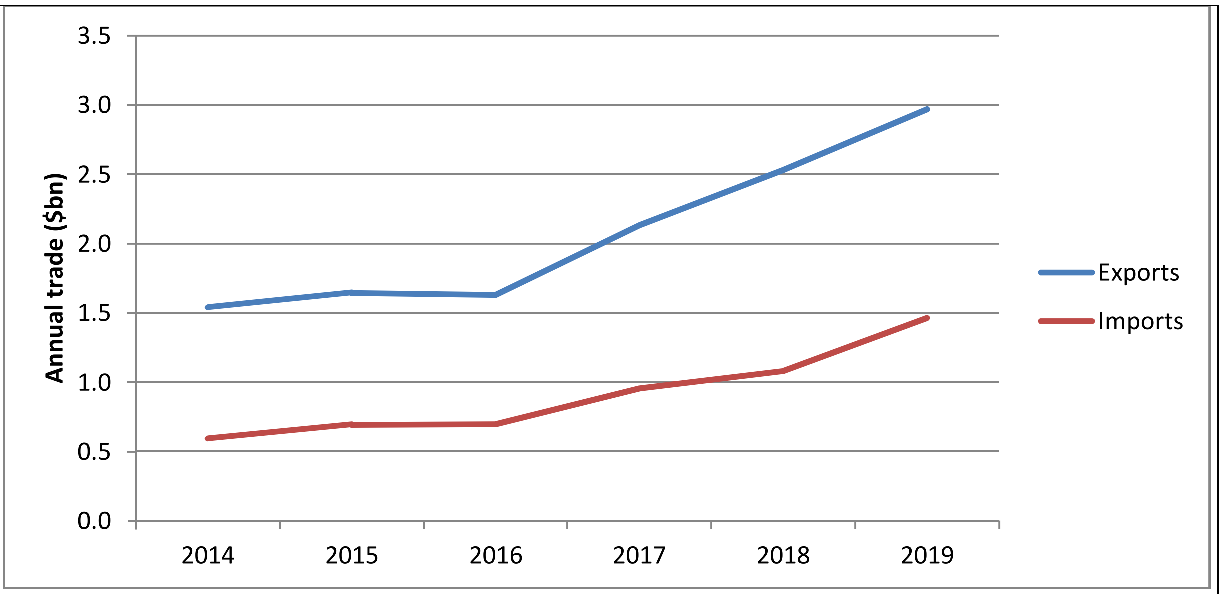


**Figure 2.1**
**Growth in the value of international trade through Christchurch International Airport 2014-2019 ($bn)**

Source : Statistics New Zealand

The values of both airfreight exports and imports had been growing strongly from 2014 to 2019:

- imports increased by almost 150 per cent, increasing from $0.6bn to $1.5bn.
- exports also almost doubled over the same period, growing from $1.5bn to almost $3bn.

With this rapid growth in the value of airfreight, its share of the total value of international trade from the South Island ports and airports also increased sharply rising from about 10 per cent of the total in 2014 to 16 to 18 per cent in 2019. This is displayed in Figure 2.2.

It is also noticeable that the shares of both imports and exports grew along a similar path, possibly reflecting the growth of air freight capacity primarily provided by passenger services through the Airport.

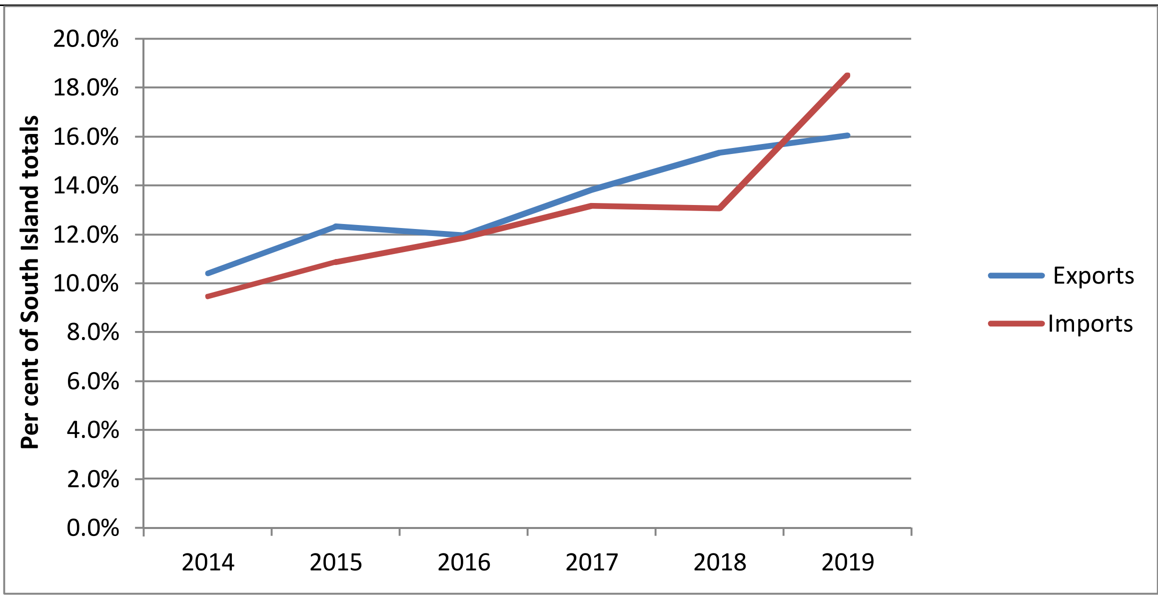


**Figure 2.2**
**Growth in the value of foreign trade through Christchurch International Airport as a share of the total for the SI as a whole (per cent)**

Source : Statistics New Zealand

As well as considering the value of airfreight, which contributes significantly to the local economy, the volumes carried are also important in relation to the capacity available for international movements. Changes in the tonnages of international airfreight into and out of Christchurch Airport are set out in Figure 2.3. It should be noted that these are very small in relation to the volumes transported by sea, amounting to about 0.2 per cent of South Island imports and exports. This demonstrates the high values per tonne for airfreight movements.

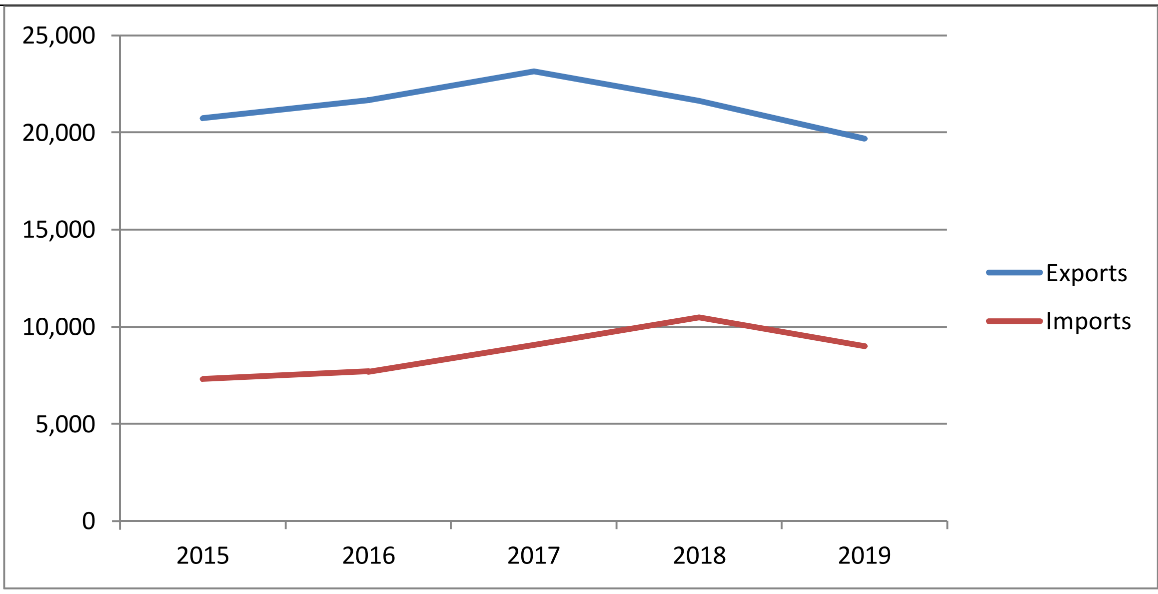


**Figure 2.3**
**International airfreight movements through Christchurch International Airport by volume**
**2014-2019**

Source : Statistics New Zealand

After growing for much of the period from 2015, volumes of both imports and exports declined slightly in 2019. This in combination with the increases in value set out in Figure 2.1 indicates a switch to the carriage of higher value commodities.

## 2.2 Overall assessment

The key findings from the consideration of airfreight through Christchurch Airport over the period up to 2019 include:-

- Traffic through the Airport in 2019 was dominated by exports both in value and volume terms;
- In value terms both exports and imports had been growing strongly over the period, increasing by 100 per cent and 150 per cent respectively;
- The value of airfreight through Christchurch Airport was also growing as a proportion of total South Island trade;
- Volumes of exports and imports had remained broadly stable with increases in total value reflecting a switch to higher value commodities.

# 3 International airfreight movements in 2019

## 3.1 Introduction

2019 represents the last normal year before the Covid pandemic struck and is therefore the most recent position from which to consider future trends. This section first considers the totality of airfreight movements in terms of imports and exports in 2019. It then goes on to look at the breakdown of these flows both in terms of the commodities handled and also the overseas markets served.

## 3.2 The general position in 2019

In 2019 the value of international trade through Christchurch Airport amounted to about \$4.4bn, representing about 17 per cent of the total international trade of the South Island. Of this, imports accounted for about \$1.47bn or 19 per cent of the total imports for the South Island. Exports, which were almost twice as large as imports, amounted to \$2.97bn or 16 per cent of the total exports for the South Island. The split between the value of imports and exports in 2019 is highlighted in Figure 3.1

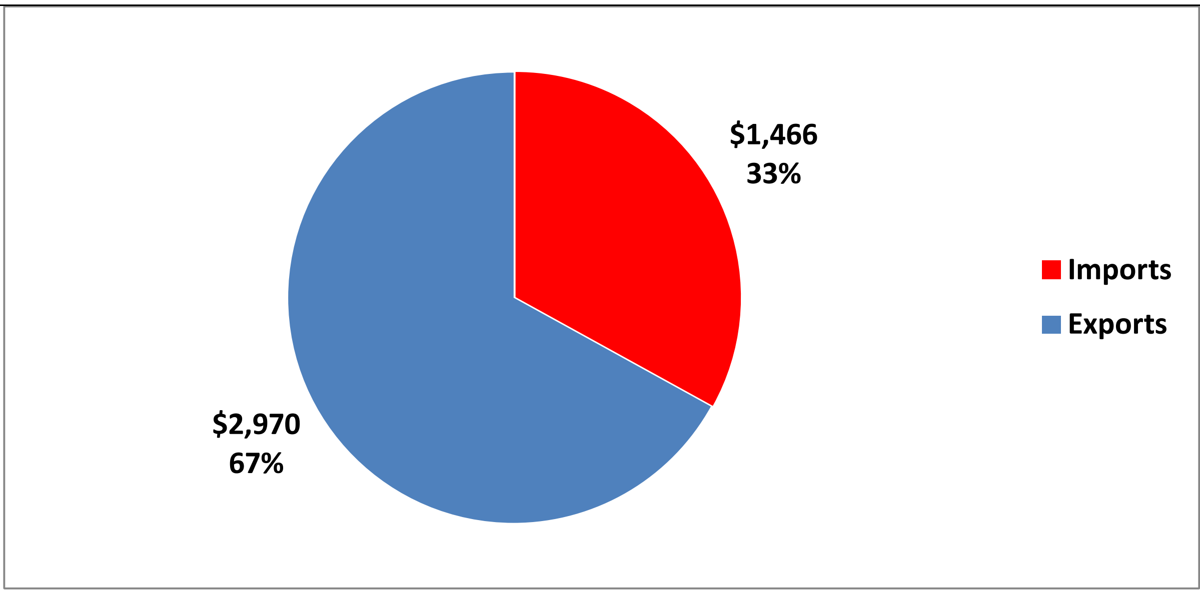


**Figure 3.1**
**Imports and exports through Christchurch airport in 2019 by value (\$m)**

In volume terms exports were again much larger than imports, at about 20,000 tonnes compared to imports of about 9,000 tonnes, although because of the nature of air freight, both represented only a very small share of the volume of total international freight to or from the South Island. The split between imports and exports by volume for 2019 is set out in Figure 3.2

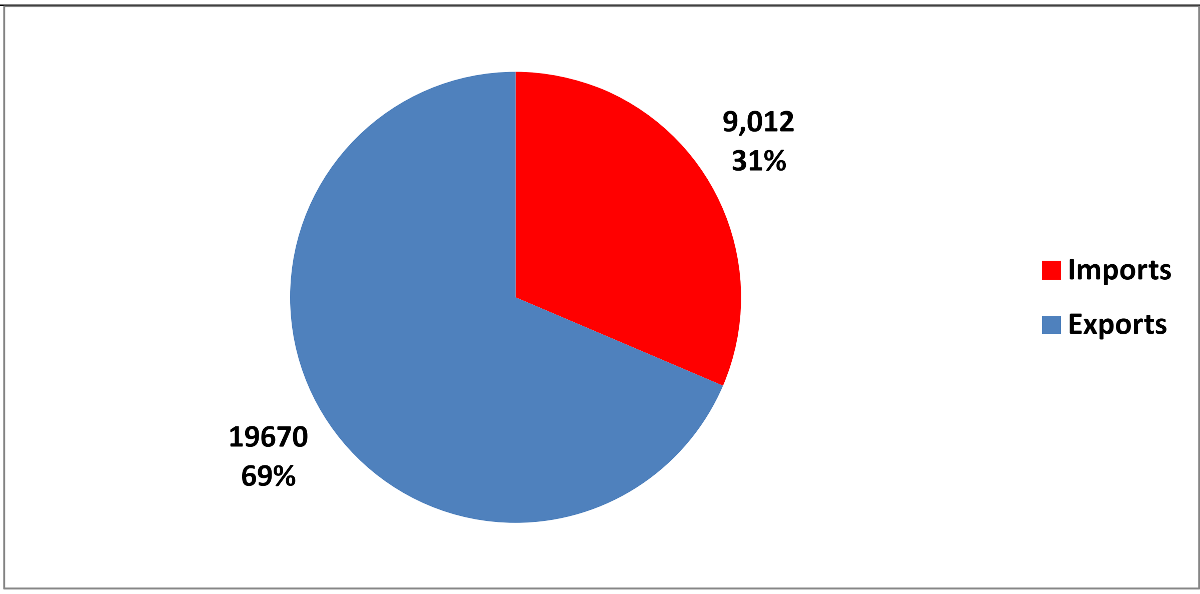


**Figure 3.2**
**Imports and exports through Christchurch airport in 2019 by volume (tonnes)**

The dominance of exports to some extent reflects the nature of the South Island economy as a whole with a strong focus on the production of goods for overseas markets, especially agricultural commodities.

The relatively high shares of airfreight in the total value of international trade highlights its importance in supporting economic activity, getting time-sensitive high value goods to overseas markets and bringing in supplies for local industries and consumers. The provision of airfreight services to and from Christchurch airport also simplifies South Island supply chains by allowing direct international export and import. This may reduce the amount of handling between supplier and customer, compared to what would be required if airfreight had to be routed through alternative locations.

## 3.3 Trade by commodity in 2019

Looking in more detail at the patterns of air freight trade, the breakdown by commodity in volume terms in 2019 is set out in Table 3.1 and summarised in Figure 3.3 and Figure 3.4.

**Table 3.1**
**Total trade through Christchurch airport 2019 (tonnes)**

| Commodity group | Exports | | Imports | |
|---|---|---|---|---|
| | Total (tonnes) | Per cent | Total (tonnes) | Per cent |
| Bulk and chemicals | 648 | 3.3% | 1002 | 11.1% |
| Dairy | 1044 | 5.3% | 48 | 0.5% |
| Fish | 6387 | 32.5% | 20 | 0.2% |
| Horticulture | 2000 | 10.2% | 351 | 3.9% |
| Live animals | 151 | 0.8% | 6 | 0.1% |
| Manufactured goods | 2421 | 12.3% | 3531 | 39.2% |
| Meat | 2830 | 14.4% | 29 | 0.3% |
| Metal products | 302 | 1.5% | 460 | 5.1% |
| Pharmaceuticals | 174 | 0.9% | 47 | 0.5% |
| Precious metals | 6 | 0.0% | 6 | 0.1% |
| Processed food | 2232 | 11.4% | 1239 | 13.7% |
| Stones and ceramics | 240 | 1.2% | 227 | 2.5% |
| Textiles | 748 | 3.8% | 1334 | 14.8% |
| Wood prods | 187 | 1.0% | 276 | 3.1% |
| Transport equipment | 292 | 1.5% | 435 | 4.8% |
| **Grand Total** | 19662 | 100.0% | 9011 | 100.0% |

Source : Data supplied by Statistics New Zealand

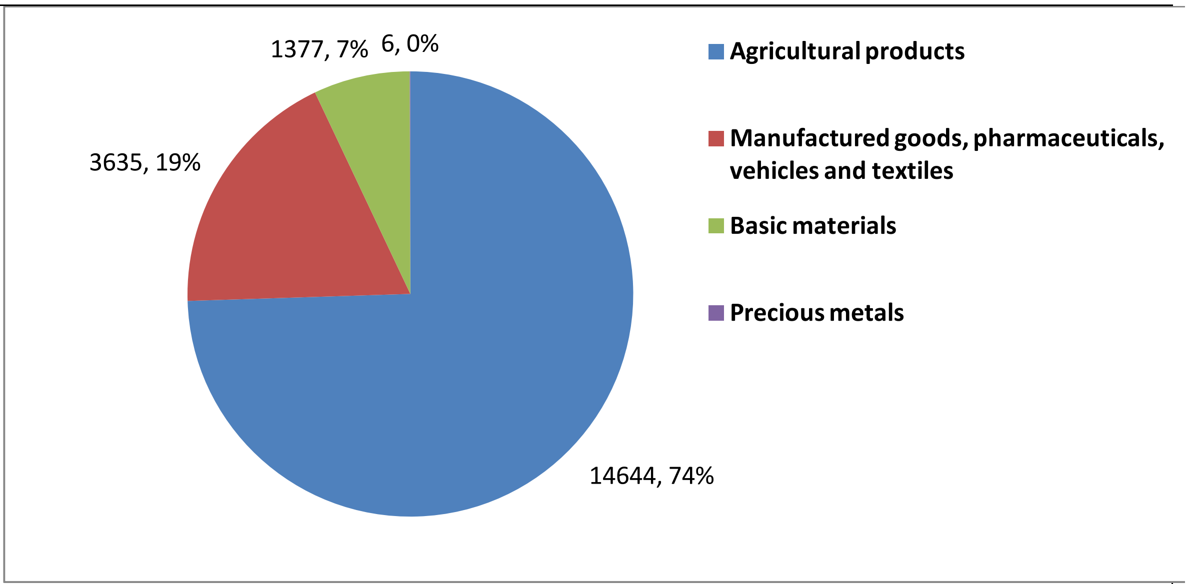


**Figure 3.3**
**Airfreight exports through Christchurch airport by broad commodity group and volume 2019**
**(tonnes and per cent of total)**

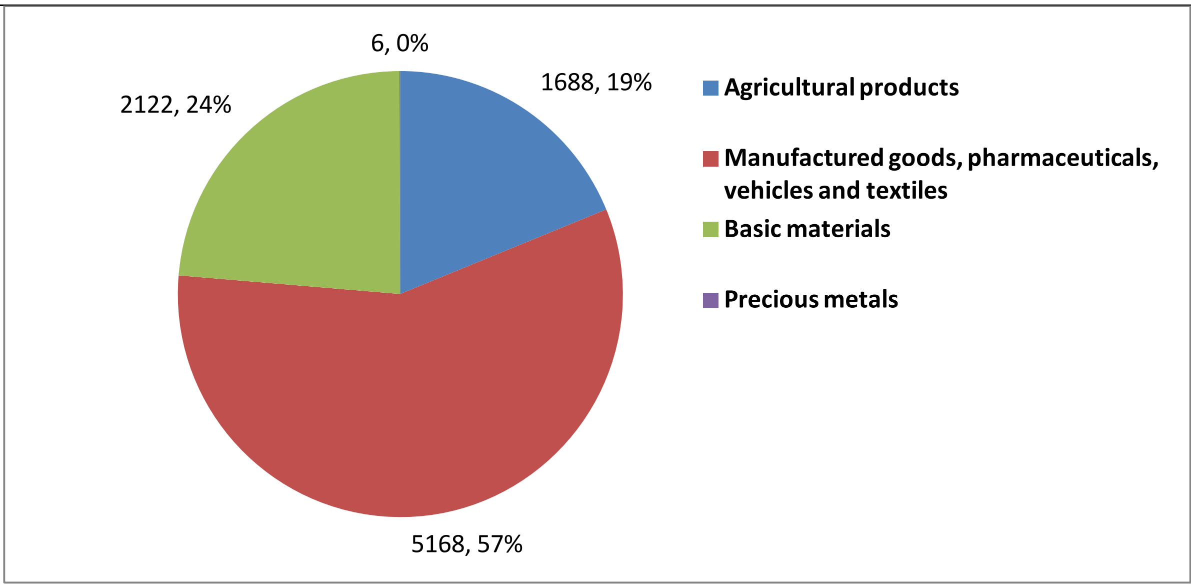


**Figure 3.4**
**Airfreight imports through Christchurch airport by broad commodity group and volume 2019 (tonnes and per cent of total)**

Export tonnage is dominated by agricultural products, especially fish, meat, processed food, horticultural items and dairy which together accounted for about three quarters of the exports through the airport in 2019. Manufactured goods including textiles, vehicles and pharmaceuticals account for a further 20 per cent of the total. For imports, there is a greater focus on manufactured goods and textiles which account for over half the total volume, with agricultural products accounting for just 20 per cent.

This pattern reflects the economic structure of the South Island with a heavy dependence on agricultural products for export and also a substantial manufacturing industry with strong overseas links. With its location to the centre of the South Island and at the junction of road and rail links to the north, south and west, Christchurch also acts as the major distribution centre for the South Island as a whole supporting businesses and consumers in general. This is evidenced by the presence of a number of South Island distribution centres. These are both for retail chains including Progressive, Foodstuffs, The Warehouse, Noel Leeming and Kathmandu in the city and also companies selling to businesses and similar agencies, such as DHL (distributing critically important healthcare products from a site close to the airport), USL biomedical services, OfficeMax, Century Yuasa Batteries, NZ Safety Blackwoods and Primepac.

In value terms the position was rather different as can be seen in Table 3.2.

**Table 3.2**
**The value of airfreight through Christchurch airport by commodity 2019 ($millions)**

| Commodity group | Exports | | Imports | |
|---|---|---|---|---|
| | Total ($m) | Per cent | Total ($m) | Per cent |
| Dairy products | 18 | 0.6% | 2 | 0.2% |
| Fish | 151 | 5.1% | 0 | 0.0% |
| Horticultural products | 39 | 1.3% | 2 | 0.1% |
| Live animals | 8 | 0.3% | 0 | 0.0% |
| Meat | 62 | 2.1% | 2 | 0.1% |
| Processed food | 67 | 2.3% | 23 | 1.6% |
| Wood products | 4 | 0.1% | 3 | 0.2% |
| Bulk and chemicals | 50 | 1.7% | 36 | 2.6% |
| Manufactured goods | 2354 | 79.3% | 1169 | 82.8% |
| Metal products | 7 | 0.2% | 14 | 1.0% |
| Pharmaceuticals | 26 | 0.9% | 8 | 0.6% |
| Precious metals | 37 | 1.3% | 4 | 0.3% |
| Stones and ceramics | 4 | 0.1% | 4 | 0.3% |
| Textiles | 53 | 1.8% | 75 | 5.3% |
| Transport equipment | 88 | 3.0% | 69 | 4.9% |
| **Grand Total** | **2969** | **100.0%** | **1412** | **100.0%** |

Source : Data supplied by Statistics New Zealand

The details in Table 3.2 highlight the importance in value terms of manufactured goods in the movements of both imports and exports through Christchurch airport, with manufactured goods accounting for about 80 per cent of the total values for both imports and exports in 2019. Agricultural products which accounted for a high proportion of the volume of exports only comprise about 12 per cent of the total value of exports and 9 per cent of imports.

## 3.4 Trade by origin or destination

The pattern of trade by origin or destination is set out in volume terms in Table 3.3.

| Table 3.3<br>International flows by overseas destination or origin through Christchurch airport by volume 2019 (tonnes) | | | | |
|---|---|---|---|---|
| **Country group** | **Exports** | | **Imports** | |
| | **Total (tonnes)** | **Per cent** | **Total (tonnes)** | **Per cent** |
| Australia | 6115 | 31.1% | 1987 | 22.0% |
| China | 3574 | 18.2% | 2382 | 26.4% |
| Vietnam | 380 | 1.9% | 134 | 1.5% |
| Taiwan | 788 | 4.0% | 106 | 1.2% |
| Japan | 637 | 3.2% | 157 | 1.7% |
| Other SE Asia | 2043 | 10.4% | 427 | 4.7% |
| US | 2661 | 13.5% | 877 | 9.7% |
| Canada | 114 | 0.6% | 79 | 0.9% |
| EU | 1947 | 9.9% | 2000 | 22.2% |
| GB | 965 | 4.9% | 296 | 3.3% |
| ME+C Asia | 232 | 1.2% | 70 | 0.8% |
| Other | 206 | 1.0% | 495 | 5.5% |
| Grand Total | 19662 | 100.0% | 9011 | 100.0% |

Source : Data supplied by Statistics New Zealand

In terms of the destinations and origins for international airfreight by volume through the Airport, Australia is the most important destination for exports followed by China, and the US. For imports China is the most important source representing 26 per cent of the market followed closely by Australia and the EU with similar shares of 22 per cent.

The pattern of trade by value is set out in Table 3.4.

| Table 3.4<br>International flows through Christchurch airport by value 2019 ($m) | | | | |
|---|---|---|---|---|
| **Country/ region** | **Exports** | | **Imports** | |
| | **Total ($m)** | **Per cent** | **Total ($m)** | **Per cent** |
| Australia | 655 | 22.1% | 80 | 5.7% |
| China | 431 | 14.5% | 105 | 7.4% |
| Vietnam | 716 | 24.1% | 13 | 0.9% |
| Taiwan | 25 | 0.8% | 18 | 1.2% |
| Japan | 27 | 0.9% | 79 | 5.6% |
| Other SE Asia | 146 | 4.9% | 37 | 2.6% |
| US | 751 | 25.3% | 649 | 45.9% |
| Canada | 8 | 0.3% | 25 | 1.8% |
| EU | 113 | 3.8% | 302 | 21.4% |
| GB | 44 | 1.5% | 57 | 4.0% |
| ME+C Asia | 31 | 1.0% | 7 | 0.5% |
| Other | 22 | 0.7% | 39 | 2.8% |
| Total | 2969 | 100.0% | 1412 | 100.0% |

Unlike the position for volumes, exports by value are dominated by trade with the US and Vietnam which together account for about half the total.  Other important export markets are Australia (22 per cent) and China (15 per cent).

Imports by value are spread between a wider set of origins but are again dominated by flows from the US (46 per cent) the EU and GB (25 per cent).

## 3.5 **Flight patterns in 2018 and 2019**

The pattern of airfreight is to some extent dictated by the availability of suitable capacity, which in turn depends on the services provided. For the most part in 2019 potential freight capacity was provided in the belly hold of passenger aircraft. The pattern of international passenger flights in 2019 and also 2018 is set out in Table 3.5. This covers the flights outbound from Christchurch but the pattern of inbound flights is effectively the same.

**Table 3.5**
**Flights from Christchurch by destination in 2018 and 2019 (flights per year)**

| Destination | Year | |
|---|---|---|
| | **2018** | **2019** |
| Brisbane | 1102 | 1105 |
| Melbourne | 1423 | 1377 |
| Sydney | 1675 | 1618 |
| OOL | 297 | 296 |
| Perth | 36 | 25 |
| **Total Australia** | **4533** | **4421** |
| Hong Kong | 40 | 49 |
| Guangzhou | 234 | 235 |
| Singapore | 395 | 405 |
| **Total China and SE Asia** | **669** | **689** |
| Rarotonga | 16 | |
| Suva | 1 | |
| Nandi | 194 | 195 |
| **Total Pacific Islands** | **211** | **195** |
| **Total all destinations** | **5413** | **5305** |

This was supplemented by a weekday freight only service to Sydney as set out in Table 3.6.

**Table 3.6**
**Freight only flights from Christchurch by destination in 2018 and 2019 (flights per year)**

| Year | Sydney | Total |
|---|---|---|
| 2018 | 260 | 260 |
| 2019 | 261 | 261 |

This weekday freight-only service operated on a loop with services Sydney-Auckland-Christchurch-Sydney. For this flight the traffic from Christchurch would have had to share the capacity in the plane with the traffic between Auckland and Sydney.

The number of flights with freight capacity declined slightly in 2019 compared with the previous year. This may be a factor in the small reduction in import and export flows noted above in Section 2.1.

## 3.6 **Overall assessment**

The key features for the airfreight movements through Christchurch in 2019 include:-

- Exports are much larger than imports both in terms of volume and value. These are therefore more likely to be constrained by the absolute volume of airfreight capacity that may be available. The smaller volumes of imports are less likely to be affected by the lack of total capacity.
- In volume terms,
    - Agricultural products represent about three quarters of the total airfreight export movements. Many of these products are time-sensitive, perishable items for which the timing of services may be critical if these products are to be able to access markets in receiving countries.

- Imports have a much higher proportion of textiles and other manufactured goods for which specific regular timing issues may be less critical. However, because of the wide range of origins for this traffic and often less predictable timing, a wider range of airfreight routes and services would be important to facilitate these flows and to support the wide range of firms operating distribution hubs in Christchurch serving both retail and business customers.
    - Export traffic is focussed on Australia, China and South East Asia which accounts for about 70 per cent of the total. The balance is split more or less equally between European destinations and the US and Canada combined.
    - For imports China is the most important source making up over a quarter of the total, with Australia and Europe having similar shares of 20-25 per cent.
- In terms of value
    - Exports and imports are dominated by manufactured goods, which account for about 80 per cent of the total. This highlights the importance of these movements to local businesses and to other consumers.
    - The key markets for exports are China and South East Asia with just under half the total market and Australia and the US with about 20-25 per cent each. For imports the market is dominated by movements from the US and Canada (just under half) and Europe (about 25 per cent).
- Direct airfreight capacity from Christchurch Airport is mainly with Australia and China and South East Asia, providing onward connections to other destinations. There are also direct flights from Christchurch to the Pacific islands but because of the small size of these islands, they do not appear to attract much freight.

# 4 Impact of Covid-19: Changes to airfreight in 2020 and 2021

## 4.1 Introduction

With the onset of Covid-19 and the associated restrictions and lockdowns affecting economic activity and trade, there were substantial changes in the patterns of airfreight activity through Christchurch Airport. In part these reflected the changes in flight patterns as passenger flows fell sharply, and in part the changes in the underlying patterns of economic activity that resulted from the constraints that ensued in 2020 and 2021 and which reduced to some extent the demand for air freight.

While this section considers both exports and imports, the detailed analysis is confined to the key export flows which represent the majority of the airfreight traffic and the area where the main issues and capacity constraints are likely to arise.

## 4.2 Changes in flight patterns and freight availability

With the onset of the pandemic there was a substantial downturn in the numbers of international flights serving Christchurch Airport providing for the movement of airfreight. This is set out in Table 4.1 and Figure 4.1.

**Table 4.1**
**Total international flights from Christchurch airport 2019-2021 (flights per year)**

| Calendar year | Passenger aircraft | Freighters |
|---|---|---|
| 2019 | 5295 | 261 |
| 2020 | 1340 | 290 |
| 2021 | 719 | 535 |

Source: Data supplied by CIAL

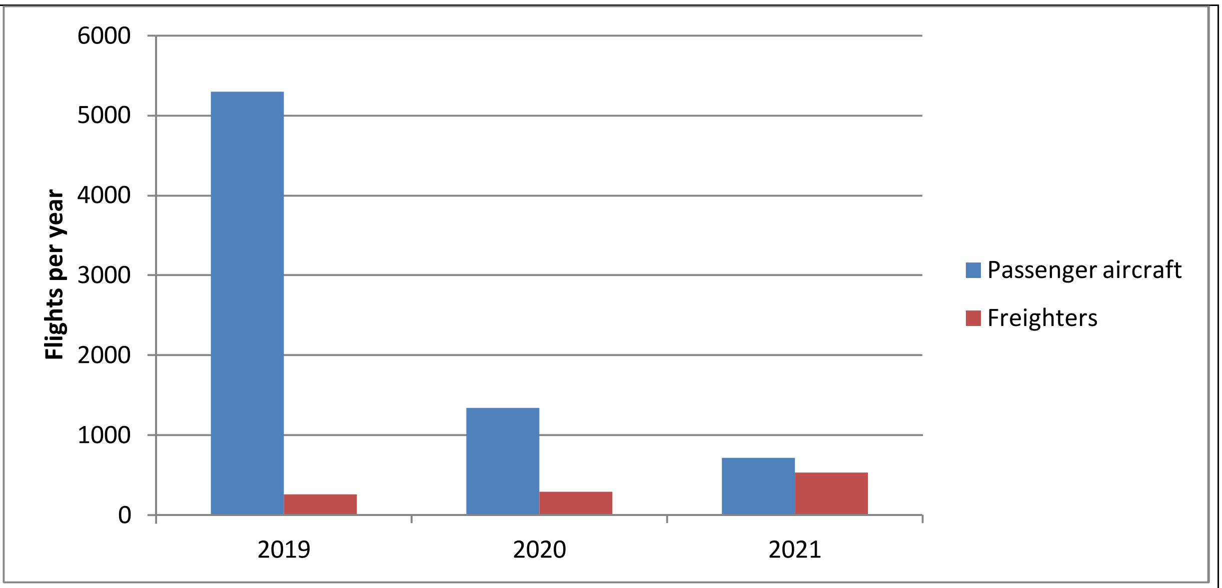


**Figure 4.1**
**Total international flights from Christchurch International Airport 2019-2021 (flights per year)**

From a total of over 5,000 international passenger flights departing Christchurch in 2019, the numbers fell by about 75 per cent in 2020 and by a further 11 per cent in 2021. Overall, the frequency of services to many of the key international destinations fell sharply. These reductions make airfreight less flexible, with connections being constrained to particular days via limited passenger services or freight-only aircraft.

To some extent the decline in the numbers of passenger aircraft offering freight capacity was balanced by increased freight capacity per aircraft as the numbers of passengers per flight declined or fell to zero. It was also balanced by increases in the numbers of freight-only aircraft, helped in part by the subsidy offered by the New Zealand government through the MIAC scheme and its predecessors. The pattern of services by destination also changed significantly as can be seen in Table 4.2

**Table 4.2**
**Changes in flights by destination 2019-2021 (flights per year)**

| Destination airport | Passenger aircraft | | | | Freight only aircraft | | |
|---|---|---|---|---|---|---|---|
| | **2019** | **2020** | **2021** | | **2019** | **2020** | **2021** |
| BNE | 1105 | 261 | 179 | | | | |
| MEL | 1377 | 368 | 167 | | | 7 | 31 |
| SYD | 1618 | 353 | 155 | | 261 | 262 | 216 |
| PER | 25 | | | | | | |
| OOL | 296 | 69 | 33 | | | | |
| ***Total Australia*** | ***4421*** | ***1051*** | ***534*** | | ***261*** | ***269*** | ***247*** |
| CAN | 235 | 41 | | | | 2 | 77 |
| PVG | | | | | | | 42 |
| HKG | 49 | 34 | | | | 3 | 8 |
| SIN | 405 | 185 | 186 | | | 1 | |
| TPE | | | | | | 2 | 8 |
| ***Total China and South East Asia*** | ***689*** | ***260*** | ***186*** | | ***0*** | ***8*** | ***135*** |
| NAN | 195 | 28 | | | | | |
| TBU | | | 1 | | | | |
| ***Pacific Islands*** | ***195*** | ***28*** | ***1*** | | ***0*** | ***0*** | ***0*** |
| LAX | | | | | | 13 | 148 |
| HNL | | | | | | | 5 |
| ***Total N America*** | ***0*** | ***0*** | ***0*** | | ***0*** | ***13*** | ***153*** |
| **Grand Total** | **5305** | **1339** | **721** | | **261** | **290** | **535** |

While the number of destinations served directly has remained broadly the same, with the support offered by the New Zealand government enabling additional airfreight capacity directly from Christchurch to destinations including Los Angeles, Guangzhou and Shanghai, the overall frequency of services to many of the key destinations fell sharply. As an example the number of flights (passengers and freight) to the major market of Australia declined from almost 4,700 in 2019 to 780 in 2021. There were similar reductions in the flights serving the gateways to South East Asia and China. The effect of these reductions in the frequency of flights would be to make airfreight less flexible, with connections being constrained to particular days via limited passenger services or freight-only aircraft. This compares with the more comprehensive potential coverage supplied in earlier years by higher frequency passenger services. The number of freight-only flights per year has been largely maintained for Australian destinations and has increased significantly for other destinations. Increases in capacity per aircraft offered by freight-only services have largely offset reductions in the frequency of passenger flights. The supported service to Los Angeles has provided a new direct connection to North America.

### 4.3 **Changes in airfreight volumes and values**

Concomitant with the reductions in the numbers of flights, the values and volumes of exports and imports fell compared to the higher levels of trade in the period up to 2019. The changes to the volumes of international air freight are set out in Figure 4.32

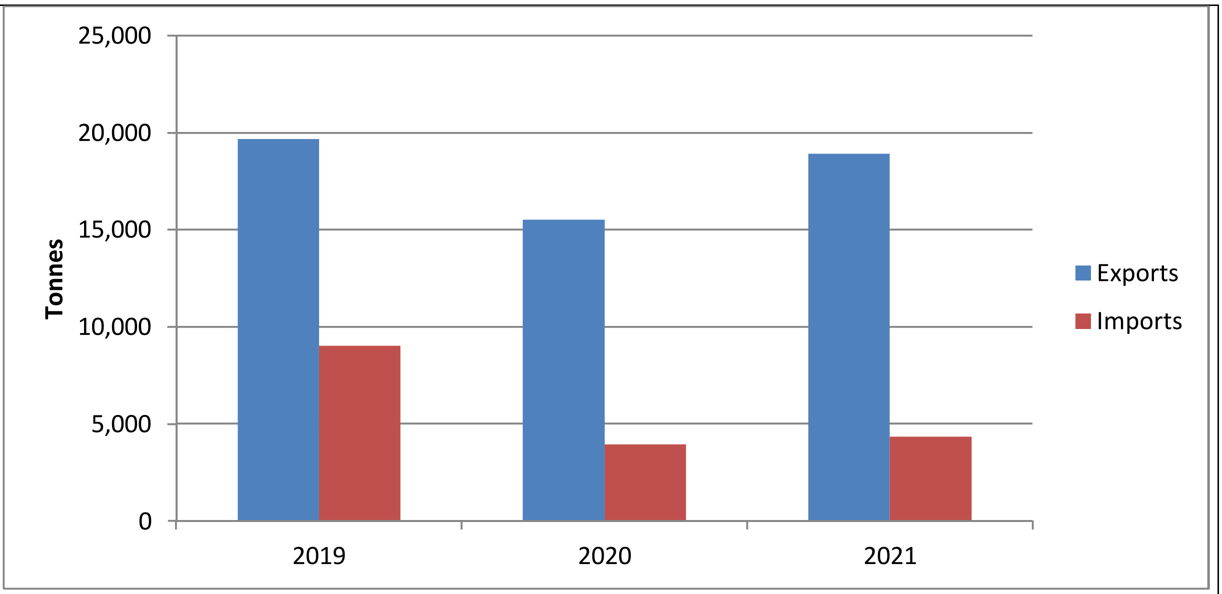


**Figure 4.2**
**Changes in the volumes of international trade through Christchurch International Airport 2019-2021 (tonnes)**

While the volume of exports declined by about 20 per cent in 2020 compared to 2019 levels, it then increased in 2021 to almost 95 per cent of its pre-Covid level. This suggests that, in aggregate, the efforts to maintain outbound airfreight capacity through the MIAC scheme for the key routes had been reasonably successful. For imports there was a decline in volumes of about 55 per cent in 2020 compared to 2019 levels, but these volumes then increased slightly in 2021. This probably, in part, represented a reduction in the demand for goods from overseas as the New Zealand economy responded to the effects of Covid, with major sectors of the economy going into lockdown and total imports by all modes declined. However, this reduction also partly reflected the diminution in the range and frequency of services provided. This is particularly important for the more irregular movements of manufactured and retail goods which represent a high proportion of the volume of imported goods (and a high proportion of the values of exports).

Although the volumes of exports in 2021 were similar to those in 2019, it was a different picture for the values of goods exported and this is set out in Figure 4.3.

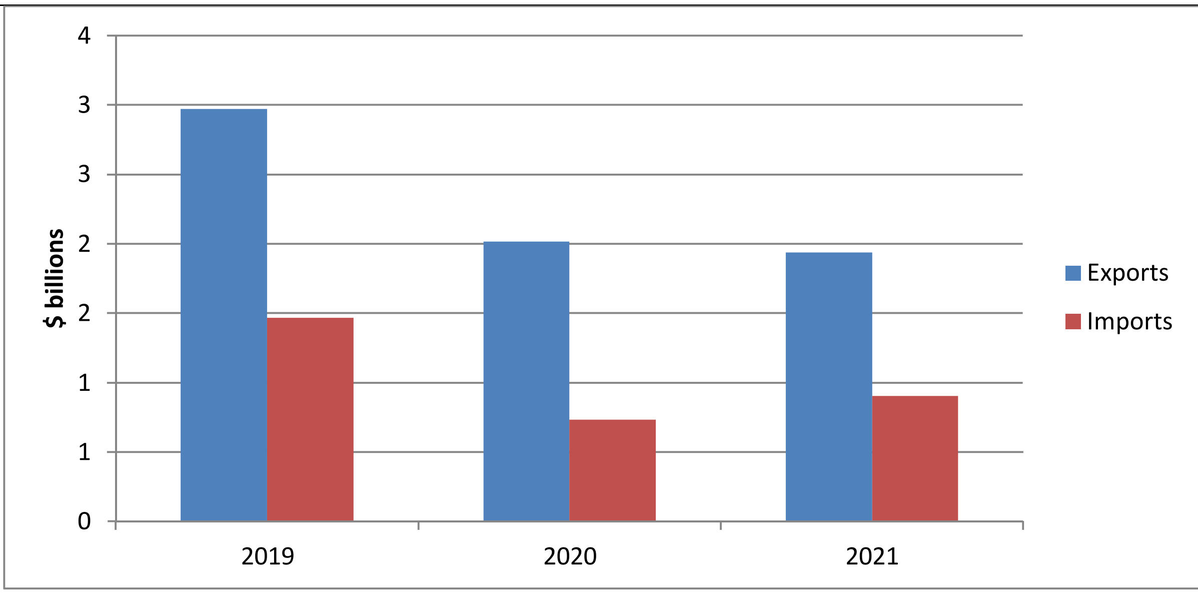


**Figure 4.3**
**Changes in the value of international trade through Christchurch International Airport 2019-2021 ($ billions)**

The value of exports dropped by about a third from just under $3bn in 2019 to about $2bn in 2020 after which the total value stabilised in 2021. In contrast while the value of imports declined by about a half to 2020, broadly in line with the changes in the volume of airfreight traffic, they recovered slightly in 2021, again broadly in line with the changes in the volume.

The different patterns of change to the volumes and values of exports suggest significant changes in the unit values of the commodities exported by air. For imports the value pattern broadly repeats the changes in total value suggesting, in aggregate, at least more consistent prices for the commodities traded.

## 4.4 **Air freight exports**

### ***4.4.1 Exports by area***

The values of export airfreight by area are set out in Table 4.3

| Table 4.3<br>Changes in the destinations of export airfreight through Christchurch International Airport 2019-2021 | | | | | | |
|---|---|---|---|---|---|---|
| | Value ($m FOB) | | | Volume (tonnes) | | |
| **Country grouping** | **2019** | **2021** | **Change 2019-2021** | **2019** | **2021** | **Change 2019-2021** |
| Australia | 655 | 637 | -3% | 6115 | 4481 | -27% |
| China | 431 | 207 | -52% | 3574 | 5457 | 53% |
| Vietnam | 716 | 98 | -86% | 380 | 432 | 14% |
| Taiwan | 25 | 20 | -22% | 788 | 886 | 12% |
| Japan | 27 | 15 | -46% | 637 | 705 | 11% |
| Other SE Asia | 146 | 141 | -4% | 2043 | 1358 | -33% |
| US | 751 | 552 | -26% | 2661 | 2654 | 0% |
| Canada | 8 | 2 | -80% | 114 | 5 | -95% |
| EU | 113 | 104 | -8% | 1947 | 1641 | -16% |
| GB | 44 | 56 | 26% | 965 | 867 | -10% |
| Middle East & Central Asia | 31 | 82 | 167% | 232 | 161 | -31% |
| Other | 22 | 19 | -14% | 206 | 174 | -16% |
| **Total** | **2969** | **1933** | **-35%** | **19662** | **18821** | **-4%** |

In value terms, all major destination countries have recorded a drop in airfreight exports from Christchurch although for Australia the decline was only very small at about 3 per cent. Of the other major longer haul markets, the US fell by 26 per cent, China fell by 52 per cent and Vietnam by a very large 86 per cent.

However these changes are in contrast to the volumes of freight exported with that to China increasing by over 50 per cent to become the largest export destination by volume and that to Vietnam increasing by 14 per cent despite the substantial reduction in value. Declines in volumes for the major markets were confined to Australia, Other South East Asia, and Europe. The difference in the changes in values and volumes suggest a change in the mix or average price of the types of goods being exported by airfreight. This is discussed in the next section.

### *4.4.2 Exports by commodity*

Exports by commodity in 2019 and 2021 are set out in Table 4.4.

**Table 4.4**
**Changes in the export commodities through Christchurch airport 2019-2021**

| | Volumes (tonnes) | | | Values ($m) | | | Value per tonne ($) | |
|---|---|---|---|---|---|---|---|---|
| | **2019** | **2021** | **2021/ 2019** | **2019** | **2021** | **2021/2019** | **2019** | **2021** |
| Bulk and chemicals | 648 | 389 | -40% | 50 | 45 | -11% | 77009 | 114541 |
| Dairy | 1044 | 682 | -35% | 18 | 10 | -46% | 17416 | 14505 |
| Fish | 6387 | 8223 | 29% | 151 | 187 | 24% | 23611 | 22700 |
| Horticulture | 2000 | 1949 | -3% | 39 | 33 | -16% | 19620 | 16899 |
| Live animals | 151 | 97 | -36% | 8 | 3 | -57% | 51303 | 34501 |
| Manufactured goods | 2421 | 1777 | -27% | 2354 | 1349 | -43% | 972379 | 759488 |
| Meat | 2830 | 3309 | 17% | 62 | 68 | 10% | 21870 | 20634 |
| Metal products | 302 | 237 | -22% | 7 | 6 | -14% | 22404 | 24639 |
| Pharmaceuticals | 174 | 169 | -3% | 26 | 27 | 4% | 150958 | 161299 |
| Precious metals | 6 | 2 | -70% | 37 | 31 | -15% | 6316892 | 18129669 |
| Processed food | 2232 | 1008 | -55% | 67 | 51 | -25% | 30165 | 50281 |
| Stones and ceramics | 240 | 137 | -43% | 4 | 2 | -48% | 17427 | 15852 |
| Textiles | 748 | 457 | -39% | 53 | 31 | -42% | 71404 | 67749 |
| Transport equipment | 187 | 260 | 39% | 4 | 87 | 1858% | 23706 | 334622 |
| Wood prods | 292 | 128 | -56% | 88 | 3 | -97% | 299827 | 23155 |
| **Total** | **19662** | **18821** | **-4%** | **2969** | **1933** | **-35%** | **150999** | **102712** |

While in general the exports for each of the identified commodity groups declined between 2019 and 2021, there were significant increases for fish and meat and, because of these, total agricultural exports increased over that period. The main decreases were in manufactured goods where the volume fell by over 25 per cent, and textiles which declined by about 40 per cent. In volume terms the balance between agricultural and other exports shifted significantly, with the agricultural share increasing from 74 per cent to 81 per cent of the total.

In value terms, while there were general decreases, the totals for fish and meat increased giving an overall increase in the value of agricultural exports from $345m to $352m. Because of the reduction in the value of exports generally, this resulted in the share for agricultural products increasing from about 12 per cent of total airfreight exports to 18 per cent.

Overall while the volumes and values of exports declined between 2019 and 2021, the totals for the time- and timing- sensitive agricultural products as a whole increased with a consequent growth in their overall share of total exports.

## 4.5 **Key findings**

The key findings from the analysis of the changes in airfreight patterns through Christchurch Airport between 2019 and 2021 are:-

- The patterns of airfreight movements show considerable change over the period after 2019. Both the volumes and values of airfreight imports and exports declined in 2020 in the face of very substantial reductions in the numbers and ranges of air services operated and changes in the patterns of demand following the pandemic.
- The bounce back in the export volumes in 2021 suggests that the recent measures to enhance the volume of air freight capacity through Christchurch have been largely successful and have allowed the key agricultural commodities to maintain and even increase their exports to key markets in volume terms.
- Compared to the position in 2019 the reduction in the range of services provided through the Airport in terms of routes and frequencies appears to have limited the ability for both exporters and importers of high value manufactured goods to take advantage of the time savings achievable with air freight with declines in both the volumes and values of these commodities. This decline has occurred despite the growth of the regional economy and highlights the importance of a wide range of air services capable of carrying freight to support this part of the airfreight market.

# 5 Looking to the future

## 5.1 Introduction

In looking to the role that Christchurch Airport might provide in supporting airfreight services to and from the Canterbury region and the South Island in general, it is likely that this will have two main components:-

- Supporting agricultural production in the region by providing enhanced access for premium products to the key markets in Australia, Asia, the US and Europe;
- Providing for the rapid movement of manufactured and other inputs for industries in New Zealand and overseas and also providing facilities for the movement of consumer goods for consumers in New Zealand.

In volume terms the first component is very important with high volumes of agricultural products looking to access premium markets around the world where the timing of services and speed of delivery are critical. In value terms it is the second component that dominates where access to and from a wide range of origins and destinations is the important factor.

## 5.2 Recent growth patterns

The analysis of the patterns of flow through Christchurch Airport above has highlighted the importance in value terms of the movements of manufactured goods through the Airport. The observed relationship between the values of the flows of international freight traffic through the Port of Lyttelton and through Christchurch Airport for manufactured goods and for total traffic is set out for movements of exports in Figure 5.1.

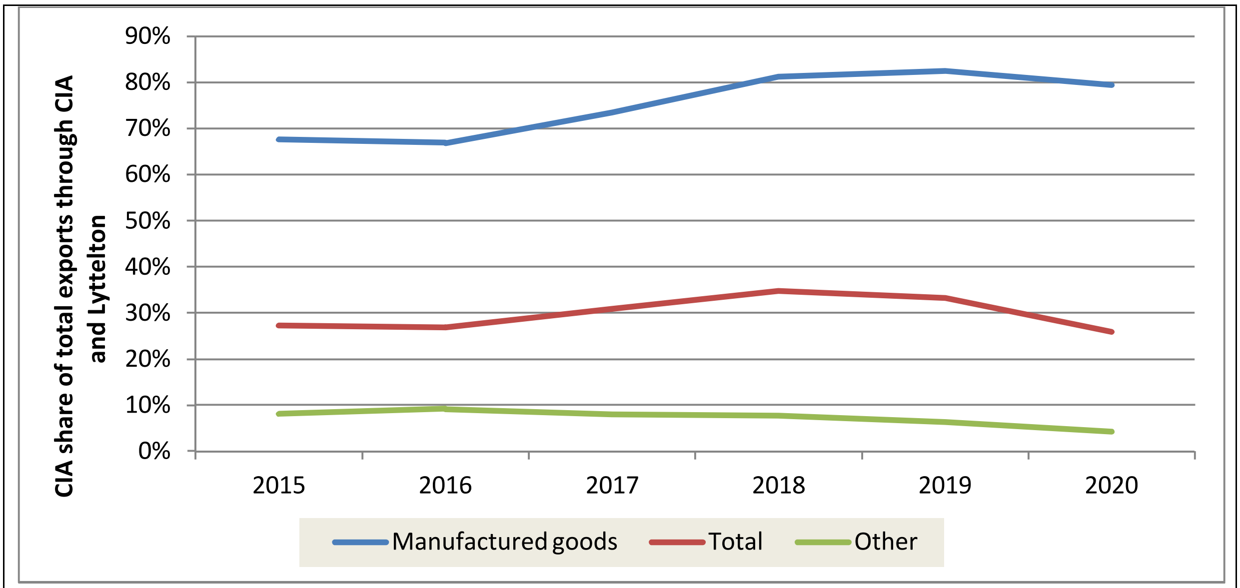


**Figure 5.1**
**Share of Christchurch International Airport in the total value of exports through Christchurch International Airport and Lyttelton Port combined (per cent of total)**

For exports of manufactured goods, the airfreight services through Christchurch Airport provide the main direct access to international markets. The Airport's share of the total value of exported manufactured goods for the Airport and Lyttelton Port combined was substantial, at between 70 and 80 per cent of the direct exports from the region, and was steadily increasing up to 2020.

The position for imports is set out in Figure 5.2.

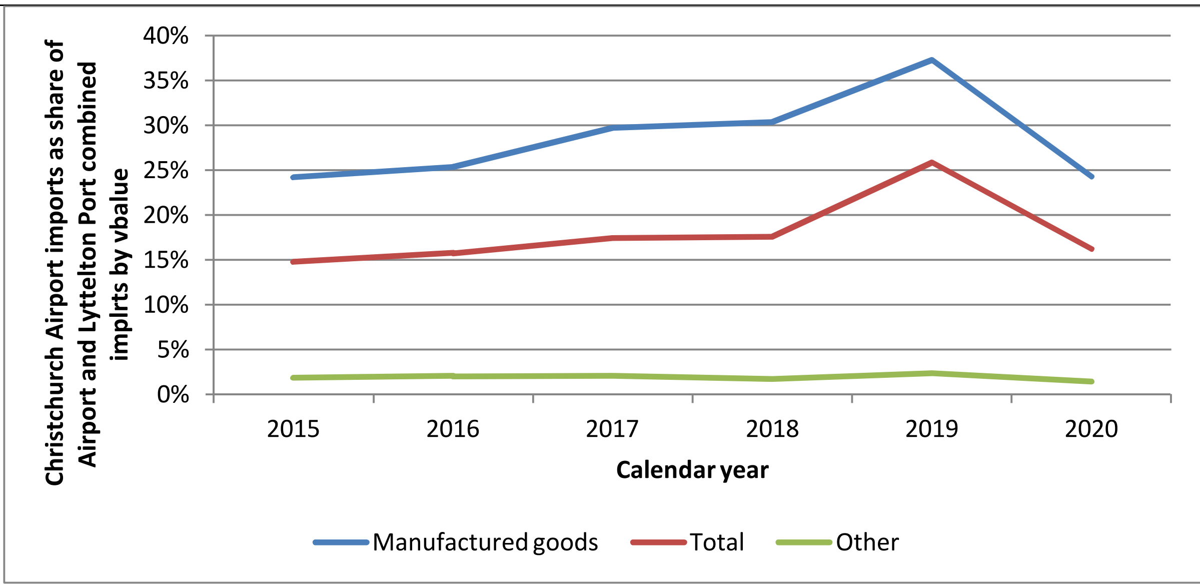


**Figure 5.2**
**Share of Christchurch International Airport in the total value of imports through Christchurch Airport and Lyttelton Port combined (per cent of total)**

A similar position to that observed for exports arises with the share again increasing over the period from 2014, although for these movements, the Airport's share of freight in the combined total for the Port and Airport is lower at 25-35 per cent.

### 5.3 Forecast growth in international freight activity for the Christchurch area

The 2018 National Freight Demand Study (NFDS)[2] provides a detailed snapshot of freight movements across New Zealand in 2018 for the main domestic modes. This, combined with the MOT Freight Futures Model which was developed from this, provide forecasts of the growth of freight for a range of commodities, including forecasts for international freight flows through the Port of Lyttelton. Because of the purpose of the NFDS, and the subsequent model development which was focussed on the potential demands on the domestic transport network in New Zealand, this work has not taken into explicit account the relatively small volumes of airfreight in tonnage terms. However the modelling does provide forecasts of the volumes of traffic by broad commodity type through the Port of Lyttelton, which as explained above is likely to be linked with increased demands for international airfreight to and from Christchurch Airport.

The forecasts of growth from the model are set out in Table 5.1

[2] https://www.transport.govt.nz/assets/Uploads/Report/NFDS3-Final-Report-Oct2019-Rev1.pdf

**Table 5.1**
**MOT Freight Futures model forecasts for international trade through Lyttelton (m tonnes pa)**

| | 2018 | 2032 | 2042 | 2052 | Growth 2018-2052 |
|---|---|---|---|---|---|
| **Exports through Lyttelton** | | | | | |
| Total trade | 3.19 | 3.40 | 1.98 | 2.08 | -35% |
| *Meat* | *0.13* | *0.13* | *0.13* | *0.13* | *0%* |
| ***Manufactured and retail goods*** | ***0.30*** | ***0.36*** | ***0.39*** | ***0.42*** | ***39%*** |
| *Horticulture* | *0.11* | *0.13* | *0.14* | *0.15* | *31%* |
| **Imports through Lyttelton** | | | | | |
| Total trade | 2.40 | 3.32 | 3.88 | 4.32 | 80% |
| *Meat* | *0.01* | *0.01* | *0.01* | *0.01* | *0%* |
| ***Manufactured and retail goods*** | ***0.73*** | ***1.38*** | ***1.74*** | ***2.06*** | ***182%*** |
| *Horticulture* | *0.02* | *0.02* | *0.03* | *0.03* | *31%* |

Source: MoT Freight Futures Model with consultant analysis

These numbers indicate a very substantial growth in the forecast movements of manufactured and retail goods through the port of Lyttelton, reflecting the growing demands generated by industries and consumers in the area. Following the trends experienced in recent years and discussed earlier in this section, this will almost certainly be accompanied by an increased demand for airfreight through Christchurch Airport. Horticulture, which is also an important component of the total airfreight market, is also forecast to grow substantially in volume terms.

As well as gaining from the growth of overseas markets in general, airfreight provides opportunities for the increasing movements of value-added elements within particular commodities. The breakdown of traffic by commodity in Section 4 has for example indicated the growing importance of airfreight exports of high value meat products. In 2021 these had a typical value for products exported by air of $21,000 per tonne compared to the values exported by sea of about $6,000 per tonne. Similarly, horticultural exports by air have an average value per tonne that is more than 12 times the average value for those exported by sea with airfreight offering direct delivery for high value perishable items to overseas markets especially Australia China and other South East Asian countries. The continuing growth in the value of airfreight in the period up to 2019 reinforces these findings.

# 6 The future role of Christchurch International Airport in servicing increased international airfreight demand

The analysis above indicates that there is likely to be growing demand for airfreight as the regional and South Island economies continue to grow following the diminution of the effects of COVID-19 pandemic and also as the use of air becomes increasingly attractive for the transport of the growing share of premium agricultural products. The latter will often require flight timings that allow the products, in many cases fresh or chilled, to be brought to markets in the destination countries at a time that meets the patterns of consumer demand. An example of this is the current service to Guangzhou for which the flights depart from Christchurch in the late evening and arrive in Guangzhou early in the morning in time for the goods to reach markets later the same day when they are still in prime condition. Limitations on the timings of the flights could have adverse impacts on this traffic.

While at present the supply of airfreight capacity through Christchurch appears to be broadly in line with the longer term trends in demand, especially for exports, this reflects the current support provided by the New Zealand government. This government support is likely to be withdrawn as passenger services offering freight capacity are reintroduced. If the anticipated levels of demand for the airfreight of agricultural products are to be met, these new passenger focussed services will need to provide both the freight capacity and timing of services that this trade requires. Any constraints on these services providing airfreight capacity could affect the sector adversely.

In addition to meeting the more specific demands of the agricultural sector, air freight also needs to meet the broader demands for the movement of manufactured goods both exported from and imported to New Zealand. These products are typically of high value, which reflects their importance to manufacturing and retail activities, and make up a large part of the inward and outward airfreight market. While absolute capacity and the specific timing of services is probably not such an issue for these movements, services to and from a range of overseas locations at a variety of times would be important. Again it is likely that this capacity would be mainly provided on passenger aircraft ideally serving directly or indirectly a wide range of destinations at reasonable frequencies.

The experience of Auckland airport, where a wider range of services is provided and where traffic is largely back up to pre-Covid trends, highlights the potential for services out of Christchurch to recapture former airfreight markets if appropriate services and frequencies are offered.

The position for Auckland is set out in Figure 6.1 and Figure 6.2. For volumes, and more particularly values, airfreight through Auckland airport has largely rebounded from the dips associated with the depths of the Covid pandemic as the level and range of services has gradually increased.

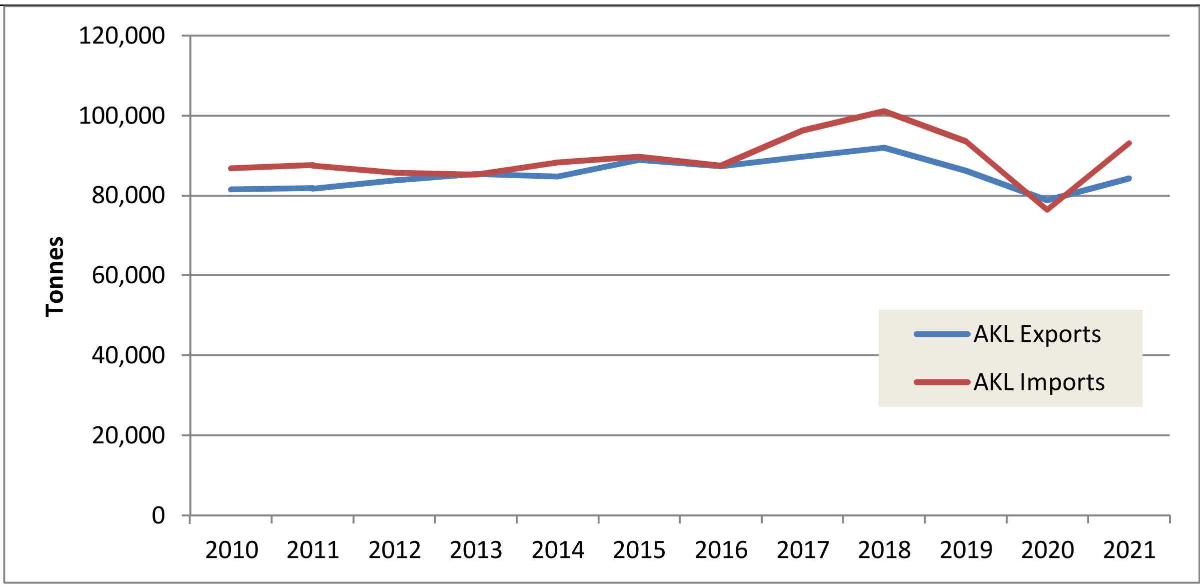


**Figure 6.1**
**Total volumes of airfreight exports and imports through Auckland International Airport (tonnes)**

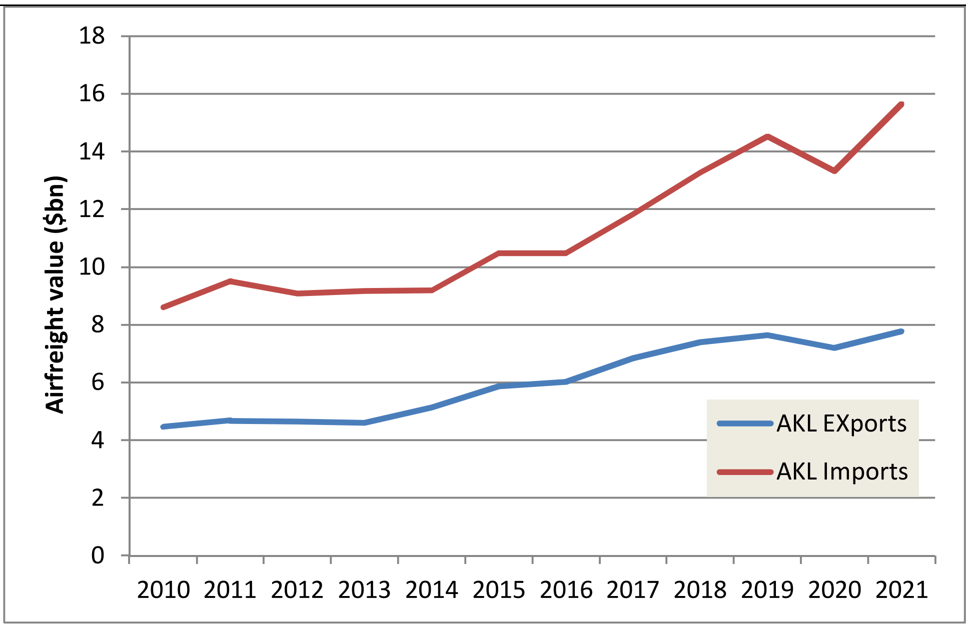


**Figure 6.2**
**Total values of airfreight exports and imports through Auckland International Airport ($bn)**

Passenger aircraft freight capacity would be likely to replace the existing freight-only services through Christchurch and more generally in New Zealand as the MIAC scheme is wound down. CIAL have made forecasts of the possible growth in international aircraft movements as passenger demands start to increase through the airport and these are set out in Table 6.1 and Figure 6.3.

| Year | Aircraft type | | | | |
|---|---|---|---|---|---|
| | **Passenger - Narrowbody** | **Passenger - Widebody** | **Freight - Narrowbody** | **Freight - Widebody** | **Total Movements** |
| FY18 | 8,524 | 2,244 | 5 | 240 | **11,013** |
| FY19 | 8,672 | 2,136 | 0 | 263 | **11,071** |
| FY20 | 6,042 | 1,683 | 20 | 264 | **8,009** |
| FY21 | 587 | 324 | 93 | 667 | **1,671** |
| FY22 | 767 | 430 | 0 | 662 | **1,859** |
| FY23 | 4,998 | 1,143 | 0 | 270 | **6,411** |
| FY24 | 6,926 | 1,656 | 0 | 270 | **8,852** |
| FY25 | 7,644 | 1,908 | 0 | 270 | **9,821** |
| FY26 | 7,977 | 1,991 | 0 | 270 | **10,238** |
| FY27 | 8,332 | 2,080 | 0 | 270 | **10,682** |

**Table 6.1**
**International aircraft movements through Christchurch International Airport (observed and forecast)**

Source: CIAL

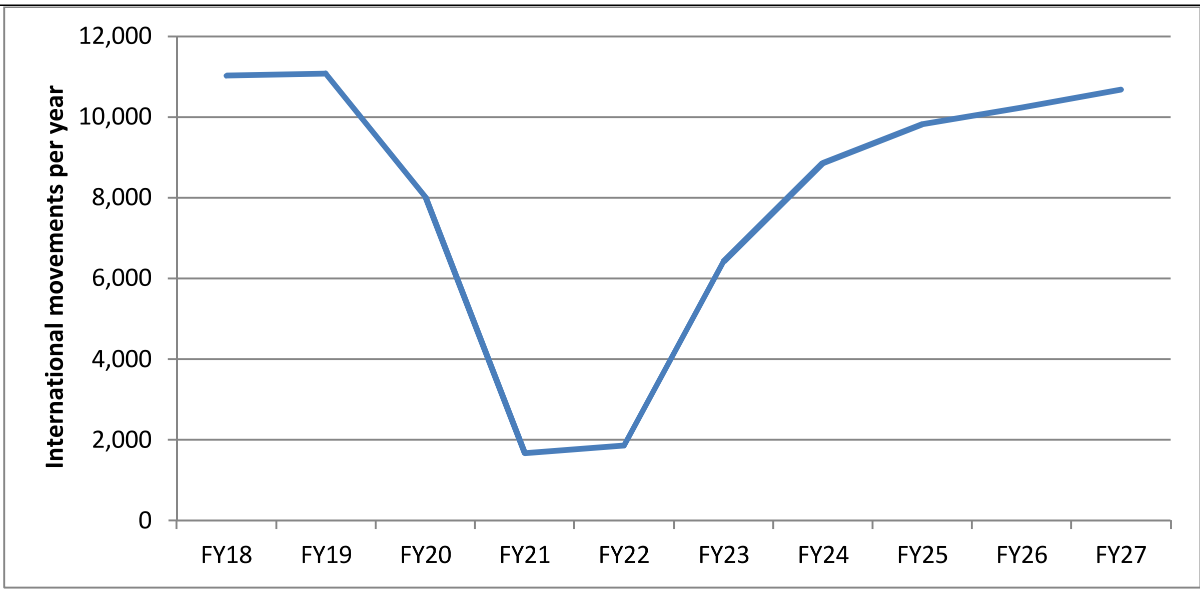


**Figure 6.3**
**International aircraft movements through Christchurch International Airport 2018-2027**
**(observed to FY21 and forecasted to 2027)**

These forecasts suggest that, by 2027, the numbers of international flights could have recovered to the levels experienced before the pandemic. However, given the position of Christchurch Airport generally as a service taker for these new passenger services, it is important that as few constraints as possible are imposed, in order to attract this level of services to a range of destinations.

Achieving these CIAL forecasts, incorporating reasonable route coverage at sufficient frequencies, would facilitate the growing demands for airfreight to and from the area. This would allow the local and wider economy to receive the full benefits by the later part of the decade, and provide the basis for the forecast continuing growth over the longer term.

# 7 Domestic freight issues

## 7.1 Introduction

Christchurch is an important staging point for e-commerce, other courier movements and mail within New Zealand, acting as a distribution centre for items delivered to South Island destinations and also as a consolidation point for those moving to North Island destinations. A very large proportion of this inter-island traffic passes through Christchurch Airport and, because of the timing required to meet customers' demands, much travels at night allowing collection of the goods at the end of the working day and delivery in the major centres the next morning. The relatively high fees charged to customers for these overnight services with expedited transit costing considerably more than slower services[3] potentially indicate the value that is attached to prompt delivery.

This section looks at the way in which this traffic has been growing in recent years and possible pointers for future growth, and then goes on to look at the way in which services to meet these demands have been developed.

## 7.2 Growth of e-commerce in the retail sector in New Zealand

A feature of recent years has been the rapid growth of e-commerce in the retail industry in New Zealand, with increasing volumes being delivered directly to customers. This is documented on a regular basis by NZ Post[4]. While this growth has been accentuated by the COVID pandemic, expansion was strong in the years before COVID increasing from $3.6bn in 2017 to $4.7bn in 2019, a growth of 30 per cent in just two years. With the onset of COVID, growth in 2020 was particularly large with the value of online retail purchasers expanding by a further 25 per cent. To some extent this reflected increases in the average value of the items purchased but the number of transactions also increased by 17 per cent. The average value per transaction in 2020 was about $110.

While there was lower growth in online expenditure in 2021 it was still increasing at an estimated 4-5 per cent per year, despite the relaxation of restrictions and the opening of more shops for direct sales.

This growth in expenditure is summarised in Figure 7.1.

[3] As an example the cost of a Size 2 NZ Post Box sent from Auckland to Christchurch would cost $17.00 for 3-day delivery but $31.20 (more than 80 per cent more) for an overnight delivery

[4] NZ Post The Full Download for 2019, 2020 and 2021

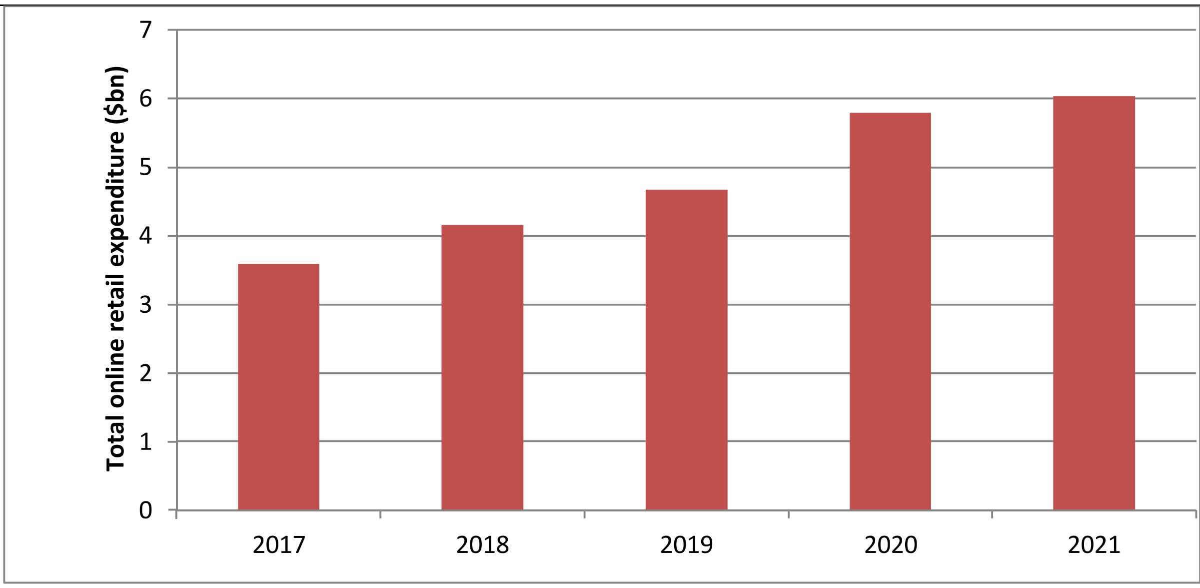


**Figure 7.1**
**Growth of retail on-line spending in New Zealand 2017-2021 ($bn)**

Even with this growth the proportion of on-line expenditure as a proportion of total retail expenditure in New Zealand is relatively low at about 11 per cent of total retail sales, compared to over 20 per cent in economies like the US and UK. This would suggest that there remains considerable scope for expansion in the share of e-commerce in New Zealand to bring it closer in line with trends in other comparable countries. As well as online expenditure taking a greater share of the existing domestic retail market, it is likely that the total domestic retail market itself (and therefore the net volume of e-commerce expenditure) will grow over the future.

## 7.3 **Future e-commerce**

Forecasts are available for the total future domestic movements of manufactured and retail goods combined. However the share of e-commerce in this is not readily available, since typically it only represents a small share of the volumes moved (although in value terms it is more important). Christchurch is an important hub for this trade with the development of a range of multi-user facilities to support it.[5]

The MoT Freight Futures model[6] provides forecasts for the movements of manufactured and retail goods combined but does not distinguish between them. This model indicates that for the manufactured and retail goods sector as whole (which would include e-commerce) there are likely to be substantial increases in the total flows into and out of the lower South Island regions accessed via Christchurch (Canterbury, West Coast, Otago and Southland regions). These forecasts are set out in Table 7.1.

[5] An example of this would be the facilities operated on behalf of a range of clients by Online Distribution Services from locations across the city.
[6] https://www.transport.govt.nz/statistics-and-insights/transport-outlook/updated-future-state-model-results/

**Table 7.1**
**Forecasts of flows of manufactured and retail products by all modes from the MoT Freight Futures model (m tonnes pa)**

| | To Lower South Island | | | | |
|---|---|---|---|---|---|
| From:- | **2018** | **2032** | **2042** | **2052** | **Total growth 2018-52** |
| Upper North Island (1) | 1.66 | 2.04 | 2.24 | 2.41 | 45% |
| Lower North Island (2) | 0.12 | 0.14 | 0.15 | 0.15 | 33% |
| Total | 1.77 | 2.18 | 2.38 | 2.56 | 44% |
| | **From Lower South Island** | | | | |
| To:- | **2018** | **2032** | **2042** | **2052** | **Total growth 2018-52** |
| Upper North Island | 1.00 | 1.20 | 1.30 | 1.39 | 39% |
| Lower North Island | 0.14 | 0.17 | 0.18 | 0.19 | 32% |
| Total | 1.14 | 1.36 | 1.48 | 1.58 | 38% |

Source: MoT Freight Futures model updated by consultants
Notes (1) Upper North Island includes Northland, Auckland and Waikato
(2) Lower North Island includes Wellington and Manawatu/Whanganui

The figures in Table 7.1 indicate that total volumes of manufactured and retail goods transported into and out of the Lower South Island are expected to increase substantially over the period to 2052.

The growing size of total movements of manufactured and retailed goods, combined with the increased share of this market likely to be taken by online sales, suggests that future growth in e-commerce is likely to be sustained and substantial.

## 7.4 **Pattern of air services**

To meet a major part of the domestic e-commerce market into and out of the South Island, domestic freight movements of mail and courier parcels are operated by Parcelair. This supports the activities of the two major New Zealand parcel and package delivery companies, New Zealand Post and Freightways, and represents the consolidation of earlier separate operations using a number of different aircraft types.

This service provides flights operating through the night between Auckland, Palmerston North and Christchurch. The pattern of these flights for a typical day in March 2022 is set out in Table 7.2 and shows a total of 8 arrivals into and 8 departures from Christchurch Airport. Flights with arrivals or departures between 2300 and 0600 are highlighted.

| Table 7.2<br>Flight pattern for Parcelair services through Christchurch Airport<br>Typical weekday in March 2022 | | | | |
|---|---|---|---|---|
| **Depart/ Arrive** | **Aircraft type** | **Date** | **Scheduled arrival/ departure time** | **Destination/Origin** |
| D | 73F | 7/03/2022 | 1730 | Auckland |
| D | 73F | 7/03/2022 | 2010 | Auckland |
| A | 73F | 7/03/2022 | 2030 | Auckland |
| D | 73F | 7/03/2022 | 2115 | Palmerston North |
| A | 73F | 7/03/2022 | 2150 | Auckland |
| D | 73F | 7/03/2022 | 2235 | Auckland |
| A | 73F | 7/03/2022 | 2305 | Auckland |
| A | 73F | 7/03/2022 | 2345 | Palmerston North |
| A | 73F | 8/03/2022 | 0005 | Auckland |
| D | 73F | 8/03/2022 | 0005 | Auckland |
| D | 73F | 8/03/2022 | 0055 | Palmerston North |
| D | 73F | 8/03/2022 | 0125 | Auckland |
| A | 73F | 8/03/2022 | 0200 | Auckland |
| D | 73F | 8/03/2022 | 0240 | Auckland |
| A | 73F | 8/03/2022 | 0330 | Palmerston North |
| A | 73F | 8/03/2022 | 0810 | Auckland |

Because of the volumes of the goods carried and the need for these to be sorted before onward despatch, these flights are spread over a wide period throughout the night. This timing of the flights also meets the main demands from customers, allowing goods despatched towards or at the end of the working day to be transported overnight and to be available for delivery the next morning. This reduces the costs of stockholding and contributes to efficient supply chains, minimising any losses of production for organisations dependent on receiving critical parts via air freight (particularly at short notice). By minimising despatch and delivery times, this supports the requirements of business and personal customers.

The substantial number of flights and the premiums that customers are prepared to pay for more rapid delivery indicates the high value of this level of service to firms and consumers across New Zealand.

## 7.5 Overall assessment

The key findings from the review of the domestic e-commerce market passing through Christchurch Airport include:-

- The demand for e-commerce in New Zealand is growing, and this growth is likely to continue into the future as total markets expand and the share of e-commerce in these grows;
- Christchurch Airport is a key gateway for these movements to and from much of the South Island;
- Because of the nature of these movements, there is a demand for flights throughout the night, allowing goods to be despatched at the end of one working day and delivered early the next, providing an efficient supply chain for business and personal customers.

# 8 Summary of findings

Christchurch Airport plays an important role in the movement of international airfreight and also in the movement of domestic airfreight including Post and courier movements into and out of the South Island. Both of these movements are important to the economy of the South Island and efficient airfreight services also give benefits to consumers who have rapid access to goods from around the world and from other parts of New Zealand. These demands are likely to grow in the future as conditions recover from the challenges of 2020 and 2021

For international air freight, a key provider of capacity will be in the range and frequency of passenger services as these return to Christchurch to meet growing demands. However given the position of Christchurch Airport as a service taker for these new operations it is important that as few constraints as possible are placed on these services, if the full benefits to the local and wider economy from air freight are to be achieved. This may involve flights arriving and departing within night-time hours. A wide range of services to a range of destinations would support the outbound and inward movement of high value manufactured goods important to local businesses and also movements of international e-commerce for New Zealand consumers. Careful timing of flights would also provide suitable avenues for the export of time sensitive agricultural products allowing goods to reach markets at appropriate timings, so allowing the best returns to be achieved for local exporters. It is anticipated that flight numbers could return to pre-Covid levels by the later part of the current decade, but again it is important that as few constraints as possible are imposed if these forecasts are to be achieved.

