Jacobs

Memorandum

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Subject	**Land use and N load estimates - Pukekohe and Horowhenua**	**Project Name**	NPS-FM Judicial Review - Specified Vegetable Growing Areas
Attention	Michelle Sands		
From	Stuart Easton		
Date	February 18, 2021		

1. Overview

This memo presents a Geographic Information System (GIS) based summary of the Specified Vegetable Growing Areas (SVGAs) in Pukekohe and Horowhenua as described in the National Policy Statement for Freshwater Management 2020 (NPS-FM). Patterns of land use, annual Nitrogen (N) loss, Māori land, and Land Use Capability (LUC) class are estimated using national and regional scale data. A national scale summary of vegetable production and land suitability for vegetable growing is also provided.

1.1 Data and limitations

Land use data is derived from the Land Use and Carbon Analysis System (LUCAS) land use map[1] for the year 2016. LUCAS is comparable to the Land Use Cover Database (LCDB) however is preferred for its differentiation between Dairy and other grazed pasture systems.

Land use categories from LUCAS have been matched to those used in local scale N-loss modelling for Pukekohe (MPI Modelling to reduce nitrogen in Pukekohe (Whangamaire stream)[2]) and Horowhenua (CASM water quality model developed for Horizons Plan Change 2[3]). The underlying land use data is therefore consistent, however the land use categories used in the tables and maps in this memo are different between the two regions as they have been maintained from the local scale modelling.

Māori land has been estimated from LINZ property parcel information[4]. LINZ caveats the data that it is known to contain omissions and errors and is indicative only.

The public GIS data, statistics, and local scale N-loss modelling used in this memo are assumed to be representative and accurate.

[1] https://data.mfe.govt.nz/layer/52375-lucas-nz-land-use-map-1990-2008-2012-2016-v008/
[2] MPI, 2021. Modelling to reduce nitrogen in Pukekohe (Whangamaire stream). https://www.mpi.govt.nz/dmsdocument/42078/direct. Accessed 6/02/2021.
[3] Snelder, T., Cox, T., Kerr, T., Fraser, C., Collins, S. 2020. Manawatū-Whanganui Region Catchment Nitrogen Models Supporting Regional Plan Change 2.
[4] https://data.linz.govt.nz/table/51567-nz-property-titles-list/

2. Pukekohe SVGA

2.1 Pukekohe SVGA boundary

Figure 1 outlines the Pukekohe SVGA boundary as described in Appendix 5 of the NPS-FM.

The NPS-FM SVGA description for Pukekohe provides an incomplete boundary; the western and eastern boundaries terminate at the border of the Auckland and Waikato regions without meeting the southern SVGA boundary (Waikato river north bank). A straight line has been extrapolated between the southern-most ends of the western and eastern boundaries and the southern boundary in Figure 1. Furthermore, the Pukekohe SVGA boundary does not follow hydrological catchments. The described boundary dissects the existing sub-catchments defined in the Waikato Regional Council (WRC) Healthy Rivers Plan Change 1 limit-setting.

The tables in this section provide statistics for all hydrological catchments that are intersected by the boundary as described in the NPS-FM, except the Wairoa river (i.e. all catchments displayed in Figure 1). The Wairoa has been excluded as it is the largest catchment, drains to the east, has very little horticultural land, and is only partially intersected by the SVGA boundary.

2.2 Land use and Nitrogen loading

Land use within the Pukekohe SVGA has been estimated using the LUCAS land use map for the year 2016. Land use categories from LUCAS have been matched to those used in the MPI modelling of the Whangamaire stream to provide an estimate of N loading and the relative contribution from the different land uses. Data is unavailable to differentiate between arable cropping and Cultivated Vegetable Production (CVP); all land classified as “Cropland – annual” is therefore assumed to be CVP.

Figure 1 shows the Pukekohe SVGA extent and land use within the intersecting catchments. Land use area and estimated annual N loss using MPI loading rates are provided in Table 1 and Table 2.

