Review of the Melbourne Environmental Monitoring Units

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Approved by: **Aircraft Noise Information Manager**

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This report contains a summary of data collected over the specified period and is intended to convey the best information available from the NFPMS at the time. The system databases are to some extent dependent upon external sources and errors may occur. All care is taken in preparation of the report but its complete accuracy can not be guaranteed. Airservices Australia does not accept any legal liability for any losses arising from reliance upon data in this report which may be found to be inaccurate.

Version Control

Version Number	Detail	Prepared by	Date
1	Draft for Review	ML	2/05/2011
2	Incorporating CACG Comments and Noise Monitoring Program for the region	ML	28/02/2012

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1 Executive Summary

A review of Melbourne Environmental Monitoring Unit (EMU) locations has been performed in accordance with Airservices Australia's legislated obligation referred to in the Terms of Reference Document (See Appendix A). The review was tabled to the Melbourne Airport Community Aviation Consultation Group (CACG) in May 2011 and to Essendon CACG members in May 2011. Comments were subsequently received from each CACG. A summary of these comments and Airservices responses can be found in Appendix C. The findings of the report detailed below have been updated accordingly.

The study has established the following:

- When considering the Melbourne NFPMS system as a whole, the number of correlated noise events is low compared to total flights. This is mainly due to a high number of aircraft departures to the west over areas without EMU coverage and is therefore not considered to be a major issue in terms of system technical integrity. This area to the west of Melbourne airport is sparsely populated when compared to the south and east.
- Sensitive areas around Melbourne have been identified from complaints data and flight paths. The highest number of complaints within the assessed period was from the suburbs of St Albans and Sunshine. A previous noise study conducted at Sunshine North from July 2004 to Feb 2005 established that this area was not specifically a priority for a permanent EMU at that time.
- Each permanent EMU is positioned well to accommodate Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs), to the north, east and south of Melbourne airport. No permanent EMUs exist to the west of the airport.
- Permanent EMU 54 located at Braybrook has been decommissioned. This monitor covered an essential area to the south of the airport and is recommended to be re-instated. A new location at a school to the north of the Braybrook location near Avondale Heights has been recommended. The recommended area should provide better coverage for arrivals and departures on the main runway.
- The remaining permanent sites, EMUs 2, 3, 4, 6 and 61 are recommended to remain as currently positioned.
- It has been shown that the current location of portable unit EMU 60 at Keilor Village is not ideal due to low angles of incidence and potential false positive readings. Following community feedback regarding the removal of this monitor, it has been recommended that this monitor remains for the time being with further analysis of data collected. Additional information is to be presented to the CACG at a later date to review the decision to remove the monitor. Data collected from the repositioned EMU 54 will form part of the comparative analysis for this additional reporting.
- In addition to the EMU 60 recommendation above, additional filtering of the data collected from the monitor will be performed within the regular quarterly NFPMS report. An indication of average aircraft noise levels captured from the EMU that are outside the requirements of ISO 20906:2009 will be provided. This will mainly apply to arrivals.
- Short term noise monitoring locations for have been recommended:
    - South west of Melbourne Airport at Caroline Springs,
    - At the boundary of Essendon Airport,
    - To the north and north east of Essendon Airport at Strathmore Heights playing fields and Oaks Primary. Oaks Primary has been included due to community feedback.
    - At populated areas around Moorabbin and Avalon Airports.

- The portable EMU currently located at Diggers Rest has been in place since November 2009. It is recommended that this monitor be relocated. No change to the detection parameters of this noise monitor were established during this review.
- The NFPMS is in general compliance with ISO20906:2009, with the following exceptions:
  - The measurement of wind conditions and flagging of potential wind induced noise events above 10 m/s is not performed.
  - An estimation of uncertainty within the noise measurements for EMUs with non-ideal positions is not in place.
- The background noise levels at each location are 15dB or more below the average aircraft maximum levels enabling adequate identification of aircraft movements and compliance with the requirements of ISO20906:2009. Portable EMU 64 at Diggers Rest has been set with a lower capture threshold to enable the monitor to capture relatively low noise events. A detailed review of this monitor indicates that that the lower threshold settings are not causing excessive false positives.
- The EMU configuration in terms of threshold settings, correlation zones and missed noise events is to be determined within the Service Provider's Noise Verification Report.
- Recommendations have been given to integrate weather stations onto permanent and portable EMUs to enable compliance with ISO20906:2009 with a series of options.

2 Context

Airservices Australia has a legislated obligation, via the Air Services Act (1995), to regard the safety of air navigation as its most important consideration. Subject to that requirement it also has obligations to, as far as practicable; protect the environment from the impact of the operation and use of aircraft. Further, a Ministerial Direction made under this Act requires Airservices to maintain and operate a Noise and Flight Path Monitoring System (NFPMS) at major Australian airports. At present this system operates around Perth, Adelaide, Melbourne/Essendon, Canberra, Sydney, Gold Coast, Brisbane and Cairns airports.

The NFPMS comprises a number of components, including Environmental Monitoring Units (EMUs) that collect noise data. Airservices Australia periodically conducts a review of the location of the EMUs. This is a key element of the quality management of the NFPMS.

3 Purpose

The purpose of this review is to assess the performance of the EMUs at Melbourne and Essendon Airports against Airservices Australia's environmental and business requirements for the management of aircraft noise. In performing this function the placement and individual configuration of each of the EMUs needs to be optimised for the measurement of the impacts of aircraft operations on the local community from operations at Melbourne and Essendon Airports. This review will assess the location of the current EMUs and make recommendations about the future use of the EMUs.

Note that the term NMT (Noise Monitoring Terminal) is sometimes used in place of EMU (Environmental Measurement Unit) within the images of this report. Both terms have the same meaning and refer to the physical system hardware.

4 Scope of Review

This review will address:

1) The location of each current EMU,
    a) With respect to complainants.
    b) With respect to sensitive regions.
    c) With respect to flight paths.
    d) With respect to communications coverage and reliability.
    e) With respect to ISO 20906:2009.
    f) Against local environmental conditions.
    g) For security and access for maintenance.
2) Licensing issues,
3) Configuration of each EMU,
    a) For noise event detection parameters; threshold, pre-trigger, duration.
    b) For calibration and preventative maintenance.
    c) Correlation zone.
    d) For false positives.
    e) For missed noise events.

In addition to the Terms of Reference, this review will also assess:

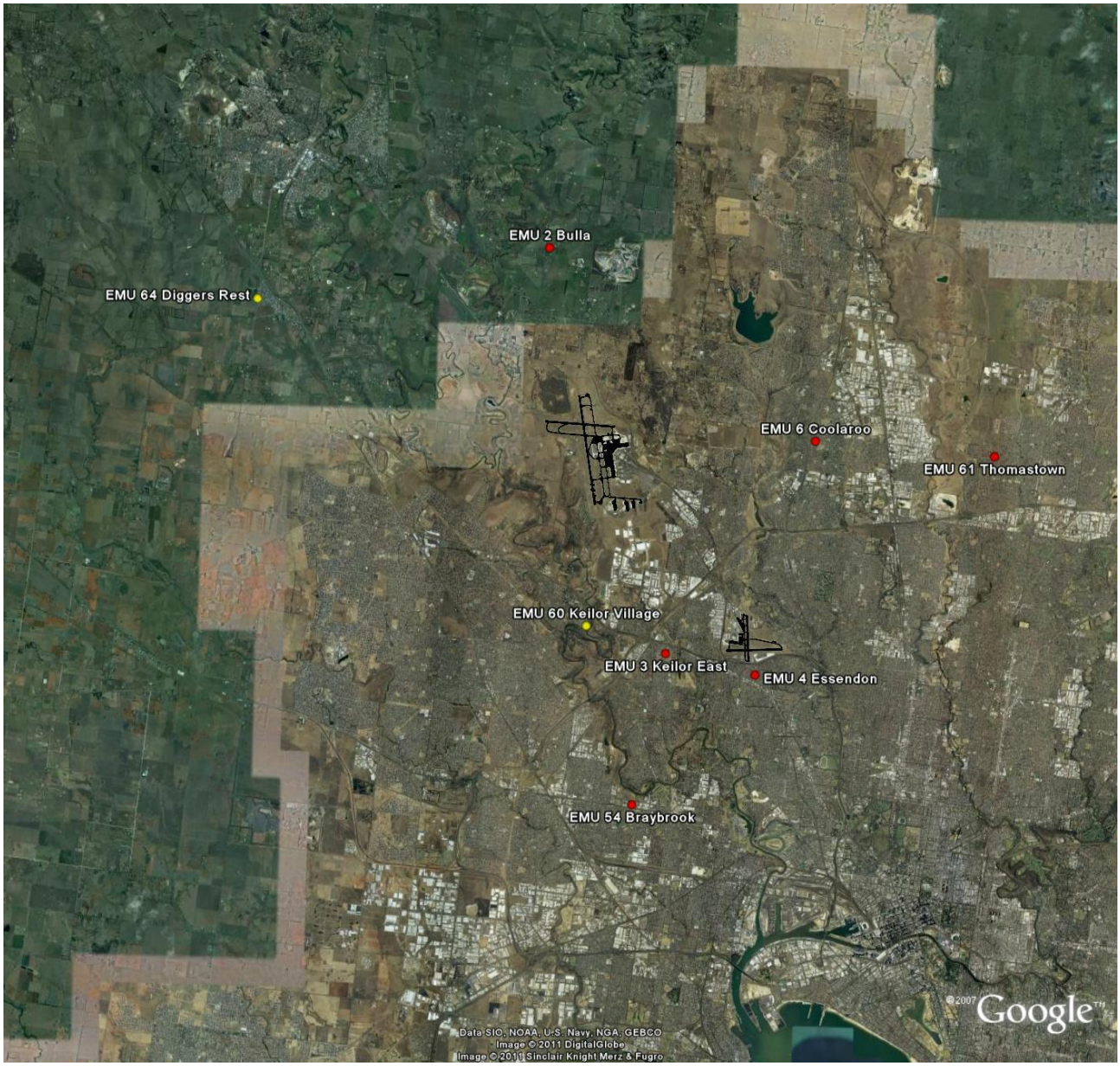
4) The adequacy of the NFPMS at Melbourne (including Essendon) with respect to placement and coverage of noise monitors, and
5) The location of each EMU with respect to the population density.

5 Melbourne EMU Background

The NFPMS has been installed and operating around Melbourne and Essendon since 1994. The Melbourne component of the NFPMS currently has six permanently installed EMUs and two portable EMUs which are strategically located around Melbourne and Essendon Airports as shown below in Figure 1.

EMU 54 at Braybrook has very recently been decommissioned due to the school at which it was located being vacated. Recommendations for the EMU's relocation have been given in this report.

Figure 1 Melbourne and Essendon EMU Locations



In the above image, permanent EMUs are coloured red and portables are yellow.

5.1 Current EMU Locations

The exact location of each EMU is given in the table below with details of the runway to which the EMU is aligned.