Services through the night would also support domestic airfreight movements linking Auckland and the upper North Island with Christchurch the key distribution centre for the South Island. These would support the efficient movement of goods, with items despatched at the end of the working day being available in businesses and consumers at the beginning of the following working day.

For both international and domestic airfreight movements the ability to work with as few constraints as possible through the night is important. This would help ensure that the maximum benefits are obtained from the movement of airfreight and its support for local industries and consumers.

# Appendix 14

Airport Contour s77K Appendix Four: CIAL Operational Constraints Economic Assessment

# PROPERTY ECONOMICS


# POTENTIAL ECONOMIC IMPACTS OF OPERATIONAL CONSTRAINTS ON CHRISTCHURCH AIRPORT

**Client:** Christchurch International Airport

**Project No:** 52173

**Date:** May 2022

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## SCHEDULE

| Code | Date | Information / Comments | Project Leader |
|---|---|---|---|
| 52173.3 | May 2022 | Report | Phil Osborne |

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# TABLE OF CONTENTS

# 1. INTRODUCTION

The purpose of this assessment is to provide understanding of the potential economic impacts associated with other land use activities within Christchurch International Airport (CIA) noise contours.

These impacts are based on an assumption that by providing for more noise sensitive activities under these contours the level of community annoyance will increase. International examples would suggest that this has the potential to lead to restrictions on the airport's activities, either through the intensity or scheduling of these activities.

This economic report provides an understanding of the level and extent of economic activity within Christchurch and the South Island that would be placed 'at risk' under an example of airport constraint.

For the purpose of this report a curfew has been assessed ranging from 11pm to 7am (internationally a typical curfew). The report assesses the potential level of economic impact by providing an unconstrained (without additional airport restrictions) and a constrained position relating to impacts on the airport's future operation potential, and by association the economic activity contributed to the City and wider community.

## 2. CHRISTCHURCH INTERNATIONAL AIRPORT OPERATIONS

Christchurch International Airport is the second largest airport in New Zealand and represents a nationally and strategically significant infrastructure asset supporting national accessibility for passengers and business that supports economic well-being well beyond the borders of both the Canterbury Region and the South Island.

The operation and importance of CIA goes beyond national and international passenger transportation and includes:

- Air freight and Mail
- Antarctic Operations
- Disaster response and recovery
- Helicopters
- Flight Training
- Maintenance
- Significant business location

It also plays a part in providing for flights that are unable to land elsewhere in New Zealand due to delays and other operational restrictions.

There are several unique aspects to CIA and its location in the roles it provides:

- Largest and most strategically important airport in the South Island
- Internationally placed for access, and providing capacity for operations to Antarctica
- The second longest runway in the country (providing the only runaway capable of catering for wide bodied aircraft)
- CIA is also the second busiest airfreight port in the country
- There is no current curfew with CIA operating 24 hours, 7 days a week.

These roles require substantial and long term infrastructure and capital provision, between 2014 and 2019 CIAL invested circa $600m in new capital expenditure with the majority of this investment provided to support freight and logistics growth.

CIA plays a vital role in both the regional and national economies, facilitating freight and passenger movements directly to Australia, China, Singapore, Hong Kong and the Pacific Islands. Its function also goes beyond its own direct operations and includes safeguarding other airports such as Auckland when acting as an alternative if aircraft are unable to land there. This in itself provides improved competitiveness for the New Zealand air transport market.

## 2.1. LAND USE ACTIVITIES AND NOISE CONTOURS

Aircraft noise is recognised as one of the most significant issues faced by airports today. While improved technologies have made plane engines quieter, there is an increasing conflict between aircraft noise, which is an unavoidable outcome, and urban populations.

CIA is no exception to the pressures and effects that arise from this conflict. CIAL's approach to managing noise effects and community pressure is through land use planning and management. CIAL seeks to avoid strict abatement or operational restrictions as these risk curtailing Airport operations.

The result, in terms of planning, has been the development of clear noise contour maps identifying the extent of noise and the potential to impact upon noise sensitive land use activities. Activities under the Airport Noise Contours are controlled, to varying degrees depending on their level of compatibility, to limit the effects of noise on the community and at the same time safeguard the critical CIA operations.

## 2.2. CHRISTCHURCH INTERNATIONAL AIRPORT ECONOMIC SIGNIFICANCE

One of the three key objectives of the New Zealand Civil Aviation Authority is, 'A vibrant aviation system is one that makes a strong contribution to the wellbeing of New Zealanders, through enabling quality of life, and supporting a strong economy.'

In order to have regard for the benefits of facilitating the efficient operation of CIA, it is necessary to recognise the significance that its operation has to the regional economy. CIA fulfils an extremely important and unique role for the Canterbury regional and South Island communities. It serves, not only as a significant employer for the region, but also as a conduit for visitors and commerce into the region and the wider South Island.

The Canterbury Regional Policy Statement explicitly recognises the significant contribution of CIA specifically in relation to land use activities, which demonstrates the priority given to protecting the efficient operation and use of CIA. In particular, the CRPS requires that new development only be provided for if it doesn't affect the efficient operation, use, development, upgrading and safety of existing strategic infrastructure.

In assessing the significance of CIA, it is important to distinguish between the types of impacts the Airport's presence and operations has on the economy. There are essentially four categories of impacts and benefits attributable to this facility:

1. **Direct Benefits**: economic impacts (benefits) derived from the actual spending / expenses incurred through the operations of CIA.
2. **Indirect Benefits**: increased activity brought about by those firms and their employees, who supply CIA and its operations
3. **Induced Benefits**: are measured in terms of the additional income that will be spent in the area due to increased business activity through those directly or indirectly employed through CIA operations
4. **Catalytic Benefits**: activity that is facilitated by CIA operations such as tourism, trade (businesses operating through imports or exports). This is the likely overall impact on the economy of not having CIA present.

## 2.3. FREIGHT

Given the expansion of high values goods in a modern economy the influence of an efficient, competitive international airport is as crucial as a modern seaport or an efficient roading network. For example, in 2019 CIA moved (via both exports and imports) approximately 5,952 tonnes of manufactured goods (20% of total tonnes moved in New Zealand) valued at over $3.5b. This value was a major contributor to both the Region and the South Island , as a whole materially contributing to the total economic contribution found in the following section.

The ownership of national airports has, until recent times (primarily post-1980), been held in the public's hands due to their importance and economic significance. While the increasing need for efficiencies has resulted in privatisation of the industry, CIA has maintained public ownership. CIA's current, and the historic dominance of, public ownership at national airports illustrates:

- Recognition of airports significant economic contribution; and
- Recognition of operational 'externalities', that the 'public good' generated by airports far outweighs its own operational costs and benefits.

CIA plays a fundamental role in the shipping of goods from a much wider area and therefore is critical to the economic and social well-being of all residents within the South Island. The presence and efficient operation of CIA enables the Canterbury region as a whole, and the districts that make up this area, to maintain a competitive environment for economic development as well as enhancing residents' quality of life through access to these services.

CIA is responsible for exporting over $3b of cargo a year[1] to other ports. This in itself has huge positive flow-on effects through the rest of Canterbury's economy with *'off'* airport jobs such as storage and transportation directly linked to these volumes. The ability of CIA to move these large valuable cargos is vital for Canterbury, and in fact the South Island to remain competitive in the location of large, high value exporters and manufacturers.

CIA operates in a relatively unique environment within the aviation sector internationally in that it is a slot taker. CIA relies on this ability to function effectively and with a competitive advantage as it allows CIA to facilitate the passage of freight planes over periods of time that allow the continual movement of goods throughout the world.

This advantage has seen significant growth in exports and imports in the pre-Covid period of 2014 to 2019 by 100% and 150% respectively.

## 2.4. PASSENGERS

In 2019 CIA catered for over 10,800 international passenger flights. Subsequently, with the onset of COVID-19, this number reduced to less than a thousand in 2021. By 2027 however, CIAL expects these numbers to be re-established

[1] 2019

catering for an increasing number of international passengers to Christchurch and the South Island. By 2031 total passenger numbers are expected to have grown from 7 million (in 2019) to just under 8 million passengers.

Visitors originating at the airport bring with them over $1b to the region with significant flow on effects from this spending. Although it is challenging to pinpoint how far reaching the economic impacts are for the presence of the airport it is clear that the current and future functionality of CIA is key to not only the Canterbury economy but to that of the whole South Island. The level of functionality is also key for CIA due to its position both in the freight chain for New Zealand but also for the Airport as a slot taker for passenger movements and the associated potential for visitor numbers.

The *'off'* airport benefits to the region relate to those generated by activities that do not take place at the airport itself. Over 50% of visitor to the Canterbury Region arrive via CIA (as measured by Tourism Research Council NZ).

## 2.5. EMPLOYMENT

As an entity Christchurch Airport directly employs over 200 people generating $187m[2] in revenue. While this alone would identify the business among Canterbury's largest business contributors, the economic activity facilitated makes it one of the largest single contributing strategic assets in the South Island.

Additionally, over 7,000 Employment Contributions (EC's)[3] are accommodated within the airport campus, making it one of, if not the, largest employment centres in the South Island. As identified in the following section, the level of economic activity supported through CIA creates over 28,000 jobs regionally.

[2] 2020
[3] *Statistic New Zealand Employment Count*

## 3. CONTRIBUTION TO REGIONAL AND DISTRICT PROSPERITY AND ECONOMIC WELLBEING

While the level of both passenger and freight numbers has fallen sharply over the last 2 years (with Covid) the number of commercial aircraft movements is expected to rebound strongly over the next 10 years. Projections from CIAL indicate the recovery of international flight movements by 2027. The reliability and ability for CIA to meet future growth demands is critical to attracting and locating to the region many national and international businesses that would not otherwise situate themselves in Canterbury.

It is not only imperative that the ability for CIA to grow efficiently is protected, but that such certainty is expressed to the market. Given the pivotal role CIA plays in the regional economy even a small level of risk or uncertainty in terms of efficient ongoing operation and development would likely derogate from investment.

Facilitating and safeguarding potential growth at CIA is not just in the interest of CIAL but has a vital flow-on benefit to the whole community. The key to this activity is that it is, for the most part, unique and is unlikely to be replicated by the market elsewhere. The demand for flights and the volume required to service this demand reduces the potential for any reduction in CIA operations to be accommodated elsewhere in the South Island. Where businesses are unable to access critical, reliable and fast transportation, there will be pressure to move to areas that can supply these efficient transport links. This is likely to result in two potential outcomes, firstly, it may result in inefficient transportation options resulting is a less competitive environment for businesses in Christchurch and the South Island, and secondly it will result in the loss for some businesses which relocate out of the Canterbury Region and the South Island.

In 2012 it was estimated that CIA contributed $2.13b to the regional economy, by 2017 this figure had risen to $2.6b[4]. Over the next 3 years (to pre-Covid year ended March 2020) with growth passenger numbers as well as a continued regional growth in higher value-added production this figure is estimated at $3.02b per annum.

To place this figure into context the largest contributing sector to the regional economy, Manufacturing, generated $4.1b over the comparable period(with the only other sector contributing more being Construction at $3.3b). It is also important to note that both of these sectors remain reliant of the facilitation of the Airport both for associated inputs and overall demand generation.

The contribution to GDP from CIA supports 28,625 jobs (ECs) within the region, constituting over 10% of Canterbury's employment. In terms of its wider economic significance, CIA contributes $4.76b (7%) to South Island GDP.

Airports have always represented significant economic assets in any economy, from large cities to smaller tourist dependent locations. In more recent times, airports have widened the scope of their activities, driving locational

[4] *"Making Sense of the Numbers, Christchurch International Airport Economic impact assessment" Berl, December 2017*

competitiveness for essential business activity. CIA is now a critical transportation link for a number of regional and South Island businesses.

A study in 2012[5] by the Air Transport Action Group ("*ATAG*") found that 25% of all companies' sales are dependent on air transport, while 70% of businesses reported that serving a bigger market is a key benefit of using air services. With $3 trillion dollars of economic activity (*GDP*) generated by this industry globally the competition is fierce.

On top of the significant direct, indirect and induced economic impacts CIA has on the region there are two key benefits that are gaining increased prominence: Connectivity and Productivity.

A recent international survey has shown that 18% of businesses reported a lack of good air links had affected their location decisions, with 59% choosing alternative locations and 23% choosing not to make an investment. While a study undertaken by Oxford Economics[6] indicated a clear relationship between connectivity and productivity. It was estimated that a 10% increase in connectivity would lead to a 0.07% increase in annual GDP.

In summary the contribution made by the Christchurch Airport to the local economy includes:

- A regional contribution of over $3b per annum;
- Growth over the past 9 years of over nearly $1b to regional GDP;
- In 2020[7] the Airport created over 28,000 regional jobs;
- Over $1.5b worth of goods were transported through CIA in 2020;
- Over $1b worth of tourism spend was generated through the Airport in 2020, supporting over 9,000 jobs;
- 50% of visitors to Canterbury arrive via the airport;
- In 2020, CIA contributed $4.76b to the South Island economy;
- The Airport accommodates 7,000 workers within its campus; and
- CIA directly employs over 200 workers, generating $187m in revenue per annum and supporting a further 500 local jobs.

[5] *Aviation Benefits Beyond Borders, Air Transport Action Group (ATAG), March 2012*

[6] *Oxford Economics, Economic Benefits from Air Transport, 2011*

[7] Year ended March 2020

# 4. POTENTIAL IMPACTS ON AIRPORT OPERATIONS AND ECONOMIC CONTRIBUTION

As identified above CIA is a fundamental contributor to the regional and South Island economies. Its operations are fundamental not only to many high value businesses, but to the efficient movement of passengers internationally.

There is a direct link between management through land use planning and the level of economic contribution provided by efficient operations at CIA. A key consideration regarding the extent of this management is measuring the level of vulnerability of CIA's operations against the opportunity cost of restricting other activities. In terms of CIA and its position in the market, it is considered a 'slot taker', an airport that provides a flexible alternative to other ports. In accepting this role, and the economic benefits which flow to the community, CIA is ultimately vulnerable to operational constraints that would reduce this flexibility.

There are a number of practical risks that could eventuate from the development of conflicting uses that would result in pressure to constrain operations at CIA. For the purposes of this report the propensity for these constraints to occur have not been tested. This report has identified the potential level of economic risk associated with curfews, which is one method of operational constraint.

It is understood (from the Airbiz report[8]) that there are a number of other constraints that can be utilised to reduce the effects of noise including:

a) Annual aircraft movement quotas or caps

b) Daily or hourly aircraft movement caps restricting the number of arrivals or departures

c) Preferential runway regimes (rotating use of runways and associated flight paths to "share" the noise burden) which are often "sub-optimal" in terms of runway or airspace capacity

d) Development of additional runways to cater for air traffic growth, to ensure no additional noise burden is placed on current flight paths

e) Other noise abatement and mitigation (noise charges, aircraft auxiliary power unit restrictions etc)

The potential economic impacts of airport curfews have become of topical interest as urban populations continue to expand and conflict with once isolated activities. Recent assessments of Perth Airport[9] found that a night time curfew could cost the Western Australian economy $46.1b and 27,000 jobs by to 2040. More extreme noise management constraints such as those at Rotterdam Airport have decreased potential passenger numbers by over 60%[10]. As

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[8] *Airbiz Report "Christchurch International Airport Outer Control Boundary and Airport Safeguarding" dated 10 June 2022.*
[9] *Perth Airport Night Time Curfew – Estimated Costs for Regional and National Economies, Jacobs Group 2015*

[10] *Modelling the Effect of Night Time Penalties on Commercial and Business Flights for Regional Airport Noise and Economics: Rotterdam Airport Case Study. Mohamed, Curran and Zwan, Delft university of Technology*

discussed further in the next section, the potential for operational constraints at CIA poses a real threat to the economic benefits it provides to the region and South Island.

# 5. POTENTIAL ECONOMIC RISKS TO CIA OPERATIONS AND THE SOUTH ISLAND ECONOMY

While the following assessment considers the potential impact to CIA operations in a pre and post Covid environment, a risk associated with constraining CIA operations is post-Covid recovery. With dramatic decreases in trade movements, passenger numbers and corresponding tourism, the potential for reduced connectivity through CIA is likely to hamper the recovery of these sectors with increasing costs and reducing associated economic benefits.

While a curfew at CIA will inevitably lower the level of overall activity, primarily for freight, there are several other implications that are likely to impact the economy.

Given the location of CIA in the aviation market the Airport operates as a 'slot taker' making itself available for flights that are unable to be accommodated elsewhere. This provides CIA with a unique advantage and has resulted in such flights as that from Guangzhou. This flight arrives in Christchurch at 5.20pm and leaves at 10.30pm arriving back at Guangzhou at 5.30am, this allows for passengers to connect to the first wave of flights connecting to Asia. As identified later in this report the potential for flights such as this to be impacted by a curfew is based on the level of risk presented to the airlines through delays, this would require a flight to be rescheduled to the following day increasing costs, inconvenience, and the competitiveness of the flight as a whole. As identified later there are a number of other flights that would fall within the curfew times themselves[11].

The inability to meet this role could reduce the range of destinations connected to Christchurch thereby reducing the markets from which Christchurch can attract tourist as well as trade and business development.

From the Airbiz report we understand that airlines may also choose to locate aircraft elsewhere given the reduced competitiveness at CIA. Limitations of night-time movements on aircraft can limit the crafts ability to be prepared for use. This would reduce the number of flights and the overall utilisation of aircraft.

The limitation of night-time air freight movements is also likely to reduce craft utilisation, increasing costs and route profitability. The impact on freight is not limited to volumes but also around time-critical or 'just in time' operations. CIA is the South Island hub for Parcelair's network, providing for overnight freight for both Freightways and NZ Post.

Parcelair facilitates the movement of 12 aircraft each night (7 days a week) shifting nearly 75,000 tonnes of overnight freight per annum. Given the level of network necessary to move this right through the South Island it is highly unlikely that this operation could be replicated at any other South Island airport. This would result in:

- Slower mail (likely to take 2 -3 days rather than overnight)
- Impact on perishable deliveries
- Impact upon Just in time businesses

[11] *Christchurch Airport Aircraft Noise Contours Update, October 2021 Airbiz, page 9*

In addition to the quantified level of risk following there is the longterm loss of investment and businesses. The level of this potential loss relates to the downturn of longterm economic contribution as a proportion of the activity at risk. Longterm effects on investment could further reduce the ability of CIA to undertake current or future levels of operation. In terms of the wider impact on business investment, the reduction in transportation options is likely to impact upon businesses locational decisions, at this point the loss to the region is likely to be materialised as a loss to the whole South Island.

There have been a number of assessments that have directly linked the level of overall economic activity within an area with the level of air services:

- "The catalytic effect of the accessibility to air cargo services" Cech P. (2004) found that increased (or conversely decreased) air cargo services led to increased income and employment.
- 75% of businesses using air services said their business would be adversely affected if they were curtailed "High Fliers: Business Leaders' View on Air Travel" UK Institute of Directors (2008). While a survey found that 30% of Chinese businesses would change their investment decisions because of constraints on air services ("Airline Network Benefits" IATA Economic Briefing No. 3 (2006).
- "The Economic Catalytic Effects of Air Transport in Europe" found that a 10% increase in air transportation increased business investment by 1.6% in the long run.
- "High-technology employment and hub airports", Journal of Air Transportation management January 1999. This analysis found that the presence of a hub airport increased 'high-tech' employment by an average of 12,000 jobs in a region (based on 321 US metropolitan areas).

There is a wealth of data illustrating the relationship between the level of a region's economic activity and the efficient operation and provision of air services within the market. Conversely a decrease in this connectivity and provision is likely to reduce this activity by a similar margin.

The level of economic activity 'at risk' is estimated utilising the methodology indicated in the introduction, comparing an unconstrained and constrained position. Two positions are essentially run through the economic model with a number of assumptions around what activities may be constrained. Under the unconstrained modelling there are no exogenous constraints placed on CIA's ability to operate (as it currently does). The constrained model assess the level of activity that currently exists within the curfew (11pm to 6am) timeslot and considers the potential loss of this activity to the wider regional and South Island economies.

The unconstrained position is outlined in section 3 above with a 2019 contribution of $3b regionally and $4.7b throughout the South Island. These estimates were based on passenger numbers projected to increase from 7 million passengers per annum to just under 8 million[12] by 2031.

Additionally, while these projections proportionalised freight based on the increase in passenger movements, the resulting numbers were in line with the growth suggested by the Richard Paling report.[13]. This linked a similar growth rate between CIA and Lyttelton Port.

It is estimated that with the proportional increase in freight and the increased passenger numbers the contribution to regional GDP made by CIA has the potential to exceed $3.87b by 2031. This level of contribution at the South Island level would constitute economic activity circa $6b per annum.

Conversely, the aforementioned numbers show if CIA had its ability to export large volumes of cargo on or offshore either reduced or removed altogether, the direct and indirect economic costs to the Canterbury Region and the wider South Island economy would be considerable and sustained.

There are a number of assumptions relating to the potential impact of constrained CIA operations under a night-time curfew including:

- Night-time freight currently makes up 51% of all freight volume from CIA
- Night-time freight currently makes up approximately 32%[14] of all freight value from CIA. The reduced proportional value is a representation of the lower export/import value of agricultural products.
- There are likely to be indirect, induced and catalytic values associated with the final product and the potential loss of business associated with constraints to air services
- The loss of potential passenger traffic has been conservatively assessed at 2.5% per annum, based primarily on flights that could be considered within a risk 'time zone' such as the South China 10.30pm flight. This is estimated based on CIAL published data insulating the number of passenger flights, within a 24-hour period that fly within the potential curfew timeframe[15].

Based on these assumptions it is estimated that were the region to forgo the economic activity generated from the above constrained activities alone by 2031 this would equate to $610m annually, and $835m per annum in forgone economic activity for the South Island. This is in addition to some of the economic impacts identified in the preceding material.

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[12] *Projections provided by Christchurch International Airport Limited.*
*13 Richard Paling Consulting "Christchurch International Airport Review of freight trends", 2022 Table 5.1*
[14] *This figure is approximated based on the sectors associated with Just in Time logistics and the relative average value per tonne, based on the 2019 trade figures provided by Richard Paling.*

[15] *This equated to 5 arrivals and 10 departures over a 24 hour period.*

In terms of employment this would equate to approximately 4,000 jobs regionally and 4,600 throughout the South Island.

Given this value is based on an annualised figure, the overall impact to 2031 (from 2022) would be in excess of $4.8b.

# Appendix 15

Airport Contour s77K Appendix Five: Assessment of Noise Effects: Annual Average Contour

MARSHALL DAY Acoustics

# CHRISTCHURCH AIRPORT RECONTOURING
## ASSESSMENT OF NOISE EFFECTS
### ANNUAL AVERAGE UPDATED CONTOURS

Report No.003 | 21 July 2022

Project: **CHRISTCHURCH AIRPORT RECONTOURING**

**Assessment of Noise Effects – Annual Average Updated Contours**

Prepared for: **Christchurch International Airport Limited**
**PO Box 14001**
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Report No.: **Report No.003**



## Document Control

| Status: | Rev: | Comments | Date: | Author: | Reviewer: |
|---|---|---|---|---|---|
| Draft | | | 17 June 22 | Laurel Smith | Chris Day |
| Draft | 01 | | 22 June 22 | Laurel Smith | Chris Day |
| Issued | 02 | | 21 July 22 | Laurel Smith | Chris Day |

# TABLE OF CONTENTS

## 1.0 INTRODUCTION

The Canterbury Regional Policy Statement (CRPS) and the three District Plans [1]contain the Christchurch International Airport Noise Contours (the Operative Noise Contours). The purpose of these contours is twofold – to use land-use planning around the airport to avoid the effects of aircraft noise on future noise sensitive users and to set a 'noise envelope' for the airport to remain within. This process is explained in detail in the New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" (**NZS6805**) and summarised in Appendix A of this report.

The Operative Noise Contours were finalised in 2008 following extensive interaction within an 'Expert Panel'. The Expert Panel was made up of experts in aviation forecasting, operational procedures (including flight tracks) and noise modelling. The basic premise behind the contours was that they were to be based on Christchurch International Airport (CIA / the Airport) operating at its 'long-term future capacity' and with future operational procedures.

The Expert Panel Report recommended that the 2008 noise contours (and the aviation assumptions they were based on) be updated in 10 years' time, which aligns with the general philosophy of updating District Plans every 10 years.

In 2018 Christchurch International Airport Limited (CIAL) began the process to update the Operative Noise Contours. Airbiz and Marshall Day Acoustics (MDA) were engaged to prepare updated noise contours, with input from Airways New Zealand (Airways) and CIAL, for inclusion in the CRPS and District Plans. The new noise contours are referred to throughout this report as the "Updated Noise Contours". The details of this process are contained in a combined report by Airbiz, MDA, CIAL and Chapman Trip titled "*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours*" (the Update Report).

The outcome of the Update Report is that several input parameters for the Updated Noise Contours are different to those used in the Operative Noise Contours. The resultant Updated Noise Contours are a different shape - being larger in some areas and smaller in others.

The purpose of this report is to provide an assessment of noise effects associated with:

1. The change in the future anticipated aircraft noise environment
2. The potential future change to the receiving environment

Four different methodologies have been used to assess the effects (see section 3.1). We've assessed the change to the future anticipated aircraft noise environment by comparing the Operative Noise Contours with the Updated Noise Contours. We have also examined the change to future receiving environment by comparing the existing housing stock in the noise contours with the potential future housing stock assuming maximum potential growth under the planning framework.

To summarise our findings, the Updated Noise Contours generally represent a moderate increase in aircraft noise effects compared with the Operative Noise Contours. This is primarily due to the updated long term future operational capacity of the Airport.

As well as considering the impact of the change in aircraft noise environment, we assessed the impact of the potential change in receiving environment. Our analysis shows that the potential increase in aircraft noise effects resulting from' worst case' growth in residential activity **currently** permitted inside the Airport Noise Contours, is far greater than the increase in effects due to the change in aircraft noise. If the land use controls applying inside the Airport Noise Contours (as of March 2022) were relaxed, the scale of airport noise effects on the surrounding population would increase even more significantly.

[1] Christchurch District Plan, Waimakariri District Plan, Selwyn District Plan

## 2.0 UPDATED NOISE CONTOURS – ANNUAL AVERAGE

Details of the process and inputs to developing the Updated Noise Contours are contained in a combined report by Airbiz, MDA, CIAL and Chapman Trip titled "*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours*" (the Update Report). The Updated Noise Contours presented in this report are the Annual Average version which is explained further below. A brief summary of the modelling assumptions and a figure showing the Operative and Updated Noise Contours is provided in Appendix C.

Christchurch International Airport effectively has four operational runways, two on the main runway and two on the shorter crosswind runway as follows:

- Runway 02 where aircraft land and take-off into a northly wind.
- Runway 20 where aircraft land and take-off into a southerly wind.
- Runway 29 where aircraft land and take-off into a north-westerly wind.
- Runway 11 where aircraft land and take-off into a south-easterly wind.

Generally, each of these runways is used during the given wind direction. The runway usage in any given three-month period will vary significantly. For example, during the summer there are often periods when the north-westerly wind is dominant for several days (necessitating higher than normal usage of the north-west Runway 29). The extent of this effect varies from year to year.

Aircraft need to be allocated to each runway in the noise modelling and there are two options for how runway usage is modelled in the Updated Noise Contours:

- The Outer Envelope future noise contour (composite of 3-month worst case runway usage for four wind directions)
- The Annual Average future noise contour (annual average runway usage)

NZS6805 recommends that noise contours are based on noise over a three-month period (or such other period as agreed)[2]. If the three-month period is used for the noise contouring, then compliance would be based on three monthly monitoring, and it is important that Christchurch Airport can comply in any given three-month period – including any unusual runway usage due to unusual wind conditions.

The Operative Noise Contours were based on a highest 3-month usage of runways 29 and 11 and an annual average usage of runways 02 and 20.

The Annual Average Updated Contours are similar to the Operative Contours as they are both based on annual average usage of the main runway (02-20). However, the Updated Annual Average Contours do not include a 3-month seasonal factor for the cross-runway (11-29) as they use the annual average. A summary of the runway usage applied in the Annual Average Updated Noise Contours is included as Appendix E.

If the annual average is adopted, it is recommended that compliance would then be based on the annual data. If a 3 month compliance period was adopted there is a potential compliance problem when assessed over 3-months. To address this, we recommend a compliance tolerance is provided to allow for worst case 3-month weather patterns.

[2] Clause 1.4.1.2 - New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning"

## 3.0 ASSESSMENT OF NOISE EFFECTS - METHODOLOGY

Appropriate management of airport noise effects is a two-pronged approach involving aircraft noise management and land use management. The scale of future noise effects is influenced by changes in both.

The Updated Noise Contours represents a change in the **aircraft noise planning environment** which we have assessed in this report by comparing with the Operative Noise Contours.

We have also considered the impact of future changes to the **receiving environment** which is determined by land use planning controls. For this assessment, we have quantified the potential change in effects due to future growth of residential activity inside the Airport Noise Contours. This analysis is based on a hypothetical Future Housing Stock calculated to be the maximum residential development permitted under the operative District Plan land use controls.

The existing aircraft noise planning environment is the level of aircraft noise permitted and anticipated in the various Operative District Plans and is defined by the Operative Noise Contours. Replacing these with the Updated Noise Contours would result in changes to the permitted and anticipated aircraft noise levels in many areas. The purpose of our assessment is to quantify and describe these changes and their associated noise effects.

To quantify the change, we have used noise contours and Geographic Information System (GIS) software to calculate the change in noise at each existing residential property within the Airport Noise Contours. Then we have used this data to quantify and describe the change for the existing population overall.

The methods we have used to quantify and assess the change in noise environment by comparing the Operative and Updated Noise Contours are:

1. Difference in number of houses within the contours;
2. Difference in number of people potentially highly annoyed;
3. Difference in future $L_{dn}$ noise level – houses affected by a noticeable change;
4. Difference in number of people experiencing aircraft noise events above 70 dB $L_{Amax}$.

As well as considering what changes the Updated Contours mean for the existing population, we have also quantified the potential change in effects due to future growth of residential activity inside the noise contours. The purpose of the Future Housing Stock analysis is to demonstrate the impact that changes to the receiving environment (i.e. land use planning) have on future outcomes.

### 3.1 Methodology - Existing and future housing stock assumptions

As described above, we have considered two different housing layers in our assessment. These are:

1. **Existing Housing Stock** - derived from Canterbury Maps Rating Units database;
2. **Future Housing Stock** - based on an estimate of the maximum residential development permitted under the existing planning framework.

The Existing Housing Stock layer was derived using the 'Rating units' database from Canterbury Maps. The rating units layer contains information on land use and we simply removed rating units that are not residential related land use.

The Future Housing Stock layer was derived by calculating a theoretical maximum number of residential units permitted on land where residential activity is enabled in the various district plans. This is essentially the residential capacity around Christchurch Airport that may develop over time as properties are subdivided and the density of noise sensitive activities increases. Details of how the potential Future Housing Stock was calculated and the limitation of the analysis is provided in Appendix D.

For the Future Housing Stock analysis, we have assumed that the operative land use controls that applied inside the Operative Noise Contours as of March 2022, would also apply inside the Updated Noise Contours. We have not made any assumptions about potential changes to the density controls occurring after March 2022.

Throughout this report the Existing and Future Housing Stock data has been used in our analysis. For the number of people highly annoyed analysis, the 'sample area' of properties was the outer extent of the 50 dB $L_{dn}$ contours from the Operative and Updated Noise Contours. We have assumed 2.5 persons per household when calculating the number of people affected. This number is from Statistics New Zealand Census data which provides an average number of people per household in Christchurch.

### 3.2 Method 1 - Difference in houses inside the contours

Replacing the Operative Noise Contours with the Updated Noise Contours would mean a change in the number of existing houses included in the contours. This is a simple method to describe the change in planning environment for the Existing Housing Stock due to the Updated Noise Contours.

We have also calculated the number of houses inside the Airport Noise Contours using the Future Housing Stock to quantify the future impact resulting from changes to the receiving environment.

### 3.3 Method 2 - Difference in community annoyance

Over the last 40 years, a number of studies have been carried out in an attempt to determine the general relationship between aircraft noise and community annoyance. Most of these studies examine the relationship between annoyance and the Day/Night Level ($L_{dn}$), as this metric is shown to correlate best with annoyance.

$L_{dn}$ is the metric recommended in NZS6805:1992 to be used for defining aircraft noise contours and hence is the metric that defines Christchurch Airport's noise contours. $L_{dn}$ represents the cumulative noise energy (or noise exposure) over 24 hours with a 10-decibel penalty added to any night flights between 10pm and 7am. It is generally calculated over a 3 month or annual period which represents the long-term noise exposure. It takes into account both the number of aircraft noise events and the loudness of each event and is a measure of noise exposure.

The results of these studies are normally plotted as a dose response curve – i.e. a graph of the number of people who report being 'Highly Annoyed' versus the noise level they experience (see Figure 1 below).

An early study carried out by Schultz in 1978 included various forms of transportation noise. In 2001 a comprehensive amalgamation of various airport noise studies was carried out by Miedema and Oudshoorn[3]. This study produced a dose-response curve that has been used widely for many years (Figure 1).

Marshall Day Acoustics has recently carried out a literature review of the more recent studies into community annoyance due to aircraft noise. Our detailed literature review is presented in a separate report "*Christchurch Airport – Community Response to Aircraft Noise Literature Review*" dated 16 May 2022. In summary, the two most significant studies were by the World Health Organisation (WHO)[4] in 2018 which included 12 airports from around the world and the Federal Aviation Administration (FAA)[5] in 2021 which included 20 airports in the USA.

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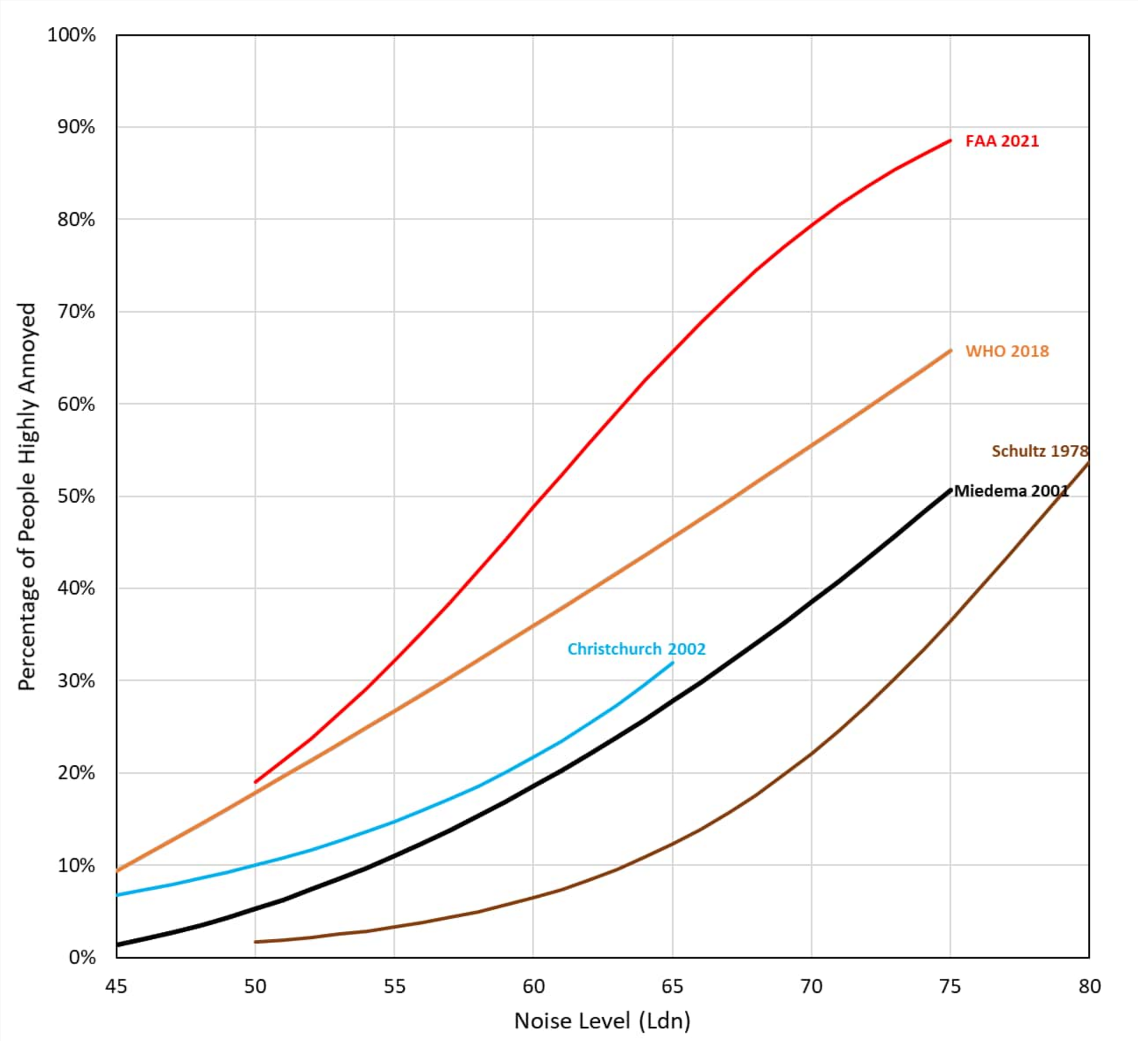
[3] Miedema and Oudshoorn (2001); "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals"

[4] World Health Organisation (2018). Environmental noise guidelines for the European Region.

[5] U.S Department of Transportation (FAA). (2021). *Analysis of the Neighbourhood Environmental Survey.*

**Figure 1: Community response to aircraft noise**




The comparison in Figure 1 shows there is an appreciable variation between the curves making it difficult to predict the actual annoyance outcome with certainty. The general conclusion from Figure 1 is that community annoyance due to aircraft noise increases with noise level exposure (as expected), and overall has increased over time.

The dose-response relationships discussed above can be used to estimate the number of people likely to be highly annoyed at various levels of aircraft noise. For example, at 55 dB $L_{dn}$, 27% of the population are likely to be highly annoyed using the WHO curve.

Our assessment of effects, calculates the number of people in Christchurch predicted to be highly annoyed using the 2018 WHO curve for both the Operative and Updated Noise Contours. We have calculated this for both the Existing and Future Housing Stock.

To determine these numbers, the Integrated Noise Model (INM) was used to calculate $L_{dn}$ contours in 1 dB increments and then GIS software was used to count the number of houses within each 1 dB noise band ($L_{dn}$). The number of people in each band was then multiplied by the annoyance level from the WHO curve to give an overall number of people annoyed under each noise contour scenario. The sample area analysed is the outer extent of the 50 dB $L_{dn}$ contour for the Operative and Updated Noise Contours.

### 3.4 Method 3 - Difference in $L_{dn}$ noise level

Replacing the Operative Noise Contours with the Updated Noise Contours will mean a change in future aircraft noise at many properties. For some houses the future noise level would increase compared to the existing planning environment, and for others it would decrease.

The subjective response to a change in noise level is widely variable from individual to individual, and also varies for a change that occurs immediately compared with a change that occurs slowly over many years.

However, the following general response to an immediate change in noise is typical:

- An increase in noise level of 10 dB sounds subjectively about 'twice as loud';
- A change in noise level of 5 to 8 dB is regarded as noticeable;
- A change in noise level of 3 to 4 dB is just detectable;
- A change in noise level of 1 to 2 dB is not discernible.

Our assessment concentrates on existing houses impacted by a noticeable change of +/-5 dB $L_{dn}$ or more between the Operative and Updated Noise Contours.

The change in $L_{dn}$ level is most relevant to the Existing Housing Stock and has little relevance to the Future Housing Stock. Therefore, we have not completed this analysis for the Future Housing Stock.

### 3.5 Method 4 - Difference in houses exposed to aircraft noise events above 70 dB

In Australia, a noise effects assessment concept known as 'Number Above'[6] is used to describe the impacts that residents living near aircraft flight paths will experience in practice. The concept is simply based on the number of aircraft noise events that people experience. The Australian study states that the 'Number Above' concept is not meant to replace the noise exposure analysis, but rather to be used in conjunction with that analysis to assist with the communication of noise effects to the public. It is proposed that residents can more easily relate to a number of noise events experienced than a noise level expressed in dB $L_{dn}$.

The authors of the concept[7] submit that an aircraft is 'registered as a noise event' by receivers when it exceeds an external noise level of 70 dB $L_{Amax}$. Thus, for any one receiver, a noise event of 90 dB $L_{Amax}$ is counted the same as an event of 71 dB $L_{Amax}$. Events below 70 dB $L_{Amax}$ are not considered to be disruptive or particularly noticeable and therefore are not counted.

Using aircraft noise modelling software, it is possible to calculate the 'number of events above' 70 dB $L_{Amax}$ at any given location for a given airport operations scenario. It is also possible to produce N70 contours to indicate where, for example, 20 aircraft events per day are experienced. This is referred to as an N70,20 contour.

We have calculated the N70 contours for the aircraft operations scenarios used in Operative and Updated Noise Contours and used this data to calculate:

- The difference in number of events at representative locations surrounding the Airport;
- The number of people predicted to experience more than 10 events above 70 dB;
- The Person Event Index for Operative and Updated Noise Contours.

We have completed this analysis for both the Existing and Future Housing Stock.

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[6] "Expanding Ways to Describe and Assess Aircraft Noise" Transport and Regional Services, Australia

[7] David Southgate, Rob Aked, Nick Fisher and Greg Rhynehart

We note the operating scenarios used for the N70 contours are an average day of aircraft operations. This means on average residents would experience 10 or more events over 70 dB $L_{Amax}$ but on any given day this number could be greater or smaller.

## 4.0 ASSESSMENT OF NOISE EFFECTS - RESULTS

### 4.1 Results 1 – Difference in number of houses inside the contours

Replacing the Operative Noise Contours with the Updated Noise Contours would mean a change in the number of houses inside the contours. We have quantified the number of houses in noise level bands (i.e. 50 – 55 dB Ldn and so on) for the Operative Contours and the Updated Contours.

Table 1 lists the results for the Existing Housing Stock and Table 2 lists the results for the Future Housing Stock.

**Table 1: Number of houses in Operative and Updated Noise Contours – Existing Housing Stock**

| $L_{dn}$ Band | Operative Contours | Updated Contours |
|---|---|---|
| 50 – 54 | 7,847 | 8,876 |
| 55 – 59 | 1,473 | 1,694 |
| 60 – 64 | 101 | 133 |
| >65 | 36 | 60 |
| Total | 9,457 | 10,763 |

**Table 2: Number of houses in Operative and Updated Noise Contours – Future Housing Stock**

| $L_{dn}$ Band | Operative Contours | Updated Contours |
|---|---|---|
| 50 – 54 | 15,260 | 13,599 |
| 55 – 59 | 1,904 | 2,559 |
| 60 – 64 | 417 | 410 |
| >65 | 36 | 60 |
| Total | 17,617 | 16,628 |

Table 1 shows a moderate increase in existing houses inside the Updated Noise Contours compared with the Operative Contours. CIAL currently has an acoustic mitigation programme in place for existing houses affected by levels greater than 65 dB $L_{dn}$ as recommended in NZS6805:1992. We recommend this programme is reviewed and updated to provide for the Updated Noise Contours.

Comparing Table 1 and Table 2 we can see that the impact of the potential change in receiving environment (i.e. additional housing) would have a greater impact on the number of houses affected by aircraft noise than the change in aircraft noise planning environment would (i.e. the Updated Noise Contours).

The analysis also shows that under the Future Housing Stock scenario, the Operative Contours would include slightly more houses than the Updated Contours. This difference is most apparent in the 50 – 54 dB $L_{dn}$ band.

The change in receiving environment is based on the assumption that the permitted density and subdivision controls that applied within the Operative Noise Contours in March 2022 would also apply within the Updated Noise Contours. Any loosening of the current land use controls inside the airport noise contours would result in an even greater increase in affected residents.

## 4.2 Results 2 – Difference in number of people highly annoyed

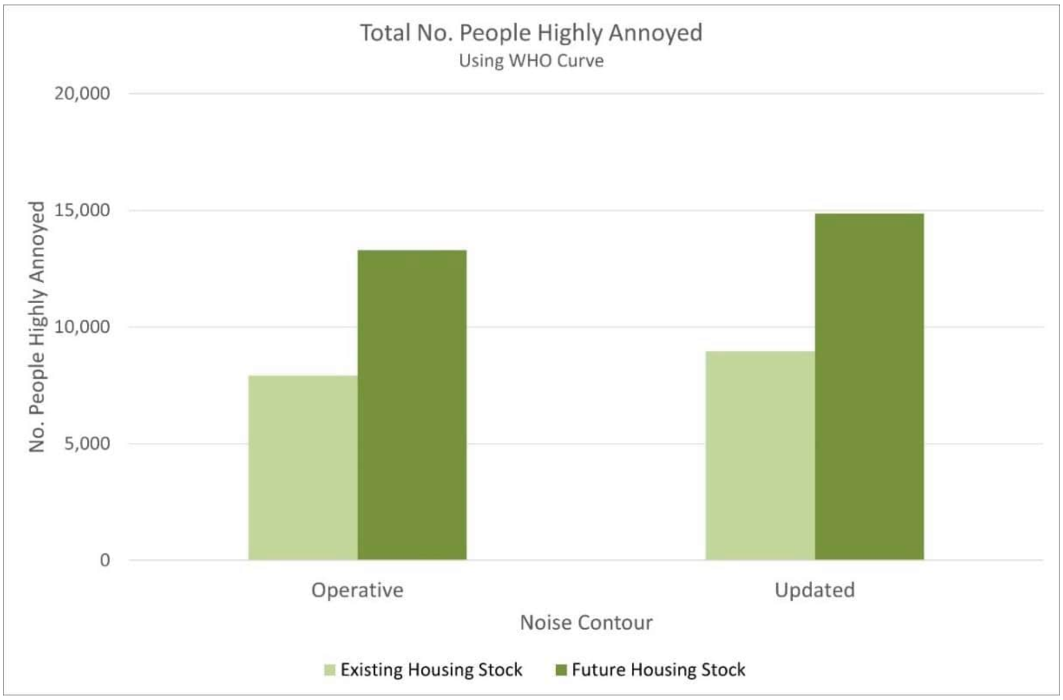
The results above show the number of houses under the different scenarios without taking into account the difference in annoyance at the different noise levels. This section uses those house counts and the noise levels to calculate the number of people potentially highly annoyed for the Operative and Updated Contours using the WHO 2018 dose-response curve[8]. The methodology is described in Section 3.3. Table 3 shows the results for both the Existing Housing Stock and the Future Housing Stock.

**Table 3: Number of people highly annoyed under the WHO curve**

| | Operative Contours | Updated Contours |
|---|---|---|
| Existing housing stock | 7,919 | 8,964 |
| Future housing stock | 13,291 | 14,869 |

For the Existing Housing Stock there is a moderate increase in people potentially highly annoyed resulting from the Updated Contours. However, the potential growth in residential development inside the Airport Noise Contours presents a far greater increase in people potentially highly annoyed. The number of people highly annoyed under the Future Housing Stock scenario is considerably greater than the Existing Housing Stock scenario (66% greater). This data is also represented graphically in Figure 2.

**Figure 2: Number of people highly annoyed Operative and Updated Noise Contours using WHO Curve**




[8] The predictions relate to the whole sample area covered by both the Operative and Updated Contours combined, including residents located outside 50 dB $L_{dn}$ for one scenario but inside 50 dB $L_{dn}$ for the other. This way we compare the annoyance outcome in the population within the same sample area for both scenarios.

Using an annoyance dose response relationship is useful for comparison purposes to evaluate the relative impacts of various scenarios. However as discussed in Section 3.3, there are various different annoyance curves available to use and it is difficult to predict the actual outcome with certainty. We have used the WHO 2018 curve which predicts approximately three times as many people being highly annoyed as the Miedema 2001 curve, which has historically been used in New Zealand.

## 4.3 Results 3 – Difference in $L_{dn}$ noise level

Replacing the Operative Noise Contours with the Updated Noise Contours would mean a change in the future anticipated $L_{dn}$ noise level at properties surrounding the Airport. For some properties the difference is an increase in aircraft noise and for others it is a decrease.

An indicative map of the difference in noise level at properties within the Airport Noise Contours is shown in Figure 3. The map shows that larger increases occur in areas such as West Melton and Ohoka between 50 and 55 dB $L_{dn}$ for the Updated Contours. These areas are not inside the Operative Contours but are in the Updated Contours due to changes in airspace management that have occurred since the Operative Contours were developed in 2008.

To further understand the scale of the change across the population, we have counted the number of existing houses impacted by a noticeable change of +/-5 decibels or more. In our view, the significance of a change also depends on the absolute noise level, for example a 5 decibel increase from 45 to 50 dB $L_{dn}$ is not as serious as an increase from 65 to 70 dB $L_{dn}$. Therefore, we've presented the results in $L_{dn}$ contour bands.

Table 4 below shows the number of houses in each contour band where the anticipated increase is 5 dB $L_{dn}$ or more. Table 4 shows that the majority of houses affected by a noticeable increase is in the lower noise contour bands. The last row in Table 4 lists the number of houses with a 5 dB or greater decrease in $L_{dn}$ compared with the Operative Noise Contours.

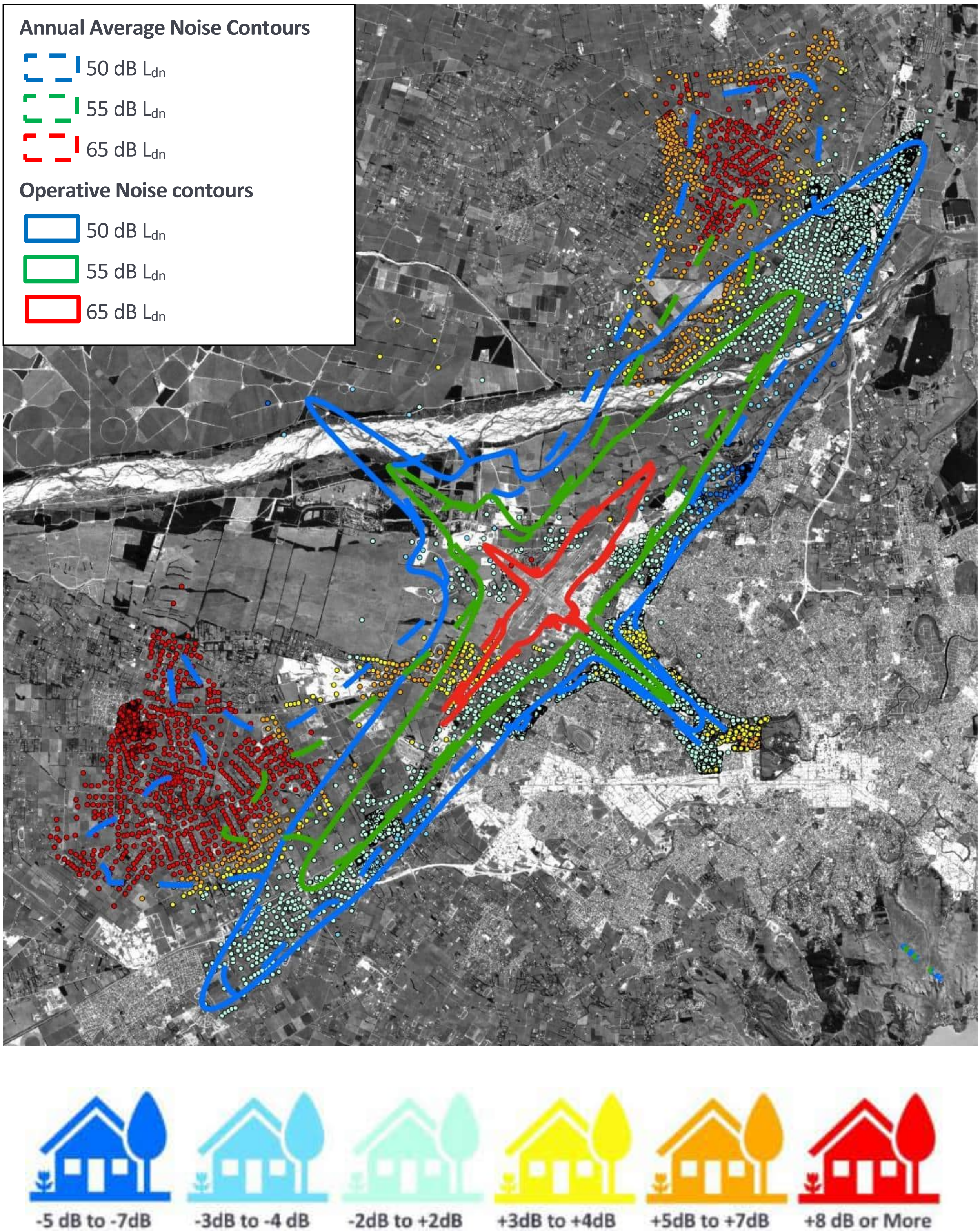
**Table 4: Number of existing houses with $L_{dn}$ increase of 5 dB or greater**

| $L_{dn}$ Band | Updated Contours |
|---|---|
| 50 – 54 | 635 |
| 55 – 59 | 203 |
| 60 – 64 | 11 |
| >65 | 1 |
| Houses with a 5 dB or greater increase in $L_{dn}$ | 850 |
| Houses with a 5 dB or greater decrease in $L_{dn}$ | 378 |

Most houses with a noticeable increase are in the lower noise bands and result from the different shape of the Updated Noise Contours. This is also demonstrated on the map in Figure 3.

**Figure 3: Difference in modelled airport noise level at each dwelling (relative to the Operative Contours)**

*Note: This diagram is indicative only. The points are based on existing titles in zones where residential activity may occur. Not all existing titles contain existing houses. The titles data used in this diagram has not been adjusted to exclude vacant land or non-residential buildings.*



### 4.4 Results 4 - Number of noise events above 70 dB

As discussed earlier, the N70 or 'Number Above' concept is aimed at identifying potential noise effects based on the number of aircraft noise events that people experience. The concept looks at the number of events above a specified noise level – $L_{Amax}$ 70 dB, which is termed N70. Aircraft events above this level are considered to be noticeable whereas events below this level are treated as not particularly noticeable or disruptive and are not counted.

We have used N70 in three ways – Methods 4a, 4b and 4c.

#### 4.1.1 Results 4a - Number of noise events above 70 dB experienced at representative locations

This method examines 11 representative locations and calculates the number of noise events experienced under the Operative Contours and under the Updated Contours. Figure 4 below shows the 11 locations (in orange) along with N70 contours for the Operative and Updated Contours.

**Figure 4: N70 contours and receiver locations for 'number above' analysis**

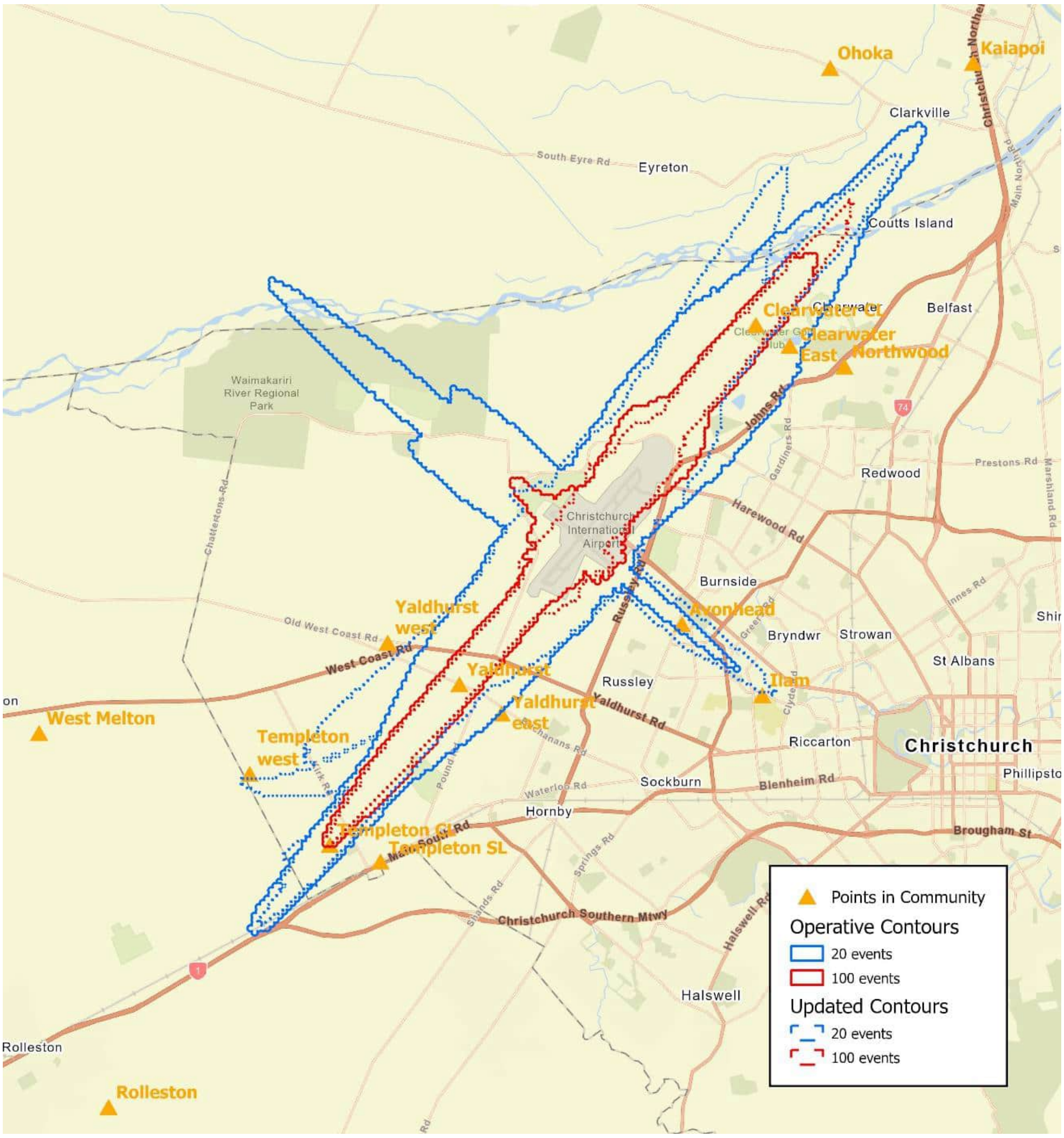


Table 5 lists the number of noise events above 70 dB $L_{Amax}$ at the 11 representative receiver locations.

**Table 5: Number of noise events above 70 dB $L_{Amax}$ per average day in each receiver location**

| Location | Operative Contours | Updated Contours | Change |
|---|---|---|---|
| Templeton East | 4 | < 1 | Decrease |
| Clearwater East | 37 | <1 | |
| Northwood | 13 | <1 | |
| Yaldhurst East | 13 | 8 | |
| Clearwater Centreline | 138 | 122 | |
| West Melton | <1 | <1 | Small increase, low to moderate number of events |
| Kaiapoi | < 1 | 4 | |
| Yaldhurst West | 3 | 4 | |
| Rolleston | < 1 | 9 | |
| Ohoka | < 1 | 8 | |
| Templeton West | 2 | 9 | |
| Ilam | 15 | 20 | |
| Avonhead | 24 | 28 | |
| Templeton Centreline | 102 | 130 | Moderate increase, substantial number of events |
| Yaldhurst | 152 | 234 | |

Templeton East, Clearwater East, Northwood and Yaldhurst East and Clearwater Centreline all have fewer noticeable aircraft noise events under the Updated Noise Contours compared with the Operative Contours.

West Melton, Kaiapoi, Yaldhurst West, Rolleston, Ohoka and Templeton West all have more noticeable aircraft noise events under the Updated Noise Contours compared with the Operative Contours, but the numbers remain relatively small (9 events or less per day on average).

Ilam and Avonhead have a moderate number of noticeable aircraft noise events per day on average, and a small increase under the Updated Contours compared with the Operative Contours. On a day with north westerly winds, the number would be greater than the average day predictions in Table 5.

Templeton and Yaldhurst are rural areas located on the extended runway centreline of the main runway. These areas experience the greatest number of noticeable aircraft noise events. For Yaldhurst and Templeton on centreline, the Updated Contours include more noticeable aircraft noise events than the Operative Contours.

### 4.1.2 Results 4b – Overall number of people experiencing aircraft noise events above 70 dB

The number of events analysis in Section 4.1.1 is helpful for residents at a particular location to assess how many events they will experience in the future, but it does not show how many people are exposed to this number of events, or how the overall community is affected.

The N70 contours can also be analysed to determine the number of people that will experience a given number of aircraft events. We have used the N70 contours to calculate the number of houses and number of people[9] that will experience events over 70 dB $L_{Amax}$ for the Operative Contours and the Updated Contours. Table 6 shows the results of this analysis for the Existing Housing Stock and Table 7 shows the results for the Future Housing Stock.

An indicative map in Figure 5 provides a geographical overview with dots for existing properties coloured to represent the number of aircraft events above 70 dB $L_{Amax}$.

**Table 6: Number of people experiencing aircraft noise events above 70 dB $L_{Amax}$ (Existing Housing Stock)**

| | Operative Contours | Updated Contours |
|---|---:|---:|
| 10-20 Events | 7,290 | 7,545 |
| 20-50 Events | 2,413 | 5,605 |
| 50-100 Events | 553 | 410 |
| 100+ Events | 350 | 288 |
| **Total** | **10,605** | **13,848** |

**Table 7: Number of people experiencing aircraft noise events above 70 dB $L_{Amax}$ (Future Housing Stock)**

| | Operative contours | Updated Contours |
|---|---:|---:|
| 10-20 Events | 16,750 | 12,645 |
| 20-50 Events | 3,315 | 6,998 |
| 50-100 Events | 968 | 785 |
| 100+ Events | 530 | 465 |
| **Total** | **21,563** | **20,893** |

Looking at the data in Table 6 we see that the Updated Contours have approximately 30% more people overall, experiencing 10 or more noticeable aircraft noise events per average day. Most of this increase occurs in the 20 – 50 events bracket (row 3 of Table 6) whereas the Updated Contours have slightly fewer people in the higher events brackets of 50 or more events per day. The large increase in people affected by 20 – 50 events per day is visible in Figure 5 where we see the Updated Contours has a larger area of green dots over urban Christchurch than the Operative Contours. The greater population density in this area of Christchurch influences this result.

Comparing Table 6 and Table 7, the scale of impact on the Future Housing Stock compared with the Existing Housing Stock is considerable. The data shows the increase in effects due to the change in aircraft noise environment is less significant than the increase resulting from the change in the receiving environment.

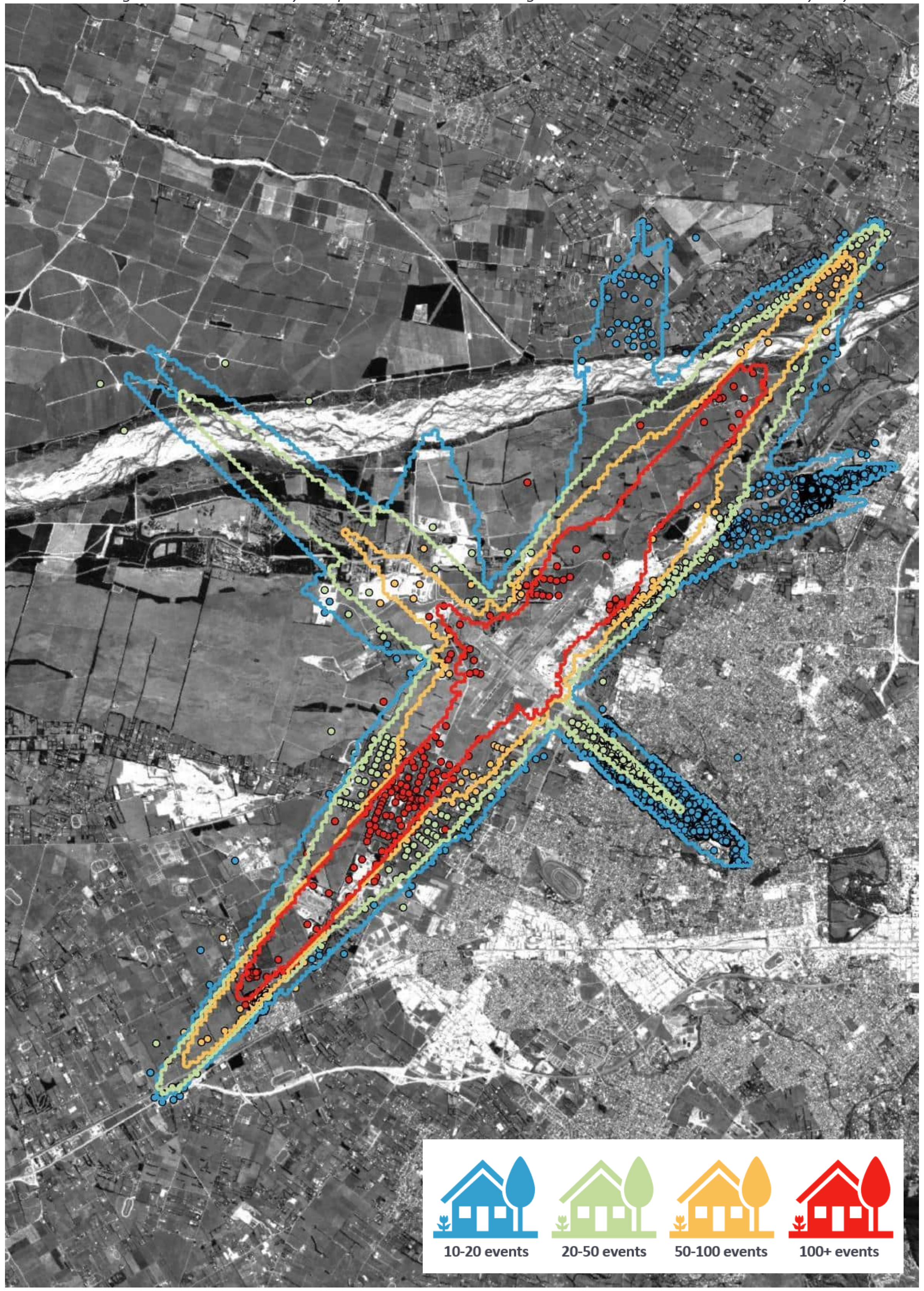
[9] The number of people per house is based on data from Statistics NZ of 2.5 persons per household

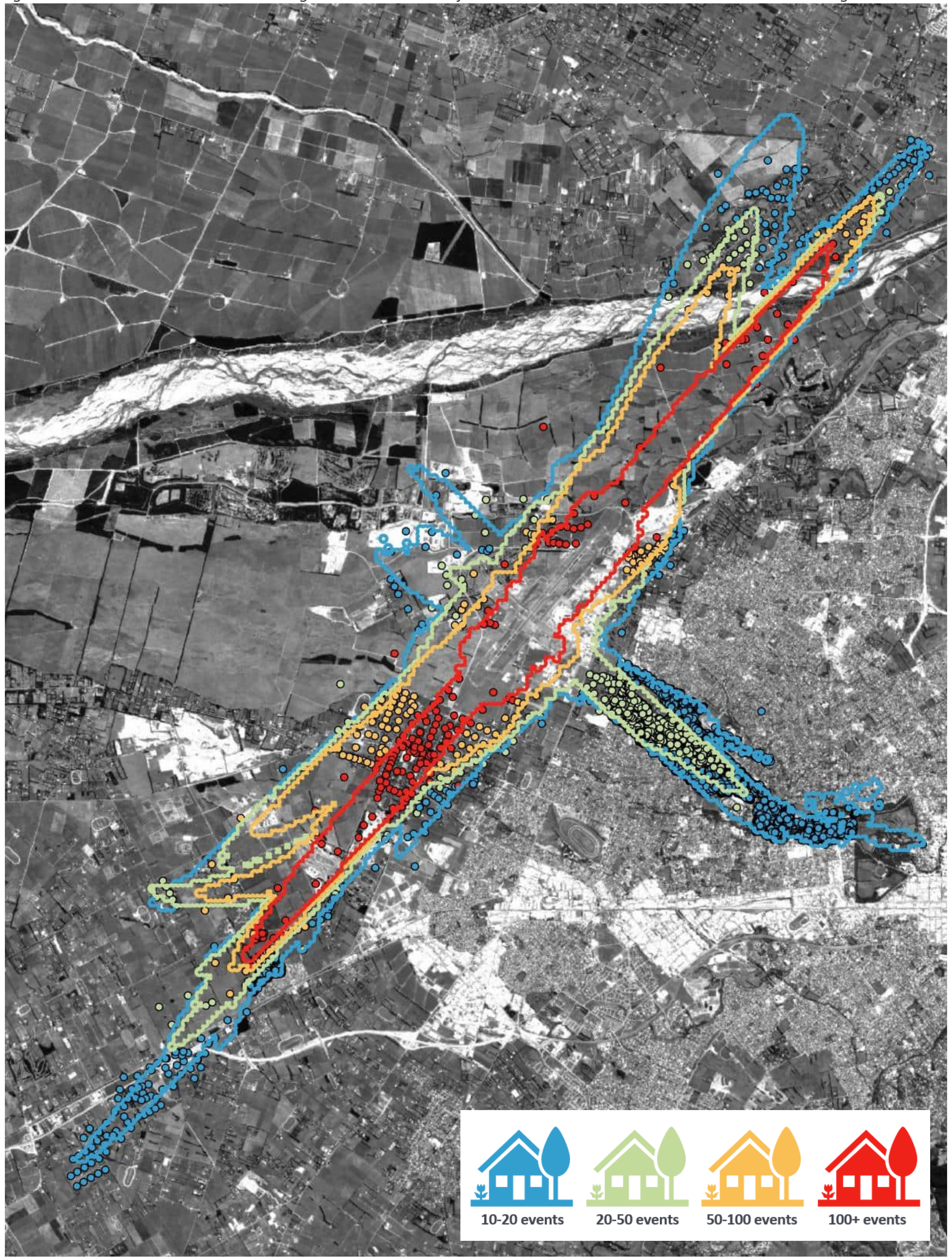
**Figure 5: Number of modelled aircraft noise events above 70 dB $L_{Amax}$ experienced at existing properties**

**Operative Contours**

**Updated Contours**

*Note: These diagrams are indicative only. The points are based on existing titles in zones where residential activity may occur. Not all existing titles contain existing houses. The titles data used in these diagrams has not been adjusted to exclude vacant land or non- residential buildings.*



### 4.1.3 Results 4c – Person event index

The above analysis provides a useful comparison of the number of people that will experience various numbers of events. However, it does not differentiate between the people that experience 10 events per day (a small effect) and those that experience 100 events per day (a greater effect).

The Australian N70 study also developed a 'Person Event Index' ("PEI") which is a single value metric used to evaluate and compare the effects on a population as a whole. From the N70 contours the Person Event Index (PEI) can be calculated by multiplying the number of people in each N70 band by the number of events. For instance, if 50 people were exposed to 10 events per day or 5 people were exposed to 100 events per day, the PEI would be 500 in both cases (i.e., 50x10 and 5x100). The PEI gives a general indication of the magnitude of the noise impact for the overall population sample.

Only dwellings exposed to 10 events or more per day have been considered. The results from the PEI analysis for the Existing Housing Stock are shown in Table 8 and for the Future Housing Stock in Table 9.

**Table 8: Person event index analysis for Existing Housing Stock (numbers reported in millions)**

| | Operative Contours | Updated Contours |
|---|---|---|
| 10-20 Events | 0.10 | 0.10 |
| 20-50 Events | 0.06 | 0.14 |
| 50-100 Events | 0.04 | 0.03 |
| 100+ Events | 0.05 | 0.05 |
| **PEI ($x10^{-6}$)** | **0.25** | **0.31** |

**Table 9: Person event index analysis for Future Housing Stock (numbers reported in millions)**

| | Operative Contours | Updated Contours |
|---|---|---|
| 10-20 Events | 0.22 | 0.15 |
| 20-50 Events | 0.09 | 0.17 |
| 50-100 Events | 0.07 | 0.05 |
| 100+ Events | 0.07 | 0.08 |
| **PEI ($x10^{-6}$)** | **0.45** | **0.46** |

We see the same trend in the PEI as we saw in method 4b in the previous section. The overall PEI for the Updated Contours is 24% greater than the Operative Contours and the greatest change occurs in the 20 – 50 event per day bracket.

The results for the Future Housing Stock in Table 9 show the potential change to the receiving environment (i.e. increase in residential activity) would result in the PEI increasing substantially.

## 5.0 RELATIONSHIP BETWEEN COMPLAINTS AND EFFECTS

As discussed in our literature review ("*Christchurch Airport – Community Response to Aircraft Noise Literature Review*" dated 16 May 2022), annoyance is determined by the noise level experienced and also a number of non-acoustic factors such as personal and attitudinal factors that can make certain individuals more sensitive to noise. Complaints are considered one of many mechanisms that can be used to cope with the annoyance being experienced. However, complaining is only one way of coping with noise annoyance. Therefore, analysis of complaint data only gives us access to a small slither of the population being annoyed by noise. Studies at Schipol and Brisbane airports showed that not all people annoyed by noise complain. Only 19% and 34% of highly annoyed respondents complained about the noise at Schipol and Brisbane airports respectively.

Complaints data has been analysed in past studies to try and determine a relationship between noise levels, annoyance and complaints. However, no reliable correlation has been found to date. A paper by FICON in 1992 commented that "annoyance can exist without complaints, and conversely complaints may exist without annoyance" and it has long been thought that we therefore cannot use complaints data to accurately predict annoyance levels. This continues to be the finding of the latest research in this area. However, recent studies have shown that analysis of complaints data can show us other trends which may be helpful to understand.

A major reason for people not complaining about noise is when they perceive nothing can be done about the noise source. This explains why often most complaints received at airports are well outside the noise contours where there is scope to shift flight paths rather than close into the airport where flight paths are essentially fixed on extended runway centreline and cannot be shifted.

This occurred at Auckland Airport throughout the SMART trials, which were trials of new arrival paths into the airport. The trial proceeded unnoticed for the first 6 months and no complaints were received. It was then picked up by a local newspaper and complaints increased as the media coverage grew and was eventually reported on the 6 o'clock news.

A large number of complaints were received during the yearlong trial that were well above historical complaint levels. These complaints were mainly from Mt Eden and Epsom (areas exposed to noise levels below 45 dB $L_{dn}$) whereas noise complaints from people living inside the noise contours were limited. In reality, the noise levels of the SMART flight paths in the Mt Eden and Epsom areas were not much different to the conventional flights paths that had flown over these areas for years.

The trial ceased after a year but interestingly the largest number of complaints received was in the week after the trial had stopped. There was also a very low correlation between people's complaints and the new flight tracks, with most people inadvertently complaining about conventional arrival and departure flight tracks thinking they were the new SMART flights tracks.

After the trial, a public consultation and review was completed, and the tracks were tweaked slightly and approved for permanent use. Complaints remained low during this period despite the tracks being used on a daily basis.

A similar scenario played out at Sydney airport and complaints from outside the noise contours resulted in a curfew being put on the airport. Similar trends are seen for complaints from Christchurch Airport, with most complainants coming from people located outside the noise contours. Analysis of complaints data from 2017 to March 2022 shows that 75% of complainants were located outside the noise contours.

Another reason people may be more likely to complain is if there is a large upcoming change proposed at an airport, such as a new runway, which people feel they can have a say in. Manchester Airport unveiled plans to construct a new runway in 1996 which caused public outcry and increased community complaint. Complaints in the years following decreased after this initial period to levels lower than those seen prior to 1996, even though the number of flights kept increasing over this time. The runway was eventually built in 2001 which again triggered another spike in complaints which were unrelated to the overall number of flight movements at the airport.

A study by Maziul in 2005 summarises that the following factors can lead people to/to not complain. As discussed above a large factor increasing people's likelihood to complaint is if they feel they can have some influence over an outcome. There are also things such as a person socio-economic status or the ease in which someone can make a complaint which influences people's likelihood of complaining.

| Factors that enhance to lodge a complaint | Factors that rather keep from complaining |
|---|---|
| Knowledge of noise complaint service | Not knowing where to complain |
| Believe in the effectiveness of the complaint | Low expectancy of success or belief in having to 'put-up-with' the disturbance) |
| Confidence in one's ability, good socio - economic status (education, house ownership) | Low socio-economic status |
| Past complaint experience | Past complaint experience |
| Noises which people believe authorities can influence | Noises which people believe authorities cannot influence |
| Time of day that noise occurred | Time of day that noise occurred |
| Individual characteristics (e.g. susceptibility, individual threshold, coping mechanisms, willing to express criticisms, tendency to complain) | |
| Way different airports deal with noise complaints | |
| Concern about health, and fear of aircraft crashes. | Neither concern about health (in relation to noise) nor fear of crashes |

In addition to the factors listed above, the noise level and time of an aircraft noise event can influence someone's likelihood of complaining. Hume 2003 did an analysis of complaints at Manchester Airport which showed that the louder the aircraft noise event, the more complaints that were generated. Also, night flights caused on average nearly five times more complaints than daytime flights. This study also found that more complaints were received in the busy season and that complaints tended to be lowest on Monday and highest on Sunday, increasing throughout the week.

Overall, we do not consider that complaints can be used as a reliable indicator of annoyance as they only represent a small proportion of people that are highly annoyed and are more likely to be from people living in lower noise environments. Complaints are also highly impacted by airport changes such a new runways or tracks being developed or public action against noise, which make them an unreliable source.

Analysis of complaints data over the years has not shown any reliable correlation to annoyance or overall noise levels. However, there are some trends that can be ascertained from looking at the data that can be helpful to understand the root cause of complaints and how an airport can best manage itself to avoid these.

This discussion confirms that it is important to use appropriate land use planning to avoid both complaints (and reverse sensitivity consequences) and to avoid annoyance (and adverse effects on the community).

## 6.0 ASSESSMENT OF NOISE EFFECTS - SUMMARY

NZS6805:1992 is intended to "*ensure communities living close to the airport are properly protected from the effects of aircraft noise whilst recognising the need to be able to operate an airport efficiently*". The Standard recommends doing this by applying a two-pronged approach that:

a. Manages aircraft noise emissions; and

b. Manages noise sensitive land use.

The current aircraft noise and land use controls for Christchurch International Airport are generally based on the NZS6805 approach.

CIA's Airport Noise Contours are intended to be reviewed every 10 years as recommended by the Expert Panel in 2008. Accordingly, CIAL has commissioned the preparation of Updated Noise Contours to replace the Operative Noise Contours.

This report considers the impact of changes to the two factors influencing the scale of aircraft noise effects on the surrounding population:

- **Change in aircraft noise planning environment** (Updated Noise Contours)
- **Change in the receiving environment** (i.e. growth in residential activity enabled by operative land use controls)

We have assessed the change in the aircraft noise planning environment by comparing the scale of aircraft noise effects for the Updated Noise Contours with the Operative Noise Contours in the context of the Existing Housing Stock.

We have assessed the change in the receiving environment by comparing the scale of aircraft noise effects for the Existing Housing Stock with that for a potential Future Housing Stock. The Future Housing Stock is based on the maximum development enabled by the existing planning framework. For this analysis, we have assumed that the operative land use controls applying inside the Operative Noise Contours as of March 2022, would also apply inside the Updated Noise Contours.

### 6.1 Annual Average Updated Noise Contours

The Annual Average Updated Noise Contours are based on the historical annual average use of CIA's four runways. Appendix E lists the runway usage splits applied in the Annual Average noise modelling.

For reference, the Operative Noise Contours are based on an annual average usage of runways 02 and 20 and a highest 3 month usage of runways 29 and 11.

A brief comparison of the inputs and resulting noise contours is provided in Appendix C.

### 6.2 Change in aircraft noise planning environment

The Updated Noise Contours represents a change in the aircraft noise planning environment which we have assessed in this report by comparing with the Operative Noise Contours. We have used four different methods to quantify the aircraft noise effects for the Existing Housing Stock:

1. Number of houses within the Airport Noise Contours (# Houses);
2. Number of people potentially highly annoyed (People HA);
3. Number of houses affected by a noticeable change in $L_{dn}$ (# Houses >5dB Increase);
4. Number of people experiencing aircraft noise events above 70 dB $L_{Amax}$ (PEI).

Table 10 summarises the difference between the Updated Contours compared with Operative Contours for each of the metrics above.