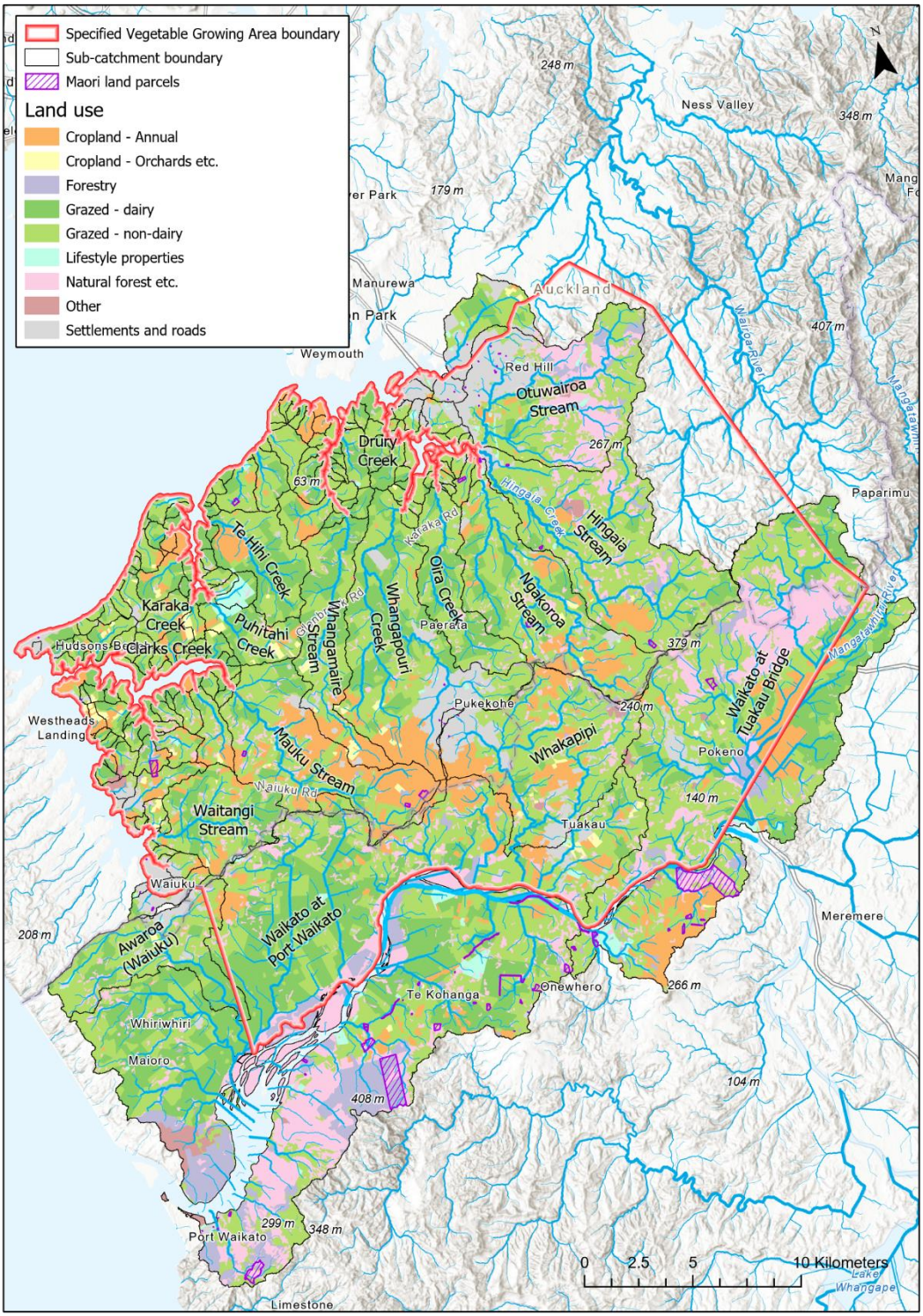

Figure 1 Pukekohe SVGA land use

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Land use and N load estimates - Pukekohe and Horowhenua

Table 1 Land use area and N load for all catchments in Pukekohe SVGA

Land use*	Area (ha)	Area (% of total)	MPI N loss rate (kg/N/ha/year)	N load (kg/year)	N load (% of total)
Cropland – Annual (assumed to be CVP)	10211	11%	65	663726	35%
Cropland - Orchards and vineyards (perennial)	829	1%	11	9117	0%
Grazed - dairy	20842	22%	30	625259	33%
Grazed - non-dairy	39126	41%	12	469508	25%
Lifestyle properties	896	1%	10	8960	0%
Natural forest, water, and grassland with woody biomass	13217	14%	4	52867	3%
Other	543	1%	4	2172	0%
Forestry	4516	5%	4	18063	1%
Settlements and roads	4346	5%	9	39117	2%
Total	**94526**			**1888790**	

***** MfE LUCAS land use (2016) applied to MPI modeling land use categories

Table 2 N load (kg/year) per catchment (catchment percentage in parentheses)

Catchment Name	Region	Cropland - Annual (assumed to be CVP)	Cropland - Orchards and vineyards (perennial)	Grazed - dairy	Grazed - non-dairy	Lifestyle properties	Natural forest, water, and grassland with woody biomass	Other	Forestry	Settlements and roads
Other*	Auckland	280011 (41.8%)	4794 (0.7%)	171491 (25.6%)	181361 (27.1%)	3372 (0.5%)	9913 (1.5%)	520 (0.1%)	1551 (0.2%)	16290 (2.4%)
Clarks Creek	Auckland	1516 (58.3%)	288 (11.1%)	141 (5.4%)	656 (25.2%)	0 (0%)	1 (0%)	0 (0%)	0 (0%)	0 (0%)
Drury Creek	Auckland	20 (0.5%)	0 (0%)	3662 (92.6%)	246 (6.2%)	7 (0.2%)	19 (0.5%)	0 (0%)	0 (0%)	0 (0%)
Hingaia Stream	Auckland	23232 (28.2%)	142 (0.2%)	11383 (13.8%)	42432 (51.5%)	144 (0.2%)	3262 (4%)	247 (0.3%)	718 (0.9%)	803 (1%)
Karaka Creek	Auckland	3030 (39.7%)	54 (0.7%)	2184 (28.6%)	2292 (30.1%)	8 (0.1%)	39 (0.5%)	0 (0%)	0 (0%)	16 (0.2%)
Mauku Stream	Auckland	92042 (73.9%)	241 (0.2%)	14416 (11.6%)	16218 (13%)	54 (0%)	1234 (1%)	0 (0%)	42 (0%)	380 (0.3%)

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Land use and N load estimates - Pukekohe and Horowhenua