Table 1 Permanent EMU Locations

	EMU 54 (Braybrook)	EMU 2 (Bulla)	EMU 3 (Keilor East)	EMU4 (Essendon)	EMU61 (Thomastown)	EMU 6 (Coolaroo)
Longitude	144°51'22.32" E	144°49'23.31" E	144°52'8.45"E	144°54'14.76" E	144°59'50.35"E	144°55'38.28" E
Latitude	37°46'44.76"S	37°36'24.70"S	37°43'56.20"S	37°44'19.68"S	37°40'15.06"S	37°39'59.04"S
Altitude (m)	120	120	65	209	140	120
Main Runways aligned with	16 / 34	16 / 34	08 / 26 (Essendon)	17 / 35 (Essendon)	09 / 27	09 / 27
Distance to Runway end (DL)	10.4 km	5.2 km	2.4 km (Essendon)	0.5 km (Essendon)	13.1 km	7 km
Distance to Runway centerline (DS)	0.3 km	0.3 km	0 km (Essendon)	0.2 km (Essendon)	0 km	0 km
Current Noise Capture Threshold radius (km)	2.5km	4.0km	1.5km	1.5km	1.5km	3.0km

Table 2 Portable EMU Locations

	EMU 60 (Keilor Village)	EMU 64 (Diggers Rest)
Longitude	144°50'17.01"E	144°42'33.03"E
Latitude	37°43'25.79"S	37°37'22.43"S
Altitude (m)	56	226
Distance to Runway end (DL)	4.2 km	10.4 km
Distance to Runway centerline (DS)	1.0 km	3.6 km
Current Noise Capture Threshold radius (km)	2.0km	2.5km

5.2 History of EMU Locations

Permanent EMU locations were chosen based on their close proximity (within 10 km) from the airport and location directly under the flight paths at the time.

Supplementary noise studies have also been conducted in Sunshine North in 2004, Pascoe Vale in 2005, Newport Lakes in 2007 and Diggers Rest in 2009. Diggers Rest, Pascoe Vale and Newport Lakes data was included in the Quarterly NFPMS reports. In the case of Sunshine North, a detailed report was produced that presented the results of noise data collected over a

period of almost seven months (23/7/2004 to 21/2/2005). The report demonstrated that the average noise data was similar to what was collected at nearby EMUs at Braybrook and Keilor East. The report showed that there are some operations out of Melbourne Airport which were unique to Sunshine North site; these represented approximately 5% of the overall noise data at the study site. While the study site met the criteria for fixed EMUs, the great majority of aircraft noise events were covered by other nearby fixed EMUs, therefore establishment of a permanent site was considered unnecessary.

6 Overall Correlated Noise Events and NFPMS Performance

The NFPMS relies on the capture and correlation of aircraft noise, therefore one measure to determine the effectiveness of the EMU system as a whole is to compare the number of flights that do not cause a correlated noise event (CNE) with the total number of movements. This provides an indication of how well the system captures and correlates aircraft noise as a whole and how many movements were potentially missed.

A non event may be caused by:

a) Aircraft noise levels being too low at the EMU due to aircraft type,

b) Large distances between the aircraft and the nearest EMU,

c) Incorrect threshold settings of the EMU, or

d) Meteorological effects.

High background noise levels have the reverse effect by causing a CNE that may be corrupted by extraneous (non-aircraft) noise.

The following tables present a summary of flights without correlated noise events compared with the total movements for the quarter for Melbourne airport only.

Table 3 Arrivals – non-correlated / total movements

Period	Q1 2010	Q2 2010	Q3 2010	Q4 2010
Jets	5390 / 21874 (24%)	2916 / 22457 (13%)	216 / 23487 (1%)	482 / 23815 (2%)
Non – Jets	854 / 2706 (32%)	514 / 2825 (18%)	152 / 2854 (5%)	160 / 2867 (6%)

Table 4 Departures - non-correlated / total movements

Period	Q1 2010	Q2 2010	Q3 2010	Q4 2010
Jets	14265/ 21836 (65%)	13130 / 22432 (59%)	11870 / 23461 (51%)	11695 / 23777 (49%)
Non – Jets	2423 / 2703 (90%)	2816 / 4020 (70%)	2200/ 2846 (77%)	2058 / 2859 (72%)

Note that Helicopters and “unknowns” are excluded from the above table. Unknowns are usually aircraft that do not have a flight plan recorded in the air traffic control system and are mainly smaller propeller driven General Aviation aircraft.

The above tables indicate that in general, a large amount of aircraft movements associated with Melbourne airport travel outside the coverage area of the noise monitors within the NFPMS. This is mainly due to air traffic to the west of the airport that fly over generally unpopulated areas in the immediate vicinity of the airport. In quarter four, 52.7% of all departures were from runway 27 to the west making it the predominant runway used. There is currently no noise monitor directly under the flight path in this location. Noise monitors are typically placed in areas that are populated to capture the noise impact. There is no point in monitoring noise levels in uninhabited areas.

For non-jets, the high percentage of non-correlated movements is due to the sometimes variable flight paths of these smaller aircraft types resulting in the aircraft being further away from the EMUs. Also, non-jet aircraft produce noise levels that are lower than jets and may not meet the EMU threshold settings.

7 Complaints Analysis

The following sections analyse complaints for Melbourne and Essendon airports separately and show where the EMUs are positioned in relation to complaints. The complaints data is gathered from November 2009 to October 2010.

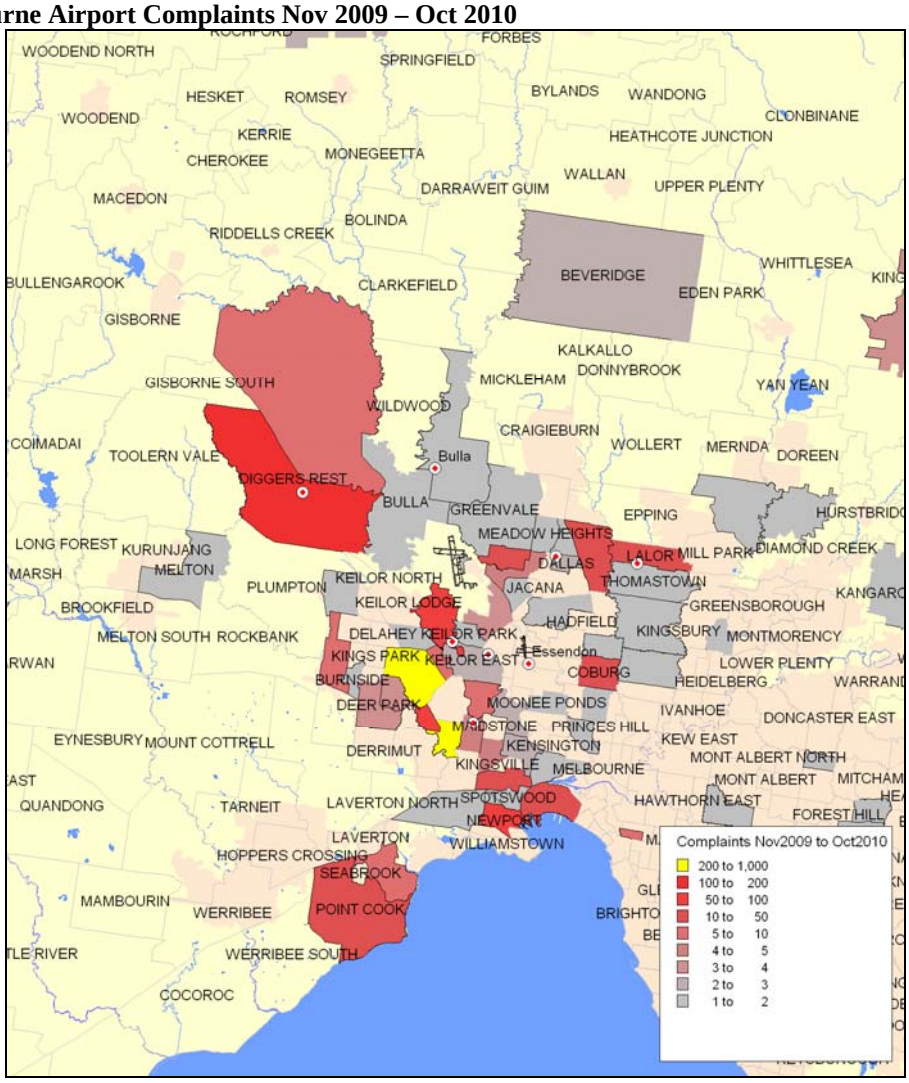
Table 5 Total Number of Complaints and Complainants (Nov 2009 to Oct 2010)

Airport	Complaints	Complainants
Melbourne	1251	174
Essendon	231	120

7.1 Complaints Density

The following figure shows a thematic map of complaints for Melbourne Airport from Nov 2009 to Oct 2010.

Figure 2 Melbourne Airport Complaints Nov 2009 – Oct 2010



The highest numbers of complaints in the period were received from the suburbs of St Albans and Sunshine (highlighted yellow on the map above). Note that the above figure relates to complaints for Melbourne Airport only.

A better measure to determine the number of persons affected or community impact from aircraft noise is to assess the number of complainants rather than the actual number of complaints. The figure below presents a graphic where suburbs are highlighted if they have complainant numbers of 5 or more.

Figure 3 Melbourne Airport Suburbs with 5 or more Complainants Nov 2009 to Oct 2009