**Table 10: Updated Noise Contours change in aircraft noise effects for Existing Housing Stock**

| | # Houses | People HA | # Houses 5dB+ Increase in $L_{dn}$ | PEI ($10^{-6}$) |
|---|---|---|---|---|
| Change compared with Operative Contours | +14% | +13% | 850 | +24% |

Our assessment shows a moderate increase in the scale of effects predicted under all four assessment methods. This change reflects the revised airspace management and operational capacity of the airport used for modelling the Updated Noise Contours.

## 6.3 Change in receiving environment

We have considered the impact of future changes to the receiving environment which is determined by land use planning controls. For this assessment, we have quantified the potential change in effects due to future growth of residential activity inside the Airport Noise Contours. This analysis is based on a hypothetical Future Housing Stock calculated to be the maximum residential development permitted under the operative District Plan land use controls.

We have compared the scale of aircraft noise effects for the Future Housing Stock with that for the Existing Housing Stock using three methods:

1. Number of houses within the Airport Noise Contours (# Houses);
2. Number of people potentially highly annoyed (People HA);
3. Number of people experiencing aircraft noise events above 70 dB $L_{Amax}$ (PEI).

Table 11 summarises the increase in the scale of noise effects for the Future Housing Stock compared with the Existing Housing Stock for each of the metrics above.

**Table 11: Increase in aircraft noise effects due to change in receiving environment**

| Noise Contour Scenario | # Houses | People HA[10] | PEI ($10^{-6}$) |
|---|---|---|---|
| Operative | +86% | +68% | +76% |
| Updated | +54% | +66% | +46% |

Table 11 shows that under the operative land use controls (March 2022), the potential increase in residential activity within the Airport Noise Contours would result in a substantial increase in the scale of aircraft noise effects in the community.

For the change in receiving environment analysis, we have assumed that the permitted density and subdivision controls that apply within the Operative Noise Contours (as of March 2022) would also apply within the Updated Noise Contours. Any loosening of the current land use controls inside the airport noise contours would result in an even greater increase in affected residents.

[10] This change relates to the whole sample area covered by both the Operative and Updated Contours combined including residents located outside 50 dB $L_{dn}$ for one scenario but inside 50 dB $L_{dn}$ for the other. This way we compare the annoyance outcome in the population within the same sample area for both scenarios.

### 6.4 Conclusions

In summary, the Updated Noise Contours generally represent a moderate increase in aircraft noise effects compared with the Operative Noise Contours. This is a result of the updated long term future operational capacity of the Airport.

As well as considering the impact of the change in aircraft noise environment, we assessed the impact of the potential change in receiving environment. Our analysis shows that the potential increase in aircraft noise effects resulting from worst case growth in residential activity currently permitted inside the Airport Noise Contours, is far greater than the increase in effects due to the change in aircraft noise. If the land use controls applying inside the Airport Noise Contours (as of March 2022) were relaxed, the scale of airport noise effects on the surrounding population would increase even more significantly.

## APPENDIX A NEW ZEALAND STANDARD NZS6805

In 1992, the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" (the Standard) with a view to providing a consistent approach to noise around New Zealand airports. The Standard was finalised after several years of preparation and consultation and forms the consensus of opinion in 1991 of many different groups including the Ministry of Transport, the Department of Health, Airline representatives, Local Authorities, residents action groups, acoustic consultants and others including CIAL.

The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to:

- "Establish compatible land use planning" around an airport; and
- "Set noise limits for the management of aircraft noise at airports"

The Noise Boundary concept involves fixing an Outer Control Boundary and a smaller, much closer Airnoise Boundary around the airport. Inside the Airnoise Boundary, new noise sensitive uses (including residential) are prohibited. Between the Airnoise Boundary and the Outer Control Boundary new noise sensitive uses should also ideally be prohibited (and of those that are required, all should be provided with sound insulation). The Airnoise Boundary is also the location for future compliance monitoring with a 65 dB Ldn limit.

The Standard is based on the Day/Night Sound Level (Ldn) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10-decibel penalty applied to night flights. Ldn is used extensively overseas for airport noise assessment, and it has been found to correlate reasonably well with community response to aircraft noise.

The location of the Airnoise Boundary is based upon the projected 65 dB Ldn contour, and the location of the Outer Control Boundary is generally based on the projected 55 dB Ldn contour. The Standard does however state in paragraph 1.4.3.8 that the local authority may show "the contours in a position further from or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case". The Canterbury Regional Council, and therefore Christchurch, Waimakariri and Selwyn Councils use the 50 dB $L_{dn}$ contour for the location of the Outer Control Boundary.

The Standard recommends that the Airnoise Boundary and Outer Control Boundary are generally based on noise over a three-month period (or such other period as agreed). Airports in New Zealand mostly use a three-month average with Auckland Airport using an Annual Average. The Standard also recommends planning and management procedures be based on predicted noise contours (Ldn) for a future level of airport activity. The Standard (clause 1.4.3.1) recommends that a "minimum of a 10-year period be used as the basis of the projected contours."

It is important for a major international airport to plan for a period significantly longer than 10 years. At Auckland International Airport the original 1995 contours were based on a projection for the year 2030 (35 years ahead at the time). At Wellington International Airport the projections were based on the ultimate runway capacity. At Christchurch Airport they are based on ultimate runway capacity.

Clause 1.1.5(c) of the Standard recommends consideration of the noise from individual maximum noise events for night-time operations, and this is normally achieved by plotting the arrival and departure SEL 95 contours from the noisiest and most frequent night-time aircraft. If the SEL 95 contour extends beyond the 65 dB $L_{dn}$ contour then a composite of both contours forms the Airnoise Boundary. For Christchurch Airport the Airnoise Boundary used for land use planning is a composite of the 65 dB Ldn contour and the single event 95 dB SEL contour from an individual aircraft event.

Land Use Planning can be an effective way to minimise population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not be sufficient alone to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive uses around an airport can unnecessarily expose additional people to high levels of noise and can constrain, by public pressure as a response to noise, the operation of the airport.

**Planning rules**

The efficient use and development of Christchurch International Airport (CIA / the Airport) as a significant regional infrastructure resource is provided for in the Canterbury Regional Policy Statement (CRPS), in both Chapter 5 (Land use and Infrastructure) and Chapter 6 (Recovery and Rebuilding of Greater Christchurch).

The Airport is defined as "Regionally Significant Infrastructure" in the CRPS and is recognised across a number of policies and objectives. Policy 6.3.5 relevantly:

- provides for the continued safe, efficient and effective use of regionally significant infrastructure;
- provides for the provision for efficient and effectively functioning infrastructure;
- seeks to ensure that land use activities and new development are managed including avoiding activities that have the potential to limit the efficient and effective, "provision, operation, maintenance or upgrade of strategic infrastructure and freight hubs";
- expressly states that this includes "avoiding noise sensitive activities within the 50 dBA $L_{dn}$ airport noise contour for Christchurch International Airport."

Policy 6.3.9(5) requires that the location and design of rural residential development avoid noise sensitive activities occurring within the 50 dB $L_{dn}$ Air Noise Contour.

The Canterbury Regional Council and territorial authorities (Christchurch, Selwyn and Waimakariri District Councils) must give effect to the CRPS through their regional and district plans. This includes those provisions which direct the protection of strategic / regionally significant infrastructure.

The 50 dB $L_{dn}$ Air Noise Contour has consistently been used as a basis for land use planning throughout Greater Christchurch. For example, in rural zones, noise sensitive land uses (including residential activities) are typically non-complying to give effect to Policy 6.3.9(5) of the CRPS. Sound insulation is also required for noise sensitive activities within 55 dB $L_{dn}$, which is reflected in relevant rules across all three district plans.

## APPENDIX B GLOSSARY OF TERMINOLOGY

| Name | Description |
|---|---|
| AANC | Annual Aircraft Noise Contour.<br>Prepared annually to determine compliance with the Air Noise Boundaries. |
| AEDT | Aviation Environmental Design Tool.<br>A proprietary noise model created by the FAA used to calculate noise contours around an airport (replacement of the INM). |
| Airways New Zealand | The sole Air Traffic Service provider in New Zealand. |
| Ambient Noise | The totally encompassing sound in a given situation at a given time, from all sources near and far including the specific sound. |
| A-weighting | The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. |
| CIAL | Christchurch International Airport Limited |
| Cross-runway | Refers collectively to Runway 11 and Runway 29. |
| CRPS | Canterbury Regional Policy Statement. |
| Current Fleet | Refers to the fleet mix provided by Airbiz that currently exists. |
| Current Runway Configuration | Refers to the currently existing main and cross-runway. Doesn't include any proposed extensions. |
| Daytime | Assumed to be from 7 am to 10 pm. |
| dB | Decibel.<br>The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 mPa i.e. dB = 20 x log(P/Pr) |
| dBA | The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. |
| DMAPS | Divergent Missed Approach Protection System. Departure tracks that turn at an angle soon after take-off, instead of flying straight and then turning when instructed by Air Traffic Control. |
| DMAPS Tracks | Refers to the flight tracks currently in use, with RNP procedures in place and DMAPS departures. |
| Existing Aircraft Noise Planning Environment | The permitted and anticipated future aircraft noise environment defined by airport noise contours on the district planning maps. |
| Existing Housing Stock | Existing houses located inside the airport noise contours. |
| Expert Panel Report | Prepared in 2008 and outlines the assumptions and methodologies used to prepare the Operative Plan Noise Contours |

| | |
|---|---|
| FAA | The Federal Aviation Administration in the United States.<br>The developer of the INM and the AEDT noise models. |
| Future Fleet | Refers to the fleet mix provided by Airbiz in the future. Includes new generation aircraft. |
| Future Housing Stock | The capacity of potential houses inside the airport noise contours based on the maximum density and subdivision permitted under the operative district plans as of March 2022. |
| Future Runway Configuration | Refers to the envisaged future main and cross-runway. Includes proposed extensions to runway 11 and 20. |
| ILS Approach | Instrument Landing System Approach.<br>A type of approach that uses a precision runway approach aid based on two radio beams that provide vertical and horizontal guidance. |
| INM | The FAA's Integrated Noise Model. A proprietary noise model used to calculate noise contours around an airport. |
| $L_{Amax}$ | The A-weighted maximum noise level. The highest noise level which occurs during the measurement period. |
| $L_{dn}$ | The day-night noise level which is calculated from the 24-hour $L_{Aeq}$ with a 10-dB penalty applied to the night-time (2200-0700 hours) $L_{Aeq}$. |
| Main Runway | Refers collectively to Runway 02 and Runway 20. |
| MDA | Marshall Day Acoustics. |
| Night-time | Assumed to be from 10 pm to 7 am. |
| Noise | A sound that is unwanted by or distracting to the receiver. |
| Noise Model | A programme used to model aircraft noise to produce the noise contours. The INM and the AEDT are types of noise model. |
| NZS 6805:1992 | New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"* |
| Operative Plan Noise Contours | The Noise Contours Currently in the Canterbury Regional Policy Statement and Christchurch, Selwyn and Waimakariri District Plans. |
| Outer Envelope | The outer extent of multiple overlaid noise contours. The Updated Noise Contours are the Outer Envelope of four runway bias scenario contours. |
| RNP | Performance-Based Navigation.<br>Encompasses a shift from ground-based navigation aids emitting signals to aircraft receivers, to 'in-aircraft' systems that receive satellite signals from sources such as the Global Positioning System (GPS). |

| | |
|---|---|
| RNP Approach | Required Navigation Performance Approach.<br>Is a type of RNP approach that allows an aircraft to fly a specific track between two 3-dimensionally defined points in space. |
| Receiving Environment | The environment affected by an external impact. In this case, the land within the airport noise contours. |
| Runway 02 | Runway 02 is the main runway with aircraft landing and taking off in a northerly direction (heading 020 degrees magnetic) |
| Runway 11 | Runway 11 is the cross-runway with aircraft landing and taking off in an easterly direction (heading 110 degrees magnetic) |
| Runway 20 | Runway 20 is the main runway with aircraft landing and taking off in a southerly direction (heading 200 degrees magnetic) |
| Runway 29 | Runway 29 is the cross-runway with aircraft landing and taking off in a westerly direction (heading 290 degrees magnetic) |
| Runway bias scenario | Four airport operating scenarios used for modelling the Outer Envelope Updated Noise Contours. Each runway bias scenario represents the highest historical 3-month usage for the runway vector (02, 20, 29 or 11). |
| SEL or $L_{AE}$ | Sound Exposure Level.<br>The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover |
| Updated Noise Contours | The updated noise contours to replace the Operative Plan Noise Contours, modelled by CIAL's experts and to be peer reviewed by a panel of experts before confirmation. |
| Visual Approach | An approach when either part or all an instrument approach procedure is not completed, and the approach is executed with visual reference to the terrain. |

## APPENDIX C CALCULATED NOISE CONTOURS

A detailed explanation of the re-modelling process and outcomes is contained in the combined report by Airbiz, MDA, CIAL and Chapman Trip titled "*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours*".

In summary, the inputs to the Updated Noise Contours differ from the Operative Noise Contours in a number of aspects. The Operative Contours were based on a different flight schedule, fleet mix, airspace management, runway configuration, runway usage and version of the noise model. These changes reflect progress in all these areas since 2008 when the Operative Contours were developed. Table C1 below summarises the main differences in inputs between the Operative and Updated Noise Contours.

### C1 Differences in noise model inputs

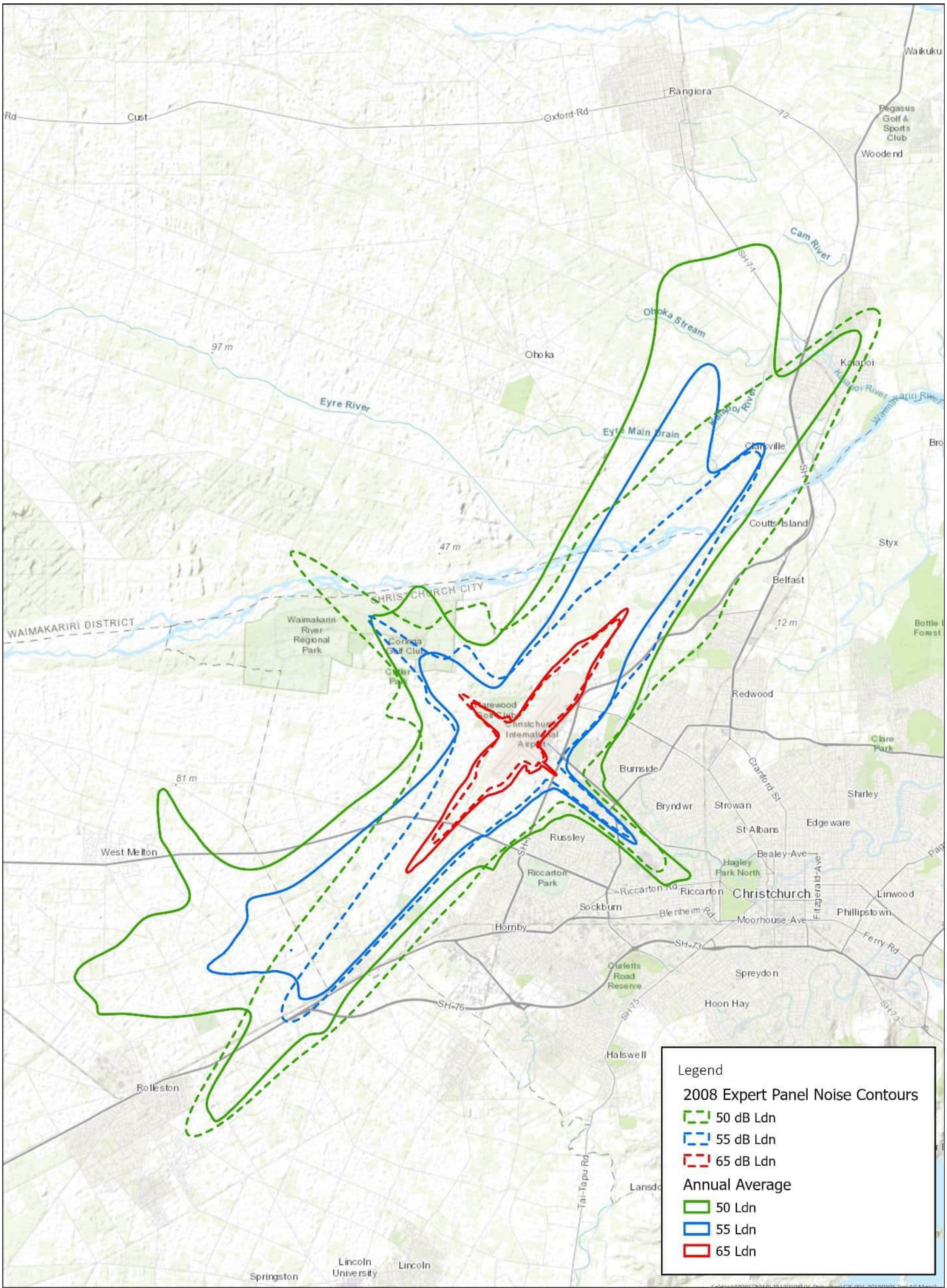
| INM Inputs | Operative Plan Noise Contours | Updated Noise Contours |
|---|---|---|
| Movement Numbers | 175k scheduled passenger<br>5 freight flights per week | 200k scheduled passenger aircraft<br>11k freight aircraft<br>15k FBO/small commercial, airline/MRO) (Antarctic/military/govt excluded)<br>29k Helicopters/drones |
| Fleet mix | Older aircraft | Newer aircraft (A320 Neos etc) but more wide bodies |
| Runway Configuration | Current RWY 02/20 length. Extension on RW11/29 | Runway extensions on 02/20 and 11/29 |
| Flight Tracks | Conventional straight tracks | Updated airspace management including DMAPS for departures and RNP arrivals |
| Taxiing | Doesn't include | Does include |
| Runway Usage | Annual average with 3 month seasonal factor applied RW11/29 | Annual average on all runways |
| Model version | INM v7.0 | INM v7d & AEDT v3d |

The resulting Updated Noise Contours are generally larger in most areas but smaller in some areas as shown in Figure C2. The Operative Noise Contours are shown as dashed lines and labelled "2008 Expert Panel Noise Contours".

The updated flight tracks result in a change to shape of the outer noise contours. The tracks used for the Operative Contours did not include RNP or DMAPS flight tracks and were predominantly straight (aligned with the runways) within the extent of the noise contours.

The Annual Average Updated Noise Contours do not include a 3 month seasonal factor for the cross-runway like the Operative Contours. The runway use factors applied in the model are detailed further in Appendix E.

## C2 Operative and Updated Noise Contours




MARSHALL DAY Acoustics
Date: 1/11/2021

**Christchurch Airport**
**Draft Noise Contours**

## APPENDIX D DERIVATION OF POTENTIAL GROWTH IN RESIDENTIAL UNITS IN THE RECEIVING ENVIRONMENT

The analysis of the potential future growth of residential units within the airport noise contours was carried out jointly by CIAL, MDA and Chapman Tripp.

The Future Housing Stock was derived using parcel information from LINZ and the operative land use controls (as of March 2022) to estimate the development potential under the current planning framework.

The Operative District Plan land use controls from Selwyn, Waimakiriri and Christchurch City Councils were used to identify zones where residential activities could occur and at what density. Non-sensitive land uses such as industrial or commercial were excluded from our analysis.

The land area of each parcel was analysed to determine the development potential under the current planning rules taking into consideration the density controls applying to land within the 50 dB $L_{dn}$ Airport Noise Contour. We have assumed that the same controls would continue to apply inside the Updated Noise Contours. No account was made for any change to density controls operative in March 2022.

The Future Housing Stock calculation **does not** account for how the following factors affect the potential number of residential units permitted on a given parcel:

- Shape of the parcel;
- Existing residential development on the land;
- Potential for combined development of adjoining parcels;
- Changes to the existing density controls and land use zones operative as of March 2022.

The calculation is simply based on parcel area and the permitted density.

In summary, we have used available GIS information to prepare an estimate of the Existing and Future Housing Stock. The data contains inherent uncertainties and therefore the housing stock numbers presented in the report are an estimate only.

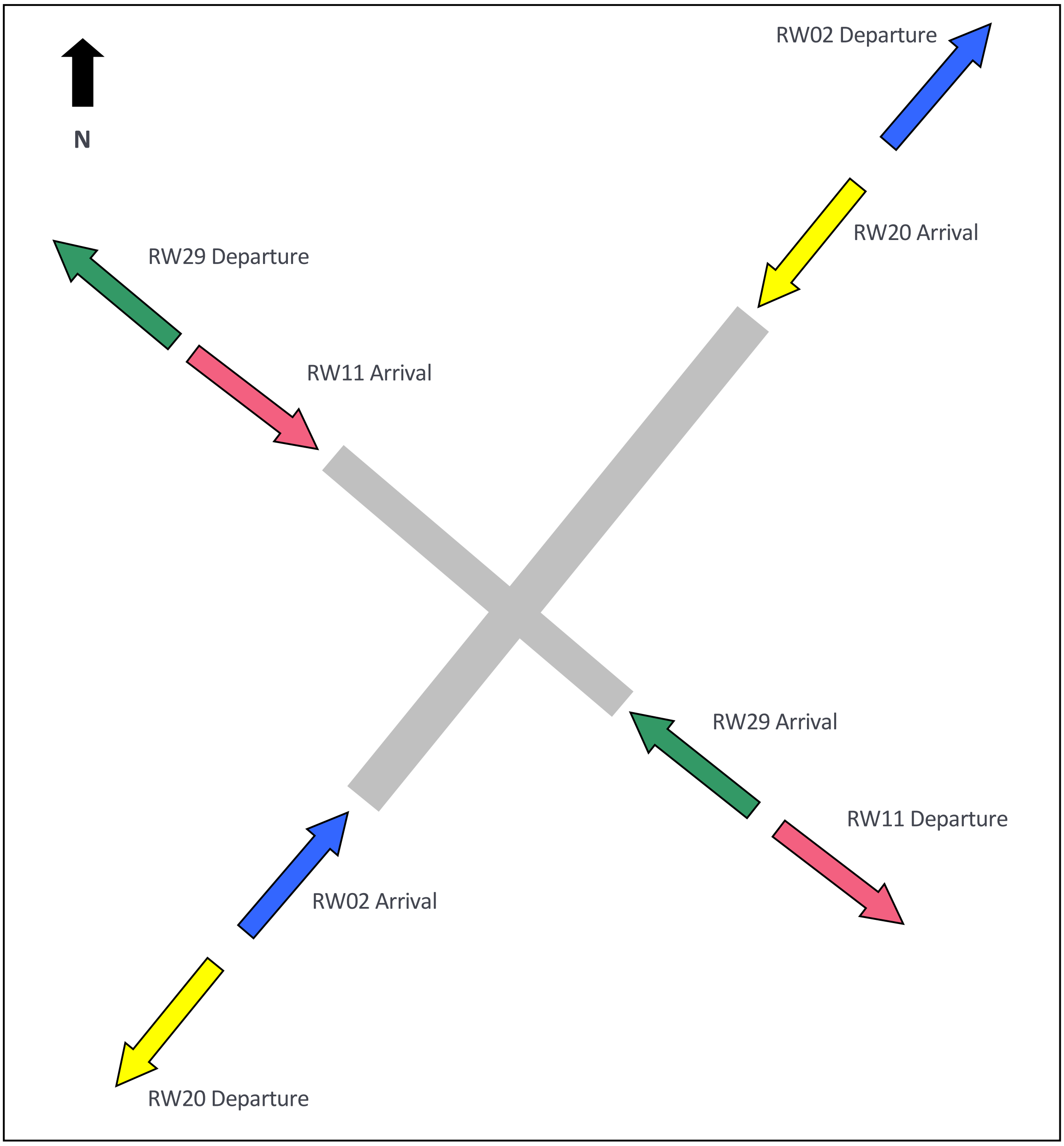
## APPENDIX E RUNWAY USAGE

**Runway 02** refers to operations using the main runway with a heading of 20 degrees from true north i.e. arrivals from the south west landing in a north easterly direction and departures towards the north east.

**Runway 20** refers to operations using the main runway with a heading of 200 degrees from true north i.e. arrivals from the north-east landing in a south westerly direction and departures towards the south west.

**Runway 11** refers to operations using the crosswind runway with a heading of 110 degrees from true north i.e. arrivals from the north-west landing in a south easterly direction and departures towards the south east.

**Runway 29** refers to operations using the crosswind runway with a heading of 290 degrees from true north i.e. arrivals from the south-east landing in a north westerly direction and departures towards the north west.



Our aircraft noise contour modelling is based on an average day of aircraft movements which means we apply average runway usage percentages to assign aircraft movements to each runway. For Christchurch Airport the runway usage in any given three-month period will vary significantly due to seasonal wind conditions. For the Updated Noise Contours, we considered two options for modelling runway usage:

- The Outer Envelope future noise contour (composite of 3-month worst case runway usage for four wind directions)
- The Annual Average future noise contour (annual average runway usage)

Therefore, five different runway splits were initially used in developing the Updated Noise Contours. Four for the Outer Envelope and one for the Annual Average noise contour. This report presents the Annual Average option, and the associated runway splits are detailed below.

**Annual Average**

The Annual Average runway splits were determined by calculating the runway splits for each calendar year from 1999-2019 and then finding the average of these. These are shown in Table E1.

RW29/11 is factored up by 10% to account for potential climate change effects on increasing the prevalence of north-westerly wind patterns. This explains why the total is 101% rather than 100%.

The runway splits given in Table E1 below are the overall runway splits that are not broken down for different aircraft types or operations. The more detailed runway splits given in Tables E2 below, reflect the fact that departures have not been allocated to runway 11 and slightly different runway splits apply for wide bodied jets which cannot use the cross-runway at all.

## E1 Annual Average Runway Splits

| Runway 02 | Runway 20 | Runway 11 | Runway 29 | Total |
|---|---|---|---|---|
| 58.5% | 36.7% | 0.3% | 5% | 101% |

## E2 Runway Splits– Detailed Annual Average

| | Runway 02 | Runway 20 | Runway 11 | Runway 29 | Total |
|---|---|---|---|---|---|
| Narrow bodied jet & Turboprop Arrivals | 58.5% | 36.7% | 0.3% | 5% | 100.5% |
| Narrow bodied jet & Turboprop Departures | 58.5% | 36.7% | - | 5.3% | 100.5% |
| Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)* | 61% | 39% | | | |

# Appendix 16

Airport Contour s77K Appendix Six: Land Use Planning 50-55dB Ldn

MARSHALL DAY Acoustics

# CHRISTCHURCH INTERNATIONAL AIRPORT
# LAND USE PLANNING

Report No.003 | 23 May 2022

| | |
|---|---|
| Project: | **CHRISTCHURCH AIRPORT NOISE CONTOURING** |
| Prepared for: | **Christchurch International Airport Limited**<br>**PO Box 14001**<br>**Christchurch Airport**<br>**Christchurch 8544** |
| Attention: | **Felicity Hayman** |
| Report No.: | **Report No.003** |



## Document Control

| Status: | Rev: | Comments | Date: | Author: | Reviewer: |
|---|---|---|---|---|---|
| Draft | | | 28-Mar-22 | Chris Day | Laura McNeill |
| Final | | | 29 May 2022 | Chris Day | Laurel Smith |

# TABLE OF CONTENTS

# 1.0 INTRODUCTION

## 1.1 The Effects of Noise on People

It is a long-established concept that aviation noise can have an adverse effect on people and communities.

World-wide, the lack of appropriate land use planning around airports has historically caused significant numbers of people to be exposed to airport noise and subsequent community action has initiated operational constraints on airports. The fore-fathers in Greater Christchurch however have managed to avoid this situation by farsighted planning of the Christchurch airport location including a 'buffer' protecting the airport.

The noise levels experienced around Christchurch International Airport (CIA) are not sufficiently high to create physiological damage such as hearing loss but there are nevertheless adverse effects caused by noise. These adverse effects include annoyance, speech interference, sleep disturbance and potentially health effects associated with annoyance.

However, at what level of noise do these effects commence? There is no doubt there are adverse effects from aircraft noise at 50 dB $L_{dn}$ [1]. While the adverse effects are less than, for example, they are at 65 dB $L_{dn}$, they are nevertheless real. If land is available elsewhere in the Christchurch region for new residential development (or intensification), it is proposed that it is not sensible from an acoustics perspective, to allow new noise sensitive activities inside the 50 $L_{dn}$ Air Noise Contour if it can be avoided. It is accepted that noise effects are just one input to the decision making process on land use restrictions.

A number of factors confirm there are adverse effects from aircraft noise inside the 50 $L_{dn}$ Air Noise Contour and that this is not a desirable noise environment in which to locate new residential development and these are discussed in this report.

Recent overseas studies have shown that between 50 dB and 55 dB $L_{dn}$, 18% to 33% of people were found to be highly annoyed by aircraft noise. If noise sensitive activities such as residential development, hospitals and education facilities are allowed to locate in this area (50 dB to 55 dB $L_{dn}$), the number of people adversely affected by aircraft noise would increase.

Specifying sound insulation to be fitted to buildings in these noise environments will not eliminate all the adverse effects of noise, due to open windows and an unsatisfactory outdoor noise environment.

Christchurch City and the Christchurch International Airport are geographically extremely well laid out for the avoidance of aircraft noise for two main reasons. Firstly, the main runway was aligned roughly north/south with the city located to the east. As airport noise contours are long and narrow, the city is relatively unaffected by aircraft noise while maintaining close access to the airport. Secondly, the authorities have managed to maintain a 'greenbelt' ensuring that new residential development has been kept away from the airport.

This approach is the basis of New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning" and is discussed throughout this report.

## 1.2 New Zealand Standard NZS6805

In 1992, the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning" with a view to providing a consistent approach to noise around New Zealand airports. The Standard was finalised after several years of preparation and consultation and forms the consensus of opinion in 1991 of many different groups including the

[1] $L_{dn}$ is the Day/Night Sound Level which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10-decibel penalty applied to night flights.

Ministry of Transport, the Department of Health, Airline representatives, Local Authorities, residents action groups, acoustic consultants and airport companies including CIAL.

The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to:

- "Establish compatible land use planning" around an airport; and
- "Set noise limits for the management of aircraft noise at airports"

The Noise Boundary concept involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Airnoise Boundary (ANB) around the airport. Inside the ANB, new noise sensitive uses (including residential) are prohibited. Between the ANB and the OCB new noise sensitive uses should also ideally be prohibited (and of those that are required, all should be provided with sound insulation). The ANB is also nominated as the location for future noise monitoring of compliance with a 65 dB $L_{dn}$ limit.

The Standard is based on the Day/Night Sound Level ($L_{dn}$) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10-decibel penalty applied to night flights. $L_{dn}$ is used extensively overseas for airport noise assessment, and it has been found to correlate well with community response to aircraft noise.

The location of the ANB is then based upon the projected 65 dB $L_{dn}$ contour, and the location of the OCB is generally based on the projected 55 dB $L_{dn}$ contour. The Standard does however state in paragraph 1.4.3.8 that the local authority may show "the contours in a position further from or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case". The Canterbury Regional Council, and therefore Christchurch, Waimakariri and Selwyn Councils use the 50 dB $L_{dn}$ contour for the location of the OCB.

The Standard recommends that the ANB and OCB are generally based on noise over a three-month period (or such other period as agreed). Airports in New Zealand mostly use a three-month average with Auckland International Airport using an annual average.

The Standard also recommends planning and management procedures be based on predicted noise contours ($L_{dn}$) for a future level of airport activity. The Standard (clause 1.4.3.1) recommends that a "minimum of a 10-year period be used as the basis of the projected contours."

It is important for a major international airport to plan for a period significantly longer than 10 years. At Auckland International Airport the original 1995 contours were based on a projection for the year 2030 (35 years ahead at the time). At Wellington International Airport the projections were based on the ultimate runway capacity. At Christchurch International Airport they are based on ultimate runway capacity.

Clause 1.1.5(c) recommends consideration of the noise from individual maximum noise events for night-time operations, and this is normally achieved by plotting the arrival and departure SEL 95 contours from the noisiest frequent night-time aircraft. If the SEL 95 contour extends beyond the 65 dB $L_{dn}$, then a composite of both contours forms the ANB. For Christchurch Airport the ANB used for land use planning is a composite of the 65 dB $L_{dn}$ contour and the single event 95 dB SEL contour from an individual aircraft event.

Land Use Planning can be an effective way to minimise population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not be sufficient alone to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive uses around an airport can unnecessarily expose additional people to high levels of noise and can constrain, by public pressure as a response to noise, the operation of the airport.

### 1.3 What Level of Aircraft Noise is Reasonable

The objective of this report is to discuss at what noise level should planning restrictions commence for Christchurch International Airport. The level of community response to aircraft noise are discussed in detail in section 4.0 of this report. However, community response to noise is clearly a 'grey scale' – annoyance does not start and stop at a specific noise level. However, to implement planning controls, a specific noise level does have to be decided upon.

Marshall Day Acoustics is of the opinion that the existing 50 dB $L_{dn}$ control is the appropriate approach to be used at Christchurch. There are a number of key arguments to support this recommendation;

- 50 dB $L_{dn}$ has historically been used at Christchurch since 1975
- NZS 6805 recommends that existing noise controls should not be downgraded
- World-wide, community annoyance from aircraft noise has increased significantly since these controls were first introduced
- Airports generally experience significant complaints from residents located outside 55 dB $L_{dn}$
- District Plan noise limits for general noise sources are set around 50 dB $L_{dn}$
- Providing sound insulation to affected dwellings does not solve all the annoyance issues from aircraft noise

Each of these issues is discussed in this report.

## 2.0 HISTORICAL LAND USE PLANNING AROUND CHRISTCHURCH AIRPORT

### 2.1 1975 Waimairi District Plan

Christchurch has been extremely fortunate in the management of aircraft noise for two main reasons. Firstly, the main runway was aligned roughly north/south with the city located to the east. As airport noise contours are long and narrow, the city is relatively unaffected by aircraft noise while maintaining close access to the airport. Secondly, the authorities have managed to maintain a 'greenbelt' ensuring that new residential development does not come too close to the airport.

Christchurch City has been extremely progressive in introducing airport noise planning at an early stage. In 1975 the Waimairi Council introduced Plan Change 10 which included a "calculated noise control line and endeavoured to control possible conflict between airport related activities and residents in the vicinity by making dwelling–houses (including the rebuilding of existing dwelling houses), a conditional use with requirements for noise insulation".

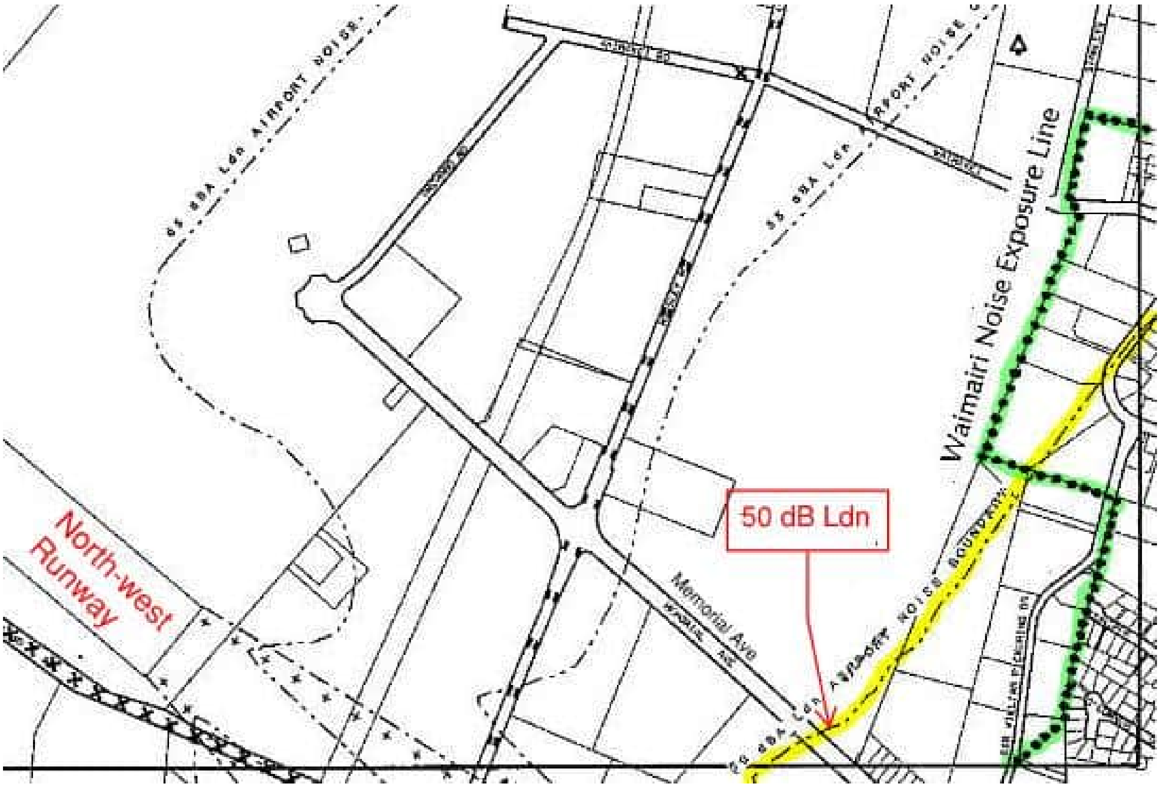
A copy of the Waimairi District Planning Scheme 1989 Section Twelve - Part One: "Christchurch International Airport Noise Exposure Line" (NEL) is attached as Appendix B.

The planning scheme clearly states the objectives of the NEL; *"The controls associated with the noise exposure line are provided both to protect residents living in the vicinity of the airport from airport related noise and also to protect the airport from complaints about noise from residents which if sustained could lead to constraints upon airport operations"*.

The location of the Noise Exposure Line at that time was based on a 50 dB Day-Night Level ($L_{dn}$) contour produced by the Department of Scientific Research.

Appendix C shows a copy of two City Plan Maps 23B and 24B from the Christchurch City Plan (which was made operative in 1995). These maps (and the excerpt Figure 1 below) show the location of the NEL and the 50 dB $L_{dn}$ Airport Noise Boundary in the City Plan near Memorial Drive. The NEL wanders either side of the 1995 City Plan $L_{dn}$ 50 dB contour but is mostly outside it.

**Figure 1 – 1975 Noise Exposure Line versus 50 dB $L_{dn}$ Airport Noise Boundary 1995 CCP**




It may appear anomalous that the 50 dB contour in 1975 is in roughly the same place as it is 20 years later. The reason for this is because of the reduction in aircraft noise due technological advances in aircraft design has roughly matched the growth in aircraft movements. This reduction in aircraft noise emissions is discussed further in Section 8.0 of this report. In 1975 there were a smaller number of noisier aircraft. These advances in aircraft technology have enabled airports to grow significantly without noticeably increasing the overall noise exposure for the community.

## 2.2 1994 Marshall Day Study

Marshall Day Acoustics was engaged in 1992, together with a series of airport planning experts, to develop noise contours for Christchurch Airport. The study involved a dual approach of examining future growth projections and a study of long-term airport capacity. In summary, Christchurch International Airport Limited developed future aircraft operational scenarios for the airport through consultation with their airport planning consultants and users of the airport. These scenarios were developed from the then current, 1993 domestic and international billing details, significant research on anticipated growth rates for the industry and the information on airline fleet replacement preferences.

The 'high' forecast growth, predicted total annual movements of 145,000. CIAL discussions with the airport planning consultants suggested the maximum capacity of the airport, with the technology available at that time, was 140,000 movements per annum. Thus, this slightly lower figure was used in the 1994 noise contour predictions. It was anticipated at the time that this capacity would be reached between the years 2015 and 2020.

Several computer based models have been developed to predict aircraft noise levels in areas surrounding airports. The most widely used of the models (and the model referenced in NZS 6805) is the Federal Aviation Authority (FAA) Integrated Noise Model (INM). The version of the INM program that was current in 1994 was used by Marshall Day Acoustics to predict the future $L_{dn}$ contours around Christchurch International Airport. The resultant contours were an accurate 'best practice' estimate of the future noise contours for Christchurch and were later included in the various District Plans. The FAA has recently updated the INM by integrating its calculation procedures into a general environmental prediction package called AEDT.

## 2.3 2007 Marshall Day/Expert Panel Study

In 2007, several parties agreed that the noise contours for Christchurch should be updated to include new operational procedures and updated knowledge of future aircraft types. It is understood this was driven by the upcoming review of the Regional Policy Statement. Marshall Day Acoustics, Airbiz, Yellow Hat Consultants and Airways were engaged to carry out a detailed study to determine future flight tracks, aircraft types and numbers of aircraft movements to provide the input for an updated INM study. The work was carried out in consultation with Mestre Greve Associates from Seattle. Most input parameters were agreed by the consultants however some inputs remained in contention.

Later, in 2007 a panel of noise and aviation experts was formed by the Environment Court to resolve the remaining 'differences'. Seven aviation and noise experts from NZ, Australia and the USA met together in a three day expert conferencing workshop to find an agreed position on input data to be run in the INM.

The people involved in the 'Expert Panel' were; Assoc Professor John-Paul Clarke (engaged by SDC & Chairman), Kevin Bethwaite (Airways), Chris Day & Laurel Smith (MDA, engaged by CIAL), Vince Mestre, Bill Bourke and Barry Malloch (engaged by Foster, the appellant in the then relevant Environment Court proceeding that had initially 'triggered' the expert panel process).

The outcome from the panel was that the modelling approach used by the CIAL experts in the initial 2007 Study was adopted on virtually all issues (flight tracks, fleet mix etc) except for the following issues.

The airport capacity using the dual runway and Simops was originally determined by Airbiz to be 220,000 movements per annum. Associate Professor J-P Clarke was of the view that the capacity was only 175,000 mpa. The airport company reluctantly agreed to a reduction in airport capacity for the modelling exercise from 220,000mpa to 175,000mpa but I understand they do not resile from their position that capacity is greater and the contours are therefore conservative. There were also some minor modifications to the approach profiles and an increased use of the cross-wind runway.

Marshall Day Acoustics subsequently ran these agreed input parameters in the 'then current version' of the INM to produce the updated noise contours. These revised contours are sometimes also referred to as the 'Expert Panel' contours and were subsequently adopted into the Regional Plan and the various District Plans. They are now often referred to as the Operative Noise Contours.

## 2.4 Planning Hearings Debating 50 dB versus 55 dB $L_{dn}$

Since 1994 there have been several hearings (Council and Environment Court) that have debated the 50 dB versus 55 dB $L_{dn}$ issue. These cases are discussed in detail by Chapman Tripp however the overall summary is that many overseas and local noise experts presented evidence as to the suitability of 50 dB vs 55 dB and in all cases the use of the 50 dB $L_{dn}$ contour for the Outer Control Boundary was reconfirmed as appropriate for Christchurch.

# 3.0 NEW ZEALAND STANDARD NZS 6805

A summary of the concepts within NZS 6805 is included as section 1.2 of this report. However, there are some specific clauses in the Standard that support the use of 50 dB $L_{dn}$.

## 3.1 Clause 1.1.4 'Do not downgrade existing noise controls'

Clause 1.1.4 of NZS 6805 states that "This Standard shall not be used as a mechanism for downgrading existing or future noise controls…"

If the City Plan adopted the $L_{dn}$ 55 dBA contour now as the commencement of land use controls (i.e. a position closer to the airport than the historical line), this would be a significant 'downgrading of the previously existing controls' (existing from 1975 until now).

### 3.2 Clause 1.4.3.8 Minimum Standard of Protection

It is understood the NZS 6805 is very much recommending a minimum level of protection with its use of $L_{dn}$ 55 dBA as the Outer Control Boundary. The Standard states in clause 1.4.3.8 that the local authority may show "the contours in a position further from, or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case".

Christchurch Airport is a unique situation where the Council and the Airport Company have diligently maintained a 'buffer' around the airport through the implementation of appropriate land use planning over a significant period of time. Many other New Zealand airports have not been as fortunate due to severe shortages of residential land. In these situations, the local authorities have tended to implement less stringent land use planning rules during the adoption of NZS 6805 into their district plans as in most cases the Standard arrived too late (1992) to prevent residential encroachment.

Auckland is an example of this less stringent approach due to the current and future shortage of residential land in the Manukau area. However, Queenstown, which also has a shortage of residential land, has adopted a more protective approach with new residential development between the OCB and ANB listed as a prohibited activity in rural zones.

I understand the Christchurch area does not have an overriding need to site residential development in areas affected by airport noise. Such land should be used for non-noise sensitive users or uses which require low population densities thus keeping the number of people impacted by aircraft noise to a minimum. There are many areas away from the airport not affected by aircraft noise that can more appropriately be used for residential development.

The NZ Standard clearly envisages that a better standard of protection than the 'minimum standard' may be implemented somewhere in New Zealand – otherwise it would not have these words in clause 1.4.3.8 of the Standard. It is difficult to imagine a more appropriate location than Christchurch with its national significance in the transportation network and its already well established 'buffer', to implement "contours in a position further from the airport".

## 4.0 COMMUNITY RESPONSE TO NOISE

### 4.1 Community Annoyance

A large number of overseas studies have been carried out over time to investigate community response to environmental noise. The general approach of these studies is to question residents (verbally or in writing) as to their level of annoyance to a particular noise source. The noise level at the respondent's location is then determined by either measuring it or by using calculated noise contours. 'Noise levels' are normally measured/calculated as $L_{dn}$ – the Day/Night Level which involves a summation of the noise energy over 24 hours with a 10 dB penalty for noise at night. Analysis of these widely varying results allows a 'dose-response curve' (regression analysis) to be prepared showing the percentage of people highly annoyed versus the level of noise they are exposed to.

In the 1970s, the Schultz curve was developed from a number of studies in general transportation noise (included air, road and rail). Later analysis by Bradley of airport studies indicated that community response is greater than the Schultz curve predicts by a factor of approximately two. The Schultz and Bradley results were used during the preparation of New Zealand Standard NZS 6805.

A comprehensive amalgamation of the various airport noise studies was carried out by Miedema and Oudshoorn in 2001[2] and the dose-response curve from this study has been used internationally and in New Zealand since then.

In 2002, Taylor Baines & Associates and Marshall Day Acoustics conducted a noise annoyance survey in Christchurch. The study was conducted to investigate how the Christchurch community responded to environmental noise when compared to the previous overseas studies (Schultz, Bradley and Miedema).

There have also been a number of international studies that have been undertaken more recently in the 21st century. MDA has recently completed a literature review of 45 of the latest studies. The full report is provided separately and a summary of the 14 most significant studies is included below.

Each study included analysis of a number of different airports. Of the 14 studies:

- 6 reported an increase in noise annoyance over time (FAA, Guski x3, WHO, Janssen and Vos)
- 1 reported a decrease (Vietnam)
- 4 reported no change (Gjestland x 2, Fidell, Gelderblom)
- 3 did not report on a change (NZTA, Brink, Gjestland 2021)

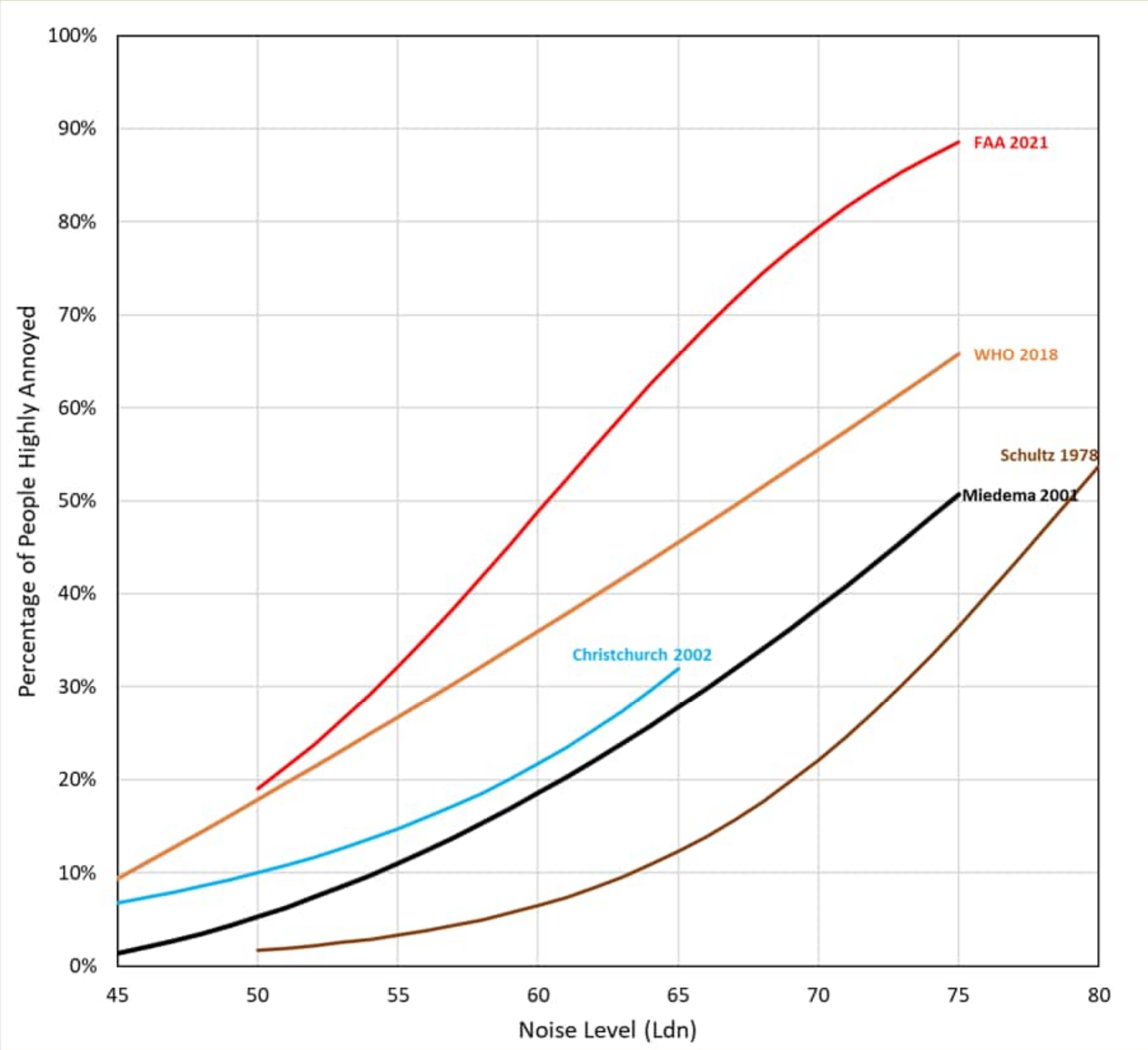
The two largest studies in this set of studies, were the World Health Organisation (WHO) study in 2018 and the Federal Aviation Administration (FAA) study in the US in 2021.

Both of these studies show a significantly higher level of annoyance than the Miedema 2001 dose-response curve. The dose response curves from these studies are shown below in Figure 2 along with the Miedema and 2002 Christchurch study for comparison.

A 'dose-response curve' is the graphed results of the percentage of people highly annoyed versus the noise level ($L_{dn}$/$L_{den}$) they experience.

2 Miedema and Oudshoorn (2001); "Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals"

**Figure 2: Comparison of Studies - Community Response to Aircraft Noise**




The clear conclusion from these recent studies and Figure 2, is that community annoyance from aircraft noise is significantly higher today than the results 20 to 40 years – which were used to develop the recommendations in NZS 6805 and adopted as the basis for airport controls in previous Christchurch District Plans.

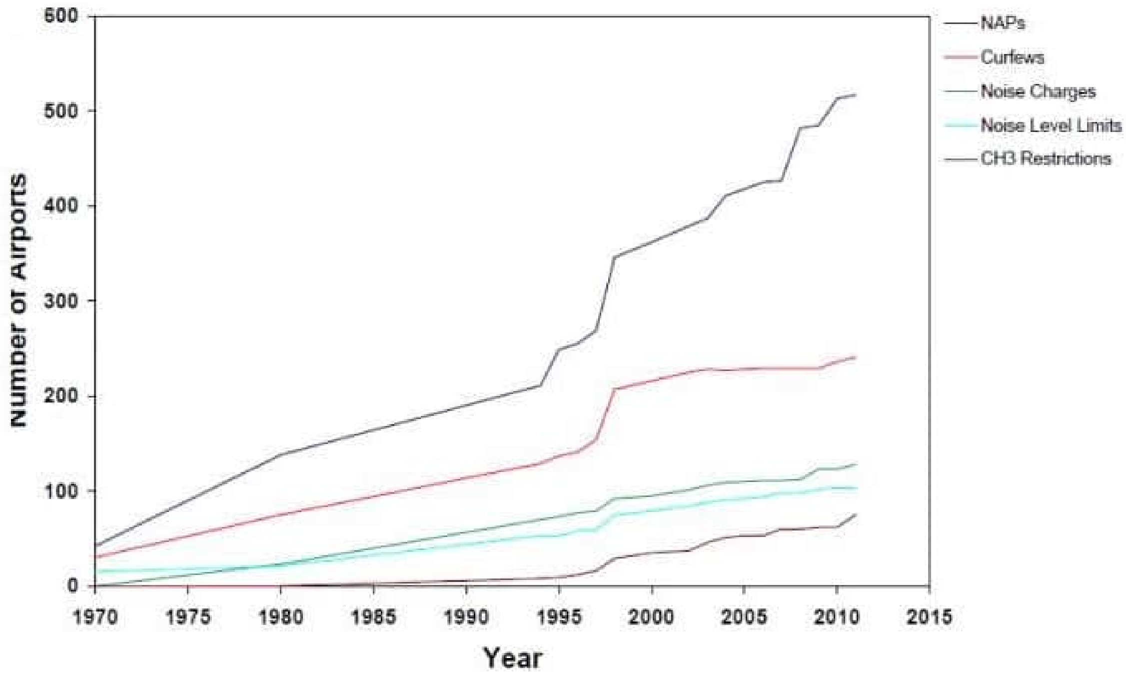
Based on these results it would not be sensible to relax the planning controls to enable residential intensification in closer proximity to the Airport (for example, by setting the OCB to 55 dB $L_{dn}$) when the level of annoyance is trending the other way.

## 5.0 PLANNING CONTROLS AT OTHER AIRPORTS

In the past debates over the 50 dB vs 55 dB issue, it has often been promoted by potential land developers, that other airports do not use 50 dB for planning controls so why should Christchurch. In my opinion this argument has no weight – the fact that other airports have failed to implement adequate planning controls is no reason to repeat the mistake in Christchurch. Other territorial authorities would be delighted to have the low numbers of people adversely affected by aircraft noise as there are in Christchurch.

Other airport authorities would be delighted to have the lack of operational restrictions that Christchurch enjoys due to the foresight of Christchurch planners. A large number of airports have operational restrictions due to noise effects. Figure 3 below shows the significant growth in airport noise restrictions over time.

**Figure 3: Growth in Airport Noise Restrictions (Boeing [3])**




Note: NAP=Noise Abatement Procedures, CH3=Only aircraft with Chapter 3 Noise Certification or quieter can fly

Each airport has individual historic circumstances that give rise to their particular land use planning controls. In many cases 'the horse had already bolted' at the time airport planning regimes were introduced. For example, when NZS 6805 was implemented at Wellington Airport there were existing houses right beside the runway and over 600 houses inside the future 65 dB $L_{dn}$ Airnoise Boundary and many thousands inside 55 dB $L_{dn}$ . This is discussed in more detail below.

Airbiz has recently carried out a review of planning controls and noise restrictions at a number of overseas airports. The next sections of this report, examine the other three 'main' New Zealand airports. Each of the airports, Auckland, Wellington and Queenstown are discussed in detail in Appendices D, E and F respectively and summarised in the next three sections.

## 5.1 Auckland Airport

The noise contours for Auckland International Airport have been based on the noise levels expected from future growth scenarios in 30 to 40 years time.

Auckland Airport is moderately well laid out geographically for the avoidance of aircraft noise effects, in that half the noise contours (the western end) lie over the Manukau Harbour (see Map 14 Appendix D). However, the other half of the contours lie over significant areas of residential land. The size of these contours is such that a large number of residents are exposed to moderate to high levels of aircraft noise – there are 379 houses in the HANA (inside 65 dB $L_{dn}$ ).

There is an Aircraft Noise Notification Area (ANNA) between 55 dB and 60 dB $L_{dn}$ with no planning controls. The land use planning rules at Auckland commence inside 60 dB $L_{dn}$ .

[3] Available online at https://www.boeing.com/resources/boeingdotcom/commercial/noise/restrictions.pdf

Between 60 dB and 65 dB $L_{dn}$ (area known as the MANA[4]) noise sensitive activities are a discretionary activity and there are density controls. Inside the 65 dB $L_{dn}$ (HANA) noise sensitive activities are a prohibited activity.

The reason for these relatively moderate land use controls is that there has been a severe shortage of residential land in Auckland and there are significant areas for new development in these moderate noise areas 55 to 65 dB $L_{dn}$ (the ANNA and MANA).

A community liaison group (the ANCCG) meet on a bi-monthly basis and provides an opportunity for the community to interact with Auckland International Airport Limited and Airways on noise issues. The majority of noise complaints at Auckland come from the relatively low aircraft noise areas – 45 to 55 dB $L_{dn}$.

In 2015, AIAL was involved in a high profile and very expensive exchange with disgruntled residents following the introduction of a new RNP arrival procedure, designed to reduce fuel burn and air emissions. The residents were exposed to relatively low levels of aircraft noise (45 to 50 dB $L_{dn}$).

## 5.2 Wellington International Airport

Wellington International Airport was built in 1959 in the middle of an existing residential area. Since then, it has been compromised in terms of a curfew on airport operations and there are a significant number of people exposed to aircraft noise (660 houses inside the ANB – approximately 1,800 people). See Figure 7 in Appendix E.

NZS 6805 was implemented for Wellington International Airport in the 1990s but with a considerably 'watered down' version of the Standard's land use planning recommendations. The Air Noise Boundary (ANB) is based on the 65 dB $L_{dn}$ noise contour from a projected capacity scenario.

New noise sensitive activities inside the ANB are not 'Prohibited' as recommended by the Standard – they are permitted in residential zones and restricted discretionary in other zones. There is no OCB included in the District Plan and thus no land use controls in the moderate noise areas. The approach taken by the decision makers in Wellington was that 'the horse had already bolted' so what's a few more houses.

Consequently, there have been further increases in the number of people exposed to aircraft noise over the years. Wellington International Airport is an excellent example of how bad land use planning has caused a significant number of people to be exposed to the adverse effects of airport noise and for consequential restrictions on airport operations.

## 5.3 Queenstown Airport

The geographical layout at Queenstown Airport is well suited to the avoidance of aircraft noise except for a small pocket of historically residential land at the Frankton end of the runway (as shown in Figure 8 in Appendix F). Figure 8 also shows the operative noise boundaries for Queenstown.

The Queenstown noise boundaries are largely consistent with NZS 6805, in that an ANB based on the 65 dB $L_{dn}$ contour, and an OCB based on the 55 dB $L_{dn}$ contour have been adopted based on a future growth scenario. There is also an annual 60 dB $L_{dn}$ contour used for mitigation offers, but this is not shown in the District Plan. There are approximately 50 houses inside the ANB at Queenstown.

New residential activity is prohibited inside both the ANB (65 dB $L_{dn}$ ) and OCB (55 dB $L_{dn}$ ) for rural and commercial zones around the airport. However, new noise sensitive activities are not prohibited by the District Plan within the residentially zoned land in the ANB, but new and altered noise sensitive activities are required to be acoustically insulated.

[4] MANA = Moderate Aircraft Noise Area, HANA = High Aircraft Noise Area (see Appendix D)

Due to the close proximity of houses to the runway, night operations are not permitted between 10pm and 6am. Noise is further restricted at Queenstown for practical reasons as the runway and surrounding topography cannot accommodate larger wide-bodied aircraft.

The noise contours for Queenstown Airport have been based on 'projected growth' rather than 'ultimate capacity' since initial implementation in 1994. In practice, the actual growth rates have turned out to be much higher than anticipated in the projections and this has resulted in the contours needing to be expanded through district plan changes. Expanded noise contours were notified in PC35 in 2010 and implemented in 2013 after a protracted series of Environment Court hearings.

In 2018 the noise contours at Queenstown Airport were again approaching the noise boundaries in the District Plan. An updated forecast and noise study projected a 5 dB expansion of the contours. This was put to the community in a series of public consultation meetings and met with significant resistance.

Some affected residents were of the view, "enough is enough, we don't want higher levels of airport noise". There was also a political faction that was of the opinion that 'Queenstown should not grow any further' and they saw the airport noise contours as a tool that could be used to restrict growth in the region. There was also a business faction that was in support of the projected growth.

The QAC have not taken the plan change any further.

## 6.0 GENERAL DISTRICT PLAN NOISE LIMITS

Because other airports have generally not used 50 dB $L_{dn}$ as the onset of land use planning controls, 50 dB $L_{dn}$ may be seen by some as unusual or 'highly conservative'. By way of comparison, however, the operative Christchurch District Plan sets the residential zone noise limits as 50 dB $L_{Aeq}$ daytime and 40 dB $L_{Aeq}$ night-time. Without going into the technical explanation, these controls are effectively the same as 50 dB $L_{dn}$. Most other district councils including Waimakariri and Selwyn Districts, set similar noise limits. This gives an indication of what local Councils view as a reasonable 'receiving noise level' for the protection for residential amenity in the wider Christchurch context.

On this basis, as it is reasonable that residential uses should be protected to a level of 50 dB $L_{dn}$ from general noise sources, it is therefore equally reasonable that residential uses should not be allowed to establish next to an existing noisy activity (such as an airport) at levels higher than 50 dB $L_{dn}$.

It is understood that in the Canterbury Regional Policy Statement and in the Christchurch, Waimakariri and Selwyn District Plans the following activities (broadly) have been classified as 'sensitive activities to aircraft noise' - residential activities, education activities including pre-schools, visitors accommodation and health care facilities.

In our opinion, it is reasonable that all these noise sensitive land uses should be protected to a level of 50 dB $L_{dn}$ from general noise sources as they are in the general district plan noise rules. It is therefore equally reasonable that these same uses should not be allowed to establish next to an existing noisy activity at levels higher than 50 dB $L_{dn}$.

### 6.1 Complaints

It is common at hearings or in planning processes for questions to arise which seek to either draw conclusions based on the number of complaints received – ("But there aren't many complaints at the moment") or to introduce anecdotal evidence from a particular individual experience ("I live in this area and the planes don't bother me").

There are several reasons for the lack of complaints about aircraft operational noise from Christchurch International Airport. Firstly, the historic land use planning has meant that there are relatively few people exposed to aircraft noise in Christchurch. Secondly, people do not complain if they assume their complaints are likely to have no effect. If the airport is operating in its normal mode and they are annoyed, they know nothing can be done about the noise. The Taylor Baines study shows that of the relatively few people exposed to current levels of aircraft noise at Christchurch, there are a number who are 'highly annoyed' but are not complaining during normal airport operations.

However, when the airport changes an operation (flight paths or runway length) then significant complaints can arise. The 2017 trial in Auckland of alternative arrival procedures caused the number of complaints to jump from 2 per month to around 500 per month. These complaints came from a relatively low aircraft noise area.

The comments that "I live in this area and the planes don't bother me", overlook the fact that the noise contours (and thus land use planning) are based on future noise levels – not current noise levels. The number of aircraft movements in the operative Air Noise Contours, are over double the current movements.

## 7.0 SOUND INSULATION

Some advocates for residential development in areas affected by aircraft noise have submitted that sound insulation fitted to proposed dwellings is sufficient on its own to avoid the adverse effect of noise and to protect the interests of the Airport. The argument is understood to be, that sound insulation provides sufficient mitigation, regardless of the population density of the land involved. In our opinion, this assertion, that sound insulation is all that is required to prevent reverse sensitivity effects, is incorrect for several reasons.

Firstly, the level of sound insulation required in the 50 to 60 dB $L_{dn}$ area is provided by a standard house. No additional construction techniques or materials are required in this area. However, 18% to 37% (WHO graph) of the population is still typically highly annoyed by aircraft noise in this environment, even though they have the opportunity to close their windows and achieve 'WHO satisfactory noise levels' inside. This is why sound insulation, on its own, is insufficient and land use controls in the form of density restrictions are the only real form of mitigation available in this case.

Secondly, houses exposed to aircraft noise, are likely to operate with their windows closed to reduce internal noise levels, particularly at night. Three scenarios are then likely:

(i) the windows are kept closed resulting in an unsatisfactory level of fresh air; or

(ii) a ventilation system or air-conditioning system is installed to improve air quality at significant cost; or,

(iii) the windows are left open resulting in an unsatisfactory noise environment.

Each of these scenarios is likely to result in annoyance and possible complaints from the residents. It is interesting to note that residents involved in the Auckland Airport mediation forum were shocked to learn that they would have to shut their windows to achieve an acceptable internal noise environment.

The third difficulty with sound insulation is that it does not deal with the outdoor noise environment. New Zealanders in general, enjoy an 'outdoor' type of lifestyle that includes barbecues and gardening. This is particularly the case in rural and urban fringe areas where people have more outdoor space and an expectation of enjoying it. Again, an unsatisfactory external noise environment is a potential source of residential complaint with demands to reduce noise, affecting airport operations. There has been a history in New Zealand of people moving into lifestyle blocks and complaining about noise from already existing activities within the rural zone e.g. bird scarers in vineyards. Minimising the number of people affected by airport noise by restricting residential development is the most effective form of mitigation available in this case.

As discussed earlier, sound insulation does not solve the problem for hospitals and education facilities as they are heavily reliant on open windows.

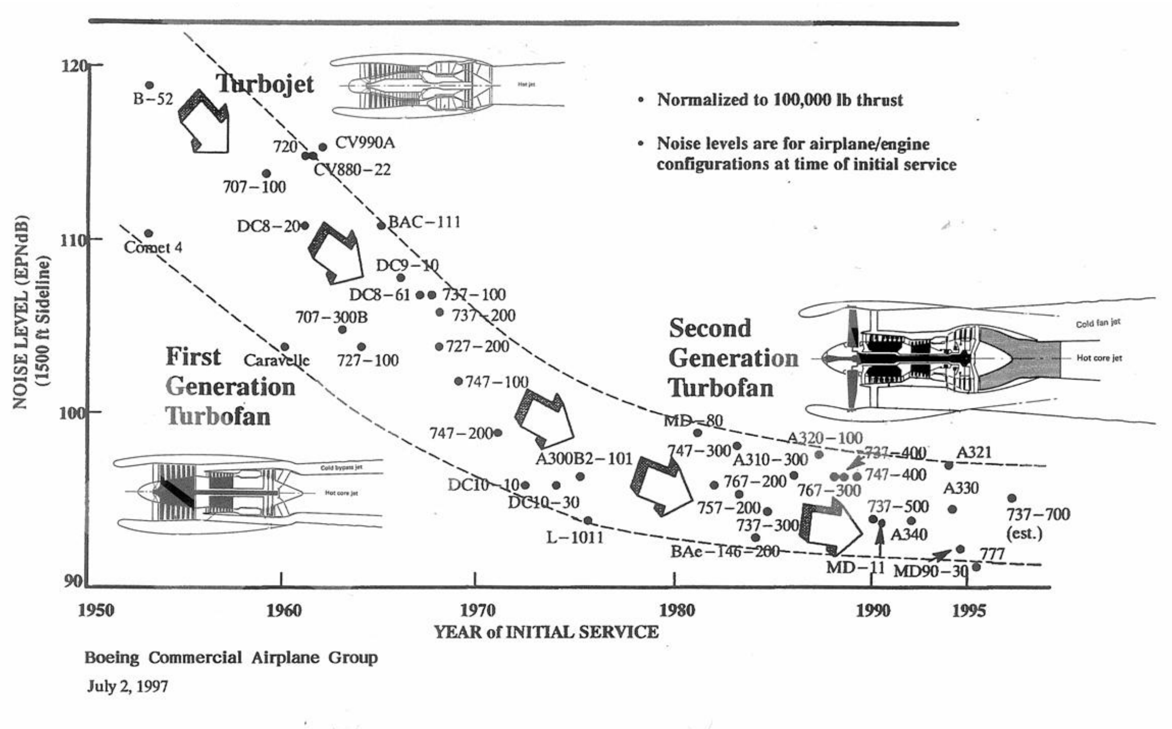
As discussed earlier, the New Zealand Standard refers to sound insulation as a fallback mitigation measure. In my opinion the Standard prefers to 'avoid' the effects of airport noise, ahead of mitigation. Table 2 in the Standard states that new residential inside the OCB "should be prohibited unless a district plan permits such uses, subject to a requirement to incorporate appropriate acoustic insulation."

In my opinion, the issues set out above, highlight why partial mitigation through sound insulation is a much less desirable option to avoiding the effects of airport noise through appropriate land use controls. Section 17 of the Resource Management Act states the duty to "avoid, remedy or mitigate" adverse effects. However, in my opinion, 'avoiding' is the preferable option in this case.

## 8.0 AIRCRAFT NOISE REDUCTION

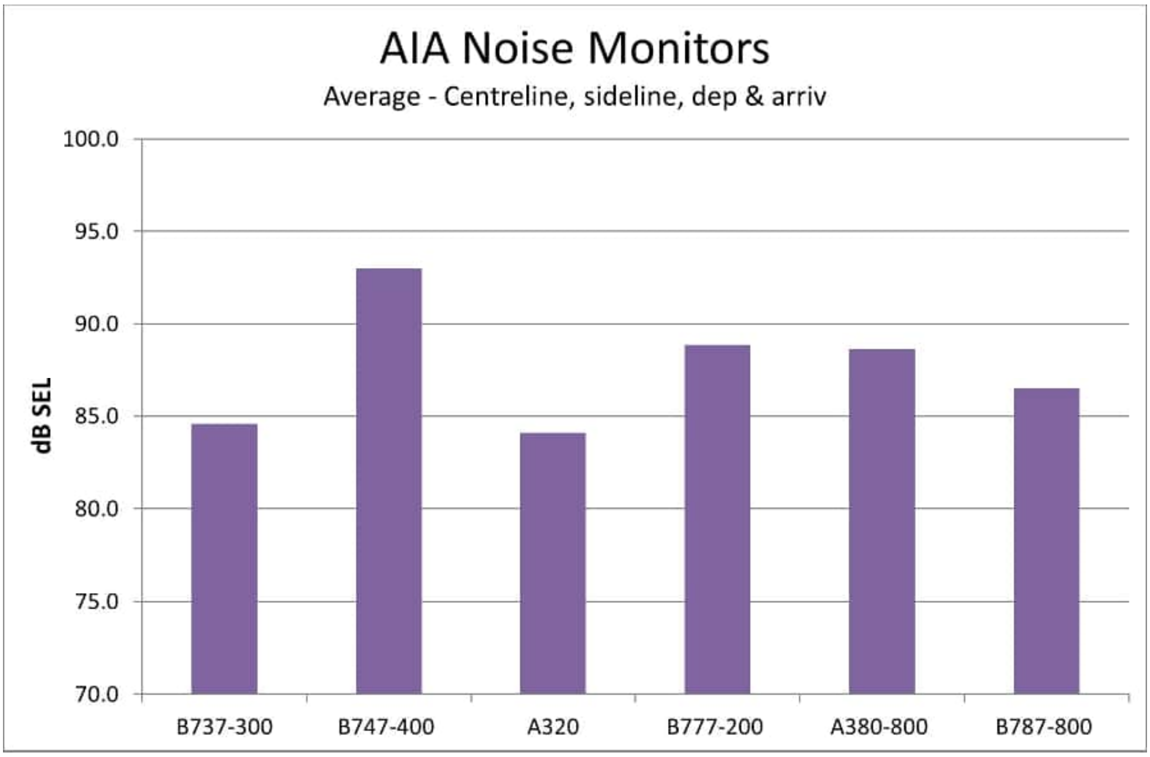
In terms of mitigation, it is worth noting that the airline industry as a whole, has spent billions of dollars mitigating noise from aircraft with the development of 'quiet technology' engines over the last 60 years. Figure 4 below, shows the reduction in noise level for the different aircraft types over time.

**Figure 4 – Progress in Aircraft Noise Reduction**




The data in Figure 4 'finishes' at 1997 and this prompts the question, "what has happened with aircraft noise reduction since 1997?" Analysis of the ongoing noise monitoring at Auckland International Airport shows that the modern aircraft are not as quiet as had been anticipated. Figure 5 below shows the average Sound Exposure Level (SEL) from the analysis of a large number of aircraft movements at 3 permanent monitoring locations at Auckland International Airport.

**Figure 5 – Noise monitoring results from Auckland International Airport**




Note: Sound Exposure Level (SEL) is a measure of the 'noise energy' from individual aircraft flyovers

Figure 5 shows the A380 produces approximately the same noise level as a B777 and the B787 Dreamliner is slightly noisier than the much earlier B737 by approximately 2dB – contrary to the general trend.

These newer aircraft do carry more passengers for similar noise output but the Auckland measurements confirm the noise levels from modern aircraft are not much different to 1990s aircraft ie. the 'curve' shown in Figure 4 above has flattened out over the last 30 years.

It is interesting to note that despite this very significant aircraft noise reduction achieved over 60 years, that during this time there has been a significant increase in the noise restrictions placed on airports and flight procedures as shown in Figure 3 above. There is a steeper increase in noise restrictions from 1995 onwards – the period aircraft noise output seems to have flattened and airports have kept growing (apart from 2020 to 2022).

Over this time, the increase in airport noise due to growth in airport operations has generally outstripped or matched the noise reduction achieved on individual aircraft.

# APPENDIX A GLOSSARY OF TERMINOLOGY

| | |
|---|---|
| ANB | Air Noise Boundary.<br>Noise control boundary used to control aircraft noise and land use with a limit of 65 dB $L_{dn}$ |
| OCB | Outer Control Boundary<br>Noise control boundary used to control aircraft noise and land use with a limit of 55 dB $L_{dn}$ |
| dB | Decibel<br>The unit of sound level.<br>Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 µPa i.e. dB = 20 x log(P/Pr) |
| A-weighting | The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. |
| $L_{Aeq(t)}$ | The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level.<br>The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am. |
| $L_{Amax}$ | The A-weighted maximum noise level. The highest noise level which occurs during the measurement period. |
| $L_{dn}$ | The A-weighted day night noise level which is calculated from the 24 hour $L_{Aeq}$ with a 10 dB penalty applied to the night-time (2200-0700 hours) $L_{Aeq}$. $L_{dn}$ is a measure of the cumulative noise exposure over time. |
| SEL or $L_{AE}$ | Sound Exposure Level<br>The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover. |
| NZS 6805:1992 | New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"* |
| NOR | Notice of Requirement |
| APU | Auxiliary Power Unit – Component of a aircraft used to generate power for essential systems when main engines are not operating |
| GPU | Ground Power Unit – Land based power supply for aircraft essential systems while parked and not running the APU |
| Noise dose-response curve | A dose–response relationship is the magnitude of the response (in this case annoyance) of a person to a certain dose of a stimulus or stressor (in this case noise).<br>Dose–response relationships can be described by dose–response curves. Dose-response curves are created by graphing the magnitude of the response (level of annoyance) for each individual against the dose (noise level) and performing a statistical analysis on this data to create a single dose-response curve for the population. |

## APPENDIX B WAIMAIRI DISTRICT PLAN 1988



SPECIAL PROVISIONS

PART ONE: CHRISTCHURCH INTERNATIONAL AIRPORT NOISE EXPOSURE LINE

INTRODUCTION

The Christchurch International Airport, although in Paparua County is located close to the Waimairi boundary. The airport, as well as being a considerable traffic generator and a local employment source, places restraints on activities in the District because of height and safety requirements and the noise associated with aircraft operations. The height and safety requirements are catered for in the Scheme by designation .

In 1975 the Council introduced Change No. 10 to the previous Scheme. That Change rezoned to Rural A, land within a calculated noise control line, and endeavoured to control possible conflict between Airport related activities and residents in the vicinity by making dwelling-houses including the rebuilding of existing dwellinghouses, a conditional use with requirements for noise insulation. Following a reappraisal of the controls proposed by Change No. 10 in 1980, revised provisions were introduced as part of a major review of rural zoning. (Change No.27)

The noise exposure line provisions in this Scheme are similar to those included in Change No. 27 except that the line has been adjusted in some places and also now includes some properties within the urban area previously excluded (Change No. 27 dealt only with the Rural area.) It is also noted that with extensions being carried out to the main runway there may be changes in aircraft noise patterns. Any necessary further revision of the noise exposure line will be introduced by variation or change to the scheme.

The controls associated with the noise exposure line are provided both to protect residents living in the vicinity of the airport from airport related noise and also to protect the airport from complaints about noise from residents which if sustained could lead to constraints upon airport operations (eg. night time curfews). The importance and economic benefit of Christchurch International Airport, not only to Waimairi District but to the Canterbury Region and beyond, is recognised by the Scheme.

SPECIAL PROVISIONS

Refer to definitions of RESIDENTIAL BUILDING, HABITABLE ROOM - SECTION THREE - DEFINITIONS.

The Airport noise exposure requirements of this Scheme are based on revised noise control lines which relate to actual flight paths and a larger number of recorded noise levels rather than the largely theoretical model on which the previous Rural A boundary had been based. The basic measure now used is the Day-Night Level (LDN). The contour line at which it is considered sound attenuation requirements should be imposed for residential buildings is the 50 LDN line, the location of which was determined by the Department of Scientific and Industrial Research and reported to the Christchurch Airport Authority in "Christchurch International Airport Noise" - July 10, 1978. The "The Christchurch International Airport Noise Exposure Line " is shown on the planning maps and generally follows the D.S.I.R. line with some adjustment for property boundaries and also takes into account the north west (29 - 11) runway, which was not subject to D.S.I.R. measurement. Although this runway is used less frequently than the main runway (20 - 02) (i.e. 5 - 8% of occasions per year) there is nevertheless a significant noise problem of ground testing of engines. This suggests the need for insulation of residential buildings in the vicinity.

It is not intended that the controls within the noise exposure line should be applied in an arbitrary manner. There will be circumstances varying for each site which will greatly affect the extent of external noise levels due to such things as local characteristics, angle of incidence of aircraft and tree planting. The noise exposure line will therefore be used as a basis for determining those sites in the District where it is expected that noise insulation will be required. By taking noise level readings at each proposed site, their amount of attenuation required can be determined and techniques for achieving it (eg. orientation of the building, internal layout, materials to be used, form and standard of construction), recommended. It is intended through these means that the indoor design sound level (i.e. the maximum noise level from an aircraft flyover, heard inside the building) should not exceed 55 dBA for habitable rooms other than kitchens and 65 dBA for other rooms in respect of normal aircraft movements to and from the Christchurch Airport. These levels, which are those recommended by the Standards Association of Australia (AS 2021 - 1977) are considered to be the maximum noise levels which will be judged by the average listener as not excessively intrusive or annoying. Because of the variability of the subjective responses to aircraft noise, however, these figures may not provide sufficiently low interior noise levels for occupants who have a particular sensitivity to aircraft noise.

## 1. SPECIAL PROVISIONS: AIRPORT NOISE EXPOSURE AREA

### 1.1 PRE-CONDITION

This ordinance shall apply to every site located between the Christchurch International Airport Noise Exposure Line, as notated on the planning map and the boundary of the District with that of the Paparua and Eyre Counties to the west.

### 1.2 REQUIREMENTS FOR RESIDENTIAL BUILDINGS

1.2.1 In addition to any requirements of the zone in which the site is located, building design, construction and insulation of residential buildings shall be such that the maximum indoor design sound level due to aircraft noise for habitable rooms other than kitchens shall not exceed 55 dBA and for other rooms 65 dBA. The New Zealand Standard N.Z.S.6801:1977 ("Methods of Measuring Noise") and N.Z.S. 6802 ("Assessment of Noise in the Environment") shall be followed in regard to noise measurement, correction, interpretation and assessment.

1.2.2 Prior to any consent being given to erect the residential building, noise level measurements shall be monitored at the site by the Council to determine the attenuation required. The applicant shall submit calculations and design details prepared by a Registered Engineer with expertise in acoustics as to how the required attenuation is to be achieved, including such of the following matters as are considered necessary by the Registered Engineer in the circumstances.

(a) Orientation of the building.

(b) Internal room layout of the building and location of windows and external doors.

(c) Materials to be used in construction, including their accoustic ratings.