Catchment Name	Region	Cropland - Annual (assumed to be CVP)	Cropland - Orchards and vineyards (perennial)	Grazed - dairy	Grazed - non-dairy	Lifestyle properties	Natural forest, water, and grassland with woody biomass	Other	Forestry	Settlements and roads
Ngakoroa Stream	Auckland	48742 (49.8%)	604 (0.6%)	22296 (22.8%)	24101 (24.6%)	120 (0.1%)	1221 (1.2%)	9 (0%)	200 (0.2%)	608 (0.6%)
Oira Creek	Auckland	970 (2.8%)	0 (0%)	22488 (65.6%)	9966 (29.1%)	45 (0.1%)	484 (1.4%)	0 (0%)	157 (0.5%)	157 (0.5%)
Otuwairoa Stream	Auckland	6531 (13.8%)	94 (0.2%)	4121 (8.7%)	21747 (46.1%)	376 (0.8%)	5620 (11.9%)	200 (0.4%)	1262 (2.7%)	7217 (15.3%)
Puhitahi Creek	Auckland	5373 (27.8%)	815 (4.2%)	8286 (42.9%)	4142 (21.4%)	537 (2.8%)	102 (0.5%)	0 (0%)	32 (0.2%)	43 (0.2%)
Te Hihi Creek	Auckland	13472 (32.3%)	56 (0.1%)	21986 (52.7%)	6029 (14.4%)	24 (0.1%)	153 (0.4%)	0 (0%)	4 (0%)	27 (0.1%)
Waitangi Stream	Auckland	15558 (33.4%)	229 (0.5%)	20919 (44.9%)	8885 (19.1%)	122 (0.3%)	801 (1.7%)	0 (0%)	15 (0%)	46 (0.1%)
Whangamaire Stream	Auckland	23073 (38.1%)	729 (1.2%)	25410 (42%)	10436 (17.2%)	0 (0%)	538 (0.9%)	0 (0%)	0 (0%)	356 (0.6%)
Whangapouri Creek	Auckland	45024 (37.6%)	618 (0.5%)	43629 (36.4%)	23332 (19.5%)	220 (0.2%)	667 (0.6%)	0 (0%)	83 (0.1%)	6136 (5.1%)
Awaroa (Waiuku)	Waikato	4683 (10.9%)	429 (1%)	18909 (43.8%)	16926 (39.3%)	164 (0.4%)	668 (1.5%)	0 (0%)	156 (0.4%)	1188 (2.8%)
Waikato at Port Waikato	Waikato	93931 (20.4%)	1116 (0.2%)	228573 (49.7%)	98636 (21.5%)	2650 (0.6%)	20341 (4.4%)	1092 (0.2%)	11566 (2.5%)	1864 (0.4%)
Waikato at Tuakau Bridge	Waikato	117625 (41%)	249 (0.1%)	73196 (25.5%)	76506 (26.7%)	1568 (0.5%)	12702 (4.4%)	190 (0.1%)	3073 (1.1%)	1634 (0.6%)
Whakapipi	Waikato	62158 (60%)	417 (0.4%)	5159 (5%)	28468 (27.5%)	45 (0%)	1545 (1.5%)	170 (0.2%)	321 (0.3%)	5347 (5.2%)

*Other is the sum of all other sub-catchments. It is mostly comprised of small first and second-order catchments draining to the Manukau Harbour.

2.2.1 Land use capability

Table 3 summarises the land area within the Pukekohe SVGA catchments by LUC class. Figure 2 shows the distribution of LUC class across the Pukekohe SVGA catchments.

Table 3 LUC class in Pukekohe SVGA catchments

LUC class	Area (ha)	Area (% of total)
1	4933	5%
2	29882	32%
3	19820	21%
4	9872	10%
5	0	0%
6	21603	23%
7	6000	6%
8	30	0%
Lake	52	0%
Quarry	204	0%
Town	1811	2%
Total	**94207**	

