Tree Loss in the Waitematā Local Board Over 10 Years, 2006-2016

Grant Lawrence, Miriam Ludbrook, Craig Bishop

September 2018 Technical Report 2018/021

Auckland Council
Te Kaunihera o Tāmaki Makaurau

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Executive summary

This report summarises tree loss within the Waitematā Local Board area over the 10-year period from January 2006 to February 2016. The report was written for the Natural Environment portfolio of the Waitematā Local Board, to provide background information and some direction and context for an urban forest strategy and provide evidence to ensure decision-makers are well-informed.

Mapping of tree loss across Waitematā Local Board was undertaken in ArcGIS through digital photo-interpretation. Only canopy losses were captured and mapped in this report. It was evident throughout the aerial analysis that newly established canopy and canopy growth of existing trees has also occurred within Waitematā Local Board, in some cases quite extensively. Given that growth was usually represented by small marginal increments across many tens of thousands of individual trees and shrubs it was impossible to identify and digitise in the same way that tree loss was.

A total of 61.23ha of tree canopy was lost from Waitematā Local Board over 10 years. The loss was made up of 12,879 different detected tree removal 'events'; meaning a <u>minimum</u> of 12,879 trees were cleared. The actual number of trees cleared is likely to be somewhat greater than this figure because the larger clearances involved the removal of multiple trees.

Tree losses were spread throughout Waitematā Local Board with particular concentrations on privately owned land in the suburbs of Arch Hill, Freemans Bay, Grey Lynn, Parnell, Ponsonby, Western Springs and Westmere. The vast majority of tree clearances were quite small in terms of the quantity of canopy removed at a single location. Fifty-seven per cent of total loss of tree canopy was caused by the combined impact of many thousands of individual clearance events, all of which were individually less than 0.01ha (100m^2) in size. In terms of proportional loss of tree canopy the suburbs with the highest rates of clearance were Grey Lynn, Ponsonby and Westmere. In contrast, Herne Bay appeared to have experienced less clearance than the other suburbs within Waitematā Local Board.

In terms of absolute area cleared, tree canopy loss was dominated by tree canopy removal on private land. However, as private land is also the dominant ownership of tree canopy in Waitematā Local Board, this is not an unexpected result. However, our data also showed that in the last 10 years there has been a considerable bias towards loss of tree canopy on private land and a lower rate of loss on public parkland.

More than 75 per cent of all cleared trees had no statutory protection and unprotected trees experienced higher rates of tree canopy clearance; about 60 per cent higher than what would be expected on a proportional basis.

More than half of tree canopy clearance had occurred for no obvious reason. That is, no new structures such as new houses or other buildings, pools, house extensions, decks or driveways had replaced the space that was beneath the cleared forest canopy. Developments, improvements and extensions to existing buildings were the second most important reason for tree canopy clearance (33 per cent). Other causes contributed a relatively small proportion of the total (eight per cent).

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1.0 Introduction

This report summarises the loss of trees within the Waitematā Local Board area over the 10-year period from January 2006 to February 2016. The report is based on a desktop analysis of high-resolution aerial imagery collected for the Auckland Council in summer 2006, 2007/8, 2010 and 2015/16. Mapping of tree loss across the Waitematā Local Board was undertaken in ArcGIS through digital photo-interpretation and manual digitisation, and recorded in a polygon/vector layer. Examples of how this process was carried out are provided in the Appendix. To further investigate the pattern and causes of tree loss, parcel scale land ownership and protection status was determined for each clearance event. Differences in tree loss between suburbs within Waitematā Local Board were also investigated.

Urban trees provide a multitude of benefits for ecosystems, the economy and community health and wellbeing (Auckland Council, 2018). Trees are crucial from an ecological standpoint, and also provide a wide range of additional landscape, environmental, social, economic, climatic, cultural and other practical benefits (Nowak and Crane, 2000, Miller et al. 2015). Auckland's urban forest is remarkable and special (Wilcox, 2012). However, rapid population growth and legislative change is leading to significant change in the urban landscape, which is reflected in the distribution and make-up of the urban forest. This report outlines the loss of urban tree cover within the Waitematā Local Board. Providing evidence to ensure decision-makers are well-informed and have a sound basis for their future decisions.

The report was written for the Natural Environment portfolio of the Waitematā Local Board, to provide background information and some direction and context for an urban forest strategy. When the local board first began to consider the urban forest issue in 2014 it soon became clear there was a lack of basic data about the loss of tree canopy in Waitematā Local Board and the Auckland metropolitan area in general. The data presented in this document is a follow-up to an earlier report (Bishop & Lawrence, 2017) which examined the distribution, ownership and protection status of tree canopy within Waitematā Local Board that was based on an analysis of 2013 LiDAR (Light Detection and Ranging) jointly captured by NZ Aerial Mapping Ltd. and Aerial Surveys Ltd. for Auckland Council. The original intention was to compare 2013 LiDAR data with 2016/17 LiDAR capture to examine the loss and gains of tree canopy within Waitematā Local Board over this shorter four- to five-year period. However, the 2016/17 LiDAR data has undergone a lengthy post-collection verification phase and as of September 2018 is still not available for the Waitematā Local Board. Therefore, as an interim step to provide more timely information on tree loss, the desk-top aerial photography analysis presented in this report was undertaken.

Robust data on the rate of urban tree loss is a critical 'piece of the puzzle' in terms of understanding the dynamics of urban forest within the Waitematā Local Board. There has been a wide range of tree loss rates reported for Auckland since the removal of blanket tree protection following the Resource Management Act (Simplifying and Streamlining) Amendment Act 2009 (RMAA09). This report helps to:

1. Better understand the status and trends of tree loss in the Waitematā Local Board area over the time period covered by the study.

2. Identify pressures that result in tree loss within the Waitematā Local Board area.
3. Assess the efficiency and effectiveness of policy statements and plans prepared under the Resource Management Act 1991.

Only canopy losses were captured and mapped in this report. It was evident throughout the aerial analysis that newly established canopy and canopy growth of existing trees has also occurred within Waitematā Local Board, in some cases quite extensively. Given that growth was usually represented by small marginal increments across many tens of thousands of individual trees and shrubs it was impossible to identify and digitise in the same way that tree loss was. A 2013 vs. 2016/17 LiDAR data comparison remains the best tool to investigate the balance between tree canopy growth and clearance within Waitematā Local Board in recent times.

2.0 Methodology

Tree canopy changes occur at fine scales, when individual or groups of trees, grow, die or are removed. High resolution aerial imagery across a 10-year timespan starting January 2006 to February 2016 (Table 1) from Auckland Council's geospatial archives were assessed for change (loss) in canopy cover. The four imagery datasets (2006 Aerials, 2007/08 Aerials, 2010 Aerials, 2015/16 Aerials) allows three change periods to be calculated (2006-2007, 2008-2009, 2010-2016). Mapping of tree loss across the Waitematā Local Board was undertaken in ArcGIS through digital photo-interpretation and manual digitisation and recorded in a polygon/vector layer. This involved an intensive assessment of the aerial imagery layers against each other to identify presence-absence changes in canopy cover.

Our definition of a 'tree' was all vegetation three metres or greater in height. Therefore the loss of 'tree' canopy includes hedges and other vegetation that would probably be regarded by the general public as shrubs. However, this 3m height threshold was the same as that used to denote urban forest in the 2013 LiDAR analysis for the Waitematā Local Board (Bishop and Lawrence 2017) and is also the threshold for some of the protection rules relating to tree clearance (Table 2).

Where possible the location and extent of individual tree losses were digitised using the presence image. Where multiple trees were removed in a single 'clearance event', and the spatial extent of individual trees could not be determined, groups or 'floristic clusters' were digitised. Because of this, the total area of clearance events, not the number of trees removed, is the more reliable information and it is the loss of tree canopy area >3m in height that is used throughout this report. Tree canopy loss is expressed in hectares (ha) with one hectare being equal to 10,000m^2.

Table 1: Summary of technical specifications of aerial imagery datasets from Auckland Council geospatial archives

Aerial imagery	Capture start*	Capture finish*	Spatial resolution (cm)	Spectral/Radiometric resolution
2006 Aerials	11/01/2006	24/02/2006	0.125	RGB[1]/8Bit
2007/08 Aerials	30/12/2007	13/01/2008	0.125	RGB/8Bit
2010 Aerials	18/02/2010	18/02/2010	0.075	RGB/8Bit
2015/16 Aerials	13/11/2015	25/02/2016	0.075	RGB/8Bit

*Capture times are representative of tiles in the Waitematā Local Board study area.

1 = Red, green, blue (RGB)

For the purpose of this report, only tree canopy losses were captured and mapped. It was evident throughout the aerial analysis that newly established canopy and canopy growth has also occurred, in some cases quite extensively. Given that growth was usually represented by small marginal increments across many tens of thousands of individual trees it was impossible to identify and digitise in the same way that tree loss was.

Each individual record or ‘clearance event’ was attributed with the year/s of presence and absence and change period. In an attempt to provide additional insight as to why the tree(s) were removed, an indicative reason classification was assigned to each ‘removal event’ using the following categories: a) development of new or extension of existing buildings; b) transport (including road widening, road safety improvements and clearance in rail corridors); c) remediation of Newmarket Park, and; d) no obvious reason (includes all other possible reasons e.g. gardening/landscaping, improving light conditions/reduce shading). Some examples of different types of tree clearance events are presented in the Appendix.

To further investigate the possible underlying forces behind tree removal over these time periods, parcel scale land ownership and protection was determined for each clearance event. The ownership and the protection datasets used for this analysis are static layers from 2015 and 2016 respectively. These layers were used in a series of spatial overlays using the centroid of the tree loss polygons to determine location and attributions.

Land ownership data was based on the 2015 Publicly Owned Land (POL) GIS dataset (Craig Fredrickson, 2016). The POL dataset was created using title ownership information attached to parcels and includes roads (both formed and unformed), public parks administered by the Auckland Council and land administered by central government agencies (e.g. Department of Conservation and Ministry of Education). For this analysis POL data was reclassified into, public parkland, road corridors and reserves, and other public land. Any parks not captured in the POL dataset were added from Auckland Council’s parks extent spatial database. Private land was established by subtracting the public land from primary parcels (download in January 2016 from Land Information New Zealand). All remaining primary parcels were considered to be indicative privately owned land.

Tree canopy protection was determined through analysis of the underlying base zones and restrictive control overlays in the Auckland Unitary Plan – Operative in part. Five different levels of protection were assigned (Table 2). The protection levels are based on a review of the vegetation related provisions in the Auckland Unitary Plan and our subjective understanding of the practical barriers to vegetation clearance, for different zones and overlays.