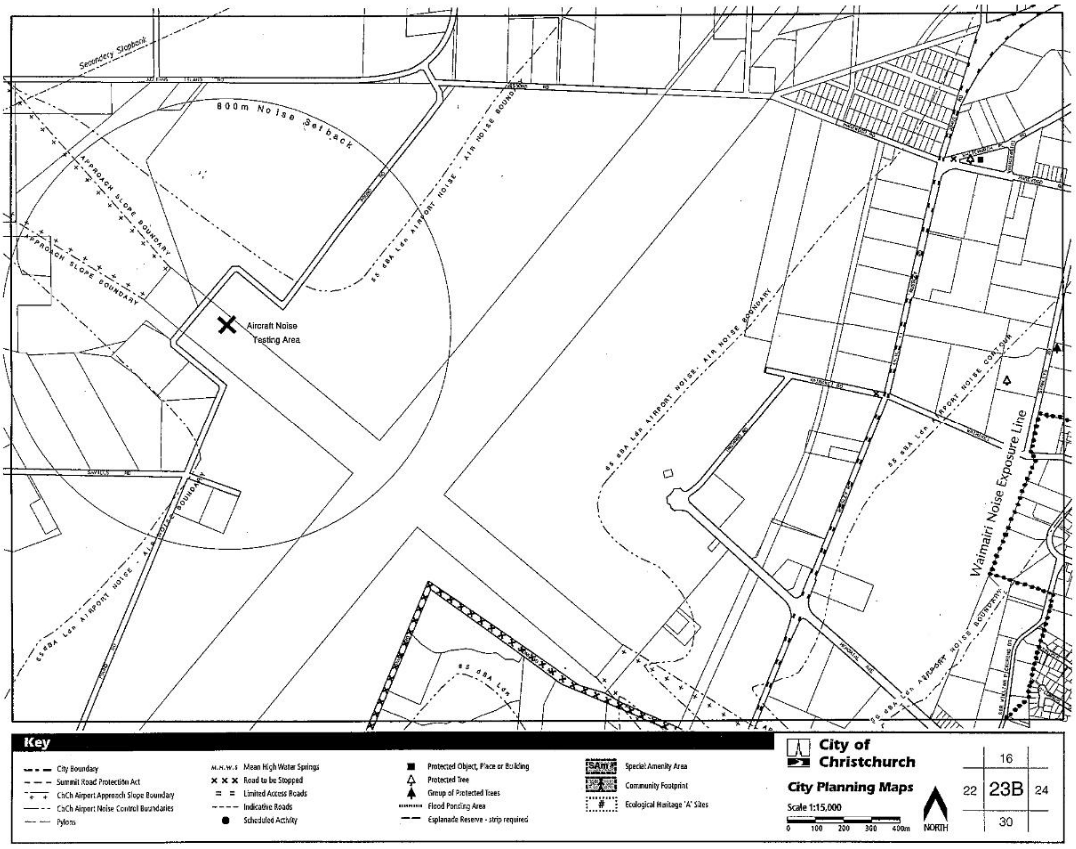
(d) Form of construction.

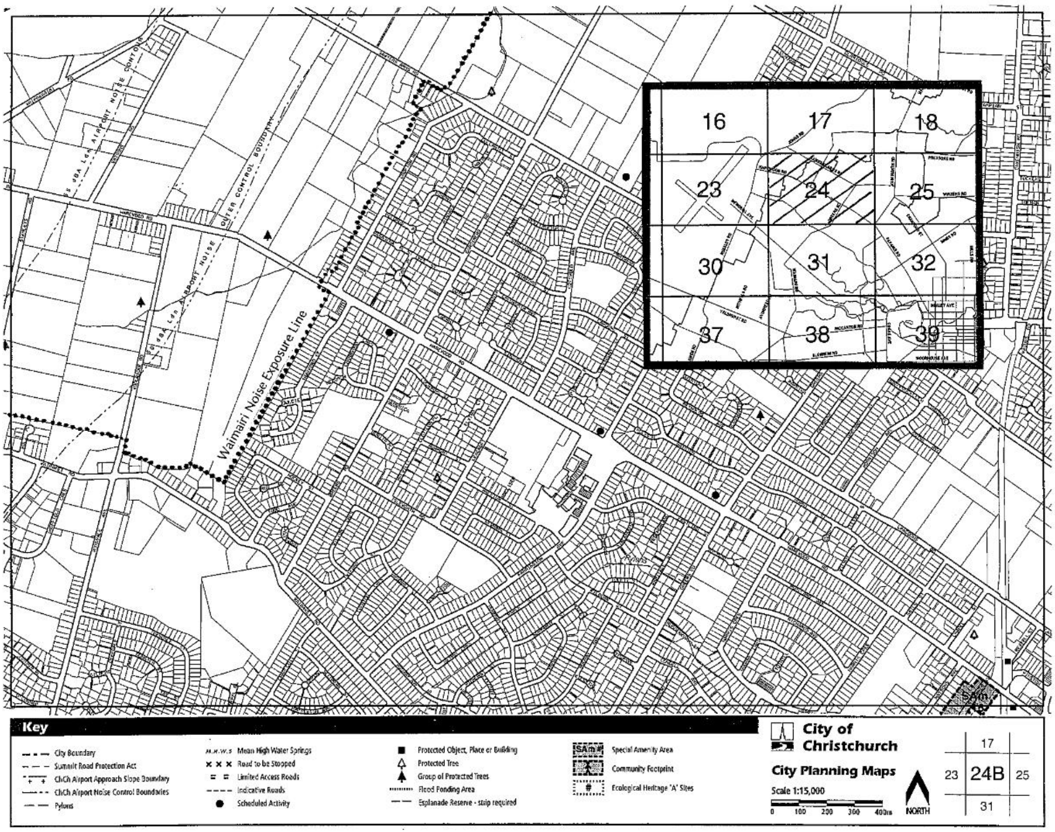
(e) Maximum window area to exterior wall area ratios.

(f) Installation of fixed-closed windows and/or double glazing.

1.2.3 Where the circumstances indicate that close supervision of the erection of the building is required in order to achieve the necessary insulation, a registered Clerk of Works or similar approved person shall supervise the erection and issue of a Certificate of Compliance that the conditions of the Council relating to noise attenuation have been satisfied.

## APPENDIX C 1975 NOISE EXPOSURE LINE VS 50 DB $L_{DN}$ OUTER CONTROL BOUNDARY (1995)



# APPENDIX D AUCKLAND INTERNATIONAL AIRPORT

## Airport Noise Boundaries/Contours

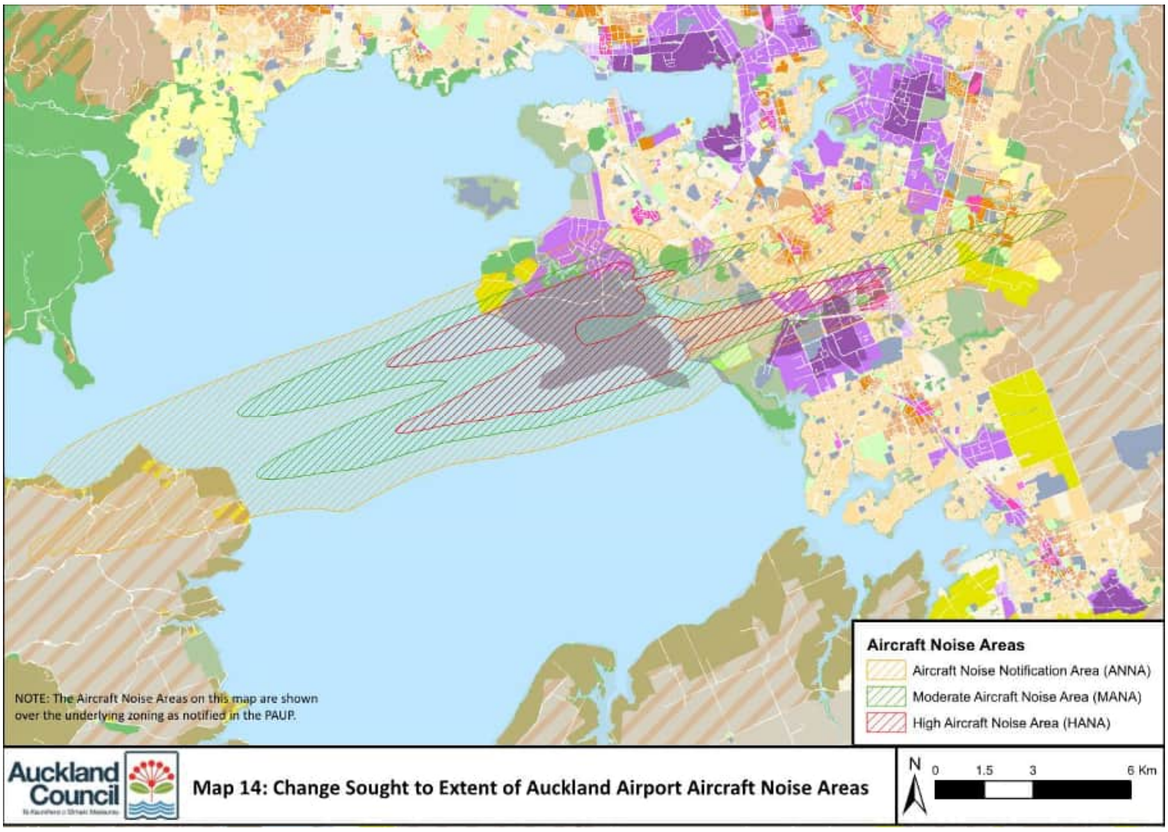
The noise contours for Auckland International Airport (AIA) are different to other airports in that 'Aircraft Noise Areas' are used which are defined by noise contours. AIA has three aircraft noise areas based on future predicted levels of aircraft noise as follows:

- The 'Aircraft Noise Notification Area' (ANNA) – 55 to 60 dB $L_{dn}$
- The 'Moderate Aircraft Noise Area' (MANA) – 60 to 65 dB $L_{dn}$
- The 'High Aircraft Noise Area' (HANA) - >65 dB $L_{dn}$

The operative noise contours represent noise in the year 2044 and include noise from a second parallel runway to the north which was previously envisaged to be built by 2028.

Auckland Airport is moderately well laid out geographically for the avoidance of aircraft noise effects, in that half the noise contours (the western end) lie over the Manukau Harbour (Map 14 below). The other half of the contours lie over significant areas of residential land. The size of these contours is such that a large number of residents are exposed to moderate to high levels of aircraft noise – there are 379 houses in the HANA (inside 65 dB $L_{dn}$ ).

**Figure 5 – Auckland International Airport – Aircraft Noise Areas (Boundaries)**




## Land Use Controls

The activity status for Activities Sensitive to Aircraft Noise (ASAN) within the noise contours are contained in Chapter D24 of the Auckland Unitary Plan and are copied below. All new ASAN or additions/alterations to existing ASAN in the MANA and HANA must be designed to meet an internal noise level of 40 dB $L_{dn}$ - see rule D24.6.3.

Development of new dwellings and other ASAN's (schools, hospitals etc) in the HANA is prohibited. For new tertiary education facilities in the HANA the activity status is non-complying.

Additions/alterations to an existing dwelling in the HAHA are restricted discretionary with additions/alterations of other ASAN's (schools, hospitals etc) being non-complying.

In the MANA the controls are more relaxed. New dwellings meeting the minimum density requirements are permitted. If they do not meet these requirements, they are restricted discretionary. New ASAN's (excluding dwellings) are discretionary.

Alterations/additions to an existing dwellings in the MANA are permitted. Alterations/additions to an existing ASAN (excluding dwellings) are restricted discretionary.

There are no land use planning controls in the ANNA – it is a noise advisory area only.

**Table 1 – Activity Status within the Aircraft Noise Areas**

| **HANA - High Aircraft Noise Area (>65 dB $L_{dn}$)** | |
|---|---|
| New ASAN's<br>(excludes tertiary ed) | Prohibited |
| New tertiary education facilities | Non-complying |
| Additions or alterations to existing dwellings | Restricted discretionary |
| Additional or alterations to existing ASAN's<br>(excludes dwellings) | Non-complying |
| **MANA - Moderate Aircraft Noise Area (60-65 dB $L_{dn}$)** | |
| New dwellings in a residential zone where:<br>• Density doesn't exceed 400 $m^2$<br>• Maximum density control in Flat bush precinct are complied with (range from 150 – 400 $m^2$) | Permitted |
| New dwellings in a residential zone where:<br>• Density exceeds 400 $m^2$<br>• Maximum density control in Flat bush precinct is not complied with (range from 150 – 400 $m^2$) | Restricted discretionary |
| New ASAN's<br>(excludes dwellings) | Discretionary |
| Additional or alterations to an existing dwelling | Permitted |
| Additional or alterations to an existing ASAN<br>(excludes dwellings) | Restricted discretionary |
| **ANNA - Aircraft Noise Notification Area** | |
| No controls – noise advisory area only | |

Note; "Activities Sensitive to Aircraft Noise" or "ASAN" means any dwellings, boarding houses, tertiary education facilities, marae, integrated residential development, papakainga, retirement village, supported residential care, educational facilities, care centres, hospitals and healthcare facilities with an overnight stay facility.

## Noise Control Rules and Abatement Procedures

### *Auckland Airport Designation 1100*

Auckland Airport Designation 1100 sets out noise performance criteria and noise management obligations for the Airport to comply with.

**Condition 5(d)** of Designation 1100 requires AIAL to undertake the following:

- Monitor noise from aircraft operations near the boundary of the High Aircraft Noise Area (HANA) to demonstrate that the Day/Night level of 65 dB $L_{dn}$ is not exceeded outside the HANA
- Use recognised noise modelling software and noise monitoring data to calculate whether the noise from aircraft operations exceeds 60 dB $L_{dn}$ anywhere outside the Moderate Aircraft Noise Area (MANA)

Noise from aircraft operations is monitored continuously by noise loggers at three locations near the boundary of the HANA (65 dB $L_{dn}$ ). Several other noise loggers are located in residential areas further away from the airport.

Approximately 4 years ago, modifications to operations on a particular RNP arrival track was required to ensure the Airport remained in compliance with these two rules.

**Condition 4** prevents aircraft from departing to and arriving from the east on the future northern runway between 10pm – 7am. This is colloquially known as “No night flights over Papatoetoe”. This is to protect people living under the new flight path in South Auckland from sleep disturbance effects.

**Condition 6** puts an interim noise limit on noise from the northern runway to not exceed 58.5 dB at the intersection of the Northern Runway centreline and State Highway 20, and at the southernmost part of Naylors Drive in the first five years of opening. This is to protect residents from large-scale changes in noise levels when then northern runway opens.

**Condition 10** requires the Airport to offer acoustic mitigation to houses located inside the 60 and 65 dB $L_{dn}$ Annual Aircraft Noise Contour (AANC). This contour is calculated annually and represents noise levels for the forthcoming year based on growth predicted by the Airport.

The airport must provide mitigation to ensure that noise levels inside the dwelling do not exceed 40 dB $L_{dn}$ and. This includes installation of a mechanical ventilation system to ensure ventilation with windows closed. The airport must pay for 100% of the cost of this mitigation for people living within the HANA and 75% of the cost for people living in the MANA.

The airport must also provide mitigation for preschools and schools within the 65 and 65 dB $L_{dn}$ AANC also and ensure aircraft noise is kept below 40 dB $L_{dn}$ inside.

### *CAA Part 93 Noise Abatement Procedures*

CAA Part 93 outlines a series of general noise abatement procedures for aircraft taking off and landing. The departure procedures are standard ‘cut-back’ procedures used at most New Zealand airports. The approach procedures are as follows:

**93.61 Approach noise abatement procedures**

(a) Each pilot-in-command of a turbo-jet or turbo-fan powered aeroplane arriving from north of the extended runway centre line and intending to land on runway 23 shall, unless otherwise instructed by ATC—

(1) when on a visual approach, intercept the extended runway centre line at a height not below 2000 feet QNH; and

(2) between the hours of 2300 and 0600 local time, intercept the extended runway centre line at a distance of not less that 14 nm from the runway threshold and at an altitude of not less than 4000 feet QNH.

(b) Each pilot-in-command of a turbo-jet or turbo-fan powered aeroplane conducting a right hand aerodrome traffic circuit for runway 23 shall not turn onto the final approach path at a distance of less than 4 nm from the runway threshold.

**93.63 Noise abatement area**

Except when operating in accordance with an instrument approach procedure, or being radar vectored by ATC, or during take-off climb, or during a visual approach to runway 23, a pilot-in-command of a turbo-jet or turbo-fan powered aeroplane shall not operate over the Auckland noise abatement areas specified in Appendix A at an altitude of less than 5000 feet QNH.

Clause 93.65 requires pilots to land and take=off over the harbour when possible:

**93.65 Noise abatement procedures: use of runway**

Each pilot-in-command of a turbo-jet or turbo-fan powered aeroplane shall, between the hours of 2300 and 0600 local time, use runway 23 for take-off and runway 05 for landing unless—

(1) the tailwind component is more than 5 knots; or

(2) compliance with the aeroplane performance operating limitations requires the use of the other runway direction; or

(3) otherwise instructed by ATC.

*Aircraft Noise Community Consultative Group (ANCCG)*

The ANCCG meet on a bi-monthly basis and provides an opportunity for the community to interact with the Airport and Airways on noise issues.

A recent issue has involved an alternative navigation point for aircraft arriving at night. This involves residents at low levels of noise exposure, nevertheless concerned about night arrivals.

## APPENDIX E WELLINGTON INTERNATIONAL AIRPORT

Wellington Airport is not well laid out geographically for the avoidance of noise effects on residents. The Airport (originally known as Rongotai) was built in 1959 in a residential area with large areas of housing immediately adjacent to the runway as shown in the photograph below.

**Figure 6 – The Construction of Rongotai Airport 1959 (photo by Whites Aviation)**

As a result of this close proximity (land use conflict) a curfew had to be implemented to reduce the night-time effects of noise on the residents.

Wellington International Airport was the first airport in New Zealand where the New Zealand Standard NZS6805 was implemented. The decision makers at the time decided to modify the recommendations in NZS6805 significantly because there were so many houses already inside the noise contours (660 inside the ANB) – 'the horse had already bolted'.

The main differences that set Wellington Airport's noise management framework apart from airports like Auckland and Christchurch, are:

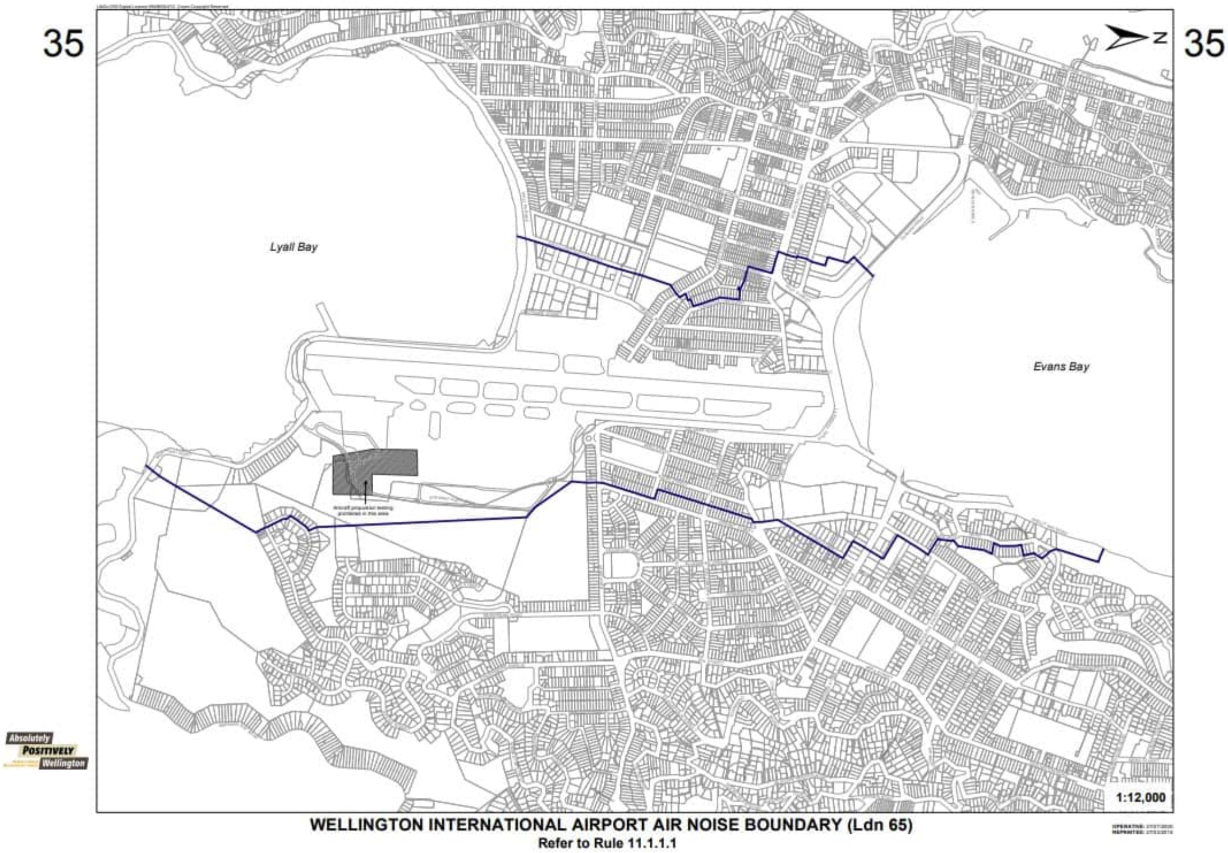
- Wellington operates with a partial night-time curfew, and
- the District Plan only controls land use inside the Air Noise Boundary (ANB) - there is no Outer Control Boundary shown in the District Plan for Wellington Airport.

The Wellington Airport Air Noise Boundary (ANB)is based on a predicted future level of 65 dB $L_{dn}$.

The ANB was prepared in the late 1990's and represents what was considered at the time to be the long-term future operational capacity of the airport. The ANB has been cadastralised around property boundaries to simplify planning procedures.

Figure 7 below shows the ANB in blue and there are a very large number of houses that are affected by aircraft noise at Wellington.

**Figure 7 – Wellington International Airport – Air Noise Boundary**
(Map 35 from the Wellington City Council District Plan)




The current planning framework for Wellington Airport sits within the District Plan zone rules. Wellington City Council recently approved a Notice of Requirement for an Airport designation however this is currently under appeal.

### Land Use Controls

The decision makers at Wellington decided not to follow the recommendations in NZS6805 and residential activity is not prohibited by the District Plan within the ANB - it is permitted in existing residential zones and restricted discretionary in other zones. New and altered noise sensitive activities are required to be acoustically insulated.

The land use restrictions for activities sensitive to aircraft noise inside the ANB were strengthened through District Plan Changes 72 and 73 following the outcome of the LUMIN Study which found that stronger controls were appropriate to curb residential intensification in this high noise environment. The changes, which became operative in November 2014, include strengthening the acoustic insulation requirements for new and altered noise sensitive activities within the ANB. Nonetheless, new noise sensitive development continues to be permitted inside the ANB in the residential zone.

### Noise Controls

Aircraft noise at Wellington Airport is currently controlled by rules in Chapter 11A of the Operative Wellington City District Plan (the District Plan). These rules have been operative since 2000.

The noise controls for Wellington Airport are based on the NZS 6805:1992 approach, although there is just an ANB and no OCB at Wellington. In summary, noise from aircraft operations (arrivals, departures and taxiing) is controlled by a 65 dB $L_{dn}$ noise limit at the ANB which is defined on Map 35 of the planning maps. The ANB also restricts military operations to a maximum of 55 dB $L_{dn}$ at the ANB, however government flights and emergency services are exempt.

In addition to the $L_{dn}$ limit (which includes a night penalty), operations at Wellington Airport are restricted by a partial night-time curfew as follows:

- Domestic operations must not occur during the hours from midnight to 6am.
- International operations must not occur during the hours of midnight to 6am for departures and 1am to 6am for arrivals.

Some exceptions apply that enable the operating hours to be extended in certain situations.

Noise from aircraft operations is measured continuously by noise loggers at three locations near the Air Noise Boundary.

### Airport Funded Noise Mitigation

There are no airport funded noise mitigation programme requirements in the District Plan. However, the Environment Court required Wellington Airport to undertake a study to determine whether such mitigation was appropriate. In response the Land Use Management and Insulation for Airport Noise Study ("LUMINS") was carried out by the Wellington Airport Air Noise Management Committee and was completed in 2009. The purpose of LUMINS was to determine the future management of land use and acoustic insulation for the properties within the ANB.

The study involved an in-depth assessment of the effects of aircraft noise on residents. This led to consideration of mitigation options such as acoustic insulation for existing houses and more stringent land use controls for new noise sensitive activities within the ANB. Recommendations from the study have been implemented through changes to the District Plan to restrict intensification of noise sensitive activities inside the ANB. Furthermore, an acoustic mitigation programme "Quieter Homes" has been implemented to retro-fit acoustic insulation and ventilation to existing dwellings inside the ANB.

## APPENDIX F QUEENSTOWN AIRPORT

Noise boundaries for Queenstown Airport are contained in the Queenstown Lakes District Plan. These are largely consistent with NZS 6805, in that an ANB based on the 65 dB $L_{dn}$ contour, and an OCB based on the 55 dB $L_{dn}$ contour (future operations) have been adopted. There is also an annual 60 dB $L_{dn}$ contour used for mitigation offers, but this is not shown in the District Plan.

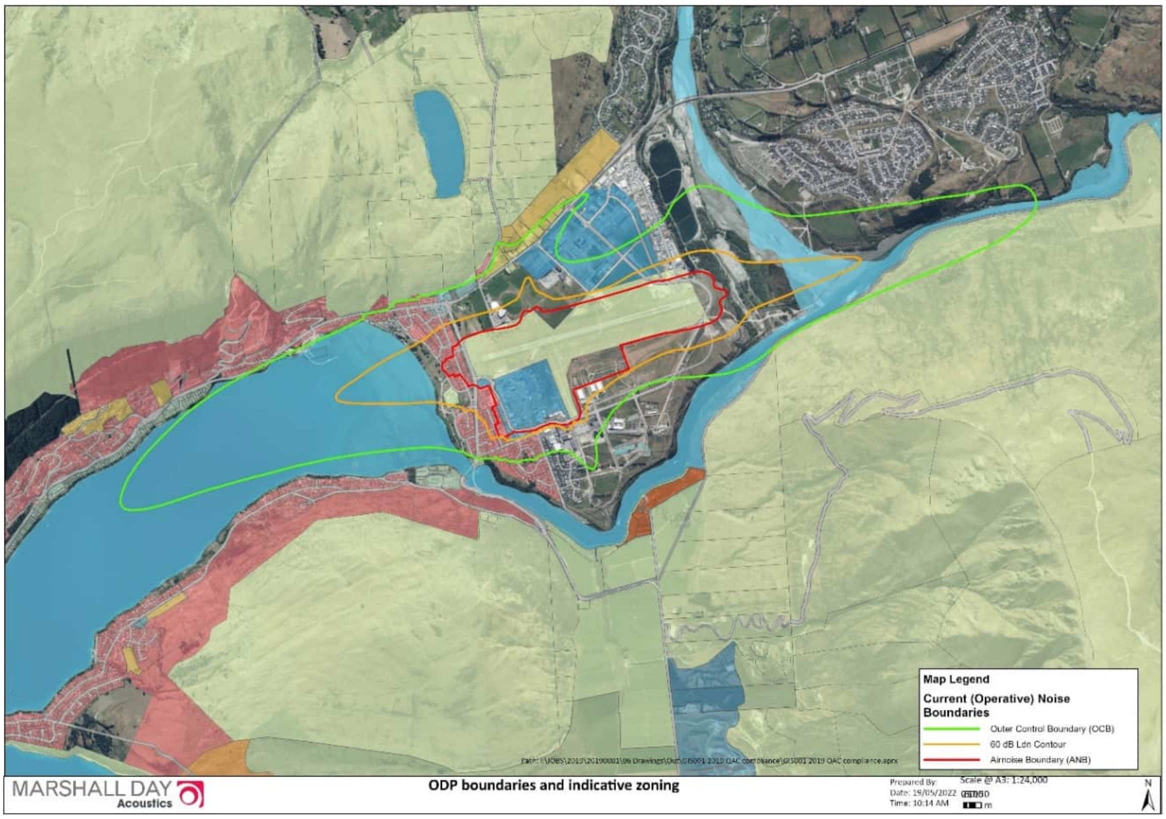
The noise boundaries have all been cadastralised around small lot residential property boundaries, but not large lot boundaries. The ANB also accounts for the possible relocation of general aviation activity to other parts of the airfield.

The ANB was implemented in 2013 and represents what was considered at the time to be a 25 year projection of future activity at the airport.

The geographical layout at Queenstown Airport is well suited to the avoidance of aircraft noise except for a small pocket of historical residential land at the Frankton end of the runway (as shown in Figure 8 below). Figure 8 also shows the operative noise boundaries for Queenstown.

These boundaries are largely consistent with NZS 6805, in that an ANB based on the 65 dB $L_{dn}$ contour, and an OCB based on the 55 dB $L_{dn}$ contour (future operations) have been adopted. There is also an annual 60 dB $L_{dn}$ contour used for mitigation offers, but this is not shown in the District Plan – it is calculated on annual basis.

**Figure 8 – Queenstown Air Noise Boundaries - QLDC Operative District Plan**




The noise contours for Queenstown Airport have been based on 'projected growth' rather than 'ultimate capacity' since initial implementation in 1994. In practice, the actual growth rates have turned out to be much higher than anticipated in the projections and this has resulted in the contours needing to be expanded through district plan changes. Expanded noise contours were notified in PC35 in 2010 and implemented in 2013 after a protracted series of Environment Court hearings.

In 2018 the noise contours at Queenstown Airport were again approaching the noise boundaries in the District Plan. An updated forecast and noise study projected a 5 dB expansion of the contours. This was put to the community in a series of public consultation meetings and met with significant resistance.

Some affected residents were of the view, “enough is enough, we don’t want higher levels of airport noise”. There was also a political faction that was of the opinion that ‘Queenstown should not grow any further’ and they saw the airport noise contours as a tool that could be used to restrict growth in the region. There was also a business faction that was in support of the projected growth.

The QAC have not taken the plan change any further.

### Land Use Controls

There are many houses in close proximity to one runway end and therefore a number of existing houses are inside the noise boundaries. As such, residential activity is not prohibited by the District Plan within the residentially zoned land in the ANB, but new and altered noise sensitive activities are required to be acoustically insulated.

However, new residential activity is prohibited in both the ANB and OCB (55 dB $L_{dn}$ ) for rural and commercial zones around the airport.

The adoption of the larger noise boundaries in 2013 included strengthening the associated acoustic insulation requirements for new and altered noise sensitive activities within the ANB.

### Aircraft Noise Controls

Aircraft noise is controlled by rules in Designation D1.

The noise controls are based on the NZS 6805:1992 approach. In summary, noise from aircraft operations is controlled by a 65 dB $L_{dn}$ noise limit at the ANB and a 55 dB $L_{dn}$ noise limit at the OCB which is defined on Map 31a of the planning maps. Compliance with these limits needs to be demonstrated every year and is based on annual noise modelling.

Part of the compliance obligations involve adjusting the noise model used to prepare the annual compliance contours to account for on-site measurement results to improve accuracy.

To achieve this, the rules require noise from aircraft operations to be measured every 2 years in several positions, and both in summer and winter. Locations for measurements are agreed with the airport community liaison group. The results are used to adjust the noise model where necessary.

Prior to Covid 19, the 2019 compliance contours were getting close to the District Plan noise limits.

In addition to the $L_{dn}$ limit, night operations are restricted in that aircraft are not permitted to fly between 10pm and 6am. Noise is further restricted at Queenstown for practical reasons as the runway and surrounding topography cannot accommodate the larger wide-bodied aircraft.

### Airport Funded Noise Mitigation

An airport funded noise mitigation programme is required in the District Plan. The airport is required to offer full mitigation to houses inside the ANB so that satisfactory internal noise levels can be achieved. Similar to the Auckland procedures, this occurs only when airport noise received at a house is likely to exceed 65 dB $L_{dn}$ in the following year. This is determined each year using the compliance contours, with an annual growth allowance added on. The treatment packages and full design and installation costs are covered by the airport.

The airport is also required to part fund a ventilation system for all properties inside the 60 dB $L_{dn}$ boundary.

# Appendix 17

Airport Contour s77K Appendix Seven: Caselaw extracts

## Appendix Five – Caselaw extracts

This Appendix provides extracts from relevant case law in which the Environment Court was required to consider land use planning rules under Air Noise Contours, and gave specific consideration to the importance of density controls.

| CASE NAME | BACKGROUND | RELEVANT EXTRACTS |
|---|---|---|
| *BD Gargiulo v Christchurch CC,* C 137/2000, 17 August 2000, Jackson J (EnvC) | Appeal against Christchurch City Council's refusal to grant a subdivision and land use consent over land which was within the 50dBA Ldn noise contour.<br><br>The Environment Court declined the appeal as the proposed plan implements a coherent pattern of objectives and policies which is consistent with the RPS in protecting the airport. The applicant's aspirations were outweighed by the public benefit of protecting the airport. | "[31] … We draw two conclusions from this uncontroverted evidence:<br><br>(a) There is a 10% chance that whoever lives on Lot 1 of Mr Gargiulo's subdivision will be highly annoyed by noise of aircraft movements (quite apart from other noise from the airport); and<br><br>(b) Moving the house on Lot 1 to the back will not change (a); nor will it mitigate the annoyance outside the house."<br><br>"[51] … All we can say here is that different objectives and policies in a district plan should be given different weights. Some should, under some plans, be given so much weight that they come close to prohibited activities (while always leaving it open for exceptional cases). We find that is the position here: the cumulative effect of the objectives and policies we have quoted show that the density provisions of the proposed plan should be given considerable weight."<br><br>"[63]… In any event on the facts of this case we find that **the density of dwellings (which is controlled by subdivision size) is so important around the Christchurch International Airport that it is a dominating factor in terms of weight.**" |

| | | |
|---|---|---|
| *Robinsons Bay Trust & Ors v Christchurch CC,* C 60/2004, 13 May 2004, Smith J (EnvC) (*Interim decision*) | Decision on how much land (either land within the 50dBA contour line or 55dBA contour line) should be covered by a policy in the proposed Christchurch City Plan restraining noise sensitive urban development.<br><br>The Environment Court concluded that the 50dBA Ldn line would be better for inclusion in the policy. | "[24] We have concluded that below 55 dBA Ldn the major known effect of noise is annoyance (an amenity effect)…"<br><br>"[49] The major argument for adopting the 50 dBA Ldn noise contour in Policy 6.3.7 relates to providing an additional control to reduce the potential for residents to become highly annoyed with aircraft traffic. We accept the clear evidence given to us that noise can create impacts on amenity and some people will become highly annoyed. We also accept that there would be some benefit to the airport in future-proofing its operation. **That benefit is one that has local, regional and national significance.** It was not clear to us what alternative means would produce this outcome. We conclude that in these circumstances alternative means are not appropriate."<br><br>"[58] … **We do accept that there are likely to be a percentage of persons highly annoyed even below the 50 dBA Ldn noise contour**. Although that percentage is significantly less than at the 55 dBA Ldn contour, we accept this may lead to an increased level of complaints. In our view such complaints are going to be inevitable in any event as the noise levels for airport activity within the existing urban area moves towards the 50 and 55 dBA Ldn contours in the next twenty to thirty years."<br><br>"[59] **We have concluded as a fact that a greater number of dwellings between the 50 and 55 dBA Ldn contour will lead to an increased number of persons being highly annoyed by aircraft traffic.** That effect is one on the amenity of the persons who may reside under the flight path and accordingly is an effect which we should properly take into account, particularly under section 5 of the Act. However, it is also an effect which has a cost (in the wider meaning of that term) in terms of its effect on the local amenity. It is an effect which is not internalised to the airport and its land and is therefore shifted to the owners of land under the flight path. Thus, although there is no prospect |

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| | | of curfew on the airport at this time, **there is likely to be an adverse effect on amenity of persons living within the 50 dBA Ldn contour line and thus an environmental cost imposed.**"<br><br>"[63] … Effectively, with the adoption of a 55 Ldn contour the Court would be accepting that there are areas where residential development is not discouraged that would have amenity levels lower than those generally anticipated in terms of the Proposed Plan in respect of noise. Disregarding noise from roads, it could be argued that many development areas of the city may be subject to noise in excess of that proposed under the Proposed Plan. However, in setting the noise level for this area, we take into account that the Proposed Plan has set out a general expectation in residential areas of 50 dBA Ldn. This provision is not critical because these standards are set for new activities to achieve compliance or to be dealt with as discretionary activities. **However it is indicative as to the expectation in respect of noise amenity generally.**"<br><br>"[64] … We have concluded that the 50 dBA Ldn line is better for the following reasons:<br><br>(1) the airport has significance in terms of the Proposed Plan, recognising its local, regional and national importance;<br><br>(2) high individual SEL levels can have more impact at lower Ldns (under 55 dBA), suggesting a conservative line to avoid amenity impacts;<br><br>(3) there is an amenity impact below 55 dBA Ldn and the Proposed Plan reflects a general expectation of lower Ldn levels in residential and rural areas;<br><br>…" |

| | | |
|---|---|---|
| *National Investment Trust v Christchurch CC,* C 41/2005, 30 March 2005 (EC) | Decision relating to the urban growth and zoning provisions of the Proposed Christchurch City Plan. The Trust sought to re zone land within the 50 dBA contour.<br><br>The Environment Court upheld the council's zoning decision. | "[45] We have concluded that any urban growth Increasing residential densities between the 50 dBA and the 65 dBA contours is discouraged by virtue of policy 6.3.7…"<br><br>"[48] We agree with the Court's summary in *Gargiulo v Christchurch City Council* which summarises the objectives and policies of the City Plan as *inter alia*:<br><br>• " …<br><br>• (c) keeping the density of dwellings within the 50 dBA Ldn contour to a level so that the number of people living within the noise affected area is kept to reasonable minimum."<br><br>We **conclude a Living 1 zone within the 50 dBA contour would increase the number of people living within the contour without any necessity for such zoning being demonstrated.**"<br><br>"[109] The Court has previously considered the Living I zone as a lower density form of development and sees other Living densities such as 3 and 4 as being higher densities. In this case we must also consider whether the general policies relating to the airport may be of more importance than the policy of the City Plan relating to higher densities. **To the extent that such policies are in conflict, it is clear that the airport policies are more significant than the policies seeking higher densities for major extensions. This would in our view be a proper basis on which the Court could consider lower density because of the requirements to take into account the impact on the airport.** In the circumstances of this case we need not explore this possibility further because of our general conclusion." |

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|---|---|---|
| *Independent News Auckland Ltd & Anor v Manukau City Council,* (2003) 10 ELRNZ 16 | Proposal for 349 household units on a Business 5 zoned site, identified in the District Plan as being subject to aircraft noise from operations Auckland Airport.<br><br>The Environment Court declined to grant consent. It held that positive effects were outweighed by the likely reverse sensitivity effects which could affect an airport, which is the most important international gateway for New Zealand. | "[52] **On analysis, we are satisfied that the issues, objectives, polices and rules of the district plan demonstrate that generally, high density residential accommodation within the high noise areas should be avoided.** The reason for such an approach is to avoid actual and potential effects on the airport, including the adverse effect of reverse sensitivity."<br><br>"[122] Of particular significance is the emphasis in issue 17.6.2.7, which explicitly recognises the importance of limiting the amount of residential development in areas affected or potentially affected by high aircraft noise (aircraft noise levels greater than Ldn 65) because it is not possible to mitigate the effects of aircraft noise on the external environment. **As Mr G J Osborne stated, this issue applies directly to the circumstances of the current case, where an acoustically insulated internal environment is proposed to be created, but nothing can be done to protect the residents from the effects of high aircraft noise when enjoying the outdoor recreational areas provided for in the development**. This proposal can be contrasted with other examples of sensitive activities such as hospitals and, perhaps, aged care facilities where patients and inhabitants are bed-ridden and immobile and have no expectation of enjoying the external environment."<br><br>"[124] … We found that aircraft noise will have an adverse effect on the residents. We also found that when the effect of allowing this proposal are compared with the baseline, the adverse effects remain significant. Further, we found there to be a clear relationship to the number of people exposed to high aircraft noise and the introduction of, or increase in, the strength of opposition to airport operations." |

| | | |
|---|---|---|
| *Ardmore Airfield Tenants and Users Committee & Ors v Ardmore Airport Ltd & Ors*, A 23/2005, 23 February 2005, Whiting J (EC) – Interim decision | Proposed plan change to introduce a planning framework for the airfield. One of the grounds of appeal was the absence of land use controls within identified noise boundaries.<br><br>The Environment Court found, and the Council accepted, that it was a serious omission to not make provision for land use controls. The Court awaited these controls to be introduced via a plan change within 9 months. | "[111] Importantly, as we have said, NZS 6805:1992 provides for a two-pronged approach — noise management controls on the one hand and land use planning controls on the other. **The two need to be considered as a composite package** for reasons we will elaborate on in discussing Issue 3."<br><br>"[136] **We are satisfied that the Papakura District Council has been remiss and guilty of a serious omission is not making provision for land use controls as part of the package**. The Council now accepts its responsibility and proposes to initiate a further plan change to introduce land use controls within a period of nine months…." |

# Appendix 18

Airport Contour s77K Appendix Eight: Section 32 evaluation

# Section 32 Evaluation Report

# Airport Related Qualifying Matters in the Christchurch District Plan

| Document Control | | | | |
|---|---|---|---|---|
| **Report Title** | Section 32 Evaluation Report – Inclusion of Christchurch Airport Noise Contours as an Existing Qualifying Matter | | | |
| **Client** | **Christchurch International Airport Limited** | | **Client Contact/Approver** | Felicity Blackmore Environmental and Planning Manager |
| **Rev** | **Date** | **Status** | **RMG Author/s** | **RMG Reviewer** |
| 1 | 9 May 2022 | Draft | Mark Leggett – Senior Consultant | Darryl Millar – Principal |
| 2 | 12 May 2022 | Draft | Mark Leggett – Senior Consultant | Darryl Millar – Principal |
| 3 | 13 May 2022 | Draft | Mark Leggett – Senior Consultant | Darryl Millar – Principal |
| 4 | 16 May 2022 | Draft | Mark Leggett – Senior Consultant | Darryl Millar – Principal |
| | 16 May 2022 | Final | Mark Leggett – Senior Consultant | Darryl Millar – Principal |
| | 8 July 2022 | Final | Darryl Millar – Principal | |
| **Current Version** | | Final 16 May 2022 Updated for AAOCB | Darryl Millar – Principal | |

## 1.0 Introduction

This section 32 evaluation report (s32 report) is focused on determining whether the Christchurch Airport remodelled 50 dB Ldn Annual Average Outer Control Boundary noise contour (AAOCB) should be included in Christchurch City Council's Proposed Plan Change 14 (PC14) as an existing qualifying matter under s77K of the Resource Management Act 1991 (the RMA).

PC14 has been initiated by Christchurch City Council (the Council) in response to its obligations under the RM (Enabling Housing Supply and Other Matters) Amendment Act 2021 (the Enabling Housing Act) and the National Policy Statement on Urban Development 2020 (NPSUD). The Enabling Housing Act requires the Council to apply medium density residential standards (MDRS) to relevant residential zones to enable residential intensification.

The Council is entitled to make the MDRS provisions as imported into the District Plan by way of PC14 less enabling of development in order to accommodate one or more of the existing qualifying matters set out in s77I, if a suitable case can be made. These matters include, for example, (e): *'a matter required for the purpose of ensuring the safe and efficient operation of nationally significant infrastructure'*, among others.

The preparation of this report is intended to satisfy the requirement in s77K(1)(c) to: *'identify in [a] report prepared under section 32 why the territorial authority considers that [one] or more existing qualifying matters apply to those areas [identified by location where an existing qualifying matter applies]'*. It has been prepared for Christchurch International Airport Ltd (CIAL) to support the Council's plan change process.

This s32 report should be read in conjunction with the background report to which it is appended. Appropriate reference to the background report is made in the body of this s32 report, particularly for background and contextual purposes.

## 2.0 Regulatory and policy direction

In carrying out a s32 analysis, an evaluation is required of how the proposal achieves the purpose and principles contained in Part 2 of the RMA.

Section 5 sets out the purpose of the RMA, which is to promote the sustainable management of natural and physical resources.

Sustainable management '*means managing the use, development, and protection of natural and physical resources to enable people and communities to provide for their social, economic and cultural wellbeing and for their health and safety, while -*

*(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
*(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
*(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment'.*

In achieving this purpose, all persons exercising functions and powers under the RMA also need to:

- Recognise and provide for the matters of national importance identified in s6
- Have particular regard to the range of other matters referred to in s7
- Take into account the principles of the Treaty of Waitangi/Te Tiriti o Waitangi in s8.

### 2.1 Section 6

There are no s6 matters relevant to this topic.

## 2.2 Section 7

The s7 matters that are relevant to this topic are:

| ***Section*** | ***Relevant Matter*** |
|---|---|
| *s7(b)* | *the efficient use and development of natural and physical resources*<br><br>Christchurch International Airport (the Airport) is a physical resource. |
| *s7(c)* | *the maintenance and enhancement of amenity values*<br><br>The AAOCB is intended, in part, to maintain the amenity values of residential areas and activities in the vicinity of the Airport. |
| *s7(f)* | *maintenance and enhancement of the quality of the environment*<br><br>The AAOCB is intended, in part, to maintain the quality of the environment of residential areas and activities in the vicinity of the Airport. |

## 2.3 Section 8

Section 8 is not relevant to this topic.

## 2.4 National Direction

### *2.4.1 National Policy Statements*

There are five National Policy Statements (NPS) currently in force:

- NPS for Electricity Transmission 2008
- New Zealand Coastal Policy Statement 2010
- NPS for Renewable Electricity Generation 2011
- NPS for Freshwater Management 2020
- NPS on Urban Development 2020 (NPSUD)

Only the NPSUD is relevant to this topic as outlined in the table below.

| ***NPS*** | ***Relevant Objectives / Policies*** |
|---|---|
| NPSUD | Includes, among others, Objective 1: *'New Zealand has well-functioning urban environments that enable all people and communities to provide for their social, economic, and cultural wellbeing, and for their health and safety, now and into the future.'* and Objective 6: '*Local authority decisions on urban development that affect urban environments are: (a) integrated with infrastructure planning and funding decisions*'<br><br>Includes, among others, Policy 3, which states, in part: '*In relation to tier 1 urban environments, regional policy statements and district plans enable: … building heights of least 6 storeys within at least a walkable catchment of the following: (i) existing and planned rapid transit stops …'* and Policy 4, which requires that '*regional policy statements and district plans applying to tier 1 urban environments modify the relevant building height or density requirements only to the extent necessary to accommodate a qualifying matter*'.<br><br>Identifies in 3.32, as a *'qualifying matter'*, among others, *'any matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure'*<br><br>Defines *'nationally significant infrastructure'* as '*any airport (but not its ancillary commercial activities) used for regular air transport services by aeroplanes capable of carrying more than 30 passengers'* |

In addition to the five NPSs currently in force there are also two proposed NPSs under development, noting that these are yet to be issued and have no legal effect:

- Proposed NPS for Highly Productive Land
- Proposed NPS for Indigenous Biodiversity

Neither of these NPS are relevant to the topic concerned.

### *2.4.2 National Environmental Standards*

In addition to the NPSs there are nine National Environmental Standards (NES) currently in force:

- NES for Air Quality 2004
- NES for Sources of Human Drinking Water 2007
- NES for Electricity Transmission Activities 2009
- NES for Assessing and Managing Contaminants in Soil to Protect Human Health 2011
- NES for Telecommunication Facilities 2016
- NES for Plantation Forestry 2017
- NES for Freshwater 2020
- NES for Marine Aquaculture 2020
- NES for Storing Tyres Outdoors 2021

There are no NESs of direct relevance to this topic.

### *2.4.3 National Planning Standards*

The National Planning Standards 2019 (the Standards) specify an iconography for zones and overlays and zone names and descriptions. Definitions are mandated for such terms as *'amenity values', 'habitable room',* noise metrics ($L_{A90}$, $L_{Aeq}$, $L_{AF(max)}$, $L_{dn}$, $L_{peak}$), *'noise', 'noise rating level', 'residential activity', 'residential unit'*, and *'special audible characteristics'*.

Finally, the Standards also mandate the application of New Zealand Standards (NZS) with respect to the measurement and assessment of noise.

## 2.5 National Guidance Documents

There is no national guidance relevant to this topic.

## 2.6 Canterbury Regional Policy Statement 2013 (RPS)

The background report to which this s32 report is appended provides a commentary on the relevant RPS provisions where this topic is concerned (refer paragraphs 102-114). For completeness, the relevant RPS objectives and policies are set out in summary form in the following table.

| ***RPS Provision*** | ***Relevant matters*** |
|---|---|
| Objective 5.2.1 | Requires that development is located and designed so that it functions in a way that:<br><br>*enables people and communities, including future generations, to provide for their social, economic and cultural well-being and health and safety; and which: …*<br><br>*b. provides sufficient housing choice to meet the region's housing needs;…*<br><br>*f. is compatible with, and will result in the continued safe, efficient and effective use of regionally significant infrastructure;*<br><br>*g. avoids adverse effects on significant natural and physical resources including regionally significant infrastructure, and where avoidance is impracticable, remedies or mitigates those effects on those resources and infrastructure;…* |

| *RPS Provision* | *Relevant matters* |
|---|---|
| | *i. avoids conflicts between incompatible activities;*<br><br>Noting that the Airport is defined, and specifically listed, as *'regionally significant infrastructure'* and *'strategic infrastructure'* and that the latter is defined as including *'facilities, services and installations which are greater than local importance, and can include infrastructure that is nationally significant'.* |
| Objective 6.2.1 | A land use and infrastructure framework that: …<br><br>*9. integrates strategic and other infrastructure and services with land use development;*<br><br>*10. achieves development that does not adversely affect the efficient operation, use, development, appropriate upgrade, and future planning of strategic infrastructure and freight hubs;*<br><br>*11 optimises use of existing infrastructure; …* |
| Objective 6.2.2 | Achieve consolidation and intensification of urban areas, by:<br><br>*2. providing higher density living environments including mixed use developments and a greater range of housing types, particularly in and around the Central City, in and around Key Activity Centres, and larger neighbourhood centres …* |
| Objective 6.2.3 | Recovery and rebuilding is undertaken in Greater Christchurch that: …<br><br>*4. provides a range of densities and uses;*<br><br>*5. is healthy, environmentally sustainable, functionally efficient, and prosperous.* |
| Policy 6.3.5 | 4. Requires that new development should only be provided for if it does not affect the efficient operation, use, development, upgrading and safety of existing strategic infrastructure, '*including by avoiding noise sensitive activities within the 50dBA $L_{dn}$ airport noise contour for Christchurch International Airport, unless the activity is within an existing residentially zoned urban area*…'<br><br>5. Focuses on: '*Managing the effects of land use activities on infrastructure, including avoiding activities that have the potential to limit the efficient and effective, provision, operation, maintenance or upgrade of strategic infrastructure and freight hubs'*<br><br>The accompanying Principal reasons and explanation' states: '*Strategic infrastructure represents an important regional and sometimes national asset that should not be compromised by urban growth and intensification… The operation of strategic infrastructure can affect the liveability of residential developments in their vicinity, despite the application of practicable mitigation measures to address effects… It is better to instead select development options where such reverse sensitivity constraints do not exist*.' |
| Policy 6.3.7 | In relation to residential development opportunities in Greater Christchurch:<br><br>*1. Intensification in urban areas of Greater Christchurch is to be focused around the Central City, Key Activity Centres and neighbourhood centres commensurate with their scale and function, core public transport routes, mixed-use areas, and on suitable brownfield land; …* |
| Policy 6.3.11 | *1. The Canterbury Regional Council, in conjunction with the territorial authorities, shall undertake adequate monitoring to demonstrate both in the short term and the long term that there is an available supply of residential and business land to meet the Objectives and Policies of this Chapter.*<br><br>*3. Prior to initiating a review of this chapter, for the purposes of information the Canterbury Regional Council may request the organisation or agency responsible for the operation* |

| RPS Provision | Relevant matters |
|---|---|
| | *of Christchurch International Airport to undertake a remodelling of the air noise contours relating to the airport.* |

## 2.7 District Plan Provisions

### 2.7.1 Introduction

The District Plan provisions relevant to this topic comprise the operative CDP provisions set out in section 2.7.2 and relate to housing supply, the location, density and amenity of residential development, the protection of strategic infrastructure including the Airport from reverse sensitivity effects, and the maintenance of the health, safety and amenity of residents. Relevant District Plan provisions also comprise the contents of PC14 set out in section 2.7.3, relating to housing provision and urban intensification and Medium Density Residential Zones.

Together with the Part 2, NPSUD and RPS directives set out above, the operative District Plan and PC14 provisions constitute the settled objectives against which the proposal that is the subject of this s32 report will be evaluated.

### 2.7.2 Operative District Plan (District Plan) Provisions

The background report to which this s32 report is appended provides a commentary on the relevant District Plan provisions where this topic is concerned (refer paragraphs 115-132). For completeness, the relevant District Plan objectives and policies are set out in summary form in the following table.

| District Plan Provision | Relevant matters |
|---|---|
| Strategic Objective 3.3.1 | *The expedited recovery and future enhancement of Christchurch as a dynamic, prosperous and internationally competitive city, in a manner that:*<br>*i. Meets the community's immediate and longer term needs for housing, economic development, community facilities, infrastructure, transport, and social and cultural wellbeing; and*<br>*ii. Fosters investment certainty; and*<br>*iii. Sustains the important qualities and values of the natural environment.* |
| Strategic Objective 3.3.4 | *For the period 2018-2048, a minimum of 55,950 additional dwellings are enabled through a combination of residential intensification, brownfield and greenfield development …* |
| Strategic Objective 3.3.7 | *A well-integrated pattern of development and infrastructure, a consolidated urban form, and a high quality urban environment that: …*<br>*iv. Increases the housing development opportunities in the urban area to meet the intensification targets specified in the Canterbury Regional Policy Statement, Chapter 6, Objective 6.2.2 (1) … in and around the Central City, Key Activity Centres (as identified in the Canterbury Regional Policy Statement), larger neighbourhood centres, and nodes of core public transport routes …*<br>*ix. Promotes the safe, efficient and effective provision and use of infrastructure, including the optimisation of the use of existing infrastructure;* |
| Strategic Objective 3.3.12 | *The social, economic, environmental and cultural benefits of infrastructure, including strategic infrastructure, are recognised and provided for, and its safe, efficient and effective development, upgrade, maintenance and operation is enabled; and* |

| *District Plan Provision* | *Relevant matters* |
|---|---|
| | *Strategic infrastructure, including its role and function, is protected from incompatible development and activities by avoiding adverse effects from them, including reverse sensitivity effects. This includes:…*<br><br>*iii. avoiding new noise sensitive activities within the 50dB Ldn Air Noise Contour and the 50dB Ldn Engine Testing Contour for Christchurch International Airport …* |
| Strategic Objective 3.3.14 | *The location of activities is controlled, primarily by zoning, to minimise conflicts between incompatible activities; and*<br><br>*Conflicts between incompatible activities are avoided where there may be significant adverse effects on the health, safety and amenity of people and communities.* |
| Objective 6.1.2.1 | *Adverse noise effects on the amenity values and health of people and communities are managed to levels consistent with the anticipated outcomes for the receiving environment.* |
| Policy 6.1.2.1.5 | *Require the management of aircraft operations and engine testing at Christchurch International Airport, so that:*<br><br>*i. noise generated is limited to levels that minimise sleep disturbance and adverse effects on the amenity values of residential and other sensitive environments so far as is practicable;*<br>*ii. where practicable, adverse noise effects are reduced over time.*<br><br>*Mitigate adverse noise effects from the operations of the Christchurch International Airport on sensitive activities, by:*<br><br>*i. prohibiting new sensitive activities within the Air Noise Boundary and within the 65 dB Ldn engine testing contour; and*<br>*ii. requiring noise mitigation for new sensitive activities within the 55 dB Ldn air noise contour and within the 55 dB Ldn engine testing contour; and*<br>*iii. requiring Christchurch International Airport Limited (CIAL) to offer appropriate acoustic treatment in respect of residential units existing as at 6 March 2017 within the 65 dB Ldn Annual Airport Noise Contour, and within the 60 dB L dn engine testing contour.* |
| Objective 7.2.1 | *An integrated transport system for Christchurch District: …*<br><br>*iii. that supports safe, healthy and liveable communities by maximising integration with land use;* |
| Policy 7.2.1.8 | *Avoid or mitigate adverse effects and promote positive effects from new transport infrastructure and changes to existing transport infrastructure on the environment, including: …*<br><br>*iii. noise, vibration and glare;*<br><br>*iv. amenity and effects on the built environment; …* |
| Objective 7.2.2 | *Enable Christchurch District's transport system to provide for the transportation needs of people and freight whilst managing adverse effects from the transport system.* |
| Policy 7.2.2.1 | *To manage any adverse effects from the ongoing use, repair, and development of the strategic transport network, whilst recognising the national and regional scale and economic importance of this network, and the role of the strategic transport network in the recovery of Christchurch.* |
| Policy 7.2.2.3 | *Manage the adverse effect(s) of an activity within the Transport Zone so that the effects of the activity are consistent with the amenity values and activity of adjacent land uses, whilst* |

| District Plan Provision | Relevant matters |
|---|---|
| | *providing for the transport network, in particular the strategic transport network to function efficiently and safely.*<br><br>*To ensure adjacent land uses are designed, located and maintained in such a way as to avoid reverse sensitivity effects on the strategic transport network.* |
| Objective 8.2.3 | *Subdivision design and development promotes efficient provision and use of infrastructure and transport networks …* |
| Policy 8.2.3.5 | *Ensure that the requirements of infrastructure, including their ongoing operation, development and maintenance, are recognised in subdivision design, including any potential for adverse effects (including reverse sensitivity effects) from subdivision …* |
| Objective 14.2.1 | *An increased supply of housing that will:*<br><br>*i. enable a wide range of housing types, sizes, and densities, in a manner consistent with Objectives 3.3.4(a) and 3.3.7;*<br>*ii. meet the diverse needs of the community in the immediate recovery period and longer term, including social housing options; and*<br>*iii. assist in improving housing affordability.* |
| Policy 14.2.1.1 | *Provide for the following distribution of different areas for residential development, in accordance with the residential zones identified and characterised in Table 14.2.1.1a, in a manner that ensures: …*<br><br>*iii. medium density residential development in and near identified commercial centres in existing urban areas where there is ready access to a wide range of facilities, services, public transport, parks and open spaces, that achieves an average net density of at least 30 households per hectare for intensification development;* |
| Objective 14.2.2 | *Short-term residential recovery needs are met by providing opportunities for:*<br><br>*i. an increased housing supply throughout the lower and medium density residential areas;*<br><br>*ii. higher density comprehensive redevelopment of sites within suitable lower and medium density residential areas.* |
| Policy 14.2.2.2 | *Enable and incentivise higher density comprehensive development of suitably sized and located sites within existing residential areas, through an Enhanced development mechanism which provides:*<br><br>*i. high quality urban design and onsite amenity;*<br><br>*ii. appropriate access to local services and facilities;*<br><br>*iii. development that is integrated with, and sympathetic to, the amenity of existing neighbourhoods and adjoining sites; and*<br><br>*iv. a range of housing types;*<br><br>*v. and which does not promote land banking, by being completed in accordance with a plan for the staging of the development.*<br><br>*To avoid comprehensive development under the Enhanced development mechanism in areas that are not suitable for intensification for reasons of: …*<br><br>*iv. reverse sensitivity effects on … Christchurch International Airport ….* |
| Objective 14.2.3 | *Development of sensitive activities does not adversely affect the efficient operation, use, and development of Christchurch International Airport …* |
| Policy 14.2.3.1 | *Avoid reverse sensitivity effects on strategic infrastructure including:* |

| *District Plan Provision* | *Relevant matters* |
|---|---|
| | *i. Christchurch International Airport;…* |
| Objective 14.2.4 | *High quality, sustainable, residential neighbourhoods which are well designed, have a high level of amenity, enhance local character and reflect the Ngāi Tahu heritage of Ōtautahi.* |
| Policy 14.2.4.1 | *Facilitate the contribution of individual developments to high quality residential environments in all residential areas (as characterised in Table 14.2.1.1a), through design: …*<br>*iv. minimising noise effects from traffic, railway activity, and other sources where necessary to protect residential amenity; …* |
| Policy 14.2.4.2 | *Encourage innovative approaches to comprehensively designed, high quality, medium density residential development, which is attractive to residents, responsive to housing demands, and provides a positive contribution to its environment (while acknowledging the need for increased densities and changes in residential character), through:*<br>*i. consultative planning approaches to identifying particular areas for residential intensification and to defining high quality, built and urban design outcomes for those areas; …* |
| Objective 15.2.4 | *A scale, form and design of development that is consistent with the role of a centre, and which: …*<br>*iii. recognises the functional and operational requirements of activities and the existing built form;*<br>*iv. manages adverse effects on the surrounding environment; …* |
| Policy 15.2.4.5 | *… Provide for the effective development, operation, maintenance and upgrade of strategic infrastructure and avoid adverse effects of development on strategic infrastructure through managing the location of activities and the design of stormwater areas. This includes but is not limited to, avoiding sensitive activities within commercial zones located within the 50 dB Ldn Air Noise Contour and within the Lyttelton Port Influences Overlay Area.* |

The zone and rule framework that follow on from the policy framework relating to the AAOCB are described in detail in paragraphs 124-132 of the background report to which this s32 report is appended.

In summary:

- areas that sit within the 50 dB $L_{dn}$ air noise contour (AAOCB) and which are subject to density controls comprise portions of the Residential Suburban (RS), Residential Suburban Density Transition (RSDT) and Residential New Neighbourhood (RNN) Zones;
- within these areas, residential activities and other sensitive activities which do not meet the permitted or controlled activity density standards, trigger **restricted discretionary activity** rules[1] requiring resource consent and enabling consideration of *'the extent to which effects, as a result of the sensitivity of activities to current and future noise generation from aircraft, are proposed to be managed, including avoidance of any effect that may limit the operation, maintenance or upgrade of … [the] Airport' [and] 'the extent to which appropriate indoor noise insulation is provided'*;

[1] 14.4.1.3 RD34 and 14.12.1.3 RD26 and the relevant permitted and controlled activity standards

- any applications triggering these rules are to be limited notified to CIAL (as a party identified as being adversely affected);
- within the above residential zones and under the AAOCB, standards apply to subdivision as a **controlled activity** and impose direct controls on density, via minimum net site areas;[2]
- sensitive activities (including residential activities) under the AAOCB and also within the Commercial Mixed Use (CMU), Commercial Office (CO), Commercial Core (CC) and Commercial Local (CL) Zones are **non-complying activities**;[3] and
- any new sensitive activities located within the Air Noise Boundary (ANB) are prohibited.[4]

Other provisions in the District Plan relate to Engine Testing Contours and also insulation requirements for habitable rooms, but are not the subject of this s32 report, as the former do not apply over residentially zoned land, and the latter do not directly relate to or directly constrain residential development densities in the way that the abovementioned rules do.

### 2.7.3 Plan Change 14 (PC14) Provisions

The background report to which this s32 report is appended provides a commentary on the relevant PC14 provisions where this topic is concerned (refer paragraphs 136-149). The Council anticipates that PC14 will be publicly notified in August 2022. For completeness, changes to <u>relevant</u> District Plan objectives and policies that would be effected by PC14 (as identified in pre-notification materials) are set out in summary form in the following table.

| ***PC14 Provision*** | ***Relevant matters*** |
|---|---|
| Strategic Objective 3.3.7 | Amend as follows (in part):<br><br>*A well-integrated pattern of development and infrastructure, a consolidated urban form, and a high quality urban environment that:…*<br><br>*ii. <u>May develop and change over time, including amenity values</u> …*<br><br>*iii. Increases the housing <u>intensification</u> ~~development~~ opportunities in the urban area to;*<br><br>*A. <u>give effect to Policies 3 and 4 and other urban intensification provisions of the National Policy Statement on Urban Development and sections 77F(1) and (6) and section 77(G) of the Act; and</u>*<br>*B. meet the intensification targets specified in the Canterbury Regional Policy Statement, Chapter 6, Objective 6.2.2 (1); particularly:*<br><br>*1. in and around the Central City, Key Activity Centres (as identified in the Canterbury Regional Policy Statement), <u>Town centres and</u> larger <u>Local</u> ~~neighbourhood~~ centres, and nodes of core public transport routes; …*<br><br>*xii. Promotes the safe, efficient and effective provision and use of infrastructure, including the optimisation of the use of existing infrastructure extent, <u>except to the that this could not be justified to limit the intensification required to be enabled in Policies 3 and 4 and other urban intensification provisions of the National Policy</u>* |

[2] 8.6.1 Table 1.a, 8.6.1 Table 1.e and 8.6.11 Table 8, also Appendix 8.10.28 and Appendix 8.10.23

[3] 15.8.1.5, 15.4.1.5 and 15.5.1.5, noting that where the CMU is concerned, there is no equivalent operative rule as the operative ANC does not apply over the zone (whereas the remodelled AAOCB will (in this respect, refer to the footnote on page 22).

[4] 6.1.7.1 and 6.1.7.2

| *PC14 Provision* | *Relevant matters* |
|---|---|
| | *<u>Statement on Urban Development and sections 77F(1) and (6) and section 77(G) of the Act;</u> …* |
| Objective 15.2.4 | Amend as follows (in part):<br><br>*A scale, form and design of development that is consistent with the role of a centre, and <u>intended built form outcomes for mixed use areas</u> and which: …*<br><br>*iii. recognises the functional and operational requirements of activities and the <u>anticipated</u> ~~existing~~ built form;*<br><br>*iv. manages adverse effects <u>(including reverse sensitivity effects)</u> on the <u>site and</u> surrounding environment, <u>including effects that contribute to the impacts of climate change</u>; and …* |
| MRZ-O1, MRZ-P1 | New objective and policy relating to the Medium Density Residential Zone purpose and low density transition. |
| MRZ-O2, MRZ-P2 to P5 | New objective and policies relating to medium density housing variety, built form, height, wind assessment and wind environment. |
| MRZ-O3, MRZ-P6 to P20 | New objective and policies relating to quality design of medium density residential developments, quality developments, passive surveillance, resident's needs, residential design principles, on-site communal living space, outdoor living areas, ground floor residential units, shading, privacy, building dominance, accessory building location, front boundary treatment, on-site waste and recycling storage, landscaping, water and fire-fighting capacity, rainwater capture and green infrastructure. |
| HRZ-O1, HRZ-P1 | New objective and policy relating to the High Density Residential Zone purpose and low density transition. |
| HRZ-O2, HRZ-P2 | New objective and policy relating to high density intensification and location of high density |
| HRZ-O3, HRZ-P3 to P6 | New objective and policies relating to built form of high density, site layout and building location, high density heights, location for increased heights and criteria for increased heights. |
| HRZ-O4, HRZ-P7 to P17 | New objective and policies relating to high quality density environments, application of high density residential design principles, high quality residential environment quality developments, outdoor living areas, ground floor residential units, shading, privacy, building dominance, accessory building location, front boundary treatment, on-site waste and recycling storage and landscaping |
| HRZ-O5, HRZ-P18 to P20 | New objective and policies relating to stormwater management, water and fire-fighting capacity, rainwater capture and green infrastructure. |

As noted in the background report to which this s32 report is appended PC14 would insert planning tools into the District Plan to achieve intensification outcomes required by the Enabling Housing Act in Medium Residential Zones. These tools include increased thresholds for standards relating to density and building height, more flexible recession plane standards, reduced building setback standards, increased site coverage rules and reduced subdivision standards.

Overall, the PC14 provisions would establish a significantly more enabling residential development regime and thus a notable increase in potential development density and built form compared to the operative District Plan.

Documentation prepared by the Council in support of PC14 acknowledges that the operative District Plan provisions restricting the scale of residential activities with the 50 dB air noise contour likely meet the prerequisites of a qualifying matter under s77I, although a definitive position in this respect is *'dependent on supplementary evidence and consultation with CIAL'*.[5]

## 2.8 Other relevant legislation or regulations

The following additional legislative / regulatory requirements are also relevant to this topic:

| ***Legislation / Regulation*** | ***Relevant Provisions*** |
|---|---|
| Medium Density Residential Standards (MDRS) | As noted elsewhere in this report, the Enabling Housing Act requires the Council to apply MDRS to relevant residential zones to enable residential intensification. The provisions of PC14 provide the vehicle for that obligation to be met.<br><br>In inserting obligations relating to provision for MDRS in district plans, s77I the Enabling Housing Act entitled councils to be less enabling of development to the extent necessary to accommodate one of more of the following qualifying matters that are relevant in a Christchurch context:<br><br>*(a) a matter of national importance that decision makers are required to recognise and provide for under section 6:*<br><br>*(b) a matter required in order to give effect to a national policy statement (other than the NPS-UD) or the New Zealand Coastal Policy Statement 2010: …*<br><br>*(e) a matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure:*<br><br>*(f) open space provided for public use, but only in relation to land that is open space:*<br><br>*(g) the need to give effect to a designation or heritage order, but only in relation to land that is subject to the designation or heritage order:*<br><br>*(h) a matter necessary to implement, or to ensure consistency with, iwi participation legislation:*<br><br>*(i) the requirement in the NPS-UD to provide sufficient business land suitable for low density uses to meet expected demand:*<br><br>*(j) any other matter that makes higher density, as provided for by the MDRS or policy 3, inappropriate in an area, but only if section 77L is satisfied.* |
| New Zealand Standard 6805:1992 'Airport Noise Management and Land Use Planning' (the Standard) | As noted in the background report to which this s32 report is appended, the Standard introduced the Air Noise Boundary (ANB) and Outer Control Boundary (OCB) concept to New Zealand planning framework.<br><br>Between the ANB and the OCB, the Standard recommends that, as a minimum, new noise sensitive land uses should ideally be prohibited (and if the District Plan permits such uses, they should be provided with sound insulation). The overall approach set in the Standard is to first and foremost avoid noise sensitive activities within the OCB wherever possible.<br><br>Consistent with the Standard, the District Plan adopts an ANB within which insulation requirements are imposed and new sensitive activities are prohibited. |

[5] *Scope of Qualifying Matters: MDRS & NPS-UD Plan Change*, Christchurch City Council, undated, page 2

## 3.0 Resource Management Issues Analysis

### 3.1 Evidence Base - Research, Information and Analysis undertaken

The operative District Plan and technical advice and assistance commissioned from various internal and external experts to assist with setting the plan framework for PC14 have been reviewed for the purpose of preparing this s32 report. This work has been used to inform the identification and assessment of the environmental, economic, social and cultural effects that are anticipated from the implementation of the provisions. This advice includes the following:

| ***Title*** | ***Author*** | ***Brief synopsis*** |
|---|---|---|
| *Christchurch International Airport*<br><br>*Airport Safeguarding at Christchurch International Airport*<br><br>14 June 2022 | Airbiz | This report outlines the role of the Airport and quantifies the scale, nature and extent domestic and international freight and passenger movements. It also considers the potential impact of capacity constraints on Airport operations. The key findings of the report are as follows:<br>• The Airport has regional, national and international significance as a passenger and freight hub.<br>• It has a key function in non-scheduled operations<br>• Long term planning frameworks are the key to preserving this significance, the amenity of those living beneath the AAOCB, avoiding reverse sensitivity effects on the Airport, and potential capacity constraints.<br>• The Airport is a “slot taker”, meaning that flight scheduling times are dictated by the network operation of the carrier overseas and timing (slot) availability at major overseas destinations.<br>• Evidence from case studies illustrate the impacts on airports from poor land use planning provisions and ineffective airport safeguarding techniques. |
| *International and Domestic Freight Trends*<br><br>June 2022 | Richard Paling Consulting | This report outlines the key trends in international and domestic freight trends, and the significance that plays in the Airports operations, the important role in the movement of air freight and its connectiveness to the freight network, and its contribution to the South Island economy. |
| *Potential Economic Impacts of Operational Constraints on Christchurch Airport*<br><br>May 2022 | Property Economics Ltd | This report provides a relevant summary (using up to date figures) of the economic significance of Christchurch International Airport. This evidence addresses:<br>• The significance of the Airport as an employer, as a conduit for freight and passenger movement and therefore commerce and tourism;<br>• The consequential contribution to the Canterbury and wider South Island and New Zealand economy; and<br>• The risks to the above associated with reverse sensitivity effects, absent the AAOCB provisions. |
| *Christchurch International Airport*<br><br>*Land Use Planning*<br><br>23 May 2022 | Marshall Day Acoustics | This report provides a summary of the acoustic effects arising from development within the 50 dB contour.<br><br>The report finds that:<br>• Lack of appropriate land use planning around airports can cause significant numbers of people to be exposed to airport noise and has, in many cases, resulted in operational constraints on airports. |

| Title | Author | Brief synopsis |
|---|---|---|
| | | • In Canterbury there is a strong regional and district planning framework controlling noise sensitive activities inside the contours.<br>• Aircraft noise inside the 50 dB $L_{dn}$ contour causes adverse effects on people and this is not a desirable noise environment in which to increase residential density.<br>• Even if sound insulation is required to be fitted to dwellings within this 50 dB $L_{dn}$ noise environment, this will not eliminate all adverse effects.<br>• Accordingly, it is preferable to avoid noise sensitive activities from locating in areas where they will experience adverse effects from aircraft noise from the outset.<br>• Where there is alternative land outside of the contours available to locate residential intensification, this should be preferred. |
| *The Enabling Act – Influence on People Affected by Aircraft Noise*, 8 July 2022 | Marshall Day Acoustics for CIAL | This report considers the implications of the Enabling Housing Act in the context of the AAOCB relating to noise effects from aircraft using the Airport.<br><br>The report finds that control of noise sensitive land use (including residential activity) within the AAOCB is important to:<br><br>• ensure people are protected from establishing sensitive land uses in areas that are exposed to levels of aircraft noise which might disturb them or affect their quality of life resulting in adverse amenity and health outcomes; and<br>• protect the Airport from reverse sensitivity effects, enabling airport operations to continue to support and benefit communities. |
| *New Medium Density Residential Standards (MDRS): Assessment of Housing Enabled in Christchurch City,* January 2022 | The Property Group for Christchurch City Council | This report provides an analysis of the impact of the recent policy direction for urban growth under the NPSUD and in particular the new MDRS for Christchurch City, with a view to understanding how those changes will impact the location and type of housing development that is enabled across the City.<br><br>The report finds that the catchments of Addington, Fendalton/St Albans, Greater Hornby, Addington, Northlands/Papanui, Riccarton, Shirley/Edgeware, Somerfield, St Martins and Sydenham show the feasible medium density development.<br><br>The analysis has not incorporated consideration of those areas that would not be subject to the MDRS as a result of qualifying matters (including Airport protection measures). |
| *New Medium Density Residential Standards (MDRS): Review of the Property Group Assessment of Housing Enabled*<br><br>May 2022 | Colliers for CIAL | The report comprises a review of The Property Group's assessment referred to directly above.<br><br>The report also undertakes an analysis of the likely loss in feasible dwelling capacity.<br><br>The report finds that this loss of development potential equates to 7% or approximately 4,000 dwellings.<br><br>Overall, the report concludes there is sufficient remaining development capacity. |

| *Title* | *Author* | *Brief synopsis* |
|---|---|---|
| | | It is important to state that the Colliers assessment used the outer envelope contour. Given that the AAOCB is spatially less extensive, the Colliers conclusions will overestimate the impact on housing capacity. |
| *2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours for review by Environment Canterbury's Independent Expert Panel* | Prepared for CIAL | This report introduces the background and context for the remodelling of the Christchurch International Airport (the Airport / CIA) air noise contours.<br><br>Accompanied by technical reports as follows:<br>• *Christchurch Airport Aircraft Noise Contours Update: Ultimate Runway Capacity Report*, AirBiz, October 2021<br>• *Christchurch Airport Air Traffic Projections*, Airways / AirBiz<br>• *Christchurch Airport Flight Track Assumptions,* Airways / AirBiz<br>• *Christchurch Recontouring Noise Modelling Report*, Marshall Day Acoustics<br><br>The report recommends updated noise contours that are a different shape and size than the operative plan noise contours, to reflect changes in aviation practices and operations since 2008, and also reflect refinements made in the underlying assumptions. The overall outcome is the contours generally shift slightly to the west.<br><br>The inputs, assumptions, and outcomes of the remodelling are currently being peer reviewed by Environment Canterbury's Independent Expert Panel. |

## 3.2 Analysis of District Plan provisions relevant to this topic

As noted in section 2.7.1, together with the Part 2, NPSUD and RPS directives set out above, the operative District Plan and PC14 provisions constitute the settled objectives against which the proposal that is the subject of this s32 report will be evaluated. The relevant operative District Plan and PC14 provisions are set out in sections 2.7.2 and 2.7.3, respectively.

## 3.3 Summary of Relevant Resource Management Issue

Based on the research, analysis and consultation outlined above the following issue has been identified:

| *Issue* | *Comment* | *Response* |
|---|---|---|
| Potentially significant adverse effects on the amenity and health of residents and continued viability of the Airport arising from a MDRS uplift in residential densification via PC14. | Absent the continued imposition of AAOCB as a qualifying matter, a significant increase in the number of residents arising from an uplift in residential development density in areas in the vicinity of to the Airport and subject to airport-related noise, is likely to have a significantly adverse impact on the amenity and health of those new residents, resulting in a volume of complaints that in turn would significantly adversely affect the continued viability of the Airport in its current location (i.e., a reverse sensitivity effect). | The proposal to which this s32 report relates involves the application of AAOCB as a qualifying matter over areas subject to residential densification via PC14. |

## 4.0 Evaluation of the Proposal

This section of the report evaluates the objectives of the proposal to determine whether they are the most appropriate means to achieve the purpose of the RMA, as well as the associated policies, rules and standards relative to these objectives. It also assesses the level of detail required for the purposes of this evaluation, including the nature and extent to which the benefits and costs of the proposal have been quantified.

### 4.1 Scale and Significance

Section 32(1)(c) of the RMA requires that this report contain a level of detail that corresponds with the scale and significance of the environmental, economic, social and cultural effects that are anticipated from the implementation of the proposal.

The level of detail undertaken for this evaluation has been determined by assessing the scale and significance of the environmental, economic, social and cultural effects anticipated through introducing and implementing the AAOCB, as a qualifying matter, relative to a series of key criteria.

Based on this the scale and significance of anticipated effects associated with this proposal are identified below:

| ***Criteria*** | ***Scale/Significance*** | | | ***Comment*** |
|---|---|---|---|---|
| | ***Low*** | ***Medium*** | ***High*** | |
| Basis for change | X | | | • Implementation of MDRS provisions is a mandatory requirement of the Enabling Housing Act, commensurate with the NPSUD.<br>• The facility to consider qualifying matters is explicitly provided for in the RMA. |
| Addresses a resource management issue | | X | | • Council is obliged to address housing supply issues under the Enabling Housing Act and NPSUD.<br>• The amenity and health of people (including residents) is a relevant resource management issue under Part 2.<br>• The efficient use and development of physical resources (and the continued viability of strategic infrastructure such as the Airport in this regard) is a relevant resource management issue under Part 2. |
| Degree of shift from the *status quo* | X | | | • As noted above, the RMA explicitly provides for the consideration of qualifying matters with respect to the implementation of MDRS.<br>• The proposed application of the AAOCB as a qualifying matter does not therefore represent a significant shift from the *status quo*.<br>• The AAOCB is predicted to reduce MDRS yield relative to uplift across the City as a whole by a maximum of 7% (or less) or approximately 4,000 dwellings. |

| Criteria | Scale/Significance | | | Comment |
|---|---|---|---|---|
| | Low | Medium | High | |
| Who and how many will be affected/ geographical scale of effect/s | | X | | • The 'effect' of the proposal, in negative terms, would be experienced by property owners and developers of sites subject to the AAOCB in the absence of the MDRS provisions, in terms of the reduced prospects for redevelopment and realising value from densification.<br>• However, the alternative of allowing medium density residential development within the areas currently subject to the AAOCB would expose a significantly larger number of existing residents to aircraft noise, thereby adversely affecting their health and amenity and inevitably leading to negative consequences with respect to the viability of the Airport. |
| Degree of impact on or interest from iwi / Māori | X | | | • Issues relating to residential intensification, the amenity and health of residents and the continued viability of the Airport are no more or less relevant to iwi / Māori than the general population. |
| Timing and duration of effect/s | | X | | • The AAOCB would apply as a qualifying matter over areas subject to the MDRS provisions upon notification of PC14 and, subsequent to that, without 'end', and therefore the effects (both negative, in terms of reducing development capacity, and positive, in terms of protecting residential health and amenity and the continued viability of the Airport) would be experienced over the long-term. |
| Type of effect/s | | X | | • As indicated above the 'effects' of the proposal can be expressed both negatively and positively.<br>• Negative in the sense that some property owners and developers of sites subject to the AAOCB provisions would incur reduced prospects for redevelopment and the realisation of value from densification.<br>• Positive in the sense a significantly larger number of existing residents are not exposed to aircraft noise, thereby protecting their health and amenity and consequently protecting the continued viability of the Airport. |
| Degree of risk and uncertainty | X | | | • The AAOCB provisions are long-standing, clear in their intent and certain in their application. |

Overall, the scale and significance of the proposed provisions are considered to be low to medium for the following reasons:

- The proposal would reduce development capacity in areas subject to the MDRS provisions over the long term to a defined and limited degree.
- However, the proposal would ensure that the health and amenity of occupants in residential areas within the AAOCB remains protected (and exposure of a potentially significant number of additional people to airport noise is avoided) together with, consequently and ultimately, the continued viability of the Airport.