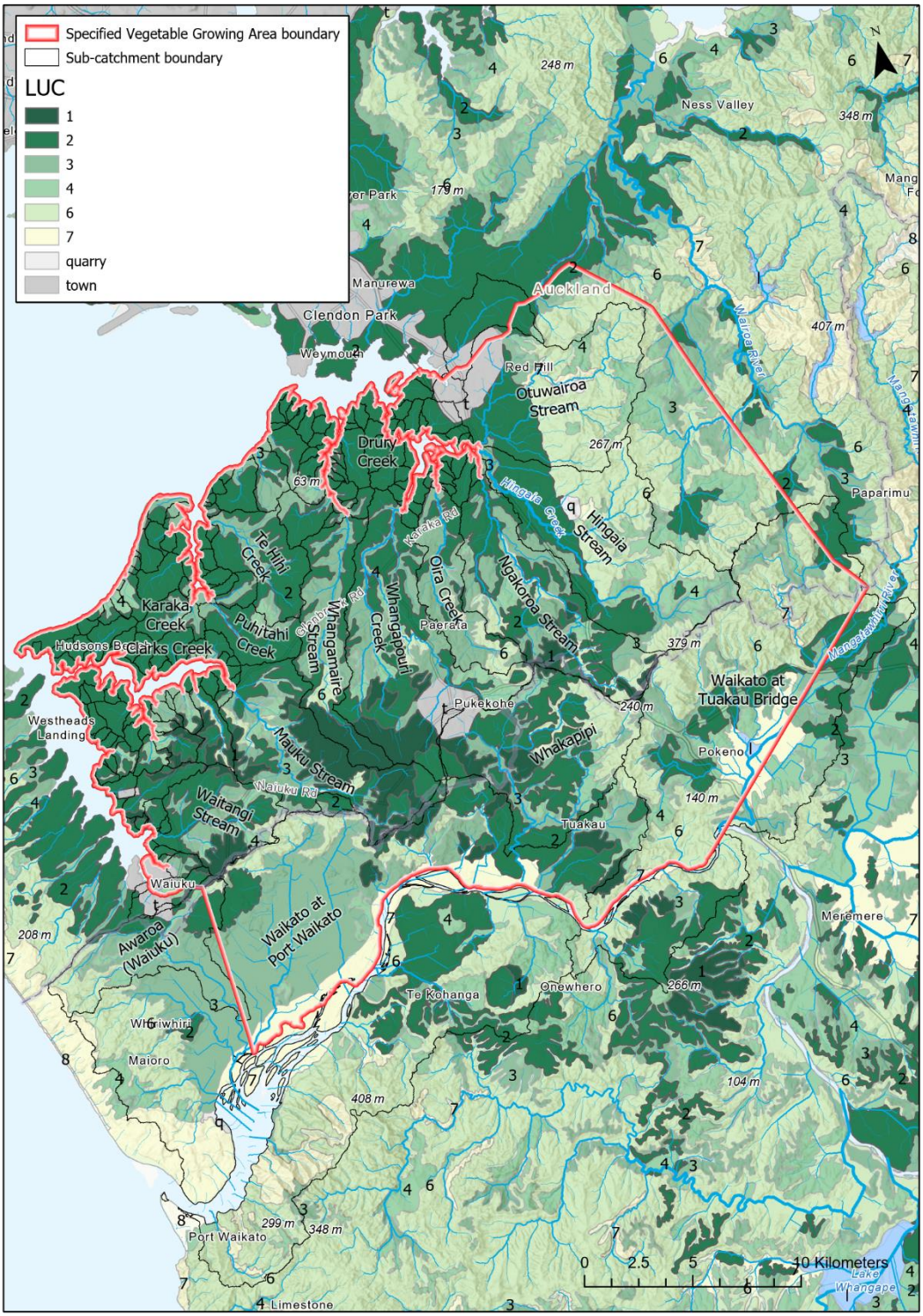

Figure 2 Pukekohe LUC class

2.2.2 Māori land

There is an estimated 628 ha of Māori land within the catchments that intersect the Pukekohe SVGA, accounting for 0.7% of the total area of the SVGA catchments. The majority of Māori land is south of the Waikato river in the Waikato at Port Waikato and Waikato at Tuakau catchments (Figure 1), which contain 301 and 265 ha of Māori land, respectively. Table 4 summarises the Māori land area by Land Use Capability (LUC) class within the SVGA catchments. Table 5 summarises the Māori land parcels by land use.

Table 4 LUC class of Māori land in Pukekohe SVGA

LUC class	Area (ha)	Area (% of total)
1	9	1%
2	98	16%
3	11	2%
4	12	2%
5	0	0%
6	456	73%
7	40	6%
Town	2	0%
Total	**628**	

Table 5 Land use of Māori land in Pukekohe SVGA

Land use	Area (ha)	Area (% of total)
Cropland - Annual	35	6%
Forestry	175	28%
Grazed - dairy	9	1%
Grazed - non-dairy	141	22%
Natural forest, water, and grassland with woody biomass	266	42%
Settlements and roads	3	1%
Total	**628**	

3. Horowhenua SVGA

3.1 Land use and Nitrogen loading

Land use within the Horowhenua SVGA has been estimated using LUCAS for the year 2016. Land use categories from LUCAS have been matched to those used in the CASM water quality model developed for Horizons Plan Change 2[5] to provide an estimate of N loading and the relative contribution of the different land uses.

The LUCAS land use category 'Orchards and vineyards (perennial)' has been matched to the CASM category 'Cropping', which provides the most appropriate estimate of N loss rate. All short rotation cropland in LUCAS is labelled as 'Horticulture' and assumed to be CVP.

Figure 3 shows the extent and land use within the Horowhenua SVGA. Land use area and estimated annual N loss using average annual N loss rates from CASM are provided in Table 6. Small differences in estimated N loads between Table 6 and those estimated directly from CASM[6] are the result of the different underlying land use data. The LUCAS data used here has increased spatial resolution to the regional CASM model and can be considered more representative.

Table 6 Land use area and N load for all catchments in Horowhenua SVGA

CASM Land use*	Area (ha)	Area (%)	CASM N loss rate (kg/N/ha/year)	N load (kg)	N load (% of total)
Builtup/Parks/Others	1026	15%	10	10260	7%
Cropping**	36	1%	13.9	507	0%
Dairy	1355	19%	37.2	50391	35%
Exotic Cover	290	4%	3.3	957	1%
Horticulture***	504	7%	66.5	33541	23%
Native Cover	204	3%	3	612	0%
Other	119	2%	2	239	0%
Sheep and/or Beef	2960	43%	16.3	48253	33%
Water Body	467	7%	0	0	0%
Total	**6963**			**144759**	

***** MfE LUCAS land use (2016) applied to CASM land use categories

** Orchards and vineyards (perennial) in LUCAS

*** Short rotation cropland in LUCAS

[5] Snelder, T., Cox, T., Kerr, T., Fraser, C., Collins, S. 2020. Manawatū-Whanganui Region Catchment Nitrogen Models Supporting Regional Plan Change 2.

[6] Easton, S. 2020. Catchment Water Quality Modelling: supporting evidence of Dr Claire Conwell. Horizons Plan Change 2 expert evidence.

