

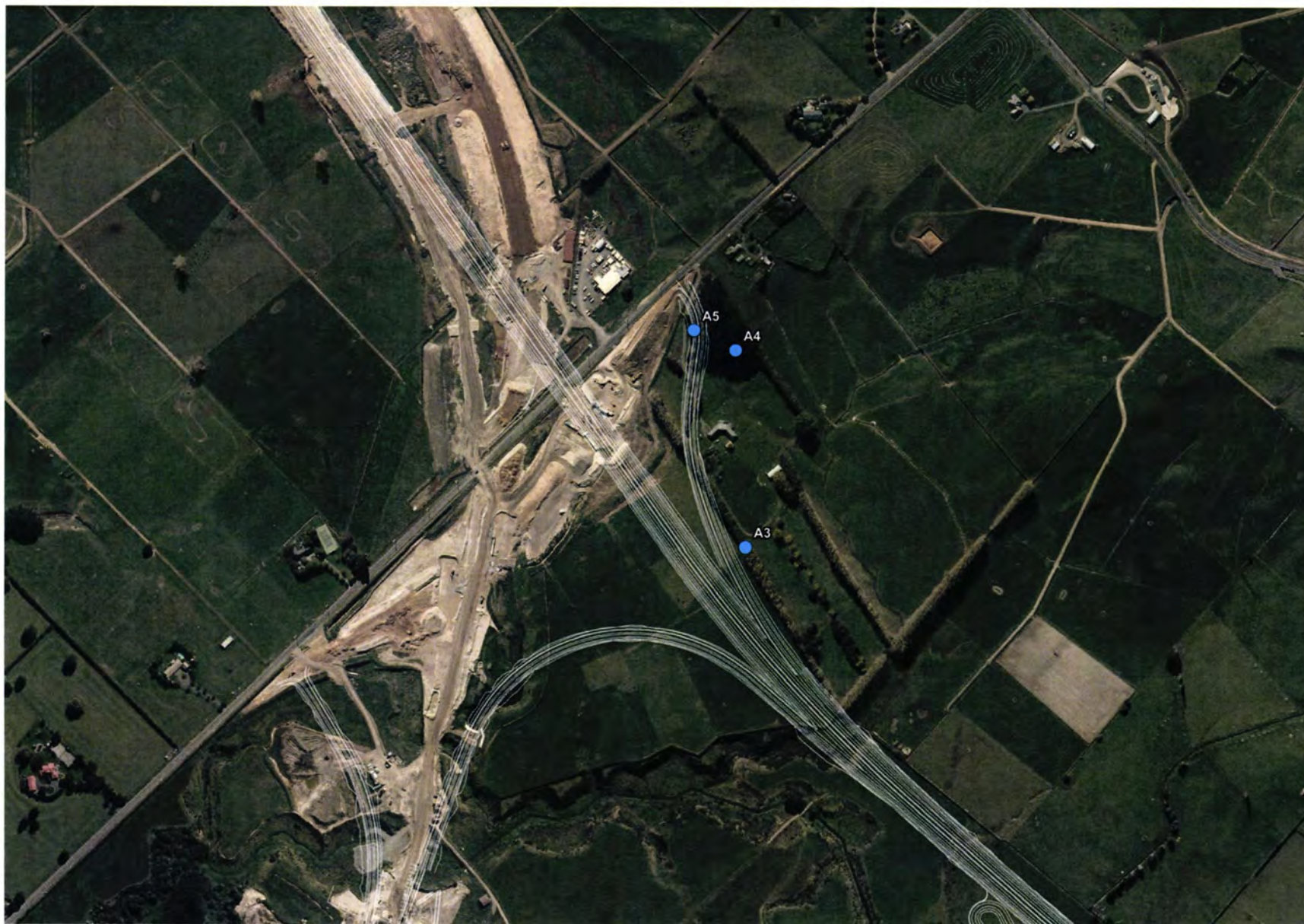
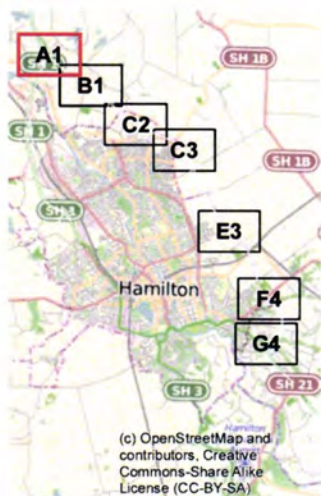
Appendix A - ABM site locations and activity levels.

Legend

Mean bat passes per night

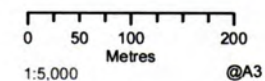
- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

A1



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15



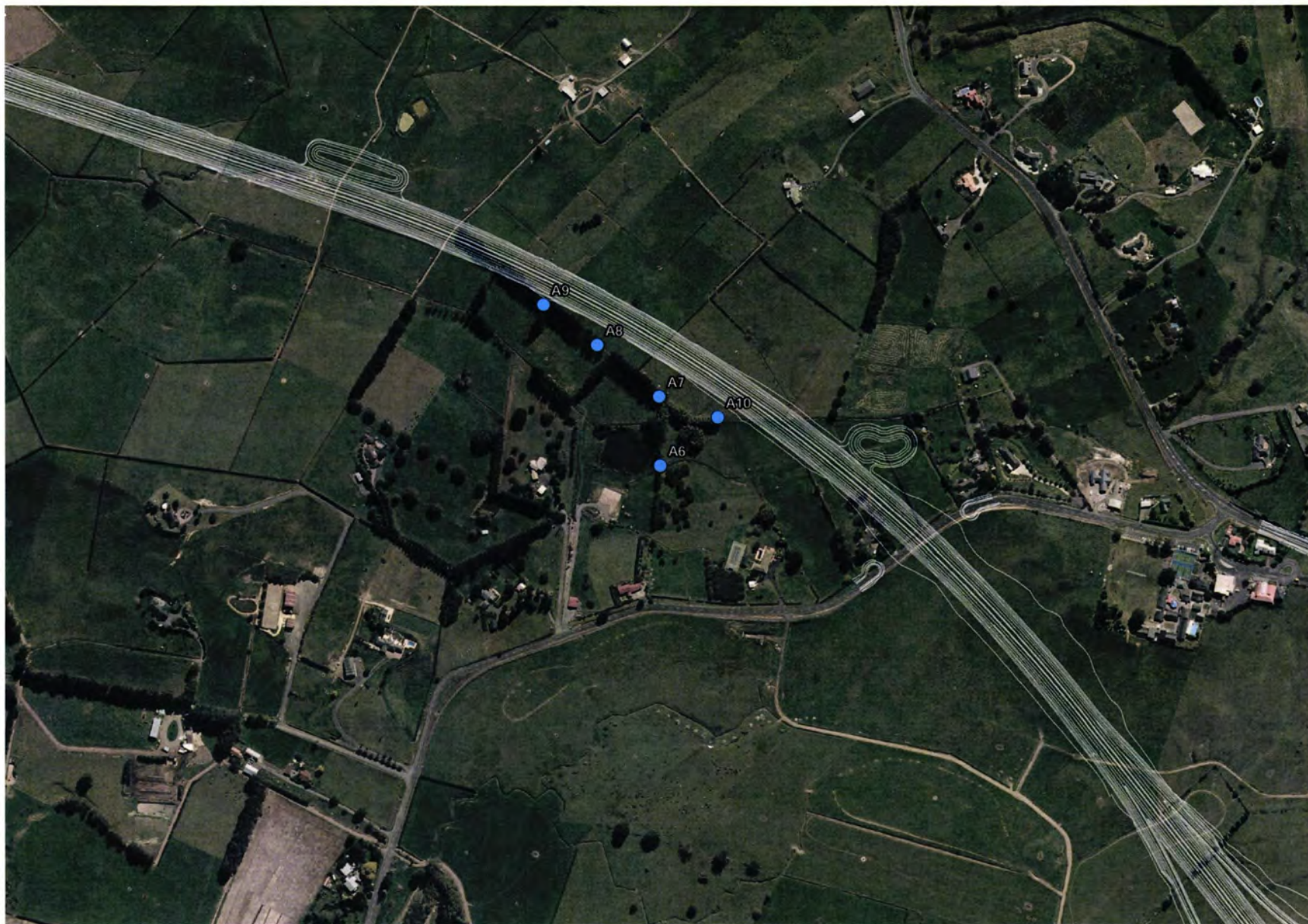
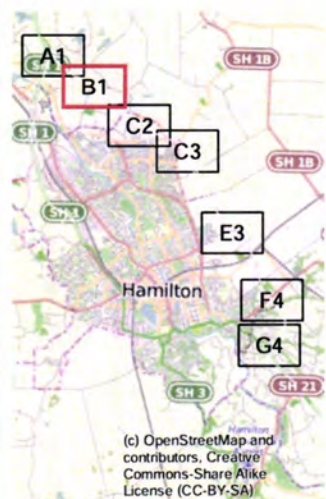
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| Date: 23/06/2015 | Revision: 0 |

Legend

Mean bat passes per night

- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

B1



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15

0 50 100 200
Metres
1:5,000 @A3



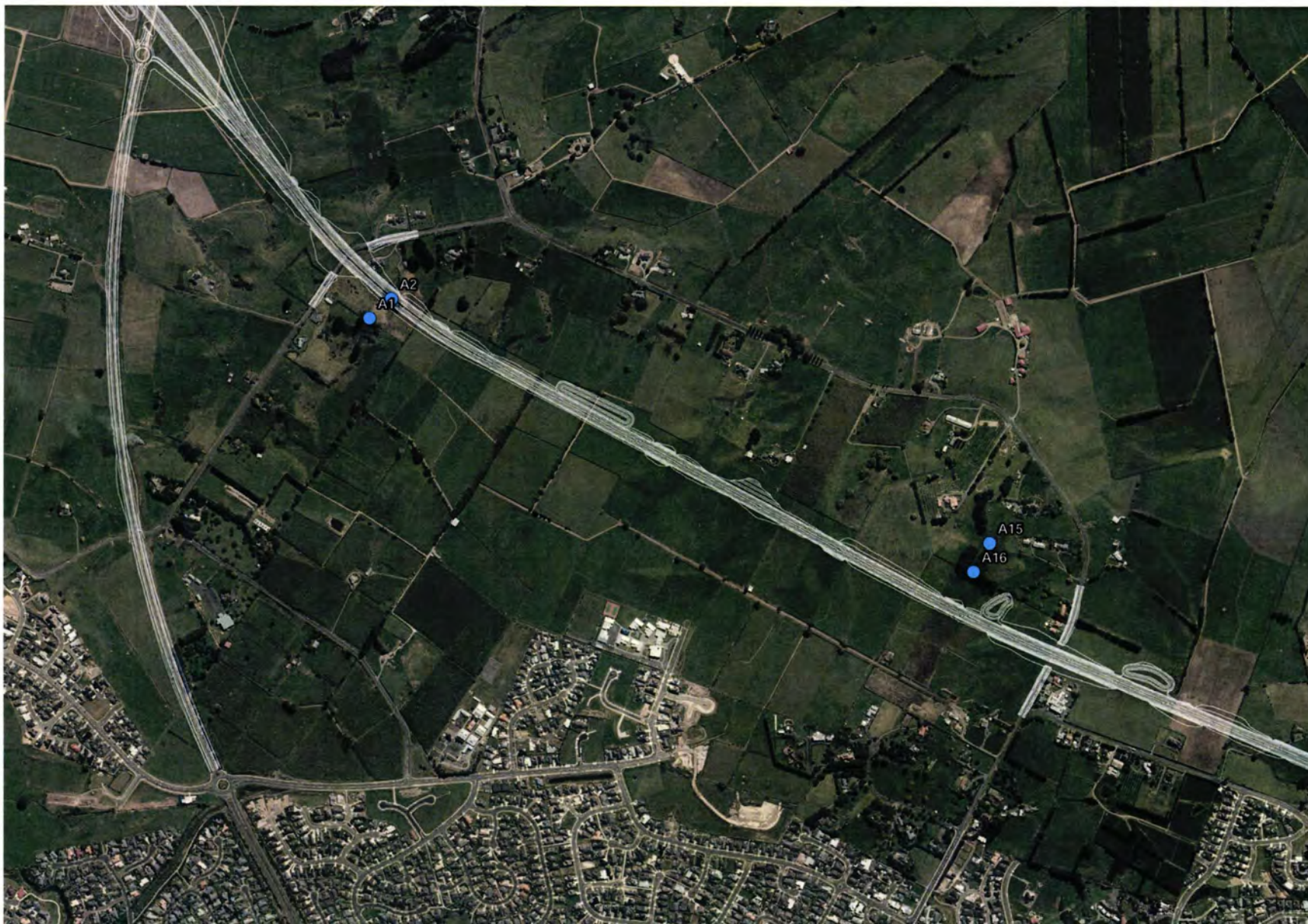
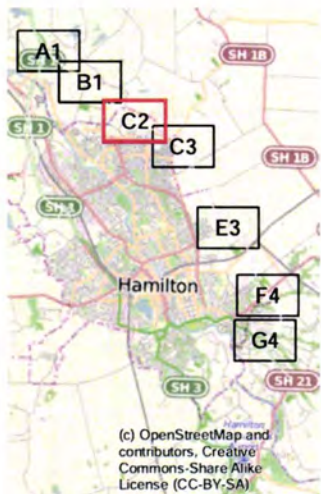
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NZGD 2000 New Zealand Transverse Mercator
| Date: 23/06/2015 | Revision: 0 |