Consequently, a high-level evaluation of these provisions has been identified as appropriate for the purposes of this report.

### 4.2 Quantification of Benefits and Costs

Section 32(2)(b) requires that, where practicable, the benefits and costs of a proposal are to be quantified.

Based on the assessment of the scale and significance of the proposed provisions in section 4.1, further specific quantification of the benefits and costs in this report is considered neither necessary, beneficial nor practicable in relation to this topic for the following reasons:

- The extent to which the proposal would reduce development capacity in areas subject to the MDRS provisions is reasonably well-understood (refer section 4.1 above)
- The evidence base described in section 3.1 provides a reasonably robust qualitative assessment of the impact that would occur were the proposal not to be effected (i.e., on the amenity and health of future residents in the vicinity of the Airport and, extrapolating from that, on the continued viability of the Airport in its current location).
- It is neither practicable nor appropriate to attempt to quantify the impact of not pursuing the proposal on the amenity and health of future residents in the vicinity of the Airport.

Instead, this report identifies more generally where any additional costs or cost may lie.

## 5.0 Overview of Proposal

The 'proposed' provisions relevant to this topic are set out after the end of the table on pages 9 to 10 of this s32 report. These provisions, together with the remodelled contours, comprise the 'existing qualifying matter' to which the proposal relates.

With respect to the remodelling exercise, and as noted in the last row of the table on page 5 under section 2.6, through RPS Policy 6.3.11 Environment Canterbury (ECan) may request that CIAL undertake a remodelling of the ANC.

That request was issued in September 2021; CIAL has since completed the task and a report has been prepared that, as noted in the table under section 3.1, recommends updated noise contours that are a different shape and size than the operative plan noise contours, to reflect changes in aviation practices and operations since 2008, and also reflect refinements made in the underlying assumptions. The overall outcome is the contours generally shift slightly to the west. Some residential properties would now fall within the remodelled contours when they did not do so under the operative provisions, whereas other properties would no longer be subject to the contours.

The inputs, assumptions, and outcomes of the remodelling await review by an expert panel assembled by Environment Canterbury. This peer review report may be available for incorporation into PC14, but the timing is not certain. An explanation as to why the remodelled contours form part of the proposed package and a description of the areas subject to the remodelled contours is contained in the background report to which this s32 report is appended (refer paragraphs 1 and 2, and to **Appendix One**).

For practical purposes, then, the remodelled contours form part of the proposal package that is the subject of the evaluation set out in this report.

# 6.0 Evaluation of Proposed Objective

## 6.1 Introduction

Section 32(1)(a) of the RMA requires that the evaluation report examine the extent to which the objectives of the proposal are the most appropriate way to promote the sustainable management of natural and physical resources.

An examination of the proposed objective along with reasonable alternatives is included below, with the relative extent of their appropriateness based on an assessment against the following criteria:

1. Relevance (i.e., Is the objective related to addressing resource management issues and will it achieve one or more aspects of the purpose and principles of the RMA?)
2. Usefulness (i.e., Will the objective guide decision-making? Does it meet sound principles for writing objectives (i.e., does it clearly state the anticipated outcome?)
3. Reasonableness (i.e., What is the extent of the regulatory impact imposed on individuals, businesses or the wider community? Is it consistent with identified tangata whenua and community outcomes?)
4. Achievability (i.e., Can the objective be achieved with tools and resources available, or likely to be available, to the Council?)

## 6.2 Evaluation of Objective

While not specifically required under s32, it is appropriate to also consider an alternative objective, so as to ensure that the proposed objective is the most appropriate to achieve the purpose of the RMA.

For the purposes of this evaluation, two potential objectives have been considered:

1. The proposed objective, which is: ***To achieve a balance in enabling housing supply and residential intensification, while protecting strategic infrastructure including the Airport from reverse sensitivity effects, and maintaining the health, safety and amenity of residents, through the imposition of the AAOCB as a qualifying matter over areas subject to MDRS provisions***.
2. A reasonable alternative objective which is: ***To enable housing supply and residential intensification, through MDRS provisions, without imposing the AAOCB as a qualifying matter, while retaining operative District Plan objectives and policies intended to promote consideration of the protection of strategic infrastructure including the Airport from reverse sensitivity effects, and maintenance of the health, safety and amenity of residents***.

| **Proposed objective:**<br>*To achieve a balance in enabling housing supply and residential intensification, while protecting strategic infrastructure including the Airport from reverse sensitivity effects, and maintaining the health, safety and amenity of residents, through the imposition of the AAOCB as a qualifying matter over areas subject to MDRS provisions.* | | |
|---|---|---|
| **Alternative objective:**<br>*To enable housing supply and residential intensification, through MDRS provisions, without imposing the AAOCB as a qualifying matter, while retaining operative District Plan objectives and policies intended to promote consideration of the protection of strategic infrastructure including the Airport from reverse sensitivity effects, and maintenance of the health, safety and amenity of residents.* | | |
| | **Preferred objective** | **Alternative objective** |
| ***Relevance:*** | | |
| Addresses a relevant resource management issue | Enabling housing supply (and therefore the social, economic and cultural well-being of people and communities), the amenity and health of people (including residents) and the efficient use and development of physical resources (and the continued viability of strategic infrastructure such as the Airport in this regard) are relevant resource management issues within the context of Part 2. | Enabling housing supply (and therefore the social, economic and cultural well-being of people and communities), the amenity and health of people (including residents) and the efficient use and development of physical resources (and the continued viability of strategic infrastructure such as the Airport in this regard) are relevant resource management issues within the context of Part 2. |
| Assists the Council to undertake its functions under s31 RMA | The balance sought by the proposal reflects the Council's obligations under s31 to achieve integrated management of physical resources ((1)(a)), sufficient capacity in respect to housing demand ((1)(aa)), the control of adverse effects ((1)(b)) and the mitigation of the effects of noise ((1)(d)). | The alternative addresses the Council's obligation under 31(1)(aa) to ensure sufficient capacity in respect to housing demand, but the lack of means (beyond policy references) to address other obligations to control adverse effects ((1)(b)) and mitigate the effects of noise ((1)(d)) would in turn to fail to achieve the integrated management of physical resources ((1)(a)). |
| Gives effect to higher level documents | Assists the Council in addressing housing supply issues under the Enabling Housing Act and NPSUD.<br><br>Assists the Council in meeting its obligations under the RPS with respect to housing demand, urban consolidation and intensification, and the protection of regionally significant infrastructure, including the Airport. | Assists the Council in addressing housing supply issues under the Enabling Housing Act and NPSUD.<br><br>Assists the Council in meeting its obligations under the RPS with respect to housing demand, urban consolidation and intensification, but the lack of means (beyond policy references) to protect regionally significant infrastructure, including the Airport suggests the alternative would not fully address relevant RPS imperatives in this regard. |
| ***Usefulness:*** | | |
| Guides decision-making | Establishes a clear intent through a combination of policy direction and consent status. In mapping areas to which they apply and imposing appropriate consent status, the AAOCB 'heads off' conflicts that might otherwise arise between 'enabling' and 'effects' oriented policies. | The lack of means to bring objectives relating to the protection of regionally significant infrastructure and the amenity and health of people to bear would mean they do not find sufficient purchase in the decision-making process. |

| | | |
|---|---|---|
| Meets best practice for objectives | The objectives are specific and state what needs to be achieved. | The objectives are specific and state what needs to be achieved. However, the achievement of objectives relating to the protection of regionally significant infrastructure and the amenity and health of people would be undermined by the lack of means to bring them to bear through the decision-making process. |
| ***Reasonableness:*** | | |
| Will not impose unjustifiably high costs on the community/parts of the community | The proposal will impose some justifiable costs on property owners and developers of sites subject to both the AAOCB and MDRS provisions, in terms of the reduced prospects for redevelopment and realising value from densification. | The proposal will impose unjustifiable costs on future residents of new dwellings on sites subject to both the AAOCB and MDRS provisions, in amenity and health-related terms. Ultimately, it will also impose unjustifiable costs on future users of the Airport and could result in wider economic costs. |
| Acceptable level of uncertainty and risk | The proposal provides a suitable level of certainty, as the AAOCB provisions provide a clear vehicle for the achievement of objectives. The risk profile is low as the provisions are well-established and their operation and effect is understood. | The alternative is uncertain, in that the manner in which policy references are interpreted and factored into decision-making is likely to be inconsistent. The risk profile is high given the likely impact on future resident amenity and health and the viability of the Airport. |
| ***Achievability:*** | | |
| Consistent with identified tangata whenua and community outcomes | The proposal, in balancing the community's expectations with respect to housing supply, residential amenity and continued use of the Airport, is likely consistent with those expectations. | The alternative will go some way to meeting the community's expectations with respect to housing supply, but not residential amenity or continued use of the Airport. |
| Realistically able to be achieved within the Council's powers, skills and resources | The objective can be achieved through ongoing management of consent processes and monitoring of plan and consent outcomes and the state of the environment. | The objective can be achieved through ongoing management of consent processes and monitoring of plan and consent outcomes and the state of the environment. |
| **Summary** | | |
| The above analysis suggests that the proposed (preferred) objective is the most appropriate means to implement the NPSUD, RPS and in turn, the purpose of the Act and the intent of recent amendments to the Act to improve housing supply and enable residential intensification. Those amendments countenance the adoption of qualifying matters, and the AAOCB directly address the facility accorded in s77I(e) i.e., *a matter required for the purpose of ensuring the safe or efficient operation of nationally significant infrastructure.* Further, the retention or effective 'rollover' of the ANC (albeit in a remodelled form) as a qualifying matter in applicable areas also subject to MDRS provisions best aligns with the existing District Plan policy framework relating to health, amenity and Airport outcomes, which PC14 does not propose to alter.<br><br>By contrast, the alternative proposal would provide limited direction to decision-makers, and only gives partial effect to the RMA and higher order direction including the RPS, as in the absence or practical means to trigger wider policy considerations, it would be overly focused on housing provision at the expense of balancing this with the maintenance of the amenity and health of residents and the protection of the continued viability of the Airport. As such, it would undermine the existing District Plan policy framework relating to health, amenity and Airport outcomes, which PC14 does not propose to alter. | | |

# 7.0 Evaluation of Reasonably Practicable Options and Associated Provisions

## 7.1 Introduction

Under s32(1)(b) of the RMA, reasonably practicable options to achieve the objective associated with this proposal need to be identified and examined. This section of the report evaluates the proposed provisions, as they relate to the associated objective.

Along with the proposed provisions, the Council has also identified through the research, consultation, information gathering and analysis undertaken in relation to this topic a reasonably practicable alternative option to achieve the objective.

The technical input used to inform this process is outlined in section 3 of this report.

## 7.2 Evaluation method

For each potential approach an evaluation has been undertaken relating to the costs, benefits and the certainty and sufficiency of information (as informed by section 3 of this report) in order to determine the effectiveness and efficiency of the approach, and whether it is the most appropriate way to achieve the relevant objective.

This evaluation is contained in the following sections.

## 7.3 Provisions to achieve Objective

For the purpose of this evaluation, the following potential options have been considered:

1. Retain the current Residential Suburban (RS), Residential Suburban Density Transition (RSDT) and Residential New Neighbourhood (RNN) zoning and related subdivision provisions applying to land beneath the AAOCB (referred to as the 'proposed approach')[6].
2. A reasonable alternative, involving the rezoning of land beneath the AAOCB to Medium Density Residential Zones (referred to as the 're-housing option').

[6] This option also involves extending the application of the AAOCB provisions (and a consequential non-complying activity status applied to sensitive activities) over those portions of the new Commercial Mixed Use Zone that are located beneath the AAOCB.

| **Objective:**<br><br>To achieve a balance in enabling housing supply and residential intensification, while protecting strategic infrastructure including the Airport from reverse sensitivity effects, and maintaining the health, safety and amenity of residents, through the imposition of the AAOCB as a qualifying matter over areas subject to MDRS provisions. | | | |
|---|---|---|---|
| **Option 1: Proposed approach (recommended)** | **Costs** | **Benefits** | **Risk of Acting / Not Acting if there is uncertain or insufficient information about the subject matter of the provisions** |
| Retain the current Residential Suburban (RS), Residential Suburban Density Transition (RSDT) and Residential New Neighbourhood (RNN) zoning and related subdivision provisions applying to land beneath the AAOCB. | ***Environmental***<br>• No direct and indirect environmental costs have been identified.<br><br>***Economic***<br>• No direct economic costs have been identified.<br>• No indirect economic costs (e.g., on economic growth or employment) have been identified.<br><br>***Social***<br>• No direct or indirect social costs have been identified.<br><br>***Cultural***<br>• No direct or indirect cultural costs have been identified. | ***Environmental***<br>• No direct and indirect environmental benefits have been identified.<br><br>***Economic***<br>• Plan users are familiar with the current zoning arrangements, related subdivision provisions and associated AAOCB triggers for consideration.<br>• Plan users would not be put to the time and costs required to understand a different approach.<br>• The Council (and ratepayers) will be faced with a reasonably manageable plan change exercise and the limited costs associated with that.<br>• No indirect economic benefits (e.g., on economic growth or employment) have been identified.<br><br>***Social***<br>• No direct or indirect social benefits have been identified.<br><br>***Cultural***<br>• No direct or indirect cultural benefits have been identified. | It is considered that there is certain and sufficient information on which to act as:<br>• the existing zoning arrangements, related subdivision provisions and associated AAOCB triggers for consideration are well understood. |
| **Effectiveness and efficiency** | ***Effectiveness***<br><br>The retention of existing AAOCB triggers for consideration will ensure that objectives relating to the protection of strategic infrastructure including the Airport from reverse sensitivity effects, and the maintenance of the health, safety and amenity of residents will continue to be effectively achieved. | ***Efficiency***<br><br>As the current zoning arrangement beneath the AAOCB would be retained, these portions of the District Plan will remain integrated with the bulk of the District Plan. The proposed approach minimises the risk of anomalies arising, as the plan change would be limited as to its scope. | |
| **Overall evaluation** | Option 1 is the most appropriate approach to achieving the related objective as it involves the least degree of change to the current zoning and planning framework and consequently entails the least risk of unintended consequences (e.g., anomalies) arising. | | |
| **Option 2: Re-housing option** | **Costs** | **Benefits** | **Risk of Acting / Not Acting if there is uncertain or insufficient information about the subject matter of the provisions** |
| The rezoning of land beneath the AAOCB to Medium Density Residential Zones.. | ***Environmental***<br>• No direct and indirect environmental costs have been identified.<br><br>***Economic***<br>• At least initially, plan users would not be familiar with the new zoning arrangements and associated AAOCB triggers for consideration.<br>• It will be difficult for plan users to identify areas where different standards apply if these are not shown clearly on planning maps (this in itself would require a complex iconography or other visual method).<br>• Plan users would be put to the time and costs required to understand the new zoning arrangements.<br>• The Council (and ratepayers) will be faced with a relatively complex plan change exercise relating to the rezoning of land | ***Environmental***<br>• No direct and indirect environmental benefits have been identified.<br><br>***Economic***<br>• No direct economic benefits have been identified.<br>• No indirect economic benefits (e.g., on economic growth or employment) have been identified.<br><br>***Social***<br>• No direct or indirect social benefits have been identified.<br><br>***Cultural***<br>No direct or indirect cultural benefits have been identified. | It is considered that there is some risk associated with acting that are not outweighed by the risks of not acting as:<br>• the complexities associated with this option are such that unintended consequences (e.g., anomalies) may arise.<br>• by way of example, the zones concerned cater for a range of activities not limited to residential activities and there is considerable risk that these elements would be overlooked during a rehousing exercise. |

| | | | |
|---|---|---|---|
| | and integration of relevant standards, including the AAOCB related triggers within those zones, and the costs associated with that.<br>• No indirect economic costs (e.g., on economic growth or employment) have been identified.<br>***Social***<br>• No direct or indirect social costs have been identified.<br>***Cultural***<br>No direct or indirect cultural costs have been identified. | | |
| **<u>Effectiveness and efficiency</u>** | ***Effectiveness***<br>The retention of existing AAOCB triggers for consideration will ensure that objectives relating to the protection of strategic infrastructure including the Airport from reverse sensitivity effects, and the maintenance of the health, safety and amenity of residents will continue to be effectively achieved. | ***Efficiency***<br>The rezoning of land subject to the AAOCB as Medium Residential Zones and the integration of relevant standards associated with the current zoning, including the AAOCB related triggers within those zones, is a relatively complex planning exercise, and essentially involves the creation of a 'mini-plan', with the associated risk of anomalies arising, as the plan change would be less limited as to its scope. | |
| **<u>Overall evaluation</u>** | Option 2 is the less appropriate approach to achieving the related objective as it involves a greater degree of change to the current planning framework and consequently entails a greater risk of unintended consequences (e.g., anomalies) or drafting errors arising.<br>There is no mandate to adopt the Medium Density Zone nomenclature or to implement a blanket rezoning of all relevant residential land to a single / universal zone as part of addressing the Council's obligations to bring the MDRS into the District Plan. Such an exercise is best left to a future, full review of the District Plan. | | |

## 8.0 Conclusion

This evaluation has been undertaken in accordance with section 32 of the RMA in order to identify the need, benefits and costs and the appropriateness of the proposal having regard to its effectiveness and efficiency relative to other means in achieving the purpose of the RMA.

The evaluation demonstrates that the proposal to impose the AAOCB as a qualifying matter over areas subject to MDRS provisions is the most appropriate objective for achieving the purpose of the RMA as it:

- represents a valid qualifying matter in respect of s77I(e);
- does not unreasonably frustrate the Council's implementation of its obligations under the NPSUD, RPS and in turn, the purpose of the Act and the intent of recent amendments to the Act to improve housing supply and enable residential intensification; and
- best aligns with the existing District Plan policy framework relating to health, amenity and Airport operational outcomes, which PC14 does not propose to alter.

Further, having settled the above, the option of retaining the current residential zoning and related provisions applying to land beneath the AAOCB, is considered the most appropriate means of implementing the objective associated with the proposal, as it:

- involves the least degree of change to the current zoning and planning framework; and
- consequently entails the least risk of unintended consequences or errors (e.g., anomalies) arising.

# Appendix 19

Airport Contour s77K Appendix Nine: Housing Capacity in Greater Christchurch in relation to airport noise impacted areas only

**AIR NOISE CONTOUR IMPACT ON**
**HOUSING CAPACITY IN GREATER CHRISTCHURCH**

## Introduction

We have been engaged by Christchurch International Airport Limited (*CIAL*) to complete a housing capacity (*HC*) study on the Greater Christchurch area to determine the availability of land for residential development and the impact that the Updated 50dB Ldn Air Noise Contours (*UANC*) will have. We have been asked to use the “Outer Envelope” Updated Air Noise Contour as the UANC in this report, as that is the larger of the two options presented to the Environment Canterbury Peer Review Panel for consideration. We have also considered the impact of the new Medium Density Residential Standards (*MDRS*). Introduction of the MDRS will result in even greater housing capacity in relevant residential areas in Greater Christchurch, especially in Christchurch City.

Our housing capacity research is limited to greenfield land[1] generally on the periphery of existing residential development in Greater Christchurch, spanning from Rangiora (Waimakariri District) in the north to Rolleston (Selwyn District) in the south, and excludes brownfield land and infill development land located within existing developed suburbs.

The object of the research work is to quantify any impact that the proposed UANC will have on housing capacity in Greater Christchurch.

This study identifies any gain or loss in housing capacity resulting from the proposed 50dB Ldn UANC compared to the existing Operative Plan 50dB Ldn Air Noise Contours (OPANC).

## Methodology

### Survey Methodology

We were provided with a set of Geographic Information System (*GIS*) data prepared by Marshall Day Acoustics on behalf of CIAL which contained the full suite of air contour lines associated with Christchurch International Airport. This GIS data was merged with our Quickmap GIS software to enable accurate identification of relevant land areas.

As specifically instructed, we have limited our analysis to the impact that the proposed 50dB Ldn UANC will have on Greater Christchurch compared to the 50dB Ldn OPANC.

The research team at Colliers Valuation (*Colliers*) reviewed the mapping data in association with aerial photographs and physical inspection on the ground, and identified respective land areas available across Greater Christchurch.

### Assumptions

We have made the following assumptions in our analysis and completion of this report.

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[1] “Greenfield land” is a term used in this report to describe undeveloped land that is potentially suitable for residential development and includes existing residential zoned land, FUDAs, Greenfield Priority Areas, plan change areas and land zoned rural but considered to be suitable for rezoning to residential.

*Rezoning Assumption*
Where we have identified land that is reasonably suitable to be rezoned for residential development, we have assessed the HC taking into account its location. We have assumed that such land is adequately serviced to allow residential development.

*HC Land Yield*
For the purposes of our analysis, we have adopted a HC density yield of 15 household units per hectare (hh/ha) in Christchurch City and 12 hh/ha in Waimakariri District and Selwyn District, unless there is an existing development plan. This yield takes into account roads, utility areas, and reserves.

Potential Future Development Capacity - Timing
The land identified under the Future Development HC Capacity category has different characteristics in terms of development timeframe. Some land (eg, FUDA's) potentially will not be developed for some time and is not as "development-ready" as existing residential zoned land or land subject to plan changes.

Housing Capacity Land Categories
We have categorised the HC into three broad categories and, in the case of the potential category, there are some sub-categories.

1. *UANC HC*
   In four locations the UANC impacts development potential when compared to the status quo under the OPANC. The locations where residential development potential is lost are Kaiapoi, Rolleston and West Melton. The only areas where there will be a gain in potential residential development potential are Harewood and Rolleston.

2. *Potential HC Land*
   We have identified potential HC land currently not zoned residential as follows:
   - Plan Changes
     We have identified plan change applications as potential areas of future residential development. The only areas in Greater Christchurch where there are plan changes currently underway to rezone land from rural to urban zoning is Selwyn District where there are 13 private plan changes and Waimakariri District where there is one plan change. The plan changes are in various stages in the regulatory timeframe.

   - Future Development Areas
     Future Urban Development Areas (FUDA's) and Greenfield Priority Areas (GPA's) as defined in the Canterbury Regional Policy Statement are all identified as future development areas in this report. This category also includes land within the Projected Infrastructure Boundary in Waimakariri District.

   - Projected Infrastructure Boundary
     In Waimakariri District the FUDA's were identified as land within the Projected Infrastructure Boundary in Rangiora and Kaiapoi in the operative District Plan.

3. *Residential Zoned Land*
   We have identified the HC development capacity of existing residential zoned land as identified in the relevant District Plans.

## Geographic Areas

We have completed our analysis on the basis of suburbs, or groups of suburbs, in Christchurch and major townships in Waimakariri District and Selwyn District. The following is a summary:

Waimakariri District

- Rangiora
- Ohoka
- Woodend / Pegasus
- Kaiapoi

Christchurch City

- North West - Belfast
- North West – Harewood
- North West – Redwood
- North East – Highfield
- North East – Cranford
- South West – Yaldhurst / Broomfield
- South West – Halswell / Awatea / Wigram

Selwyn District

- Prebbleton
- Lincoln
- Rolleston
- West Melton

## Residential Market Overview

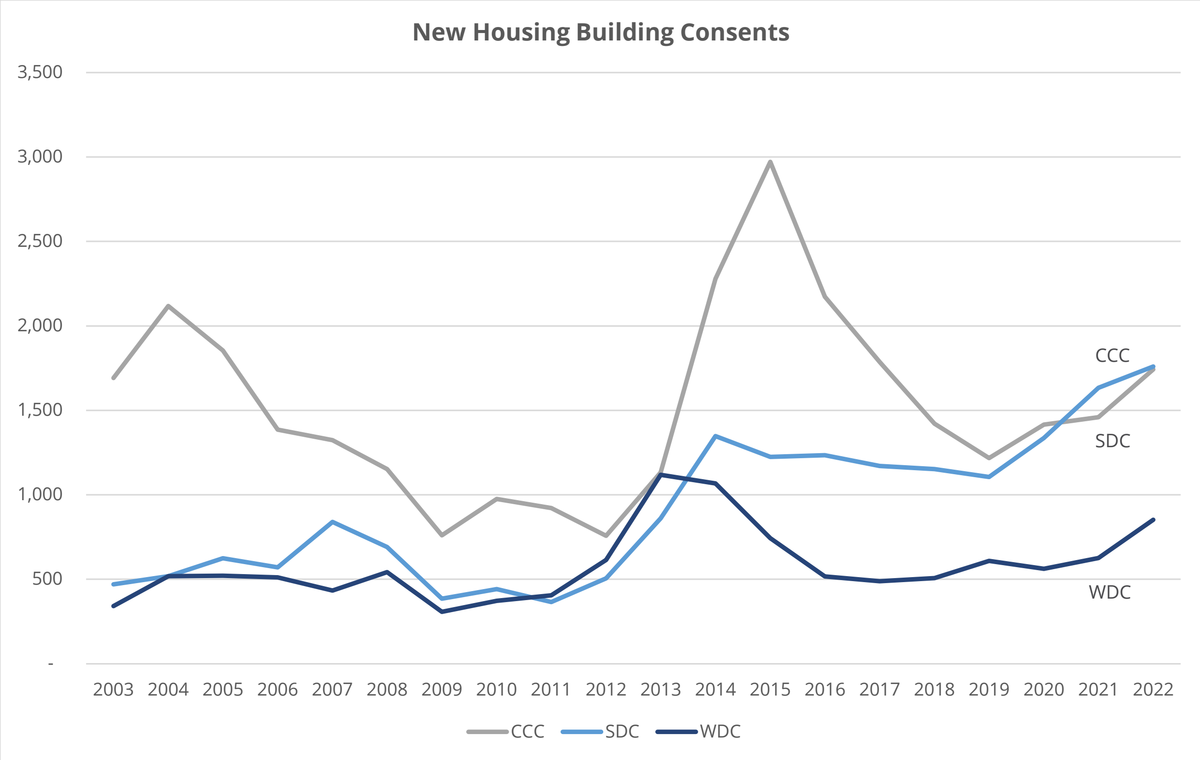
New Zealand's residential property market has experienced a significant boom, largely driven by historic low interest rates never seen before in New Zealand. After a sustained, strong cyclical period between 2012 and 2016, the market experienced a slowdown in growth in 2017 and moderate decreases in mid-late 2018. During early 2020 the market began to see growth again, until the emergence of the COVID-19 pandemic and subsequent lockdown in March 2020. During the early stages of the pandemic, the residential market was widely predicted to experience a sharp correction in line with forecasts for the wider economy. Actions taken by the government and Reserve Bank of New Zealand to support the national economy through the pandemic provided a huge stimulus to the residential market in 2020 resulting in a surge in values.

The reduction of interest rates to historic lows and the removal of the loan to value (LVR) restrictions provided support to the market as New Zealand entered lockdown in March 2020. These drivers, subsequently bolstered by New Zealand's stronger than expected economic performance, resulted in a rebound in consumer confidence as perceptions of job security increased.

It is apparent that the rampant value appreciation witnessed over the last 12-18 months has peaked and softened during the last three months. The reimposition of LVR restrictions and increases in the Official Cash Rate (OCR), with a clear indication of a further lifting of the OCR over the pending 12 month period together with affordability constraints and inflation, have moderated demand and resulted in a decline in growth; a situation which is positive for the market given that the rate of increase evident over the last 18 months was unsustainable.

We have completed analysis on building consents issued for new residential dwellings in the Greater Christchurch area over the last 20 years. The following is a summary table:

| **New Dwelling Building Consents – Greater Christchurch** | | | | |
|---|---|---|---|---|
| **Year** | **CCC<br>#** | **SDC<br>#** | **WDC<br>#** | **Total<br>#** |
| 2003 | 1,691 | 470 | 341 | 2,502 |
| 2004 | 2,117 | 518 | 518 | 3,153 |
| 2005 | 1,855 | 625 | 521 | 3,001 |
| 2006 | 1,386 | 570 | 511 | 2,467 |
| 2007 | 1,324 | 839 | 434 | 2,597 |
| 2008 | 1,152 | 691 | 543 | 2,386 |
| 2009 | 761 | 385 | 308 | 1,454 |
| 2010 | 975 | 442 | 372 | 1,789 |
| 2011 | 922 | 365 | 405 | 1,692 |
| 2012 | 757 | 506 | 614 | 1,877 |
| 2013 | 1,132 | 861 | 1,119 | 3,112 |
| 2014 | 2,279 | 1,347 | 1,067 | 4,693 |
| 2015 | 2,971 | 1,224 | 744 | 4,939 |
| 2016 | 2,173 | 1,234 | 517 | 3,924 |
| 2017 | 1,787 | 1,171 | 489 | 3,447 |
| 2018 | 1,422 | 1,152 | 507 | 3,081 |
| 2019 | 1,217 | 1,105 | 609 | 2,931 |
| 2020 | 1,415 | 1,337 | 562 | 3,314 |
| 2021 | 1,459 | 1,633 | 626 | 3,718 |
| 2022 | 1,742 | 1,760 | 852 | 4,354 |
| **Total** | **30,537** | **18,235** | **11,659** | **60,431** |




Source: New Zealand Statistics – New Dwellings consented by 2022 statistical area 2 (Monthly)

In all three local authority areas, the volume of new dwelling consents climbed in the 2009 – 2010 period, following the global financial crisis in 2008.

Following the Canterbury earthquake sequence in 2010 - 2011, new dwelling consents surged in all three localities in the 2012 – 2016 period which resulted from demand from relocated red zone owners. Following the earthquake related rebuild, the market returned to business as usual in Christchurch City and the Waimakariri District, however there was a significant surge in consents in Selwyn District which coincided with the rapid expansion in Rolleston. Since 2019, the volume of new dwelling consents has increased in all three localities on the back of the boom in the residential market.

In the year ending March 2022, the total volume of new dwelling consents in Greater Christchurch was 4,354, at or near the peaks in 2014 – 2015.

The significant surge in demand for residential housing and residential sections during the last 18 months has placed stress on the supply of both vacant and improved product resulting in significant price escalation. This market cycle is well publicised and results from a mix of low interest rates and constrained supply.

In some locations there are few or no vacant residential sections available which resulted in significant price escalation. For example, in Selwyn District, price escalation in Prebbleton, Lincoln and Rolleston ranged between 100% - 145% over a 12 month period. In Rolleston, there were sections of at or around 600 sqm sold in 2020 for $180,000 and a similar sized section sold in August 2021 for $435,000, an increase of 142%. This is an extreme example, however it illustrates the constraint in supply of residential sections in Greater Christchurch.

## Housing Capacity Assessment

The following is a summary of comments in relation to each geographic area:

Waimakariri District

*Rangiora*

In Rangiora, there is 29.26 ha or HC of 293 household units (HHU's) relating to land which is zoned for residential development (not including FUDA's). This land is located in the north, east and south west parts of the township. Significant areas are identified as FUDA's within the 'Projected Infrastructure Boundary', which is land identified as suitable for future urban development located in the Greenfield Priority Areas. Large blocks are located on the north eastern, south eastern and south western periphery of the township. In total there is 331.48 ha of land within FUDAs, which equates to a HC of 3,977 HHU's. In total, Rangiora has a total potential HC of 4,270 HHU's.

Ohoka

In Ohoka a plan change request was lodged in March 2022 by Rolleston Industrial Developments Limited to rezone 155.93 ha from rural to residential which will produce approximately 1,871 HHU's.

*Woodend / Pegasus*

In the Woodend and Pegasus location, there is 41.61 ha of land zoned for residential development which equates to a HC of 509 HHU's. In addition, there is a total GPA area which falls within the Projected Infrastructure Boundary comprising 46.56 ha or a HC of 559 HHU's. This land is located at the northern and southern ends of the township. The total HC in Woodend/Pegasus is 1,068 HHU's.

*Kaiapoi*

Kaiapoi is impacted by the OPANC and UANC. The UANC extends the air noise contour envelope further to the north east and encroaches over land which is identified in the Proposed Infrastructure Boundary. Kaiapoi has limited opportunity for further expansion due to the significant areas of land which is Red Zoned in and around the Kaiapoi River part of the township.

In Kaiapoi there is 40.58 ha zoned for residential development which equates to 568 HHU's. This land is located on the eastern edge of the developed township and also to the west adjacent to Silverstream. There is 59.30 ha identified within the Projected Infrastructure Boundary (FUDA), however 36.30 ha of this land falls within the UANC and therefore reduces the total FUDA area to 23.00 ha or 276 HHU's. The imposition of the UANC in Kaiapoi reduces HC by 436 HHU's. The net total area of potential and current residential zoned land is 63.58 ha or 844 HHU's.

Following the Canterbury earthquakes parts of Kaiapoi under the noise contours were specifically exempt from restrictions. This land was provided to ensure more residential areas could be developed and to offset red zoned land in Kaiapoi.

Rezoning of additional areas of residential zoned land was fast tracked in Silverstream Estates (1,180 HHU's), Sovereign Palms (280 HHU's) and Ruby Views (now Beach Grove) (750 HHU's) to offset the reduction in HC resulting from extensive Red Zoning in Kaiapoi.

## Christchurch

*North West – Belfast*

In Belfast, we have identified a total area of 112.93 ha or 1,721 HHU's currently zoned for residential development. This includes land in Belfast Village, and a block named Blue Skies adjacent to Belfast Village.

*North West – Harewood*

The UANC in Harewood has moved further to the north west, opening up the opportunity for significant areas of land currently zoned Rural Urban Fringe as suitable to be rezoned for residential development.

We have identified a total area of 74.66 ha of land zoned for residential development located just outside the OPANC which equates to 1,120 HHU's. The movement to the north west of UANC has unlocked the potential for 110.69 ha or 1,659 HHU's to be rezoned for residential development. This land is located on the city side of Johns Road (SH.1).

There is an area of land located on the northern side of SH.1 comprising 22.25 ha and equivalent to 333 HHU's adjacent to Clearwater Avenue and Willowcreek Lane. We have chosen to exclude this land on the basis that it is isolated by SH.1, however this land could potentially be added to the HC.

Combining the existing greenfield zoned residential land with the land identified as potentially suitable for rezoning following the movement of the UANC, the total HC is 2,779 HHU's.

*North West – Redwood*

We have identified 71.79 ha in Redwood which is zoned for residential development, which produces 1,077 HHU's.

*North East – Highfield*

Highfield includes the area in and around Prestons Road and further to the east where we have identified 61.88 ha zoned for residential development, which equates to a HC of 928 HHU's.

*North East – Cranford*

We have identified two blocks of land either side of Cranford Street where there is 33.71 ha zoned for residential development, which equates to an HC of 505 HHU's.

*South West – Yaldhurst / Broomfield*

There are three blocks of land in Yaldhurst/Broomfield which also includes land at Riccarton Park adjacent to Riccarton Racecourse. In total there is 43.40 ha zoned for residential development, which equates to 651 HHU's.

*South West – Halswell / Awatea*

There is significant vacant land zoned for residential development in the Halswell / Awatea and Wigram areas of the city. This area of Christchurch has the most potential for further development in the short to medium term under the current zoning. We have identified 314.87 ha, which equates to 4,724 HHU's.

## Selwyn District

*Prebbleton*

In Prebbleton there is just 4.84 ha of land zoned for residential development which converts into 59 HHU's.

Prebbleton is currently the subject of three plan changes summarised as follows:

| Plan Change Status – Prebbleton | | | | |
|---|---|---|---|---|
| **PC #** | **Applicant** | **Area Ha** | **Lots #** | **Status** |
| PC 68 | Urban Holdings Limited etc | 67 | 820 | Hearing completed – Pending |
| PC 79 | Birchs Village Limited | 37 | 400 | Pending |
| PC 72 | Trices Road Rezoning Group | 28 | 290 | Approved |

On the assumption that all of the above plan changes are approved, comprising 132.78 ha, there will be an additional HC of 1,510 HHU's.

Therefore, the total HC in Prebbleton including the plan change land is 1,569 HHU's.

*Lincoln*
Currently, there are virtually no titled vacant residential sections for sale. There are a number of blocks of land on the south eastern and north eastern edges of the township which are zoned for residential development comprising 75.48 ha, which equates to 842 HHU's. There is currently one major plan change on the southern edge of the township. Plan Change 69, where the applicant is Rolleston Industrial Developments Limited, involves 194.41 ha and can be developed with 1,710 HHU's. The hearing has been completed and the commissioner has recommended to the Selwyn District Council that the land be rezoned in accordance with the plan change. Council approved the plan change on 8 June 2022. The addition of the plan change land to the existing land zoned residential produces a total area of 269.89 ha or 2,842 HHU's.

*Rolleston*
Rolleston is the largest township in Selwyn District. Currently, there are virtually no titled residential sections for sale. We have identified a total area of 83.48 ha of land zoned for residential development which is equivalent to 1,002 HHU's.

In addition to the land zoned residential there is 194.95 ha in the FUDA, which equates to 2,339 HHU's. The proposed UANC in the Rolleston area alters the 50dB Ldn line moving it to the north east and shifting slightly to the south east. The impact of this change releases FUDA land which is the subject of Plan Change 71. This area consists of 15.44 ha or 185 HHU's. The UNAC change to the south reduces the FUDA area by 2.47 ha or 29 HHU's. The net number of HHU's following addition and removal of the land affected by the UANC is 2,310.

There are nine plan changes in various stages of process. The following is a summary:

| Plan Change Status – Rolleston | | | | |
|---|---|---|---|---|
| **PC #** | **Applicant** | **Area Ha** | **Lots #** | **Status** |
| PC 73 | Rolleston West Residential Ltd | 160 | 1,922 | Declined and under appeal |
| PC 82 | Brookside Road Residential Ltd | 110 | 1,317 | Application stage |
| PC 81 | Rolleston Industrial Developments | 28 | 341 | Application stage |
| PC 70 | Hughes Developments Limited | 61 | 736 | Application stage |
| PC 64 | Hughes Developments Limited | 35 | 421 | Approved and developed |
| PC 76 | Dunweavin 2020 Limited | 13 | 156 | Approved |
| PC 78 | Urban Estates | 63 | 774 | Approved |
| PC 75 | Your Section Limited | 25 | 296 | Approved |
| PC 71 | Four Stars Development Limited etc | 38 | 443 | Decision pending |

Inclusion of all of the plan change areas adds 535.33 ha of residential development capacity, which equates to 6,424 HHU's.

The proposed UANC encroaches into the PC 71 area, reducing the development land by 1.53 ha or 18 HHU's.

Combining the existing greenfield zoned residential land, the FUDA land area and the land subject to plan change, totals a net area of 826.73 ha, which is equivalent to 9,921 HHU's.

*West Melton*
There is no land in West Melton which is zoned and available for residential development.

There are three plan changes in West Melton which are as follows:

| **Plan Change Status – West Melton** | | | | |
|---|---|---|---|---|
| **PC #** | **Applicant** | **Area Ha** | **Lots #** | **Status** |
| PC 67 | GW Wilfield Limited | 33 | 131 | Approved |
| PC 74 | Hughes Developments Limited | 21 | 130 | Submission stage |
| PC 77 | Marama Te Wai Limited | 50 | 525 | Application stage |

Plan Change 67 has been approved which produces 131 HHU's. The proposed UANC encroaches further over West Melton and essentially envelopes all of the land in PC 74, comprising 20.69 ha. We have excluded this land from our HC assessment. Therefore, in total, the net area of land subject to plan changes unaffected by the UANC comprises 83.77 ha or 656 HHU's.

**Summary**

Attached at **Appendix A** is a map of Greater Christchurch identifying the various categories of land in this HC study.

The following table summarises our assessment of HC in Greater Christchurch:

| **Colliers Housing Capacity Summary** | | | | |
|---|---|---|---|---|
| **Location** | **UANC #** | **Potential #** | **Zoned #** | **Total #** |
| **Waimakariri District** | | | | |
| Rangiora | - | 3,977 | 293 | 4,270 |
| Ohoka | - | 1,871 | - | 1,871 |
| Woodend / Pegasus | - | 559 | 509 | 1,068 |
| Kaiapoi | (436) | 712 | 568 | 844 |
| **Christchurch City** | | | | |
| North West – Belfast | - | - | 1,721 | 1,721 |
| North West – Harewood | 1,659 | - | 1,120 | 2,779 |
| North West – Redwood | - | - | 1,077 | 1,077 |
| North East – Highfield / Preston | - | - | 928 | 928 |
| North East – Cranford | - | - | 505 | 505 |
| South West – Yaldhurst/Broomfield | - | - | 651 | 651 |
| South West – Halswell / Awatea / Wigram | - | - | 4,724 | 4,724 |
| **Selwyn District** | | | | |
| Prebbleton | - | 1,510 | 59 | 1,569 |
| Lincoln | - | 1,710 | 842 | 2,552 |
| Rolleston | 156 | 8,763 | 1,002 | 9,921 |
| West Melton | (130) | 786 | - | 656 |
| **Total** | **1,249** | **19,888** | **13,999** | **35,136** |

In total, there is the potential for 13,999 HHU's to be developed on land currently zoned Residential, and the potential for 19,888 HHU's to be developed on land that has the potential to be rezoned, is located in FUDA's or is subject to plan change.

The total impact of the proposed UANC on Greater Christchurch, taking into account potential gains from rezoning and losses, equates to an increase in housing capacity of 1,249 HHU's.

The following is a summary table of the impact:

| **UANC Impact** | |
|---|---|
| **Location** | **Dwg #** |
| Harewood | 1,659 |
| Kaiapoi | (436) |
| Rolleston | 156 |
| West Melton | (130) |
| **Net Total** | **1,249** |

In the case of Harewood, this land is in a desirable residential location where residential development has generally transacted in the mid to upper price bracket.

**Medium Density Residential Standards**

The Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 is designed to accelerate housing supply in areas of high demand. The Act enables greater levels of permitted residential development within low and medium density residential zones in New Zealand's largest centres.

For completeness, we have considered the potential impact of MDRS standards on HC in Christchurch City. This is based on The Property Group's (TPG) Assessment of Housing Enabled by the new Medium Density Residential Standards (MDRS) dated January 2022.

TPG was engaged by Christchurch City Council to undertake an analysis of the impact of the recent policy direction of urban growth under the National Policy Statement on Urban Development (NPS-UD) and in particular, the new Medium Density Residential Standards (MDRS) for Christchurch City.

TPG's assessment demonstrated that the new policy framework enables medium density development in the majority of the Christchurch City residential areas, creating an estimated plan enabled capacity of 222,478 dwellings. This total included 158,772 dwellings through comprehensive redevelopment and 63,706 through infill development.

TPG completed further analysis to assess the projected feasible capacity and concluded there was the potential for 58,188 feasible dwellings made up of 37,441 dwellings through comprehensive redevelopment and 20,747 through infill development.

The TPG analysis did not include undeveloped residential zoned land on the periphery of the city.

Accordingly, if the TPG assessed projected feasible capacity of 58,188 dwellings for Christchurch City is added to our total of 35,136 dwellings then the total HC in Greater Christchurch incorporating the MDRS is 93,324 dwellings.

We have previously analysed the impact that the UANC Line has on the TPG feasible dwelling total of 58,188. We concluded that the new UANC would reduce the feasibility capacity by 4,064 dwellings. Therefore, the net dwelling housing capacity reduces to 89,260 dwellings.

The TPG analysis did not include the residential zones in Waimakariri District and Selwyn District. If the TPG analysis was extended to the Waimakariri and Selwyn relevant residential zones, the net dwelling HC would be even higher.

We trust this report is suitable for requirements, however if you require any further information or discussion, please do not hesitate to contact the undersigned.

For and on behalf of:
CVAS (CHC) Limited trading as Colliers

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# Appendix 20

Christchurch Justice and Emergency Services Precinct Radio Communication – Cost Benefit Analysis - Formative Limited

10 August 2022

Ike Kleynbos
Principal Advisor Planning – City Planning (E)
Christchurch City Council

By email: ike.kleynbos@ccc.govt.nz

**Re: Radio Communication Appendices**

The following *Christchurch Justice and Emergency Services Precinct Radio Communications Cost Benefit Analysis* report was completed four months ago. Since then, the findings from this report, another round of public feedback[1], and planning processes around the Housing Supply Amendment Act (HSAA) have progressed[2], which have all resulted in changes to the policy.

The most significant change is that the Justice and Emergency Services agencies have decided not to seek protection for the UHF radio communication pathways. There have also been some minor modifications to the policy to remove trees and some utilities, as these issues are irrelevant (i.e. microwave radio communication pathways are higher than either of these objects). In the following report, the discussion on UHF is no longer relevant to the current policy.

Another significant change is that the policy has been shifted into the planning processes around the HSAA. Specifically, Plan Change 9F has been incorporated into Plan Change 14 (PC14), with the protection of the microwave radio communication pathways being proposed as a Qualifying Matter which modifies the heights enabled within the corridors. The exact nature of PC14 was not defined at the time that the following report and research were conducted.

The following report does include a discussion of HSAA and an indicative assessment. This indicative assessment suggested that at most 18,000m$^2$ of floorspace could be impacted by the inclusion of microwave radio communication pathways as a Qualifying Matter (see Figure 5.3). However, this assessment was based on the assumption that the land within the microwave radio communication pathways would be zoned City Centre (i.e. unlimited height).

We understand that PC14 is proposing Mixed Use Zone for the land within the microwave radio communication pathways. Also, the land is within the walking catchment of the CBD, which means the height limits are proposed to be 10 levels (32 metres).[3] For the most part, this would mean building

[1] Global Research (2022) Draft Radio Communication Pathways Plan Change PC15 Public Engagement Syntheses Report - 11th April 2022 - 13th May 2022.
[2] Christchurch City Council (2022) Draft Housing and Business Choice Plan Change (PC14)
[3] Christchurch City Council (2022) NPS-UD and Commercial Changes – the detail.

heights that are enabled by PC14 would be lower than microwave radio communication pathways. Council's latest assessment suggests that only 11 sites are now impacted by the microwave radio communication pathways heights. While not assessed, this difference would likely mean that the impacts are much lower than suggested in the following report. Specifically, the inclusion of microwave radio communication pathways as a Qualifying Matter in PC14 would be even more beneficial than what is shown in the following report.

In summary, it is considered that overall findings in the report below that relate to the microwave radio communication pathways are unaffected by these changes and are relevant to the planning process.

Yours sincerely,

Rodney Yeoman

Director

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# Christchurch Justice & Emergency Services Precinct Radio Communication

## Cost Benefit Analysis

**Ministry of Justice and Emergency Services**

**17 March 2022**

Formative

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# Contents

# Figures

# 1 Introduction

Emergency communication are a critical part of the response to both daily and large-scale emergencies. The maintenance of quick and unbroken communications between personnel responding in the field to an incident and the response coordinators at the operation offices is imperative, as delays in response can be the difference between life and death in an emergency situation. Continual and unbroken emergency communications can reduce the potential damages that can occur as a result of an emergency event, which includes a reduction in impacts on property, buildings, injuries and potentially preventable loss of life.

Given the importance of emergency communications, it is clear that for the good of the community they need to be maintained. This report is not focused on whether communications should be maintained, but rather on the options for maintaining these communications.

To avoid any confusion, it is clear that emergency communications must be maintained. This report is tasked with assessing the costs and benefits associated with the alternative options, policy or mitigation, that could be used to maintain the emergency communications in Christchurch.

Following the Christchurch earthquakes, a new Christchurch Justice and Emergency Services Precinct (CJESP)[4] was constructed in the Central City, which brings together all justice and emergency services agencies into one purpose-built precinct that can operate off the grid for 72 hours (IL4 standard).

The design for the communications systems at the CJESP consolidated numerous existing radio systems and services based across Christchurch, to one site. The radio communication facilities installed on the roof of CJESP were constructed to ensure fixed radio links to four key outlying sites. These links provide daily communication coverage for Police, FENZ, and St John, and a direct link to the airport.

The CJESP is presently the tallest building in the southern part of the Central City with the permitted height limits in the operative District Plan mostly being lower than the pathway of the Emergency Radio Communication Links (ERCL).

Recently, there have been two instances where landholders have applied for resource consent to undertake developments that intrude into the pathway of the ERCL. Also, the government has introduced new intensification requirements which are likely to result in more development being enabled in the corridors of the ERCL.

[4] The CJESP is made up of the Justice Building, the Emergency Services Building and a car park for operational vehicles.

The Christchurch City Council (CCC) and justice and emergency services that operate in the CJESP have proposed a change to the District Plan (Plan Change 9F – "PC9F") which would include a new sub-chapter in Chapter 6 to protect ERCL from adverse effects resulting from buildings, structures, utilities, and trees intruding into the pathways. This report provides economic research of the costs and benefits associated with PC9F policy, other policy options, and mitigation options.

## 1.1 Background

ERCL fall under the definition of "strategic infrastructure" which is necessary infrastructure facilities, services, and installations that are of greater than local importance. The District Plan seeks to protect strategic infrastructure from incompatible development and activities by avoiding adverse effects on them.[5] There are currently no explicit provisions in the District Plan that protect the ERCL. However, the maximum building heights set in the District Plan are mostly lower than the ERCL pathways, which provides implicit protection[6].

Critically important to this report is that the government has made policy changes that are intended to increase intensification, which was first defined in the National Policy Statement for Urban Development[7] (NPSUD) and has recently been codified in the RMA legislation (via the Housing Supply Amendment Act, Schedule 3B) [8].

Under this new policy and legislation Tier 1 councils, which includes Christchurch City Council, will be required to remove maximum height restrictions in the City Centre zone. The NPSUD policy came into effect in August 2020, with councils having until August 2022 to implement the height changes. Also, the Housing Supply Amendment Act (HSAA) has been introduced (under urgency) in December 2021 to bring forward and codify in legislation the implementation of the intensification required in the NPSUD.

Due to the changes in national policy, the risks to the ERCL are:

- That new buildings reach high enough to degrade or completely block existing microwave and UHF communication pathways from CJESP. Also, under the current rules in the District Plan, building and resource consent applications can be approved by CCC without consultation with the CJESP agencies.

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[5] Christchurch District Plan 3.3.12(b)

[6] The permitted height limits in the Airport UHF corridor do not exclude all development that could intrude into the pathway.

[7] Ministry for the Environment (2020) National Policy Statement on Urban Development – July.

[8] Government Bill (2021) Resource Management (Enabling Housing Supply and Other Matters) Amendment Act – Passed December 14th.

- Potential for costs to be incurred to supply engineering assessments where there is any likelihood or potential for impacts to ERCL. This could extend to appeals or additional remediation engineering and installation (if any such options exist).

## 1.2 Scope

The focus of this report is to provide economic research of the costs and benefits associated with maintaining or protecting ERCL from the CJESP, including to:

- Quantify, to the extent possible, costs and benefits of the proposed PC9F relative to the status quo of the operative height limits, and height limits enabled under the national policy.
- Establish which stakeholder groups will bear the costs and benefits. This includes landholders, the Ministry of Justice, and other parties.
- Assess the costs and benefits of alternative options for enabling communications, including increasing the antenna size; increasing the transmitter power; locating antennas and possibly equipment on other buildings to allow transmission over that building; and installing a new site on another building to redirect the beam going around the intrusion.

This report adopts the Cost Benefits Analysis (CBA) method which is an economic assessment framework that is used to assess the outcomes from a policy or investment. CBAs are commonly used by local and central governments to improve decisions on public spending or policy. The key aspect of the CBA method is to quantify the flow of costs and benefits that are expected to be generated in the future from the public spending or policy options. These values can then be compared with the investment of public money to establish whether the benefits of the investment outweigh the costs, i.e. what is the net position of the public spending or policy.

## 1.3 Structure

This report is structured into five subsequent sections, as follows:

- Section 2 discusses key aspects of the CJESP and ERCL, and the areas that are in the transmission corridors.
- Section 3 outlines the potential options for protecting the ERCL, which includes the operative District Plan, proposed PC9F, HSAA/NPSUD, and the alternative mitigation options that could be adopted.
- Section 4 describes qualitatively the range of costs and benefits that flow from the protection of the ERCL, and to whom these costs and benefits accrue.

- Section 5 quantifies, where possible, the costs and benefits associated with the different potential policy or mitigation options. This assessment provides an estimate of the net outcome, to establish which option produces the best outcome for the community as a whole.
- Section 6 provides the findings of the research.

# 2 CJESP Emergency Communication

The CJESP houses eight agencies Ministry of Justice, NZ Police, Corrections, Fire and Emergency NZ (FENZ), St John, Christchurch City Council, Emergency Management Canterbury, and Ministry of Civil Defence and Emergency Management. These agencies have critical roles in the response to both daily emergencies and large-scale disasters. The agencies in the CJESP must have the ability to provide communications to the rest of Canterbury, to ensure that personnel can be coordinated to maintain the safety of the community.

The precinct is located on the southern edge of the Central City Business Zone, on the block between Tuam, Lichfield, and Durham Streets. Most of the land to the south and west of the CJESP is commercial, with buildings of less than four levels.

**Figure 2.1: Christchurch Justice and Emergency Services Precinct**


While the focus of this report is on ERCL, it is acknowledged that the agencies within CJESP use multiple communication links. The other communication links from the CJESP include commercial networks (landline, fibreoptics, and cellular network) for general communications and satellite uplinks as a last resort. [9]

The ERCL is used for daily operational communications for small-scale incidents (business-as-usual) and also for major emergencies. Each of the ERCL is used to provide connections from the Precinct Communications Centres to radio networks that cover Canterbury (Police and Fire) or all New Zealand

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[9] Richard Smart (2021) Operational aspects of CJESP Radio Communications and discussion 6/12/2021.

(Ambulance). A vital function of the communications on the ERCL is to alert (turnout) crews to respond, manage and coordinate responding crews and appliances.

The ERCL is in daily and continuous use – not just in extreme circumstances. This daily use of the radio network is important as it ensures that personnel are proficient in the system, so that when a major event occurs communications are easily maintained. Also, the continued use of the system ensures that any faults or failures in the system can be identified and fixed immediately, which ensures that these issues do not result in loss of communications during a major emergency.

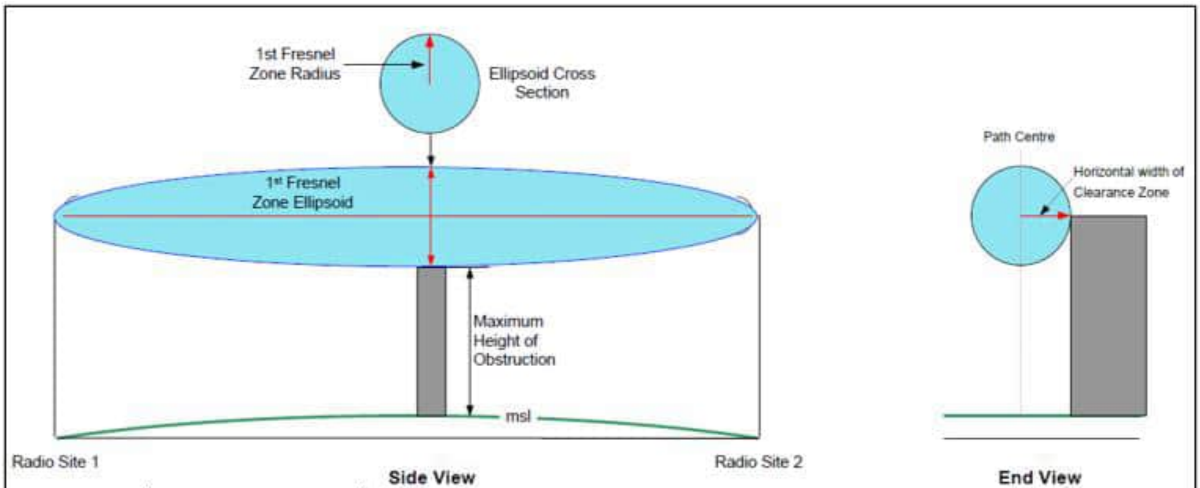
Finally, there are also plans for all of government communication links, with Next Generation Critical Communications group investigating the potential for one combined system for all agencies, which is expected to include radio communication links and potentially satellite links.[10]

## 2.1 Emergency Radio Communication Links

There are five ERCLs transmitted from the CJESP which provide communications for the various emergency services and one backup corridor which does not currently have communications. The radio links are transmitted from the roof of the CJESP out to receivers to the west of the city at Christchurch Airport (two links), south to the Port Hills (three links), and the backup corridor to Sugarloaf (no link).

There are two types of ERCL transmitted from CJESP, microwave, and UHF. While each of the links has different properties, they have an elongated ellipsoid shape along the pathway, which is narrower at each end with a circular cross-section (Figure 2.2).[11]

**Figure 2.2: Emergency Radio Communication Link Pathway**

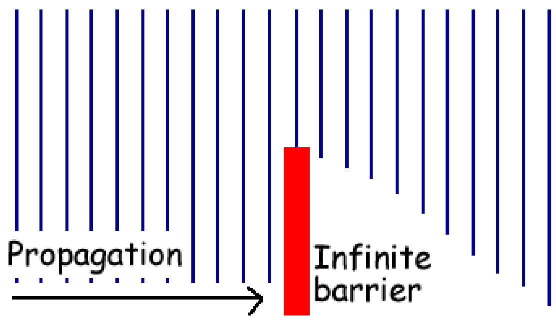



*Source: RHW Telecommunications Limited*

[10] NGCC (2021) Public Safety Network: Strategy and Benefits.
[11] RHW Telecommunications Limited (2021) Emergency Radio Communication Pathway Diagram.

Any obstruction of the radio pathway by buildings, vegetation, and/or terrain can impact the radio signal. However, the transmission of a signal will generally be partially blocked by a building (infinite barrier), which tends to create a disruption that dissipates because of diffraction (see Figure 2.3). In simple terms, diffraction of the signal can allow the communication link to bend around objects.[12] This issue is taken into account when assessing the extent to which obstructions can be accommodated within the transmission pathway of the ERCL.

**Figure 2.3: Radio Communication Propagation, Barrier and Diffraction**




### 2.1.1 Microwave Links

There are two microwave links (11.2 GHz), which are transmitted from CJESP to the Port Hills and are received at Cashmere/Victoria Park and Mt Pleasant (see Figure 2.4). There is also potential for an additional link to Sugarloaf, however this would require new equipment to be installed at the site.

The microwave links carry many voice and data circuits at once. Failure or interruption of the microwave link will impact many radio channels with the potential to lose communications over the whole province or more. The Cashmere/Victoria Park and Mt Pleasant links are bi-directional, they both send and receive the same communications and act together as a circuit to ensure that there is redundancy in the system.

Specifically, if Mt Pleasant fails then Cashmere/Victoria will still carry the communications and vice versa. This is important as the communications are designed for 99.99% of atmospheric conditions, and there is potential for the planned or unplanned interruption in one link.[13]

For example, in extreme rain conditions, there is a risk that one microwave link could fade out and communications are lost on one of the links. Also, the links require maintenance once or twice a year, which means that a link can be planned to be taken down for a short period. There is also a risk of an unplanned outage with a link failing occasionally, however this is very rare and tends to happen only every few years or so. There is also the risk of large-scale natural disasters damaging one of the radio

[12] RHW Telecommunications Limited (2021) Radio Engineering Requirements for CJESP Radio Corridors.
[13] Emergency services in New Zealand use combinations of Fibre Optical circuits, and/or additional microwave circuits to ensure that the service remains as close as possible to 100% available.

masts on the hill sites. All of these reasons justify the use of the two links, which provides redundancy as it is less likely that both sites would be down in the same incident.

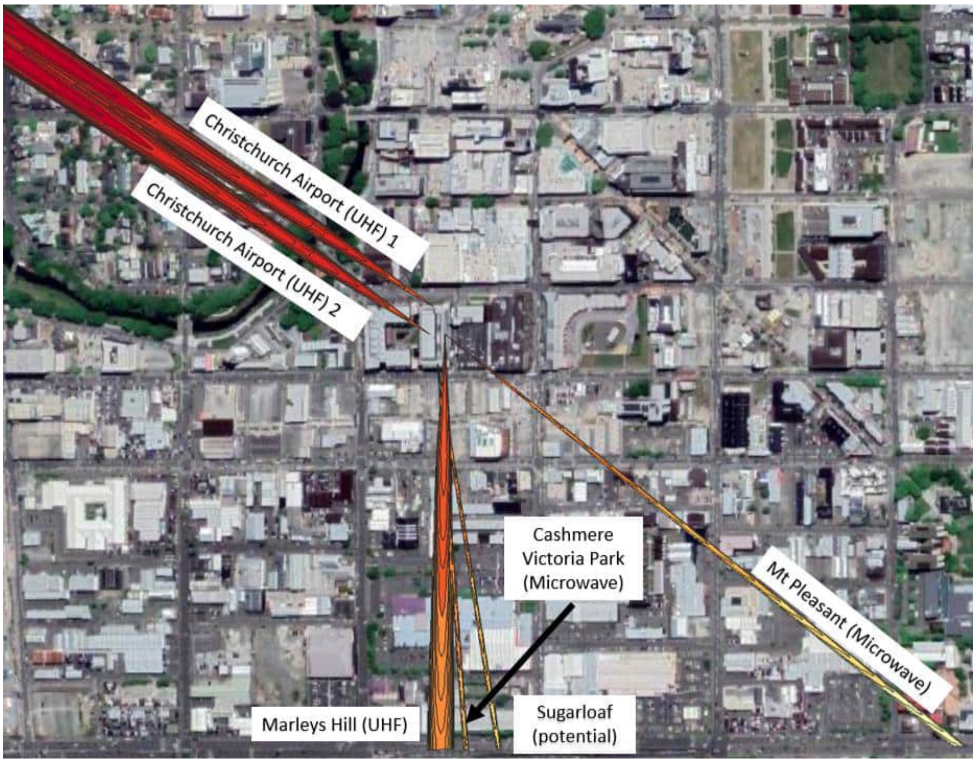
Finally, the Cashmere/Victoria Park and Mt Pleasant sites are linked together with the Sugarloaf in a ring system, which adds further protection of the communication links. The potential for the additional link to Sugarloaf provides an additional medium-term backup, which could be brought into operation if required, with the addition of communication systems at both Sugarloaf and CJESP.

The Cashmere/Victoria Park and Mt Pleasant microwave links are critically important, as they carry communications for the police and FENZ. These ERCL provides the communications between dispatch and personnel, both for day-to-day operations and large-scale emergencies.

The beam of microwave links is much tighter than UHF, which means that any intrusion by a building along the path will significantly reduce the communication link. The tightness of the microwave link also means that volume of airspace that is needed to ensure the link is maintained is relatively narrow (see Figure 2.4). This means that the protections that may be required are relatively confined for these links, both in terms of width (corridor) and height (pathway) of the beam.

At Tuam Street, the airspace is less than 4 metres in diameter, which increases to 20 metres by the time they reach Moorhouse Avenue. The microwave links start at around 26 metres above ground level at the CJESP and all increase to over 50 metres above ground level by the time they reach Moorhouse Avenue.

**Figure 2.4: CJESP Emergency Radio Communication Corridors – Microwave Link and UHF Link**



### 2.1.2 UHF Link

There are three UHF links that are transmitted from CJESP. One link is received at Marleys Hill and two at Christchurch International Airport (see Figure 2.4). The contour of the land means that the height (above ground) of the UHF link to Christchurch Airport is much lower than the other links, ranging from 8 metres to 16 metres for the parts of the pathway in the Central City and down to as little as 2 metres in Hagley Park. This compares to Marleys Hill UHF link which increases from 24 metres at the CJESP and reaches 38 metres at Moorhouse Avenue.

The beam of a UHF link is much wider than a microwave link, with the two Airport beams combined having a width of 70 metres when they reach Rolleston Avenue and the Marleys Hill beam having a diameter of around 40 metres by the time it reaches Moorhouse Avenue.

The UHF beam can maintain communications with a large amount of intrusion along the path. For example, the UHF radio link between CJESP and the Airport is partially obstructed by trees and a building along the path (mostly within Hagley Park), and several buildings (Quest on Cambridge, PWC building, EY building, and West End Carpark). While obstructed in part, the UHF link to the airport is still operational. The UHF beam can tolerate intrusions before the communication link is lost, so it needs to maintain at least 60% clearance to be operational.

The broader transmission path of UHF means that the volume of airspace that is covered is relatively large, however the nature of the UHF means that more intrusion into the path can be tolerated. This means that the protections of these links do not need to be as rigid. However, the signal path is narrowest at either end (see Figure 2.2) which means that size of the blockage(s) required to cause a significant impact on the UHF link decreases near the beginning of the corridor, which becomes much less likely to occur outside of the Central City.

Also of importance is that the UHF links are unidirectional, with communications only being sent in one direction. In this case, one of the Airport UHF links transmits out from the CJESP while the other is a receiver of communications from the Airport. The Marleys Hill UHF link only transmits communications out from the CJESP.[14]

The Airport UHF links provide a direct link into the airport's communications network, which is used by St John and FENZ in the event of a major emergency (aviation accident, etc). This link is an official direct link that is a backup to the normal 111 network, which can be overwhelmed in a major emergency.

[14] There is a UHF link transmitted back from Marleys Hill to the CJESP. This link repeats the outgoing message so that the system can confirm that the communication was received at Marleys Hill. This incoming link is encompassed by the outgoing UHF link, so is protected by the same corridor.

The Marleys Hill UHF link is used by St John to send pager messages to personnel. This system is additional to the other communication methods, with St John personnel receiving the same message via multiple links which ensures that messages are received.

## 2.2 Other Communication Links

The agencies in CJESP also use other methods for communications, which include the commercial landline, cellular networks, and fibreoptics[15]. While these methods of communication are reliable for most emergency incidents, they are vulnerable to large-scale natural disasters, which can disrupt land-based infrastructure. Also, these networks can become overwhelmed by large volumes of public communications, which tend to occur during a major incident.

A clear example of this is the recent earthquakes in Christchurch, where land-based communication infrastructure was knocked out and the large volume of public communications overwhelmed the remaining undamaged system. While major events are rare, these land-based communication infrastructure can be susceptible to disaster, flood, tsunami, weather events, earthquakes, etc.

The CJESP also has satellite links, however these currently have limited capacity and they represent the last resort communication method. They are currently capable of allowing limited communications to other national operation centres, rather than communication to personnel in the field.

Finally, it is important to note that in 2020 the government established the Next Generation Critical Communications Executive Governance Board and Next Generation Critical Communications (NGCC) organisation, who "will replace emergency services radio networks that are up to 30 years old and rely heavily on voice communications, with limited national coverage", with $47.8m budget allocated to develop a combined Public Safety Network (PSN).[16]

The tender process on the PSN (Te Kupenga Marutau Programme) was recently completed, which will purchase "leading-edge communication technology, which will enable the emergency services to maintain law and order, keep people safe, protect life and property, and deal with health events."[17] The project has not yet been awarded to a supplier, however it is the government's plan that Fire and Emergency, Police, and St John will use the PSN by 2022.[18]

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[15] In the last two years in the South Island alone, there have been two significant bridge washouts that have caused fibre outages that lasted several days. A third event was a 'near miss' and would have caused widespread internet and other service interruptions with a long restoration time.
[16] Minister of Police Stuart Nash (2020) Independent oversight of emergency services communications project – press release 28th August.
[17] GETS 23829934 Public Safety Network – Closed 7th May 2021.
[18] NGCC (2021) Public Safety Network.

While the NGCC organisation is leading a process that will result in an evolution of communications, the organisations at the CJESP considered that ERCL will still be required for many years and that the PSN will be expected to maintain the existing ERCL. It is considered that satellite will be useful for remote areas of New Zealand but given the existing technology that radio communications will still be required for most communications.[19]

The ERCL from the CJESP provides critical daily communication and redundancy for these other communication infrastructures when major events occur, which is vitally important.

## 2.3 Emergency Radio Communication Link Corridors

As shown in Figure 2.4 the ERCL corridors extend west and south, across land that is mostly used for commercial activity. In total, the ERCL corridors traverse 84 parcels of commercial land, which in total have 20.1 hectares of land (excluding land beyond Rolleston Avenue – i.e. Hagley Park). The ERCL corridors directly cover 4.3 hectares or 21% of the land in the parcels that are traversed by the ERCL corridors. Also, most of the land directly under the corridors is located under the Airport UHF pathway, which has almost half of the land impacted. However, the Port Hill Microwave corridor crosses almost half of the parcels that are within the corridors.

**Figure 2.5: CJESP Emergency Radio Communication Link Corridors – Parcels and Land**

| CJESP Radio Communication Corridors | Parcels in Corridor | Land Area | | |
|---|---|---|---|---|
| | | Parcel (ha) | Corridor (ha) | % in Corridor |
| Port Hills Microwave | 47 | 13.7 | 0.8 | 6% |
| Marleys Hill UHF | 16 | 5.7 | 1.1 | 20% |
| Airport UHF* | 26 | 5.5 | 2.3 | 42% |
| **Total CJESP Corridors**** | **84** | **20.1** | **4.3** | **21%** |

**excludes land beyond Rolleston Avenue, Hagley Park, Botanic Garden and Christ College*

***unique count, only counts a property once if it is in any corridor.*

In total, the parcels have buildings with a total floorspace of 150,000m$^2$.[20] The intensity of development is relatively low with an average Floor Area Ratio (FAR)[21] of less than 1, with very few buildings over four levels. The following subsection describes the types of activity that are currently located within each corridor.

[19] Richard Smart (2021) Operational aspects of CJESP Radio Communications and discussion 6/12/2021.
[20] Christchurch City Council (2021) Rateable Units Database.
[21] The ratio of floorspace to the land area on which the floorspace is accommodated.

### 2.3.1 Airport UHF Corridors

The Airport ERCL corridors traverse land that is zoned Central City Business (CB), some Residential Central City (RCC), and a small amount of Residential Guest Accommodation (RGA). Much of the land has been redeveloped after the earthquakes and there are several historic buildings in the area.

**Figure 2.6: Airport UHF Corridors and Parcels - Zones**


Moving along the ERCL corridors east to west out from the CJESP, the following parcels of land and activities are traversed (refer to Figure 2.7).

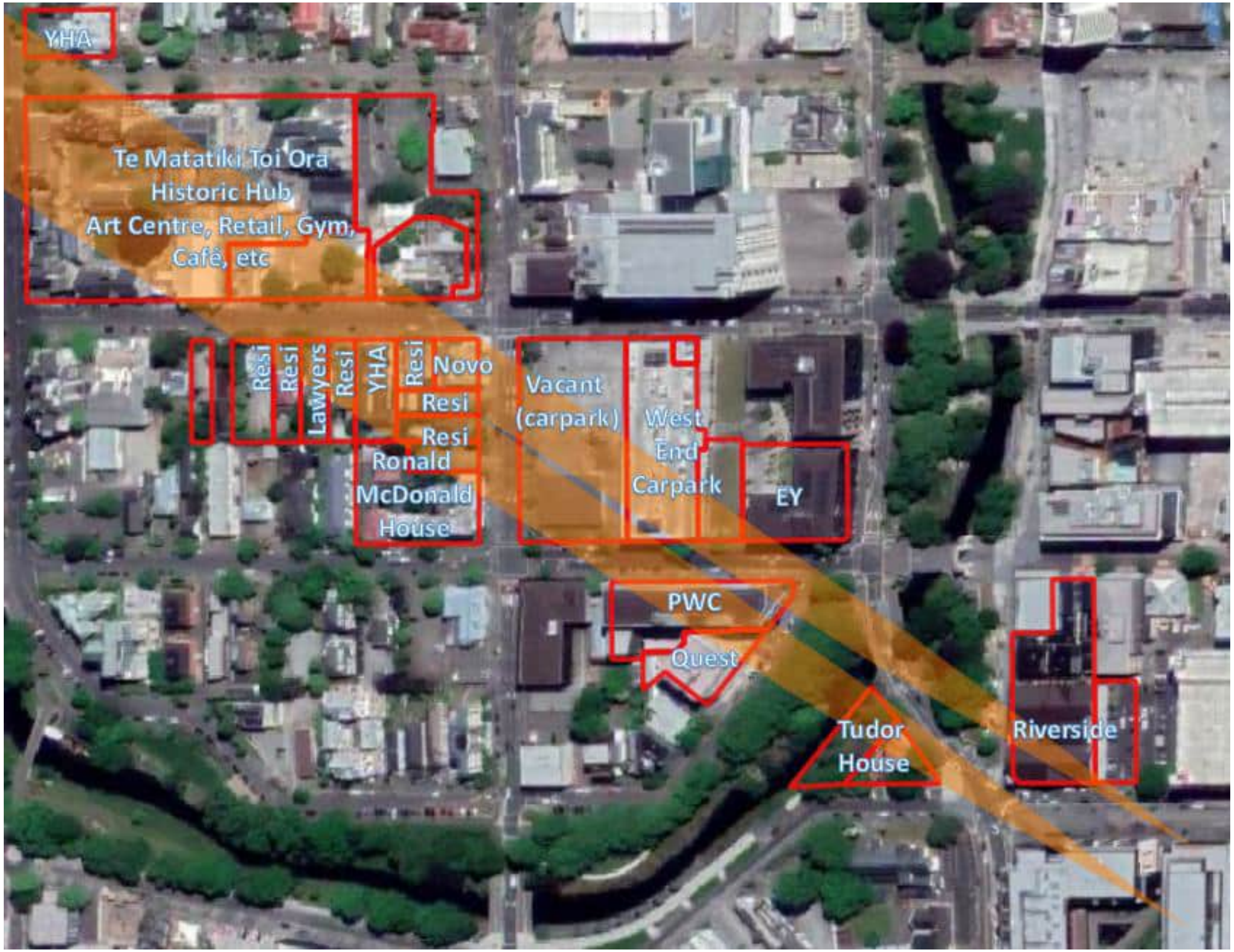
- **Riverside**: on the corner of Oxford Terrace and Lichfield Street, across the road from the CJESP and was built in 2019. It is a delicatessen and marketplace, which has two levels of retail and hospitality space.
- **Tudor House**: is a heritage-listed two-level building that was built in 1907 On a triangular site bordered by Oxford Terrace, Durham Street, and the river. Currently, there is a restaurant operating from the building, Regatta on the Avon.

- **Quest on Cambridge**: Quest will open a new hotel in a renovated six-level building in mid-2022.
- **PWC Centre**: a five-level office and mixed-use building that was constructed in 2016. The building is leased by a range of tenants, including PWC, Tonkin+Taylor, Chapman Tripp, EQ Consultants, etc.
- **Pita Te Hori Centre (EY)**: a five-level office and mixed-use building that was constructed in 2017 by Ngāi Tahu Property. The building is leased by a range of tenants, including EY, Aurecon, Vero, Ministry of Education, etc.
- **West End Carpark**: six levels of car parking, which was constructed in 2017 by Ngāi Tahu Property.
- **Vacant/Carkparking**: a large lot of land that is used for at grade car parking and portable building with NZ Post Private Boxes.
- **Ronald McDonald House**: a new (2015) four-level accommodation building that has 26-bedrooms, with shared facilities, which provides a 'home-away-from-home' for families who must travel to Christchurch for their child's medical treatment.
- **Residential houses**: there are five pre-earthquake single and double-level houses under the pathway.
- **Novo Group Planners**: a heritage art deco office building that is occupied by planners.
- **YHA Hostels**: has two locations in the area, Christchurch Backpackers (36 Hereford Street) and Rolleston House Backpackers (5 Worcester Steet).
- **Brandts-Giesen McCormick Lawyers**: have offices within a double-level residential house.
- **Te Matatiki Toi Ora**: comprises 22 heritage-listed buildings that are being used as an art centre and museum, with some auxiliary commercial activity (café, some retail, and a gym). The buildings were damaged in the earthquakes, but are being progressively restored.

Of the 26 parcels and 5.5ha of land within the Airport corridor, most of the land is heritage (2.5ha) or recently redeveloped (1.7ha), which means that most of these sites are unlikely to be redeveloped in the coming decade(s).

There is one parcel that is vacant and nine with pre-earthquake buildings that may be redeveloped in the coming decades, with a total land area of 1.2 hectares. These sites are mostly less than 700m$^2$, which also suggests that development potential on these sites may be limited.

Figure 2.7: Airport UHF Corridors - Parcels and Land use



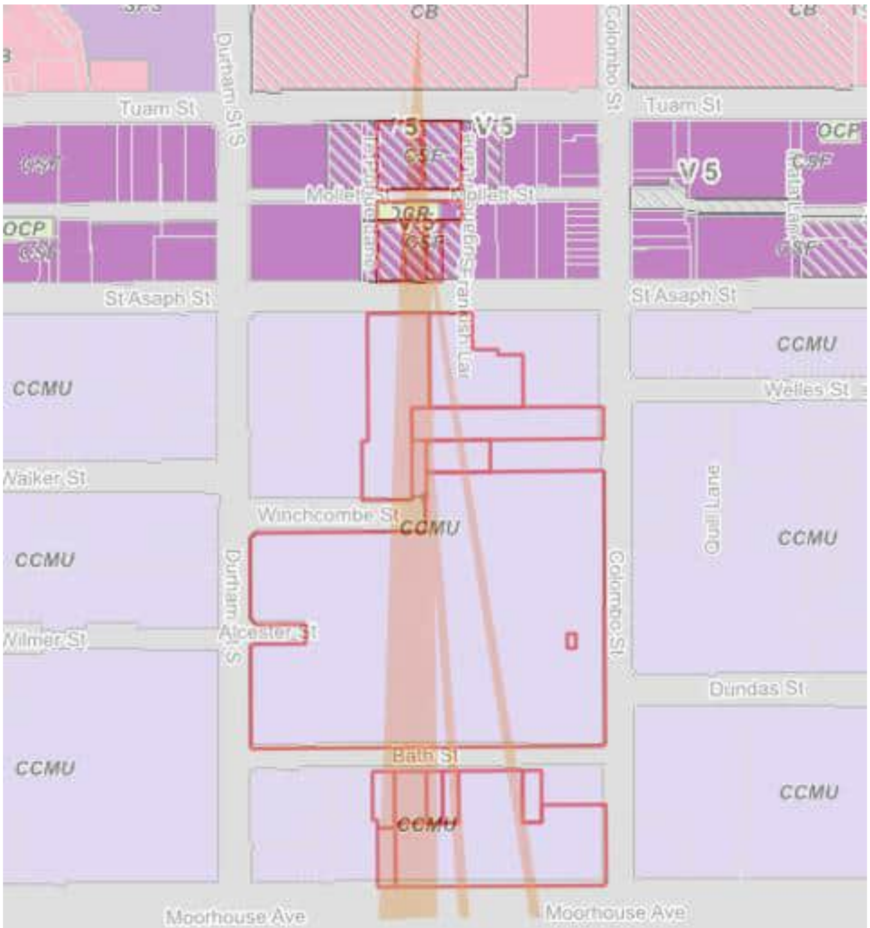
## 2.3.2 Marleys Hill, Cashmere, and Sugarloaf Corridors

The Marleys Hill, Cashmere/Victoria Park, and Sugarloaf ERCL corridors traverse land that is zoned for mixed-use, City South Frame (CSF) and Central City Mixed Use (CCMU), and a small amount of open space. Most of the land under the ERCL corridors has not been utilised very intensively, with a considerable amount of at grade parking and large-scale retail.

There was recently a resource consent application to build a six-level building, at 150 Tuam Street and 9 Mollet Street which is directly opposite the CJESP. This development was granted consent and will include commercial on the ground floor, residential apartments above, and a car parking area. It is also understood that a resource consent has been submitted for a six-level hotel immediately adjacent to the residential apartments. Both applications sought to exceed the 17 metre permitted height limit (Rule 15.12.2.1 Building height) and impacted the microwave pathways.

One of these paths was (just) able to clear the building, however, the second path required a microwave antenna to be relocated, as this would have completely blocked the pathway, cutting off communications. The affected agency was able to relocate this antenna, but at a cost of tens of thousands of dollars.