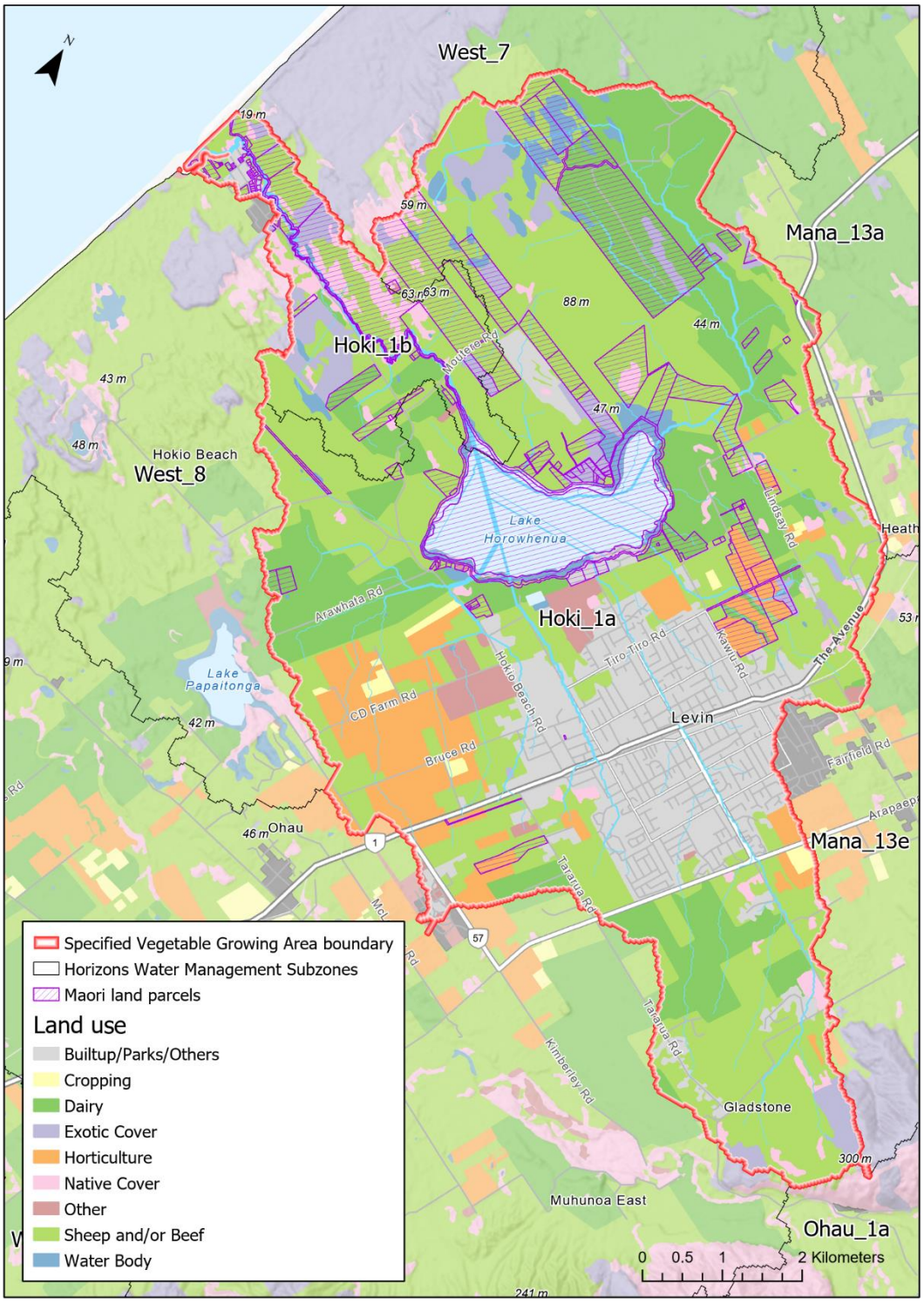

Figure 3 Horowhenua SVGA land use

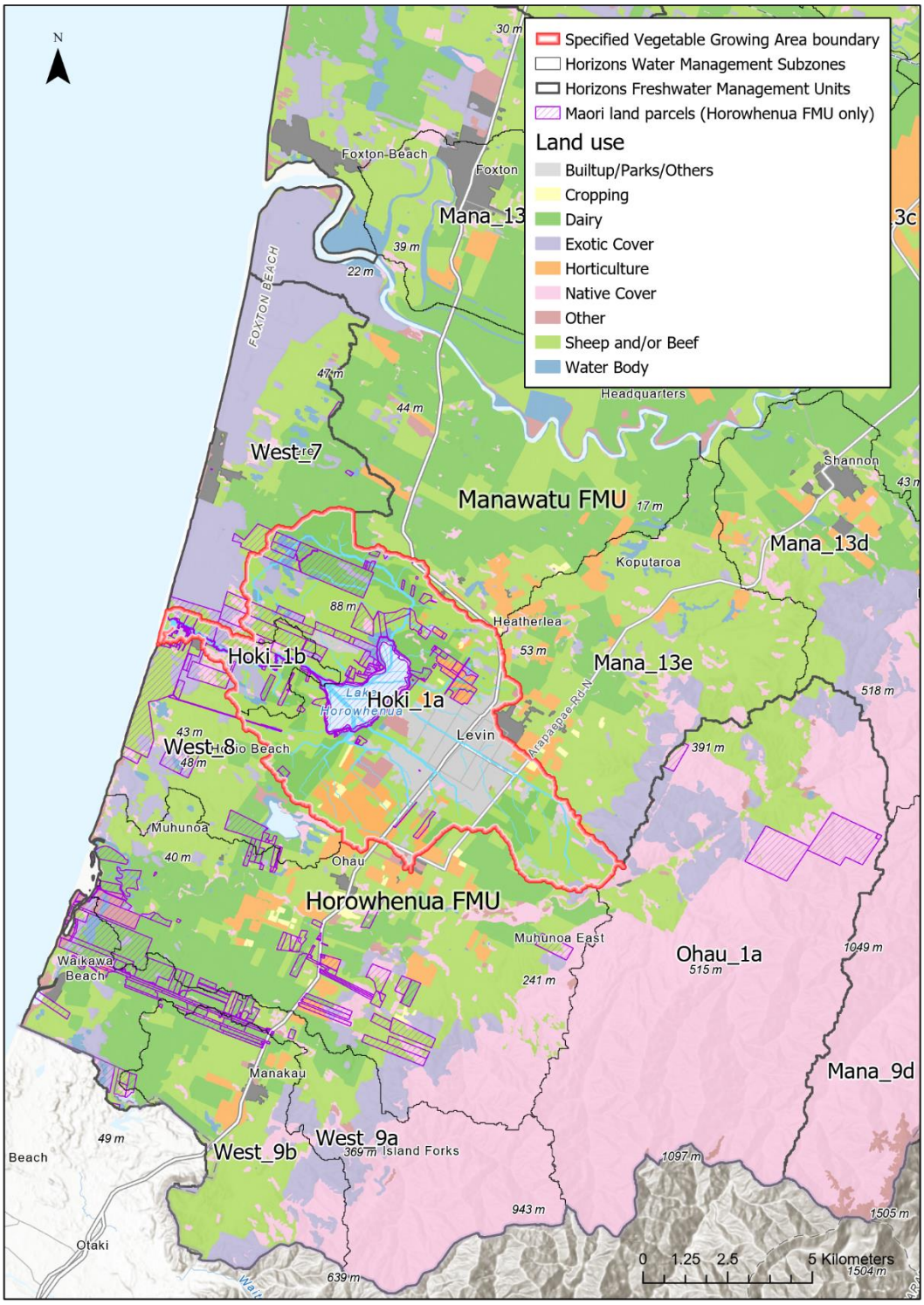

Figure 4 Horowhenua FMU land use

3.1.1 Land use capability

Table 7 summarises the land area within the Horowhenua SVGA and Freshwater Management Unit (FMU) by LUC class. Figure 5 shows the distribution of LUC class across the Horowhenua FMU.