Legend

Mean bat passes per night

- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

C2



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15

0 100 200 400
Metres
1:10,000 @A3



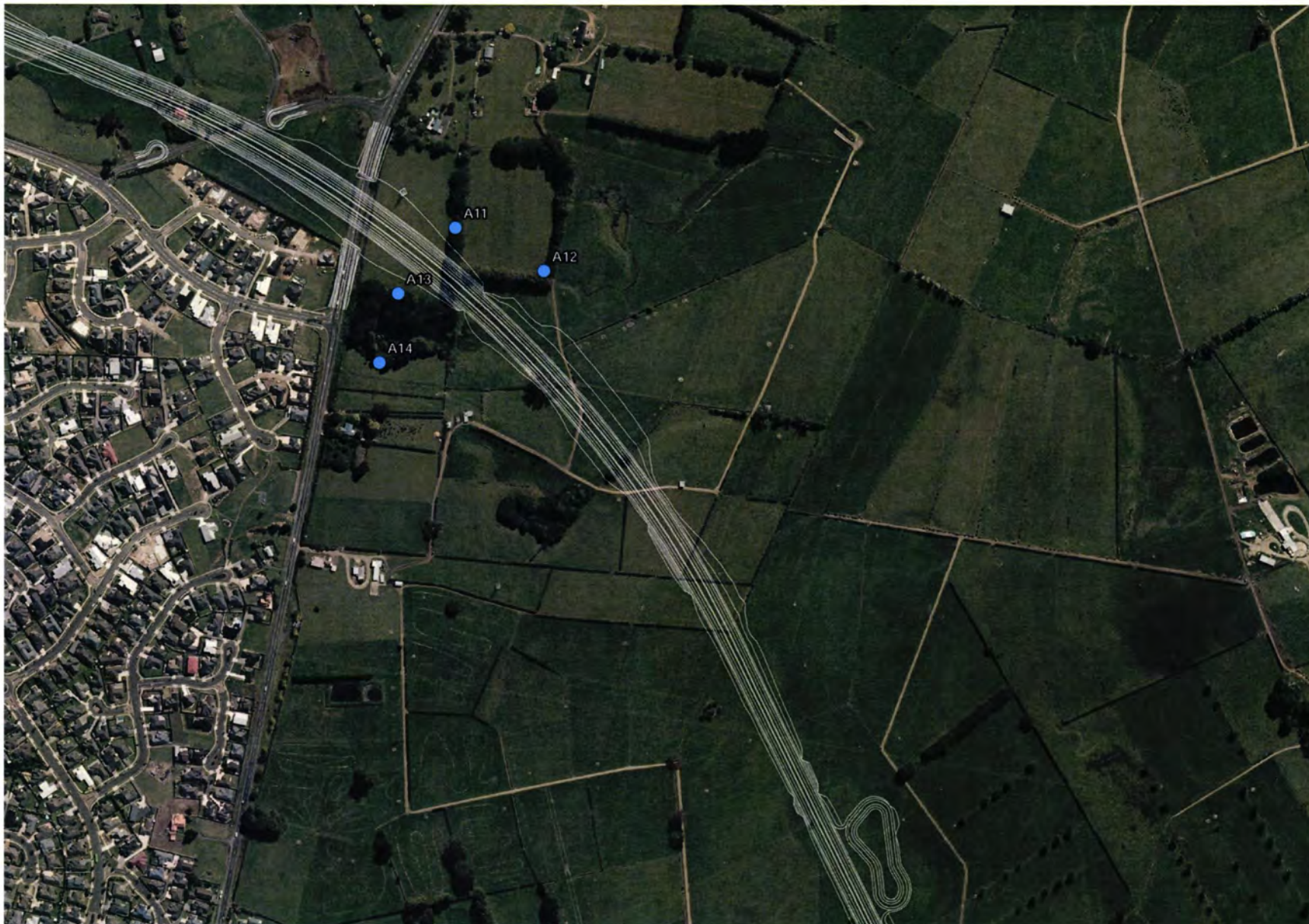
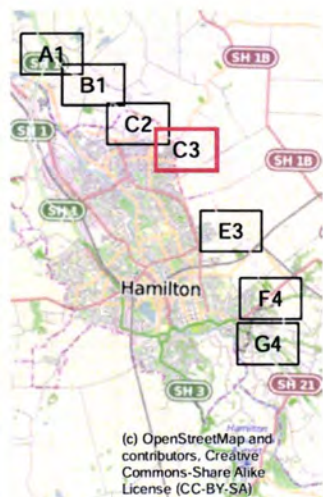
Projection:
NZGD 2000 New Zealand Transverse Mercator
[Date: 23/06/2015 | Revision: 0]

Legend

Mean bat passes per night

- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

C3



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15

0 50 100 200
Metres
1:5,000 @A3



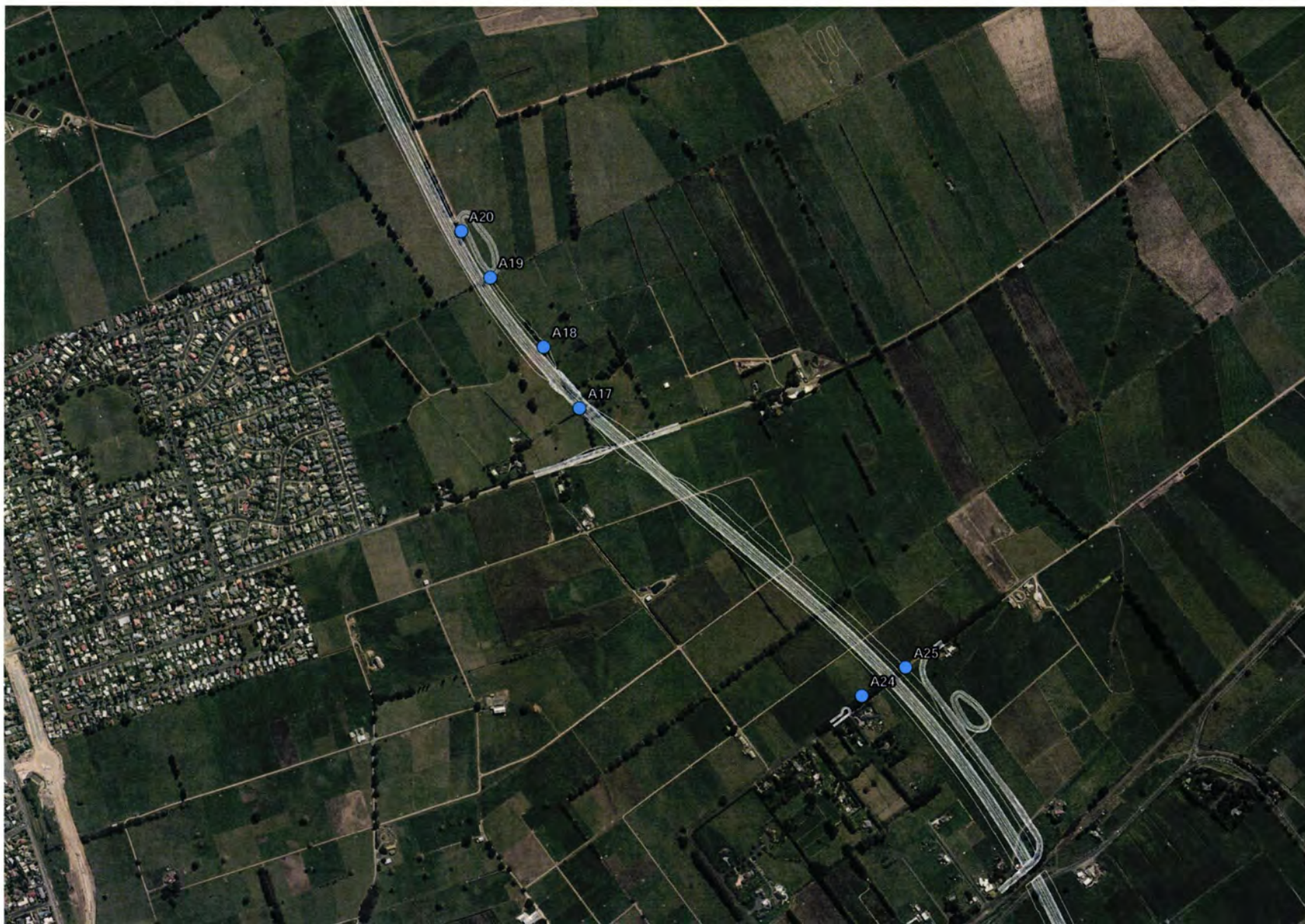
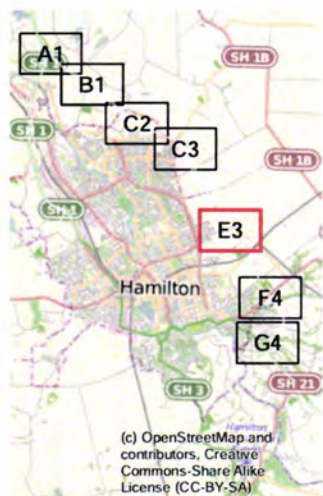
Projection:
NZGD 2000 New Zealand Transverse Mercator
| Date: 23/06/2015 | Revision: 0 |

Legend

Mean bat passes per night

- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

E3



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15

0 100 200 400
Metres
1:10,000 @A3



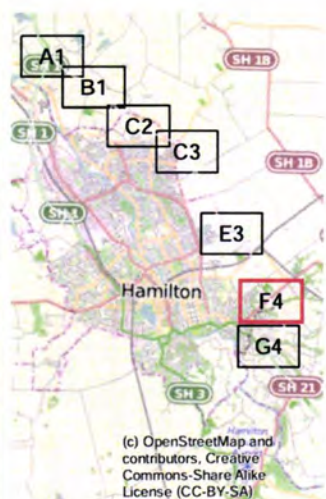
Projection:
NZGD 2000 New Zealand Transverse Mercator
| Date: 23/06/2015 | Revision: 0 |