**Figure 2.8: Marleys Hill, Cashmere, and Sugarloaf Corridors - Zones**



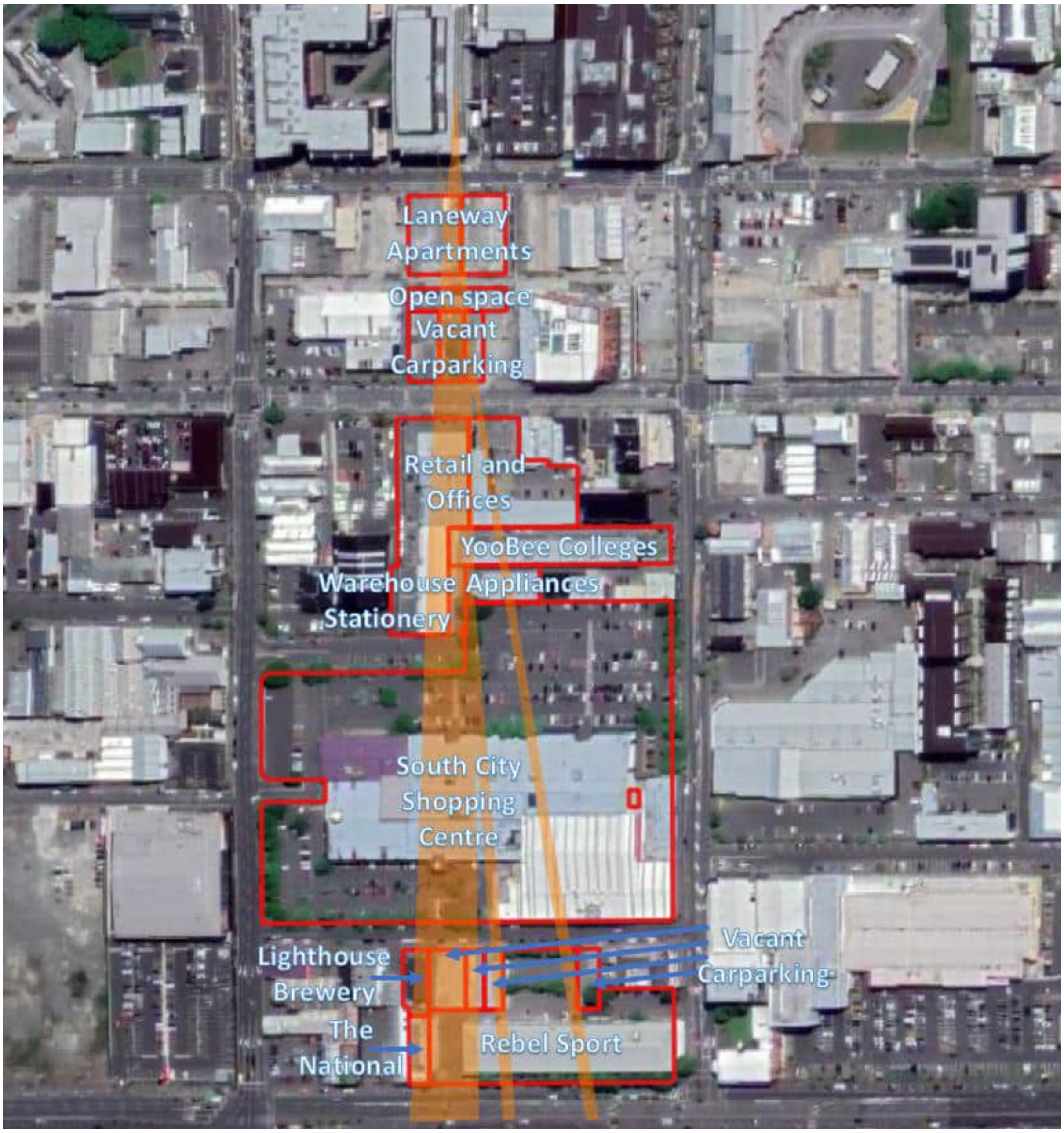
Moving along the ERCL corridors north to the south out from the CJESP, the following parcels of land and activities are traversed (refer to Figure 2.9).

- **Laneway Apartments**: a six-level building currently under construction, immediately opposite the CJESP on Taum Street (as discussed above).
- **Carparking St Asaph Street**: at grade car parking lot, which is vacant.
- **Retail/Offices**: two-level buildings with retail on the ground and offices above. The tenants include lawyers, a boxing gym, handmade goods, and Warehouse Stationery.
- **YooBee Colleges**: a two-level building which has a school of design, animation, film, and technology, which offers short courses and online study.
- **Appliances Store**: a two-level building which is used for retail.
- **South City Shopping Centre**: a shopping mall that has a range of retail and services, which includes major anchor tenants, The Warehouse and Chemist Warehouse. The mall was built in 1990s.
- **Lighthouse Brewery:** is located within a single-level warehouse building.
- **Carparking Bath Street (20, 24, 26, and 36):** several small parcels that have at grade car parking lot, which is vacant.
- **The National**: is an art dealer/gallery that specialises in jewellery, which is located in the old Lime Works building.
- **Rebel Sport**: a large format retail store that extends across most of the block.

Of the 18 parcels and 5.8 hectares of land within the Marleys Hill, Cashmere/Victoria Park, and Sugarloaf ERCL corridors, most are either pre-earthquake buildings (5.3ha) or vacant (0.3ha). Many of these sites in the area are large, ranging from 2000m$^2$ to upwards of 30,000m$^2$, which suggests that development potential on these sites could be considerable.

As discussed above, two parcels are currently under construction, with a total land area of 0.2 hectares. Once completed, it is considered that these sites are unlikely to be redeveloped in the coming decades.

Figure 2.9: Marley Hill, Cashmere, and Sugarloaf Corridors - Parcels and Land use



## 2.3.3 Mt Pleasant Microwave Corridor

The Mt Pleasant ERCL corridor traverses land that is zoned for mixed-use, City South Frame (CSF) and Central City Mixed Use (CCMU), and a small amount of Specific Purpose Tertiary Education (SPT). More of the land has been utilised, however still at low intensity, with considerable numbers of small-scale retailers and some large-scale retail.

**Figure 2.10: Mt Pleasant Microwave Corridor - Zones**


Moving along the ERCL corridor west to the east out from the CJESP, the following parcels of land and activities are traversed (refer to Figure 2.9).

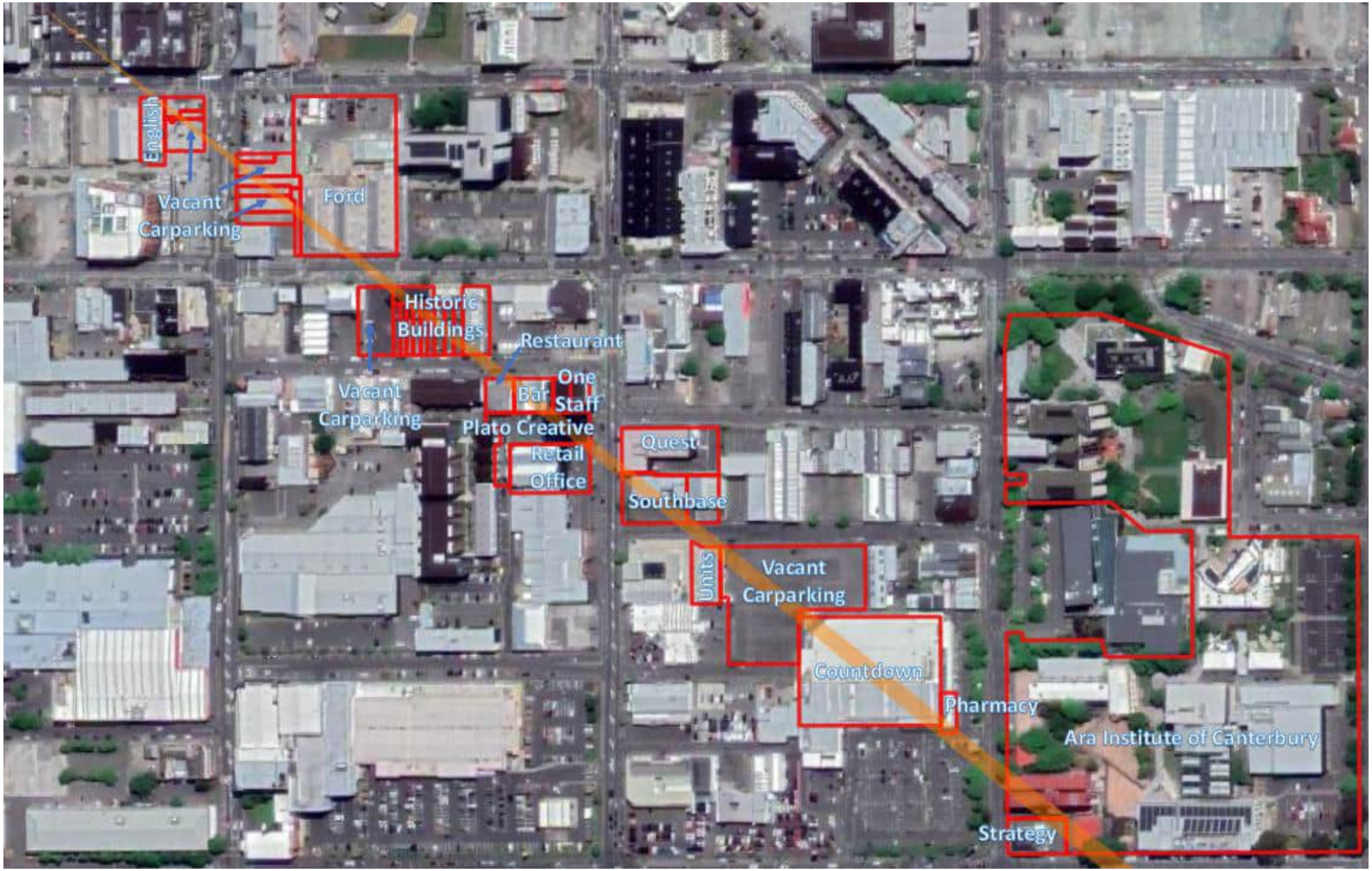
- **English School:** the Canterbury College operates out of a single-level building, providing English courses.
- **Carparking Colombo Street**: several small parcels that have at grade car parking on both sides of Colombo Street, which is vacant.
- **Ford**: a dealership yard and showrooms, with a large service and tyre centre in an old warehouse.
- **Historic Buildings**: there are several two and three-level historic buildings on St Asaph Street, ranging from 1878 to 1903, which are currently used for offices with car parking along Welles Street.

- **Carparking Welles Street**: a group of small parcels that have a car parking lot, which is vacant.
- **Restaurant**: the Winnie Bagoes City restaurant is located in a newly refurbished two-level building.
- **Bar**: the Welles Street pub, operates out of an old single-level warehouse building.
- **One Staff**: a newly constructed four-level building with offices on the upper floor (One Staff) and a café on the ground floor (Raw Sugar).
- **Plato Creative**: a newly constructed two-level building with offices in the upper level (Plato Creative) and a gym on the ground floor (Iron Hood).
- **Retail and Office**: several small retail businesses operate out of this older two-level building (Hi Tea, Kiwi grab, etc).
- **Quest on Manchester**: a new three-level commercial hotel built in 2019, which includes 46 serviced apartments including studio, one, and two bedroom apartments.
- **Southbase**: a construction company, which includes offices and storage/warehouse.
- **Shop Units**: two units that are occupied by a screen printer (Goose) and a motorbike rental/tour operator.
- **Countdown/Pharmacy**: several retail activities are located in this large building, including a supermarket and a pharmacy.
- **Ara Institute of Canterbury**: operates on most of the block between Moorhouse Avenue and St Asaph Street, which means that only a small part of the campus is under the ERCL corridor.
- **Strategy**: a heritage two-level building which is used for offices by a creative branding company.

Of the 40 parcels and 8.8 hectares of land within the Mt Pleasant corridor, most of the land is either pre-earthquake buildings (7.1ha) or vacant (0.9ha). While most of these sites are small in the area, there are some large sites over 5,0000m$^2$ or upwards, which suggests that development potential on these sites could be considerable.

There is some heritage (0.3ha) or recently redeveloped (0.4ha) land, which is not likely to be developable in the coming decades.

**Figure 2.11: Mt Pleasant Microwave Corridor - Parcels and Land use**



## 2.4 Summary of CJESP Emergency Radio Communication Links

In summary, the CJESP communication links are critical to emergency response, both day-to-day events, and large-scale disasters. Although the agencies use multiple communication links, it is clear that ERCLs is vital.

While the government has begun the process of developing a new Public Communication Network that will consolidate and change the existing communication links, this process will evolve over the coming decade, which means that the ERCL from CJESP are likely to be needed for many years, if not the entire life of the District Plan. The agencies in the CJESP consider that the existing technology (cellular and satellite systems) are not currently at a sufficiently advanced point to allow CJESP to switch from the ERCL.

There are currently five ERCLs and one potential backup link. The microwave links to Cashmere and Mt Pleasant provide critical links for Police and FENZ, to allow communication to personnel in the field both for day-to-day events and large-scale disasters. Given the critical importance of the microwave links, there is a third potential link to Sugarloaf which could be used in new equipment was installed. The microwave links are much tighter, which means that disruption of communications can occur more easily. Also, the links are transmitted up to the Port Hills, which means that they increase in height quickly and are relatively high.

The three UHF links provide backup services, to allow direct communication with Christchurch Airport if a major event occurs (two links) and an outgoing pager service for St Johns ambulances which provides redundancy for other communication links. The UHF links are much wider, which means that they can maintain a link even if there are several intrusions into the pathway. However, this means that the UHF pathways are much lower to the ground, which means that new buildings can more easily intrude into the pathway.

The recent application for a six-level building at 150 Tuam Street and 9 Mollet Street, directly opposite the CJESP, shows a situation where development has interrupted one of the microwave links. This example shows that there is a real risk to the ERCL, even under the existing planning framework.

The review of activity along the ERCL shows that there are considerable differences between each of the corridors:

- **Airport Corridors (UHF)**: there is a lot of newly constructed buildings and heritage buildings in this pathway. This means that there is a limited number of places where new buildings could be constructed along the pathway and there are fewer opportunities for the ERCL to be disrupted.

- **Marleys Hill (UHF), Cashmere/Victoria Park (MW), and Sugarloaf Corridors**: there is a lot of pre-earthquake buildings in this corridor, with the parcels tending to be relatively large. This suggests that development potential on these sites could be considerable and there is further opportunity for the ERCL to be disrupted.
- **Mt Pleasant Corridor (MW)**: there is a lot of pre-earthquake buildings and vacant land in this corridor, which also tend to be relatively large. This suggests that development potential on these sites could be considerable and there is an opportunity for the ERCL to be disrupted.

# 3 Protection Options

This section draws information from the agencies in the CJESP and Christchurch City Council to define three policy options to manage the ERCL and four mitigation options. This is a fundamental step in the economic assessment, as the first step of the CBA is to define the counterfactual and alternative options that will be used in the remainder of the assessment.

The counterfactual is used as the baseline from which alternative options are tested, i.e. relative to the counterfactual does the option produce a better outcome (greater benefits than costs)? The correct definition of the potential options, including counterfactual and alternative options, is vital as it directly impacts the range of costs and benefits examined, and the resulting quantum.

Generally, the counterfactual is defined as the 'do nothing', 'do minimum', or even 'business-as-usual', whereas the alternative options allow for intervention or change. While this step may seem relatively uncontroversial, the definition of the options may not always be straightforward and could evolve over the research period, as has happened in this situation. In this study, there are both policy and mitigation options, which are discussed in the following subsections.

## 3.1 Policy Options

First, there are four policy options that need to be considered. These include the rules in the current operative district plan, the proposed PC9F, designation, and potential intensification enabled under the NPSUD (and codified in HSAA).

Based on the knowledge of the agencies in the CJESP, and of Council's planner and other communication experts, it is considered that there are no known instances in New Zealand where an ERCL has been protected explicitly within a District Plan or national policy. However, it may be that some plans have implicit protections which relate to maximum height limits in the district plan. Therefore, there is no existing precedent in any other jurisdiction on this type of protection.

The Christchurch situation may be unique because the government decided, after the earthquakes, to build a single precinct to house all the agencies in one location, which in turn resulted in the consolidation of emergency communications to this single location. Potentially this unique outcome has not been repeated elsewhere in the country as there has been no need for a complete rebuild of the emergence networks in other cities.

### 3.1.1 Operative District Plan

The Operative District Planning (ODP) framework was established following the earthquakes. It provided for a range of building heights in the Central City, with a maximum height limit for buildings of 30 metres. CJESP land is within the 28-metre height limit overlay.

The land to the south of the CJESP is within the 17-metre height limit overlay. This covers all of the land within the Marleys Hill, Cashmere, Sugarloaf, and Mt Pleasant ERCL corridors. The CCC building height data shows that currently there are no buildings in the corridor that exceed the overlay.[22] The new One Staff 4-level office building is the highest, at 14.6 metres. There are also taller buildings on the Ara Campus (at 23 metres), but these are located on the northern edge of the campus which is removed from the Mt Pleasant corridor. However, there is one building currently under construction which is going to reach 20.9 metres when completed, Laneway Apartments, 150 Tuam Street.

The land under the Airport ERCL corridors is mostly within the 28-metre height limit overlay, which covers the Commercial Central City Zone immediately to the west of the CJESP, either side of the Avon River. The three tallest buildings in this area reach up 24 metres[23], with the PWC, Quest, and EY buildings all intruding into the Airport ERCL corridors which is between 16 to 18 metres at this location. Further to the west, the block next to Hagley Park is within a 14-metre height limit overlay and with the highest building being Ronald McDonald house at just under 10 metres[24].

Under the current Christchurch District Plan provisions, exceeding the height limits relating to buildings in the Central City zones is mostly a restricted discretionary activity status and the matters of discretion do not include effects on ERCL. Therefore, the ERCL cannot be considered when assessing an application to breach the permitted height limits.

In a permitted activity context, the height limits in the District Plan are currently sufficient to ensure that the ERCL to the Port Hills is maintained and not disrupted. However, the permitted height limits in the Airport ERCL corridor do not exclude all development that could intrude into the pathway.

It has become apparent through recent developments that have breached the permitted height limits that there are limitations with the restricted discretionary activity rule framework meaning that the effects on the ERCL from new developments are unable to be considered.

### 3.1.2 Proposed Plan Change 9F

The purpose of PC9F is to include a new sub-chapter in Chapter 6 to protect ERCL from adverse effects resulting from buildings, structures, utilities, and trees intruding into the pathways. The Plan Change proposes the following amendments:

- Changing the definition of 'height' to remove the exceptions that may affect radiocommunication pathways;
- Inserting a new sub-chapter into Chapter 6 for the protection of Radio Pathways;

[22] Christchurch City Council (2021) Light Detection and Ranging Data.
[23] Ibid.
[24] Ibid.

- Inserting a new objective, policies, and rules requiring consent as either a restricted discretionary or non-complying activity for any buildings, structures, utilities, and trees above the maximum height limit;
- Inserting standards for the protection of radio pathway corridors including the requirement for an assessment of effects by a suitably qualified and experienced radio engineer and tables specifying the maximum height limit for any building, structure, utility, or tree within the pathway;
- Inserting an appendix which includes diagrams for interpreting the radio pathway corridors; and
- Amending Planning Map Central City Zoning, Other Notations, Designations, and Heritage Orders Planning Map to include a new overlay identifying each of the radio pathway corridors.

The area identified as being within the ERCL corridors is where a building has the potential to protrude into the radio communication path causing diffraction and hence the attenuation of the radio signal. The protections are identified in the new appendix as the bottom or lowest point of the pathway i.e. “Maximum Height Limit”, and the horizontal width as the widest part of the pathway i.e. “Clearance zone”. This protection is a box-like in shape, which is larger than the ERCL pathway, which is ellipsoid in shape (as shown in Figure 2.2).

The ellipsoid of the microwave ERCL pathways will be close in size to the protections proposed in PC9F. From a practical perspective, the two-dimensional protection that is proposed in PC9F is likely to be reasonably close to the actual three-dimensional communication pathway.

Conversely, the ellipsoid of the UHF ERCL pathways is much wider, which means that there will be more variance between the two-dimensional protection that are proposed in PC9F and the actual three-dimensional communication pathway. For example, on the outer parts of the corridor, the height of the ellipsoid of the UHF can be upwards of 10 metres higher than the heights proposed in PC9F. We note that during this project that Council has developed 3-dimensional model of the pathways. This report has been based on the PC9F two-dimensional protection, and if these were changed to the 3-dimensional model then the assessment could be updated.

It is acknowledged that the definition of the protections in PC9F is a balance between accuracy and clarity of information and that this simplified approach avoids having a complex three-dimensional matrix in the District Plan. In the UHF ERCL pathways, the applicants can still apply to build above the Maximum Height Limit.

For UHF ERCLs, development above certain heights would be a Restricted Discretionary activity, which reflects the fact that this link may not be impacted by some intrusions into the communication pathway and that the Maximum Height Limit does not reflect the three-dimensional cross-section of the pathway. The purpose of PC9F is not necessarily to prevent development in the pathways but to require consent so an assessment can be made of the potential effects on the pathway and mitigation investigated. The radio engineering assessment commissioned by CJESP agencies suggests "that mitigation is unlikely to be required unless the path is obstructed close to CJESP (20m away)" or if multiple buildings are obstructing the ERCL.[25]

For the Microwave links, development above certain heights would be a Non-complying activity, which reflects the fact that this type of link is more easily impacted by intrusions into the communication pathway.

In summary, PC9F would restrict the development heights in the ERCL corridors. The plan change introduces rules that trigger a need for developers to communicate with the agencies in the CJESP, so that the effects on the ERCL can be considered and where possible mitigations can be established.

### 3.1.3 Designation

Consideration was given to designating the radiocommunication pathways. The pathways would be included on the District Planning Maps and would place restrictions on what anyone other than the designating authority (CJESP) could do within the designated airspace.

This option is inconsistent with how similar protection corridors have been included in the Christchurch ODP. Specifically, the airspace around the Christchurch International Airport is managed by the way of objectives, policies, and rules to protect the approach to the airport to maintain a satisfactory level of safety. Designations have generally been used for land parcels rather than air space and provide less flexibility in terms of allowing development where alternative mitigation can be adopted.

However, there are examples of television communication links being protected in the old Christchurch District Plan using designations, and also examples in the existing Auckland Plan.

- **Christchurch TVNZ**: two designations restricted the development of structures into the airspace between the Gloucester Street Studios and Sugar Loaf (to south) and Mt Grey (to the north).[26] These pathways were relatively confined, but much lower heights than those in the ERCL from the CJESP.
- **Auckland TVNZ**: two designations restrict structures around the Auckland CBD television studios. The designation restricts development to the west and north, which

[25] RHW Telecommunications Limited (2021) CJESP Radio Corridors Link Mitigation Options, page 7.
[26] Christchurch City Plan 2005 – Appendix 4.

protect the microwave transmission and satellite path.[27] Given the contour of the land, the protections have a limited impact on development potential. For example, much of the designation is more than 200 metres above ground level, which is beyond the height of most buildings.

### 3.1.4 National Policy Statement Urban Development and Housing Supply Act

The NPSUD and HSAA are intended to remove overly restrictive barriers to development to allow growth up and out in locations that have good access to existing services, transport networks, and infrastructure.

Christchurch City is identified as a Tier 1 urban environment which means that the Policy 3 directive applies, and the Council is required to ensure that the District Plan enables building heights that provide "as much development capacity as possible" in city centre zones.

Councils can modify this requirement but only to the extent necessary to accommodate a qualifying matter in that area (Policy 4). Qualifying matters and how the intensification requirements can be modified are described in subpart 6 of the NPSUD. ERCL is not defined as nationally significant infrastructure and therefore are not considered a qualifying matter by clauses specifically stated in the NPSUD.

Clause 3.33(3) sets out that a matter is not a qualifying matter under clause 3.32(1)(h) unless the evaluation report also identifies the specific characteristic that makes the level of development directed in Policy 3 inappropriate and justifies why it is inappropriate in light of the national significance of urban development and the NPSUD. The evaluation must also include a site-specific analysis that identifies the site to which the matter relates, evaluates the specific characteristics on a site-specific basis to determine the spatial extent where intensification needs to be compatible with the specific matter and evaluates a range of options to achieve the greatest heights and densities directed by Policy 3 while managing the specific characteristics.

This policy has been codified within the Housing Supply Amendment Act, which also brings forward the requirement of councils to implement changes in their planning frameworks to enable intensification via an Intensification Streamlined Planning Process (ISPP). The HSAA is directive, it requires unlimited heights and densities within the Central City, and a minimum of six-levels within a walkable catchment of the Central City (unless a qualifying matter applies, as discussed above).

It is understood that the Council is considering the inclusion of ERCL as a qualifying matter by way of a plan change that will be notified in 2022. At this point, the Council is still assessing how it will

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[27] Auckland Unitary Plan – 8301 and 8302.

implement the intensification requirements and is commissioning research on the amount of intensification that should be enabled as well as qualifying matters.[28]

CCC has suggested that the following assumptions be adopted for determining the potential development that could be enabled within the ERCL corridors:

- **City Centre Zone**: for this assessment, it is assumed that the City Centre Zone comprises the area within the four avenues – i.e. area bounded by Bealey, Deans, Moorhouse and Fitzgerald Avenues. However, Hagley Park and the Botanic Gardens would be excluded.
- **Building Heights**: for this assessment, it is assumed there are no height limits within the City Centre Zone.

The above is based on an interpretation of the NPSUD that is more permissive and is one of several options still being considered. However, for the economic analysis, the above should be viewed as the maximum potential and there are several reasons why land within the four avenues will not be developable which includes heritage, open space, qualifying matters, other market factors, etc.

## 3.2 Mitigation Options

The agencies that rely on the ERCL could undertake mitigation to avoid the potential disruptions of the pathways. The range of mitigation options has been assessed by RHW Telecommunications Limited[29] and Kordia[30], who have estimated the cost and feasibility of the alternatives mitigations that could be employed. The following discussion provides a summary of the different mitigation options, which includes increasing the antenna size, increasing transmitter power, shifting the antenna on the CLESP, new relays on other buildings, and other communication links (i.e. consolidate ERCL).

### 3.2.1 Increasing the antenna size

The receive level can be increased by increasing the antenna size, increasing the antenna gain at an end will improve the receive level in both directions and increase the height of the ERCL pathway.

For the CJESP, the current antenna pole arrangement was designed with little or no capability for expansion, being constrained by the weight-bearing capacity of the main beams and columns of the building. RHW Telecommunications has suggested the following option for each of the radio communication pathways – which is called Mitigation Option 1:

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[28] Christchurch City Council (2022) GETS - Request for Proposal Economic Cost Benefits Advice for Intensification – Closed 28th January.
[29] RHW Telecommunications Limited (2021) CJESP Radio Corridors Link Mitigation Options.
[30] Kordia (2021) Justice and Emergency Services Precinct – Te Omeka Radio Corridor Protection Project – Structural
Engineering Response.

- **Airport**: there is no option available, as the antenna at the Airport cannot be increased in size.
- **Marleys Hill**: there is no option available, as the antenna at the Marleys Hill cannot be increased in size.
- **Cashmere**: the antenna could be increased in size by using an antenna of 1.2m diameter, and would increase the height that a building could reach by one floor at 20 metres from CJESP and two floors at 50 metres from CJESP.
- **Mt Pleasant**: the antenna could be increased in size by using an antenna of 1.2m diameter, and would increase that a building could reach by one floor at 50 metres from CJESP and two floors at 200 metres from CJESP.

The cost of the equipment and works to install the new antenna is expected to be in the order of $212,000. However, the feasibility of this mitigation option will depend on whether the building structure is strong enough to enable the larger antenna to be located on the roof of the CJESP and whether the Port Hills masts are strong enough.

### 3.2.2 Increasing the transmitter power

To increase radio transmitter power, the level must be increased at both ends of the link to be effective. According to RHW Telecommunication, it is unlikely that transmitter power can be increased without replacing the radio equipment, assuming suitable equipment can be found. Also, increasing transmitter power may not be possible because it will cause adverse interference to other radio links using the same frequency band.

RHW Telecommunication considers that the receive level cannot be practically increased for either the UHF or Microwave ERCL.

### 3.2.3 Shift antenna on CJESP to alternative pole

According to the RHW Telecommunication report, there is limited scope for changing the antenna position on the CJESP. One option would be to shift the microwave antennas to Pole 10 on the Justice Building, however this building is not IL4 standard and would need to be improved to ensure resilience in major events. RHW Telecommunication considers that there may be issues with the rigidity of the pole, in terms of the maximum deflection requirement for the microwave antennas.

Also, given the geometry, this option is likely only to be effective if the obstruction building is close to CJESP (within 100 metres) and the south. This option will only be useful for the microwave radio link to Cashmere, which could be employed if the car parking lot on St Asaph street was redeveloped and a building intruded into the pathway.

### 3.2.4 New relay antennas on another building

The ‘relay’ or middle site would ideally be located on the top of the building obstructing the current ERCL pathway, but it could be another location provided it had clearance back to CJESP and the Port Hills/Airport, and the agreement of the property owners.

To maintain the resilience of the ERCL any buildings used for the ‘relay’ site would need to be IL4 rated (NZ Building Code), capable of operating off the grid for at least 72hrs, and the means for mounting antennas with sufficient rigidity. This requirement is unlikely to be met by any commercial building since it is likely to be uneconomic for any developer. Therefore, a likely alternative location for the relay site could be the Middleton Railyards, which is a good location because:

- the path to this location probably has the lowest risk of being obstructed as most of the path is outside the “four avenues” crossing either South Hagley Park or low-density office/warehouse building along Blenheim Rd.
- There are already two high communications poles/towers in the area so getting resource consent for a 40-50m tower/pole is likely to be possible.

RHW Telecommunication has suggested the following option for each of the microwave ERCL pathways - which is called Mitigation Option 3a and 3b:

- **Building in Pathway**: the relay transmitter on the new building, which would cost $50,000 for equipment and upwards of $140,000 for engineering installation. However, relay site-building is unlikely to meet IL4 and hence the site is not considered resilient for emergency communications.
- **Other IL4 Building**: the relay transmitter on another public IL4 constructed building, which would cost $50,000 and upwards of $1.1 million for engineering installation. For example, a purpose built IL4 facility at Middleton Railyards with a 40+ metre tower.

**Figure 3.1: Middleton Railyard and Antenna view back to Central City and CJESP**


## 3.2.5 Other Communication Links or Consolidation

Once cost-effective and fit for purpose, the NGCC will evolve PSN's capability, transforming to digital radio – with full capability and nationwide accessibility.[31] However, it is not clear when this will occur and is beyond the control of the agencies in CJESP.

This option will only be feasible if the government invests considerable money in a national level system upgrade. The agencies in CJESP consider that radio communications will be required for the coming decade or more.[32]

Also, there is potential for some ERCL from CJESP, such as the Marleys Hill UHF, to be consolidated with other communications in the coming years as the PSN programme develops into one system.[33] As discussed in RHW Telecommunication report the Marleys Hill UHF could be consolidated with the microwave links.

# 3.3 Summary of Protection Options

In conclusion, there are several alternatives for maintaining ERCL from the CJESP. For the remainder of this report, the Operative District Plan (**ODP**) has been used as the counterfactual from which all other options are tested. Specifically, the assessment of costs and benefits compare the outcome under the alternative options as compared to the ODP.

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[31] NGCC (2021) Public Safety Network: Strategy and Benefits.
[32] Richard Smart (2021) Operational aspects of CJESP Radio Communications and discussion 6/12/2021.
[33] Richard Smart (2021) Operational aspects of CJESP Radio Communications and discussion 6/12/2021.

The following alternative protection options have been assessed:

- **PC9F**: the policy option that has been proposed by CCC and the agencies in the CJESP.
- **Designation**: a policy option of defining designations to protect the ERCL.
- **Mitigation Option 1**: the mitigation option to increase antenna heights to avoid intrusions in the microwave links and PC9F is updated to the new heights.
- **Mitigation Option 3**: the mitigation option to relay to another building or Middleton Railyards to avoid intrusions in the microwave links and no protection is afforded to UHF pathways. This reflects the intensification that may be enabled under the NPSUD and HSAA.

The PSN and potential for links have not been assessed independently. The PSN will evolve emergency communications over time, which will mean that the need for policy or mitigation options for CJESP can be expected to change accordingly. The PSN and potential for new links are a medium-term solution, which impacts the time over which the alternative options can be expected to have effects and is used to define the temporal extent of the CBA.

Finally, we also note that not all Emergency Services agencies are part of or able to access PSN services (e.g. Ministry of Civil Defence and Emergency Management are not). While Ministry of Civil Defence and Emergency Management have not yet implemented ERCL from CJESP, any such future deployments may use the same corridors as the existing ERCL.

# 4 Protection Assessment Framework

The following section establishes a qualitative framework of the range of costs and benefits that can be expected to accrue from each policy or mitigation option associated with the protection of ERCL from the CJESP. This step is important as it provides a robust framework from which to ensure that all aspects of the policy and mitigation options are covered.

The framework uses first principles to develop a list of the stakeholder groups which will be impacted and the types of cost and benefits and to whom they will flow. The framework was informed by information discussed in the preceding sections of this report, literature review, the feedback received on PC9F, and information drawn from the agencies and experts involved in the development of PC9F.

## 4.1 Stakeholders

First, the ERCL can be expected to affect several stakeholders, which includes landholders, community (and representative public bodies), Tangata Whenua, and the agencies within the CJESP.

The protection of the ERCL pathways will mostly generate benefits for the wider community and the agencies in the CJESP, in terms of reduced risks from major emergencies. However, these groups will also bear some costs, which may include direct costs to the agencies and the community could lose some wider economic benefits. But overall, it is expected that these groups will receive net positive benefits from the protection of the ERCL pathways.

Conversely, the landholders that own property under the ERCL corridors are expected to mostly bear negative costs associated with the protection of the pathways. The following discussion outlines the feedback received on PC9F that relates to each group, which provides an indication as to some of the costs and benefits associated with the protection of the radio communication pathways.

### 4.1.1 Landholders

There are approximately 84 parcels that are within the ERCL pathways, which have a total land area of 20.1ha (excluding open space), of which 4.3ha is directly under the pathways (Figure 2.5). Ten landholders provided feedback, nine of whom have property immediately within the corridors and one that was in the vicinity.

First, eight of the landholders provided the same feedback which was assisted by Novo Group planning[34]. This included the Carter Group, Caisson Group, JPA Holdings, Peebles Group, and IPG (181

[34] Novogroup (2021) Jeremy Philips email of feedback.

High Limited, Riverside Limited, Percasky Holdings Limited, and Duncans Lane Limited). The following points were raised:

- there are economic costs associated with lost site utilisation and development potential.
- alternative mitigation options could achieve satisfactory communication for the CJESP.
- there is a need to compensate for any lost site or development potential.
- the proposed protections have inadequate regard to the NPSUD.
- introduce additional consenting timeframes, costs and uncertainty.
- inconsistent with aims for recovery and regeneration.
- could generate perverse or undesirable outcomes e.g. poor urban design/form, diminished Central City intensification/development, diminished confidence in Central City investment and development, etc).
- practical testing/application of the rules to real world scenarios and/or the appreciation of the commercial/cost implications.

Also, the SSJ Family Trust, which owns 162 – 166 Tuam Street, which is across the road from the CJESP under the Mt Pleasant microwave pathway (i.e. Canterbury College), provided feedback that they had plans to build up to 17 meters high, which was the height limit under the ODP and are concerned that the protections might constrain the development opportunity on their land. They consider that control of building heights in Central City is a temporary solution, which will give way to pressure from political and business interests. They also question whether a satellite link may provide secure links to the CJESP.

Finally, the owners of Pak'n Save on 299-305 Moorhouse Avenue, supports the proposed radio pathway protection corridors as long the ERCL corridor do not affect their property. Based on the spatial layers provided by Council this property is not within the pathways, so is unaffected.

The landholders are likely to bear direct costs associated with the protection of the communication pathways, which will include lost development potential and consenting costs.

### 4.1.2 Community

The wider community, as a combined group, will receive benefits and costs associated with the protection of ERCL pathways. While there has not been any feedback from the wider community, there has been feedback from public entities that are tasked with representing them, which includes Environment Canterbury and Kāinga Ora.

Environment Canterbury (ECan), which has a statutory obligation to represent the regional community, has submitted feedback in support of the proposed protection of ERCL corridors in PC9F. Ecan considered that the draft amendments will ensure that development does not create adverse effects on regionally significant infrastructure, or strategic infrastructure and better give effect to the objectives and policies of the Canterbury Regional Policy Statement.

Kāinga Ora, which has a statutory objective to contribute to sustainable, inclusive and thriving communities, has significant concerns regarding the potential impacts of the controls on the ability of Christchurch City to thoroughly enable intensification in the Christchurch City Centre as mandated by the NPSUD. It is concerned that PC9F prioritises the protection of ERCL pathways at the cost of intensification and development potential. It is considered important that matters such as those in the proposed PC9F can be considered more cohesively at the same time that responses to the NPSUD are being considered.

Moreover, the non-complying activity status that is proposed for infringements of maximum height standards in the microwave ERCL does not offer much option or flexibility for those sites within the identified pathways.

Also, Christchurch City Council, which has a statutory obligation to represent the local community, is the body that has submitted the proposed plan change. The council is supporting PC9F, having borne some of the cost of developing PC9F and has presented supporting material. The council will also have to administer the rules and assess consent applications, which will be a cost to the council and local ratepayers.

The wider community may be expected to bear the burden of the potential change in development activity in these locations, which will include the administration costs and potential impacts on the well-function urban environment. Conversely, much of the benefits from the protection, in terms of emergency response during major events, will flow to the wider community.

### 4.1.3 Iwi

There has been no feedback from Tangata Whenua about the proposed protections for the ERCL pathways. Ngāi Tahu is a major landholder and developer, they have constructed the West End carpark and Pita Te Hori Centre (EY), which both fall within the Airport UHF pathways. Both buildings intrude into the pathway.

The iwi may also own other land that is under the pathway. Neither Ngāi Tahu nor Ngāi Tahu Property Development provided feedback on the PC9F, so it is not possible to establish the extent to which the proposed projections may impact the Tangata Whenua.

### 4.1.4 CJESP Agencies

The CJESP agencies will benefit from protections of the ERCL pathways, which will maintain the overall operational efficiency. The agencies have provided information and supported the development of PC9F which has been a real cost in terms of internal staff time and external expert consultant time.

The agencies will need to engage with Council and landholders when there are applications for development that exceed the height limits. Conversely, if no protections are implemented then the agencies may have to invest money to mitigate the potential loss of an ERCL, which can be much more costly or not feasible to implement.

## 4.2 Protection of Emergency Communication Costs and Benefits

The literature review research conducted in this study indicates that there is little research on the costs and benefits associated with the protection of ERCL, either in terms of international or domestic literature. Discussion with the CJESP agencies and communication experts also indicated that they are unaware of any study on the topic.

While not directly relevant, Caravel Group researched the benefits and costs associated with integrated radio communications for land-based search and rescue in New Zealand.[35] This study was conducted for New Zealand Search and Rescue but was focused on operational or in-field communications in remote locations (HF, VHF, and satellite) and the scope of research does not include communications through urban areas back to head office (UHF, Microwave, etc). The assessment was qualitative and did not assess the relative costs and benefits of the alternatives. This study provides limited information that applies to this situation.

Also in 2013, the Whole of Government Radio Network was developed to integrate communications by all agencies into a single network[36], and the Whole of Government Critical Communications Strategy has a goal to develop and adopt alternate mobile digital technologies such as Long Term Evolution (LTE) and Satellite.[37] However, these plans were replaced recently by the Next Generation Critical Communications project and the PSN[38]. However the CJSEP consider that LTE and satellite solutions are not yet mature enough, nor provide adequate coverage, to provide the functionality required for mission critical communications.[39] While there may be some research on the costs and

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[35] Caravel Group (2016) Integrated Radio Communications Framework for New Zealand Land-Based Search and Rescue Operations.
[36] NZ Police (2013) Aggregated model for Whole of Government Radio Network (WGRN).
[37] CDEM (2016) CDEM Sector - Alternate Communications.
[38] As discussed above the PSN does not include the Ministry of Civil Defence and Emergency Management.
[39] Richard Smart (2021) Operational aspects of CJESP Radio Communications and discussion 6/12/2021.

benefits of emergency communication links and their protection, this research does not appear to be publicly available and could not be found in the literature search.

### 4.2.1 Protection Benefits

The research undertaken in this study suggests that the benefits associated with the protection of radiocommunication pathways mostly relate to efficient coordination and response during daily events and large scale emergencies.

The wider community is expected to receive the following main benefits, which includes:

- A reduction in the risk to life and property.
- Reduce the impact on the environment through efficient response to hazards, and
- Maintain community trust and confidence in these services.

In theory, it would be possible to quantify these three benefits. However, this would require extensive scientific study of the risks that could be avoided, which would need to assess the probability of the emergencies occurring, the potential impacts of those events and then the improvement in response that the ERCL would provide. While in theory this could be conducted, it would be a substantial task and require many experts from a range of fields. Therefore, it is considered that it is not practical to provide an estimate of these benefits. However, the protection of these ERCL could result in lives being saved or property not being damaged, which is likely to be significant.

Indicatively, the communications on the ERCL relate to approximately 60,000 serious incidents each year. Most of the incidents are handled on the Microwave pathway, with around 37,000 serious ambulance calls[40], 20,000 police priority one calls[41], and 1,500 life-threatening fire call outs[42]. The Marleys Hill pathway handles pagers to all events, which provides additional backup to the microwave communications. The Airport UHF handles a few major events, while no data was available it may handle less than 10 per annum.

It is clear that fast and efficient communication results in lives being saved during these serious incidents. In the indicative assessment, we have assumed that communications result in an avoided fatality for 0.5% of the serious incidents. If this was the case then this would mean the communications result in around 300 fatalities avoided in a year, most of which would relate to microwave (295) and Marleys Hill (8). The avoid fatalities associated with the Airport UHF would be relatively small. However, we stress that the number of avoided fatalities would be different for every incident which means that this indicative assessment is overly simplistic. For example, an ambulance call to a cardiac

[40] St Johns (2020) Ambulance Incidents – Purple and Red Triage Priority.
[41] NZ Police (2022) Priority 1 Events by Offence/ Incident Types.
[42] NZ Fire (2022) Major Fire events – Purple and K41.

incident is incredibly time-critical and any delay could result in an avoidable fatality. Conversely, a delay in response to a priority one property offence is much less likely to result in an avoidable fatality. As noted above, while in theory these differences could be assessed it would be a costly and time-consuming endeavour.

The economic value associated with the avoided fatalities can be estimated using the standard Value of a Statistical Life (VoSL) that is developed by the Ministry of Transport to assess the benefits associated with road safety outcomes and updated by the NZ Treasury for other government policy assessments. The latest estimate by NZ Treasury shows that the VoSL is $4.89m.[43] Applying this value to the avoided fatalities shows that the communications could generate $1.48 billion each year. This outcome merely reflects the opening statement in this report,

> "*Given the importance of emergency communications, it is clear that for the good of the community they need to be maintained. This report is not focused on whether communications should be maintained, but rather on the options for maintaining these communications.*"

Finally, to understand the value of the ERCL themselves we would then need to establish the portion of the economic value related to the maintenance of the UHF and Microwave, as a method for handling the communications. We consider that it is likely that the ERCL represent the best and most efficient alternative for handling the communications and that the alternatives may be marginally worse. However, there is no information available on the quantum of the potential margin. Indicatively, if we assume ERCL is 0.2% faster/better than the second-best alternative then the potential impact of disruption of the links could be in the order of $3.0 million. Most of this benefit would be linked to the Microwave ($2.9m), followed by Marleys Hill UHF ($0.1m), and then a small amount for the Airport UHF.

**Figure 4.1: Indicative Value of Major Incidents handled by CJESP Communication Corridors**

| CJESP Radio Communication Corridors | Incidents | Lives Saved* | Economic Value ($m)** | Impact of Link Disruption* |
|---|---|---|---|---|
| Port Hills Microwave (Police/Fire and St John) | 58,966 | 295 | $ 1,441 | $ 2.9 |
| Marleys Hill UHF (St John pager) | 1,583 | 8 | $ 39 | $ 0.1 |
| Airport UHF | < 10 | < 1 | <$1 | <$0.1 |
| **Total CJESP Corridors** | 60,549 | 303 | $ 1,480 | $ 3.0 |

**assumes that for 0.5% of incidents that communication results in a life saved.*

*** value of statistical life of $4.9m*

**** assumes that there is 0.2% drop in service if link disruption occurs and a pro rata loss of life.*

[43] NZ Treasury (2022) CBAX Model Inputs.

The communications will also result in a reduction of other impacts, including injuries and property damage. However, given the available information, we do not consider that providing further indicative analysis will improve the understanding of the situation.

Also, the agencies themselves will benefit from the protection of the ERCL, because it will enable services to operate on a cost-effective basis, and protect staff who operate in the field during an emergency[44]. While these benefits could be quantified, they are expected to be relatively small compared to the other benefits (and costs). Therefore, this benefit is not quantified in the CBA.

The other main benefit is that the potential requirement for resource consent means that the effects of any specific intrusion can be considered on a case-by-case basis, and can be approved in appropriate circumstances and declined where not appropriate. This would potentially enable the agencies to avoid the cost of mitigation measures.[45] These have been assessed by RHW Telecommunications, and are incorporated in the CBA below.

### 4.2.2 Protection Costs

The research undertaken in this study, suggests that the costs associated with the protection of ERCL mostly relate to the development potential that could be impacted.

The most significant cost associated with the protection of the ERCL is the lost development potential, which will mostly flow directly to the landholders in the pathway. Protection of the ERCL may restrict the height of development within the affected corridor, resulting in a cost to the landholder. This cost can be estimated using the land use planning rules that are proposed under each of the policy options and potential returns that could be lost. This cost is important and should be considered within the CBA.

The loss of development potential can result in less efficient use of land, which can be expected to generate costs that arise as a less well-function urban environment. This cost will accrue broadly across the community in the form of reductions in wider economic benefits, because of the potential reduction in intensification. There are qualitative methods that can be adopted for assessing these wider economic values. For example, Waka Kotahi NZTA provides a method for estimating these values[46], which is generally applied to large roading projects that will transform the network. Given the limited scale of the land potential impacted by the ERCL pathways, it is considered that it would not be justified to apply this method. For this CBA the wider economic values are not quantified.

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[44] There is a risk to the safety of operations staff if situational knowledge cannot be passed on prior to arriving event. Loss of communications with front line staff hinders the ability of essential services to react in real time.
[45] i.e. the avoided costs associated with the need to redesign/shift radiocommunication facilities on the CJESP building due to disruption to the network (if practicable).
[46] Waka Kotahi NZTA (2020) Monetised Benefits and Costs Manual.

In the case that a landholder wishes to develop there will be additional application costs, both in terms of direct costs (application, expert reports, etc), time costs (consenting period) and additional uncertainty. These costs could be significant and are being considered in the CBA.

Also, CCC will have to administer the policy and will need to assess applicants' material to establish whether any proposed development should be approved. These administration costs are likely to be relatively small but can be easily quantified based on information that CCC has provided about other application processes that they administer.

Finally, the costs associated with progressing PC9F which have been expended by CCC and the agencies at the CJESP are sunk costs. These costs have already occurred and will not change regardless of the outcome of the process. It is standard in CBA that sunk costs should not be included in the assessment.

## 4.3 Summary of Assessment Framework

The research on the assessment framework has shown that the CBA should focus on some key costs and benefits and that some important benefits cannot easily be quantified. The protection of the ERCL pathways will mostly generate benefits for the wider community and the CJESP, in terms of reduced risks from major emergencies and daily events. However, these groups will also bear some costs, which may include direct costs to the agencies and the community could receive less value in terms of wider economic benefits. However, overall it is expected that these groups will receive net positive benefits from the protection of the radio communication pathways. Conversely, the landholders that own property under the ERCL corridors are expected to mostly bear negative costs associated with the protection of the pathways.

In summary, the benefits and costs of the protection are:

- A reduction in the risk to life and property during a hazard event, both daily events and major emergencies.
- Reduce the impact on the environment through efficient response to hazards.
- Maintain community confidence in these services.
- Ensure cost-effective services are maintained.
- Protect staff who operate during an emergency.
- Potential reduction in mitigation costs for agencies in CJESP.
- Lost development potential will mostly flow directly to the landholders.
- Potential reduction wider economic benefits from reduced intensification.
- Increased compliance and application costs to landholders.

- Increased administration costs for CCC.

Where possible, the CBA presented in the remainder of this report will quantify the scale of the costs and benefits.

# 5 Protection Economic Assessment

The third step of the research was to quantify the costs and benefits using the CBA approach. As with any CBA, the most important, and difficult, task is to value the cost and benefits associated with the proposed policies. Broadly, the valuations in the CBA are established by developing an understanding of the key economic processes through which these benefits arise and the cost implications – as well as the trade-offs, implied choices, opportunity costs and foregone options (as these also have cost). In many cases, there are no direct market values that can be used, so it is common to identify proxy measures for the costs and benefits that are not already expressed in monetary terms.

## 5.1 Model Structure

The following discussion outlines the key model structure and assumptions that have been used to develop the estimates of values for each cost and benefit. This study has included sensitivity analysis to establish which assumptions are critical to the findings of the economic assessment.

The following key model assumptions have been applied in the assessment:

- **Temporal** – a key assumption is the period over which the costs and benefits are assessed. The setting of the period over which the CBA is conducted is critically important in most assessments. This is because the proposed policy will generally have an upfront investment (cost) in the early years while the benefits will generally accrue over the life of the investment.[47] This evaluation period can be chosen to provide information about the relative merits of the options while not being so long as to include too much uncertainty. For this study, the selected period is a decade, which is generally the lifespan of the District Plan policy. Also, the PSN and new technologies will likely mean that the need for ERCL may be change after this period.
- **Spatial** – the geographic locations over which the costs and benefits are assessed. The spatial element of the CBA is also important as it defines what parts of the activity may be viewed as new or additional, and the extent of the activity that may simply be a transfer.[48] The perspective of the assessment should link to the level of the decision-maker, with local decisions assessed at the local level. In this report, the spatial geography applied is Christchurch City.

[47] Generally, the assessment Period is set at the length of the life of the key investment or policy – mostly between 10 to 20 years. However, it is acknowledged that it may be argued that the assessment period could be longer (60 years) to match the life of assets (road, building etc).
[48] For example, a regional level assessment would result in domestic tourist activity being included, while a national level assessment would exclude domestic spend.

- **Discount Rate** – is the value of time used to convert costs and benefits into today's values. The following CBA was conducted using a common unit of value – today's dollars, which is presented using standard Net Present Value (NPV). Simply, the NPV is the sum of all quantified benefits and costs (in today's value) that accrue from the public spending or policy. This is important as in many cases governments tend to invest in a project today, which then generates a flow of benefits and costs that accrue in the future. In a CBA, the future cost and benefit values are discounted to present value using a 'discount rate', which has been set at 5% that is defined by Treasury.[49] Broadly, a larger Discount Rate will result in future values (which are generally benefits) being discounted to a lower value. Conversely, a lower Discount Rate will result in future values being discounted by less.

Finally, a core step in a CBA and economic modelling is to test the sensitivity of outcomes to key assumptions. All economic models apply assumptions because an economy is too complex to replicate in a mathematical system and there is inherent uncertainty associated with the future. This means that it is common practice to test the results from CBA and economic models by varying key assumptions, to ensure that the findings are not 'sensitive' to an unknown factor. The sensitivity analysis is presented in Appendix A.

## 5.2 Assessment of Costs

The costs associated with the ERCL corridors are mostly quantifiable as they relate to the potential use of the land that is impacted by the policy, both to the landholder (compliance costs and lost development potential) and the wider community (council administration costs and wider economic benefits).

First, the lost development potential and wider economic benefits associated with the ERCL corridors is related to the capacity of the parcels to be developed (potential for development heights and proportion of the parcel impacted by the corridors) and the potential for the development to be achieved.

The land use assessment that was conducted for this research shows that the number of parcels in each corridor has limited development potential because of their use which includes heritage, open space or having been recently developed. Most importantly, the assessment of land use showed that less than half the parcels in the Airport UHF corridor are potentially developable over the coming decade, which is less than half the land in this corridor. The Port Hills Microwave has the largest number of developable parcels, with 31 being available for redevelopment. The Marley Hill UHF has 14 developable parcels.

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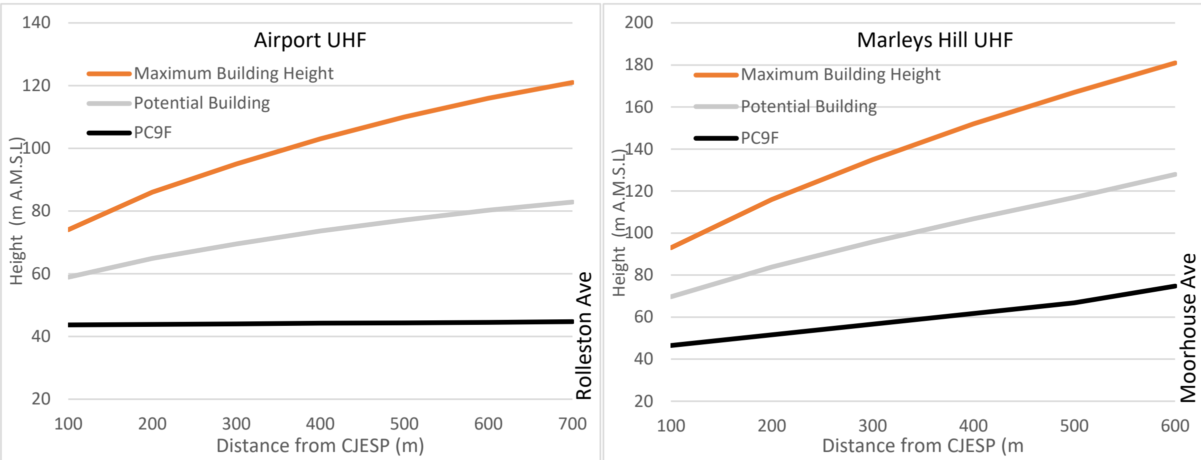
[49] The Treasury (2020) Discount Rates.

The capacity of these developable parcels was established for each protection option as follows. First, the assessment adopted the following building heights for each protection option.

- **Operative District Plan**: set using the height limits in the existing operative District Plan rules, with 17 metres in the Port Hills microwave and Marleys Hill UHF, and between 14 metres to 28 metres in the Airport UHF.
- **Designation**: set using the heights defined in the communication pathways, with Port Hills microwave ranging from 30-62 metres, Marleys Hill UHF ranging from 24-38 metres, and Airport UHF ranging from 10-12 metres.
- **PC9F**: set using the heights defined in the communication pathways, plus an allowance for some intrusion into the UHF. The RHW Telecommunication report indicates that obstruction margin may be allowable for UHF, in this report it is assumed that half of the difference between PC9F and Maximum Building Height can still be achieved within the rules of the policy. The outcome is depicted in the figure below that shows potential buildings PC9F (black line) and max. Figure 5.1 shows the PC9F heights (black line) and maximum building height from RHW Telecommunication report (orange line), along with the potential building height (grey line) which is halfway between the policy and the maximum.

**Figure 5.1: CJESP UHF – Building Heights (metres A.M.S.L)**




- **Mitigation Option 1**: assumes that the antenna is increased on the Port Hills microwave and that heights in PC9F are increased for the pathway, ranging from 39-65 metres. The heights achievable in the UHF are assumed to be the same as PC9F.
- **HSAA and Mitigation Option 3**: assumes no protection and allows unlimited building height within the Four Avenues. The agencies develop alternatives, as required, to maintain microwave links. Given recent development trends within the Four Avenues, it is possible that there could be buildings of over 65 metres tall developed within the

corridors.[50] For this assessment, it is assumed that the development potential may be as high as 65 metres. However, we note that the potential new pathway to Middleton could impact development in other locations, which has not been assessed because the GIS spatial information on the alternative pathway is not available. Also, it may be that when Council completes the intensification assessment required by the HSAA, that some zones within the Four Avenues could have height limits. If the proposed height limits are lower than the ERCLs then this could reduce the impacts on development potential and also implicitly protect the communication links in those locations.

**Figure 5.2: CJESP Communication Pathways – Building Heights (metres)**

| CJESP Radio Communication Corridors - Heights | Port Hills Microwave | Marleys Hill UHF | Airport UHF |
|---|---|---|---|
| Operative District Plan | 17 | 17 | 14-28 |
| Designation | 30-62 | 24-38 | 10-12 |
| PC9F | 30-62 | 56-65 | 39-45 |
| Mitigation Option 1 | 39-65 | 56-65 | 39-45 |
| Mitigation Option 3 and HSAA | 65+ | 65+ | 65+ |

The building heights are then combined with assumed site coverage[51], height per level of 4 metres[52], existing floor space and the area of each of the developable parcels within the corridor to estimate total floorspace under each of the five options. While this simple assessment does not model built form that could be developed, as this would require urban design assessment which is beyond the scope of this research, it provides sufficient detail to understand the potential quantum of the capacity that could be achieved on the land under each of the ERCL corridors. Figure 5.3 shows the additional built space for the four protection options for the radio communication corridor.

In summary, compared to the operative District Plan the other four protection options will allow more development potential (except the Designation for Airport UHF). The Mitigation Option 3 would enable an additional 146,000m$^2$ of development potential across the three ERCL as compared to the supply in the ODP. The designation would enable the smallest increase of supply, at 29,000m$^2$. The proposed PC9F would enable 101,000m$^2$ and Mitigation Option 1 would provide 110,000m$^2$.

[50] Under the existing District Plan there have been proposed developments for new buildings ranging from 12 to 16 levels, which would be up to approximately 65 metres. The HSAA will enable unlimited heights which may encourage the development of buildings that are greater than 16 levels. For the purposes of this report, it is considered conservative to apply 65 metres within the corridors. The development may actually be lower or higher, the impact of this assumption was tested in the sensitivity analysis in Appendix A, and the findings of this report do not change within the range of 12 to 20 levels (48m to 80m).
[51] Christchurch City Council uses a site coverage of 50% for their capacity assessment for the NPSUD, which is also adopted in this report.
[52] The twenty tallest buildings in Christchurch have an average height of 48 metres and 12 levels, which suggests that the average level is 4 metres.

The assessment shows that the Airport UHF corridor has the least development potential, which mostly relates to the fact that much of the land in this corridor is not developable, either because of heritage or because the land has recently been developed. The Marleys Hill UHF has the most potential supply, which relates to the width of the pathway and the nature of the existing activity in the pathway. Finally, while the Port Hills Microwave affects a large number of properties and these properties have development potential, it is much narrower than the UHF pathways so impacts less development potential.

**Figure 5.3: CJESP Emergency Pathways – Potential Additional Built space ($m^2$)**

| CJESP Radio Communication Corridors - Floorspace | Port Hills Microwave | Marleys Hill UHF | Airport UHF |
|---|---|---|---|
| Designation | 22,000 | 15,000 | - 8,000 |
| PC9F | 22,000 | 60,000 | 19,000 |
| Mitigation Option 1 (and PC9F) | 31,000 | 60,000 | 19,000 |
| Mitigation Option 3 (and HSAA) | 40,000 | 64,000 | 42,000 |

While the capacity in Figure 5.3 could in theory be developed, it is likely that much of the potential will not be developed in the coming decade. This is because of the likely scale of demand and the remaining development capacity in other parts of the Central City and the rest of Christchurch.

Christchurch City Council has recently commissioned research on the amount of demand over the coming three decades as required under the NPSUD, which includes both residential and commercial. The residential research does not provide demand projections or capacity assessment for the central city area, that more work needs to be undertaken.[53] The business research suggests that demand in the wider Central and West quadrant of the city is expected to be less than 16,000$m^2$ of floorspace (commercial and retail) per annum over the coming decade.[54] Even if all this demand was located within the Four Avenues it could be accommodated in less than one hectare of land each year.[55]

Also, Council capacity assessment research shows that there is still considerable development potential within the Four Avenues, both on vacant land that is yet to develop since the earthquakes and redevelopment potential on other underutilised parcels. Christchurch City Council has recently estimated that there are 32 hectares of vacant land available in the Four Avenues.[56] The Council has not assessed the redevelopment potential in the Four Avenues, however, council officers acknowledge that redevelopment will provide even more supply.

[53] Greater Christchurch Partnership (2021) Housing Development Capacity Assessment.
[54] Greater Christchurch Partnership (2021) Business Development Capacity Assessment – draft November.
[55] Assuming a building coverage of 50% and height of 6 levels, this demand could be accommodated within 0.52 hectares of land.
[56] Greater Christchurch Partnership (2021) Business Development Capacity Assessment – draft November.

The parcel-level assessment conducted in this research for the ERCL corridors showed that approximately half of the development potential under the operative District Plan is on vacant land, with the other half on redevelopment land. While no assessment has been conducted for the entire Four Avenues area it is reasonable to expect that there will be a considerable amount of redevelopment potential in the Central City.[57]

Based on the Council's projected business demand and the vacant land supply alone, there would be sufficient capacity in the Four Avenues to accommodate over half a century's demand. However, it is acknowledged that there is growing demand for residential within the area, with building consents for new dwellings issued in the Four Avenues increasing from 200 per annum in 2015 to 400 in 2021.

Also, the redevelopment parcels would also allow considerable development which suggests an even larger pool of capacity. This is important as it shows that a large share of the development potential in the Four Avenues, and the ERCL corridors, will not be reasonably realisable in the coming decade. That is only a small share of the capacity in the Four Avenues and the ERCL corridors can be expected to be developed over the coming decade.

Finally, the HSAA will require CCC to establish plan changes to allow even more capacity in the Four Avenues (and other locations within the urban environment) to meet the intensification requirements. The Council is commissioning research on the amount of intensification that should be enabled.[58] Based on our understanding of the intensification requirements and capacity modelling, it is considered likely that the Council will be required to introduce additional intensification in the Four Avenues and the rest of the urban environment that will significantly increase the development potential, both on vacant land and redevelopment potential.[59] The supply in the Four Avenues will be substantially increased[60], which will mean that the amount of land required in each year to accommodate demand can be expected to decrease and the chances of parcels within the ERCL corridors being redeveloped can be expected to decrease.

Therefore, under either the ODP, Designation, PC9F, or HSAA it is very likely that most of the development potential within the Four Avenues or the ERCL corridors will not be acted on in the medium term, or even within the long term. This means that a significant portion of the development potential in Figure 5.3 will not be developed in the coming decade.

[57] Much of the land in the four-avenues has height limits in the operative District Plan that are higher than those that apply within the radio communication pathways.

[58] Christchurch City Council (2022) Request for Proposal Economic Cost Benefits Advice for Intensification – Closed 28th January.

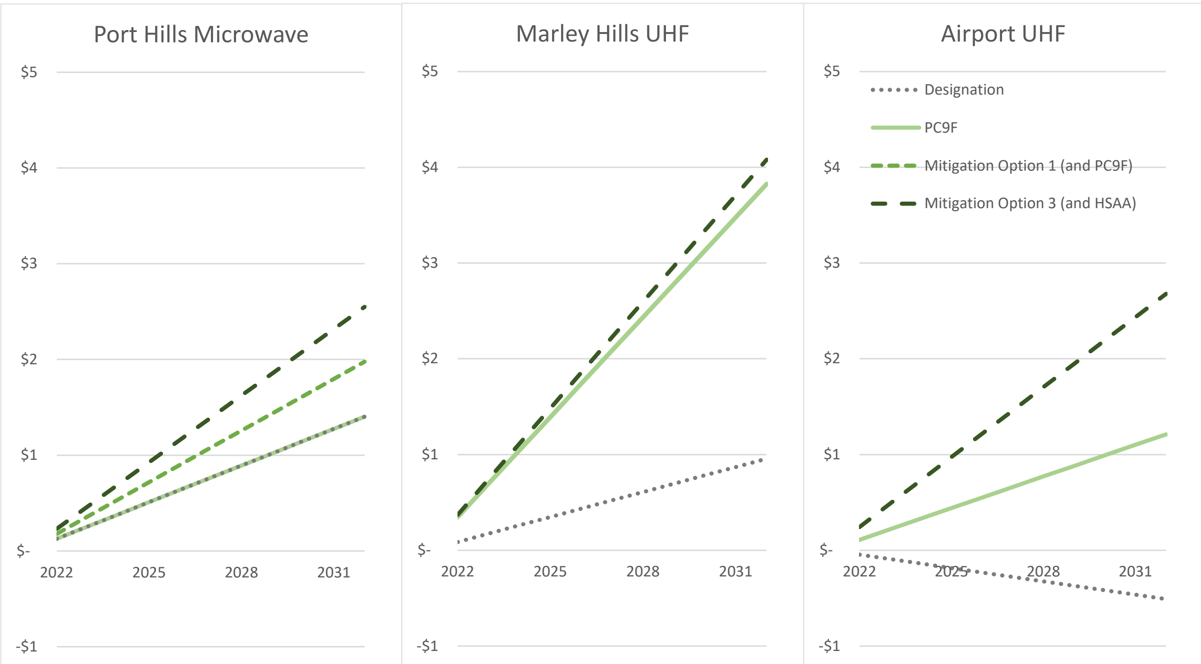
[59] This is likely to be unlimited for most of the area in the four-avenues Policy 3(a), or at least 6-levels Policy 3(c), with some parcels excluded to accommodate qualifying matters.

[60] The requirement to enable intensification in the rest of the urban area will also increase capacity significantly in Christchurch – Policy 3(b-d). This may further disperse growth into the urban area outside of the four-avenues.

In the following assessment, it is assumed that 1.6% of the potential capacity is developed each year, which results in 16% being developed over the decade. This is a conservative assumption, which results in development activity in the ERCL corridors that is similar to the rest of the Four Avenues. This uptake has been defined using the CCC's draft Business Land Assessment which shows a similar implied uptake rate over the coming decade.[61]

The development in each year is then combined with average rents for office space in the Four Avenues of $358 per square metre.[62] The results show that rents that could be achieved are highest for Marley Hills UHF and then Port Hills microwave, with lower rents for Airport UHF (see Figure 5.4). The Mitigation Option 3 (dark green dotted line) has the highest rent, followed by Mitigation Option 1 and then PC9F.

**Figure 5.4: CJESP Communication Pathways – Rental by Protection Options ($million)**




Also, as discussed above if development potential is not enabled in this area there is likely to be substantial potential in other parts of the Four Avenues to accommodate growth. Therefore, the local loss within the corridors may not result in a reduction in overall activity within the Christchurch City or the Four Avenues. This report has not made any assumption about the proportion of the development potential and rent that may be lost.

The wider economic benefits associated with the potential development and economic activity within the ERCL corridors can be expected to generate additional benefits in the economy. However, given the small scale of the land potential impacted by the ERCL corridors, it is considered that it would not

[61] Greater Christchurch Partnership (2021) Business Development Capacity Assessment – draft November.
[62] CBRE (2021) Christchurch CBD Office – Sept 21st.

be justified to apply this method. For this CBA the wider economic values are not quantified but are considered to be negative.

Next, the administration and compliance costs can be estimated using the number of developable parcels in each ERCL corridor and assumptions about the potential application costs. The assessment of land use shows that less than half the parcels in the Airport UHF corridor are potentially developable over the coming decade, which is less than half the parcels in this corridor. The Port Hills Microwave has the largest number of developable parcels, with 31 being available for redevelopment. The Marley Hill UHF has 14 developable parcels.

As set out above, if 1.6% of the developable parcels are subject to an application for a development per annum, then there would be less than one application per annum in each of the corridors. Applying assumed administration costs for the Council of $20,000 per application and compliance costs for the landholder of $40,000 per annum would indicate that the cost associated with resource consent applications could be a total of less than $60,000 per annum. Most of this cost could be expected to be related to the Port Hills Microwave.

While this quantification is based on the assumption of the potential cost per application, it is considered that these values will be within the correct order of magnitude and the Council has suggested that the costs could be in the tens of thousands per application.[63]

**Figure 5.5: CJESP Communication Pathways – Administration and Compliance Costs**

| CJESP Radio Communication Corridors | Developable Parcels* | Develop p.a. | Admin Cost | Comply Cost |
|---|---|---|---|---|
| | | 1.6% | $ 20,000 | $ 40,000 |
| Port Hills Microwave | 31 | 0.5 | $ 10,036 | $ 20,071 |
| Marleys Hill UHF | 14 | 0.2 | $ 4,532 | $ 9,064 |
| Airport UHF | 10 | 0.2 | $ 3,237 | $ 6,475 |
| **Total CJESP Corridors** | **55** | **0.9** | **$ 17,805** | **$ 35,610** |

**excludes heritage, openspace, and new buildings*

In terms of the avoided mitigation costs that the CJESP agencies may have to bear, the assessment provided by the communications expert suggests that mitigation is only feasible for the Port Hills microwave. The cost ranges from $212,000 for Mitigation Option 1 (taller antenna) up to $1.125 million for Mitigation Option 3 (new relay).

## 5.3 Assessment of Benefits

The majority of the benefits associated with the ERCL pathways are not quantifiable as there is limited information about the potential risks or the level to which the protection of the communication links

[63] Council officers consider that the cost could $10,000 per application for the UHF Corridors and $20,000 for the Microwave.

enables the emergency services to moderate these risks. If there was scientific research on the probability of the events that are handled on each of the communication links and the associated impacts of those events, then it would be possible to quantify the relative benefits.

Notwithstanding the lack of scientific research, it is evident that each of the ERCL pathways will produce benefits in terms of reduction in injury, loss of life, property damage, environmental impacts and will ensure that community confidence is maintained. Given the nature of the communications that are enabled on each ERCL pathway, it is considered that the benefits will be largest for Port Hill microwave which is used for a wide range of events and services, followed by Mt Pleasant UHF which provides communications for the ambulance services and lastly the Airport UHF which just provides communication if a major event occurs at the airport.

The following table provides a qualitative presentation of the relative benefits for the community.

- **Port Hills Microwave**: while this communication system is mostly used for small scale daily emergency events, it is also designed to help coordinate services for large scale events where the impacts can be severe and wide ranging across the local and regional community. It may be expected that this system could be used to respond to major events within the assessment period. Therefore, in terms of the risk to life and property and community confidence, it is likely that the benefits are largest for the Port Hills microwave. Also, this system could result in the mitigation of damage to the environment, mostly as a result of FENZ being able to mitigate the impacts of hazards.
- **Marleys Hill UHF**: while similar to Port Hills in terms of responding to large scale events where the impacts can be severe and wide ranging across the local and regional community, this system relates to a backup one-way pager link to ambulances. This link supports fewer communications and benefits, than the multi-service and multidirectional microwave link. Therefore, in terms of the risk to life and property and community confidence, it is likely that the benefits are smaller for the Marleys Hill UHF. This system is unlikely to mitigate damage to the environment.
- **Airport UHF**: handles communications relating to a few specific events, which will have very localised impacts. While these can be large scale, they impact a comparatively smaller amount of property or people than the other two links. This system is unlikely to mitigate damage to the environment.

Figure 5.6: CJESP Communication Pathways – Community Benefits

| Community Benefits | Port Hills Microwave | Marleys Hill UHF | Airport UHF |
|---|---|---|---|
| Risk to life and property | +++ | ++ | + |
| Damage to environment | + | | |
| Community confidence | ++ | + | + |
| **Total Benefits** | **+++** | **++** | **+** |

The other main benefits of the protection of the ERCL pathways relate to the potential savings that the CJESP agencies receive costs savings from the protection of the current system. This includes cost-effective communications and the protection of staff.

While it is likely that the current set of communication systems will generate gains to CJESP agencies from efficient coordination of operational staff and potential to protect staff in life-threatening situations, the agencies have not provided information about these benefits which means that we cannot quantify these benefits. However, based on the nature of the communications on each link it is likely that most of the benefits will relate to the Port Hills microwave, and less so for the UHF links.

Figure 5.7: CJESP Communication Pathways – Agencies Benefits

| CJESP Agencies | Port Hills Microwave | Marleys Hill UHF | Airport UHF |
|---|---|---|---|
| Cost effective system | ++ | + | + |
| Protect staff | ++ | | |
| **Total Benefits** | **++** | **+** | **+** |

The CJESP agencies have designed each of the protection options to ensure that communications are maintained, this means that the benefits should be approximately the same under all the protection options. The only difference is the Mitigation Option 3 (and HSAA), where the benefits of the UHF links could be lost as development occurs.

## 5.4 Net Outcome CBA

The following tables present the net outcomes for the different protection options for each of the three ERCL corridors. The assessment has been conducted using the assumptions in the model structure, which includes a 10 year assessment period, spatial area of Christchurch City and a discount rate of 5%.

First, the benefits associated with the Port Hill Microwave should be approximately the same for all options, as they are all designed to protect this critical communication link. While it is not possible to quantify these benefits, they are likely to be more significant than the other corridors as this link handles more communications and for a wider range of emergencies (which is why the “+++” is used in Figure 5.8).

The compliance costs, administration costs and mitigation costs are all less than $1.1 million, which suggests that these costs are not likely to be critical to the decision around the choice of protection option.

The largest cost is the development potential that is enabled under each protection option. The table shows the development potential relative to the largest development option (HSAA), which shows that the value of the development potential may be in the order of several million.

Broadly the benefits associated with the Port Hills Microwave do not change between the options and the compliance costs, administration and mitigation costs are relatively small. This means the only material difference between the options is the extent of the development potential. Therefore, at a community level, Mitigation Option 1 and Mitigation Option 3 are likely to be preferred over the policy options (PC9F or designation).

However, the engineering reports suggest that it may not be feasible to implement the mitigation options. Given the critical nature of the communications on the Port Hills microwave, these links do need to be maintained and if the mitigation options are not feasible then one of the policy options will need to be adopted.

**Figure 5.8: Cost Benefit Analysis Net Outcome for Port Hills Microwave**

| CBA - Net Present Value | Port Hills Microwave | | | |
|---|---|---|---|---|
| | Designation | PC9F | Mitigation Option 1 | Mitigation Option 3 |
| **Benefits** | +++ | | | |
| **Costs** | | | | |
| Lost Development Potential | -$4.8 | -$4.8 | -$2.4 | $0.0 |
| Compliance Cost | | -$0.15 | | |
| Administration Cost | | -$0.08 | | |
| Wider economic benefits | - | | | |
| Mitigation Costs | | | -$0.21 | -$1.13 |
| **Total Costs** | **-$4.8** | **-$5.0** | **-$2.6** | **-$1.1** |
| **Net Outcome** | **3rd** | **4th** | **2nd** | **1st** |

The Marleys Hill UHF has the same benefits associated with the two protection options that are available, as they are both designed to protect the communication link. While it is not possible to quantify these benefits, they are likely to be smaller than the microwave ERCL, as the UHF link handles fewer communications and for a narrow range of emergencies (which is why the "++" is used in Figure 5.9).

The compliance costs and administration costs are both less than $0.1 million, which suggests that these costs are not likely to be critical to the decision around the choice of protection option.

The largest cost is the development potential that is enabled under each protection option. The table shows the development potential relative to the largest development option (HSAA), which shows that the value of the development potential may be in the order of millions.

Broadly the benefits associated with the Marleys Hill UHF do not change between the options and the compliance costs and administration are relatively small. This means the only material difference between the options is the extent of the development potential. Therefore, PC9F is likely to be the preferred protection option over designation. However, it is not clear whether PC9F would be preferred over the Housing Supply Amendment Act.

**Figure 5.9: Cost Benefit Analysis Net Outcome for Marleys Hill UHF**

| CBA - Net Present Value | Marleys Hill UHF | | |
|---|---|---|---|
| | Designation | PC9F | HSAA |
| **Benefits** | ++ | | $0.0 |
| **Costs** | | | |
| Lost Development Potential | -$13.0 | -$1.1 | $0.0 |
| Compliance Cost | | -$0.07 | |
| Administration Cost | | -$0.03 | |
| Wider economic benefits | - | | |
| **Total Costs** | **-$13.0** | **-$1.2** | **$0.0** |
| **Net Outcome** | **2nd** | **1st** | **?** |

The Airport UHF has the same benefits associated with the two protection options that are available, as they are both designed to protect the communication link. While it is not possible to quantify these benefits, they are likely to be smaller than the other two corridors as this link handles fewer communications and for a small number of emergencies (which is why the "+" is used in Figure 5.9).

The compliance costs and administration costs are both less than $0.1 million, which suggests that these costs are not likely to be critical to the decision around the choice of protection option.

The largest cost is the development potential that is enabled under each protection option. The table shows the development potential relative to the largest development option (HSAA), which shows that the value of the development potential may be in the order of millions.

Broadly the benefits associated with the Airport UHF do not change between the options and the compliance costs and administration are relatively small. This means the only material difference between the options is the extent of the development potential. Therefore, PC9F is likely to be the preferred protection option, over designation. However, it is not clear whether PC9F would be preferred over the Housing Supply Amendment Act.

**Figure 5.10: Cost Benefit Analysis Net Outcome for Airport UHF**

| CBA - Net Present Value | Airport UHF | | |
|---|---|---|---|
| | Designation | PC9F | HSAA |
| **Benefits** | + | | $0.0 |
| **Costs** | | | |
| Lost Development Potential | -$13.3 | -$6.1 | $0.0 |
| Compliance Cost | | -$0.05 | |
| Administration Cost | | -$0.02 | |
| Wider economic benefits | | - | |
| **Total Costs** | **-$13.3** | **-$6.2** | **$0.0** |
| **Net Outcome** | **2nd** | **1st** | **?** |

# 6 Conclusion

The economic research conducted for this report has established the following key findings on the protection options for the ERCL pathways that connect to the CJESP:

- While it is not possible to quantify the benefits associated with the protection of the ERCLs, these will likely be significant – including a reduction in risks to life and property. Also, the nature of the communications on each link suggests that the Port Hill Microwave will have the largest benefits from being protected. The two UHF links are expected to have fewer benefits from being protected.
- The development potential that could be enabled within the corridors could be significant, generating millions of economic value over the coming decade. The method that is employed to protect the ERCL pathways can be expected to impact this value, which will be an important issue when considering which protection option is employed in each pathway.
- The administration, compliance and mitigation costs are all relatively small, which suggests that these costs are not likely to be critical to the decision around the choice of protection option.

For each of the ERCL pathways the CBA shows:

- For the Port Hills Microwave link, the community would receive a better net outcome if the mitigation Option 3 or Option 1 were employed, rather than implementing PC9F. This is primarily because of the close balance between the value of development potential in the corridor as compared to the potential mitigation options that are relatively low in cost. That is an investment by the CJESP (a million) could enable development potential (several millions of dollars). However, this assumes that the mitigation options can be feasibly implemented. The engineering[64] and planning assessments[65] suggest several issues that may mean that the mitigation options are not feasible and/or that they would take some time to implement. If a building is developed that blocked the path of a microwave link it could be 12 months or more before mitigation could be implemented to restore the link. During this time the resilience of the communications could be jeopardised, and there could be potential for damage to buildings, injuries or loss of life during a major event.

[64] RHW Telecommunications Limited (2021) CJESP Radio Corridors Link Mitigation Options.
[65] Incite (2021) Plan Change 9f - Planning Assessment.

- For the Marleys Hill and Airport UHF link the community would receive a better net outcome if PC9F was implemented, as compared to the alternative policy option (Designation). However, it is not possible to establish whether the protection of these two ERCL pathways would represent a better outcome than no protection – i.e. unlimited height and no protection under the HSAA may or may not be better than the PC9F.

This outcome is somewhat counter-intuitive. The Marleys Hill and Airport UHF link are likely to generate fewer benefits than the Port Hills Microwave link. Also, Marleys Hill and Airport UHF corridors impact more land than Port Hills Microwave corridors.

This outcome is mainly driven by the fact that the CBA has only been able to consider mitigation options for the Microwave links and not the UHF links. Given the critical nature of the communications on the Port Hills microwave, these links do need to be maintained, and the question is which protection method is the most efficient. This assessment indicates that the cost to the community would be lower if either of the mitigation options were implemented by CJESP agencies, as opposed to each landholder bearing the cost.

However, the engineering reports suggest that it may not be feasible to implement the mitigation options. Given the critical nature of the communications on the Port Hills microwave, these links do need to be maintained and if the mitigation options are not realistically feasible then one of the policy options will need to be adopted.

Given that the costs associated with protecting the ERCL Microwave are likely to be relatively small, and issues around implementing the mitigation options could mean that the resilience of the communications could be jeopardised it would be prudent to apply a precautionary approach and protect this system using the policy suggested within PC9F.

Specifically, if there were no protection of the microwave ERCL and a pathway was affected, there would be a timing issue associated with the implementation of any mitigation option, that could impact the resilience of the communications and result in a cost in terms of property damage or even loss of lives. While from a CBA perspective this outcome is a positive position, it may be from a social perspective that this outcome would not be acceptable.

The core of the situation is that the CJESP agencies can only mitigate the effects if they are aware that ERCL will be blocked. If the corridors are obstructed such that a link fails, there will be a window of time before any mitigation can be implemented, during which there is a heightened risk to the public.