Table 7 LUC classes in Horowhenua

LUC class	Area in SVGA (ha)	Area in SVGA (% of total)	Area in FMU (ha)	Area in FMU (% of total)
1	1145	16%	2517	6%
2	561	8%	2646	7%
3	2412	35%	8215	21%
4	154	2%	1604	4%
5	0	0%	0	0%
6	1311	19%	9332	24%
7	181	3%	7661	19%
8	21	0%	6030	15%
Lake	308	4%	366	1%
Town	870	12%	1008	3%
Total	**6963**		**39379**	

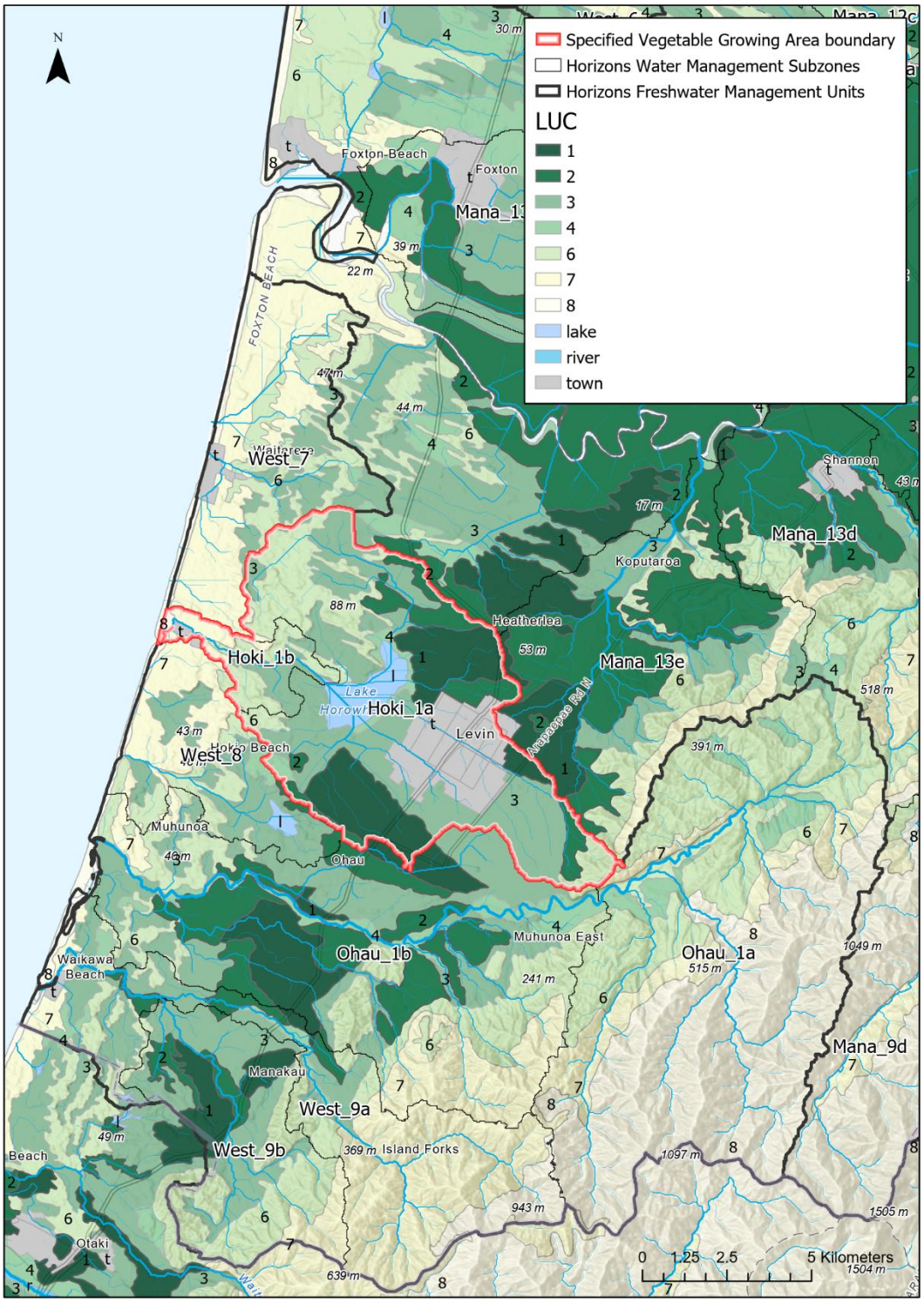

Figure 5 Horowhenua LUC class

3.1.2 Māori land

Māori land parcels within the Horowhenua SVGA total 1450 ha (21% of the total SVGA area), 308 ha of which covers Lake Horowhenua. Table 8 summarises the Māori land in the Horowhenua SVGA and within the wider Horowhenua FMU by LUC. Table 9 summarises the Māori land in the Horowhenua SVGA and within the Horowhenua FMU by land use.

Table 8 LUC of Māori land in Horowhenua

LUC class	Area in SVGA (ha)	Area in SVGA (% of total)		Area in Horowhenua FMU (ha)	Area in Horowhenua FMU (% of total)
1	98	7%		177	4%
2	51	4%		208	5%
3	343	24%		1166	29%
4	76	5%		196	5%
5	0	0%		0	0%
6	424	29%		896	22%
7	137	9%		908	23%
8	7	1%		166	4%
t	7	0%		9	0%
l	308	21%		308	8%
Total	**1450**			**4034**	

Table 9 Land use of Māori land in Horowhenua

CASM land use	Area in SVGA (ha)	Area in SVGA (% of total)		Area in Horowhenua FMU (ha)	Area in Horowhenua FMU (% of total)
Sheep and/or Beef	524	36%		1264	31%
Native Cover	85	6%		676	17%
Exotic Cover	96	7%		351	9%
Dairy	237	16%		1041	26%
Horticulture	82	6%		118	3%
Builtup/Parks/Others	19	1%		22	1%
Other	4	0%		106	3%
Water Body	404	28%		457	11%
Total	**1450**			**4034**	