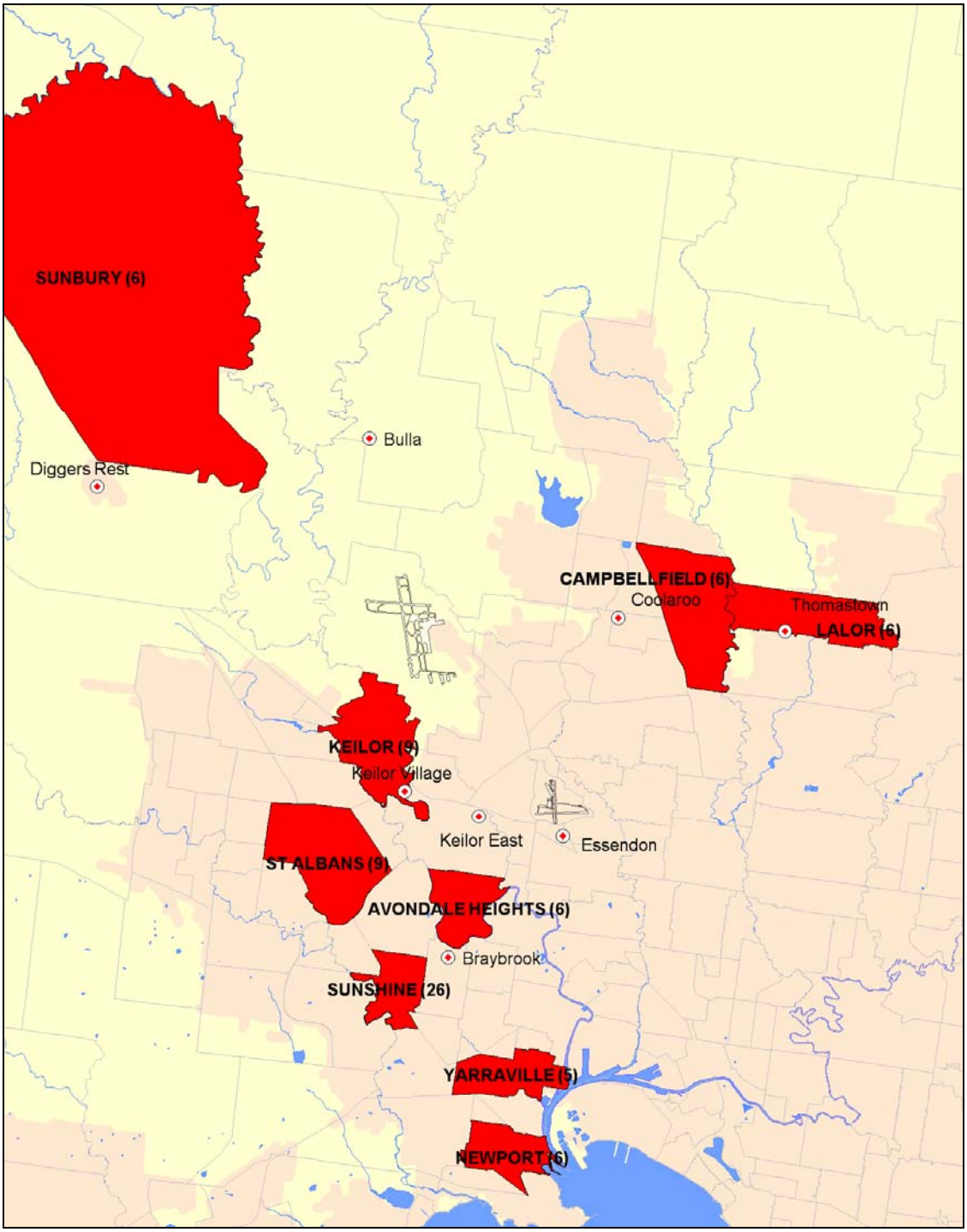
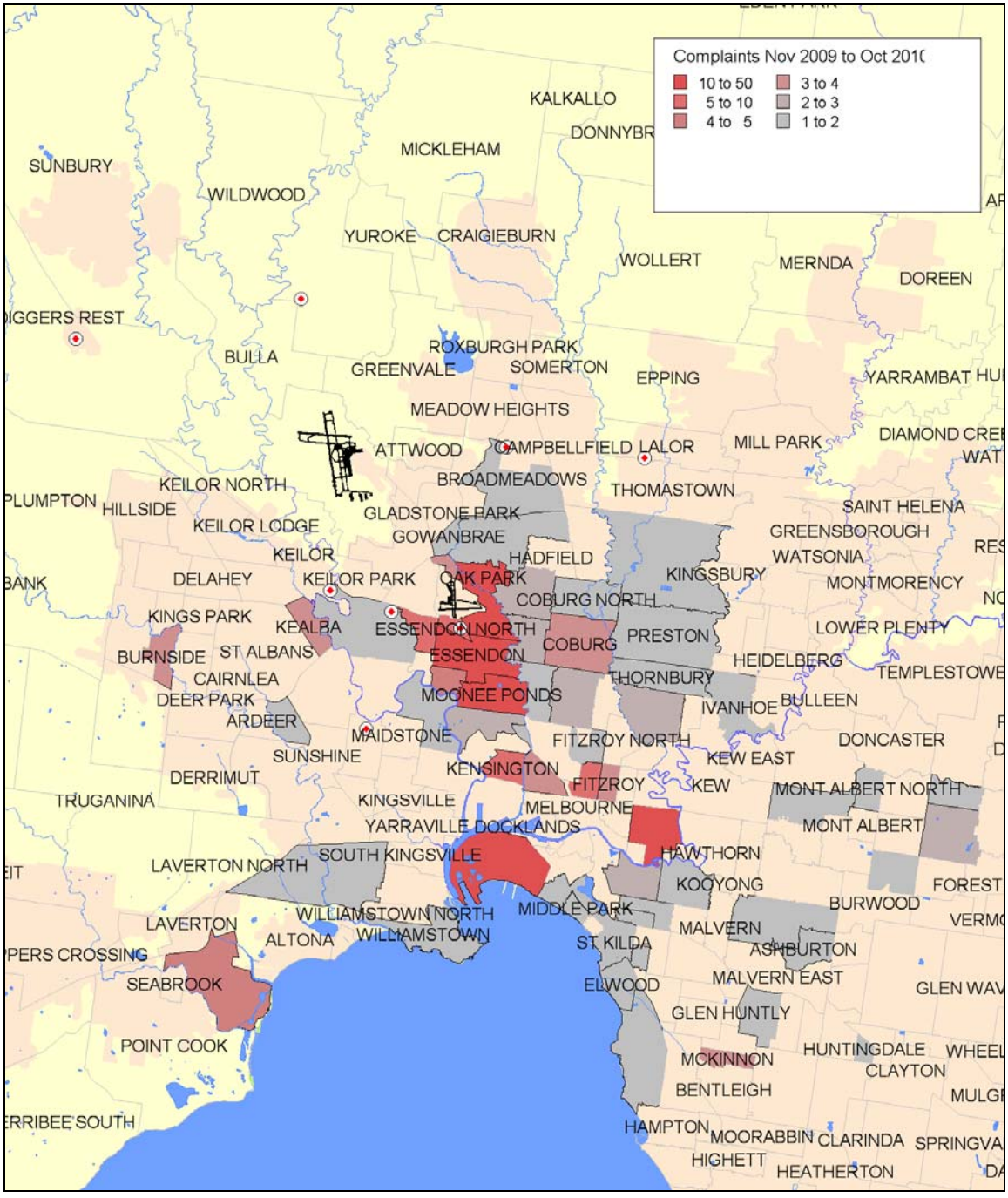


Figure 3 shows suburbs with relatively high numbers of complainants relating to Melbourne Airport operations. The total numbers of complainants are given within the brackets. The

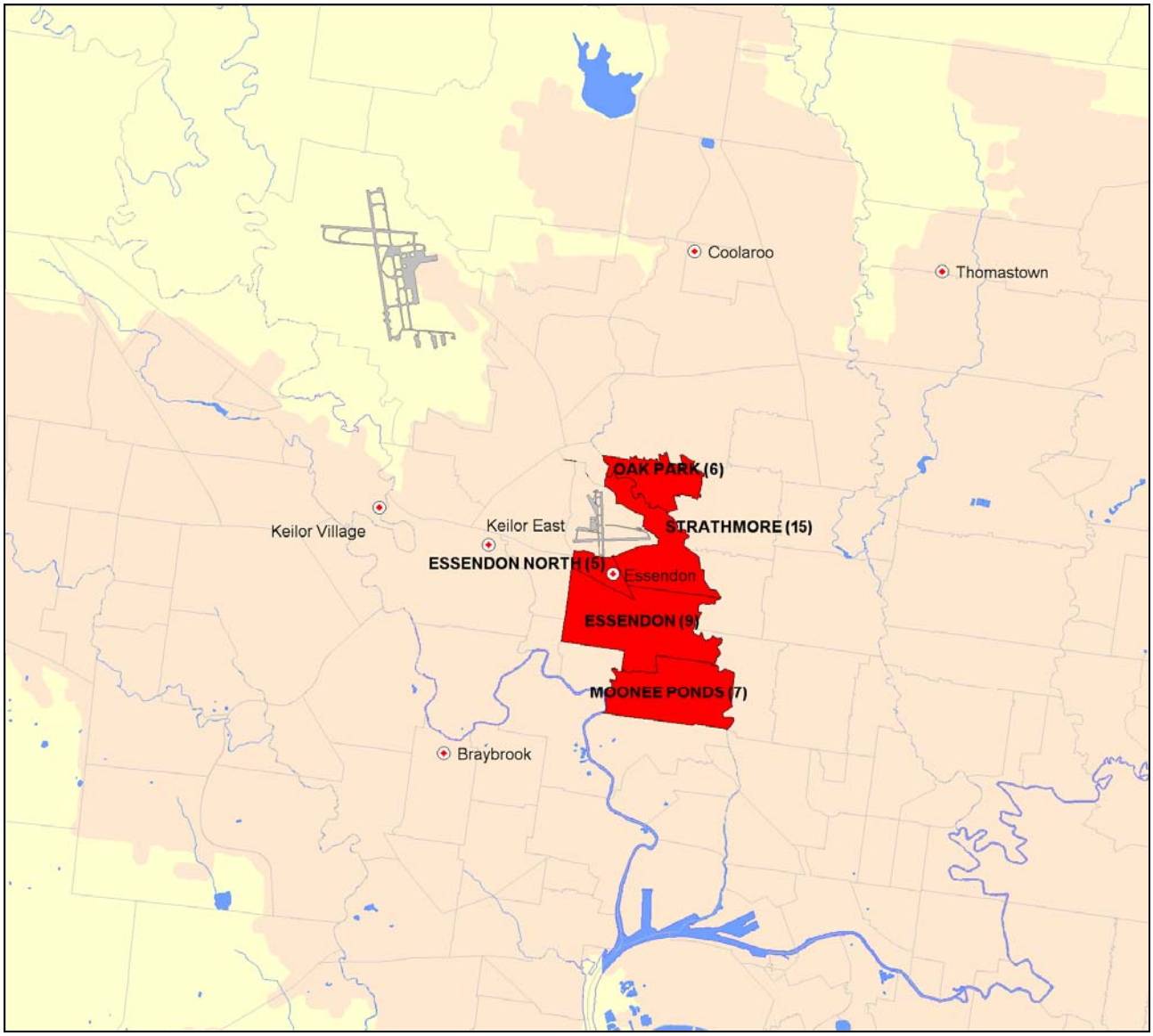
suburbs to the south of the airport at Avondale Heights, Sunshine, Yarraville and Newport are generally outside areas covered by current EMU locations (noting that EMU 54 at Braybrook is currently non-operational).

Figure 4 Essendon Airport Complaints Nov 2009 – Oct 2010



Complaints relating to Essendon Airport are mainly concentrated around the airport and to the north, south and east. The area directly east of Essendon falls outside the range of the existing EMUs. Note that the above complaints relate to Essendon Airport only.