# Appendix 1 Sensitivity Analysis

The model was tested for the following assumptions, Discount Rate, Period, Development Uptake, Mitigation Costs, Administration Cost, Compliance Cost, Floor height, Building Coverage, PC9F additional Building Height in UHF and HSAA Building Height. Figure A.1 shows the base assumptions that we applied in the body of this report and the sensitivity tests (High and Low) that were applied to test the sensitivity of the CBA to these assumptions. The outcome of the sensitivity testing showed **that none of the findings in this report change in any of the testing**, this means that the findings in this report are **not sensitive to the assumptions**.

Notwithstanding the above, the model is most sensitive to Period, Development Uptake, PC9F additional Building Height for UHF, and the HSAA Building Height which have larger impacts on the values than the other assumptions. Specifically, if the period is increased (to 20 years), development uptake increases (3% p.a), consents issued up to 40% of UHF pathway, or building heights increased (20 levels) the costs associated with the development potential increase significantly (in millions). This means that the CBA outcome suggests that the mitigation options are even more preferred.

The other assumptions have a medium or small (less than 10%) impact on the CBA outcome.

**Figure A.1: CBA Sensitivity Analysis**

| Assumptions | Sensitivity | | | |
|---|---|---|---|---|
| | Base | High | Low | Impacts |
| Discount Rate | 5% | 7% | 3% | Small (10%) |
| Period (years) | 10 | 5 | 20 | Large(million) |
| Development Uptake (per annum) | 1.6% | 1% | 3% | Large(million) |
| Mitigation Costs | Budget | -50% | +50% | Medium |
| Administration Cost (per consent) | $20,000 | $10,000 | $30,000 | Small (10%) |
| Compliance Cost (per consent) | $40,000 | $30,000 | $60,000 | Small (10%) |
| Floor Height (m) | 4.0 | 3.5 | 5.0 | Medium |
| Building coverage | 50% | 60% | 40% | Small (10%) |
| PC9F additional Building Height UHF | 50% | 60% | 40% | Large(million) |
| HSAA Building Height (levels) | 16 | 12 | 20 | Large(million) |

# Appendix 21

Investigation of Qualifying Matters Ōtautahi Christchurch Suburban Character Areas - Boffa Miskell

Boffa Miskell

# Investigation of Qualifying Matters

Ōtautahi Christchurch Suburban Character Areas
Prepared for Christchurch City Council

1 June 2022

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## Document Quality Assurance

| | | |
|---|---|---|
| Bibliographic reference for citation:<br>Boffa Miskell Limited 2022. *Investigation of Qualifying Matters: Ōtautahi Christchurch Suburban Character Areas*. Report prepared by Boffa Miskell Limited for Christchurch City Council. | | |
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| Status: Final | Revision / version: [2] | Issue date: 1 June 2022 |

# CONTENTS

# 1.0 Introduction

In line with the National Policy Statement – Urban Development (NPS-UD), Christchurch City Council (the Council) is reviewing and investigating potential Qualifying Matters, including Character Areas.

The suburban Character Area Overlays identified through the District Plan Review became operative in 2016. These Character Areas are areas in residential neighbourhoods that are distinctive from their wider surroundings and are considered to have a character, in the whole, worthy of retention. There are several provisions in the District Plan that apply to these Overlays in order to maintain and enhance their identified special character values.

This report has been prepared on behalf of the Council to ascertain the potential of the Character Areas as a Qualifying Matter by reviewing the integrity of the existing Character Areas and updating, including retaining, reducing or removing, their boundaries, and then analysing their capacity for intensification. Development scenarios have been considered in alignment with the medium density (MDRS) provisions notated in the Resource Management (Enabling Housing Supply and Other Matters) Amendment Bill, adopted by Government in December 2021.

This report has been prepared in two stages, as follows:

**Stage 1: Desktop Evaluation and Investigation of Development Opportunities (February 2022)**

- A high level, (primarily) desktop evaluation to identify substantial changes to the integrity of the existing Character Areas and review the boundaries.
- Use the 2015 Beca assessment criteria to identify whether a Character Area has sufficient primary and contributory sites to remain with a reduced boundary, or to recommend removal of a Character Area.
- For the revised Character Areas, identify what level of, and where, intensification may be possible to achieve the greatest heights and densities directed by the NPS-UD, while retaining Character Area-specific values.
- Recommend design parameters that could lead to development of a set of District Plan standards.

The outcomes of Stage 1 have been utilised as the basis of the pre-notification consultation of the Plan Change proposal. This included the proposed removal of two Character Areas (Clifton and the Spur), the reduction in the size of seven Character Areas, with the remaining six retaining the original boundaries.

**Stage 2: Site Visit and Further Investigation of Development Opportunities (May 2022)**

- Assessment that builds on the work undertaken at Stage 1, with additional site-by-site and area-wide evaluation to confirm that that the initial analysis was correct in terms of the status of the site (primary, contributory, neutral or intrusive), and the overall intactness of each Character Area proposed to be retained.
- The additional site-by-site and area-wide evaluation was undertaken via a drive by of sites and by utilising Google Streetview.
- Character Area boundaries were revised based on any updated rankings.

- The draft design parameters outlined at Stage 1 were reviewed. These could lead to development of a set of District Plan standards while retaining Character Area-specific values.

This report presents the findings of the Stage 1 and 2 assessments.

# 2.0 Background

## 2.1 Context

Character Areas (formerly known as Special Amenity Areas or SAMs) were originally established in the mid-1990's with the development of the operative Christchurch City Plan. At that time, 41 areas within Christchurch were considered to embody special characteristics worthy of protection. Over time, there was some erosion of the characteristics of these areas due to redevelopment. The Canterbury earthquakes of 2010 and 2011 further exacerbated this, with whole areas red zoned or significantly damaged and rebuilt.

Character Areas were reassessed as part of the District Plan Review in 2015/2016, to identify whether they remained distinctive with a residential character worthy of retention. An assessment methodology was developed, and evidence was prepared to justify their inclusion in the District Plan at that time. This included categorising Character Areas as Category 1 or 2, with Category 1 having the most integrity. This resulted in the inclusion of 15 Suburban Character Areas as well as Akaroa and Lyttelton Character Areas in the Christchurch District Plan.

## 2.2 Qualifying Matters

The NPS-UD outlines government policy directing councils to allow for more housing and businesses with greater height and density, in places close to jobs, services, public transport and infrastructure. Clause 3.32 of the NPS allows for 'qualifying matters', characteristics under which these building height and density requirements may be modified.

The Council considers Residential Heritage Areas (RHA's) and Character Areas are Qualifying Matters.

The Resource Management (Enabling Housing Supply and Other Matters) Amendment Act sets out the specific requirements necessary to achieve Qualifying Matter status:

> *77LFurther requirement about application of section 77I(j)*
>
> *A matter is not a qualifying matter under section 77I(j) in relation to an area unless the evaluation report referred to in section 32 also—*
>
> *(a) identifies the specific characteristic that makes the level of development provided by the MDRS (as specified in Schedule 3A or as provided for by policy 3) inappropriate in the area; and*
>
> *(b) justifies why that characteristic makes that level of development inappropriate in light of the national significance of urban development and the objectives of the NPS-UD; and*
>
> *(c) includes a site-specific analysis that—*

*(i) identifies the site to which the matter relates; and*

*(ii) evaluates the specific characteristic on a site-specific basis to determine the geographic area where intensification needs to be compatible with the specific matter; and*

*(iii) evaluates an appropriate range of options to achieve the greatest heights and densities permitted by the MDRS (as specified in Schedule 3A) or as provided for by policy 3 while managing the specific characteristics.*

# 3.0 Scope of Study

The scope of the investigation included the existing District Plan Character Areas. Sites and areas beyond the District Plan Character Areas were not assessed.

The Christchurch Character Area Overlays included in this study were:

*Table 1 Character Areas*

| Current District Plan # | Character Area |
|---|---|
| CA1 | Esplanade |
| CA2 | Clifton |
| CA3 | Cashmere |
| CA4 | Beckenham Loop |
| CA5 | Tainui |
| CA6 | Piko |
| CA7 | Heaton |
| CA8 | Beverley |
| CA9 | Ranfurly |
| CA10 | Massey |
| CA11 | Malvern |
| CA12 | Severn |
| CA13 | Francis |
| CA14 | Dudley |
| CA15 | Englefield |

# 4.0 Methodology and Assumptions

The methodology incorporates two key tasks: the evaluation of change to the Character Areas; and identifying development potential. Specific background to the GIS approach applied to the project is set out in ***Appendix 3***.

## 4.1 Methodology for Evaluating Change within Character Areas

There are 15 existing suburban Character Areas identified in the Christchurch District Plan that require reassessment. They range in size from a minimum of 20 sites to more than 800 sites per

Character Area. The review was undertaken during Stages 1 and 2 within the limitations of the time and resource available.

#### 4.1.1 Stage 1

Stage 1 undertaken in February 2022 comprised the following key steps:

1. Confirm the methodology[1] utilised for the 2015 Character Area Study was still appropriate in the current context, with particular regard to the requirement that 80% of properties within Character Areas must be Primary (50%) or Contributory (30%). The following classification system was applied to the sites:

    - *Primary – Sites with buildings, structures, landscape, garden and other features that **define** the character of an area.*
    - *Contributory – Sites with buildings, structures, landscape, garden and other features that **support** the character of an area.*
    - *Neutral – Sites with buildings, structures, landscape, garden and other features that **neither defines, supports or detracts** from the character of an area.*
    - *Intrusive – Sites with buildings, structures, landscape, garden and other features that **conflict/ detract** from the character of an area.*[2]

2. A (primarily) desktop evaluation of each Character Area to determine their remaining level of integrity, using:

    - Conversion of the 2015 spreadsheets and maps into GIS files (see ***Appendix 3*** for further details).
    - Comparison of 2015 assessment against building (over $200k value) and resource consent data (including demolitions) from 2015 to 2021, to indicate where significant change is most likely to have occurred.
    - Broad scale comparative analysis of 2015 and 2021 aerials to clarify the extent of change and identify where further significant change may have occurred in the area.
    - Use of Google Street View (and historical Street View options) for initial observations.
    - A drive-by of each area to observe properties and what impact any redevelopment has had on the Character Area, utilising and recording observations in the GIS files.
    - Recording of any other significant changes observed during the drive by.

3. Where change was observed, draft site classifications (primary, contributory etc.) were updated and mapped based on the following methods and assumptions:

    - Where no change was identified during Step 2 above, properties retained their 2015 classification.

---

*[1] The broad methodology was considered fit for the purposes of this high-level investigation and in particular, the 80% (and 50/30) criteria was discussed and considered appropriate for Character Area selection. A full review of the 2015 methodology was not undertaken.*
*[2] Christchurch Suburban Character Areas Assessment, 2015, prepared for Christchurch City council, prepared by Beca, p4*

- Where a resource consent had been issued but not implemented, properties were assessed as ‘No Change’ i.e., retained their 2015 classification.
- Streetscapes that had changed since 2015 were not assessed.
- Where there was an obvious discrepancy between the 2015 Beca maps and working spreadsheets, the map has been considered the baseline. For example, there were many instances where data had not been provided in the 2015 spreadsheets, but a final classification was displayed in the maps.
- Some properties within the Clifton Character Area District Plan boundary did not have any data attributed to them in 2015 – either in the spreadsheet or on the map. As a result, a draft assessment/classification was made in order to complete the gap, however it did not change our recommendation regarding this Character Area.

4. Character Area boundaries were confirmed using an iterative process involving creating a sensible grouping of an area which demonstrated both cohesiveness and consistency.
5. A check was then made as to whether the grouping generally met the 80% and 50/30 (or 50%+) thresholds as described earlier. Where the tests were not satisfactorily met, the boundary was modified.
6. Updated Character Areas were mapped and pie charts used to communicate the comparative split between each of the classifications and demonstrate how the Character Area aligned with the 50/30% test – for 2015 and using the revised 2022 classifications. These are attached as ***Appendix 4***.

### 4.1.2 Stage 2

Stage 2 undertaken in May 2022 comprised the following key steps:

1. A site visit evaluation of each Character Area to determine their remaining level of integrity, using:
    - The GIS tool developed during Stage 1 (see ***Appendix 3*** for further details).
    - A drive-by and/or walk-by of each street within each Character Area.
    - Recording of any changes observed and updating the GIS tool with appropriate ranking of each site (that was visible from the street) based on the following methods and assumptions:
        - Rear sites were often not visible from the street and therefore defaulted to a Neutral status. If rear sites were visible, these were ranked accordingly.
        - Primary sites include a representative character dwelling. Completely new buildings (not the original dwelling) that were representative of the Character Area were rated as Contributory.
        - In Character Areas where the attribute was for single storey dwellings, double storey dwellings were not penalised if they were a dwelling of the representative era.
        - Even though some properties beyond the study area were visible from within the Character Area and represented primary rankings, they were not included in the mapping exercise as they were outside the existing study area extent.

- Primary sites with a garage in the front yard were not penalised if the garage was sympathetic and the main dwelling was still clearly contributing and visible from the street.
- Poor maintenance of properties did not detract from the classification status.
- Where vegetation was so dense that dwellings were not clearly visible from the street, they were typically rated as Neutral (unless the dwelling was known to be of Primary status, then it would be rated as Contributory).
- The attributes adopted from the 2015 Beca study were applied with a 'judgement call' on their weighting. For example, they were not applied in a numbers sense (i.e. 4 out of 8 attributes are met so it is Neutral). Rather, more weight was given to the dwelling being of the representative era, than the landscape attributes.
- Roof lines or garages of infill dwellings on rear sites were usually visible down driveways. Rear sites were generally rated as Neutral, unless they contributed exceptionally to the character (either by being more visible due to elevation, or exemplary primary dwellings which were then rated as Contributory).
- In most instances where an original era dwelling had unsympathetic alterations such as replaced windows or extensions, they were given a lower classification rating.

2. <u>Character Area boundaries</u> were confirmed based on any changes from the classification of sites based on the following methods and assumptions:

   - In order to be considered a Character Area, at least 80% of sites must be either Primary or Contributory. The 80% generally comprises a 50/30 split where at least 50% are Primary sites and at least 30% Contributory sites.
   - However, **in some cases when the Primary sites exceed 50% but the Area does not meet 80% overall, a judgement call has been made to retain the Character Area.** This has been based on consideration of the greater 'value' of the Primary sites and the key elements they retain in terms of defining the Area's character.
   - Where there were large clusters of rear sections that could not be seen (and classified as Neutral), many of these were removed from the Character Area unless they could be considered part of a consistent, coherent streetscape or sensible grouping overall.
   - There were errors in the existing data where a property made up of multiple parcels was not rated the same for each parcel. This defaulted to a Neutral rating which misrepresented the categories. These sites were amalgamated to show as one site with one ranking.
   - As a general rule, the Character Area boundaries have been adopted on both sides of a street (unless on the external extent of the Area). This also means for properties which may be intrusive or neutral, they have not been excluded from a Character Area if they front a Character Area street.
   - Where a site contains two dwellings, but is on one title, the entire site has been given the same ranking.

- Boundaries were either removed, reduced, or retained.

3. A review was then undertaken as to whether the grouping generally met the 80% and 50/30 (or 50%+) thresholds as described. Where the threshold was not satisfactorily met, the boundary was updated.
4. Final Character Areas were mapped, and pie charts used to communicate the comparative split between each of the classifications and demonstrate how the Area aligned with the 50/30% test.

## 4.2 Methodology for Identifying Development Potential

Following the above process, investigations turned to identifying where and what potential development opportunities within the 13 Character Areas may be possible using the following steps.

1. Group the Character Areas into six 'types' based on shared characteristics.
2. Identify a number of likely development scenarios. The following assumptions were noted:
   - The level of development directed by Policy 3 of the NPS-UD would be inappropriate in the Character Areas, but some level of development may be appropriate.
   - The special characteristics and values attributed to these Character Areas are maintained or enhanced.
   - The value of the Character Area as a whole is retained.
   - 'Heritage Items / Heritage Setting' properties will restrict the development opportunity, with these properties being excluded for assessment purposes.
   - Unit title arrangements were factored into the development opportunities identified. Unit title arrangements could enable internal subdivision of existing large scale dwellings (hidden density).
   - The most practical development scenarios are outlined, that will retain the character attributes of the Area.
   - The following development scenarios would enable intensification within the Character Areas to varying degrees, with these options considered the most likely to occur. They comprise practical alternative developments that could maintain the attributes of the Areas.
     (1) Scenario 1: Redevelopment (demolition and rebuild) of the existing house into a multi-unit, larger footprint 2 storey development with single vehicle access.
     (2) Scenario 2: Conversion (renovation) of the existing dwelling to a multi-unit development to enable an additional unit.
     (3) Scenario 3: Retain the existing dwelling and infill to the rear, utilising the existing vehicle crossing and driveway.
     (4) Scenario 4: Combination of Scenarios 2 and 3 with incorporation of/redevelopment of a garage to the rear with a residential unit above.

(5) Scenario 5: Site amalgamation that would enable multiple units depending on site size.

- It was identified that some additional capacity for housing is appropriate within the Character Areas. However, it is anticipated that more than two units per site would adversely affect the attributes and qualities that have been identified through this study.

3. Identify the potential impacts of intensification on the attributes of the Character Areas, including (but not limited to) the following:

   - Loss of the original dwelling.
   - Scale/dominance of new/additional building.
   - Garage/manoeuvring area/parking located within the front yard and the associated visual impact, effects on vegetation and loss of connection to the dwelling.
   - Increase to 50% site coverage from around 30-40% or less, with an associated loss in space and vegetation, including a sense of openness and spaciousness.
   - Loss of sight lines and view lines to the rear.
   - Loss of large-scale vegetation.
   - Front yard open space/privacy conflict and loss of visual connection with the street, with an increase in the height of fencing.
   - Multiple vehicle accessways from the street impacting on the continuity of the streetscape.

4. Identify a set of 'design parameters' that would provide increased development opportunity whilst minimising impacts and retaining Character Area values within the existing development framework. The following assumptions were noted:

   - Consideration of the MDRS provisions, and where possible these are incorporated into the parameters. The outcomes anticipated under the MDRS provisions are outlined in ***Appendix 1*.**
   - Consideration of the existing District Plan provisions where relevant. To enable development some changes are anticipated to the existing District Plan provisions in order to maintain the attributes of the various Character Areas.
   - The design parameters will inform the suite of potential District Plan provisions to be included in the Plan Change proposal, with 3D modelling of the potential design outcomes being undertaken by the Council.
   - Each Character Area is currently accompanied by a non-statutory Design Guide. The parameters have been recommended assuming development for alterations or new development would require a resource consent and would be considered based on assessment matters and updated design guides.

# 5.0 Evaluation of Character Areas and Recommended Design Parameters

## 5.1 Overview

Findings following the Stage 1 review process can be seen in the summary table provided in ***Appendix 2*** while the Stage 1 maps can also be referred to for more detail in ***Appendix 4***. Overall, the final findings recommend:

- 5 Character Areas being retained as they are - Beverley, Ranfurly, Massey, Malvern and Severn;
- 8 Character Areas remain but with reduced boundaries recommended - Cashmere, Beckenham, Tainui, Piko, Heaton, Francis, Dudley and Englefield;
- 2 Character Areas be removed - The Esplanade, and Clifton.

The maps and graphs clearly show Character Area 1 (The Esplanade and Character Area 2 (Clifton) fell well short of the 80% threshold and the 50/30 Primary/Contributory split. The Primary ranked properties within The Esplanade for example, fell from 48% to 28% while those in Clifton reduced from 82% to 36%.

The following section provides a summary of each of the Character Areas recommended to be considered as a Qualifying Matter. As the Clifton and Esplanade Character Areas did not meet the threshold to be considered Character Areas and were recommended for removal in Stage 1, they were not reviewed in Stage 2 and have not been evaluated for development potential.

The summaries of the remaining Character Areas include:

- An overview of the Character Area.
- A list of the key characteristics that make the area distinctive from their surroundings. This includes photographs of both representative dwellings and the streetscape.
- A map outlining the boundary of the Character Area, the categorisation of each property within it and a graph showing the percentage of Primary, Contributory, Neutral and Intrusive ranking of properties.
- Specific assumptions and analysis pertaining to the Character Area.
- Recommended design parameters to inform future development standards within the District Plan.

To avoid duplication of information the Character Areas have been grouped into six types given a number of the Character Areas include some commonalities.

The key attributes for each Area were developed using information from the 2015 Character Area Assessment and (where there was missing data) the Christchurch City Council Design Guides for the relevant Character Areas. These attributes were also used as a basis to consider potential impacts on the special characteristics to be retained.

It is important to note that the Character Areas have evolved over time through the development of various District Plan reviews. It was noted by the Council staff that the existing Character

Areas are not representative of a wide range of development eras but have largely been identified for evaluation by the subject community. At the time of writing, pre-notification engagement commentary was being collated, noting potential further Character Areas for review, that include a wider range of development eras.

When evaluating the Character Areas, the following observations were made:

- Dwellings of the original era made the strongest contribution to the streetscape and Character Area and should be encouraged to be retained. Provisions which allow the original dwelling to be moved to the front of a site could encourage the retention of original dwellings.
- The use of materials plays a critical role in influencing the character of a dwelling – particularly if it is a new development. Dwellings that had a similar material selection are much more sympathetic to the Character Area than others.
- Landscaping and vegetation are important contributing attributes of the Character Areas. Further development should encourage the retention or replacement of vegetation.
- The sense of enclosure from multi-storey developments adjoining Character Areas may reduce the quality of the Area (i.e. creates visual dominance).

### 5.1.1 Confirmation of Character Areas and their Boundaries

The above process for evaluating change to the existing Character Areas created a revised list of Character Areas, some with new boundaries, and this is set out in Table 2. A full table showing the percentage of ranking categories within each Character Area is provided as ***Appendix 2***.

*Table 2 Revised boundaries for Character Areas*

| Current DP # | Character Area | Stage 1 Action | Stage 2 Action (in comparison to District Plan) |
|---|---|---|---|
| CA1 | Esplanade | Remove | Remove* |
| CA2 | Clifton | Remove | Remove* |
| CA3 | Cashmere | Reduce | Reduce |
| CA4 | Beckenham Loop | Reduce | Reduce |
| CA5 | Tainui | Retain | Retain |
| CA6 | Piko | Reduce | Reduce |
| CA7 | Heaton | Reduce | Reduce |
| CA8 | Beverley | Retain | Retain |
| CA9 | Ranfurly | Retain | Retain |
| CA10 | Massey | Retain | Retain |
| CA11 | Malvern | Retain | Reduce |
| CA12 | Severn | Retain | Retain |
| CA13 | Francis | Reduce | Reduce |
| CA14 | Dudley | Reduce | Reduce |
| CA15 | Englefield | Reduce | Reduce |

*These Characters Areas were not re-assessed during Stage 2.

## 5.2 Character Type 1: Beverley, Heaton

### 5.2.1 Overview

Character Type 1 comprises the Heaton (CA7) and Beverley (CA8) Character Areas, located northwest of the central city. These two areas largely consist of original early 20th century homes representing Georgian Revival, English Domestic Revival and Arts and Craft styles. The distinctiveness of these Areas is created through the grouping of dwellings that are primarily large in scale, wooden two-storey buildings on generous, intact lots with mature vegetation. Discretely located garaging to the rear or side of the houses and low to medium fencing also means there is generally a good visual relationship with the streetscape in these Areas.

While these two Character Areas are broadly similar, the Heaton Character Area only consists of properties on the south side of the street, where the houses are consistently located well set back with large front gardens. The Beverley Character Area incorporates properties on both sides of Beverley Street, creating a strong sense of neighbourliness. As with Heaton, front gardens on the south side are typically generous but setbacks are generally small on the north side of the street.

### 5.2.2 Key Characteristics of Character Area Type 1

It is the combination of the following key elements that contribute to the distinctiveness and sense of place of the Heaton and Beverley Character Areas:

- Consistent double-storey generally detached dwellings with large footprints located on sections that are largely intact.
- Architectural detailing that primarily reflects the Georgian Revival, English Domestic Revival and Arts and Craft styles.
- Building form and detailing which includes steep pitched roofs, timber weatherboard cladding, iron or slate tile roofing, bay and box windows, a mixture of small and medium sized windowpanes within overall large frames, various styled dormer windows, window shutters, exposed rafter ends to extended eves and occasional shingle detailing on gable ends. Entrance canopies, a variety of detailed entry features, verandas and porches also feature throughout the Area.
- A feature of Heaton in particular, is the consistent balance between house and garden size and both Character Areas have a general spaciousness when viewed from the street, including generous separation between houses and gardens with substantial vegetation. This means a typical site coverage of approximately 30% and an average setback from the street of around 8.5m for Heaton. Beverley has consistently smaller setbacks of approximately 4m on the north side of the street and deeper setbacks varying between 6-14m on the south side.
- Both Areas are characterised by mature boundary and on-site vegetation.
- Low fencing of approximately 1m to 1.5m in height with some stone walls a feature of the Beverley Character Area.
- Visual connectivity between dwellings and the street – through low fencing, placement of windows and dwelling entrances and porches.
- Garages which are generally excluded from the street.


Heaton


Beverley

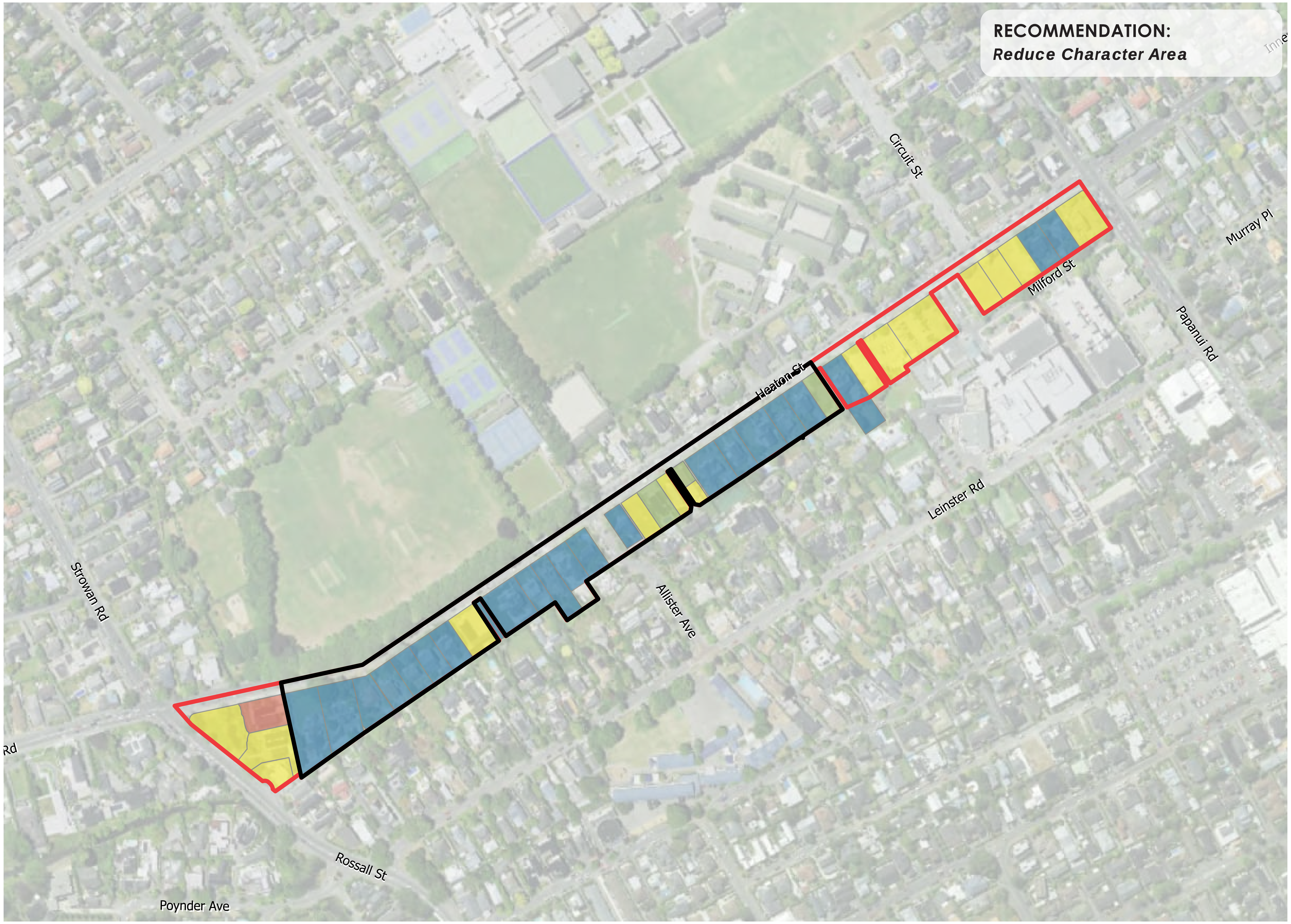

Beverley Streetscape, Beverley Street


Heaton Streetscape, Heaton Street

### 5.2.3 Character Area Boundaries and Categorisation of Properties

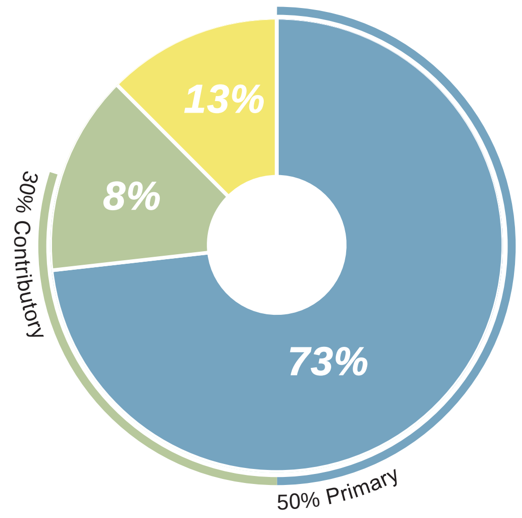
Maps 1 and 2 identify the boundary of the Beverley and Heaton Character Areas along with the categorisation of each property within it. The graph identifies the percentage of each ranking category within the Character Area boundary.

# CHARACTER AREA 7 - HEATON

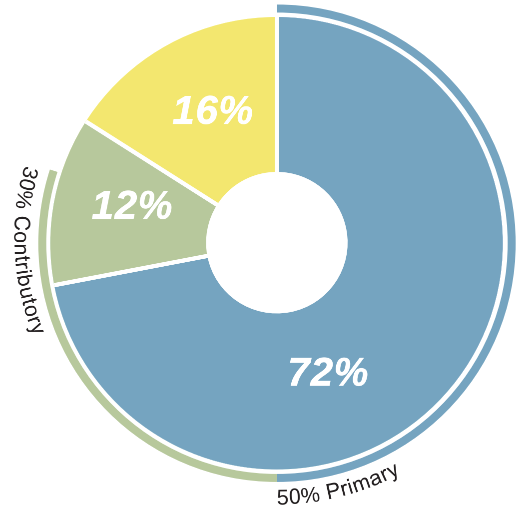



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

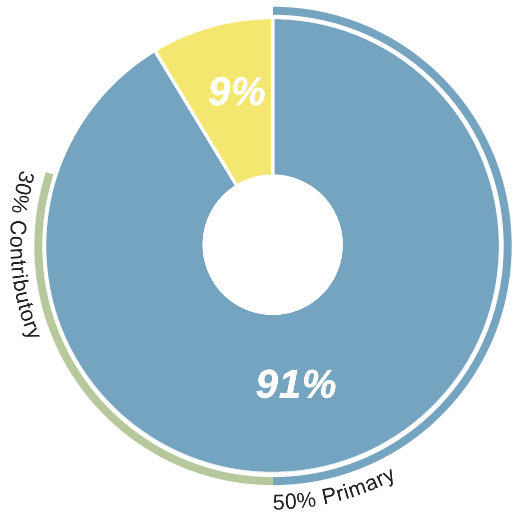
- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

Scale: NTS

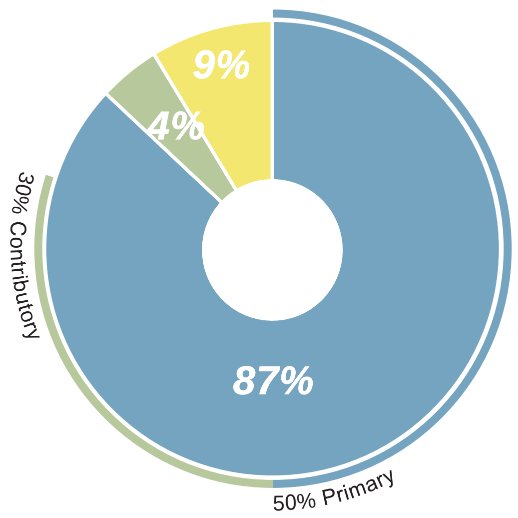
# CHARACTER AREA 8 - BEVERLEY


## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

### 5.2.4 Specific Assumptions and Analysis

**Heaton**

- Properties west of Allister Avenue have a slightly different character from the rest of Heaton Street due to the streetscape contribution of Elmwood Park and the large, mature trees along the park edge.
- Planted gardens and large trees on private properties are an important feature across the Character Area.
- Houses with historic significance have a Primary contribution.
- One property was revised from Contributory to Neutral at Stage 2 due to its inconsistent built form – particularly the roof form, design details and materiality, including large areas of glazing.
- The eastern end of Heaton Street has undergone considerable change with several buildings being demolished and being developed by St Georges Hospital. With the loss of attributes on this cluster of properties, they no longer contribute to the Character Area and therefore the boundary has been moved to exclude them.
- New developments in contemporary style with different layout patterns at the western end of Heaton Street has also eroded the character and these have also been excluded from the final boundary.

**Beverley**

- Primary properties located on corner sites in Beverley assist with creating an intimate character and a highly cohesive Character Area.
- There is very limited change apparent from the street. Low stone walls and fences remain an important characteristic in Beverley however, this is one of the few aspects that is changing with taller fences being erected. Avoiding garages from being located along the street boundary has generally been successful.
- The Character Area boundary has not been revised.

### 5.2.5 Character Area Type 1 Recommended Design Parameters

**Landscape and Vegetation**

The consistent setbacks and sense of separation between houses as well as the presence of mature boundary and garden vegetation are key features of Type 1 Areas. To maintain consistency with these characteristics:

- Houses should be aligned with dominant setbacks of existing adjacent houses. Therefore, in Heaton, deep minimum boundary setbacks are recommended consistent with the existing average of around 8.5m while in Beverley, smaller minimum setbacks on the north side are appropriate of no more than 4m on the north side and approximately 7m on the south side.
- Buildings should be setback sufficiently from the side boundaries to maintain the sense of openness and a consistent development pattern. Side setbacks of between approximately 2-3m and 5m are recommended.

- Due to the importance of large scale established trees in contributing to the character of Type 1 Areas, for Beverley, a minimum landscape strip should be required at the front boundary of no less than 2m and a minimum landscaped area of approximately 20% is recommended. For Heaton at least 3 large specimen trees should be planted in the front setback as well as a 20% landscape area across the site.

- To further ensure a sense of spaciousness, setting a minimum outdoor space is recommended and should be at least 80m$^2$ with a minimum dimension of around 7m.

**Streetscape and Connectivity**

Type 1 Areas are characterised by good visual connectivity between dwellings and the street primarily through low fencing, placement of windows and dwelling entrances and porches and the location of garages and parking generally to the rear or at least not dominating the front of the house. To maintain consistency with these characteristics:

- Entries and windows should be oriented to face the street and with similar proportions to existing adjacent houses with glazing at least 20% of the front façade.

- Fencing should be a maximum 1.8m in Heaton and 1.2m in Beverley and consider using fencing materials sympathetic with those of the house.

- Garages and parking should ideally be located at the rear to avoid diluting the character of the house and reducing the front garden area and vegetation. If they are at the side, these should be set back from the front face of the dwelling.

**Built Form**

As Type 1 Areas are characterised by Georgian Revival, English Domestic Revival and Arts and Craft styles, alterations or new dwellings should use materials and an architectural style sympathetic to houses from this era.

It is recommended that new dwellings should be two-storeys with a maximum height of approximately 9m to ensure the height is in keeping with the existing original houses on these streets. Height in relation to boundary rules should also encourage a two-storey form with pitched gable or hip roofs that are consistent with the adjacent primary dwellings.

Buildings within the same site should be separated by 5m to remain in keeping with the detached form of the Character Area.

Buildings can be relatively large in size but no greater than 35% of the site coverage.

For sites with long frontages, long buildings would be inconsistent with the Character Area, therefore a 60% maximum building frontage to the street is recommended.

**Subdivision Pattern**

The original subdivision pattern remains largely intact in Type 1. Sections vary in size and are typically large, ranging generally between 780-1300m$^2$. While the design parameters have been recommended to allow for two units per site, a subdivision minimum rule would limit the density allowed and assist in retaining large section sizes and maintaining a consistent pattern.

Vehicle crossing access widths should be kept as narrow as possible to allow for safe access, without dominating the streetscape of the Character Area. Double-access widths, where adjacent access points adjoin each other, should be avoided.

## 5.3 Character Area Type 2: Englefield

### 5.3.1 Overview

Type 2 is made up solely of the Englefield Character Area, located immediately northeast of the city centre and just to the south of the Ōtākaro Avon River. This Area comprises distinctive house types that date to early settlement of Christchurch, including a high proportion of Victorian worker's cottages dating to 1870s that are not represented in other Character Areas. The streets are narrow and the sections are small with narrow street frontages creating a distinctively intimate scale and relationship between the houses, gardens and streets.

### 5.3.2 Key Characteristics of Character Area Type 2

It is the combination of the following key elements that contribute to the distinctiveness and sense of place of the Englefield Character Area:

- Consistent single-storey, detached buildings with small footprints.
- Architectural detailing that primarily reflects workers cottages from the 1870s and several wooden bungalows from the 1920's and 1930's.
- Building form and detailing is simple and includes small projections for porches, low angled gable and hip roofs, weatherboard cladding, symmetrical frontage, clearly defined entrance, verandas, porches, windows to the street.
- A feature of Englefield is the consistently small scale layout, with narrow streets, small sections and small setbacks. This means a typical site coverage of approximately 40% and setbacks from streets varying between approximately 3m and 7m with an average of 4.5m.
- Most properties are characterised by mature boundary and on-site vegetation.
- Low fencing of approximately 1m to 1.5m in height with some timber/picket fencing a feature of the Area.
- Good visual connectivity between dwellings and the street through low fencing, narrow street setbacks and the placement of large windows at the front of the dwellings.
- Properties with garages have generally placed these at the rear.

Englefield

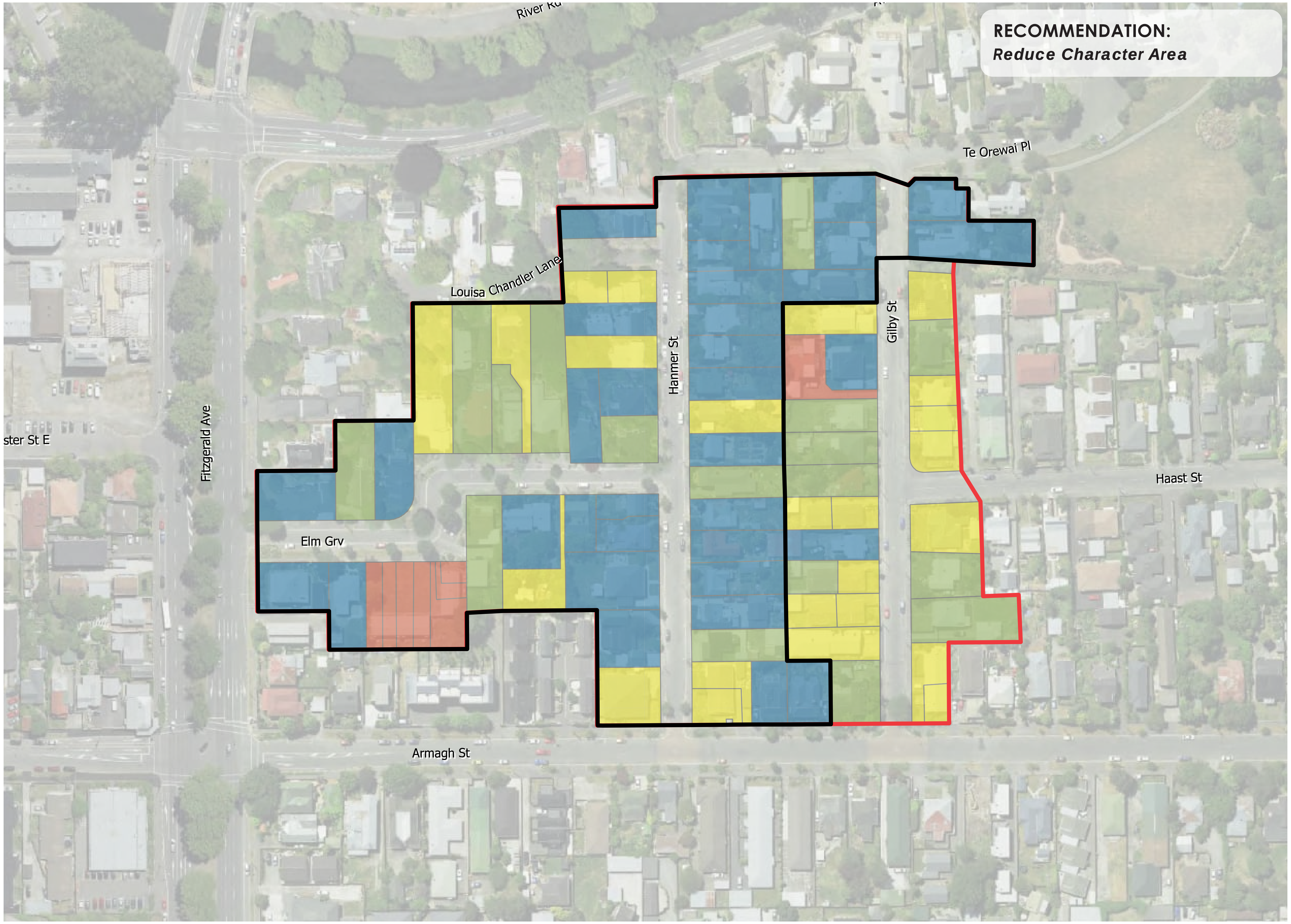
Englefield


Englefield Streetscape, Hanmer Street

### 5.3.3 Character Area Boundaries and Categorisation of Properties

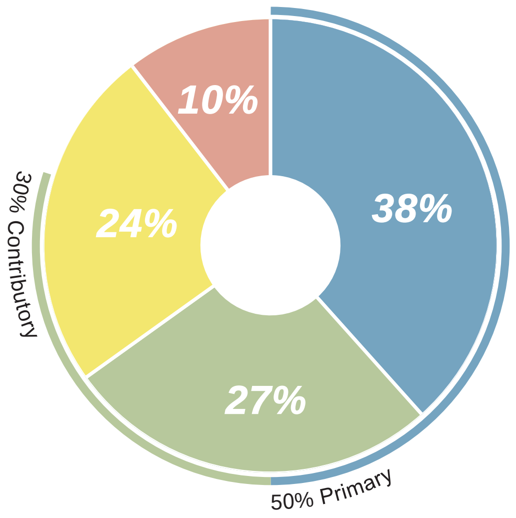
Map 3 identifies the boundary of the Englefield Character Area along with the categorisation of each property within it. The graph identifies the percentage of each ranking category within the Character Area boundary.

# CHARACTER AREA 15 - ENGLEFIELD*

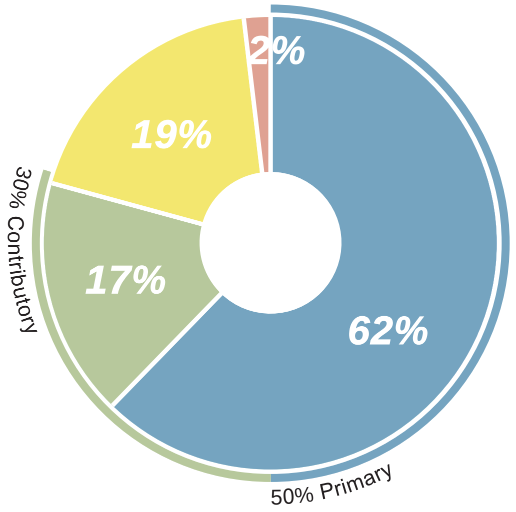



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

*Further refinement of the boundary would enable full compliance with the 80% Primary and Contributory threshold. In addition, 22 Elm Grove includes seven 'intrusive' address points which in this case has been manually changed to identify as one property.

Scale: NTS

### 5.3.4 Specific Assumptions and Analysis

- The streetscape has minimal landscaping and narrow footpaths however the planting in the front gardens is a consistent feature in this Area and contributes considerably to the character of the streetscape.
- The categorisation of a number of properties on Elm Grove and Hanmer Street were revised upwards, either to Primary or Contributory ratings, while properties on Gilby Street were revised down to Contributory or Neutral. While the Gilby streetscape retains consistent small scale elements with the narrow street and setbacks, there are few Primary properties remaining and as such the built form attributes of this area are no longer represented in a consistent or cohesive way. Therefore, most of Gilby Street has been excluded from the revised Character Area boundary.

### 5.3.5 Chapter Area Type 2 Recommended Design Parameters

**Landscape and Vegetation**

The consistent narrow spacing and pattern of street frontages and the well planted gardens are key features of the Type 2 Area. To maintain consistency with these characteristics:

- Houses should be aligned with dominant setbacks of existing adjacent houses. Therefore, in Englefield, where the small front yards are a key feature, small minimum boundary setbacks are recommended of around 3-5m to be in keeping with the current average of around 4.5m.
- Given the existing close pattern of development, it is recommended that small building setbacks from side boundaries be encouraged, with a minimum of approximately 1.5m and no more than 5m.
- Front gardens in Englefield are small but are a key contributor to the character of the streetscape, so a minimum landscape strip should be required at the front boundary of no less than 2m and a minimum landscaped area of approximately 20% is recommended.
- Similarly, a minimum outdoor space is recommended which should maintain the consistent balance between the size of house and gardens. Given the smaller scale of properties this could be around 50m2 with a minimum dimension of at least 5m.

**Streetscape and Connectivity**

There is good visual connectivity creating a strong neighbourhood environment primarily through low fencing, porches and verandas and close, clear views to the street. To maintain consistency with these characteristics:

- House entrances, windows and porches should be oriented to face the street and with similar proportions to existing adjacent houses with glazing at least 20% of the front façade.
- Fencing should be low (a maximum of 1-1.2m is recommended) and consider using fencing materials and style sympathetic with the original houses such as timber/picket fencing.
- Given the proximity to the Central City, garages and carports are discouraged. If new garages or carports are proposed, they should be small-scale, detached from the dwelling and located to the side of the dwelling to avoid dominating the dwelling.

**Built Form**

As the Englefield Character Area is characterised by Victorian workers cottages and wooden bungalows, alterations or new dwellings should use materials and an architectural style sympathetic to houses from this era.

It is recommended that new dwellings be single storey and similarly scaled with similar sized footprints to existing houses. Therefore, a maximum building height of approximately 5m is recommended, together with height in relation to boundary rules that encourage a single storey form with pitched gable or hip roofs that are consistent in form with the adjacent primary dwellings. Buildings should be modest in size and no greater than 35% of the site coverage.

Buildings within the same site should be separated by 5m to remain in keeping with the detached form of the Character Area.

For sites with long frontages, long buildings would be inconsistent with the Character Area, therefore a 60% maximum building frontage to the street is recommended.

**Subdivision Pattern**

The original subdivision pattern remains largely intact in the Type 2 Area. Sections are generally larger on Elm Grove and smaller on Hanmer Street where sizes are typically around 450m$^2$. While the design parameters have been recommended to allow for two units per site, a subdivision minimum rule would limit the density allowed and assist in maintaining a consistent layout.

Access widths should be kept as narrow as possible to allow for safe access, without dominating the streetscape of the Character Area. Double-access widths, where adjacent access points adjoin each other, should be avoided.

## 5.4 Character Area Type 3: Francis, Malvern, Massey, Ranfurly, Severn, Tainui

### 5.4.1 Overview

Type 3 represents the largest group, comprising the Francis, Malvern, Massey, Ranfurly, Severn, and Tainui Character Areas, located broadly to the north of the central city. These six areas largely comprise early to mid 20th century detached bungalows and villas with modest footprints. Some subdivision with infill housing has occurred over time however generally these areas have remained largely cohesive in character and sections remain relatively intact.

The vegetation and street amenity are also a distinctive feature that adds significantly to the cohesive character of these Areas. Large scale, mature street trees and grass berms as well as vegetated front gardens are characteristic of the Type 3 Areas, often helping to mark the 'gateways' of the Character Area.

### 5.4.2 Key Characteristics of Character Area Type 3

It is the combination of the following key elements that contribute to the distinctiveness and sense of place of these six Character Areas that make up Type 3:

- Generally single storey, moderate-scale, individual buildings with occasional 2-storey homes.
- Architectural detailing primarily reflecting the wooden Californian-style bungalows of the 1920s and 1930s and occasional villas. Tainui Character Area includes some dwellings of the English Domestic Revival (EDR) style.
- Building form and detailing includes simple forms with the addition of small projections, low-pitched hip roofs, gable ends with shingles, bay or bow windows and weatherboard cladding, leadlights and shingle gable ends. The dwellings generally have large windows and porches addressing the street.
- The original block layout in these Character Areas is generally intact. There is some infill in Tainui.
- A feature of many of these areas is the high amenity streetscape with mature street trees and well landscaped gardens with consistent, generous setbacks. Typical site coverage is between approximately 35%-45% with average setbacks of around 8-9m. The Massey Character Area is slightly deeper with an average of approximately 10m.
- All areas are characterised by mature boundary and on-site vegetation including specimen trees.
- No fencing or low fencing of approximately 1m to 1.5m in height with some picket and stone walls are a feature of the Severn Character Area.
- Visual connectivity between dwellings and the street through low or no fencing, placement of windows and dwelling entrances and sympathetic on-site landscaping.
- Garages generally excluded from the street.

Malvern

Massey

Francis

Ranfurly

Severn

Tainui

Massey Streetscape, Massey Crescent

### 5.4.3 Character Area Boundaries and Categorisation of Properties

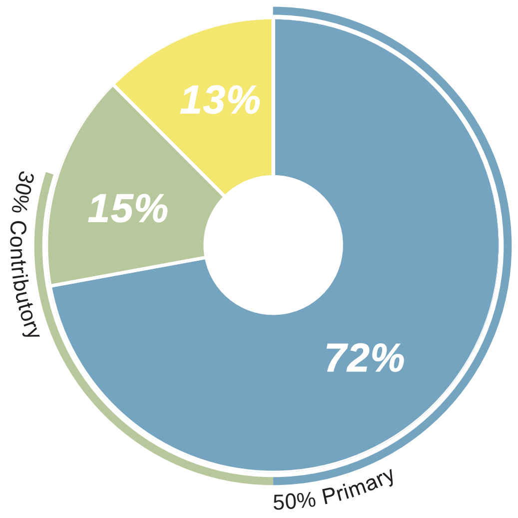
Maps 4-9 identify the boundary of the Type 3 Areas along with the categorisation of each property within it. The graph identifies the percentage of each ranking category within the Character Area boundary.

# CHARACTER AREA 13 - FRANCIS*

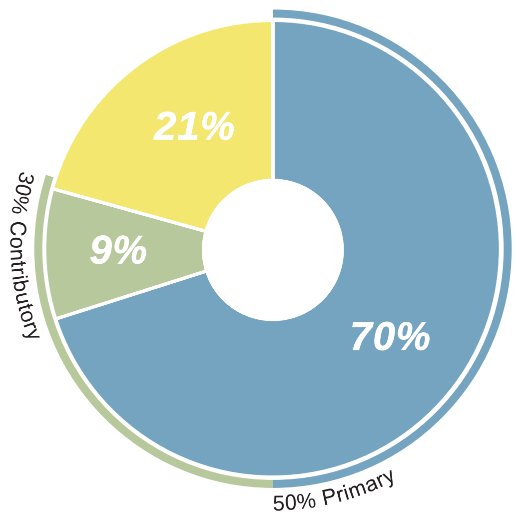
**RECOMMENDATION:**
***Reduce Character Area***


## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT



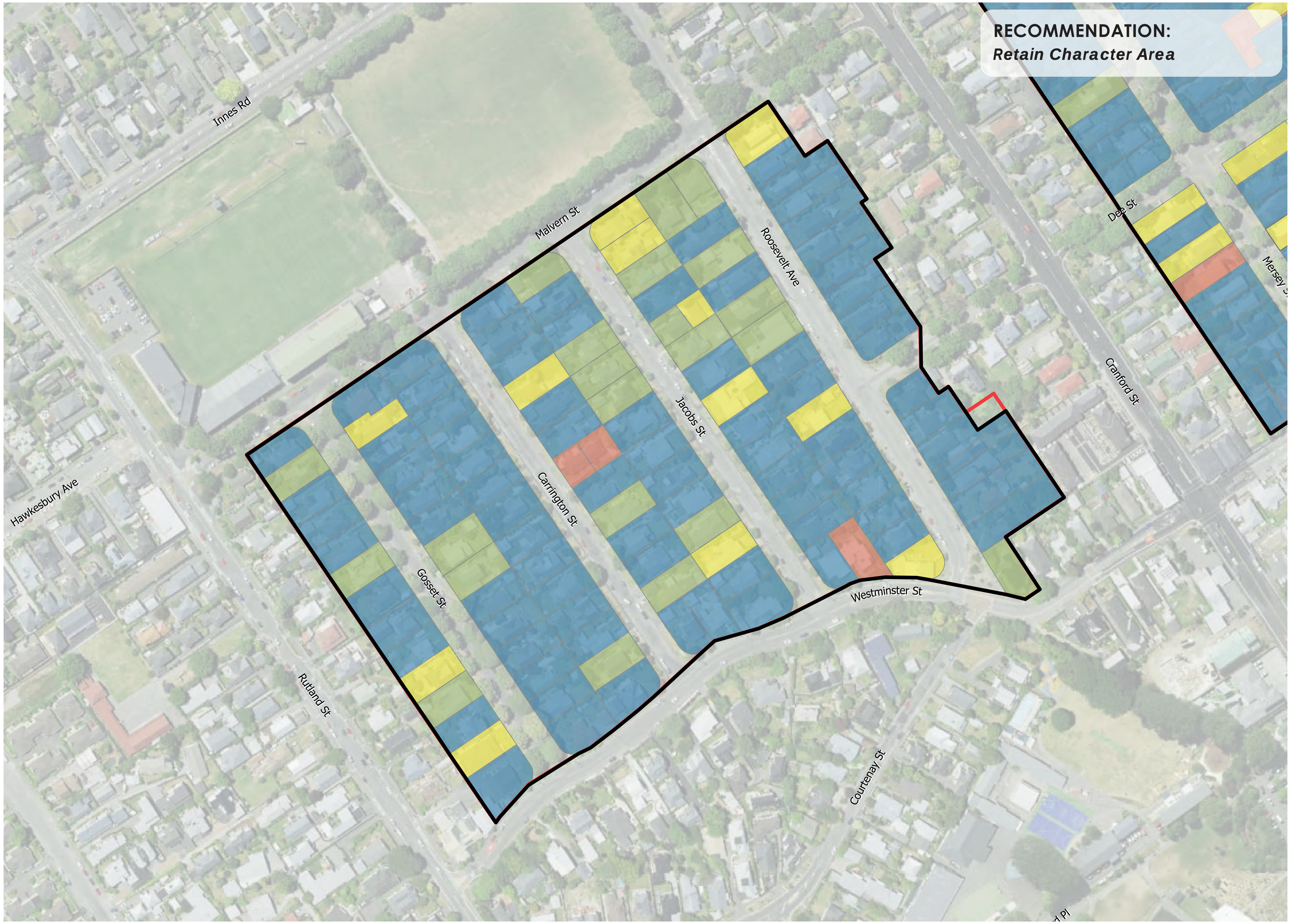

**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

* This area does not meet the 80% requirement but does exceed the 50% Primary score. The boundary could be altered further to exclude “properties not visible from the street” to enhance the percentage scores overall and more accurately represent the Character Area.

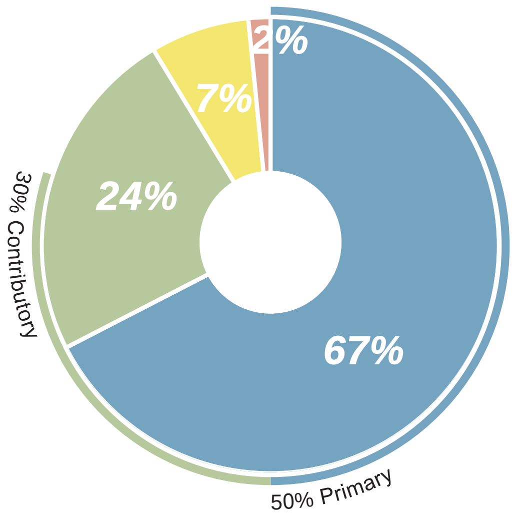
Scale: NTS

# CHARACTER AREA 11 - MALVERN

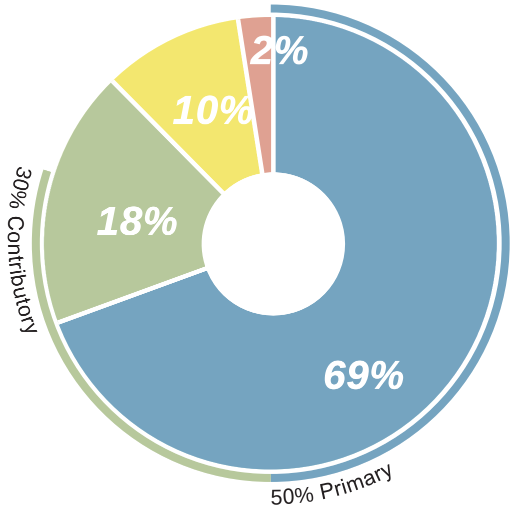



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

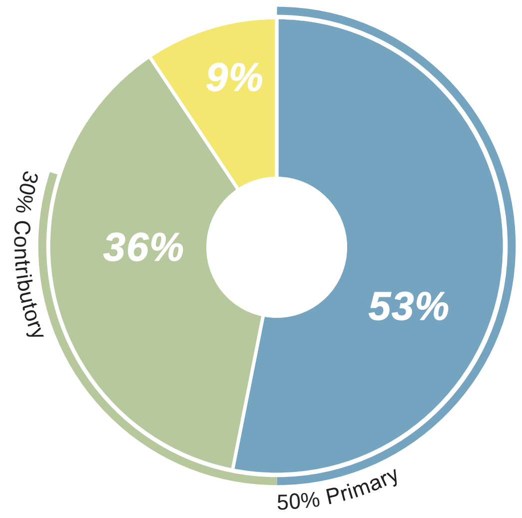
- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

Scale: NTS

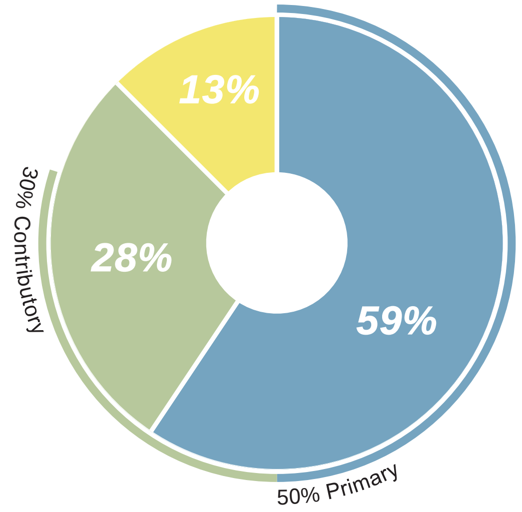
# CHARACTER AREA 10 - MASSEY


## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT

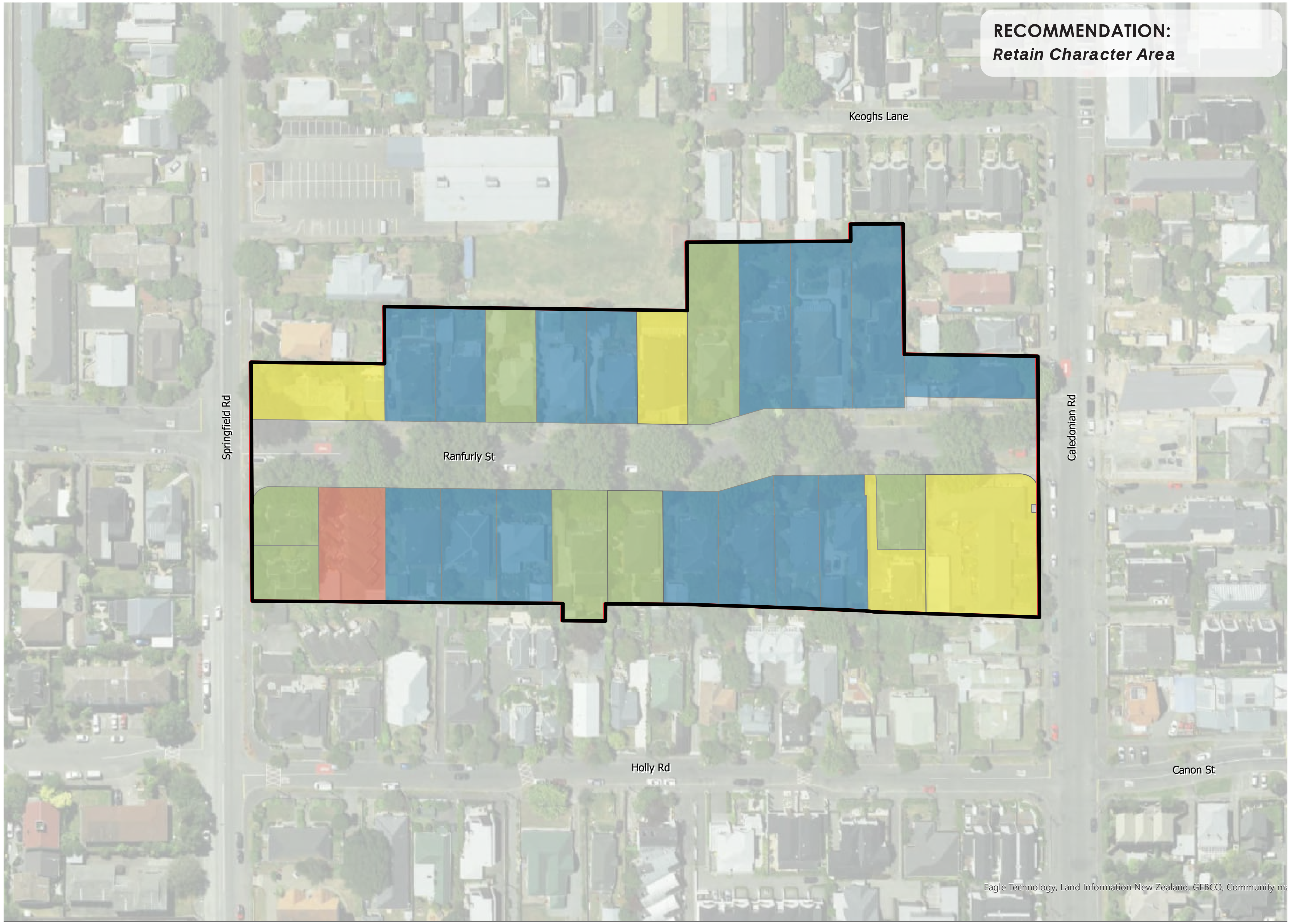



**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

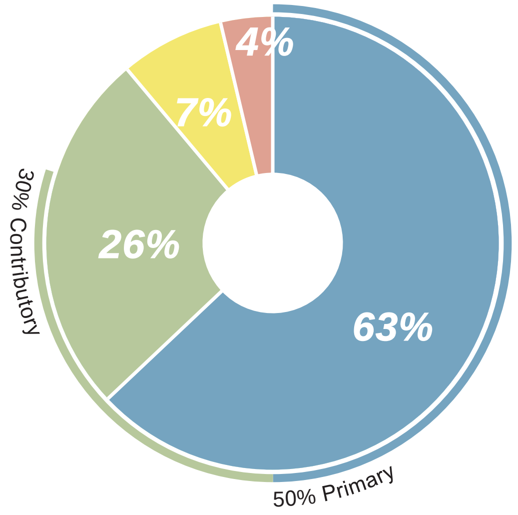
Scale: NTS

# CHARACTER AREA 9 - RANFURLY

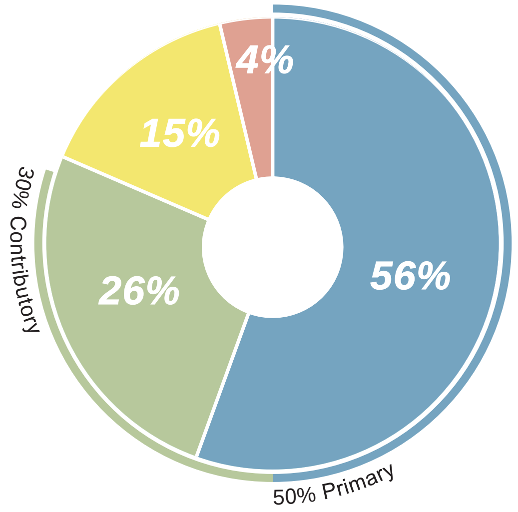



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT

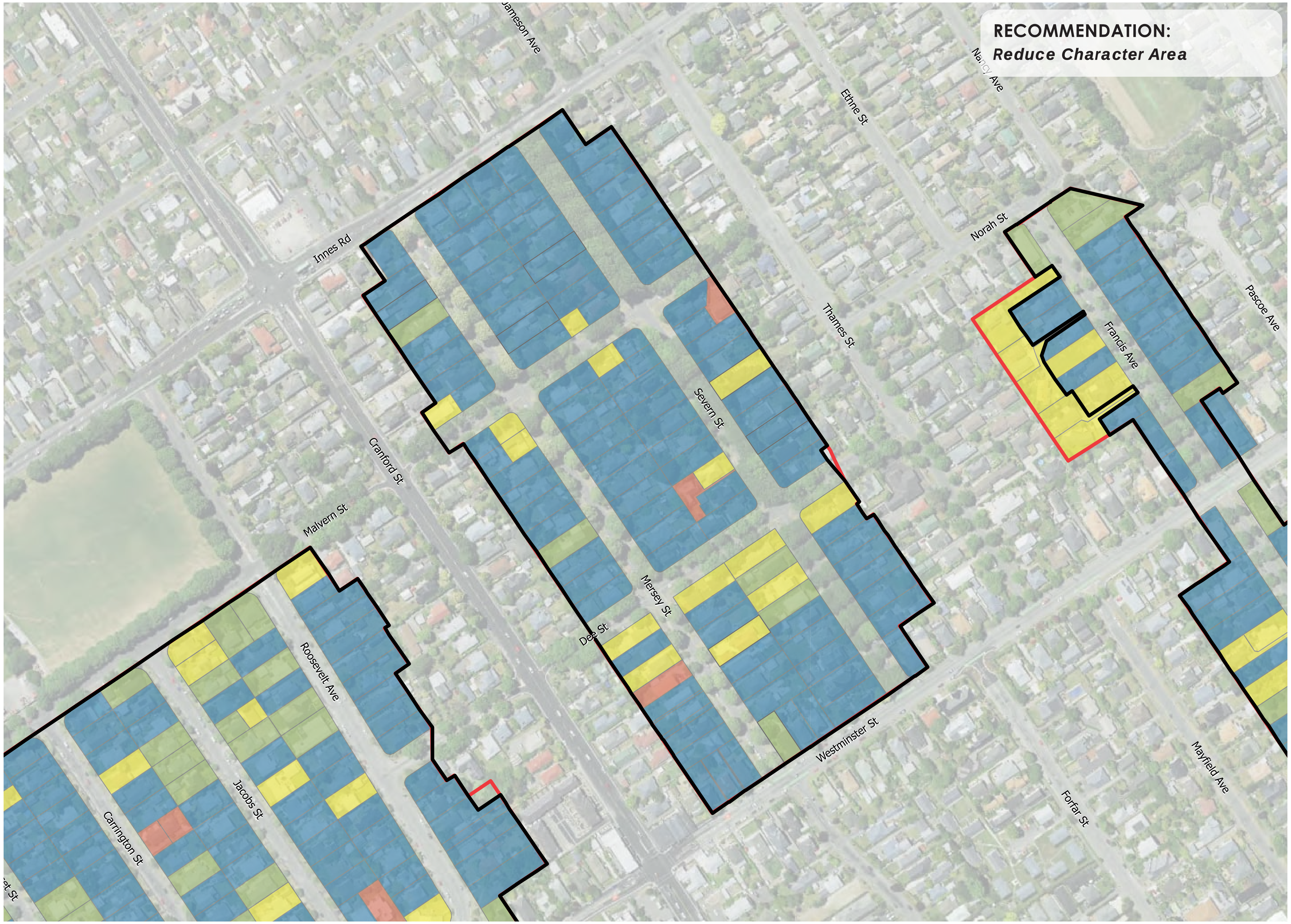



**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

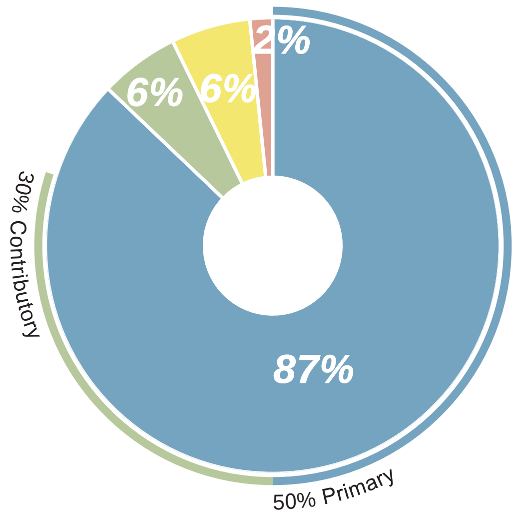
Scale: NTS

# CHARACTER AREA 12 - SEVERN

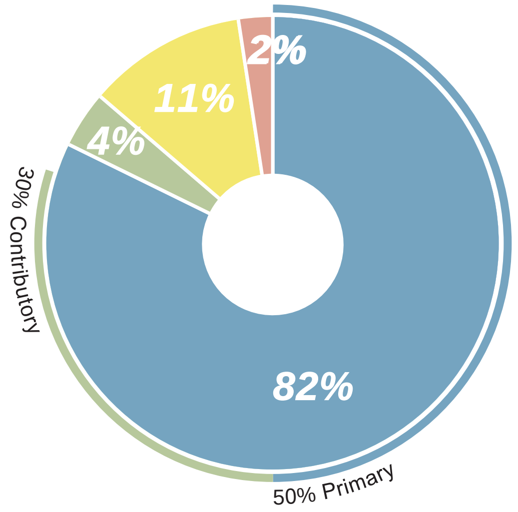



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT

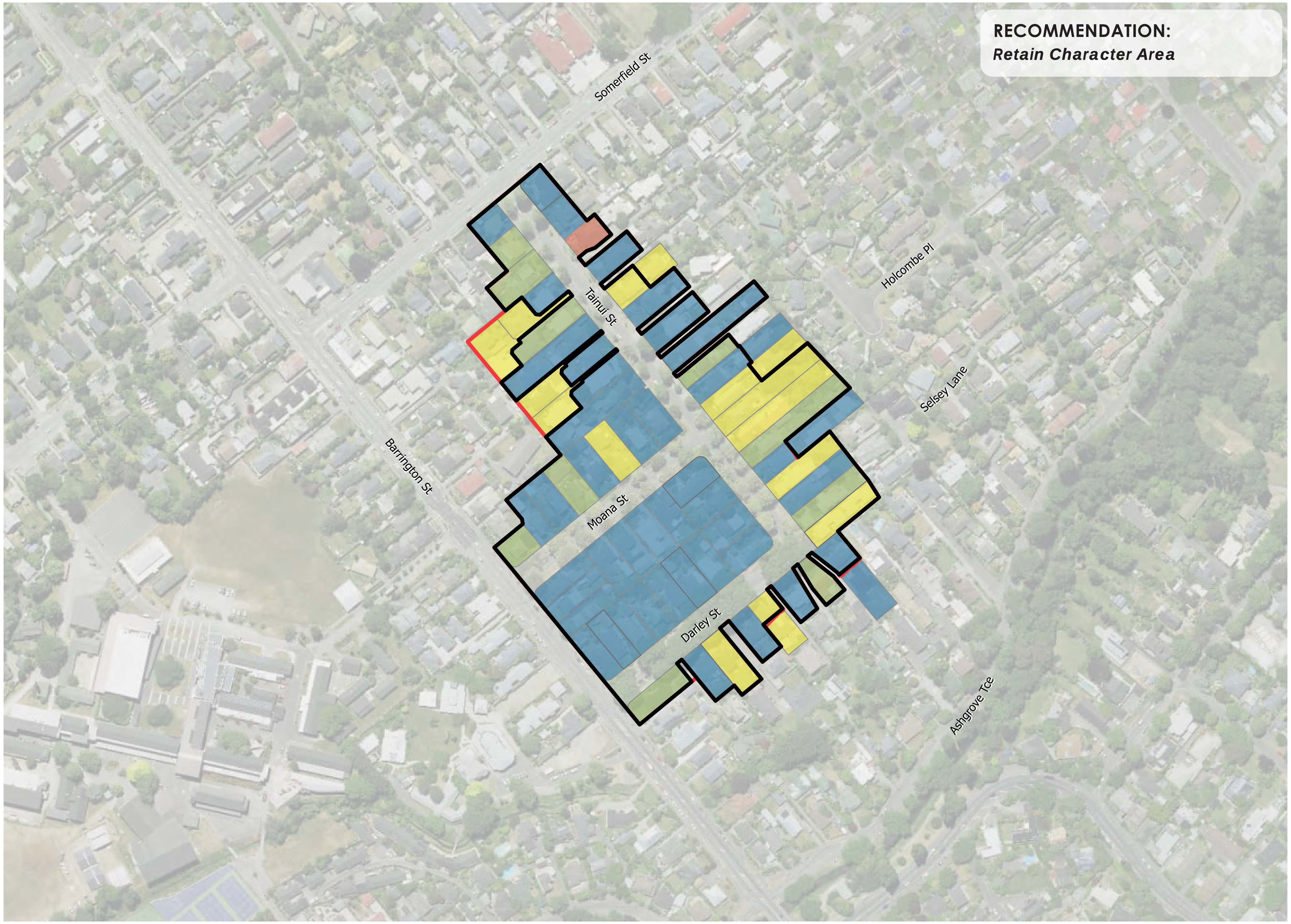



**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

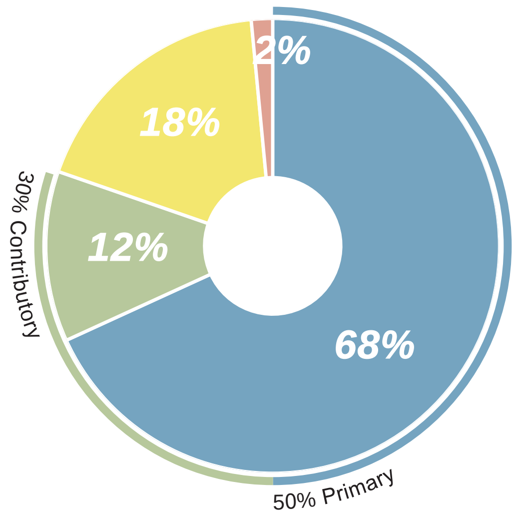
Scale: NTS

# CHARACTER AREA 5 - TAINUI

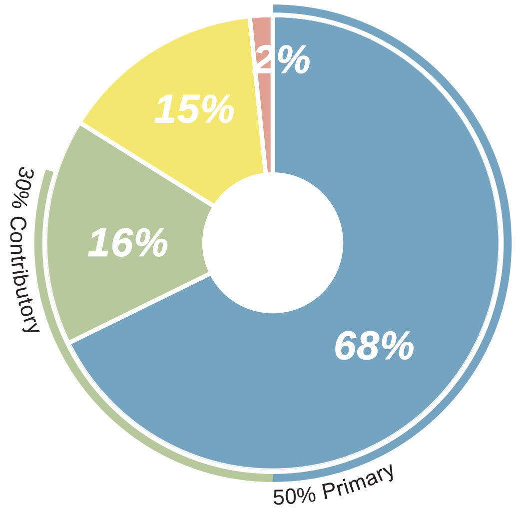



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

Scale: NTS

### 5.4.4 Specific Assumptions and Analysis

**Francis**

- The mature street trees and Primary and Contributory properties on the corner sites, assist with a sense of this as a tight, highly cohesive Character Area.
- The categorisation of a small number of properties have been revised upwards, for example, due to considering the strength of the original property outweighing the negative impact of a front garage.
- The Character Area boundary has had a minor reduction due to the decision to exclude a cluster of Neutral rear properties.

**Malvern**

- Primary properties on corner sites in Malvern, together with the mature street trees, assist with a sense of this as a tight, highly cohesive Character Area.
- The categorisation of several properties in Malvern were revised upwards during the Stage 2 process reflecting the ground-truthing process.
- The Character Area essentially remains intact with exception of a rear property which has been excluded as it belonged to a property accessed off Dee Street, outside the Malvern Character Area.

**Massey**

- The mature street trees and Primary and Contributory properties on the corner sites, assist with a sense of this as a tight, highly cohesive Character Area.
- Very limited change is apparent from the street. As a result the boundary of the Area has not been revised.

**Ranfurly**

- The new development on the corners of the Ranfurly Character Area are eroding the consistency of the Character Area, however the mature street trees assist with its cohesion.
- Very limited change is apparent from the street and as a result the boundary has not been revised.

**Severn**

- Primary properties on corner sites, together with the mature street trees, assist with a sense of this as a tight, highly cohesive Character Area.
- There is very limited change apparent from the street and as such the boundary has not been revised.

**Tainui**

- Primary properties on corner sites, together with the mature street trees, assist with a sense of this as a cohesive Character Area.
- Some older infill has occurred however limited further change is apparent from the street. The boundary of the Area has not been revised.

### 5.4.5 Character Area Type 3 Recommended Design Parameters

**Landscape and Vegetation**

Houses in the Type 3 Character Areas are characterised by their very consistent, deep street setbacks as well as the presence of mature boundary and garden vegetation and mature street trees. To maintain consistency with these characteristics:

- Houses should be aligned with dominant setbacks of existing adjacent houses. Therefore, deep minimum boundary setbacks are recommended consistent with the existing average in most Character Areas of around 8m.
- Buildings should be setback sufficiently from the side boundaries to maintain the sense of spaciousness and a consistent development pattern. Side setbacks of between approximately 2m and 5m are recommended.
- Due to the importance of established vegetation in contributing to the character of Type 3 Areas, a minimum landscape strip should be required at the front boundary of no less than 3m and a minimum landscaped area of approximately 20% is recommended.
- To further ensure a sense of spaciousness, setting a minimum outdoor space is recommended and should be at least $50m^2$ with a minimum dimension of around 5m.

**Streetscape and Connectivity**

Good streetscape connectivity remains characteristic of the streets in the Type 3 Areas. This strong relationship is primarily due to low fencing, entrances, windows and porches facing the street, and the exclusion of garaging from the street front. To maintain consistency with these characteristics:

- House entrances, windows and porches should be oriented to face the street and with similar proportions to existing adjacent houses with glazing at least 30% of the front façade.
- Fencing should be low (a maximum of 1.2m is recommended) and consider using fencing materials and style sympathetic with the original houses such timber/picket fencing.
- New garages or carports in Type 3 Areas should be located to the rear of the house to avoid diluting the strong relationship between the street and the dwelling. If they are at the side, they should be set back from the front facade of the dwelling.

**Built Form**

The Type 3 Character Areas are characterised by single-storey wooden Californian-style bungalows of the 1920s and 1930s, therefore alterations or new dwellings should use materials and an architectural style sympathetic to houses from this era.

It is recommended that new dwellings be single storey and similarly scaled with similar sized footprints to existing houses. Therefore, a maximum building height of approximately 5.5m is recommended, together with height in relation to boundary rules that encourage a single storey form with low pitched gable or hip roofs that are consistent in form with the adjacent primary dwellings. Buildings should be modest in size and no greater than 35% of the site coverage.

Buildings within the same site should be separated by 5m to remain in keeping with the detached form of the Character Area.

For sites with long frontages, long buildings would be inconsistent with the Character Area, therefore a 60% maximum building frontage to the street is recommended.