4. National scale vegetable production

4.1 Vegetable production statistics

The 2017 agricultural production survey[7] describes the distribution of vegetable production in New Zealand. Figure 6**Error! Reference source not found.** summarises the total area used for growing outdoor vegetables by regional council. The largest producing areas are Canterbury, Hawke's Bay, Auckland (Pukekohe SVGA), Waikato (Pukekohe SVGA), Gisborne, and Manawatu-Whanganui (Horowhenua SVGA). The vegetable producing area in Canterbury and Hawke's Bay is dominated by process-vegetables such as peas and beans and extensive vegetable rotations of onions, potatoes, and squash. The growing areas in Pukekohe (Auckland and Waikato regions) and Horowhenua (Manawatu-Whanganui region) are particularly important for the production of brassicas (broccoli, cauliflower, and cabbage), lettuce and other leafy vegetables (spinach, silverbeet, bok choy, etc.), potatoes, and onions (Figure 7).

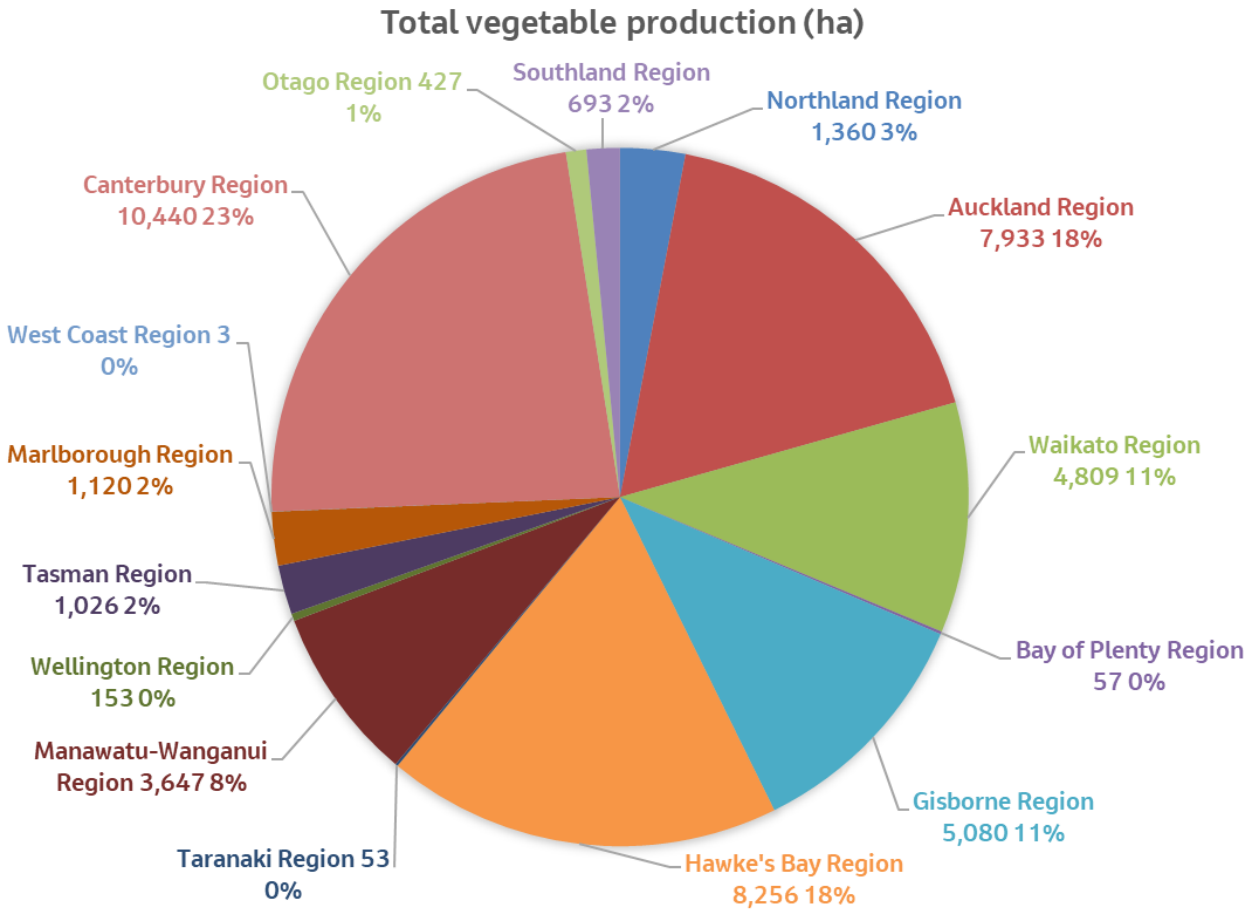

Figure 6 Outdoor vegetable production by regional council (2017)

[7] https://www.stats.govt.nz/information-releases/agricultural-production-statistics-june-2017-final