Figure 5 Essendon Airport Suburbs with 5 or more Complainants Nov 2009 to Oct 2009

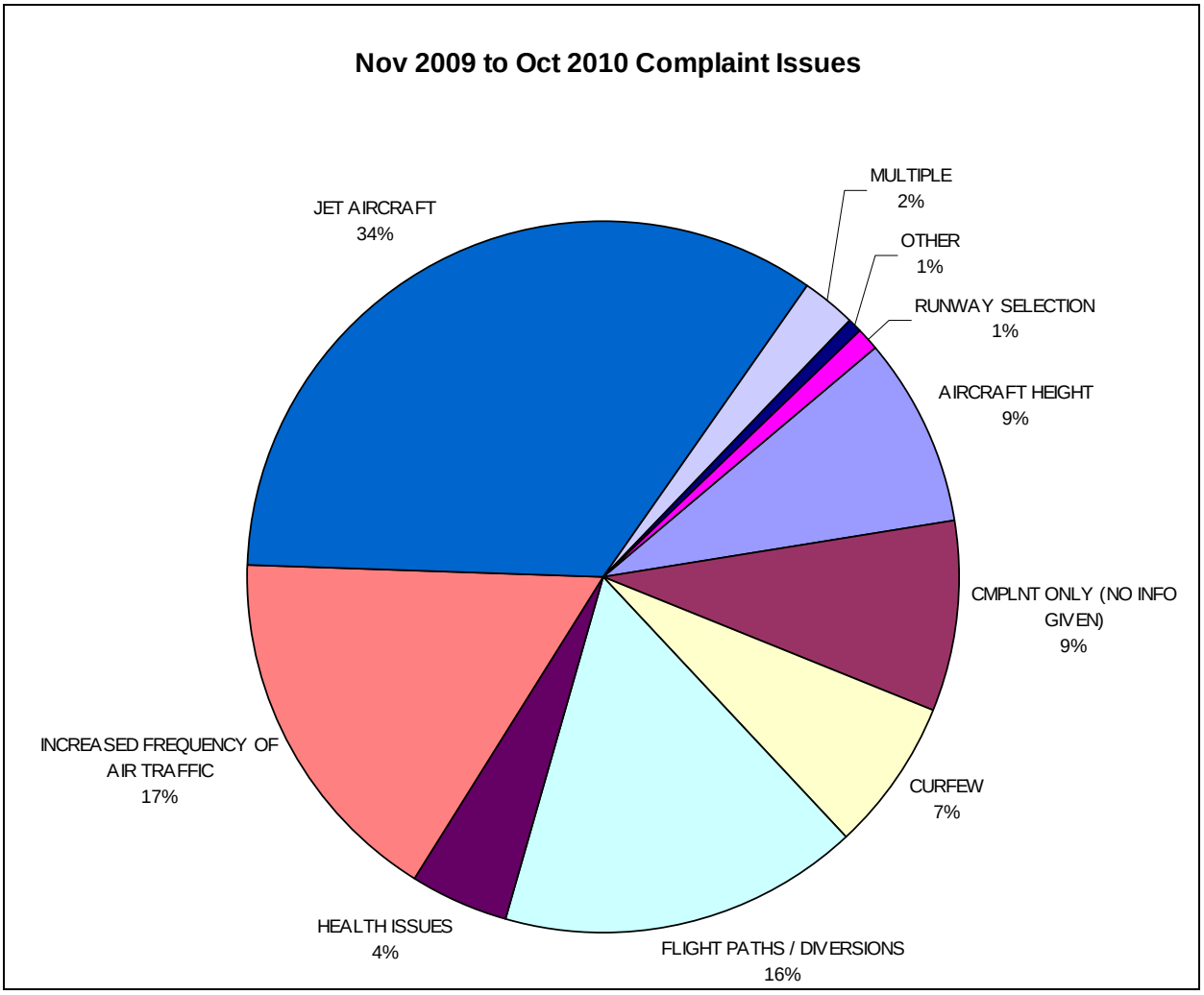


The above figure presents the suburbs that have five or more complainants relating to operations at Essendon airport. The numbers in brackets are the actual numbers of complainants.

7.2 Key Issues of Complaints

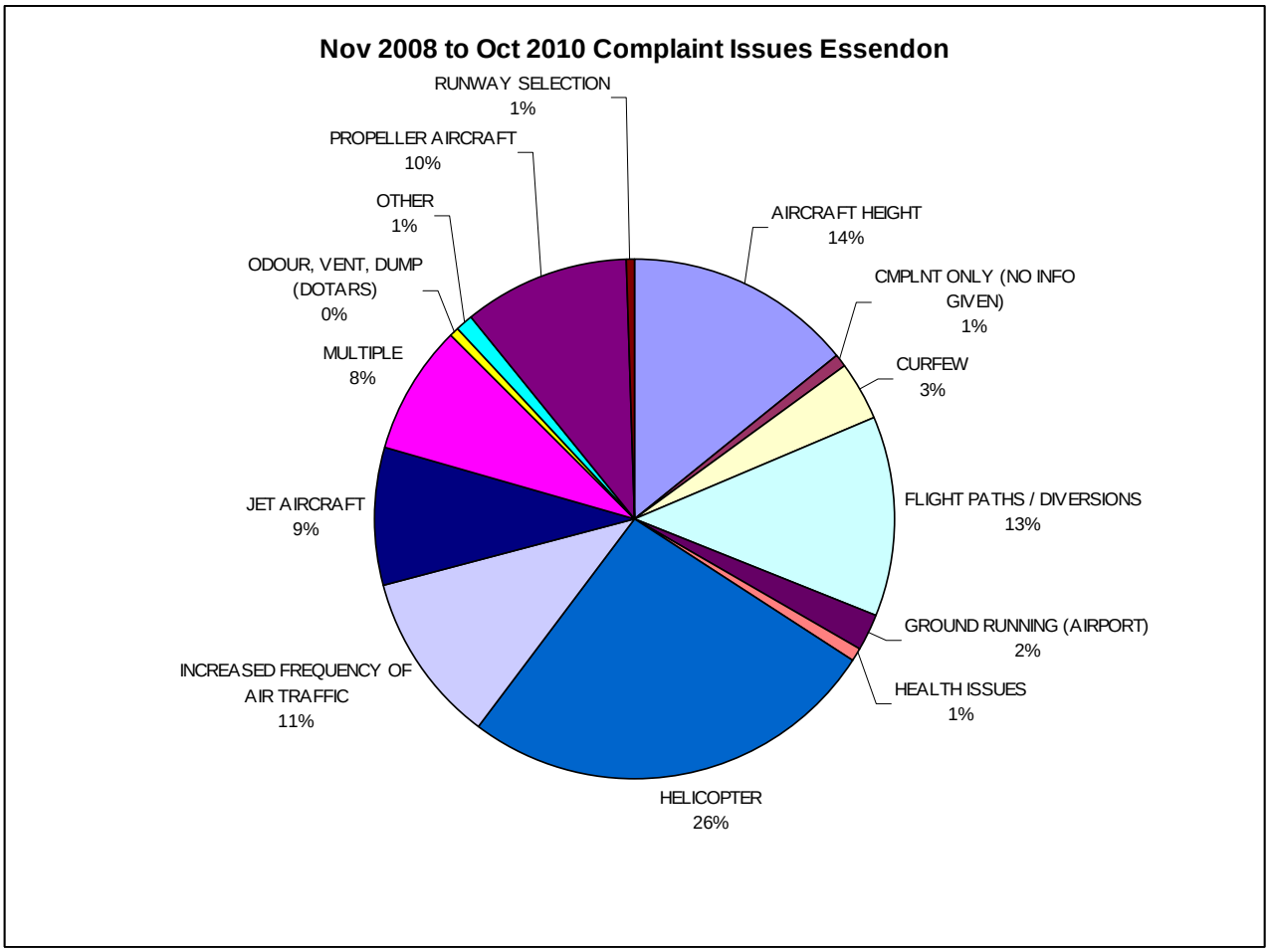
Each complaint can be related to a number of issues. The table below presents the complaint issues for complaints relating to Melbourne airport, gathered over November 2009 to October 2010. The key issues were related to jet aircraft, increasing flight traffic and flight paths/deviations.

Table 6 Melbourne Airport Complaint Subjects Nov 2009 – Oct 2010



The above figure highlights the main issues of complaints associated with Melbourne airport. The chart shows no specific attention to any issue that can be easily related to EMU placement. The category Multiple is used when a single complaint relates to a number of aircraft operations.

Table 7 Essendon Airport Complaint Subjects Nov 2009 – Oct 2010



The above figure shows that a greater amount of complaints from Essendon airport relate to helicopters and propeller driven aircraft compared to Melbourne airport. Also, ground running and aircraft height related complaints are received. This is likely due to the close proximity of houses to the airport.

7.3 Complaints with Respect to Flight Paths

Complaints with respect to flight paths have been assessed in the following section. The three figures below overlay complaint data with jet movements from a typical single week, aligned with the standard flight routes for arrivals and departures. Note that the third figure below of Essendon has been shown with all aircraft types rather than just jets.

Figure 6 Melbourne Airport Complaints with Respect to Jet Departures

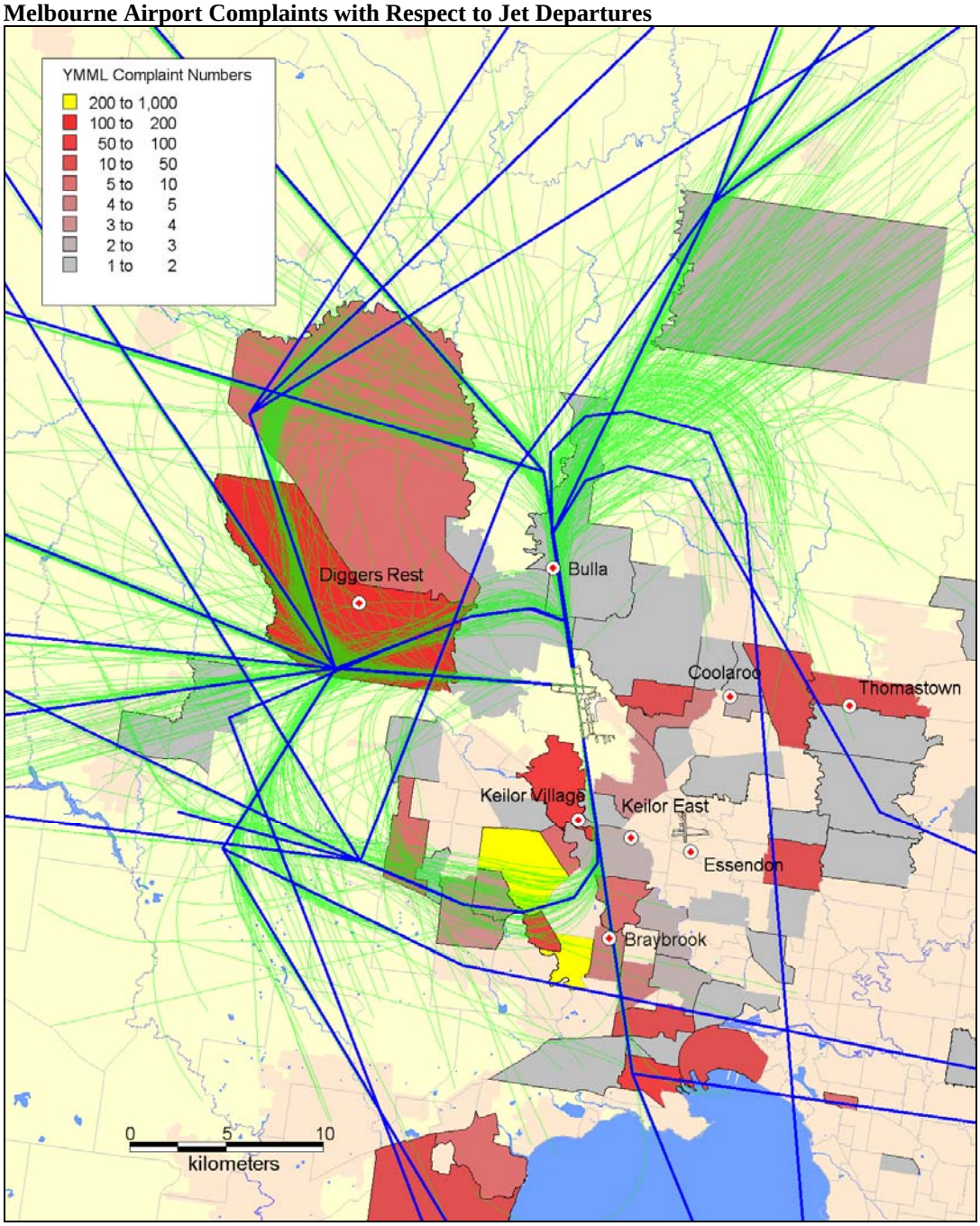


Figure 6 shows how actual flight paths of aircraft correlate with Standard Instrument Departures (in bold lines above) during a one week period. The figure shows how some track shortening occurs over the Diggers Rest area with aircraft departing on cross runway 09/27 to the west then turning north. Note that the population of Diggers Rest lies close to the portable

monitor and the majority of flight traffic through this area is located over non-residential areas.