**Subdivision Pattern**

While sections remain largely intact in Type 3, there are examples within these Character Areas where subdivision is starting to erode the consistent division pattern. The pattern varies between Character Areas; however section sizes are most typically between approximately 550-750m$^2$ and are generally very consistent within Areas. While the design parameters have been recommended to allow for two units per site, a subdivision minimum rule would limit the density allowed and assist in maintaining a consistent layout.

Access widths should be kept as narrow as possible to allow for safe access, without dominating the streetscape of the Character Area. Double-access widths, where adjacent access points adjoin each other, should be avoided.

## 5.5 Character Area Type 4: Dudley, Beckenham

### 5.5.1 Overview

Type 4 comprises the Dudley and Beckenham Character Areas. These two larger Areas comprise a number of streets with homes predominantly dating between the 1920s and 1940s, with similar sized sections and street setbacks. Waimea Terrace and Eastern Terrace form Beckenham Loop which follows the river and encircles a grid like street patten of Beckenham. Dudley has a linear grid street layout, aside from Stapletons Road and Julius Terrace which are dictated by the river.

### 5.5.2 Key Characteristics of Character Area Type 4

It is the combination of the following key elements that contribute to the distinctiveness and sense of place of the Type 4 Character Areas:

- Consistent style and era of dwellings (primarily consisting of single-storey wooden Californian-style bungalows of the 1920s - 1940s).
- Dwellings are typically single-storey, with some exceptions and are generally detached buildings of a moderate scale.
- Buildings and roofs are generally simple forms with projections, gable and hip roofs.
- Architectural detailing includes bay and bow windows, shingle gable ends and weatherboard cladding.
- Dwellings are setback between 6-9m from the street, with larger setbacks present bordering the river at Beckenham (Waimea Terrace and Eastern Terrace, Beckenham).
- Fencing is 1m to 1.5m, although evidence of non-compliance with this standard is eroding this consistency.
- Moderate street widths, consistent dwelling setbacks (more generous along the river edge).
- Visible boundary vegetation and landscaping in the front yard.
- Good visual connectivity between the dwellings and the street through low fencing, dwelling entrances, placement of windows.

- Mature deciduous trees lining Dudley Street, Dudley and Fisher Avenue and Norwood Street, Beckenham.

Dudley

Dudley

Dudley Streetscape, Dudley Street

Beckenham

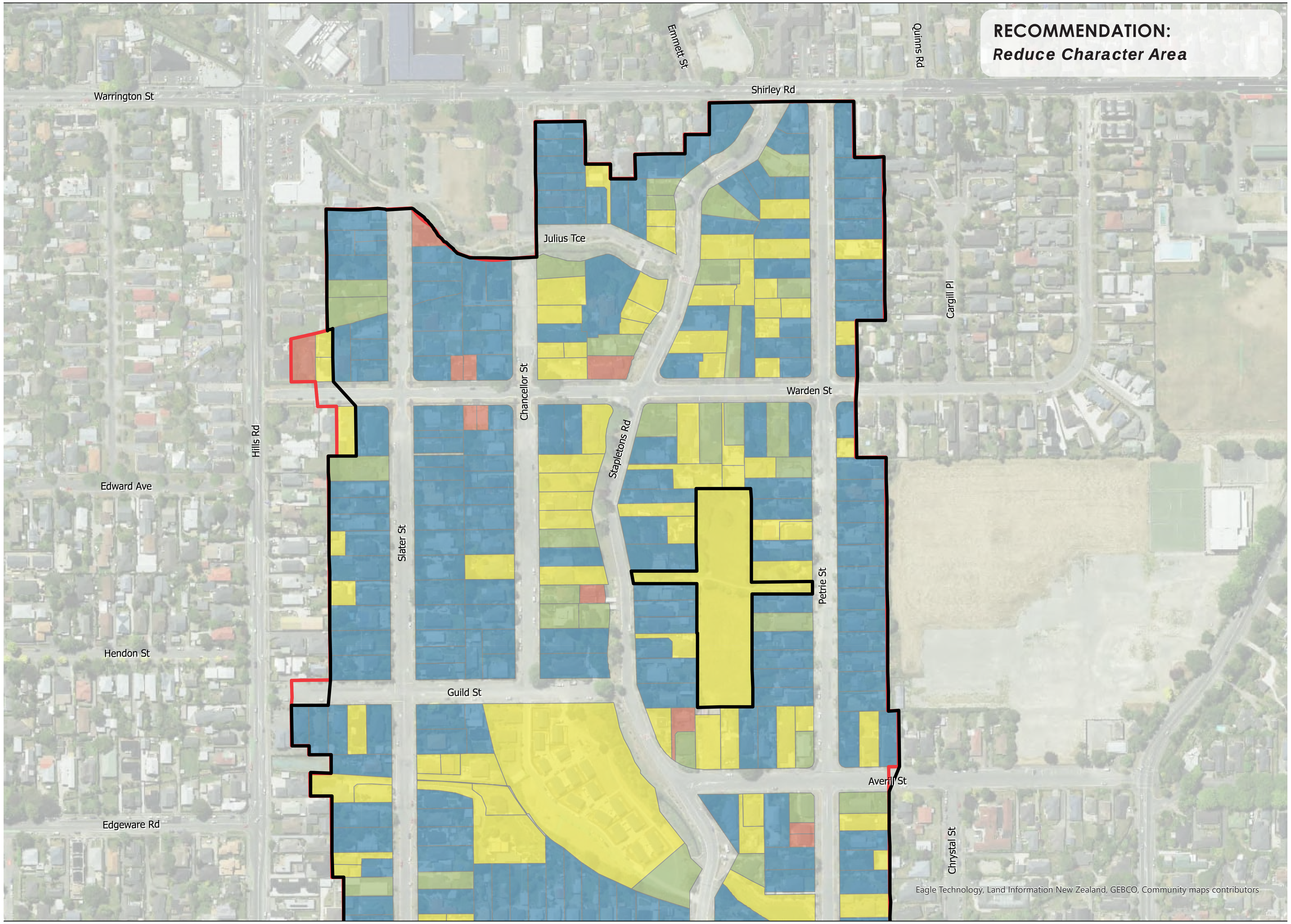
Beckenham

Beckenham Streetscape, Birdwood Avenue

### 5.5.3 Character Area Boundaries and Categorisation of Properties

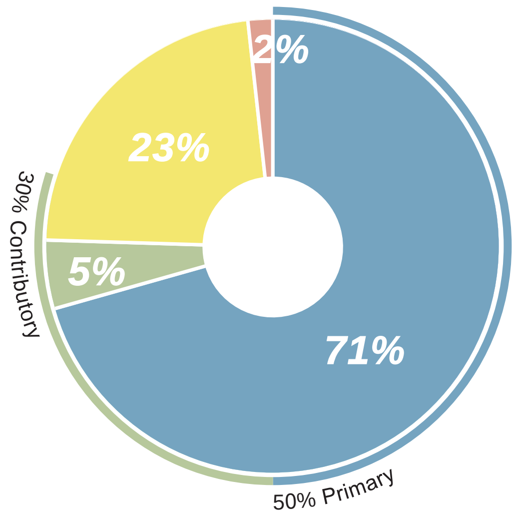
Maps 10 and 11 identify the boundary of the Type 4 Areas along with the categorisation of each property within it. The graph identifies the percentage of each ranking category within the Character Area boundary.

# CHARACTER AREA 14 - DUDLEY*

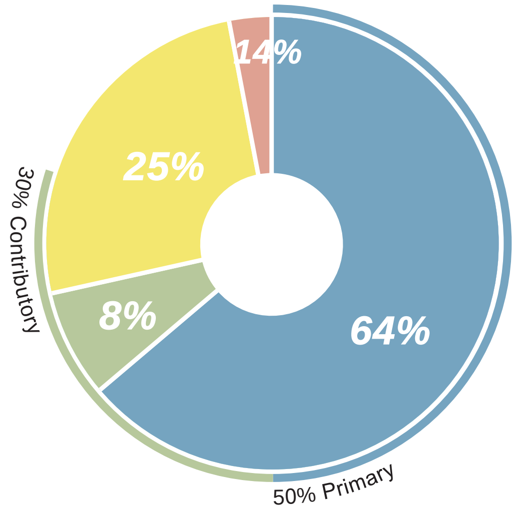



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

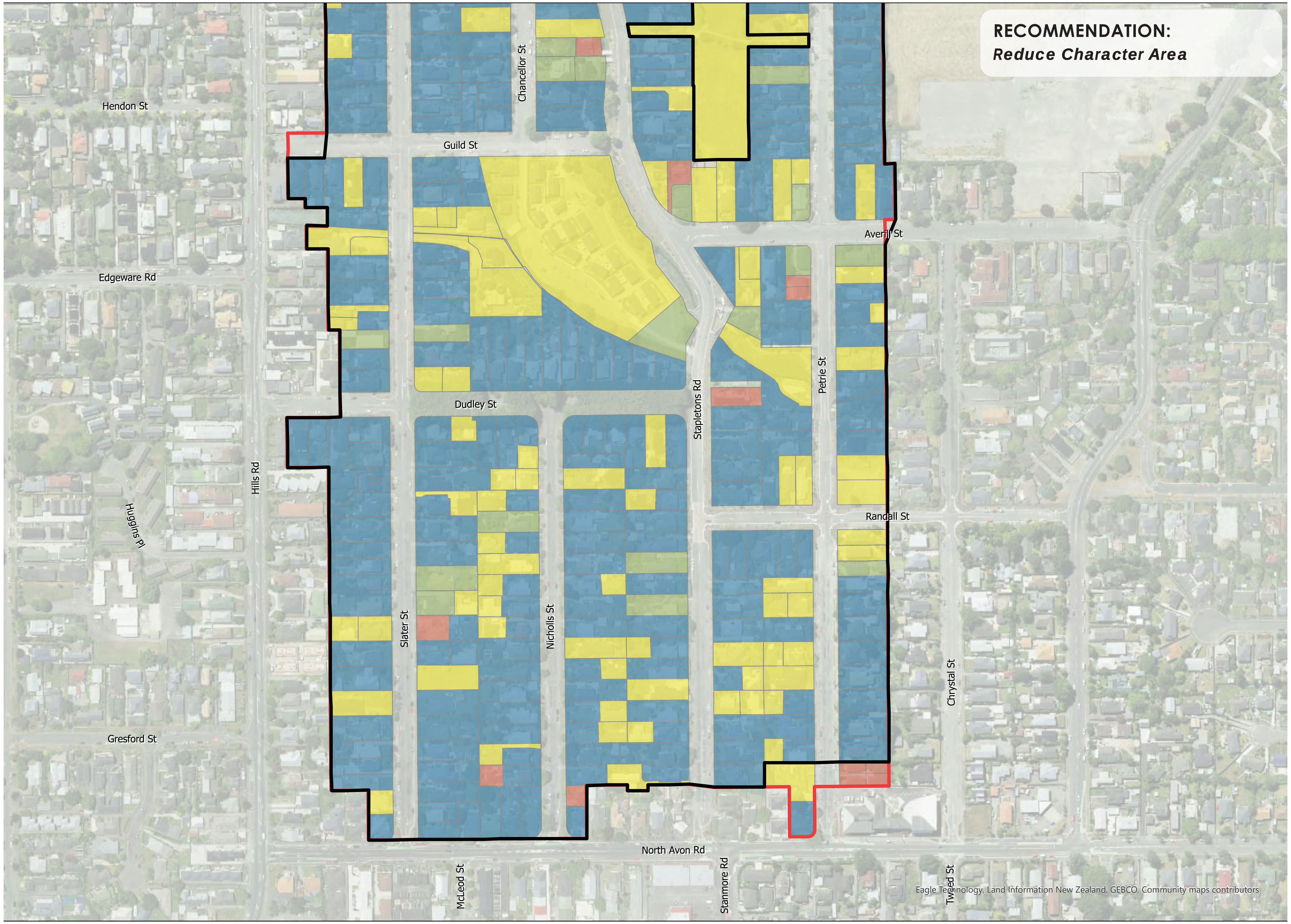
- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

* This area does not meet the 80% requirement but does exceed the 50% Primary score. The boundary could be altered further to exclude “properties not visible from the street” to enhance the percentage scores overall and more accurately represent the Character Area.

*Petrie Park has been excluded from the revised character area boundary. Classified as neutral in 2015 assessment (as shown above).

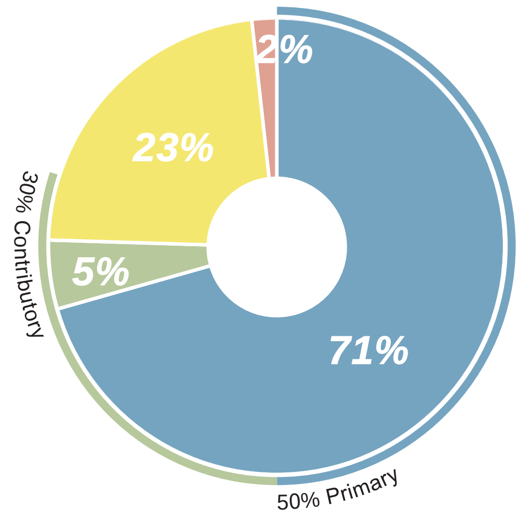
Scale: NTS

# CHARACTER AREA 14 - DUDLEY*

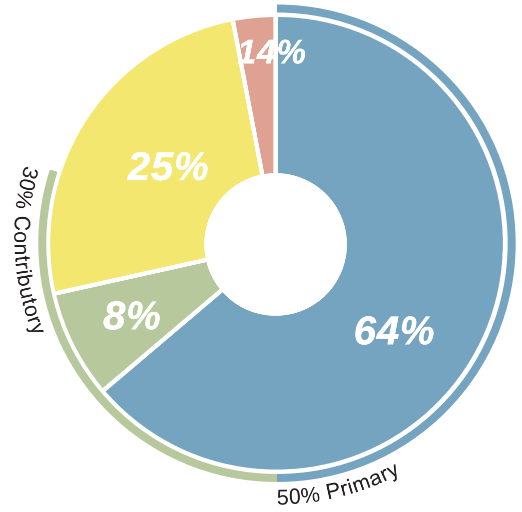



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT



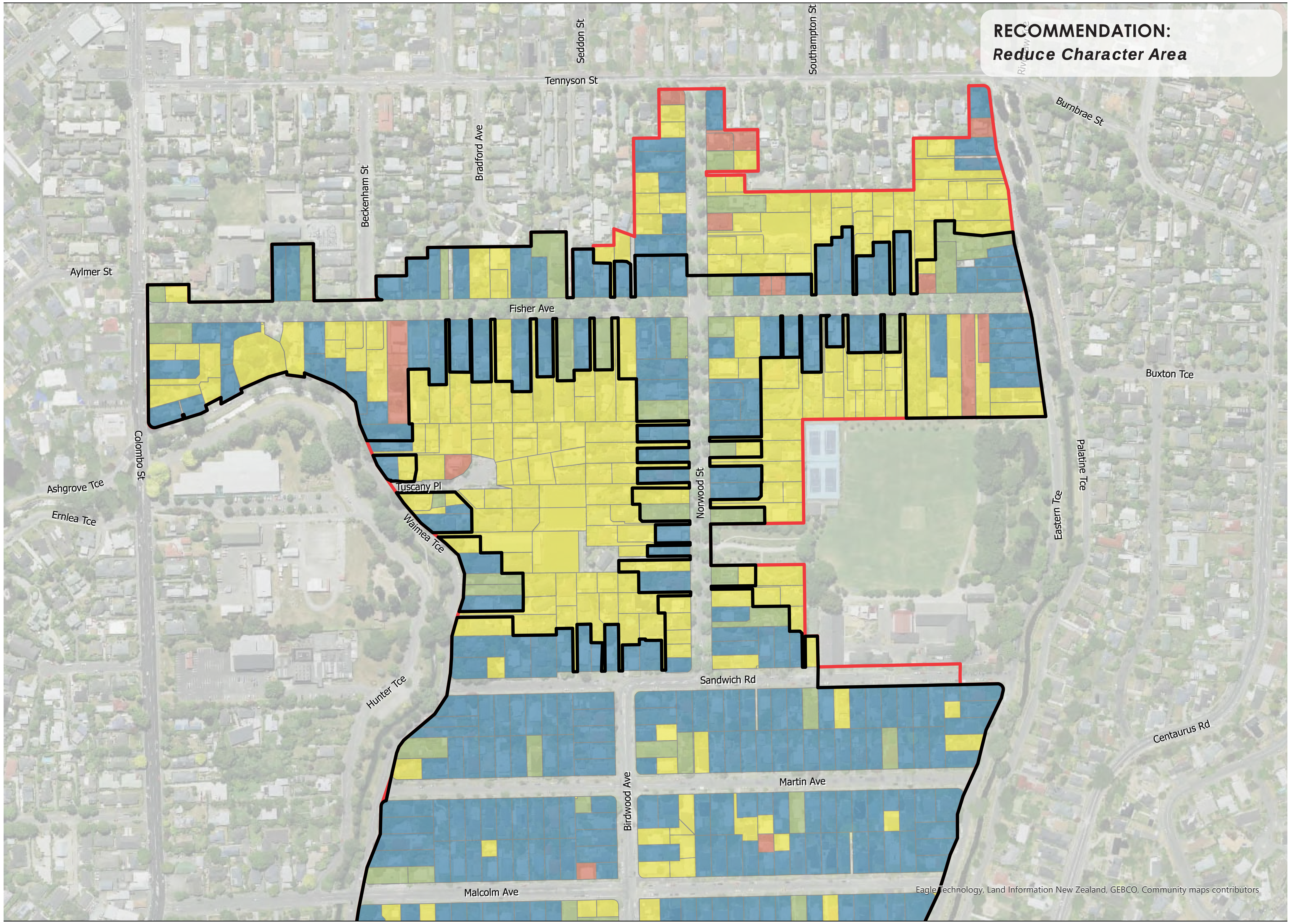

**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

* This area does not meet the 80% requirement but does exceed the 50% Primary score. The boundary could be altered further to exclude “properties not visible from the street” to enhance the percentage scores overall and more accurately represent the Character Area.

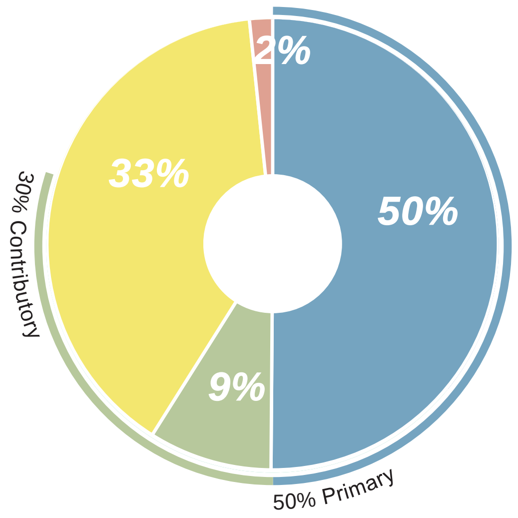
Scale: NTS

# CHARACTER AREA 4 - BECKENHAM LOOP * (NORTH)

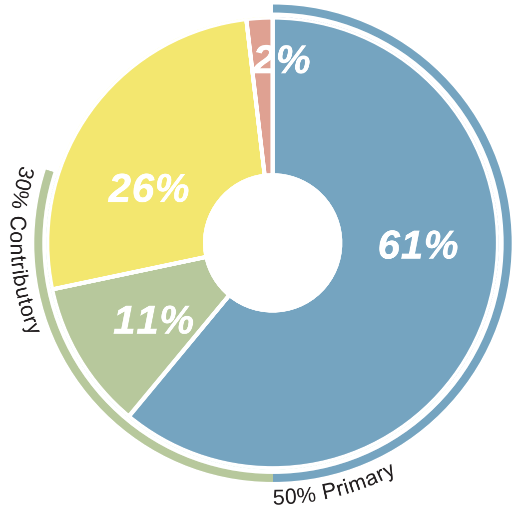



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

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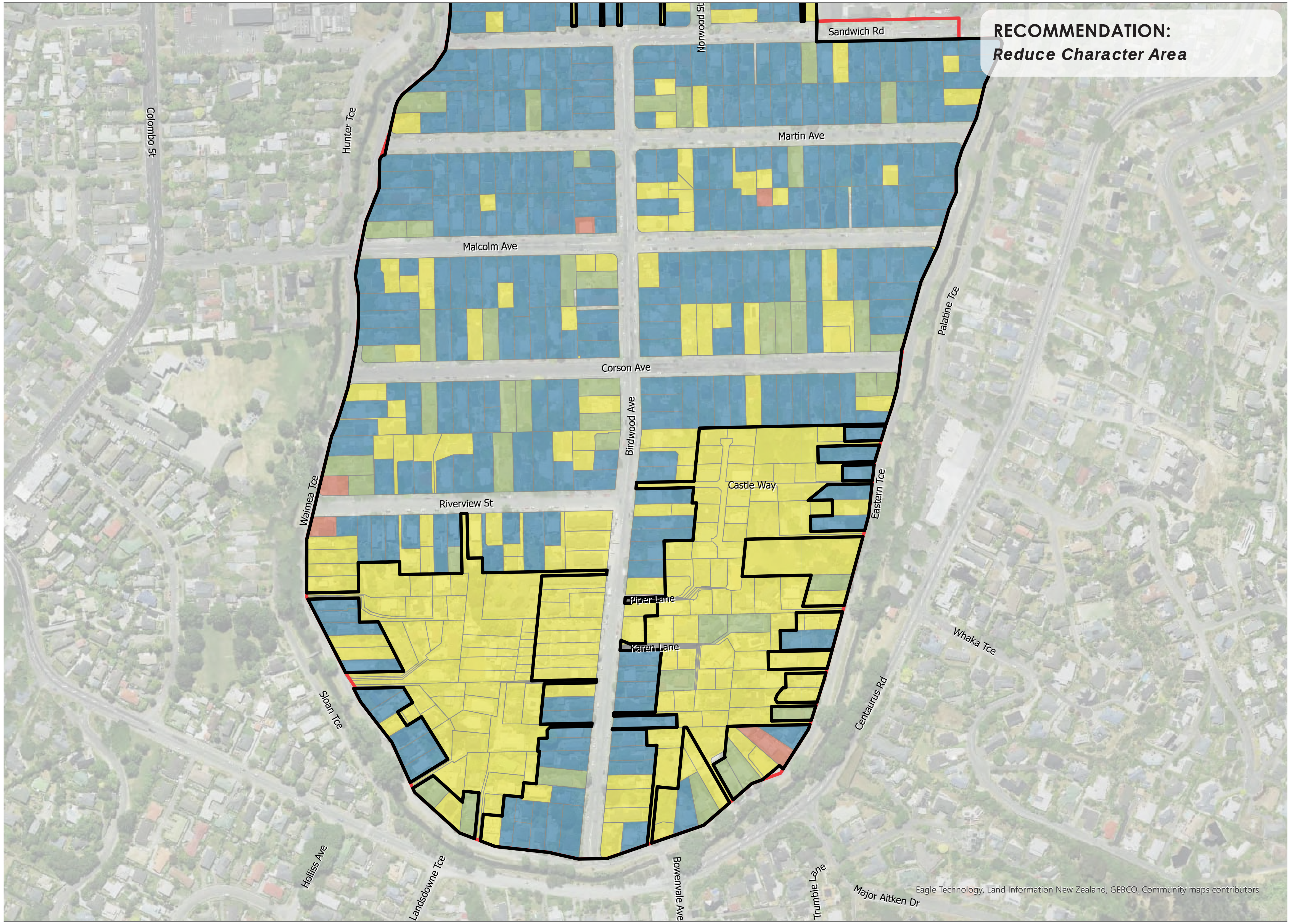
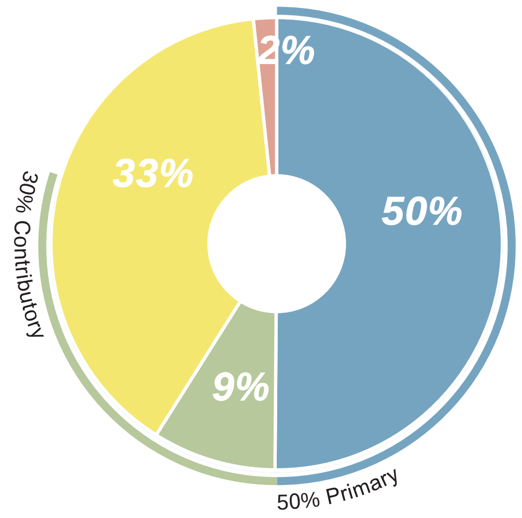
Scale: NTS

# CHARACTER AREA 4 - BECKENHAM LOOP *
# (SOUTH)

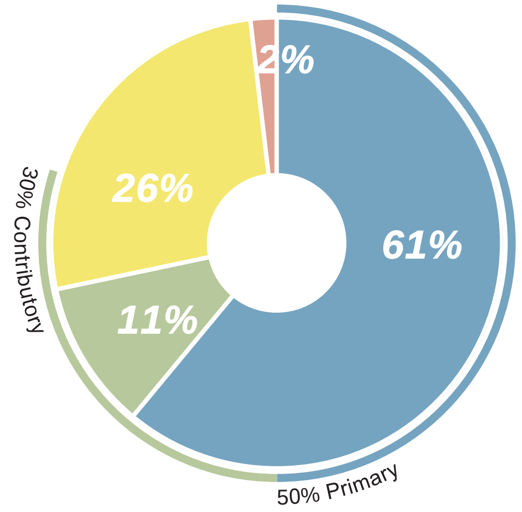



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
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- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

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Scale: NTS

### 5.5.4 Specific Assumptions and Analysis

**Dudley**

- The Area is generally flat (exception noted below), therefore infill housing at the rear of properties is usually not visible from the street.
- A Kainga Ora development between Stapletons Road and Chancellor Street was changed from a Contributory rating in Stage 1 to a Neutral rating at Stage 2. The development does have vegetation and a modest built form consistent with the attributes of the Character Area. However, the layout and elevation of the site are inconsistent with the attributes of the Character Area.
- There are a number of small pedestrian and vehicle bridges which traverse the rivers running through the Character Area.
- Some street improvements have been made at the start of street entrances including extended curbs and planting and will contribute to the Character Area over time.
- The boundary of the Area was reduced at Stage 2 at the southern end of Petrie Street, where you enter the Character Area from North Avon Road. There are a number of new developed properties at this intersection which erode the consistency in character of the Area. The boundary has been realigned to reflect this.

**Beckenham**

- A retirement village development on Birdwood Avenue interrupts the consistency of the character along the southwestern part of the street.
- Infill development is resulting in the increased presence of accessways which interrupt the consistency along the streetscape (particularly where two access-ways are adjoining each other).
- Properties on Waimea Terrace and Eastern Terrace have a slightly different character to the remainder of Beckenham. These sloping sites tend to have an elevated dwelling with a single garage located on the front boundary.
- The recommended boundary of the Character Area creates “donuts” with centres which are not recommended to be included within the Character Area. These areas include rear lot infill subdivision. Beckenham School is also excluded from the Character Area.

### 5.5.5 Character Area Type 4 Recommended Design Parameters

**Landscape and Vegetation**

The separation between houses and the landscape and vegetation on individual properties and within the public realm (street trees or river vegetation) contribute to the overall character of the Type 4 Areas. To maintain consistency with these characteristics:

- Dwellings should maintain a consistent setback from the front boundary of around 6-9m and have a landscape strip within this front yard setback.
- Require a larger than average outdoor space to assist with achieving openness across the site.
- Mature vegetation that contributes to the streetscape character should be retained where possible.

**Streetscape and Connectivity**

To maintain Type 4's strong relationship to the street, new dwellings should have a clear front entrance that is visible from the street, along with windows facing the street.

To respect the connectivity to the street, garages and carports should ideally be at the rear, however if they are at the side, these should be setback from the front facade of the dwelling. In some instances, such as along Waimea Terrace and Eastern Terrace, single garages forward of the dwelling may be appropriate where the elevation allows the dwelling to still achieve connectivity with the street.

Fencing should allow connectivity with the street and visibility of the vegetation, and the dwellings glazing and entranceways.

**Built Form**

Alterations or new dwellings should use similar materials and a sympathetic architectural style to the predominant bungalow of the 1920-40s era.

Dwelling height should be restricted to single storey to maintain consistency across the Character Area and prevent rear infill causing dominance effects over the primary front dwelling. Height in relation to boundary rules should encourage a single storey form with projections, gable and hip roofs.

Buildings should be setback from the side boundaries to maintain the sense of openness in the Character Area. Buildings within the same site should be separated to remain in keeping with the detached form of the Character Area.

Buildings should be modest in size and be no greater than 35% of the site coverage. For new developments, two individual dwellings is generally preferable than one duplex building.

For sites with long frontages, long buildings would be inconsistent with the Character Area, therefore a maximum building frontage to the street is recommended.

**Subdivision Pattern**

There are examples within the Type 4 Character Areas where subdivision of sites is starting to erode the consistent division pattern of sites being between 650-850m$^2$. While design parameters have been recommended to allow for two units per site, a subdivision minimum rule would limit the density allowed.

Vehicle access widths should be kept as narrow as possible to allow for safe access, without dominating the streetscape of the Character Area. Double-access widths, where adjacent access points adjoin each other, should be avoided.

## 5.6 Character Area Type 5: Piko

### 5.6.1 Overview

The Piko Character Area that makes up Type 5 is located between Blenheim Road and Riccarton Road, west of the central city. It is a distinctive, comprehensively designed State House subdivision with an intact and memorable layout including homes facing onto curving crescents and backing onto public open spaces.

The Area comprises two distinct parts with primarily two storey row and duplex houses on Shand Crescent and single standalone houses on Piko Crescent. The streetscape along Piko

Crescent has minimal landscaping which is limited to grass berms and unremarkable pedestrian character. The streetscape along Shand Crescent is of a higher quality due to the openness of, and relationship to, Shand Crescent Reserve.

### 5.6.2 Key Characteristics of Character Area Type 5

It is the combination of the following key elements that contribute to the distinctiveness and sense of place of the Piko Area:

- Unique street and subdivision pattern with relatively narrow streets.
- Consistent style and era of dwellings, primarily consisting of State Housing of the 1930s and 1940s.
- Generally single storey on Piko Crescent, and some double storey dwellings of a moderate scale on Shand Crescent.
- Simple rectangular buildings with small projections, and hip and gable roofs with ornamentation around doorways and windows, materials and use of porches, entranceways, brick or weatherboard.
- Generous front yards with low or no fencing.
- Strong relationship between dwellings and the street.
- Easy pedestrian access to nearby parks and reserves.

Piko

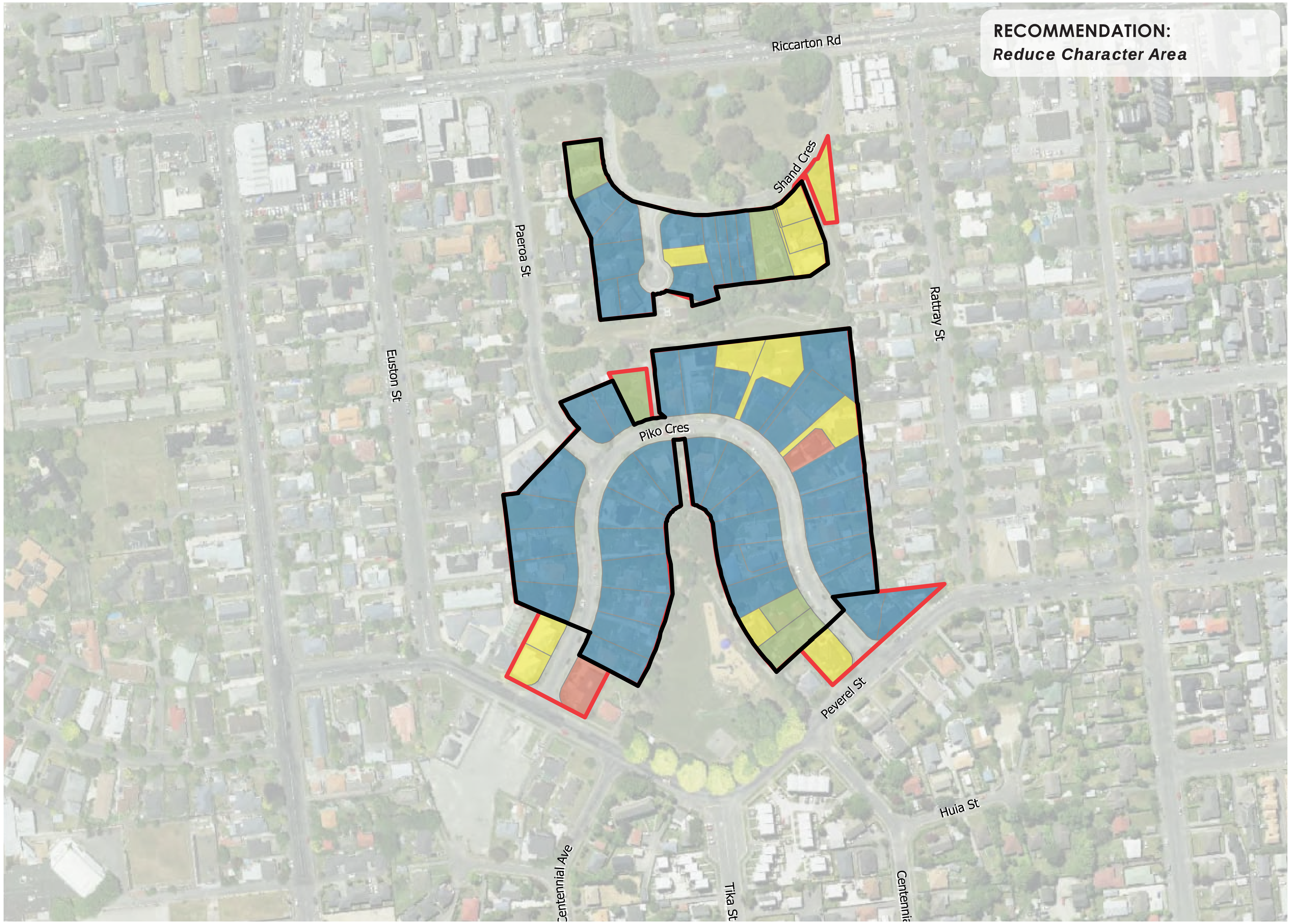
Piko

Piko Streetscape, Piko Crescent

### 5.6.3 Character Area Boundaries and Categorisation of Properties

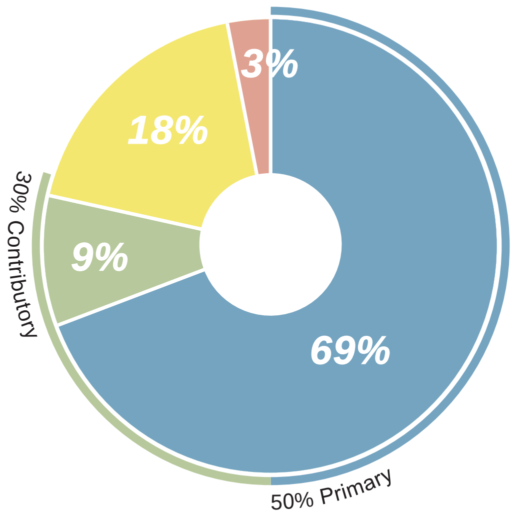
Map 12 identifies the boundary of the Piko Character Area along with the categorisation of each property within it. The graph identifies the percentage of each ranking category within the Character Area boundary.

# CHARACTER AREA 6 - PIKO

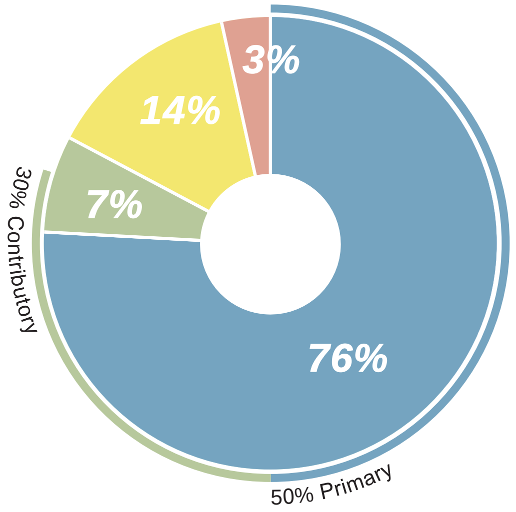



## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

Scale: NTS

### 5.6.4 Specific Assumptions and Analysis

- The consistency of original dwellings is relatively intact. The dwellings are of a modest size and mostly detached. A few examples of large duplex dwellings are evident on Shard Crescent.
- Garages and car ports do not dominate the streetscape and are setback or at the rear of dwellings.
- The Kindergarten on Shand Crescent is recommended to be removed from the Character Area boundary as it is separated from the nearest Character Area property by a walkway to the reserve and only contains an outdoor play space, rather than a residential dwelling.
- At the south-eastern end of Piko Crescent at the intersection with Peverel Street, two properties are recommended to be removed from the Character Area boundary. One is a circa 1940s era Art Deco style duplex, however there is a resource consent to demolish the dwelling and the setbacks and character are distinctively different to the remainder of Piko Crescent. The property on the adjacent corner is a new dwelling which has a larger footprint than the modest dwellings on Piko Crescent. For these reasons, the boundary has been altered to exclude these dwellings.

### 5.6.5 Character Area Type 5 Recommended Design Parameters

**Landscape and Vegetation**

There is a consistent setback pattern within the Type 5 Character Area, and to maintain this, buildings should be setback around 8m from the front boundary with room for landscaping in the front yard.

The reserve in the middle of the Character Area provides a backdrop of vegetation, while individual properties should provide vegetation within the yard setbacks to maintain the vegetated character of Type 5.

**Streetscape and Connectivity**

Type 5 is characterised by good visual connectivity between dwellings and the street primarily as a result of very low or no fences. Therefore, keeping fence heights to no greater than 1m is recommended.

Windows and front door entrances should be visible from the street and not blocked by garages or car ports in the front yard. Garages and carports should be at the rear of dwellings or if located at the side, should be setback from the front façade. They are often not integrated into the main dwelling.

**Built Form**

The built form in the Type 5 Character Area is generally modest single storey and detached dwellings. An exception to this could be for Shand Crescent where two storey and duplexes are present.

Unless attached as a duplex on Shand Crescent, dwellings should be separated by at least 5m from other buildings within the site. Generous side yards are recommended.

Height in relation to boundary rules should encourage a simple built form with a high roof pitch. Flat roofs should be avoided.

**Subdivision Pattern**

The subdivision pattern, particularly on Piko Crescent, in this Character Area is very intact and strongly contributes to the uniqueness of the Character Area. Therefore, restricting subdivision through a minimum lot size of 700m$^2$ is recommended.

## 5.7 Chapter Area Type 6: Cashmere

### 5.7.1 Overview

Type 6 comprises the Cashmere Character Area located to the south of the City on the Port Hills. This is similar to the Type 1 Area, however it was identified as separate due to its elevation on the lower slopes of the Port Hills.

This area consists of properties on Hackthorne Street, parts of Dyers Pass Road and MacMillan Avenue. Lot sizes are large with large statement dwellings that are generally well maintained.

There has been change in this Character Area resulting in contemporary dwellings which erode the consistency of the Character Area, however there are still strong examples of Primary sites with original era dwellings that contribute to a special character of Cashmere.

### 5.7.2 Key Characteristics of Cashmere

The key characteristics of Character Area Type 6 are:

- Hillside topography with steep slopes, ridges and valleys.
- Dwellings which are typically large, two-storey dwellings which respond to the topography.
- The architecture is most consistently represented by dwellings from the late 19th to early 20th century, with a mix of styles including English Domestic Revivalist and Arts and Crafts styles.
- Buildings have completed forms including projections, pitched roofs with architectural detailing including timber cladding, simple but decorative detailing, well defined large dormer and decorative winders.
- Setbacks vary, depending on the topography, although often dwellings are very close to street edge (within approximately 5m, but some primary examples are much greater).
- Property boundaries are marked by basalt stone walls along the street edge, although larger fences are evident for providing privacy.
- Front gardens or boundaries are often planted, typically with established trees, hedges or shrubs.
- Generally good visual connectivity between the dwellings and the street but this can be affected by topography and vegetation, and sometimes by fences.

Cashmere

Cashmere

Cashmere Streetscape, Hackthorne Street

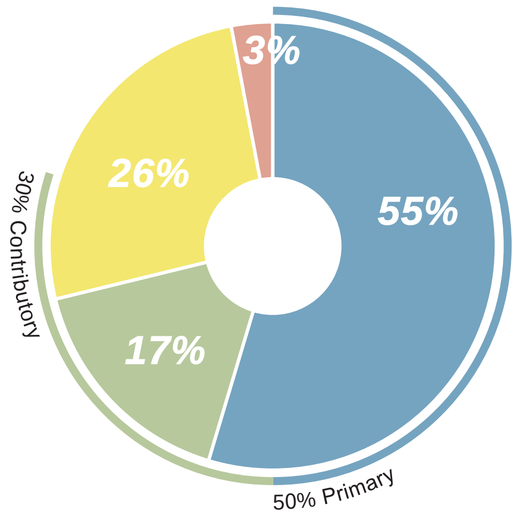
### 5.7.3 Character Area Boundaries and Categorisation of Properties

Map 13 identifies the boundary of the Cashmere Character Area along with the categorisation of each property within it. The graph identifies the percentage of each ranking category within the Character Area boundary.

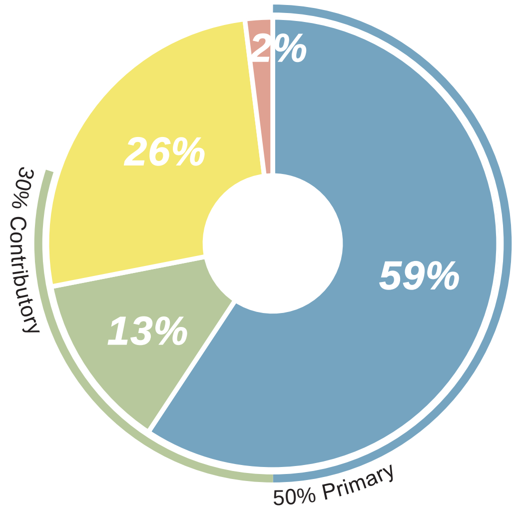
# CHARACTER AREA 3 - CASHMERE *


## COMPARATIVE ANALYSIS

### 2015 CHARACTER ASSESSMENT




### 2022 CHARACTER ASSESSMENT




**LEGEND**

- PRIMARY
- CONTRIBUTORY
- NEUTRAL
- INTRUSIVE
- DISTRICT PLAN CHARACTER AREA BOUNDARY
- 2022 RECOMMENDED CHARACTER AREA BOUNDARY

* This area does not meet the 80% requirement but does exceed the 50% Primary score. The boundary could be altered further to exclude “properties not visible from the street” to enhance the percentage scores overall and more accurately represent the Character Area.

Scale: NTS

### 5.7.4 Specific Assumptions and Analysis

- The topography and high level of vegetation greatly dictates the visibility of properties.
- Some rear properties that could be seen from the street due to topography greatly contribute to the Character Area. Conversely, if these sites were developed unsympathetically, they would be easily visible from the street.
- As sites are large, infill development is not as evident from the street, unless looking upslope, as outlined above.
- The Cashmere Presbyterian Church was rated as Neutral in the Stage 1 assessment, however it was revised to be Contributory in the Stage 2 assessment as the site and surrounds (including the adjacent open space) does contribute to the Character Area albeit not being of a residential activity.
- Between the Stage 1 and 2 assessments, MacMillan Avenue was recommended to be added back into the Character Area boundary. This was largely due to an error in the data during Stage 1, where properties with multiple allotments were not identified as the same rating. Rather, the data was rating one of the multiple parcels as Primary, and the remainder as Neutral. This disproportionality represented the Neutral ratings. Consequently, the MacMillan Avenue composition has more Primary sites than represented in Stage 1.
- The bend of Dyers Pass Road from Whisby Road to MacMillan Avenue is removed from the Character Area boundary as the re-development of several properties in this area has noticeably eroded the character. The slip road in combination with the width of the bend mean that the relationship between the properties on either side of the road is lost.

### 5.7.5 Character Area Type 6 Recommended Design Parameters

**Landscape and Vegetation**

There is not a strong regular setback for dwellings in this Character Area due to the varied topography. Dwellings are typically closer to the street that other Character Areas, therefore a 5m front yard setback is recommended.

Mature vegetation should be encouraged to be maintained where it is visible from the streetscape. Due to the importance of large scale established trees in contributing to the character of Type 6 Area, a minimum landscape strip should be required at the front boundary of no less than 3m and a minimum landscaped area of approximately 20% is recommended.

**Streetscape and Connectivity**

Type 6 Area has a mix of good visual connectivity between dwellings and the street on the upward sloping sites, but poor visual connectivity between dwellings and the street on sites which slope away from the street. Where the elevation allows, dwellings which are visible from the street should include a high level of glazing and a clear entrance facing the street.

Fence heights vary across the Character Area due to the topography. Rock walls should be low with vegetation planted on top for added privacy, rather than tall fences. Retaining walls may be an exemption to this if required due to the elevation.

Garages and carports should ideally be located at the rear of dwellings or setback from the front façade. It is noted however, that this can be more challenging to achieve with elevated sites.

**Built Form**

As the Type 6 Character Area is characterised by English Domestic Revival and Arts and Craft Styles, alterations or new dwellings should use materials and architectural style sympathetic to houses from this era.

The Type 6 Character Area has large, detached dwellings. To maintain this Character, the following built form parameters are recommended to be sympathetic to houses from the era:

- At least a 5m separation distance between buildings on a site. Duplexes are not a characteristic of this Character Area.
- Buildings should be setback sufficiently from the side boundaries to maintain the sense of openness. Side setbacks of between approximately 3m and 5m are recommended.
- Height limits should provide for large two-storey dwellings with projections and pitched roofs. Height in relation to boundary provisions should encourage two storey forms with pitched hip and gable roofs with gable ends facing the street.
- A maximum site coverage of 35% is recommended to maintain openness, particularly on larger sites.
- For sites with long frontages, a maximum building frontage to the street of 60% is recommended to avoid uncharacteristically long buildings.

**Subdivision Pattern**

The subdivision pattern in this Character Area is a not as uniform as other Character Areas. While some sites have already been subdivided to less than 800m$^2$, there are still a number of very large sites. In these instances, the preference would be for Character buildings to be retained at the front of the site and the rear of the site subdivided.

Vehicle crossing access widths should be kept as narrow as possible to allow for safe access, without dominating the streetscape of the Character Area. Double-access widths, where adjacent access points adjoin each other, should be avoided.

# Appendix 1 – MDRS Provisions

**Schedule 3A**

**MDRS to be incorporated by specified territorial authorities**

**Part 1 General**

**1 Interpretation**

(1) In this schedule, unless the context otherwise requires,—

**construction** includes construction and conversion, and additions and alterations to an existing building

**density standard** means a standard setting out requirements relating to building height, height in relation to boundary, building setbacks, building coverage, outdoor living space, outlook space, windows to streets, or landscaped area for the construction of a building

**subdivision** means the subdivision of land, as defined in section 218(1).

(2) Terms used in this schedule that are defined in section 77F have the same meaning in this schedule as they do in that section.

(3) Terms used in this schedule that are defined in the national planning standards have the same meaning in this schedule as they do in those standards.

**2 Permitted activities**

(1) It is a permitted activity to construct or use a building if it complies with the density standards in the district plan (once incorporated as required by section 77G).

(2) There must be no other density standards included in a district plan additional to those set out in Part 2 of this schedule relating to a permitted activity for a residential unit or building.

**3 Subdivision as controlled activity**

Subdivision requirements must (subject to section 106) provide for as a controlled activity the subdivision of land for the purpose of the construction and use of residential units in accordance with clauses 2 and 4.

**4 Restricted discretionary activities**

A relevant residential zone must provide for as a restricted discretionary activity the construction and use of 1 or more residential units on a site if they do not comply with the building density standards in the district plan (once incorporated as required by section 77G).

**5 Certain notification requirements precluded**

(1) Public notification of an application for resource consent is precluded if the application is for the construction and use of 1, 2, or 3 residential units that do not comply with 1 or more of the density standards (except for the standard in clause 10) in the district plan (once incorporated as required by section 77G).

(2) Public and limited notification of an application for resource consent is precluded if the application is for the construction and use of 4 or more residential units that comply with the density standards (except for the standard in clause 10) in the district plan (once incorporated as required by section 77G).

(3) Public and limited notification of an application for a subdivision resource consent is precluded if the subdivision is associated with an application for the construction and use of residential units described in subclause (1) or (2).

**6 Objectives and policies**

(1) A territorial authority must include the following objectives in its district plan:

*Objective 1*

(a) a well-functioning urban environment that enables all people and communities to provide for their social, economic, and cultural wellbeing, and for their health and safety, now and into the future:

*Objective 2*

(b) a relevant residential zone provides for a variety of housing types and sizes that respond to—

(i) housing needs and demand; and

(ii) the neighbourhood's planned urban built character, including 3-storey buildings.

(2) A territorial authority must include the following policies in its district plan:

*Policy 1*

(a) enable a variety of housing types with a mix of densities within the zone, including 3-storey attached and detached dwellings, and low-rise apartments:

*Policy 2*

(b) apply the MDRS across all relevant residential zones in the district plan except in circumstances where a qualifying matter is relevant (including matters of significance such as historic heritage and the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga):

*Policy 3*

(c) encourage development to achieve attractive and safe streets and public open spaces, including by providing for passive surveillance:

*Policy 4*

(d) enable housing to be designed to meet the day-to-day needs of residents:

*Policy 5*

(e) provide for developments not meeting permitted activity status, while encouraging high-quality developments.

*Subdivision requirements*

**7 General subdivision requirements**

Any subdivision provisions (including rules and standards) must be consistent with the level of development permitted under the other clauses of this schedule, and provide for subdivision applications as a controlled activity.

**8 Further rules about subdivision requirements**

Without limiting clause 7, there must be no minimum lot size, shape size, or other size-related subdivision requirements for the following:

(a) any allotment with an existing residential unit, if—

(i) either the subdivision does not increase the degree of any non-compliance with the density standards in the district plan (once incorporated as required by section 77G) or land use consent has been granted; and

(ii) no vacant allotments are created:

(b) any allotment with no existing residential unit, where a subdivision application is accompanied by a land use application that will be determined concurrently if the applicant for the resource consent can demonstrate that—

(i) it is practicable to construct on every allotment within the proposed subdivision, as a permitted activity, a residential unit; and

(ii) each residential unit complies with the density standards in the district plan (once incorporated as required by section 77G); and

(iii) no vacant allotments are created.

**9 Rules about common walls**

For the purposes of clause 8(a)(i), if a subdivision is proposed between residential units that share a common wall, the requirements as to height in relation to boundary in the district plan (once incorporated as required in section 77G) do not apply along the length of the common wall.

**Part 2**

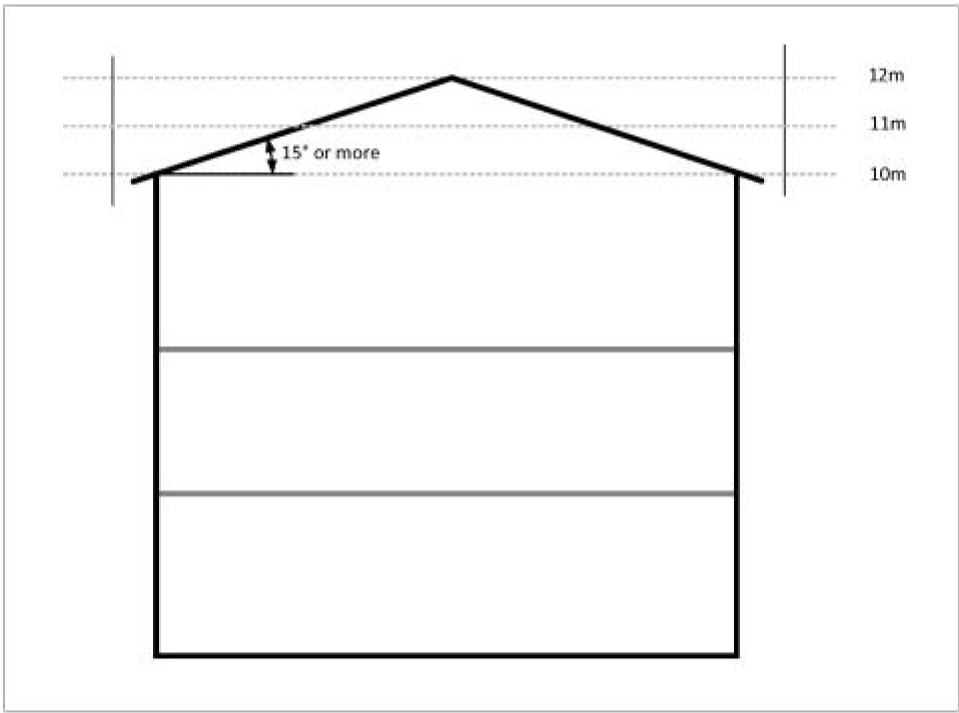
**Density standards**

**10 Number of residential units per site**

There must be no more than 3 residential units per site.

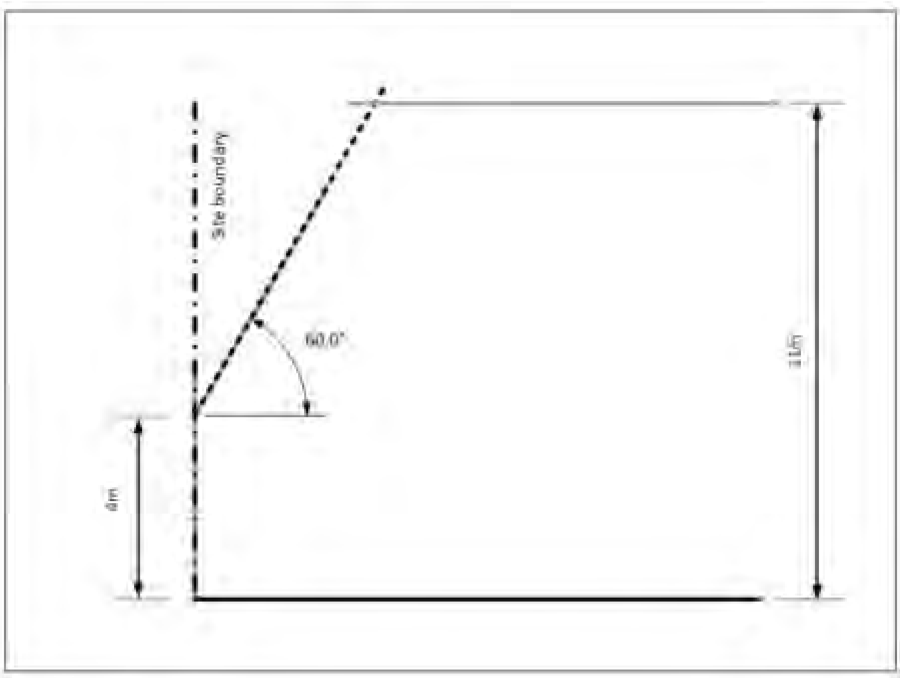
**11 Building height**

Buildings must not exceed 11 metres in height, except that 50% of a building's roof in elevation, measured vertically from the junction between wall and roof, may exceed this height by 1 metre, where the entire roof slopes 15° or more, as shown on the following diagram:




**12 Height in relation to boundary**

(1) Buildings must not project beyond a 60° recession plane measured from a point 4 metres vertically above ground level along all boundaries, as shown on the following diagram. Where the boundary forms part of a legal right of way, entrance strip, access site, or pedestrian access way, the height in relation to boundary applies from the farthest boundary of that legal right of way, entrance strip, access site, or pedestrian access way.




(2) This standard does not apply to—

(a) a boundary with a road:

(b) existing or proposed internal boundaries within a site:

(c) site boundaries where there is an existing common wall between 2 buildings on adjacent sites or where a common wall is proposed.

**13 Setbacks**

(1) Buildings must be set back from the relevant boundary by the minimum depth listed in the yards table below:

| Yard | Minimum depth |
|---|---|
| Front | 1.5 metres |
| Side | 1 metre |
| Rear | 1 metre (excluded on corner sites) |

(2) This standard does not apply to site boundaries where there is an existing common wall between 2 buildings on adjacent sites or where a common wall is proposed.

**14 Building coverage**

The maximum building coverage must not exceed 50% of the net site area.

**15 Outdoor living space (per unit)**

(1) A residential unit at ground floor level must have an outdoor living space that is at least 20 square metres and that comprises ground floor, balcony, patio, or roof terrace space that,—

(a) where located at ground level, has no dimension less than 3 metres; and

(b) where provided in the form of a balcony, patio, or roof terrace, is at least 8 square metres and has a minimum dimension of 1.8 metres; and

(c) is accessible from the residential unit; and

(d) may be—

(i) grouped cumulatively by area in 1 communally accessible location; or

(ii) located directly adjacent to the unit; and

(e) is free of buildings, parking spaces, and servicing and manoeuvring areas.

(2) A residential unit located above ground floor level must have an outdoor living space in the form of a balcony, patio, or roof terrace that—

(a) is at least 8 square metres and has a minimum dimension of 1.8 metres; and

(b) is accessible from the residential unit; and

(c) may be—

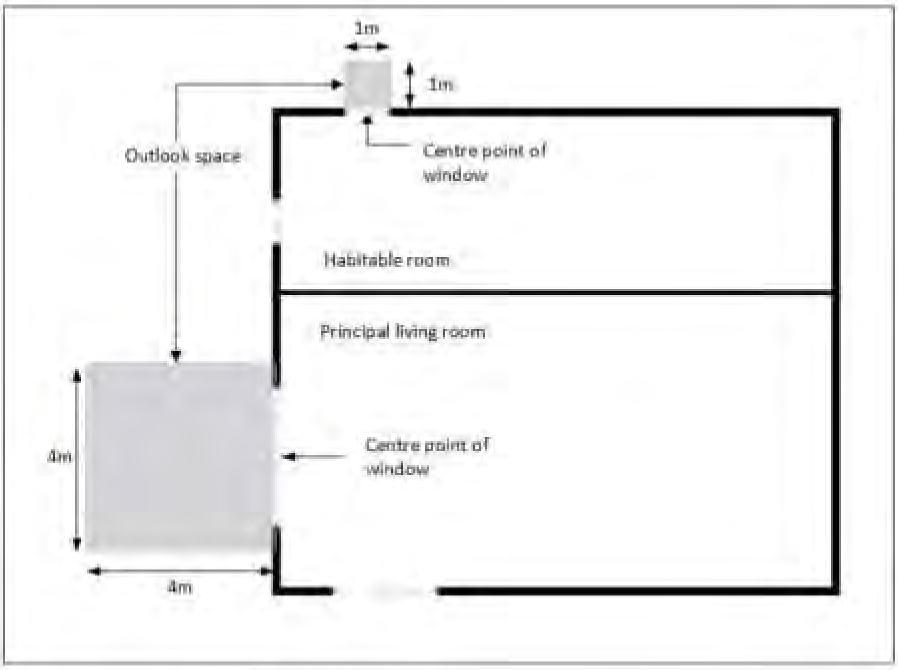
(i) grouped cumulatively by area in 1 communally accessible location, in which case it may be located at ground level; or

(ii) located directly adjacent to the unit.

**16 Outlook space (per unit)**

(1) An outlook space must be provided for each residential unit as specified in this clause.

(2) An outlook space must be provided from habitable room windows as shown in the diagram below:




(3) The minimum dimensions for a required outlook space are as follows:

(a) a principal living room must have an outlook space with a minimum dimension of 4 metres in depth and 4 metres in width; and

(b) all other habitable rooms must have an outlook space with a minimum dimension of 1 metre in depth and 1 metre in width.

(4) The width of the outlook space is measured from the centre point of the largest window on the building face to which it applies.

(5) Outlook spaces may be over driveways and footpaths within the site or over a public street or other public open space.

(6) Outlook spaces may overlap where they are on the same wall plane in the case of a multi-storey building.

(7) Outlook spaces may be under or over a balcony.

(8) Outlook spaces required from different rooms within the same building may overlap.

(9) Outlook spaces must—

(a) be clear and unobstructed by buildings; and

(b) not extend over an outlook space or outdoor living space required by another dwelling.

**17 Windows to street**

Any residential unit facing the street must have a minimum of 20% of the street-facing façade in glazing. This can be in the form of windows or doors.

**18 Landscaped area**

(1) A residential unit at ground floor level must have a landscaped area of a minimum of 20% of a developed site with grass or plants, and can include the canopy of trees regardless of the ground treatment below them.

(2) The landscaped area may be located on any part of the development site, and does not need to be associated with each residential unit.

# Appendix 2 – Summary of Character Area Rankings

# SUMMARY

## SUMMARY TABLE

| | 2015 CHARACTER AREA ASSESSMENT RANKING (%) | | | | 2022 STAGE 1 CHARACTER AREA ASSESSMENT RANKING (%)** | | | | 2022 FINAL CHARACTER AREA ASSESSMENT RANKING (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | C | N | I | P | C | N | I | P | C | N | I | RECOMMENDED CHANGE TO DISTRICT PLAN BOUNDARY |
| 1 - THE ESPLANADE | 48% | 41% | 11% | - | 28% | 56% | 12% | 4% | - | - | - | - | Remove Character Area |
| 2 - CLIFTON | 82% | 9% | 9% | - | 36% | 9% | 55% | - | - | - | - | - | Remove Character Area |
| 3 - CASHMERE* | 55% | 17% | 26% | 3% | 49% | 18% | 30% | 9% | 59% | 13% | 26% | 2% | Reduce Character Area |
| 4 - BECKENHAM LOOP* | 50% | 9% | 39% | 2% | 45% | 9% | 44% | 2% | 61% | 11% | 26% | 2% | Reduce Character Area |
| 5 - TAINUI | 68% | 12% | 18% | 2% | 65% | 14% | 20% | 2% | 68% | 16% | 15% | 2% | Reduce Character Area |
| 6 - PIKO | 69% | 9% | 18% | 3% | 70% | 8% | 18% | 3% | 76% | 7% | 14% | 3% | Reduce Character Area |
| 7 - HEATON | 73% | 14% | 13% | - | 58% | 11% | 29% | 3% | 72% | 12% | 16% | - | Reduce Character Area |
| 8 - BEVERLEY | 91% | - | 9% | - | 87% | 4% | 9% | - | 87% | 4% | 9% | - | Retain Character Area |
| 9 - RANFURLY | 63% | 26% | 7% | 4% | 56% | 26% | 15% | 4% | 56% | 26% | 15% | 4% | Retain Character Area |
| 10 - MASSEY | 53% | 38% | 9% | - | 53% | 38% | 9% | - | 59% | 28% | 13% | - | Retain Character Area |
| 11 - MALVERN | 67% | 24% | 7% | 2% | 64% | 24% | 9% | 2% | 69% | 18% | 10% | 2% | Retain Character Area |
| 12 - SEVERN | 87% | 6% | 6% | 2% | 85% | 6% | 6% | 2% | 82% | 4% | 11% | 2% | Retain Character Area |
| 13 - FRANCIS* | 72% | 15% | 13% | - | 63% | 11% | 26% | - | 70% | 9% | 21% | - | Reduce Character Area |
| 14 - DUDLEY* | 71% | 5% | 23% | 2% | 63% | 8% | 26% | 3% | 64% | 8% | 25% | 3% | Reduce Character Area |
| 15 - ENGLEFIELD* | 38% | 27% | 24% | 10% | 37% | 23% | 29% | 10% | 62% | 17% | 19% | 2% | Reduce Character Area |

* These areas do not meet the 80% requirement but do exceed the 50% Primary score. The boundary could be altered further to exclude “properties not visible from the street” to enhance the percentage scores overall and more accurately represent the Character Area.

** Calculated using District Plan Character Area Boundary

# Appendix 3 – GIS Background including Attributes

**Overview of GIS Approach**

GIS was used as a collation tool and for storage of the individual characteristics of a site and also to visualise the neighbourhood and broader patterns spatially (rather than analytically). By using GIS we could present Council District Plan data, Council Building\Resource Consent data and the underlying character assessment attributes symbolically to represent the current or previous study in the desktop analysis. By hosting the GIS data sets in the Cloud it was possible to seamlessly integrate with data collection tools to record detailed site reviews in the field. Individual assessment attributes were retained for each study area, allowing a review of 2015, 2022 and 2022 stage 2 data.

Finally, all photos were collected and associated to parcels or streets and we have also linked the Google Streetview photos to addresses.

**Character Area Attributes**

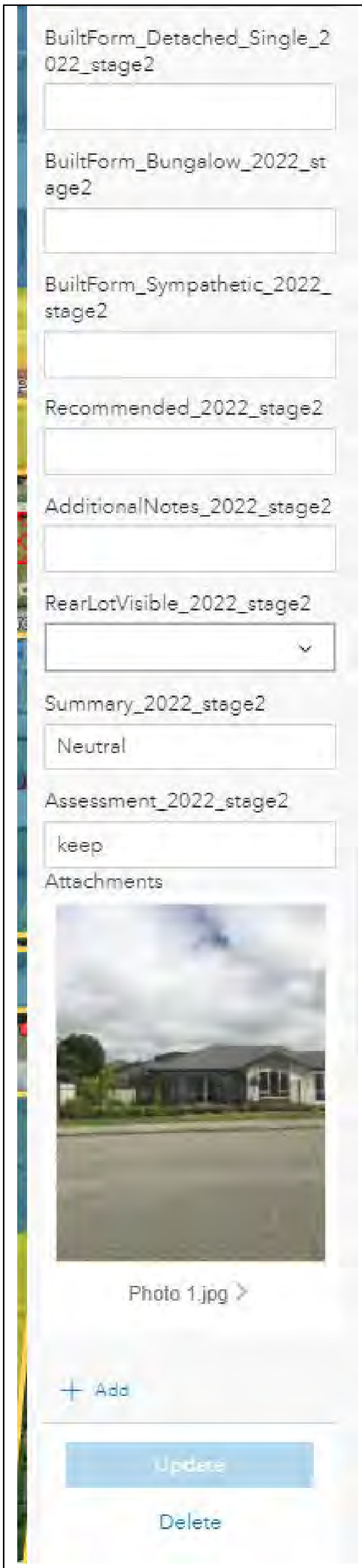
The following provides an example of the list of the attributes captured for Beckenham. The site characteristics are recorded up to 3 times depending on the applicable study (the attribute suffix being 2015, 2022 and\or 2022_stage2).

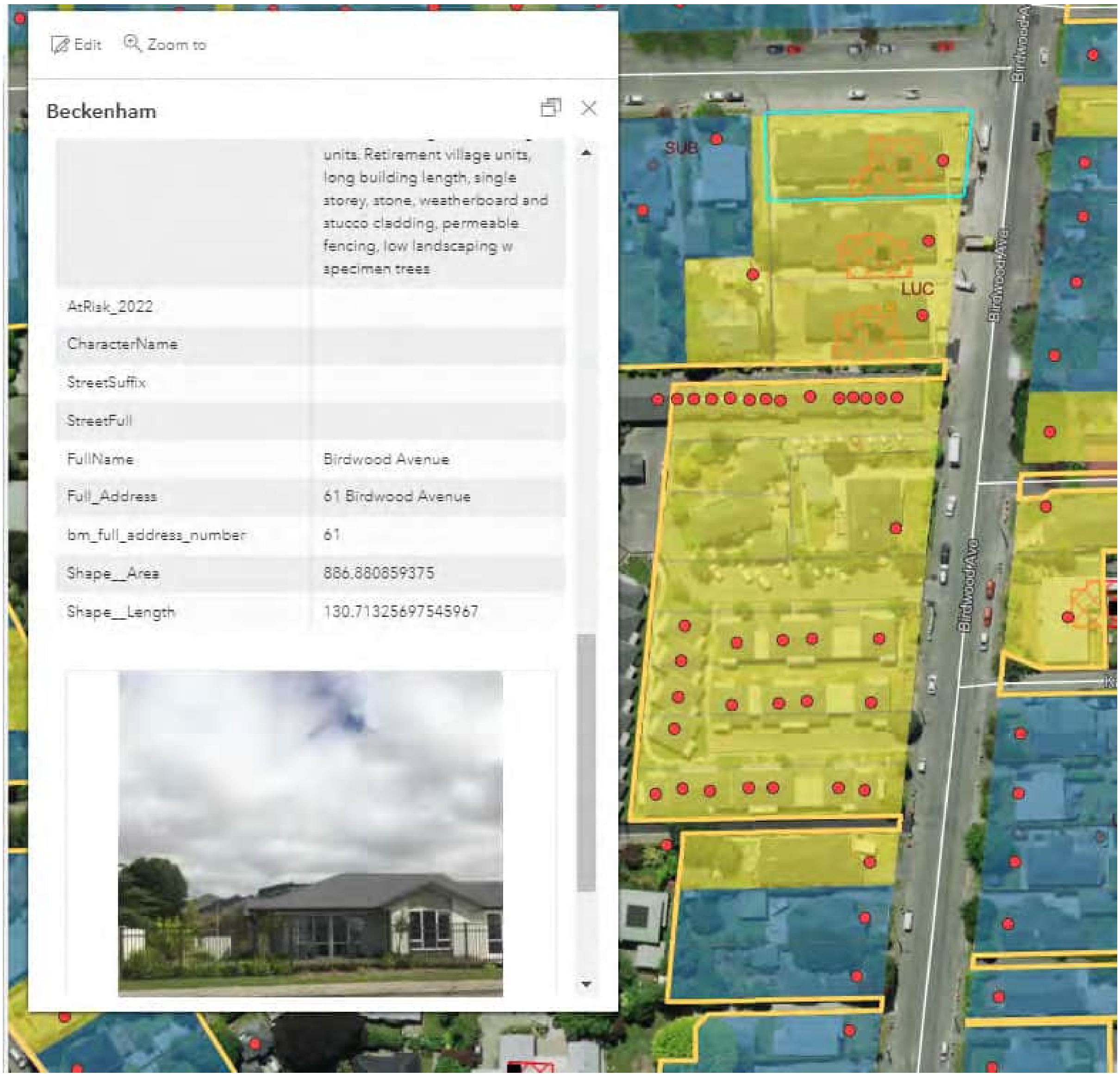
OBJECT ID

FullAddress_2015
SAM_Name
CharacterNumber
CharacterArea
ParcelID
prulpi
SAM_Number
StreetAddressID
StreetNo
StreetName
CharacterName
StreetSuffix
StreetFull
FullName
Full_Address
bm_full_address_number
Shape__Area
Shape__Length
Shape
RMA_Check_2015
Landscape_FrontYard_2015

Landscape_Vegetation_2015
Landscape_SensitiveBoundary_2015
BuiltForm_Detached_Single_2015
BuiltForm_Bungalow_2015
BuiltForm_Sympathetic_2015
Site_Primary_2015
Site_Contributory_2015
Site_Neutral_2015
Site_Intrusive_2015
AdditionalNotes_2015
Demolished_2015
AtRisk_2015
Summary_2015
RMA_Check_2022
Landscape_FrontYard_2022
Landscape_Vegetation_2022
Landscape_SensitiveBoundary_2022
BuiltForm_Detached_Single_2022
BuiltForm_Bungalow_2022
BuiltForm_Sympathetic_2022
Recommended_2022
Summary_2022
DesktopChange_2022
DesktopCheck_2022
FieldCheck_2022
AdditionalNotes_2022
AtRisk_2022
Landscape_FrontYard_2022_stage2
Landscape_Vegetation_2022_stage2
Landscape_SensitiveBoundary_2022_stage2
BuiltForm_Detached_Single_2022_stage2
BuiltForm_Bungalow_2022_stage2
BuiltForm_Sympathetic_2022_stage2
Recommended_2022_stage2
AdditionalNotes_2022_stage2
RearLotVisible_2022_stage2
Summary_2022_stage2
Assessment_2022_stage2

## Example Screen Shots of GIS Data and Maps





Edit
Zoom to
Beckenham
units. Retirement village units, long building length, single storey, stone, weatherboard and stucco cladding, permeable fencing, low landscaping w specimen trees
AtRisk_2022
CharacterName
StreetSuffix
StreetFull
FullName
Birdwood Avenue
Full_Address
61 Birdwood Avenue
bm_full_address_number
61
Shape__Area
886.880859375
Shape__Length
130.71325697545967
SUB
LUC
Birdwood Ave

Legend
bml Stage 2 Boundary
bml Stage 1 Boundary
District Plan Residential Character
Residential Character Boundary
SAM 02 Beckenham
Summary_2022_stage2
Primary
Neutral
Contributory
Intrusive
ResourceConsent513890
Resource Consent
BuildingConsents513890
Building Consent
BuildingDemolition513890
Building Demolition
DistrictPlanTreeProtection
Protected Tree
DistrictPlanHeritageItem
Heritage Item
DistrictPlanHeritageSetting
Heritage Setting
DistrictPlanProtectedVegetation
Protected Vegetation
Norwood St
Sandwich Rd
Martin Ave
LUC

# Appendix 4 - Stage 1 Maps and Rankings

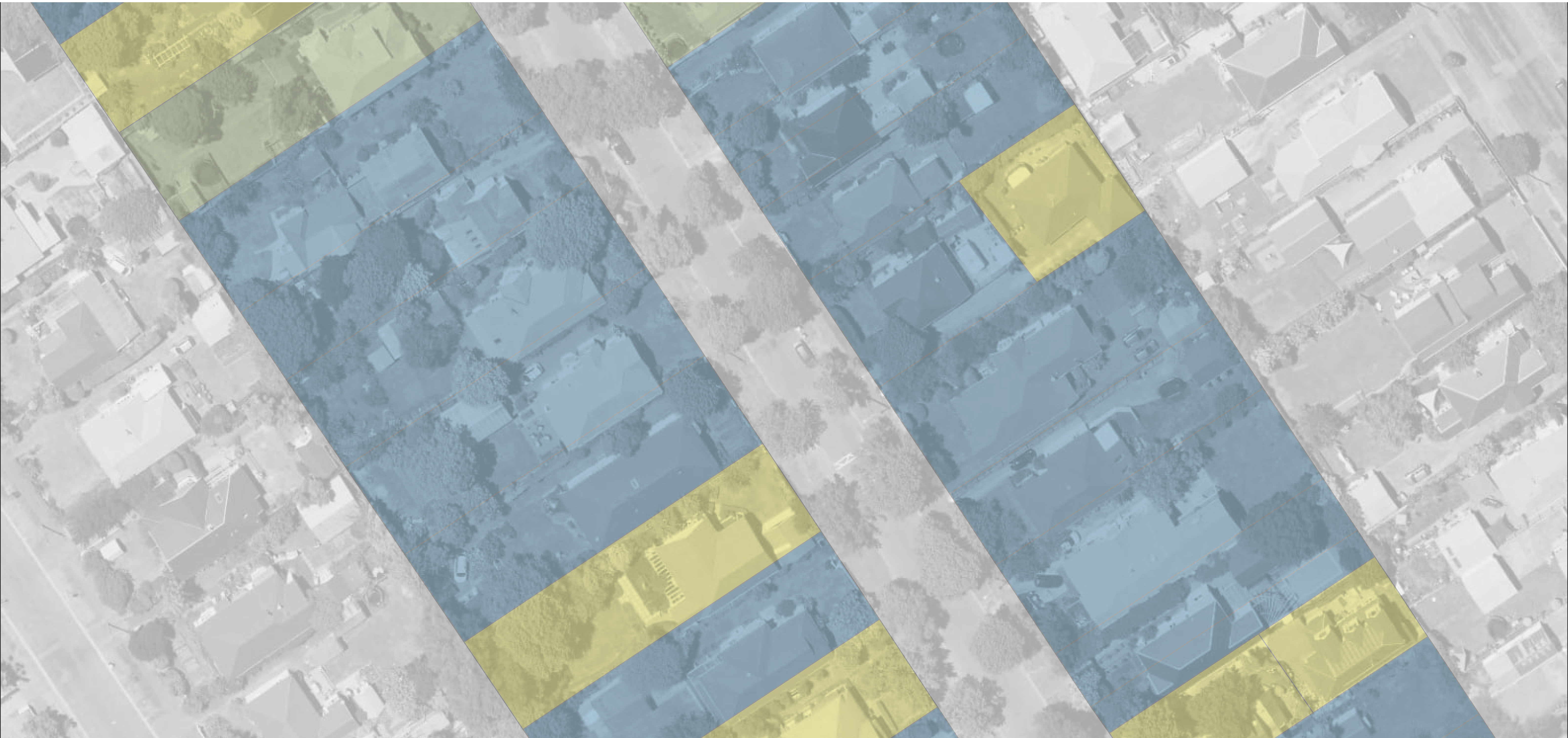
DRAFT

Boffa Miskell

# INVESTIGATION OF QUALIFYING MATTERS – ŌTAUTAHI CHRISTCHURCH SUBURBAN CHARACTER AREAS

## APPENDIX 2: DESKTOP EVALUATION OF CHARACTER AREAS 2022

24 FEBRUARY 2022



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**BIBLIOGRAPHIC REFERENCE FOR CITATION:**

Boffa Miskell, 2022. *INVESTIGATION OF QUALIFYING MATTERS – ŌTAUTAHI CHRISTCHURCH SUBURBAN CHARACTER AREAS - STAGE ONE: DESKTOP EVALUATION.* Report by Boffa Miskell Limited for Christchurch City Council.

| | | |
|---|---|---|
| **PREPARED BY:** | Olivia Johnstone<br>Urban Designer/ Landscape Architect<br>Boffa Miskell Ltd | |
| | Hannah Wilson<br>Landscape Planner<br>Boffa Miskell Ltd | |
| **REVIEWED BY:** | Jane Rennie<br>Urban Designer / Associate Partner<br>Boffa Miskell Ltd | |
| | Sue McManaway<br>Landscape Planner<br>Boffa Miskell Ltd | |
| **STATUS: [DRAFT]** | Revision / version: 2 | Issue date: 24 February, 2022 |

File ref: BM211166_CA_StageOne_DesktopEvaluation

Cover photograph: Description, © Photographer, year

# CONTENTS

# SUMMARY

## SUMMARY TABLE

| | 2015 RANKING (%) | | | | 2022 RANKING (%)** | | | | | 2022 RANKING (%) CHANGED BOUNDARY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | C | N | I | P | C | N | I | RECOMMENDED CHANGE TO BOUNDARY | P | C | N | I |
| 1 - THE ESPLANADE | 48% | 41% | 11% | - | 28% | 56% | 12% | 4% | Remove Character Area | | | | |
| 2 - CLIFTON | 82% | 9% | 9% | - | 36% | 9% | 55% | - | Remove Character Area | | | | |
| 3 - CASHMERE* | 55% | 17% | 26% | 3% | 49% | 18% | 30% | 9% | Reduce Character Area | 55% | 13% | 32% | 1% |
| 4 - BECKENHAM LOOP* | 50% | 9% | 39% | 2% | 45% | 9% | 44% | 2% | Reduce Character Area | 64% | 10% | 24% | 2% |
| 5 - TAINUI | 68% | 12% | 18% | 2% | 65% | 14% | 20% | 2% | Retain Character Area | | | | |
| 6 - PIKO | 69% | 9% | 18% | 3% | 70% | 8% | 18% | 3% | Reduce Character Area | 77% | 8% | 13% | 2% |
| 7 - HEATON | 73% | 14% | 13% | - | 58% | 11% | 29% | 3% | Reduce Character Area | 73% | 15% | 12% | - |
| 8 - BEVERLEY | 91% | - | 9% | - | 87% | 4% | 9% | - | Retain Character Area | | | | |
| 9 - RANFURLY | 63% | 26% | 7% | 4% | 56% | 26% | 15% | 4% | Retain Character Area | | | | |
| 10 - MASSEY | 53% | 38% | 9% | - | 53% | 38% | 9% | - | Retain Character Area | | | | |
| 11 - MALVERN | 67% | 24% | 7% | 2% | 64% | 24% | 9% | 2% | Retain Character Area | | | | |
| 12 - SEVERN | 87% | 6% | 6% | 2% | 85% | 6% | 6% | 2% | Retain Character Area | | | | |
| 13 - FRANCIS* | 72% | 15% | 13% | - | 63% | 11% | 26% | - | Reduce Character Area | 67% | 11% | 22% | - |
| 14 - DUDLEY* | 71% | 5% | 23% | 2% | 63% | 8% | 26% | 3% | Reduce Character Area | 64% | 8% | 26% | 3% |
| 15 - ENGLEFIELD* | 38% | 27% | 24% | 10% | 37% | 23% | 29% | 10% | Reduce Character Area | 53% | 22% | 24% | 2% |

* These areas do not meet the 80% requirement but do exceed the 50% Primary score. The boundary could be altered further to exclude “properties not visible from the street” to enhance the percentage scores overall and more accurately represent the Character Area.

** Calculated using District Plan Character Area Boundary