There are two significant limitations with the manual digitisation approach that we have taken in this study, and interpretation of the results needs to take account of these limitations:

1. We have only measured tree canopy loss as it was impractical to manually digitise incremental growth of existing trees;
2. The tree canopy loss totals we provide are a two-dimensional dataset that takes no account of the height (i.e. overall size) of the ‘trees’ that were removed. Larger trees provide exponentially greater environmental, amenity and social benefits compared with small trees (Davies et al. 2011, Nowak et al. 2013, Moser et al. 2015) and the height of tree is not always proportional to its canopy area, as many of the older trees have been pruned in a way that reduces their canopy extent.

As a result of these limitations, a 2013 vs. 2016/17 LiDAR data comparison remains the best tool to investigate the balance between tree canopy growth and clearance within Waitematā Local Board in recent times, and changes in the size-class structure of tree canopy. LiDAR data, combined with the information presented in this report, will provide a better understanding of urban forest changes, the reasons for those changes, and their impact.

Table 2: Level of protection for tree canopy based on zone and overlay rules in the Auckland Unitary Plan – Operative in part.

Protection zone	Detail on rules and restrictions
0 – no protection	There is no statutory protection for tree canopy and/ or rules preventing tree or vegetation clearance in this location
1 – some protection	Within an open space active recreation zone or a road corridor. For both these areas restricted discretionary resource consents are required to fell or remove trees > 4m in height. However, development pressures are often high in these locations and trees are often regarded as incompatible with the main land uses. The Auckland Unitary Plan rules for street trees are more permissive in terms of what utilities can do around and to trees – including pruning as permitted activity.
2 – low protection	Within a coastal natural character area, or an area zoned as 'Open Space Informal Recreation' restricted discretionary consent is needed to remove trees/ vegetation 4m+ in height. The Auckland Unitary Plan rules for park trees are more permissive in terms of what utilities can do around and to trees – including pruning as permitted activity.
3 – moderate protection	• Outstanding Natural Feature (restricted discretionary consent needed to remove 25m^2+ of contiguous indigenous vegetation)^A, • Outstanding Natural Landscape (restricted discretionary consent needed for alteration or removal of 50m^2+of any contiguous indigenous vegetation)^A, • Coastal yard (restricted discretionary consent needed to remove native trees/ vegetation 3m+ in height)^A • Open Space Conservation Zone not within a SEA (restricted discretionary consent needed to remove trees/ vegetation 4m+ in height) • Historic heritage (discretionary consent needed to remove trees/ vegetation 3m+ in height) • Riparian yard (restricted discretionary consent needed to remove any trees or shrubs) • Lake protection zone (restricted discretionary consent needed to remove any trees or shrubs)
4 – high protection	• Significant Ecological Areas (SEA) (discretionary consent needed to remove any trees or vegetation) • Notable trees (discretionary consent needed to remove any notable tree or shrub)

^{A} = vegetation protection in these areas is restricted to indigenous species and does not cover exotic plants. In some cases (e.g. coastal zone) the removal of exotic vegetation is specifically mentioned as a permitted activity. Exotic trees can provide similar benefits to native species, so this is a negative in terms of protection of urban forest values

3.0 Results and discussion

3.1 Summary

Figure 1 shows the locations of all the tree removals detected within Waitematā Local Board over the 10-year period from 2006-2016. Losses over three different time periods – provided by the four different 'time-stamps' of the time series aerial photographs – are highlighted with different colours. The length of each time period, total tree loss and rate of tree loss are summarised in Table 3. A total of 61.23ha of tree canopy was lost from the Waitematā Local Board over 10 years.

Tree losses were spread throughout Waitematā Local Board with particular concentrations on privately owned land in the suburbs of Arch Hill, Freemans Bay, Grey Lynn, Parnell, Ponsonby, Western Springs and Westmere. Figure 1 has a number of areas where relatively few trees were felled between 2006 and 2016. However, with one exception, the areas without tree loss are correlated with locations that have a lack of trees available to be cut down due to the extensive cover of impervious surfaces (e.g. Central Business District (CBD), Mechanics Bay, Newmarket and Newton Gully). The exception to this pattern appears to be Herne Bay, which has experienced a relatively few tree removal 'events' compared to the surrounding suburbs.

Another feature of Figure 1 is the relative small number of tree clearance events on public parkland, which is coloured a lighter grey than surrounding land in Figure 1. There are two exceptions to this. Auckland Zoo has seen significant clearance of trees associated with its on-going re-development, both in the zoo itself and on adjoining land. Victoria Park has also experienced a significant amount of tree loss associated with the construction of the Victoria Park tunnel. New trees have been planted within Victoria Park to compensate for the loss of tree canopy during tunnel construction. However it is likely to be several decades before these new plantings reach a size where they are providing the environmental and health benefits of the large trees they replaced, and they will need to be closely monitored over this time (Howell Davies, council arborist personal communication).

Table 3: Total canopy area lost, and rate of tree canopy loss, within Waitematā Local Board over 10 years

Time period	Days*	Years	Count	Area of tree canopy loss (ha)	Rate of canopy loss (ha/ year)
2006-2007	719	2.0	2,904	11.9	5.95
2008-2009	781	2.1	2,950	12.87	6.13
2010-2016	2142	5.9	7,025	36.46	6.18
2006-2016 (Total)	3642	10.0	12,879	61.23	6.12

*From end of capture period to start of capture period for each aerial set

The 61.23ha of canopy loss was made up of 12,879 different detected clearances; meaning a minimum of 12,879 trees were cleared. The actual number of trees cleared is likely to be significantly greater than this figure because the larger clearances involved the removal of multiple trees. For example, 1.67ha of tree canopy was removed[1] from Newmarket Park as part of the remedial works to halt and stabilise subsidence, and remove contaminated landfill material. While this work was counted as 14 ‘clearance events’[2] in terms of the total listed above, the actual number of trees removed during these works was on the order of 400+ individual stems (L. Schwendenmann personal communication 2018). Similarly, the removal of a group of trees forming a hedge in a more urban setting would count as a single removal, despite it involving the clearance of multiple trees.

[1] The cleared areas of Newmarket Park have been re-planted with native trees and shrubs which will – over time as they establish, grow and mature – provide a larger overall area of tree cover and habitat when compared to the area prior to remediation work.

[2] The reason for multiple removals is the work was staged, both spatially and temporally, and each separate and discrete patch was recorded as a different removal ‘event’.

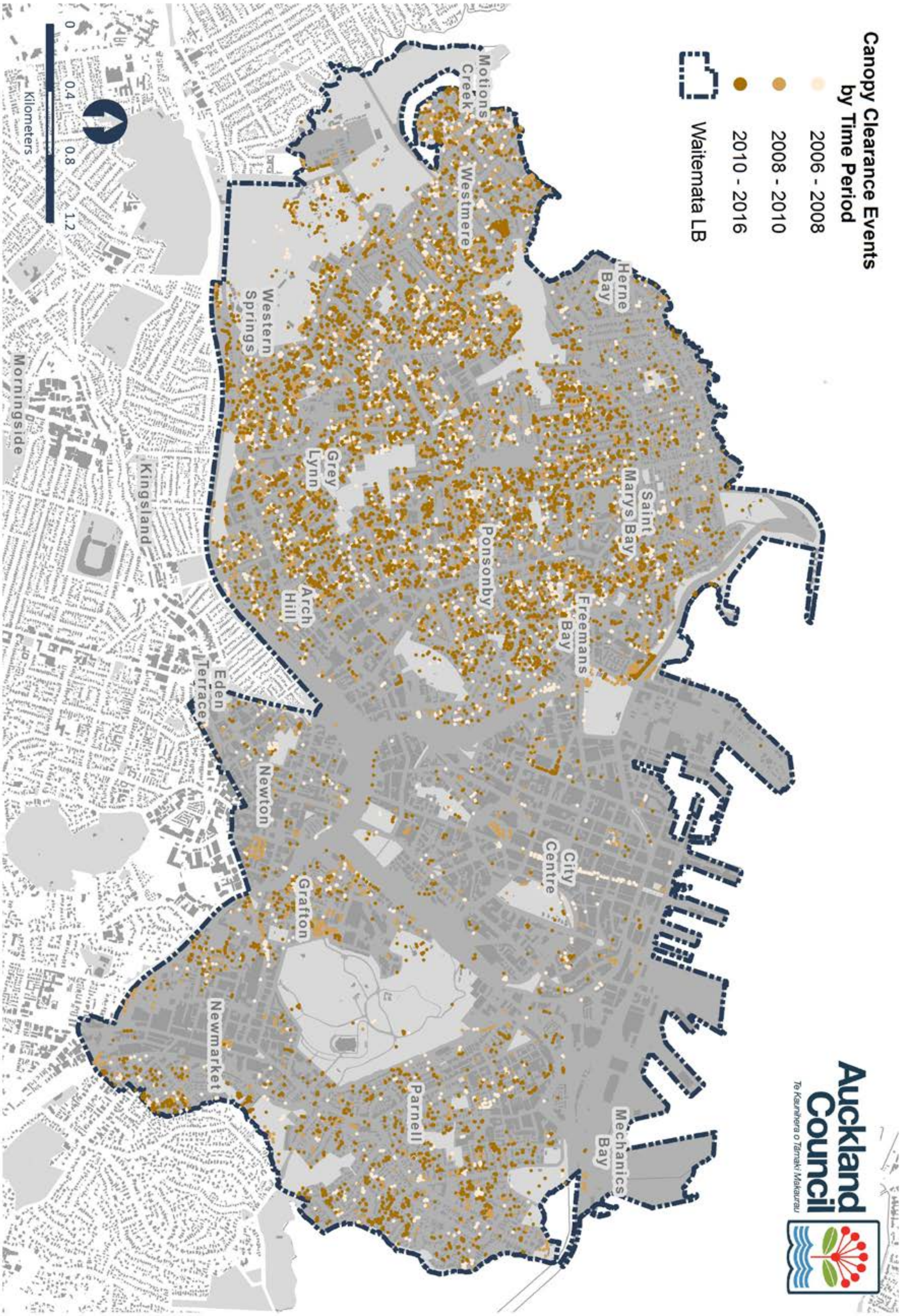

Figure 1: Distribution of tree canopy 'clearance events' detected within the Waitematā Local Board using aerial photographs 2006-2016. The colour of the dots denotes the three different time periods in which the clearance occurred. Note that the time periods are not of equal timespan and therefore the larger number of dots denoting clearance events in 2010-2016 does not reflect an increase in clearance during this time period, compared to the earlier periods.

One possible explanation for the static clearance rates across the whole 10-year period would be if a small number of big clearance projects on public land – most of which involved immediate planting – were responsible for most of the canopy loss in the two earlier time periods (i.e. 2006-2007 and 2008-2009) while the clearance in the more recent 2010-2016 period consisted of a large number of smaller tree removals that were concentrated on private land. However, Table 4 shows that there has been only marginal up and down movement of tree canopy clearance rates across the three time periods considered in this study, irrespective of land tenure/ ownership.