In the figure above, a large number of Jet aircraft that depart to the south turn to the west after the Keilor Village EMU. The aircraft generally follow the SIDs but turn differently depending on the performance capability and characteristics of the aircraft. This produces the spread of aircraft over the Sunshine and St Albans suburbs.

Figure 7 Melbourne Airport Complaints with Respect to Jet Arrivals

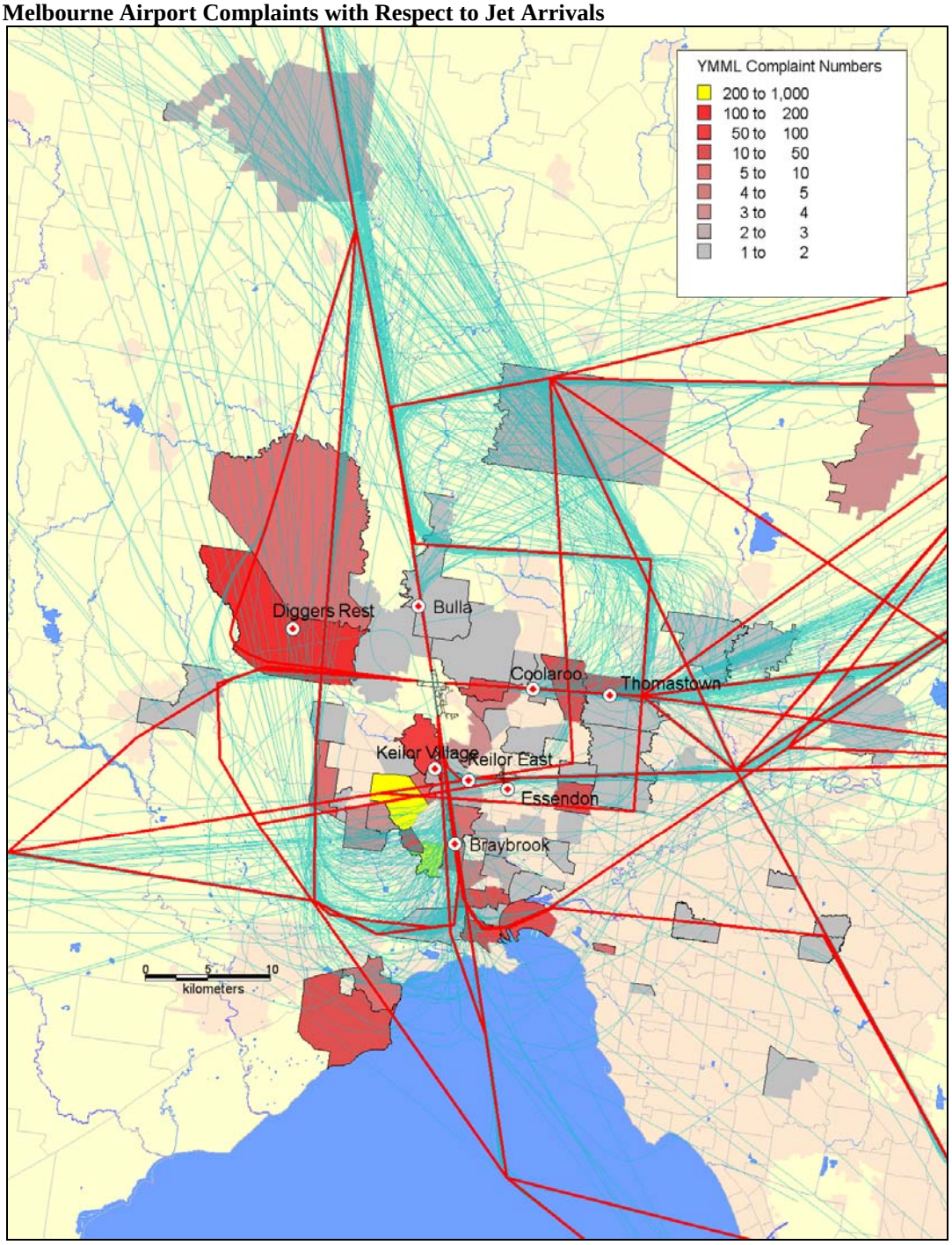


Figure 7 shows the high concentration of flight traffic south of the airport around the Braybrook monitor and the large amount of complaints that relate to operations arriving from

the south. Some deviation from the STARs can be seen in the above image due to track shortening for aircraft sequencing.

Figure 8 Essendon Airport Complaints with Respect to Flight Paths (all aircraft types)

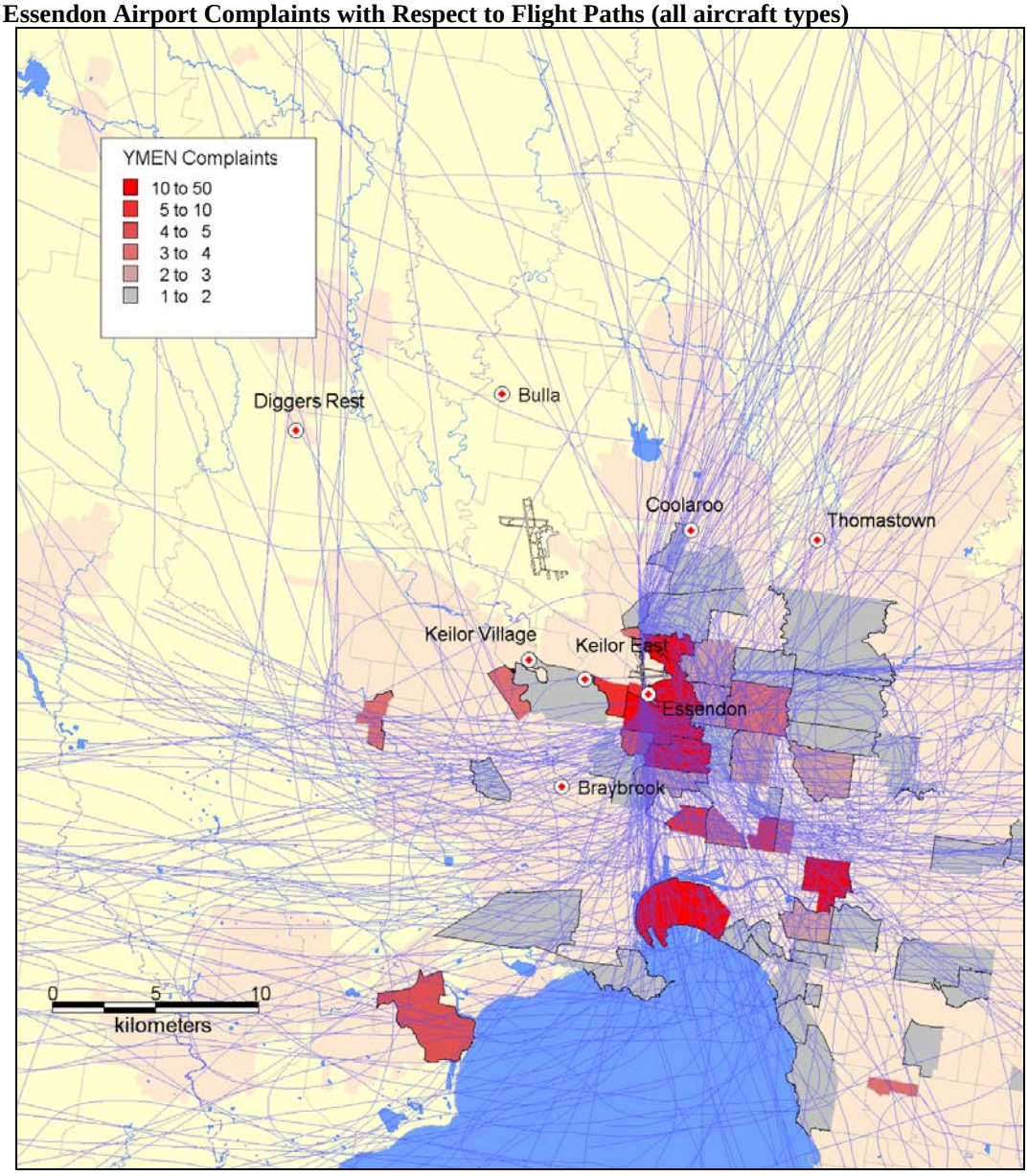


Figure 8 shows that the majority of Essendon traffic and complaints are located on the eastern side of the airport. The area to the immediate east is not generally covered by current EMU locations. It is difficult to place monitors for Essendon Airport as the aircraft tracks are generally more spread out and these sorts of aircraft often don't lodge detailed flight plans.

7.4 Complaints in Relation to EMU Locations

When reviewing the thematic maps provided above of complaints data, the following observations can be made:

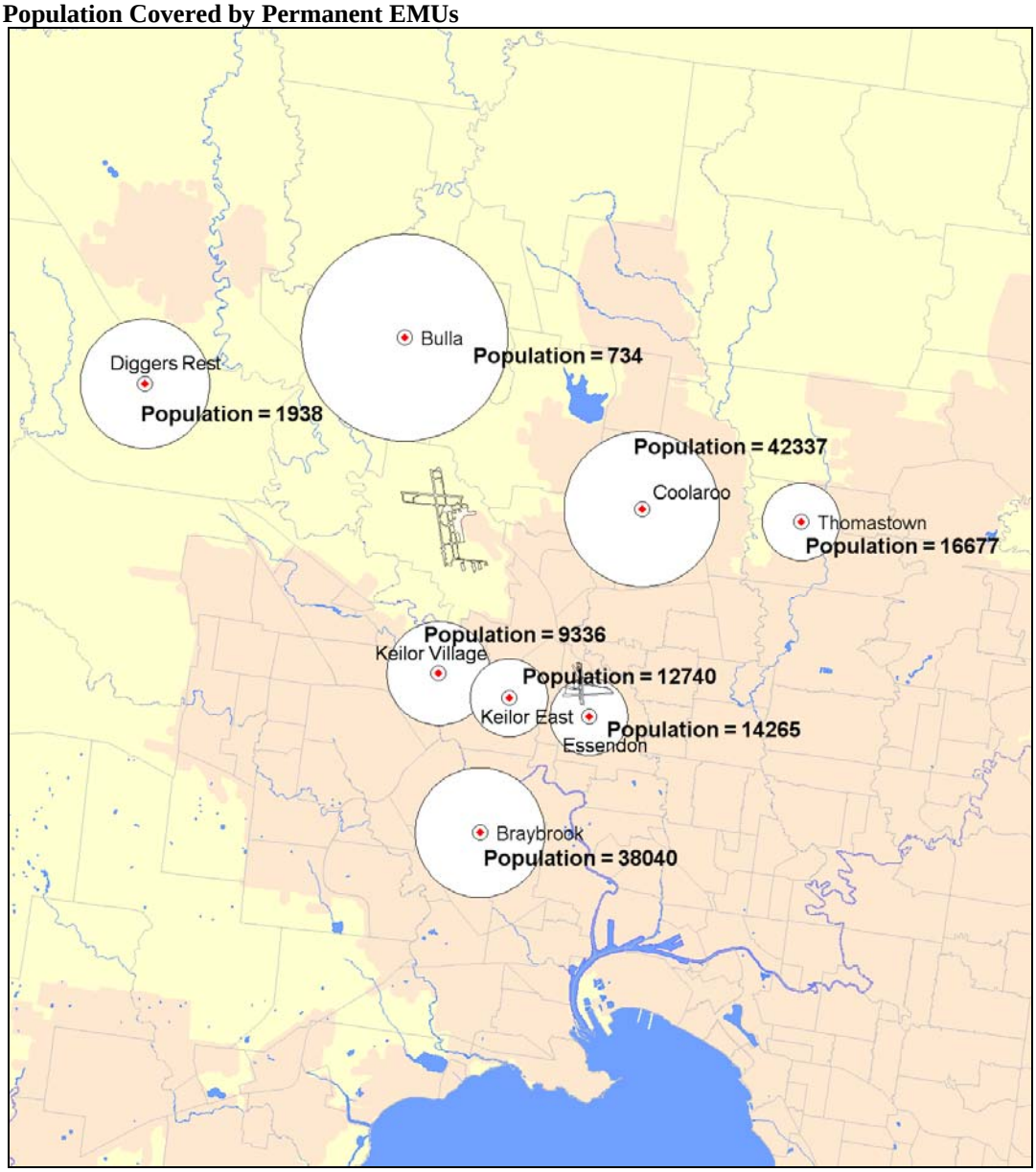
- There is some deviation between actual aircraft flight paths and the standard operating procedures, mainly evident on aircraft turns.
- Some track shortening over Diggers Rest is evident from departures off the cross runway when aircraft turn north.
- There is a wide spread of movements as aircraft depart south of the main runway then turn west over the suburbs of Sunshine and St Albans.
- Flight traffic around Essendon is generally wide spread and follows less of a distinct path due to smaller aircraft types. There is a fairly high concentration of movements to Essendon's east and north that correspond with complaint data.
- A large amount of aircraft movements and complaints relate to the area directly south of Melbourne airport aligned with the main runway. The permanent EMU 54 at Braybrook previously covered aircraft from this direction and needs to be reinstalled in a similar location.
- Sensitive areas that would benefit from short term noise monitoring and that have not previously been monitored include:
    - north and north east of Essendon.
    - south west of Melbourne airport around Caroline Springs.

7.5 Population within Capture Threshold

The population within the capture zone of each EMU is assessed below to help determine how useful EMU locations are in relation to community coverage.

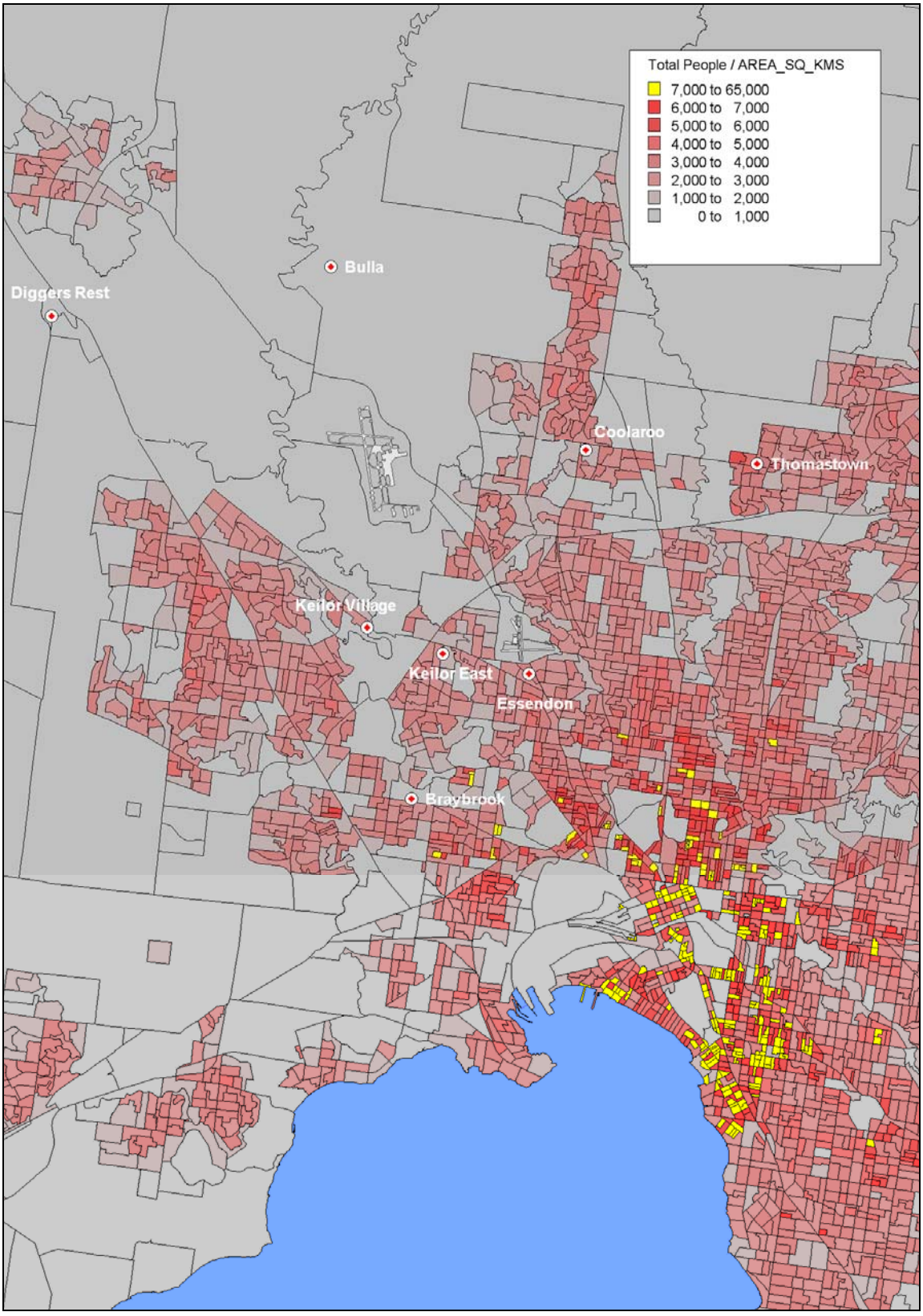
The population around each EMU has been calculated using available 2006 census data from the Australian Bureau of Statistics (ABS). The settings of each EMU have been used to determine the population within each capture zone. The capture zones are highlighted below.

Figure 9 Population Covered by Permanent EMUs



The highest population coverage is from EMU 6 at Coolaroo followed by EMU 54 at Braybrook. To determine the overall population density for Melbourne, a thematic map has been created and shown below for population per square km.

Figure 10 Overall Population per Square Km



The figure above is used to display the heavily populate areas of Melbourne. It shows the heavily populated areas south east of the airport and that Essendon airport is surrounded by

areas that are moderately populated. Some high density hot spots exist near the Braybrook EMU.

8 Analysis of Sensitive Areas

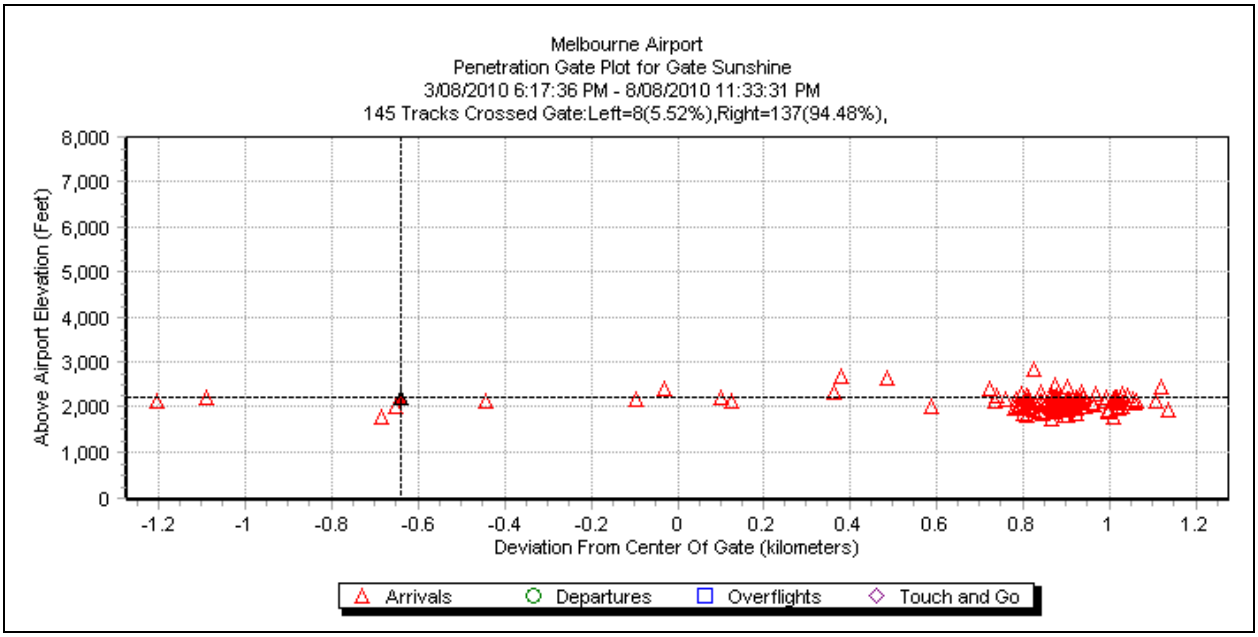
The following section analyses sensitive areas of Melbourne in relation to aircraft noise that have been shown to have the greatest number of complaints and complainants. Other sensitive areas exist, however these areas have been analysed in detail because they are within close proximity to the airport, have a high population and are regularly overflown.

8.1 Sunshine

High levels of complaints have been received from the suburb of Sunshine which is located south of Melbourne Airport. This suburb has a population of 8,075 people according to the 2006 Census data. This suburb has recorded 352 complaints from 26 complainants from October 2009 to November 2010.