Legend

Mean bat passes per night

- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

F4



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15

0 50 100 200
Metres
1:5,000 @A3



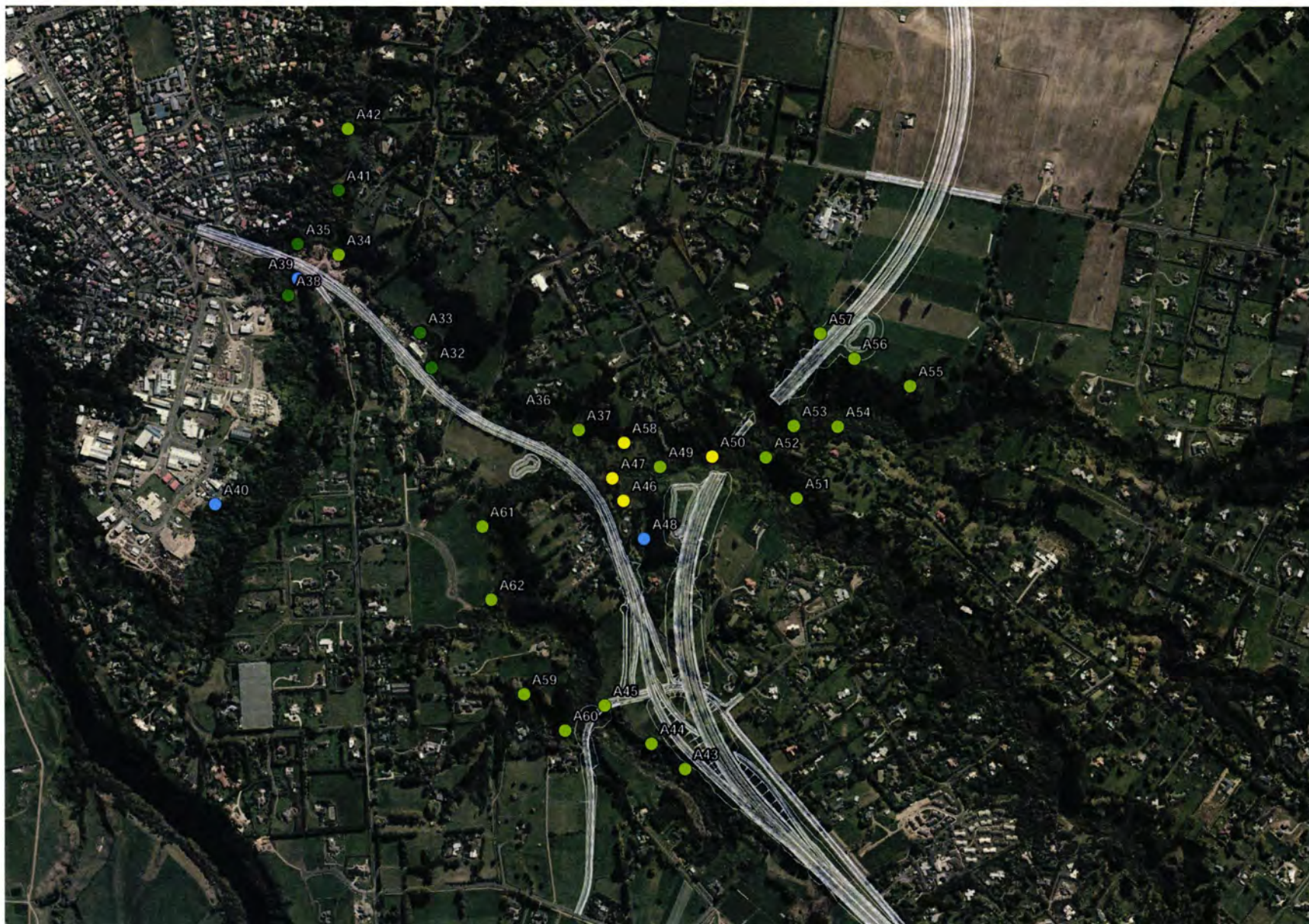
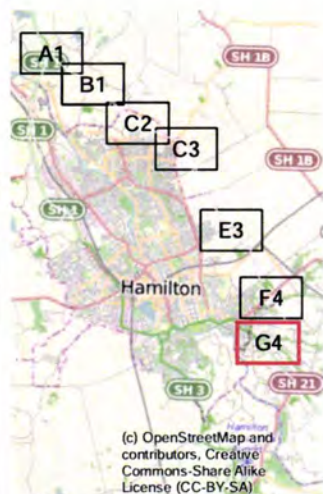
Projection:
NZGD 2000 New Zealand Transverse Mercator
| Date: 23/06/2015 | Revision: 0 |

Legend

Mean bat passes per night

- 51+
- 41-50
- 21-30
- 1-10
- <1
- Fault
- No bat activity

G4



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Long-tailed bat distribution & relative activity - Survey 1, 2014/15

0 100 200 400
Metres
1:10,000 @A3



Projection:
NZGD 2000 New Zealand Transverse Mercator
[Date: 23/06/2015 | Revision: 0]



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Appendix C – 2014/15 Baseline Survey 2 Report



NZ Transport Agency

Hamilton Section Long-tailed Bat Survey 2015

Survey 2: Long-tailed Bat Distribution



NZ Transport Agency

Hamilton Section

Long-tailed Bat

Survey 2015

Survey 2: Long-tailed Bat Distribution

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Date: May 17th 2016
Reference: 2-31695.00
Status: Final

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1 Introduction

The New Zealand Transport Agency (Transport Agency) has obtained resource consent to undertake construction of the Hamilton Section of the Waikato Expressway. As part of the resource consent approval process, the Waikato Regional Council (WRC) has specified consent conditions that must be met prior to, during and following the construction of the road, with regard to possible impacts on long-tailed bats (*Chalinolobus tuberculatus*).

Long-tailed bats are known to inhabit Hamilton's southern peri-urban fringe, with activity concentrated in the Waikato River corridor south of the Cobham Drive bridge, and within the Mangaonua, Mangaone and Mangaharakeke gullies. Research conducted between 2004-2007 by Dekrout (2009) found a significant preference for these river and gully habitats by long-tailed bats, and highlighted the importance of maintaining the connectivity of these systems in order to maintain the urban bat population in Hamilton.

A survey carried out in 2011 out as part of the Hamilton Section Assessment of Ecological Effects (AEE) (Le Roux, 2011) confirmed the continued presence of long-tailed bats in the Mangaonua, Mangaone and Mangaharakeke Gully systems. Bat presence has also previously been confirmed within the East-West Link gully (Mueller et al., 2013). Resource consent conditions were subsequently written with the intention of minimising effects of the Hamilton Section on the local bat population, and mitigating the effects of construction and operation of the road.

WRC Consent AUTH130361.01.01 includes conditions 48 (f) (vi) and (vii), requiring:

48 (f) (vi). *Details of a monitoring programme to identify and assess changes in bat activity and behavioural patterns that may occur as a result of construction and operation of the Hamilton Section of the Waikato Expressway at all locations where bats are detected during comprehensive pre-construction baseline distribution surveys required by condition 48(f)(vii). The monitoring programme should be sufficiently robust to inform the mitigation design and subsequent assessment of the effectiveness of mitigation.*

48 (f) (vii). *Pre-construction baseline distribution surveys shall include surveys using appropriate techniques to assess bat distribution and behaviour within areas of potential bat habitat along the entire Hamilton Section of the Waikato Expressway alignment. A minimum of two surveys shall be undertaken during the months of November to April inclusive for a minimum of two monitoring seasons, immediately prior to construction commencing. Monitoring for the surveys should take place on nights when the temperature remains above 10 degrees for the first two hours after sunset and little precipitation occurs. Temperature and precipitation must be recorded.*

This report describes results from the second of two distribution surveys conducted in the summer 2015 monitoring season, carried out to partially fulfil condition 48 (f) (vii).

2 Objectives

Two baseline surveys were carried out in the 2014/15 monitoring season. The objectives of the 2014/15 bat surveys were to:

1. Determine the distribution and, to the extent practicable, assess behaviour of bats along the alignment;
2. Provide information to assist in the development of mitigation to be included in the Bat Management Plan (BMP); and
3. Provide a baseline against which future bat distribution, activity level and behavioural feeding/foraging data can be compared over time during and post road construction, to detect significant changes and/or trends in relation to construction.

This report documents the findings from the second of the two baseline surveys, conducted in April and May 2015, and is a follow up to the survey 1 report (Connolly, 2015a). Both of these reports are intended to inform NZTA and construction tenderers about the distribution of long-tailed bats along the alignment.

3 Methods

3.1 Overview

Two distribution surveys were required in the 2014/15 season to assess long-tail bat distribution and behaviour along the alignment (condition 48 (f) (vii)), and to provide a baseline for subsequent assessment of changes to bat activity and behaviour patterns during and post construction (condition 48 (f) (vi)). Consultation with WRC and the Department of Conservation (DOC) was undertaken during development of the survey methodology, resulting in an agreed, 2-phase approach to fulfilling the above conditions. The agreed methodology took into account the requirements of the consent conditions, but also acknowledged logistical constraints, particularly the challenging topography and habitat within and surrounding the Mangaone/Mangaharakeke and Mangaonua Gully systems.

The topography and vegetation of the gully systems are such that capture and radio telemetry of long-tailed bats within these systems was discounted as a long-term monitoring technique. This decision was partially based on the difficulties in capturing sufficient numbers of bats during the research of Dekrout (2009), who during 4 years of capture effort at Hammond Bush managed to successfully radio-track only 11 individual bats. The habitat within the Hamilton Section gully systems offers greater difficulties than at Hammond Bush in terms of trapping individual bats, and the steep, boggy, weed-infested nature of the gully habitat, combined with the large number of private properties surrounding the gullies, presented significant challenges for tracking bats. It was therefore agreed that radio-tracking was not a technique suited to meeting the relevant resource consent conditions for long-term monitoring of effects for the Hamilton Section.

Instead, a quantitative programme of acoustic survey was devised (Connolly, 2015b). The first of the two 2014/15 surveys was undertaken purely as a distribution survey (Connolly, 2015a), and to provide spatial information on bat presence along the alignment. Following availability of the new DOC Automatic bat Detectors (ABMs), the 2nd baseline survey (the results of which are the focus of this report) was undertaken immediately afterwards in April and May 2015. This second survey followed a more intensive quantitative methodology, where 123 ABMs were deployed along the alignment, with a further ten ABMs located in the Pukemokemoke Reserve, approximately 22km north of the Manganoua Gully crossing, which acted as control sites during the entire duration of the survey. The Reserve is known to provide habitat for a population of long-tailed bats and is sufficiently distant from the Hamilton Section alignment to be isolated from the effects of construction. This survey is intended as the first in a series of repeatable surveys to detect

significant long-term effects of road construction and operation on bat activity and behavioural patterns (Connolly, 2015b). Results from a power analysis (O'Donnell & Langton, 2003) indicated that the proposed methodology for the second and subsequent surveys should enable detection of significant changes in relative abundance of bat activity over time at key sites, using a Generalised Linear Mixed-effects Model (GLMM), with the number of bat calls per ABM across the hours of operation each night as the response variable. GLMMs may also be used to identify cumulative trends over time, e.g. a declining level of activity over 5 years upstream of a newly-constructed bridge in the Mangaonua Gully. In a case such as this, changes in relative abundance of activity may be rapid and if so, pairwise comparisons of relative activity levels between individual years can assess the significance of such a change.

Using GLMM analysis, repeat surveys during and post construction will allow comparison of data with baseline monitoring results, will further inform mitigation design, and may assist with subsequent assessment of the effectiveness of mitigation, and potential changes to mitigation that may be required. Data will be analysed in order to:

- a) Detect significant changes in relative abundance of bat activity over time at key sites, and allow comparison between ABM groupings and habitat types;
- b) Estimate the rate of any changes in relative abundance of activity detected over time, and identify associated trends;
- c) Detect significant changes in patterns and locations of foraging behaviour over time; and
- d) Attempt to identify variables that most strongly influence any significant changes in relative abundance of bat activity and feeding behaviour.

Further details of this quantitative methodology can be found in the document *Hamilton Section: Waikato Expressway - Long-tailed Bat Pre-Construction Baseline Survey Methodology (Summer 2014/15)* (Connolly, 2015b).

3.2 2nd Distribution Survey 2015

123 sites were monitored along the entire length of the Hamilton Section alignment and at a further ten sites at Pukemokemo Reserve between 31st March and 31st May 2015. Towards the end of March the new DOC ABMs became available for purchase in large numbers, and eventually 50 were used to complete this second survey.