Table 4: Total canopy area lost and rate of tree canopy loss, by land ownership/ tenure, within Waitematā Local Board over 10 years

Tenure	Time period	Number of years	Area of tree canopy loss (ha)	Rate of canopy loss (ha/year)
Private land	2006-2007	2.0	8.28	4.14
	2008-2009	2.1	7.59	3.61
	2010-2016	5.9	23.71	4.02
Public parkland	2006-2007	2.0	1.17	0.59
	2008-2009	2.1	2.41	1.15
	2010-2016	5.9	6.06	1.03
Road corridors and reserves	2006-2007	2.0	1.46	0.73
	2008-2009	2.1	1.46	0.69
	2010-2016	5.9	4.03	0.68
Other public land	2006-2007	2.0	1.00	0.50
	2008-2009	2.1	1.42	0.68
	2010-2016	5.9	2.64	0.45

3.2 Size-class distribution

The size-class distribution of all 12,879 digitised clearance events shows that the majority of tree clearances were quite small in terms of the quantity of canopy removed at a single location (Figure 2). Almost half were less than 0.005ha ($50m^2$) in size, and two-thirds were less than 0.01ha ($100m^2$). However, because of the very large number of small clearances, collectively they did account for a greater proportion of the overall canopy loss, compared to the small number of larger clearance events (Figure 3). Fifty-seven percent of total loss of tree canopy was caused by the combined impact of many thousands of individual clearance events, all of which were individually less than 0.01ha ($100m^2$) in size.

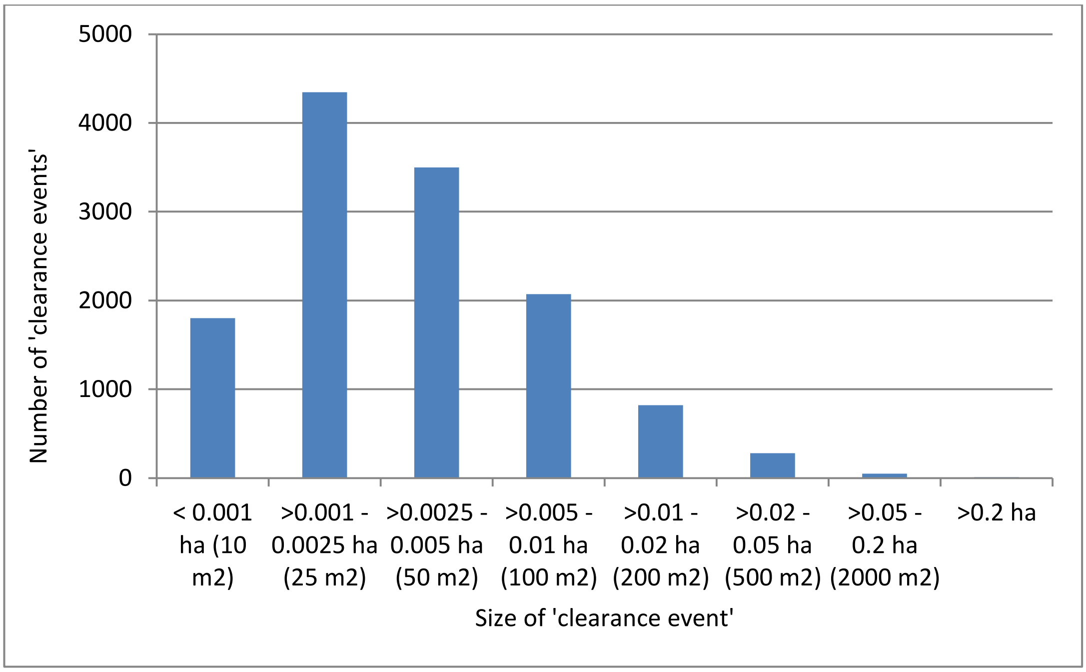

Figure 2: Size-class distribution of the 12,879 digitised 'clearance events'

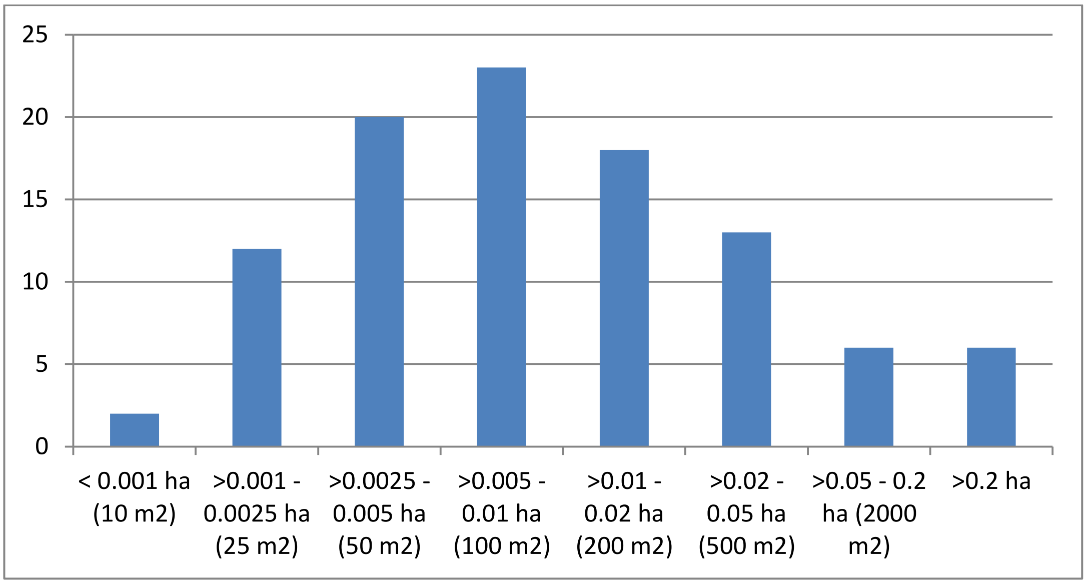

Figure 3: The percentage (per cent) of total cleared area accounted for by different sized 'clearance events'

3.3 Tenure / Ownership

The tenure of the 61.23ha of canopy clearance is presented in Figure 4. In terms of absolute area cleared, tree canopy loss is dominated by tree canopy removal on private land. However, as private land is also the dominant ownership of tree canopy in Waitematā Local Board, comprising 45 per cent of all the tree canopy within the local board (Bishop and Lawrence 2017), this is not an unexpected result. The ‘other public land’ category includes government owned land, which in the Waitematā Local Board is dominated by schools and tertiary institutions.

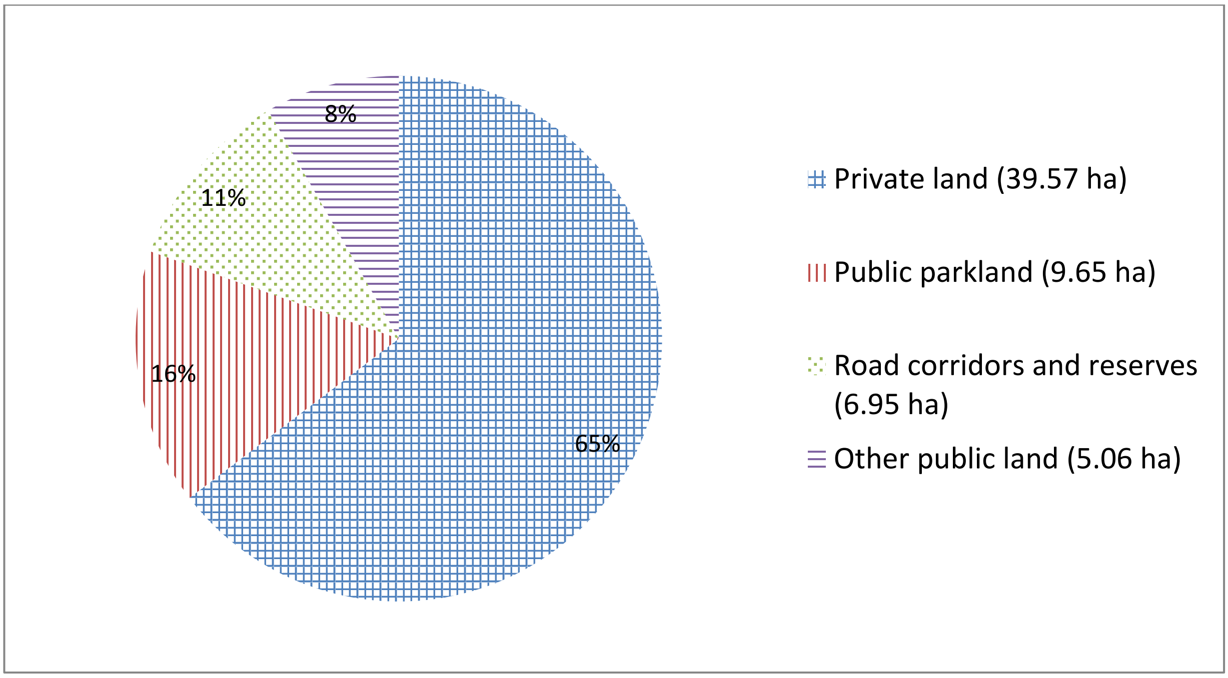

Figure 4: Loss of tree canopy, by land ownership, within Waitematā Local Board 2006-2016

Figure 5 presents data on the proportion of clearance within each land tenure class, compared to the proportion of tree canopy ownership in the same land tenure class across the whole of Waitematā Local Board. If the light-coloured bar is larger than the dark-coloured bar in Figure 5 this means that tree canopy loss within that land tenure/ ownership class is greater than what would be expected if canopy loss was evenly balanced. If the dark-coloured bar is larger than the light-coloured bar, then canopy clearance is less than expected. These data show that in the last 10 years in Waitematā Local Board there has been a considerable bias towards loss of tree canopy on private land and a disproportionally low rate of loss on public parkland. In contrast, the loss of tree canopy for roads and other public land was close to what would be expected, given the relative proportion of these ownership classes in terms of total tree canopy cover.