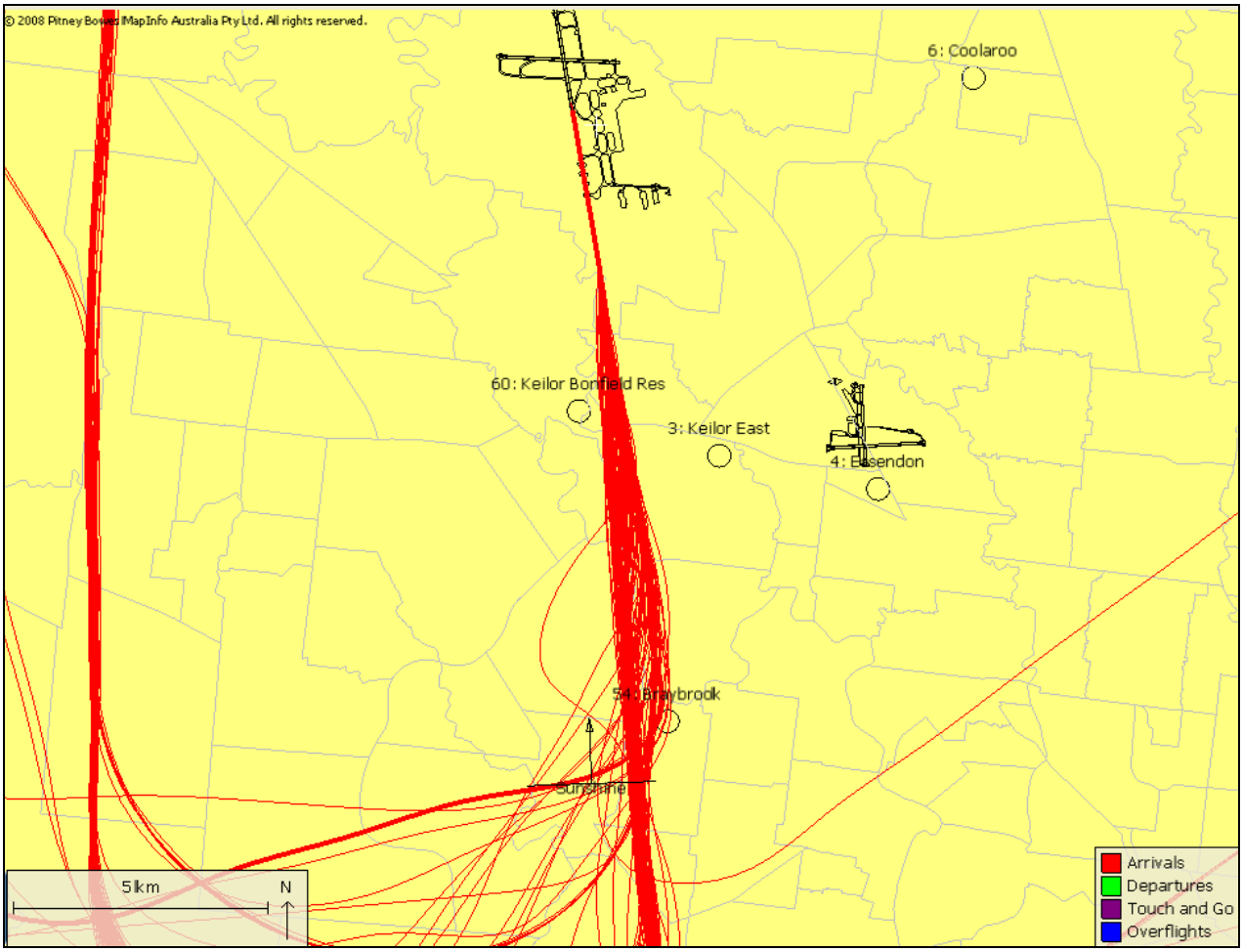
The main aircraft movements over the suburb are arrivals and departures onto the main runway.

Figure 11 Aircraft Heights above Sunshine East to West Gate (1st week August 2010)



The above figure shows aircraft movements in one week of August that track over the suburb of Sunshine.

Figure 12 Gate Location at Sunshine



The above image is sourced directly from the Noise and Flight Path Monitoring System and it should be noted that EMU 60 is designated as Keilor Bonfield Res in the system in place of Keilor Village.

8.2 St Albans

High levels of complaints have been received from the suburb of St Albans which is located south west of Melbourne airport. This suburb has a population of 33,509 people according to the 2006 Census data. This suburb has recorded 366 complaints from 9 complainants from October 2009 to November 2010.

The main aircraft movements over the suburb are departures from the main runway which traverse the southern part of the suburb.

Figure 13 Aircraft Heights above St Albans North to South Gate (1st week August 2010)

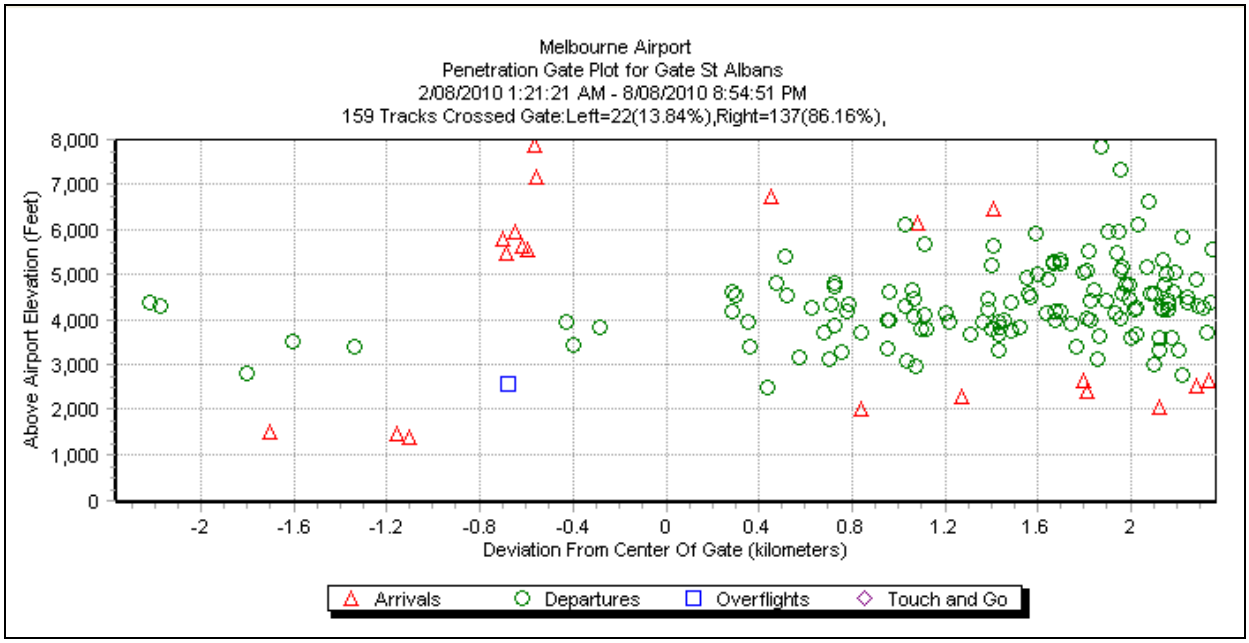
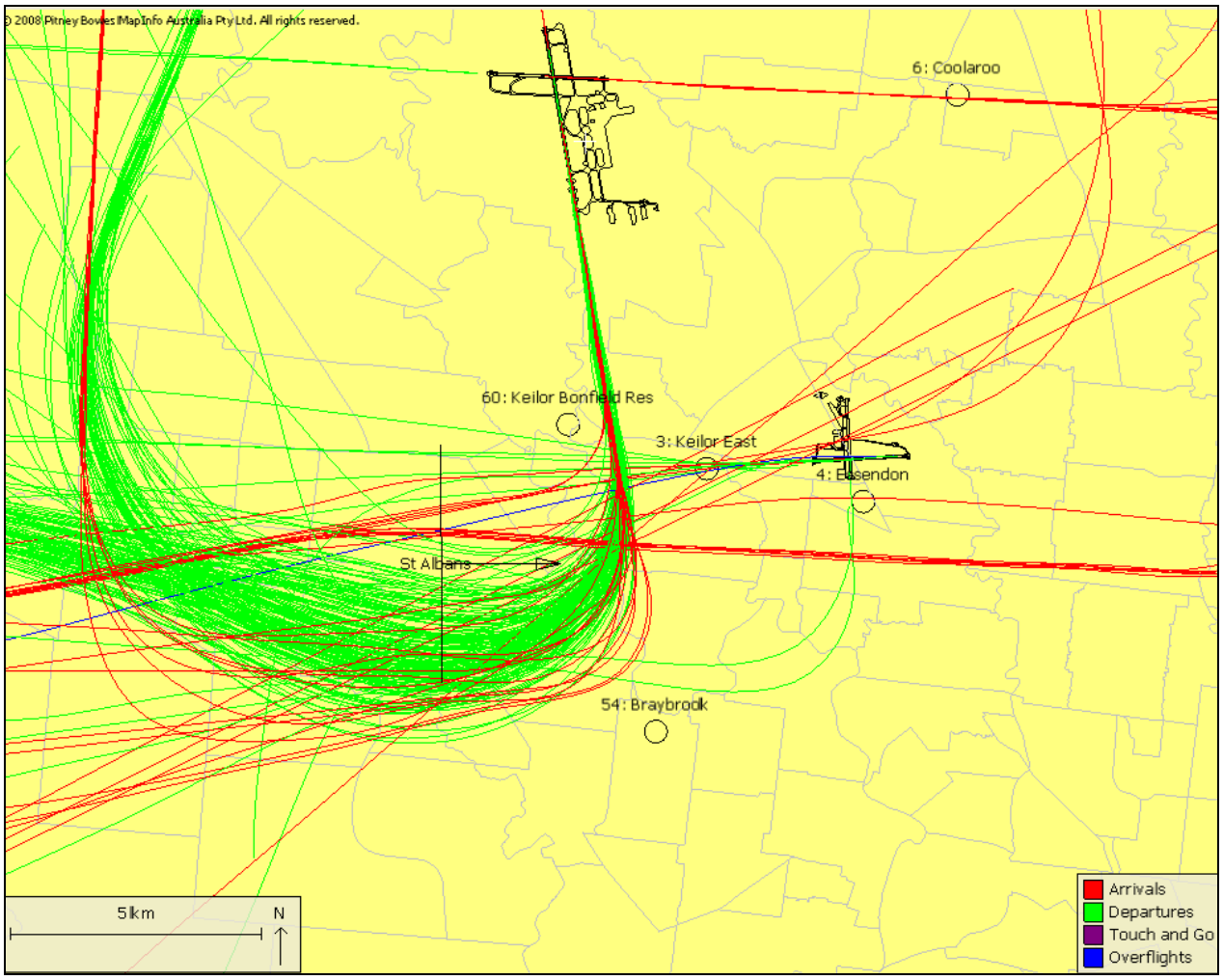