3.2.1 ABM deployment

Sites along the alignment offering greatest potential for long-tailed bat habitat were chosen to conduct the survey. A large number of individual properties lie along the alignment, particularly surrounding the Mangaonua, Mangaone and Mangaharakeke gullies, and as a result in some cases the choice of site location was restricted by access issues.

In terms of bat habitat, the landscape along the Hamilton Section is divided by SH26. North of SH26, the landscape is essentially flat, dominated by agricultural pasture with scattered exotic trees and hedgerows, and little obvious connectivity exists with known bat habitat. South of SH26 the extensive, linear, deeply incised Mangaonua, Mangaone and Mangaharakeke Gully systems dominate the landscape, offering extensive potential bat habitat with a swampy willow-dominated base and large numbers of mature exotic trees along the gully sides and edges. The gully systems extend to the Waikato River corridor, providing a significant area of habitat with connection to a known bat population (although SH1 Cambridge Road runs between the river and the gully

systems). The survey effort reflected this habitat difference with the majority of effort focused on the gully systems south of SH26.

Sites monitored can be seen in Maps 1-12 in Appendix A.

At each site, a DOC Frequency Compression Acoustic Bat Monitor (ABM) was deployed for a minimum of seven nights with minimum temperatures above 10°C and with little precipitation in the first two hours after sunset, as per resource consent condition requirements. Weather data was retrieved from the NIWA CliFlo website (www.cliflo.niwa.nz), with two weather stations available within close proximity (Hamilton Ruakura 2 Ews and Holland Rd Hamilton Cws). Data from both sites were used to exclude those nights where temperature and precipitation exceeded consent conditions.

4 Results

A total of 468,302 recordings were made by the ABMs during the survey dates. However, the vast majority of these recordings were not long-tailed bat passes ($n=457,137$). 11,165 recordings were assigned as long-tailed bat passes using the DOC BatSearch3 software. Data from the first 7 valid nights of deployment at each site are the focus of this report, where a 'valid' night is defined as exhibiting a minimum temperature above 10°C and with little precipitation in the first two hours after sunset, congruent with resource consent condition requirements. At ten out of the 123 sites where data was collected, the ABM had a technical fault and stopped recording before 7 valid nights were recorded. Average bat activity/night is therefore calculated as the total number of bat passes / number of nights before fault occurred.

The large number of files generated by the ABMs required a significant amount of time to extract the long-tail bat data from the entire database of recordings. Stu Cockburn (DOC) has since indicated that an electronic component was at fault in some units and this resulted in large numbers of irrelevant recordings, causing monitors to stop before 7 valid nights of data are recorded; these components were replaced subsequent to completion of the 2nd 2014/15 survey. Stu is in the process of developing software capable of automatically extracting bat data from large numbers of recordings such as this, however this is not yet available.

Data were analysed and summarised in terms of:

- Distribution of bat activity along the alignment; and
- Levels of activity at each site.

Levels of long-tailed bat activity at sites along the alignment are shown in Table 1 and aerial maps of ABM locations and recorded bat activity are shown in Appendix A.

Table 1: Long-tailed bat activity at ABM sites along the alignment

SITE	SURVEY NIGHTS	SURVEY NIGHTS WITH BAT ACTIVITY	TOTAL BAT PASSES	MEAN BAT PASSES/NIGHT**	GULLY
S1	7	3	7	1.0	Mangaonua
S2	4*	3	20	5.0	Mangaonua
S3	2*	0	0	0.0	Mangaonua
S4	7	6	81	11.6	Mangaonua
S5	7	7	103	14.7	Mangaonua
S6	7	4	18	2.6	Mangaonua
S7	7	3	7	1.0	Mangaonua
S8	7	1	1	0.1	Mangaonua
S9	7	4	34	4.9	Mangaonua
S10	7	6	55	7.9	Mangaonua
S11	7	5	45	6.4	Mangaonua
S12	7	6	73	10.4	Mangaonua
S13	7	7	64	9.1	Mangaonua
S14	7	6	55	7.9	Mangaonua
S15	7	3	6	0.9	Mangaonua
S16	7	5	12	1.7	Mangaonua
S17	7	5	23	3.3	Mangaonua
S18	7	5	307	43.9	Mangaonua
S19	7	2	2	0.3	Mangaonua
S20	7	4	107	15.3	Mangaonua
S21	7	MONITOR FAULT			
S22	7	3	12	1.7	Mangaonua
S23	7	4	50	7.1	Mangaonua
S24	7	3	47	6.7	Mangaonua
S25	7	0	0	0.0	Mangaonua
S26	7	6	25	3.6	Mangaonua
S27	7	7	59	8.4	Mangaonua
S28	7	6	19	2.7	Mangaonua
S29	5*	1	2	0.4	Mangaonua
S30	4*	0	0	0.0	Mangaonua
S31	7	0	0	0.0	Mangaonua
S32	7	0	0	0.0	Mangaonua
S33	7	2	3	0.4	Mangaonua
S34	7	2	2	0.3	Mangaonua
S35	7	0	0	0.0	Mangaonua
S36	7	1	3	0.4	Mangaonua
S37	7	0	0	0.0	Mangaonua
S38	7	2	7	1.0	Mangaonua
S39	7	1	1	0.1	Mangaonua
S40	7	2	2	0.3	Mangaonua
S41	7	6	27	3.9	–
S42	7	4	6	0.9	–
S43	7	0	0	0.0	–
S44	7	2	8	1.1	–
S45	7	0	0	0.0	–
S46	7	1	1	0.1	–
S47	7	2	10	1.4	–
S48	7	6	31	4.4	–
S49	4*	1	1	0.3	–

S50	5*	3	8	1.6	-
S51	7	7	505	72.1	Mangaone
S52	7	3	3	0.4	Mangaone
S53	7	4	86	12.3	Mangaone
S54	7	7	302	43.1	Mangaone
S55	7	7	355	50.7	Mangaone
S56	7	5	83	11.9	Mangaone
S57	7	7	215	30.7	Mangaone
S58	7	7	430	61.4	Mangaone
S59	7	7	286	40.9	Mangaone
S60	7	7	164	23.4	Mangaone
S61	7	7	137	19.6	Mangaone
S62	7	5	16	2.3	Mangaone
S63	7	6	148	21.1	Mangaone
S64	7	7	97	13.9	Mangaone
S65	4*	6	130	32.5	Mangaone
S66	7	3	143	20.4	Mangaone
S67	7	7	284	40.6	Mangaone
S68	7	3	85	12.1	Mangaone
S69	7	7	265	37.9	Mangaone
S70	7	7	532	76.0	Mangaone
S71	7	4	18	2.6	Mangaharakeke
S72	7	5	21	3.0	Mangaharakeke
S73	7	5	134	19.1	Mangaharakeke
S74	7	5	153	21.9	Mangaharakeke
S75	7	5	46	6.6	Mangaharakeke
S76	7	6	41	5.9	Mangaharakeke
S77	7	6	87	12.4	Mangaharakeke
S78	7	4	11	1.6	Mangaharakeke
S79	7	6	43	6.1	Mangaharakeke
S80	7	6	45	6.4	East-West Link
S81	7	3	18	2.6	East-West Link
S82	7	3	7	1.0	East-West Link
S83	7	7	43	6.1	East-West Link
S84	7	3	8	1.1	East-West Link
S85	7	7	224	32.0	East-West Link
S86	7	6	420	60.0	East-West Link
S87	7	5	35	5.0	East-West Link
S88	7	7	110	15.7	East-West Link
S89	7	3	4	0.6	East-West Link
S90	7	5	90	12.9	East-West Link
S91	3*	2	18	6.0	East-West Link
S92	7	6	66	9.4	East-West Link
S93	7	5	25	3.6	East-West Link
S94	7	6	28	4.0	East-West Link
S95	5*	1	5	1.0	East-West Link
S96	7	3	16	2.3	East-West Link
S97	7	6	72	10.3	East-West Link
S98	7	7	2	0.3	East-West Link
S99	7	7	35	5.0	-
S100	7	4	10	1.4	-
S101	7	2	3	0.4	-
S102	7	3	67	9.6	-

S103	7	3	11	1.6	-
S104	7	1	36	5.1	-
S105	7	0	0	0.0	-
S106	7	0	0	0.0	-
S107	7	0	0	0.0	-
S108	7	0	0	0.0	-
S109	7	0	0	0.0	-
S110	7	0	0	0.0	-
S111	7	0	0	0.0	-
S112	7	0	0	0.0	-
S113	7	0	0	0.0	-
S114	7	0	0	0.0	-
S115	7	7	0	0.0	-
S116	7	7	0	0.0	-
S117	7	7	0	0.0	-
S118	7	7	0	0.0	-
S119	7	7	0	0.0	-
S120	7	MONITOR FAULT			
S121	6*	7	0	0.0	-
S122	7	7	0	0.0	-
S123	7	7	0	0.0	-

*indicates a site where the ABM experienced a technical fault and stopped recording before 7 valid nights of data were recorded

** mean calculated from 7 valid nights of activity (or for sites where ABMs experienced technical faults, the mean is calculated as total bat passes / number of nights before fault occurred)

4.1 Activity north of SH26

Bat activity north of SH26 was detected only in areas within 3km of SH26.

- 18 out of the 23 sites located north of SH26 recorded zero bat activity (see Table 1). The monitor at one of these sites (S123) had a technical fault.
- Three of the four sites where bat activity was recorded (S101, S102 and S103) lie within 500m of SH26 (see Map 7, Appendix A). The fourth site (S104) is located 3km north of SH26 (see Map 6, Appendix A).
- Activity levels at these sites was generally low, although S102 had the highest activity of the four sites (9.6 passes/night).
- No bat activity was recorded along the alignment north of site S104.

4.2 Activity south of SH26

The majority of bat activity was recorded south of SH26, as follows:

- 10 out of 100 ABMs deployed in sites south of SH26 recorded zero bat activity, and these sites are generally located on the western side of the southern end of the Mangaonua gully (see Map 10, Appendix A). One of the ten ABMs had a technical fault (S121).
- Bat activity was recorded at the remaining 91 sites south of SH26, throughout the Mangaone, Mangaharakeke and East-West link gully systems comprising;

- Low activity levels (<1 pass/night) at 15 sites.
- Low-moderate activity levels (1-10 passes/night) at 44 sites.
- Moderate-high activity levels (11-40 passes/night) at 22 sites.
- Very high activity levels (>40 passes/night) at 9 sites.
- Sites of high activity were concentrated in two main areas south of SH26; the Mangaone Gully and the East-West Link Gully. The Mangaonua Gully, located further north along the alignment just south of Morrinsville Road/SH26, had generally lower levels of bat activity compared to the other two gully systems on the alignment. With the exception of one ABM (S18) which recorded an average of 44 bat passes/night, all other sites in the Mangaonua Gully had much lower levels of activity (0-15 passes/night; see Maps 8 and 9, Appendix A).

4.3 Sites of high activity

Sites of high and very high activity were concentrated in two main areas south of SH26; the Mangaone Gully (see Maps 10 and 11, Appendix A), and the East-West Link Gully (see Map 12, Appendix A). For the purpose of this report, graphs illustrating activity by hour after sunset have been provided for areas of high and very high activity (>40 passes/night) sites.

4.3.1 Mangaone Gully (East)

Bat activity was recorded at all sites within the Mangaone Gully and neighbouring Mangaharakeke Gully north of SH1 Cambridge Rd, although bat activity was higher at sites located in the eastern part of the Mangaone Gully (see Map 11, Appendix A).

The ABM at site S70 on the southern gully bank to the east of the proposed Mangaone Gully bridge recorded the highest levels of activity anywhere along the alignment, with 76 bat passes/night (Figure 1).