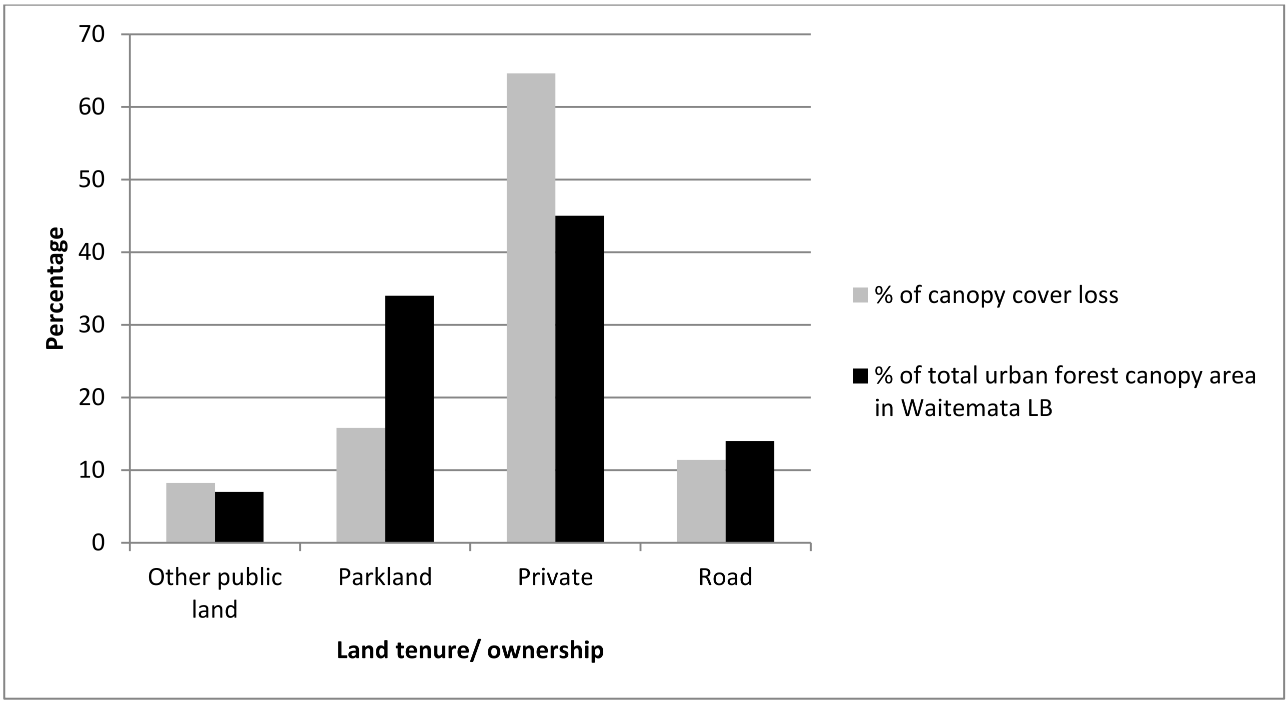

Figure 5: Comparing the proportion of tree canopy loss (2006-2016) with canopy 'ownership' (in 2013) in Waitematā Local Board

Canopy loss as proportion of the total area of tree canopy in 2013 within each of the four land tenure classes is outlined in Table 5. We also note that the data in Table 5 is from two different urban forest studies that used different methods to determine canopy area; automatic classification using LiDAR for the total canopy area data (Bishop and Lawrence 2017) and digitising aerial photos for the lost canopy area data. As this is to some extent an ‘apples and oranges’ comparison the percentage loss figures in the final column of Table 5 should be regarded as an estimate, rather than a precise number.

Table 5: Loss of tree canopy 2006-2016, by land tenure/ ownership, as a proportion of all total tree canopy cover within the same tenure/ ownership class

Land tenure	Total canopy area (ha) in 2013 (LiDAR data)	Lost canopy area (ha) 2006-2016 (aerial analysis)	Percentage of the total canopy (in 2013) lost from 2006-2016
Private	145.2	39.57	27.3 %
Parkland	122.6	9.64	7.9 %
Road	67.2	6.95	10.3 %
Other public land	33	5.06	15.3 %

On the face of it, these proportional losses seem relatively high. For example, an almost one-third loss of tree canopy cover on private land means that if the loss rate of 2006-2016 was to continue into the future, then tree canopy on private land would be mostly gone by 2035. However, this result is misleading. The data presented in this report **only includes tree losses**. It was evident throughout the aerial analysis that **trees also grow** in terms of the extent of their canopies, in some cases quite dramatically. Given that growth was usually represented by small marginal increments across many tens of thousands of individual trees it was impossible to identify and digitise in the same way that tree loss was. A better understanding of the balance between the gains and losses of tree canopy within Waitematā Local Board will be possible after the 2016/17 LiDAR data is released and compared with the 2013 LiDAR analysis.

3.4 Reasons for clearance

We collected some basic data on the reasons why tree canopy was cleared, and this is summarised in Figure 6. More than half of the clearance had occurred for no obvious reason. That is, no new structures such as new houses and other buildings, pools, house extensions, decks or driveways had replaced the space that was beneath the cleared forest canopy. The motivations for these types of clearance were unclear, but probably included the usual range of reasons given for tree clearance; such as improving light and removing shading, improving views, reducing nuisance litter fall, or to alleviate health and safety concerns with respect to falling trees and branches. Developments, improvements and extensions to existing buildings was, by a very wide margin, the second most important reason for tree canopy clearance. Other causes contributed a relatively small proportion of the total (8 per cent) however one of these causes was attributed to a single project; the Newmarket Park re-development. The urban forest cleared at Newmarket Park has been re-placed by new native plantings that will – as they grow – more than replace the tree canopy that was removed as a result of the re-development.

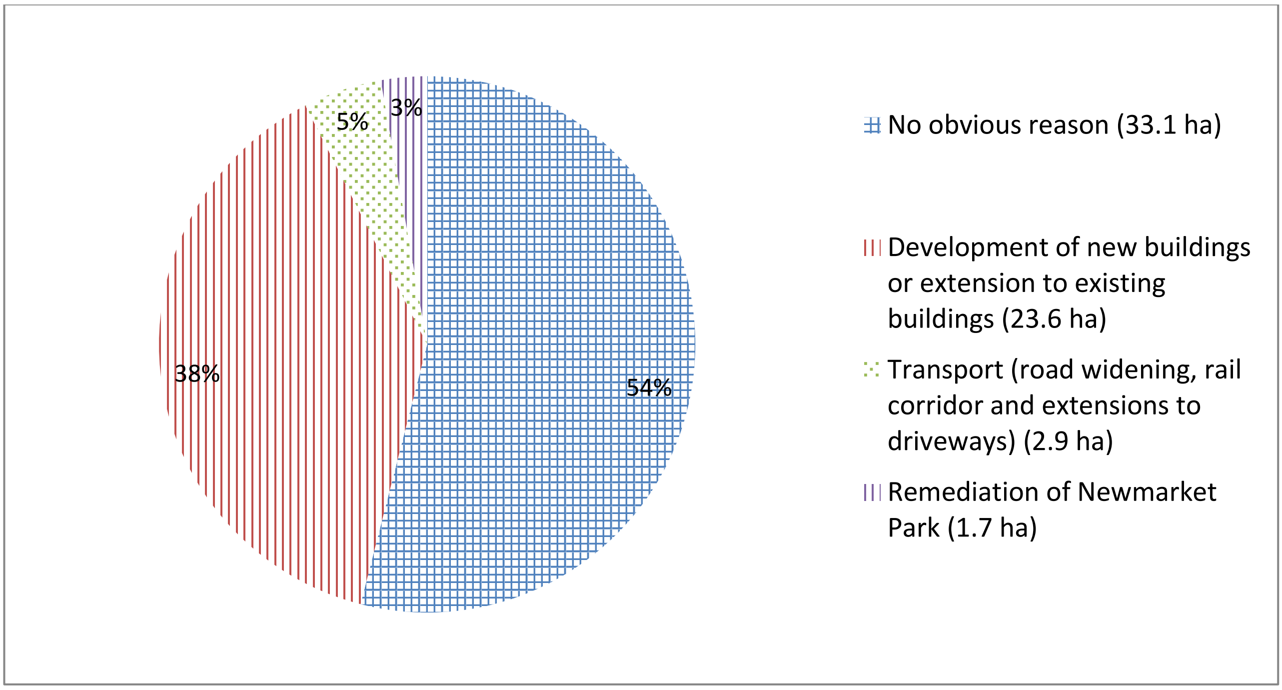

Figure 6: Reason for urban forest clearance

We examined the ‘top 10’ tree clearance events individually to get a good idea of their cause(s). These events are summarised in Table 6. The 10 largest clearance events represented six per cent of the total area of tree canopy loss between 2006 and 2016. Nine of the top 10 clearance events were associated with public infrastructure projects. In addition, more than half of these events were accompanied by some remedial action to replace the trees removed and/ or they involved the removal of weedy tree canopies.

Table 6: ‘Top 10’ individual tree canopy clearance events in Waitematā Local Board, 2006-2016, and the location and potential effect of the tree clearance (see Figure A1 in the Appendix for an example of the large-scale clearance event in Newmarket Park)

Reason for clearance	Tenure	Type of effect	Area (ha)
Park re-development – Newmarket	Park	Removal of planted natives and replacement with new native plantings	0.532
Park re-development – Newmarket	Park	Removal of planted natives and replacement with new native plantings	0.459
Park re-development – Western Springs	Park	Removal of large exotic trees and replacement with new native plantings	0.453
Zoo re-development	Park	Development on edge of large patch of native dominated urban forest (SEA site)	0.354
Park re-development – Newmarket	Park	Removal of planted natives and replacement with new native plantings	0.341
New residential dwelling	Private	Development on edge of large patch of native dominated urban forest (SEA site)	0.295
Park re-development – Western Springs	Park	Removal of large exotic trees	0.282
Zoo re-development	Park	Removal of large exotic trees	0.242
Replanting motorway corridor with natives	Road	Removal of weedy exotic trees and replacement with new native plantings	0.221
Replanting motorway corridor with natives	Road	Removal of weedy exotic trees and replacement with new native plantings	0.212
TOTAL (= 6 per cent of total cleared area)			3.391

3.5 Clearance pattern between suburbs

The absolute and proportional amount of canopy tree loss within individual suburbs[3] of the Waitematā Local Board is presented in Figures 7 and 8 respectively. Figure 9 investigates if clearance is more 'biased' to some suburbs by comparing the proportion of total canopy loss within individual suburbs to the same suburbs proportion of all tree canopy within Waitematā Local Board.

Figure 7 shows there is a wide variation in the absolute amount of tree loss; Grey Lynn lost more than five times the amount of trees that Herne Bay did for instance. However, some suburbs are much larger than others, and therefore contain more tree canopy. Figure 8 shows the proportion of tree canopy lost from 2006-2016, based on the total canopy cover of the same suburb in 2013. Once again the results are highly variable between suburbs.

Mechanics Bay has the highest proportion of tree canopy lost, but the absolute amount of canopy in Mechanics Bay is very small, so this value actually represents a very small loss (just 0.06 ha). In contrast, while a relatively high amount of tree canopy was cleared from Parnell in absolute terms (8.85 ha), clearance is much lower here on a relative basis – due to the large tracts of protected tree canopy on public land. In addition, a lot of the clearance in Parnell was associated with Newmarket Park development and this has mostly been re-planted with new native shrubs.