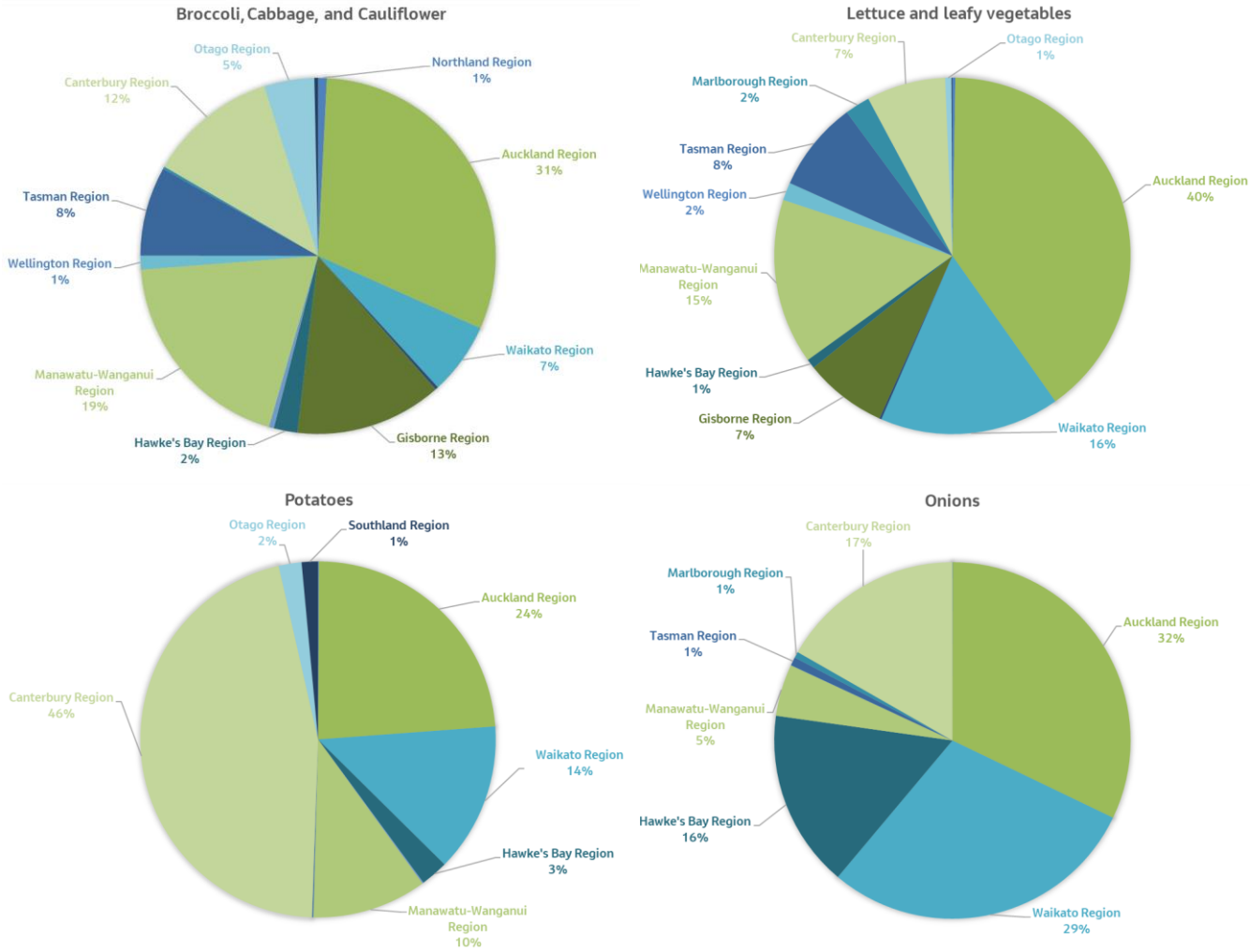

Figure 7 National production area for selected vegetables by regional council (2017)

4.2 Distribution of suitable land for CVP

LUC classes 1 and 2 are generally considered to be versatile[8] and therefore suitable for CVP. Another estimate of suitable food-producing land is 'high-class land'[9]. This definition is similar to class 1 and 2 land in the LUC classification, but with differences in the thresholds for climate, erosion, and drainage class, among others. High-class land has been mapped by the Ministry for the Environment[10]. Table 10

[8] Andrew, R., & Dymond, J. R. (2013). Expansion of lifestyle blocks and urban areas onto high-class land: An update for planning and policy. Journal of the Royal Society of New Zealand, 43(3), 128-140.
[9] Webb T, Jessen M, McLeod M, Wilde R 1995 . Identification of high-class land. Broadsheet November 1995: 109 – 114
[10] https://data.mfe.govt.nz/layer/52830-high-class-land-for-food-production-north-island-2012/

summarises the distribution of high-class land and LUC class 1 and 2 land by regional council. Figure 8 maps the high-class land across New Zealand.

Climatic limitations such as frost prevalence and Growing Degree Days (GDDs) further limit the suitability of some high-class land and LUC class 1 and 2 land for commercial vegetable production. Plant and Food[11] estimate 671,000 ha across New Zealand meet the criteria of LUC class 1 or 2, greater than 800 10-degree GDDs, <= 5 degrees slope, and has 180 days frost free: approximately half of the total LUC 1 & 2 land.

Table 10 High class land and LUC class 1 & 2 by regional authority

Regional Authority	Area (ha)	High Class Land (ha)	High Class land (% of region)	LUC 1 & 2 (ha)	LUC 1 & 2 (% of region)
Northland Region	1250425	27754	2%	36569	3%
Auckland Region	494107	63183	13%	59243	12%
Waikato Region	2390036	286631	12%	298806	13%
Bay of Plenty Region	1207181	37221	3%	56065	5%
Gisborne Region	838533	40749	5%	21046	3%
Manawatū-Whanganui Region	2222058	148357	7%	205460	9%
Hawke's Bay Region	1413801	92672	7%	44005	3%
Taranaki Region	725447	87081	12%	92017	13%
Wellington Region	804860	36290	5%	34857	4%
Marlborough Region	1045782	37735	4%	13843	1%
Tasman Region	961613	15975	2%	9642	1%
Nelson Region	42219	304	1%	695	2%
Canterbury Region	4450428	319426	7%	293160	7%
West Coast Region	2324524	322	0%	0	0%
Otago Region	3118633	87915	3%	50335	2%
Southland Region	3119612	183950	6%	172930	6%
Total	**26,409,260**	**1,465,566**	**6%**	**1,388,673**	**5%**

[11] Clothier B, Müller K, Hall A, Thomas S, van den Dijssel C, Beare M, Mason K, Green S, George S. March 2017. Futures for New Zealand's arable and horticultural industries in relation to their land area, productivity, profitability, greenhouse gas emissions and mitigations. A Plant & Food Research report prepared for: New Zealand Agricultural Greenhouse Gas Research Centre.

Figure 8 High class land distribution