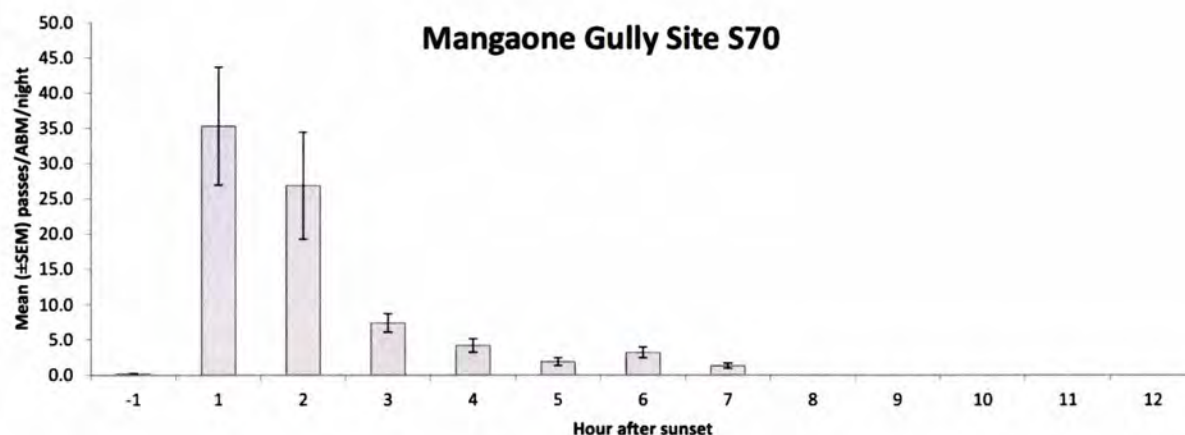


Figure 1. Mean bat activity at site S70 by hour after sunset.

The data show a sharp spike in activity in the first 2 hours after sunset at this site, suggesting a bat roost may be in the vicinity. It is not known however, how close the roost may be or how many bats may have been recorded.

Three other sites in the eastern part of the Mangaone Gully (S65, S67 and S69) also had very high activity, where 32, 38 and 50 bat passes/night were recorded respectively (Figures 2-4).

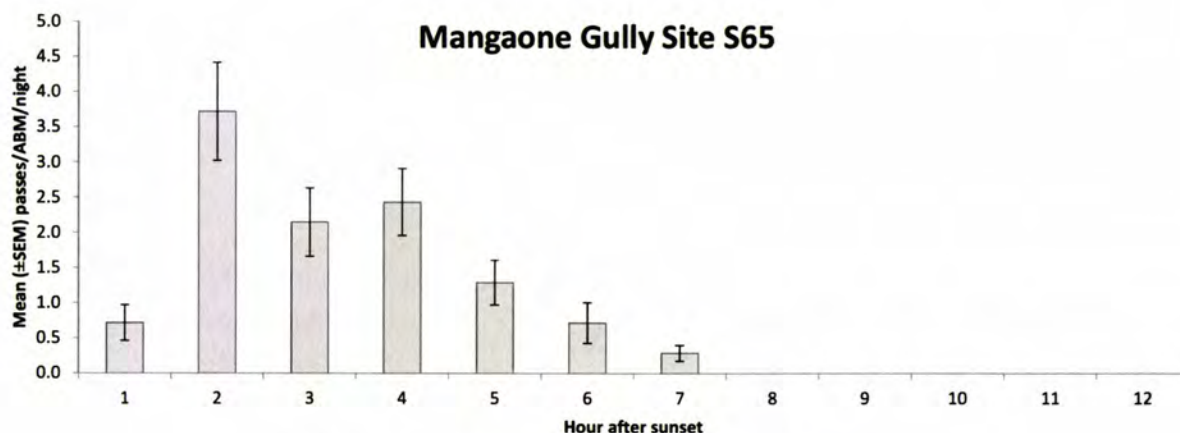


Figure 2. Mean bat activity at site S65 by hour after sunset.

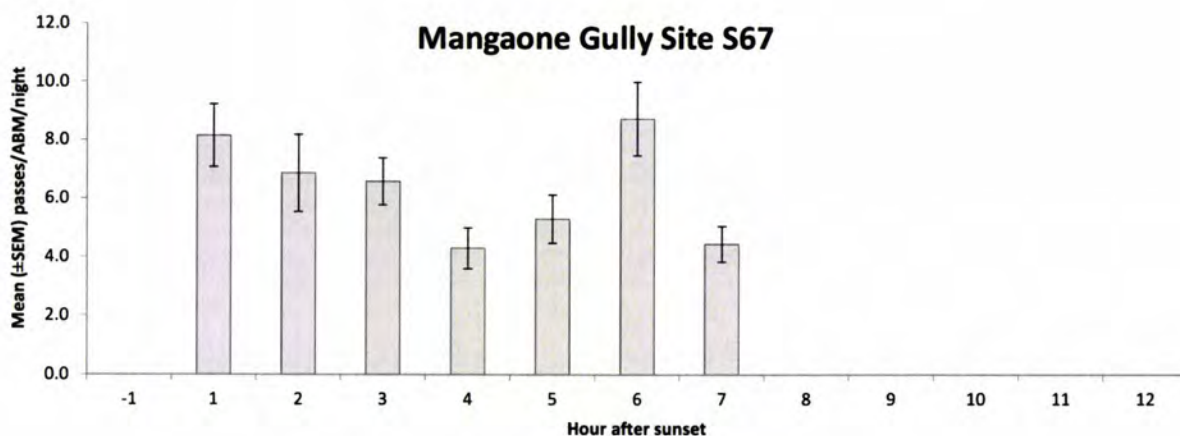


Figure 3. Mean bat activity at site S67 by hour after sunset.

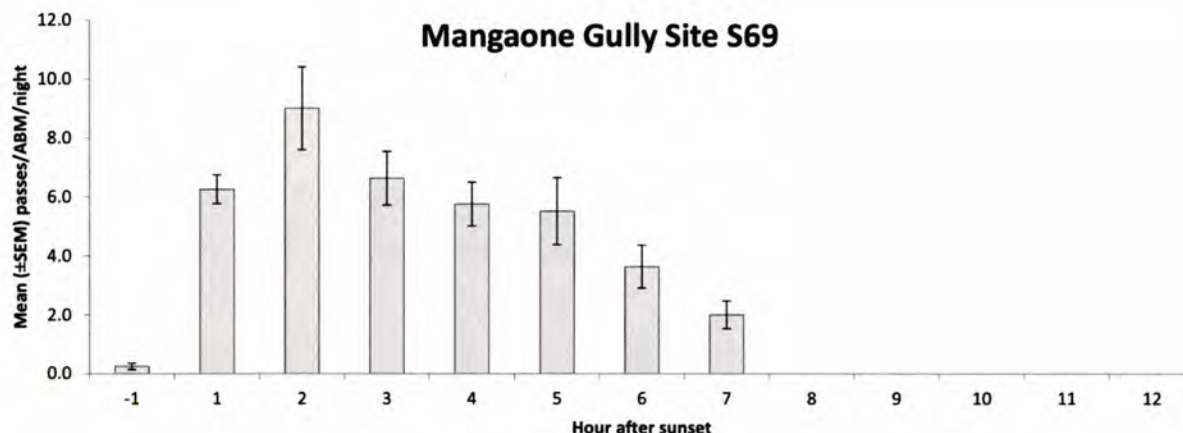


Figure 4. Mean bat activity at site S69 by hour after sunset.

Mean bat activity was again highest within 2 hours of sunset at sites S65, S67 and S69, although activity was considerably lower during these hours compared to site S70. Also, activity at these three sites continued at much higher levels from 3 to 7 hours after sunset compared to the same time period at site S7. Activity at site S67 in particular remained fairly consistent throughout the 7 hours after sunset. Very early activity in the hour before sunset was also recorded at site S65. At all sites, bat activity ceased after 7 hours post sunset. Sites S65 and S67 are located near open wetland habitat and the continued use of the area throughout much of the night may indicate that this is an important foraging area.

The other six ABMs deployed along the eastern area of the Mangaone Gully all recorded moderate levels of activity (12-21 passes/night, see Table 1). Three out of the ten ABMs located in the neighbouring Mangaharakeke Gully recorded high levels of activity (12-22 passes/night), whilst the other seven ABMs recorded low levels of activity (1-7 passes/night, see Table 1).

4.3.2 Mangaone Gully (between proposed Mangaone bridge and existing SH1)

In the area between the proposed Mangaone bridge to the east and the existing SH1 to the west (See Map 10, Appendix A), bat activity was very high at many of the sites. Six out of the ten ABMs deployed in this area recorded over 30 passes/night, three of which were amongst the highest recordings along the entire alignment (sites S55, S58, S51 where 50, 61 and 72 mean passes/night were recorded respectively; Figures 5-7). At Site S54, an average of 43 bat passes/night was recorded and this site is particularly close (approximately 30 metres) to the proposed Mangaone bridge (Figure 8).

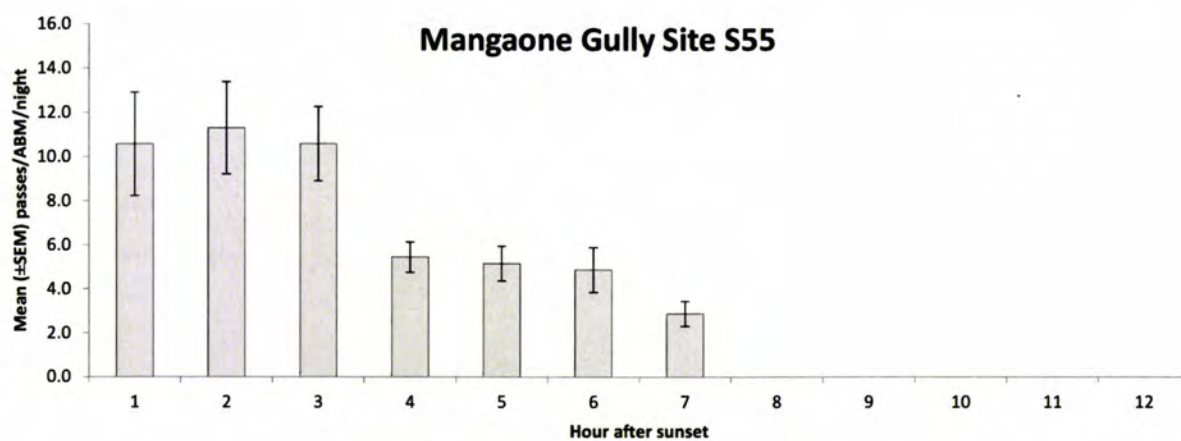


Figure 5. Mean bat activity at site S55 by hour after sunset.

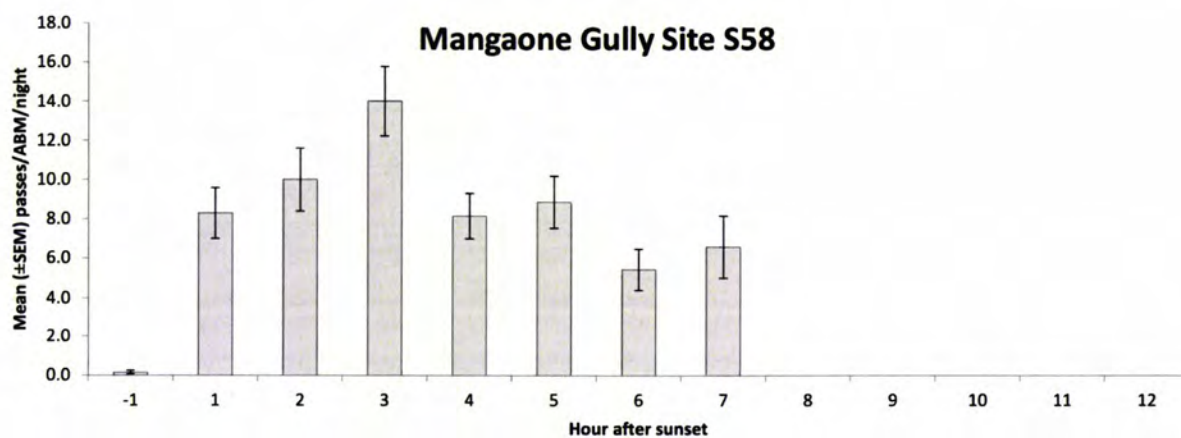


Figure 6. Mean bat activity at site S58 by hour after sunset.