Figure 9 shows that, in terms of proportional loss of tree canopy the suburbs with the greatest tree loss are Grey Lynn, Ponsonby and Westmere. This result isn't surprising, as most tree canopy in these suburbs is privately owned, and privately owned tree canopy has been disproportionally affected by canopy clearance

In Figure 1 Herne Bay appeared to have experienced less clearance than the other suburbs within Waitematā Local Board. The data in Figure 9 confirms that Herne Bay has lost a proportionally smaller area of forest. While Auckland Central and Parnell also experienced proportionally smaller canopy losses, this is probably due to the high proportion of publically owned tree canopy, including large areas of parkland, in these two suburbs. In contrast, tree canopy in Herne Bay is largely on privately owned land.

[3] Our analysis includes all suburbs that are entirely, or almost entirely, within Waitematā Local Board and excludes suburbs which are shared with contiguous local boards.

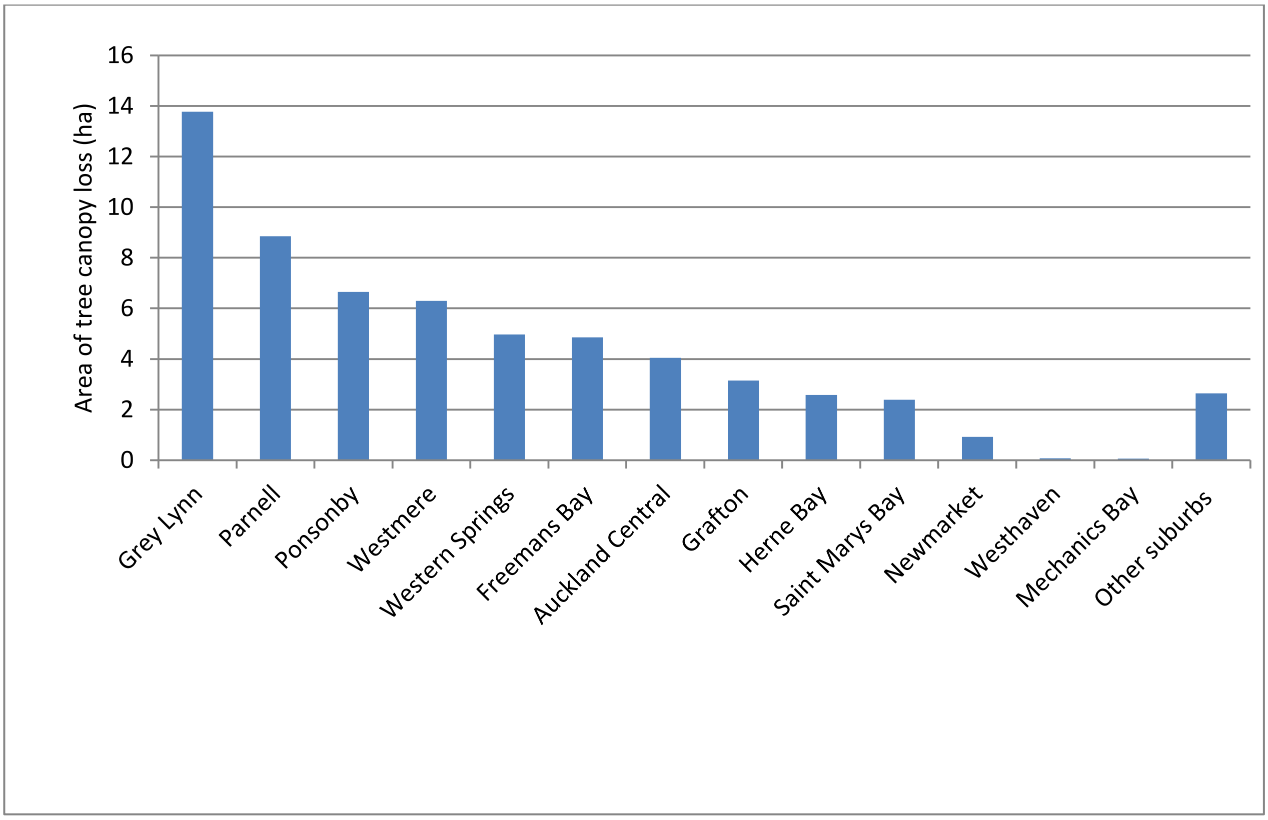

Figure 7: Area (ha) of urban forest canopy cleared, by suburb, in Waitematā Local Board 2006-2016

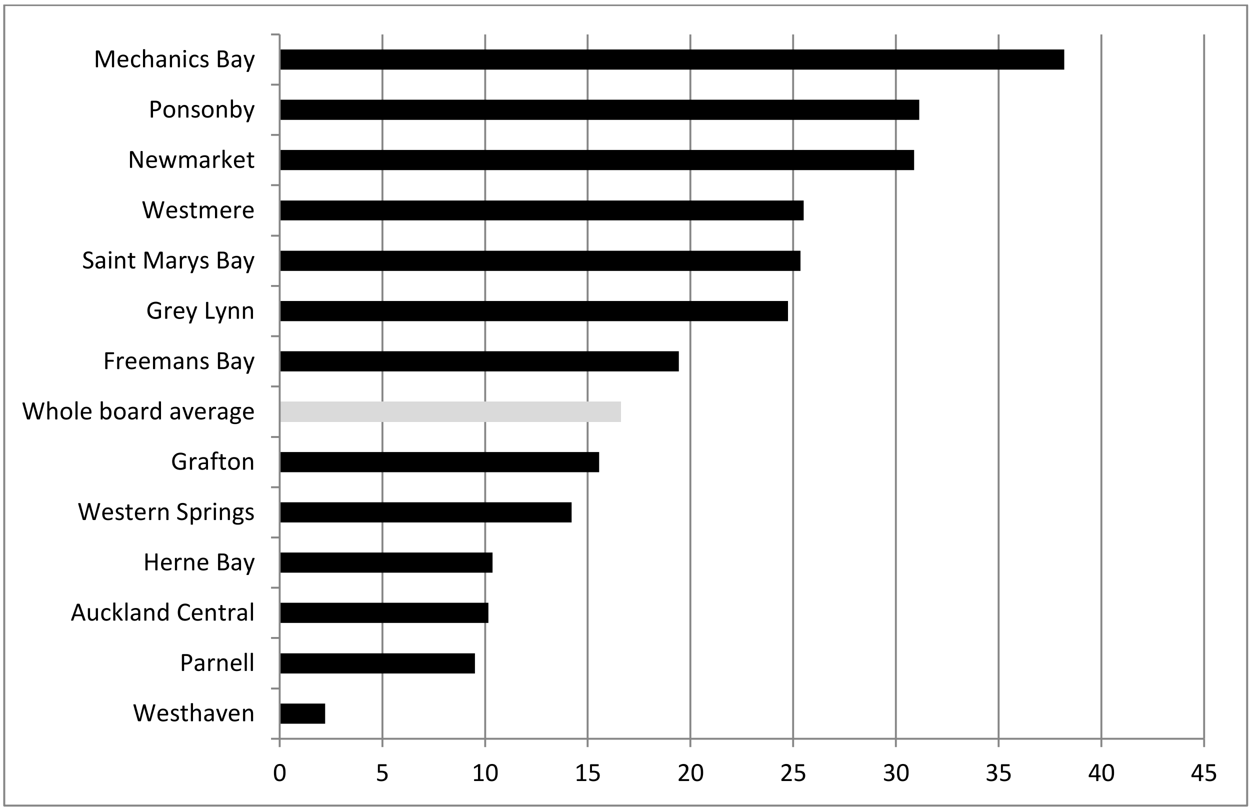

Figure 8: Percentage of total urban forest canopy cleared from 2006-2016, by suburb

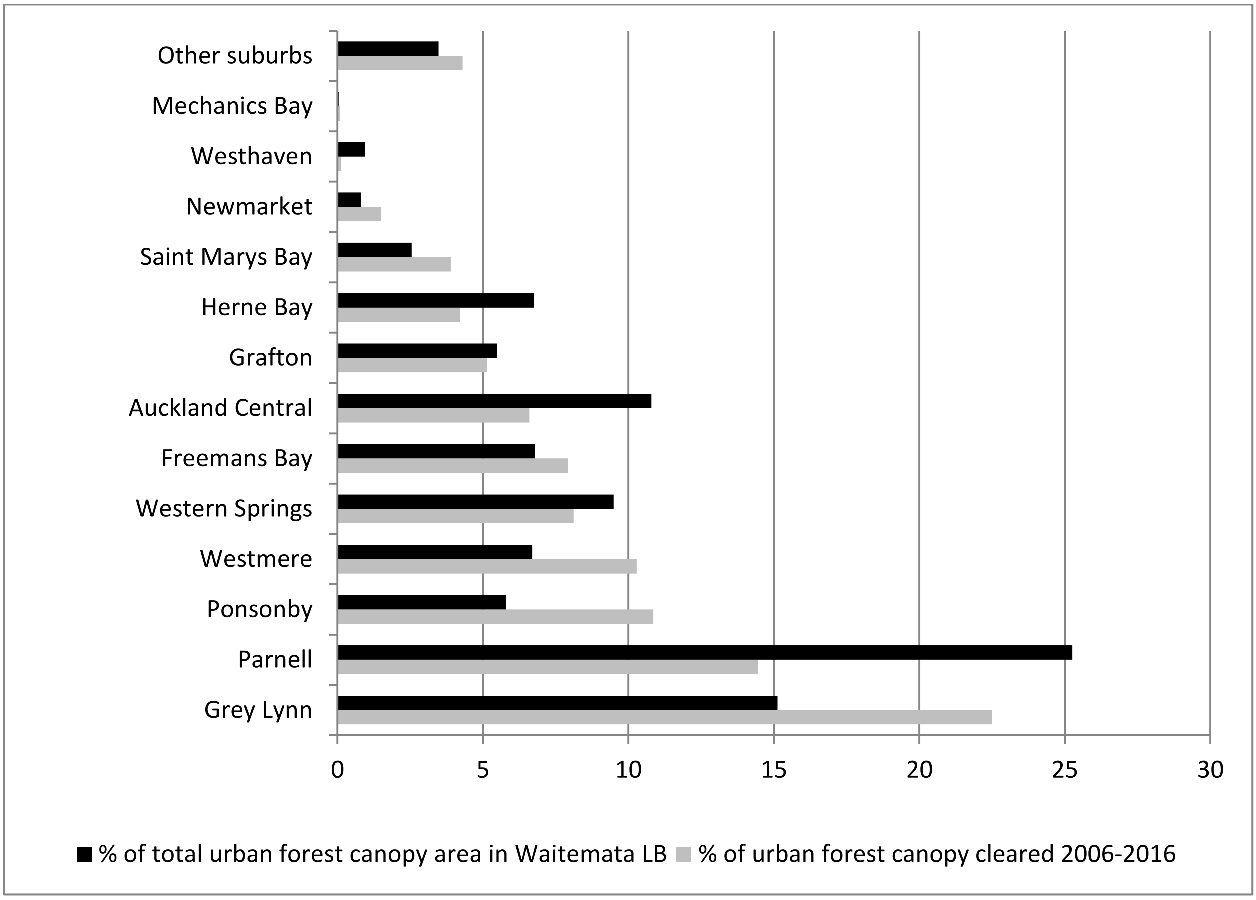

Figure 9: The proportion (per cent) of tree canopy loss (2006-2016) in suburbs within Waitematā Local Board, compared with their percentage contribution to total canopy cover (in 2013)

3.6 Protection status of trees

Figure 10 shows data on the statutory protection status of cleared trees. Protection status was grouped into five categories, which are outlined in the methods section of this report. Figure 10 shows that tree loss has been greatest for trees that had no protection; more than 75 per cent of all cleared trees had no statutory protection. However, as almost half of the tree canopy within Waitematā Local Board is not protected (Bishop and Lawrence 2017), if tree canopy clearance was evenly distributed across all protection categories we would expect around half of the cleared trees to be un-protected in any case.