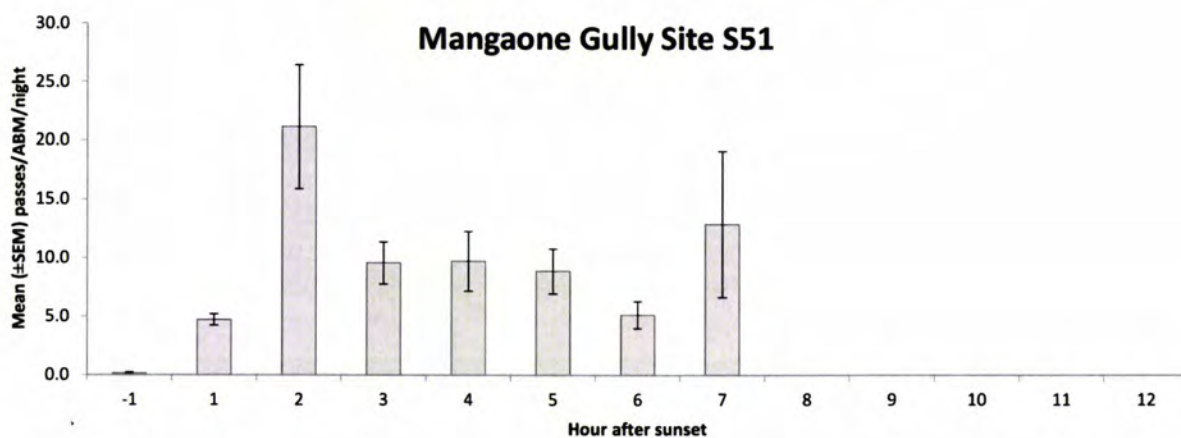


Figure 7. Mean bat activity at site S51 by hour after sunset.

Activity at Site S55 was consistently high 1 – 3 hours after sunset, and activity continued until 7 hours after sunset. At both sites S58 and S51 there was evidence of some activity an hour before sunset, whilst the highest activity occurred at 2 and 3 hours after sunset, tailing off until 7 hours after sunset when activity ceased.

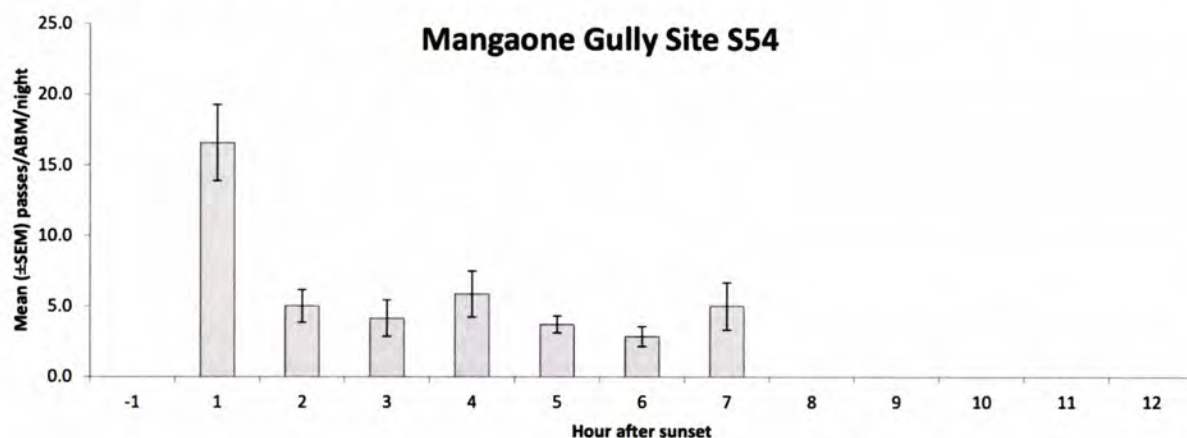


Figure 8. Mean bat activity at site S54 by hour after sunset.

Following a similar pattern as neighbouring sites S55, S58 and site S54 also exhibited a peak of activity 1 hour after sunset, followed by a consistently lower levels until 7 hours after sunset.

4.3.3 The East-West Link gully

All 19 ABMs deployed within the East-West Link gully recorded bat activity. ABMs were sited on both sides of the proposed fill and levels recorded were in most cases low to moderate (1-15 passes/night). However, two of the 19 ABMs in this area recorded very high levels of activity (sites S85 and S86, where 32 and 60 mean passes/night were recorded respectively). Both of these sites are located on the eastern side of the East-West Link Gully, 120 and 150 metres from the alignment (see Map 12, Appendix A).

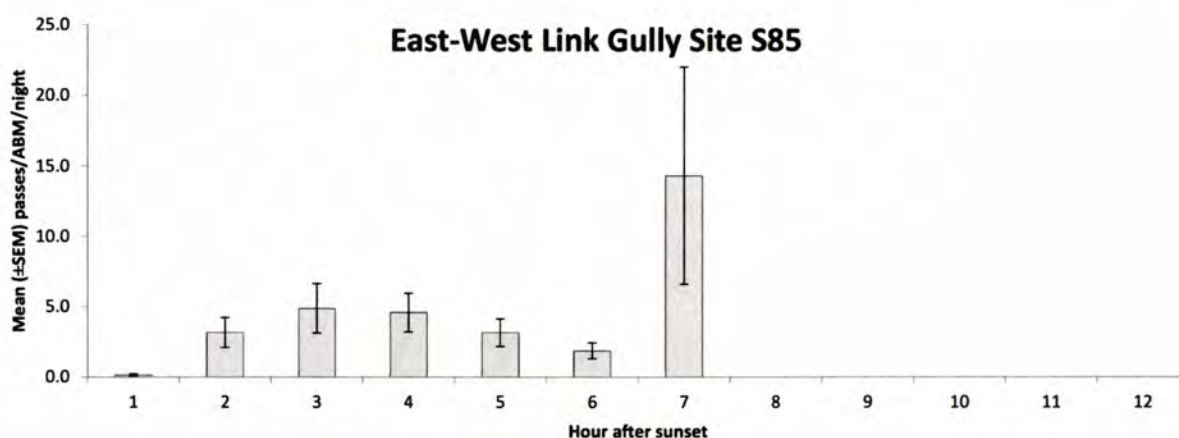


Figure 9. Mean bat activity at site S85 by hour after sunset.

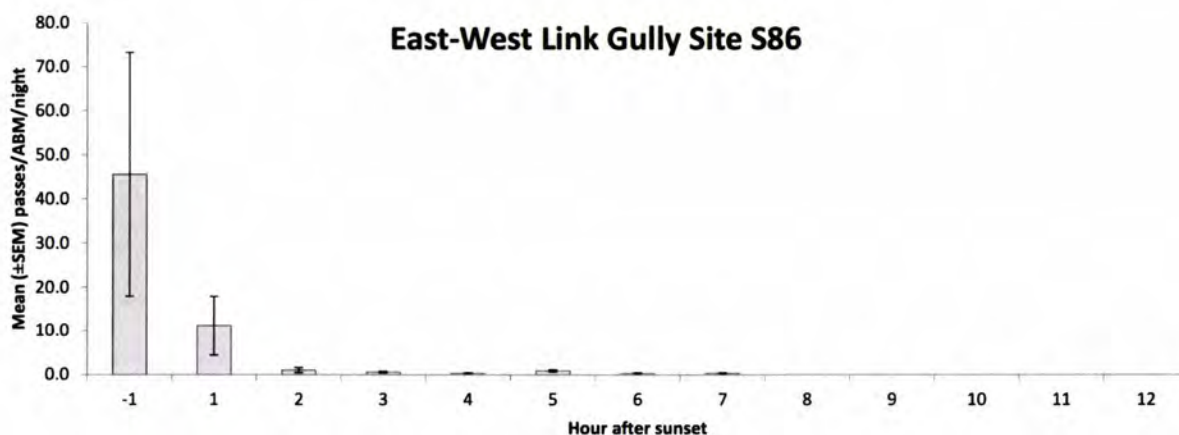


Figure 10. Mean bat activity at site S86 by hour after sunset.

Bat activity at the two neighbouring sites S85 and S86 show interesting contrasting activity patterns, as activity was very high at site S86 1 hour before sunset, with minimal activity thereafter. In contrast, activity at site S85 was relatively low in the hours immediately before and after sunset, whilst a peak of activity occurred 7 hours after sunset.

5 Discussion

5.1 Activity north of SH26

Only four sites north of SH26 recorded activity and all of these sites were more than 500m north of SH26. Long-tailed bats were not detected north of site S104. This is not surprising given the predominantly agricultural landscape, relative scarcity of appropriate habitat north of SH26 and the lack of obvious connectivity to known bat habitat beyond site S104. The bat or bats active at this site may roost within the Mangaonua Gully either to the south of SH26 or in the gully arm

running between the SH26/Silverdale Rd intersection and the end of Nevada Rd, although this is unknown. No street lighting exists between the 3 ABM sites closest to SH26 (S101, S102 and S103) and either arm of the gully.

5.2 Activity within the Mangaone Gully

Bat Activity was recorded on the vast majority of ABMs deployed within the Mangaone Gully, confirming the widespread use of this gully by long-tailed bats. The early evening activity at the three high-activity sites (including pre-sunset activity) suggests possible emergence from a nearby roost, followed by consistent activity taking in the gully slopes and base suggesting foraging, particularly around open wetland habitat in the base of the gullies. Potential roost trees are relatively common throughout the gullies including large pines, eucalypts, kahikatea and willows.

5.3 Activity within the East-West Link gully

Activity levels within this gully were generally low-moderate and activity was recorded on both sides of the proposed gully fill and on all ABMs deployed, confirming that bats are active throughout the gully. These results are consistent with the findings of Mueller et al., 2013.

The high activity levels at sites S85 and S86 both early on and late in the night may indicate that bats could possibly be roosting in large pines trees located near to these two sites, and then later they are returning to their roosts after foraging elsewhere during the course of the night.

This gully connects with the Mangaonua, Mangaone and Mangaharakeke Gullies to the north and therefore the presence of bat activity here is not surprising. Some potential roost habitat exists with several large mature pine trees and a small number of reasonably large kahikatea along the gully sides and in the gully base.

6 Conclusions

The widespread bat activity recorded through the gullies crossed by the Hamilton Section and the pattern of intensive early evening activity at certain sites suggests long-tailed bats roost within and forage extensively throughout the gully systems. Given the speed at which long-tailed bats are capable of moving through the landscape and the relatively high number of large, mature native and exotic trees within and surrounding the gully systems, it is possible that the bat/s recorded at these sites may roost some distance away. However the pre-sunset activity, followed by a sharp increase in activity during the first 2 hours after sunset at several sites in particular suggests this is not the case, and that a roost or roosts likely exist in close proximity to the alignment within all gullies surveyed. Most likely roost trees include the kahikatea, pines and eucalypts near the Mangaonua Gully bridge, and the many mature pines and eucalypts in the Mangaone Gully between SH1 and the proposed Mangaone Gully bridge. Open wetland habitat in the gullies bases also appear to be a focus for foraging.

7 Recommendations

The results of the monitoring indicate a risk of bat roosts being present in the areas where trees are to be cleared to allow construction of the Expressway. Tree removal protocols are detailed within the Hamilton Section Bat Management Plan. Strict adherence to these protocols will be required to minimise the risk of direct adverse effects on long-tailed bats during tree removal. In particular, every effort should be made to ensure any colonial roosts are not affected.