Figure 11 examines whether unprotected trees have been disproportionally affected by tree clearance, compared to protected ones. The figure shows that unprotected trees have experienced higher rates of tree canopy clearance; about 60 per cent higher than what would be expected on a proportional basis. This disproportionate loss is matched by disproportionate protection of the existing tree canopy across the four other protection classes (Figure 11). Interestingly, there is little evidence in our data of increasing rates of tree canopy protection with increasing protection status. All four protection classes had clearance rates that were 50-60 per cent lower than expected, based on their proportion of the total tree canopy, irrespective of how strong that protection was.

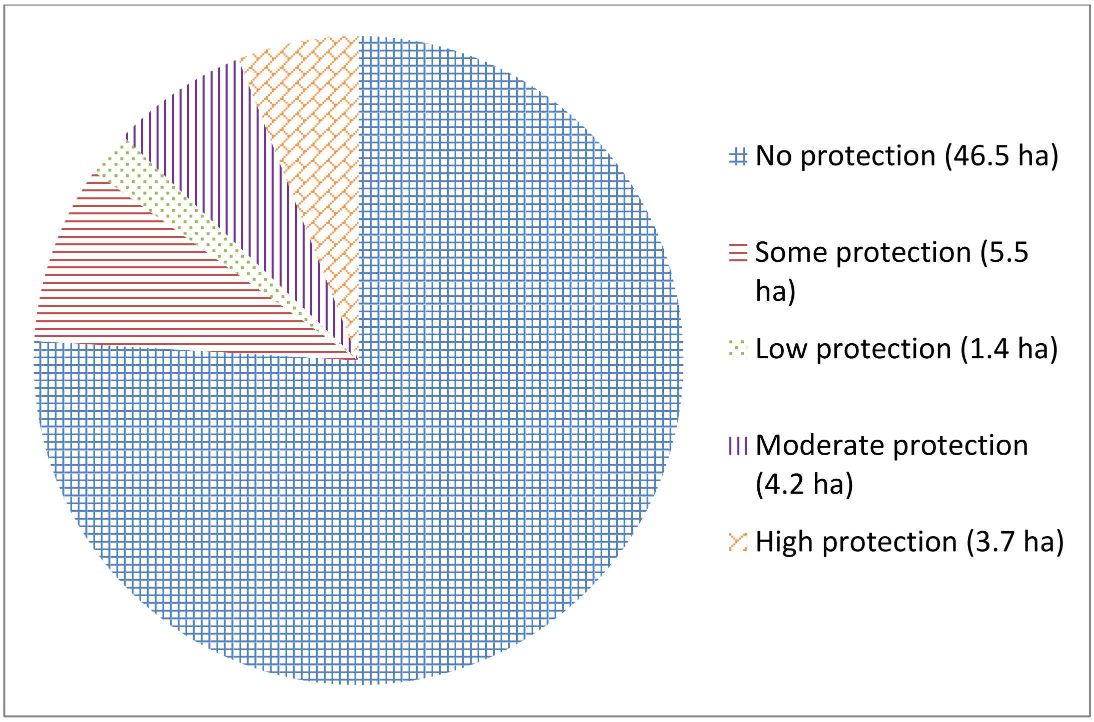

Figure 10: Canopy area of cleared trees (ha) 2006-2016 in Waitematā Local Board by protection status of tree canopy

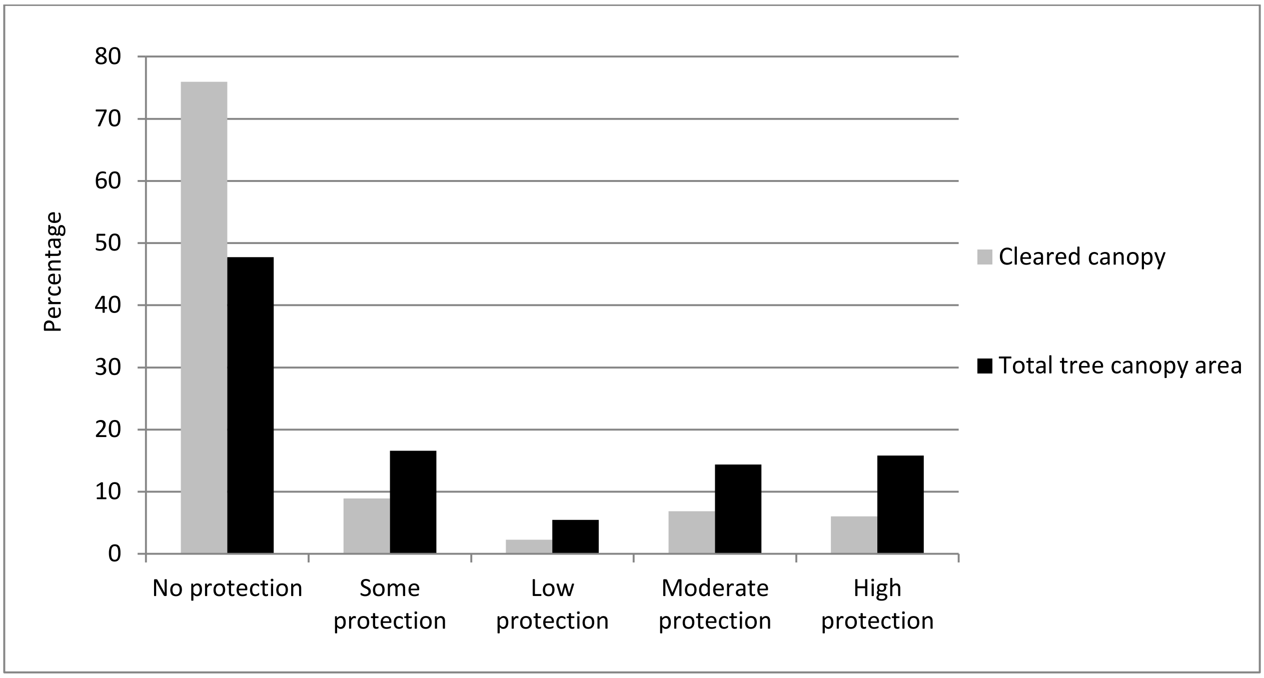

Figure 11: Proportion (per cent) of tree canopy clearance (2006-2016) in different protection classes

3.7 Case study: clearance of highly protected trees

Tree clearance in the high protection category was examined more closely. The high protection zone is supposed to include the best examples of urban forest in the Waitematā Local Board, and this zone often included remnants of urban forest that were dominated by native plants and therefore had high indigenous biodiversity values as well. The 3.7ha of cleared tree canopy in the high protection zone was made up of 122 different clearance ‘events’, most of which were quite small (Figure 12). Approximately 86 per cent of the high protection clearance was on public land (mostly public open space) and 14 per cent on private land. The 3.7ha of cleared canopy represented 6.4 per cent of the total area of highly protected tree canopy within Waitematā Local Board (based on 2013 LiDAR data presented in Bishop & Lawrence 2017). However, the re-planting of 1.85ha of indigenous forest in Newmarket Park will eventually recover 50 per cent of this loss of highly protected tree canopy.

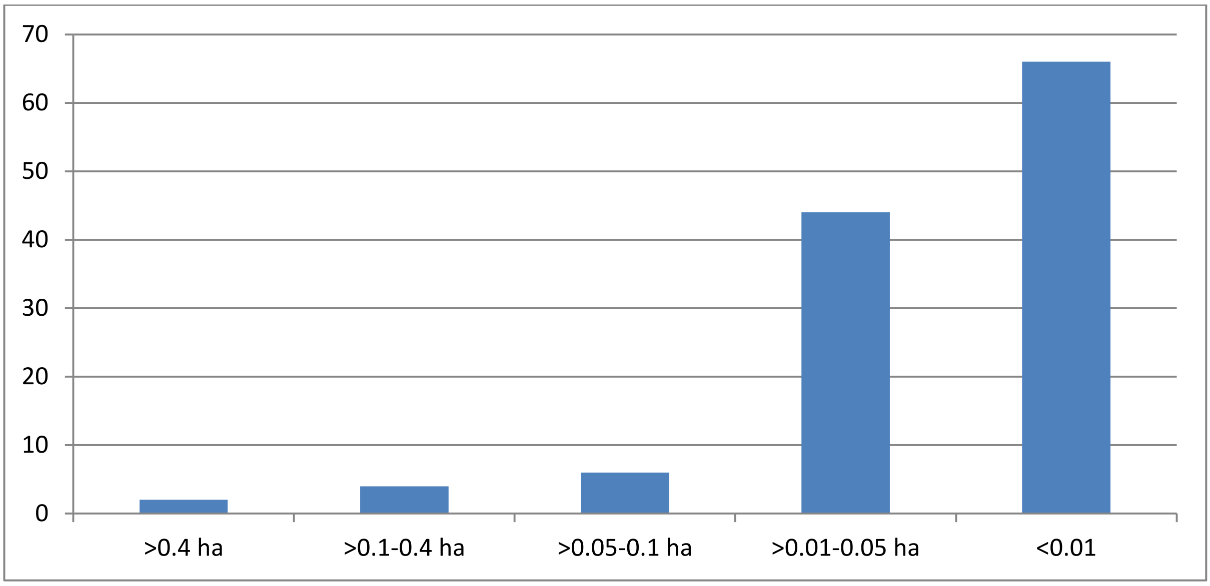

Figure 12: Number and size of tree clearance 'events' of urban forest with high protection status 2006-2016 (n = 122)

The 15 largest clearances in all land tenures, and all clearances >0.05 ha, were individually examined to determine the reasons for clearance and possible effects of the clearance on the high protection site values. These results are summarised in Tables 7 and 8. Most clearance of high protection status forest was caused by the maintenance or creation of public assets on council owned and managed parkland.

Table 7: Reasons for clearing tree canopy with high protection status in Waitematā Local Board. Includes data for the largest clearance events only, which encompass 84 per cent of the total cleared area with high protection status

Reason	Private land Area (ha)	Public land Area (ha)	Per cent of total
Newmarket Park Stabilisation	0	1.660	45
Private clearance for new structures etc.	0.450	0.095	15
Zoo re-development	0	0.530	14
Park maintenance	0	0.256	7
Western Springs re-development	0	0.106	3
Reason for clearance not checked – this figure includes 70 different clearance 'patches' with an average size of 0.009ha (median 0.006 ha)	0.062	0.534	16
Total	0.512	3.181	100
Grand Total	3.693		100

Table 8: Potential ecological effects/ impact of clearing tree canopy with high protection status in Waitematā Local Board. Includes data for the largest clearance events only which encompass 84 per cent of the total cleared area with high protection status

Type of effect	Area (ha)	Per cent of total
Removal of section of SEA (Significant Ecological Area) tree canopy	1.757	48
Development on the edge of SEA. Often involving the removal of a tree to 'straighten the edge' of the SEA. Mostly exotic trees removed	0.923	25
Negligible effect on SEA as the tree canopy cleared was isolated from the main SEA forest remnant and provided limited buffering	0.311	8
Coastal edge removal	0.106	3
Reason for clearance and effect of clearance not checked	0.596	16
Grand Total	3.693	100

3.8 General discussion

The rate of tree canopy loss within Waitematā Local Board was 6.12ha / year over the 10-year period of the study. Based on the total tree canopy cover calculated using 2013 LiDAR data – the 61.2ha of canopy clearance is almost 17 per cent of the total area of tree canopy (in 2013). This is almost half the 30 per cent 'tree canopy loss' figure quoted elsewhere (e.g. North and South 2018). However, as outlined in the results section above, the actual proportion of canopy loss within Waitematā Local Board is probably significantly lower than 17 per cent. This is because there has been growth in the ground coverage of many tree crowns that were not cut down in the 2006-2016 period. While this expansion in the coverage of tree crowns was clearly apparent in the aerial photos, it was not practical to measure this expansion in canopy cover as it would have involved very intricate, time-consuming and costly digitisation of hundreds of thousands of individual trees. An accurate determination of the actual proportion of canopy loss in Waitematā Local Board therefore requires further data, either from fine scale measurements of a sub-set of aerial photographs and/ or a comparison of 2013 LiDAR and 2016/17 LiDAR (when available).

We found no evidence for an increased rate of canopy loss across the 10-year time period covered by the aerial photographs. It is possible that canopy clearance rates have increased dramatically only in the last 2.5 year period (approx.) which is not covered by aerial photographs (i.e. since 2015/16 summer). Again, a 2013 vs. 2016/17 LiDAR data comparison is probably the best tool to investigate the balance between tree canopy growth and clearance in recent times.

In terms of the pattern of tree canopy loss, it really is 'death by a thousand cuts'. More than 90 per cent of clearance events were <0.01ha in size, yet these clearances accounted for almost two thirds of the total area of canopy loss.

Council is a significant player when it comes to the removal of tree canopy in the 'high protection' categories; it was responsible for 86 per cent of the canopy loss of highly protected tree canopy over the past 10 years within Waitematā Local Board. While the absolute amount of clearance is low (3.7ha or 6.4 per cent of total canopy clearance) sustained cumulative loss of this magnitude over a longer period would have a significant effects on the buffering and function of forest within Significant Ecological Areas. However, we note that more than half of the loss on public land was due to the Newmarket Park re-development, and this site has been replanted with native vegetation and managed to return native insects, reptiles and birds. However, it is likely to take at least 25-30 years of growth before the vegetation at this site replaces what was removed in terms of its habitat value and ecological functioning.

Not all tree loss is necessarily bad in terms of overall public or community benefits. Nine of the top 10 clearance events were associated with public infrastructure projects, which presumably had other important social, environmental and/ or economic benefits to offset the loss of tree canopy. Many of the tree canopy clearances on public land, particularly the larger ones, are accompanied by some remedial action to replace the trees removed or they involved the removal of weedy tree canopies.

There was considerable variation in the relative proportions of canopy loss across all the categories we examined; by suburb, by land tenure and by protection class. This suggests that if urban forest protection and management initiatives are to be effective, they will need to be aware of the specific needs and drivers of tree canopy loss in the location being protected or managed. Working with communities (e.g. mana whenua and local boards) to identify pressures and understand the reasons for tree canopy clearance is a key component of the Auckland urban forest strategy (Auckland Council 2018).

Unprotected trees experienced higher rates of tree canopy clearance although, interestingly, there was little evidence for decreasing rates of canopy loss with increasing protection status. All types of tree protection mechanism (e.g. notable trees vs. ecological areas vs. riparian yard vs. street trees etc.) reduced tree clearance by approximately equal amounts, irrespective of how strong that protection was.

Tenure loss data showed a lower than average tree loss on parkland and greater than average loss on private land. This is the loss pattern that we expected, given knowledge of the different ‘drivers’ of tree loss within the different land tenures. That is, there is much more of a focus on protecting and retaining trees on public parkland, whereas the increasing intensification of private land for housing and other uses has meant that tree loss is disproportionally occurring in these areas.

Herne Bay has experienced significantly less tree canopy loss than other suburbs within Waitematā Local Board over the 10-year period examined in this report. The reason for this is not clear. One possibility is differences in relative section size and sub-division potential of Herne Bay compared to other locations. This warrants further investigation; if there is a reason why private landowners are not felling trees in Herne Bay then lessons from this could be applied to tree canopy protection across the Auckland metro area.

While the method used in this report is time-consuming, and therefore relatively expensive, it does provide accurate data on the rate and pattern of tree canopy loss. It also provides useful information on how clearance rates might have changed over the time period covered by the aerial photographs.