8 References

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Appendix A – ABM site locations and activity levels

Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

● Fault

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Map
1 of 12

0 50 100 150 200m
1:5,000 @A3



Projection:
NZGD 2000 New Zealand Transverse Mercator
| Date: 8/03/2016 | Revision: 1 |

Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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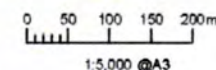


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Map
2 of 12



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Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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Map
3 of 12

0 50 100 150 200m
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Projection:
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| Date: 8/03/2016 | Revision: 1 |

Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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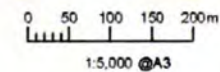
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Map
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Legend

Mean Bat Passes per Night

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- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1
- No bat activity
- Fault

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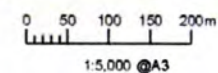
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Map
5 of 12



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Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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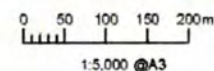
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Legend

Mean Bat Passes per Night

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- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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Map
7 of 12

0 50 100 150 200m
1:5,000 @A3



Projection:
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| Date: 8/03/2016 | Revision: 1 |

Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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Map
8 of 12

0 50 100 150 200m
1:5,000 @A3



Projection:
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Legend

Mean Bat Passes per Night

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- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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Map
9 of 12

0 50 100 150 200m
1:5,000 @A3



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Legend

Mean Bat Passes per Night

- >51
- 41-50
- 31-40
- 21-30
- 11-20
- 1-10
- <1

○ No bat activity

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Map
10 of 12

0 50 100 150 200m
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| Date: 8/03/2016 | Revision: 1 |

Legend

Mean Bat Passes per Night

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● 31-40

● 21-30

● 11-20

● 1-10

● <1

○ No bat activity

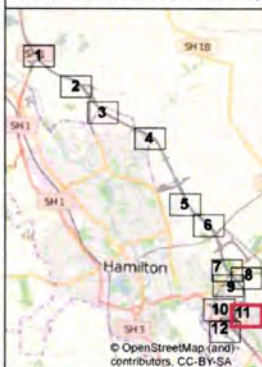
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Map
11 of 12

0 50 100 150 200 m
1:5,000 @A3



Projection:
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Legend

Mean Bat Passes per Night

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- 31-40
- 21-30
- 11-20
- 1-10
- <1

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Map
12 of 12

0 50 100 150 200m
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Appendix D – Hamilton Section Long-tailed Bat Survey Sites

Legend

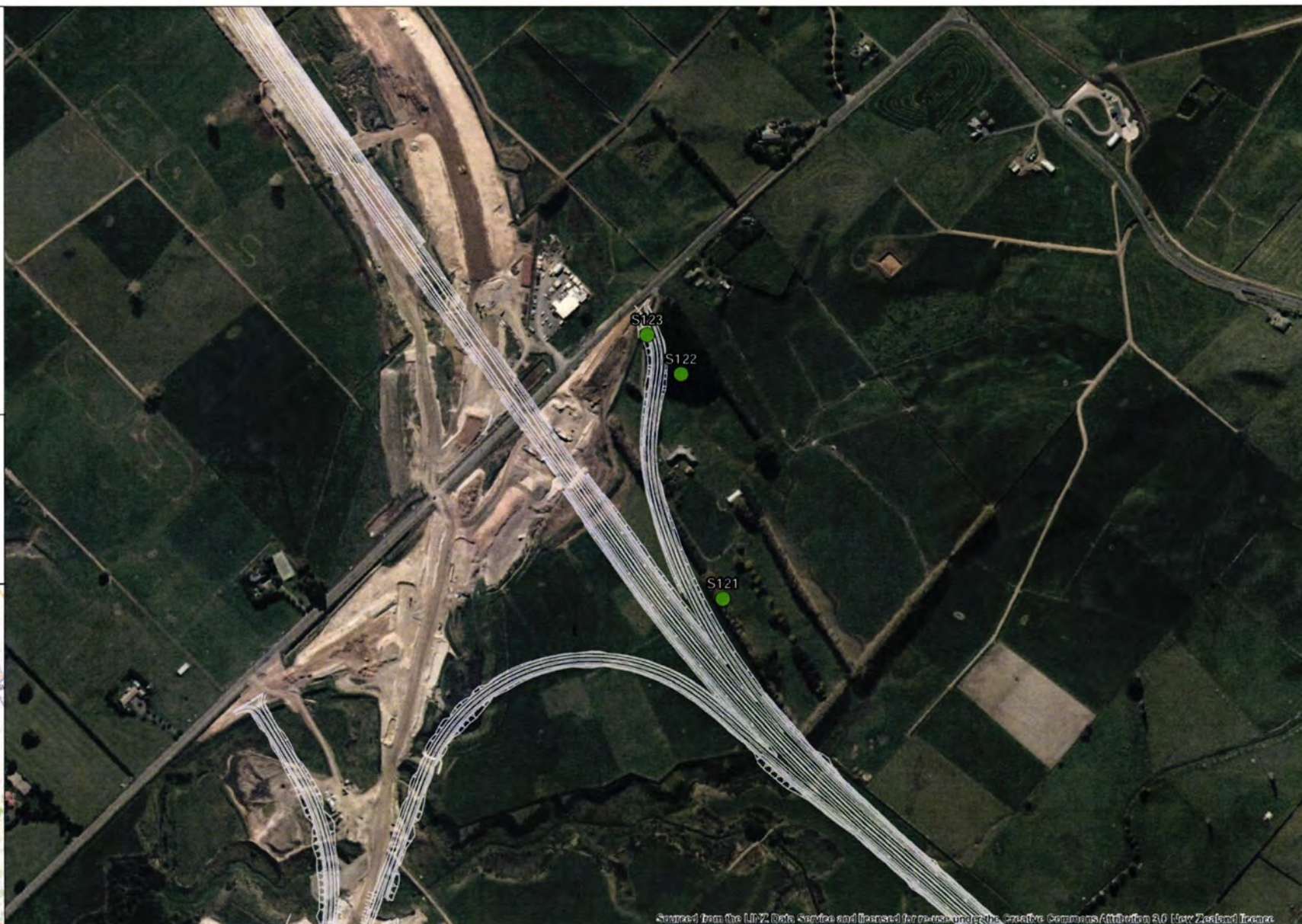
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● ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
1 of 15

0 50 100 150 200 m

1:5,000 @A3



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Legend

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● ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
2 of 15

0 50 100 150 200 m
1:5,000 @A3



Projection:
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| Date: 21/04/2016 | Revision: 1 |

Legend

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● ABM sites - 2015-16 Baseline surveys

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Map
3 of 15

0 50 100 150 200 m

1:5,000 @A3



Projection:
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Hamilton Section

● ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
4 of 15

0 50 100 150 200 m
1:5,000 @A3



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Hamilton Section

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
5 of 15

0 50 100 150 200 m

1:5,000 @A3



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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
6 of 15

0 50 100 150 200 m
1:5,000 @A3



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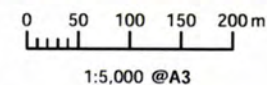
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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
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0 50 100 150 200 m
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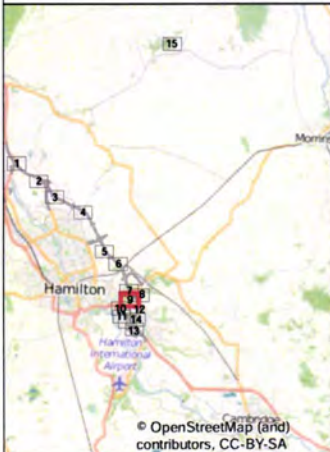
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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
9 of 15

0 50 100 150 200 m

1:5,000 @A3



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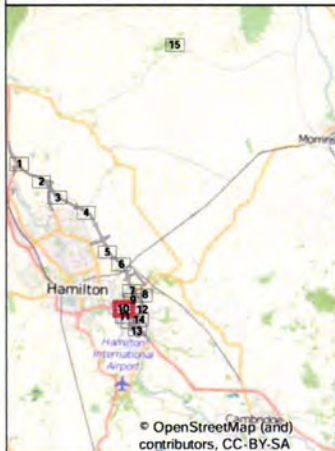
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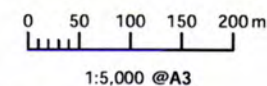


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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
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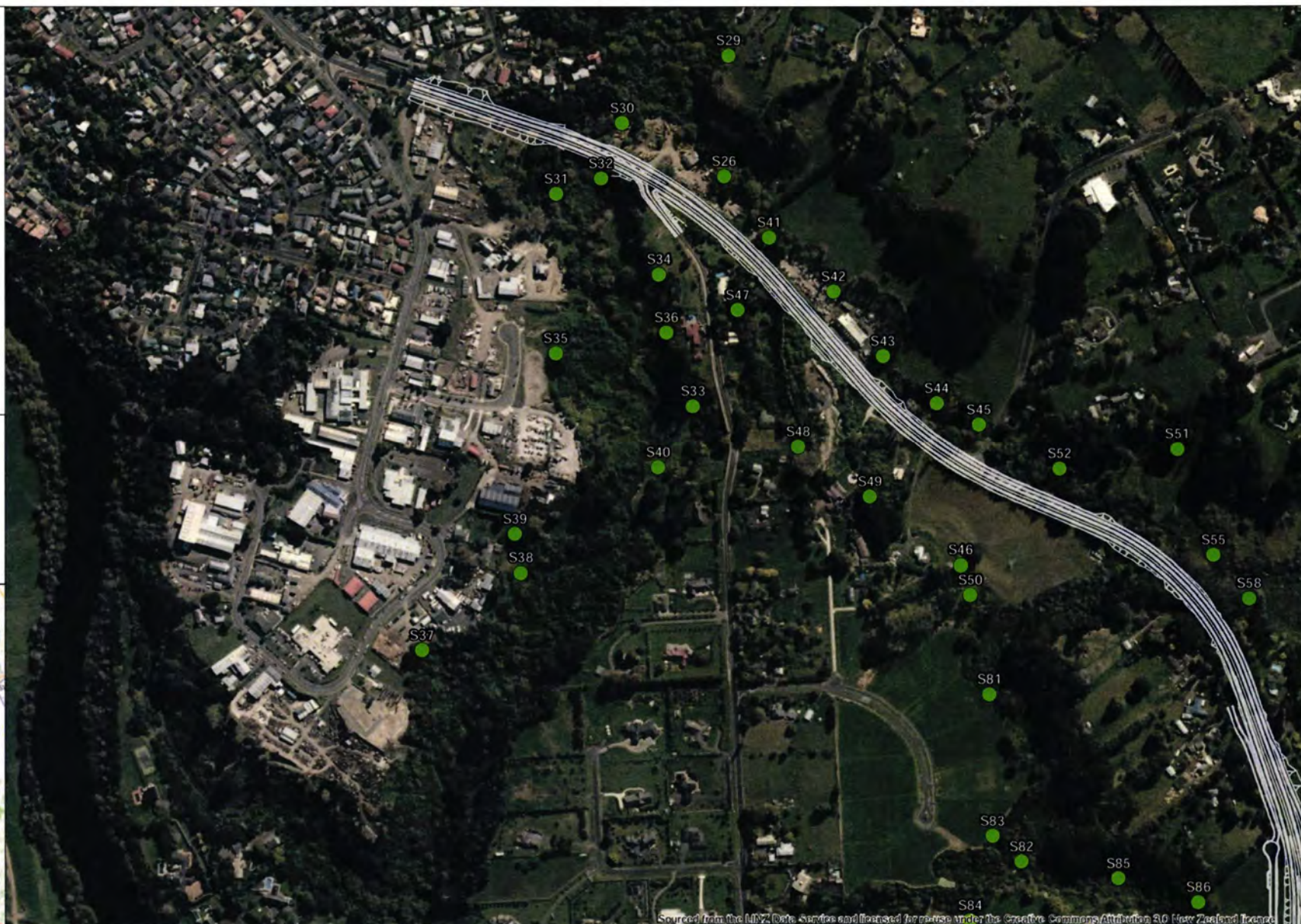
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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
11 of 15

0 50 100 150 200m

1:5,000 @A3



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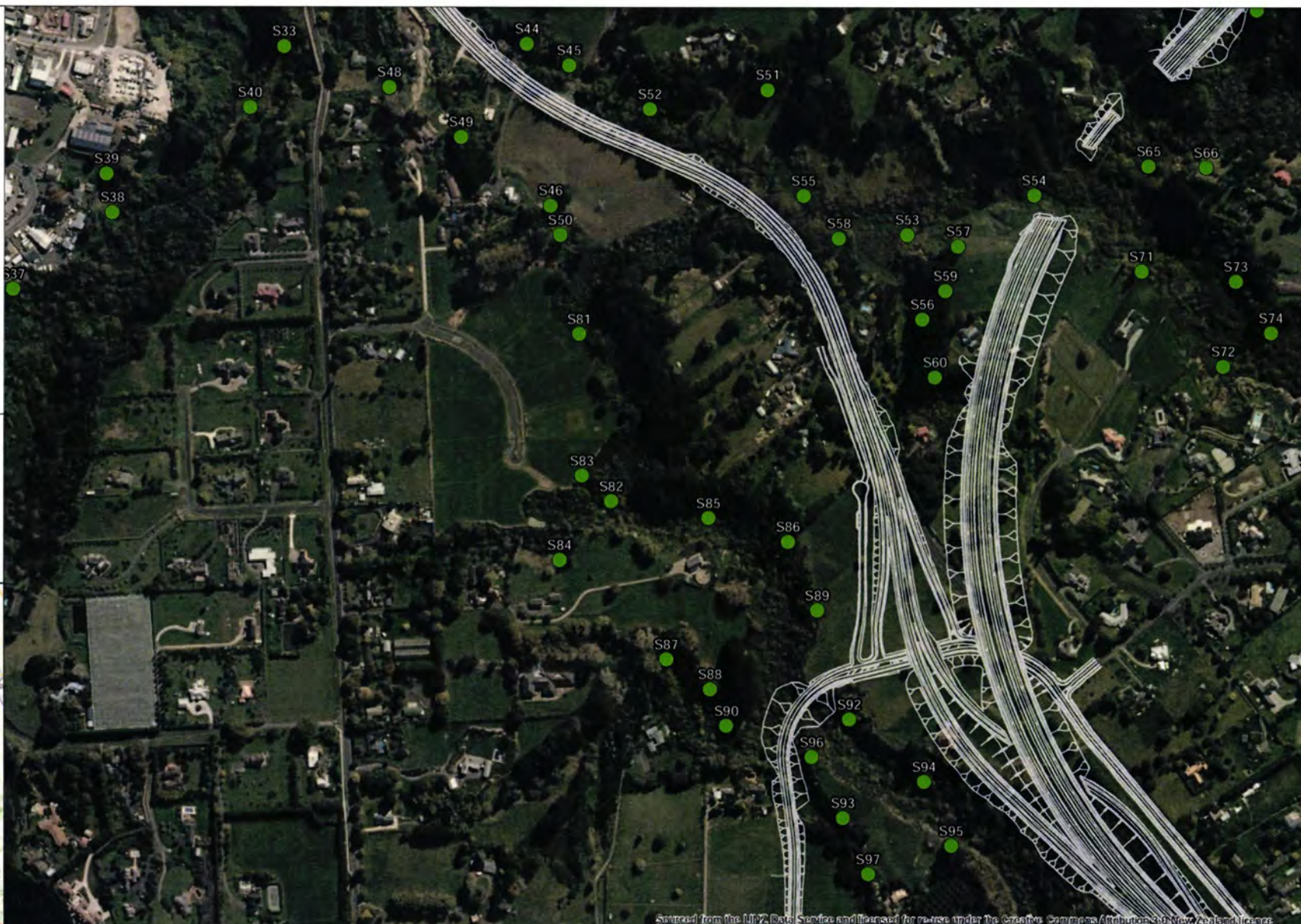
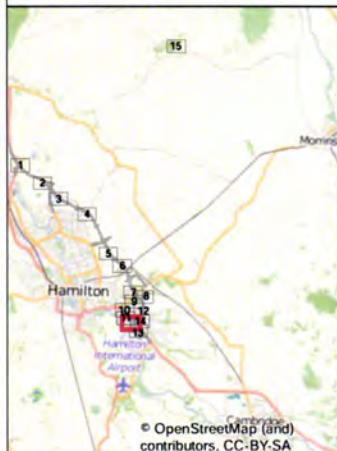
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- ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
12 of 15

0 50 100 150 200 m

1:5,000 @A3



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● ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
13 of 15

0 50 100 150 200 m

1:5,000 @A3



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● ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16

Map
14 of 15

0 50 100 150 200 m
1:5,000 @A3



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● ABM sites - 2015-16 Baseline surveys

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Waikato Expressway - Hamilton Section Long-tailed Bat baseline activity survey 2015/16 - Pukemokemoke control site

Map
15 of 15

0 50 100 150 200 m

1:5,000 @A3



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● ABM sites - During & Post-Construction

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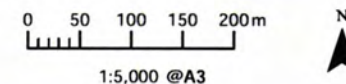


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Map
1 of 11



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Hamilton Section

● ABM sites - During & Post-Construction

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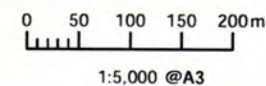


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Waikato Expressway - Hamilton Section Long-tailed Bat During and Post Construction Monitoring

Map
2 of 11



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Hamilton Section

● ABM sites - During & Post-Construction

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Waikato Expressway - Hamilton Section Long-tailed Bat During and Post Construction Monitoring

Map
3 of 11

0 50 100 150 200m
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Hamilton Section

● ABM sites - During & Post-Construction

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Map
4 of 11

0 50 100 150 200m

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Map
5 of 11

0 50 100 150 200m
1:5,000 @A3



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Map
6 of 11

0 50 100 150 200m

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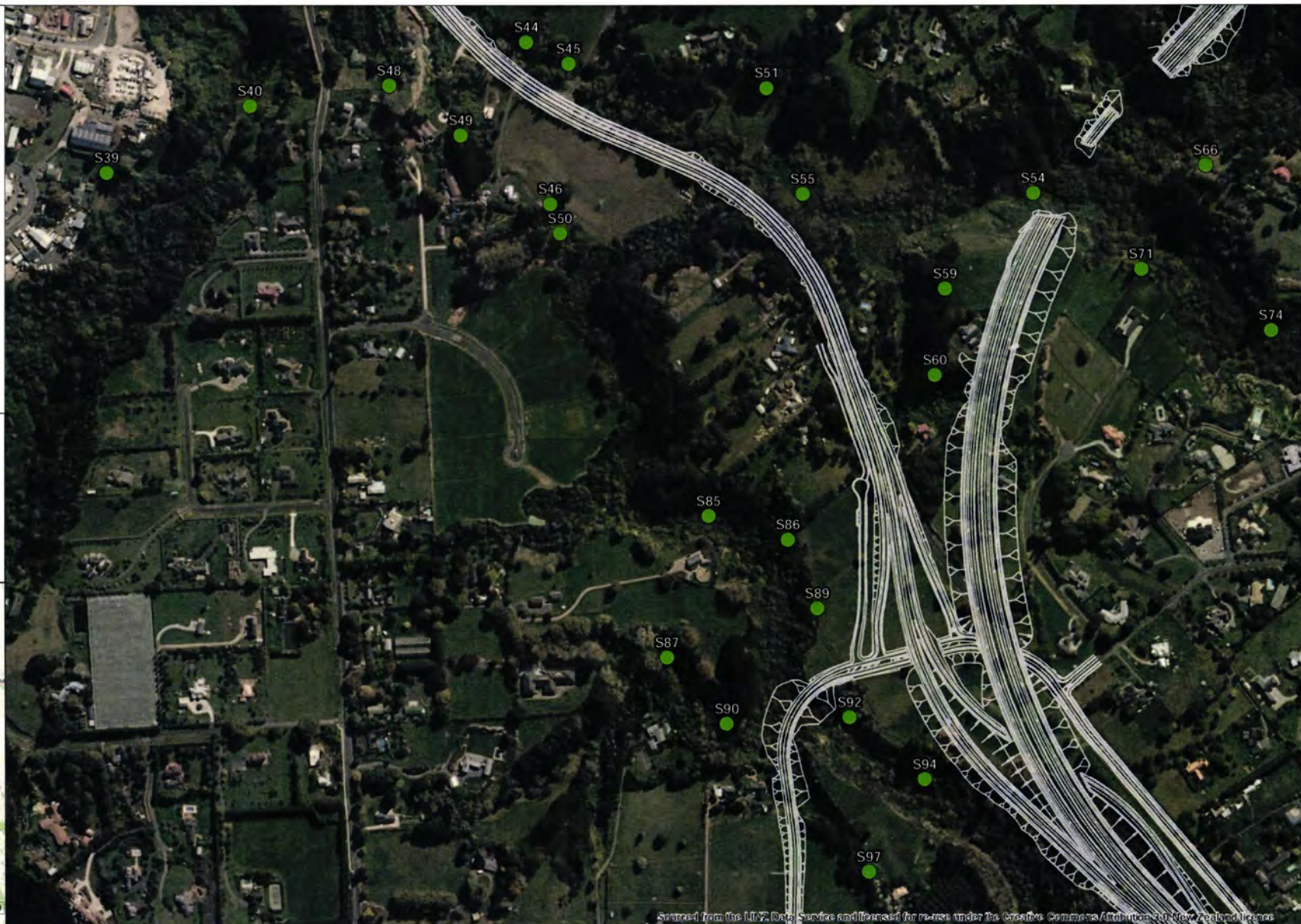
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Map
7 of 11

0 50 100 150 200m
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Hamilton Section

● ABM sites - During & Post-Construction

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Map
8 of 11

0 50 100 150 200m

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Map
9 of 11

0 50 100 150 200m
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Waikato Expressway - Hamilton Section Long-tailed Bat During and Post Construction Monitoring Maungakawa control site

Map
10 of 11

0 50 100 150 200m
1:5,000 @A3



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● ABM sites - During & Post-Construction

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Waikato Expressway - Hamilton Section Long-tailed Bat During and Post Construction Monitoring Pukemokemoke control site

Map
11 of 11

0 50 100 150 200m
1:5,000 @A3



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Appendix E – Tree Removal Ecologist Team Relevant Experience

Trevor Connolly

Ecologist

Bat handling and survey experience: Handled short-tailed bats at Auckland Zoo in 2015 under supervision of Debra Searchfield. Located and observed long-tailed bat roosts near Hamilton under guidance of Darren Le Roux 2012. Experience in the use of ABMs and data analysis and interpretation using BatSearch 3.0 software on several NZ Transport Agency roading projects between 2012-2016. Experience in night observation using hand-held acoustic detectors 2012-2016 and the use of a thermal imaging camera to observe long-tailed bat behaviour 2016. Other relevant experience includes training and field experience live capturing, handling and anaesthetising small mammals (rats, ferrets), and husbandry of a captive stoat colony, with HortResearch in 2004-2005.

John Turner

Principal Ecologist

Bat handling and survey experience: Handled short-tailed bats at Auckland Zoo in 2015 under supervision of Debra Searchfield. Experience in the use of ABMs and data analysis and interpretation using BatSearch 3.0 software on several NZ Transport Agency roading projects between 2011-2016. Has searched for and located likely long-tailed bat roost with bat specialist Darren Le Roux in 2012. Recent experience in night observation using a FLIR thermal imaging camera to observe long-tailed bat behaviour. Has over 40 years experience in observing wildlife in the field. Has handled reptiles, mammals and birds, with extensive experience in the handling the latter.

Roger MacGibbon

Principal Ecologist

Bat handling and survey experience: No physical bat handling experience. Four years' experience operating ABMs and analysing and interpreting data using BatSearch 3.0 software on several NZTA roading projects in the Waikato. Five years' experience of night observations using hand held acoustic detectors in the Waikato and Canterbury and recent experience in night observation using a FLIR thermal imaging camera to observe long-tailed bat behaviour. 30 years' experience live capturing and handling small mammals including possums, feral cats, ferrets, stoats, hedgehogs, rats and mice.

Dr Liz Deakin

Senior Ecologist

Bat handling and survey experience: Captured horseshoe bat species (*Rhinolophidae*) using harp traps positioned across forest paths in Botum Sakor National Park, Cambodia whilst holding the position of Assistant Research Coordinator for Frontier Environmental between October 2005 to May 2006. Was trained in bat handling by a local bat specialist. Also has experience recognising NZ long-tailed bat calls using BatSearch 3.0 software (written by The Department of Conservation).

Chris Smuts-Kennedy

Freelance Ecologist

Bat handling and survey experience: Experienced handling long tailed and short tailed bats.
Bat survey experience includes mist netting and acoustic monitoring.