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5.0 Appendix

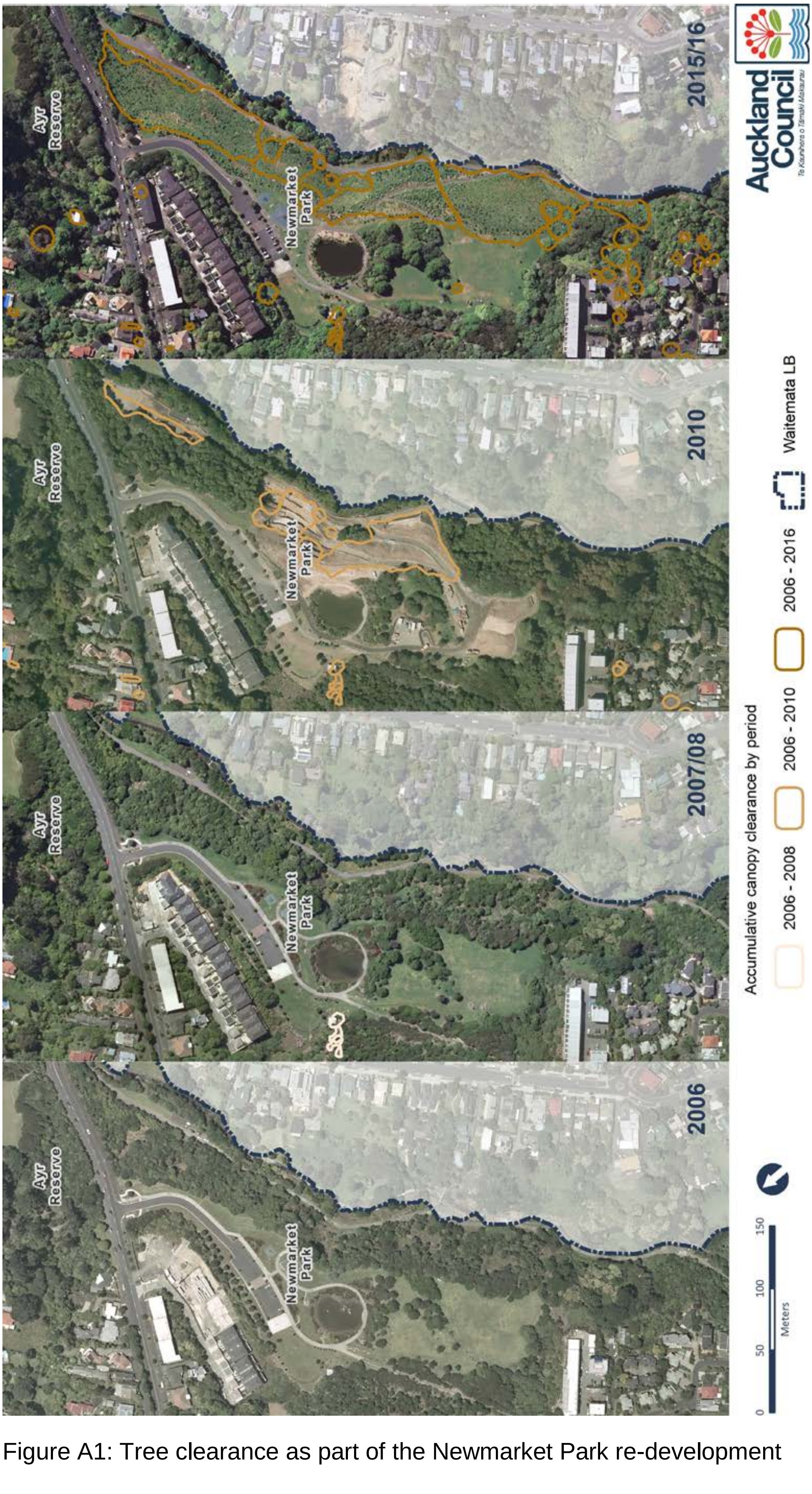

Figure A1: Tree clearance as part of the Newmarket Park re-development

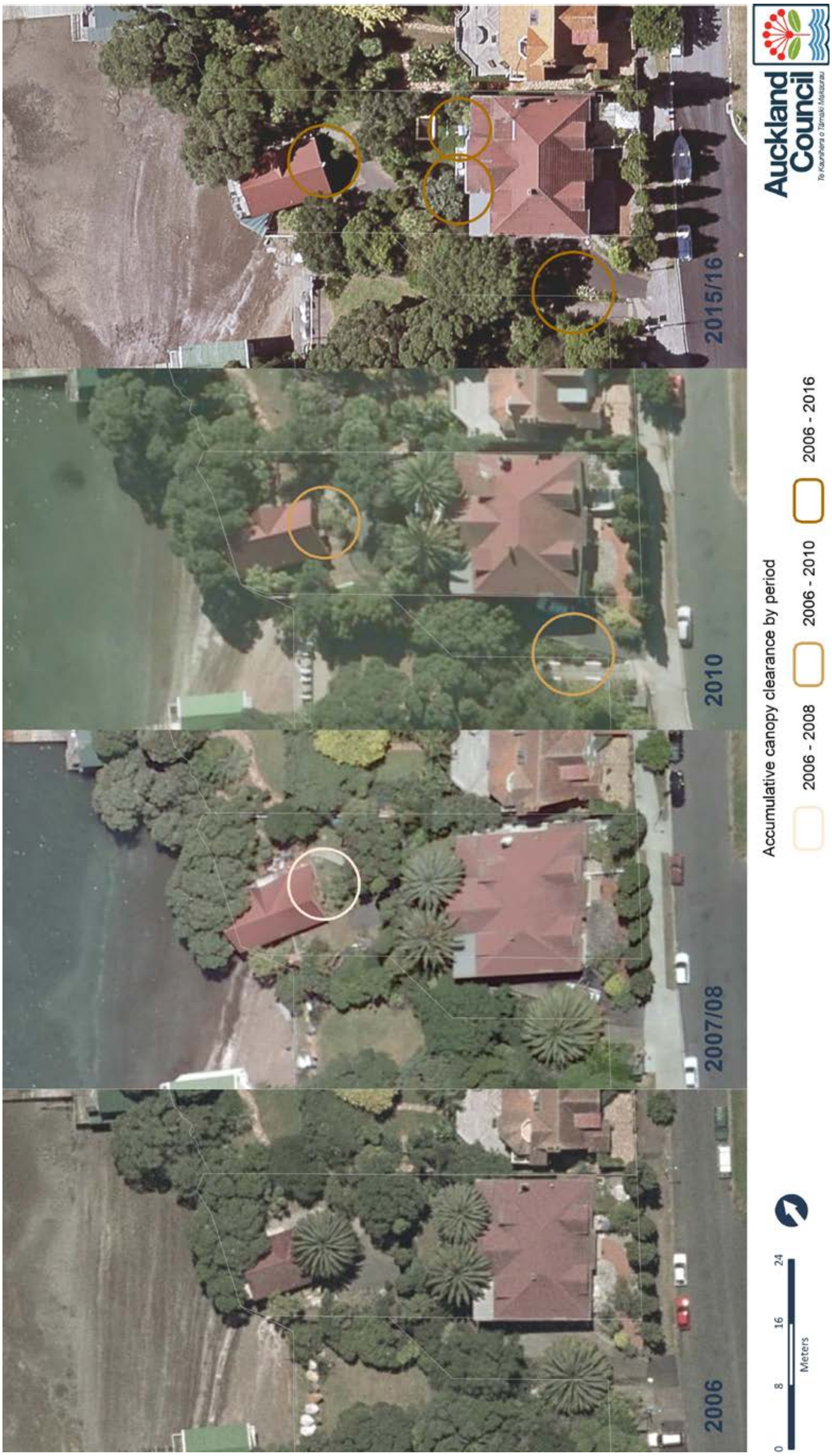

Figure A2: Tree clearance on private land within the coastal zone

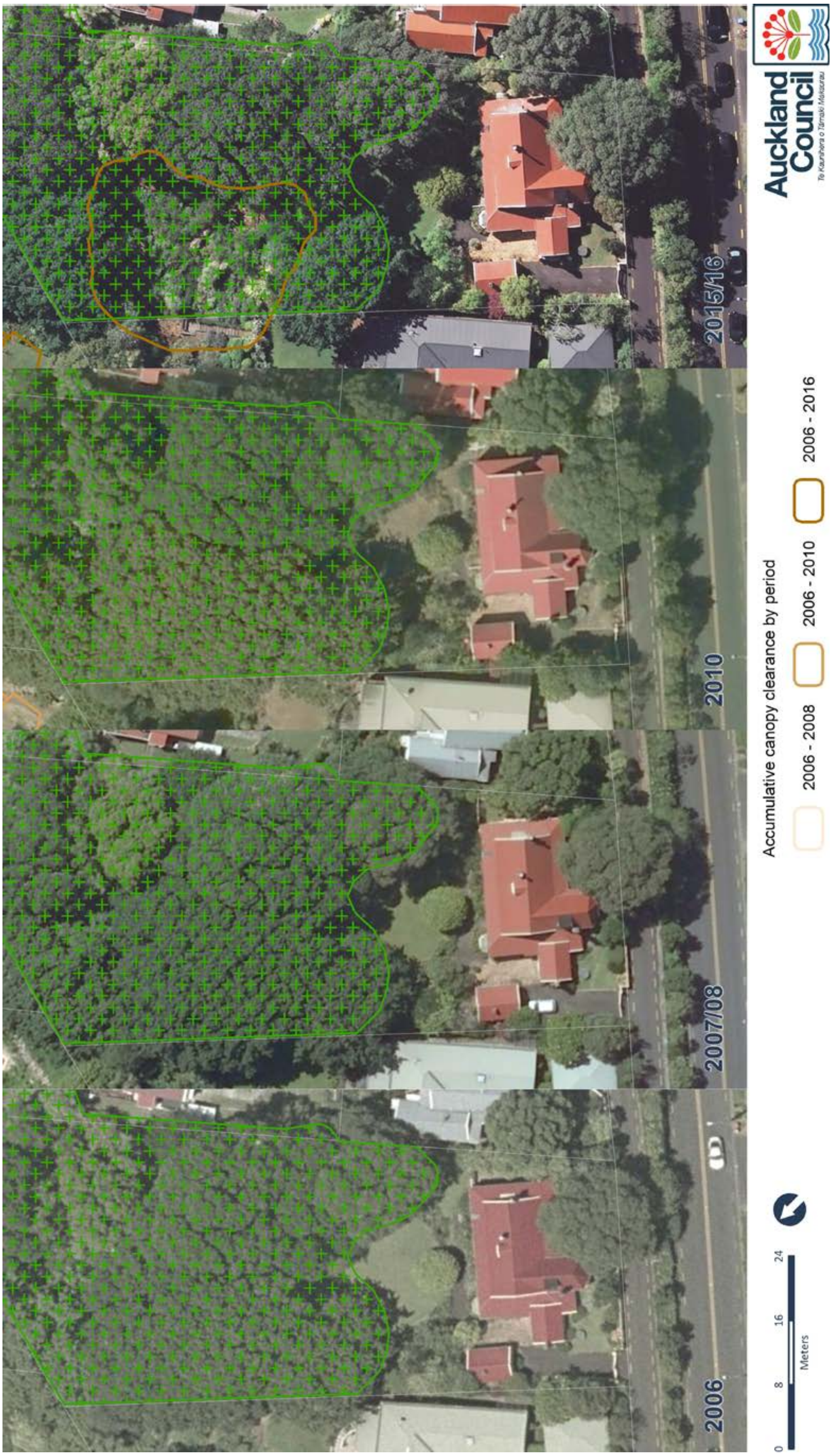

Figure A3: Tree clearance on private land buffering a Significant Ecological Area (SEA)

Figure A4: Clearance of parks trees for maintenance or health and safety

Figure A5: Tree clearance on private land to accommodate new dwelling

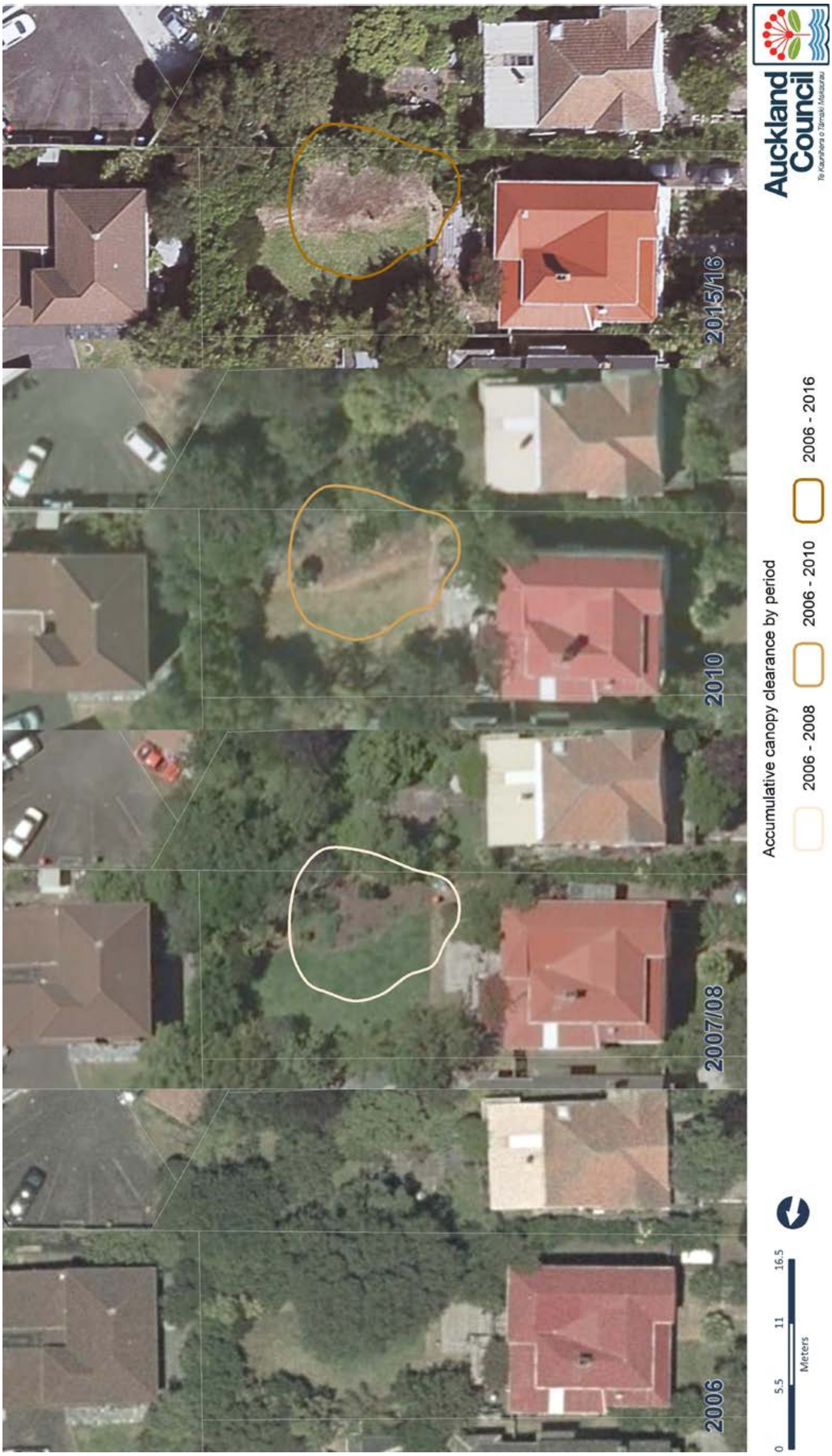

Figure A6: Tree clearance on private land for unknown reason

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