Figure 14 Gate Location at St Albans



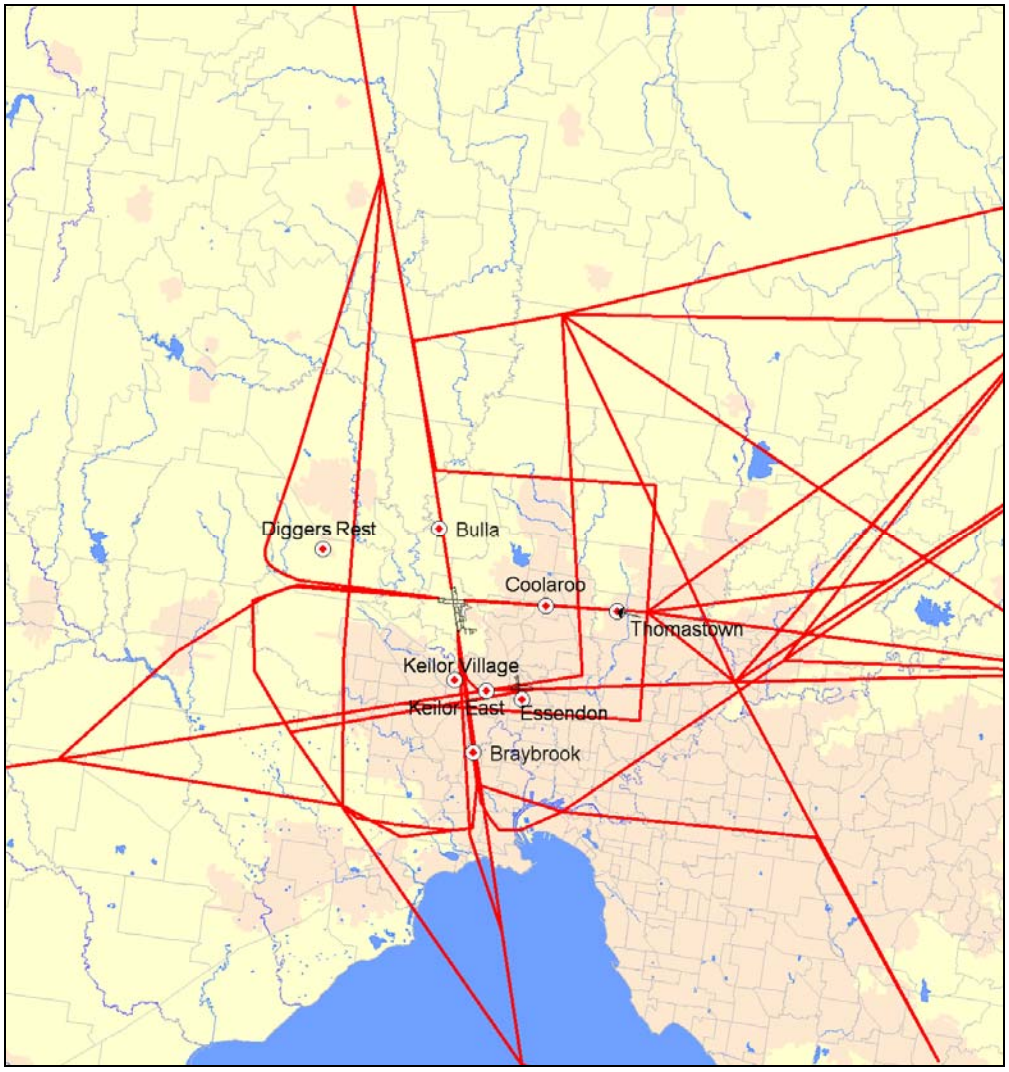
The above image is sourced directly from the Noise and Flight Path Monitoring System and it should be noted that EMU 60 is designated as Keilor Bonfield Res in the system in place of Keilor Village. The gate location at St Albans is shown above in black.

9 Overall Flight Path Analysis

EMU locations have been assessed against the current Standard Arrival Routes (STARs) and Standard Instrument Departures (SIDs). Jet STARs and SIDs can be seen above in Section 7.3 with flight track information and below. A list of all STARs and SIDs can be seen in Appendix B.

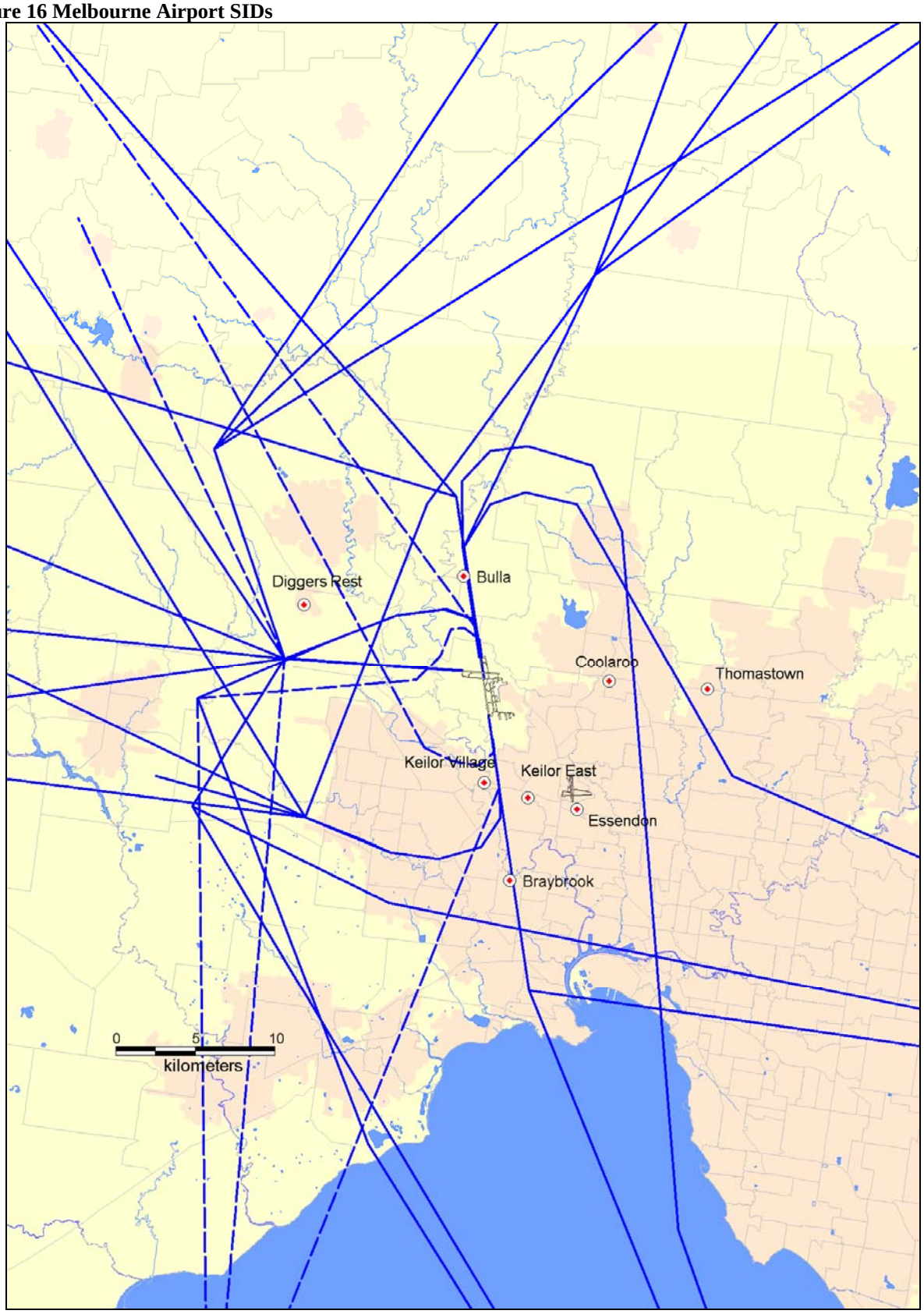
The jet STARs and SIDs are presented in Figure 15 and Figure 16 below in red and blue respectively. Jet procedures have been used in the following analysis as they are associated with the greatest impact to the community.

Figure 15 Melbourne Airport STARs



As shown above, permanent EMUs align well with respect to the current STARs. Problems occur where aircraft seem to stray from STARs as shown in Figure 7.

Figure 16 Melbourne Airport SIDs



Current SIDs to the west off the cross runway are not covered by EMUs, however these areas are not densely populated. The dotted lines represent dedicated non jet SIDs.

10 Communications Coverage and Reliability

The following table presents the number of days that each EMU was available to collect data over 2010. Note that the total possible number of days is within the brackets. Outages occur due to:

- Network outage,
- Preventative Maintenance,
- Internal calibration,
- Power outages,
- Internal faults within the EMU itself.

Table 8 Analysis of Operational Days

Number	Location	Q1 (90)	Q2 (91)	Q3 (92)	Q4 (92)
EMU 2	Bulla	89.8	90.7	91.7	91.7
EMU 3	Keilor East	89.7	85.6	91.7	91.7
EMU 4	Essendon	89.8	90.7	91.7	91.7
EMU 6	Coolaroo	89.7	90.6	91.7	91.7
EMU 54	Braybrook	79.4	90.7	48.3	N/A
EMU 60	Keilor Village	89.8	90.6	91.7	91.7
EMU 61	Thomastown	89.8	90.7	91.7	91.7
EMU 64	Diggers Rest	89.8	90.2	91.6	91.8

Each permanent EMU achieved good availability over 2010 with the exception of EMU 54 (Braybrook). EMUs were partially operational only during brief periods of preventative maintenance and internal calibration. No major communication concerns have been identified.

EMU 54 ceased to be operational due to a site power issue from 18th August 2010. The site became unoccupied by the owner in this month and therefore was a security risk until decommissioned in February 2011.

11 ISO 20906:2009 Requirements

ISO 20906:2009 relates to unattended permanent monitoring of aircraft noise in the vicinity of airports. To be compliant with this standard, the following site requirements are relevant:

- Aircraft noise should be at least 15dB above the non-aircraft background noise;
- Angle of elevation of aircraft relative to the ground plane is to be greater than 30 degrees;
- The line-of-sight angle to the flight path should be free of any obstructions for at least 70 degrees;
- Microphone is to be 6 m from ground and 10 m from reflecting surfaces (to limit the uncertainty of measured noise data);
- Meteorological conditions (except wind) need to be monitored close to airport;

- Wind conditions need to be monitored at several sites;
- Noise events that occur for wind speeds >10 m/s should be flagged by the system;
- Calibration of noise and meteorological instrumentation need to be performed yearly;
- An estimate of the uncertainty for measurements must be made.

The current Noise and Flight Path Monitoring System is in general accordance with the above requirements with the exception of wind conditions and an estimate of uncertainty. Noise events measured during periods of wind speed greater then 10 m/s are currently not flagged. Therefore, the NFPMS runs the risk of reporting on noise levels that may be elevated due to high wind conditions.

11.1 EMU Calibration and Preventative Maintenance

EMU preventative maintenance and site inspection for each permanent site is performed annually. An EMU Maintenance Report is produced by the Service Provider. For 2010, the annual maintenance report was dated 3rd Sep 2010 and contained the following summary:

Table 9 Preventative Maintenance Summary 2010

EMU	Location	Date	Details
2	Bulla	30/08/10	Replaced Microphone, wind screen and SIM card
3	Keilor East	17/08/10	Replaced Microphone and SIM card
4	Essendon	17/08/10	Replaced Microphone
61	Thomastown	30/08/10	Replaced Microphone and SIM card
6	Broadmeadows (Coolaroo)	18/08/10	Replaced Microphone and SIM card
60	Keilor Village	30/08/10	Replaced Microphone and SIM card
64	Diggers Rest	18/08/10	Replaced Microphone and SIM card

Automatic calibration checking is performed daily using an electrostatic calibration test. Daily calibration is performed 4 times a day. Calibration checking can also be performed adhoc as required.

Annual acoustic calibration is performed at each site. For 2010, all microphones were replaced at Melbourne during preventative maintenance and calibrated. Calibration results are provided in the EMU Maintenance Report.

The above calibration methods are in accordance with Section 4.8 of ISO20906:2009(E).

11.2 Average Elevation Angle

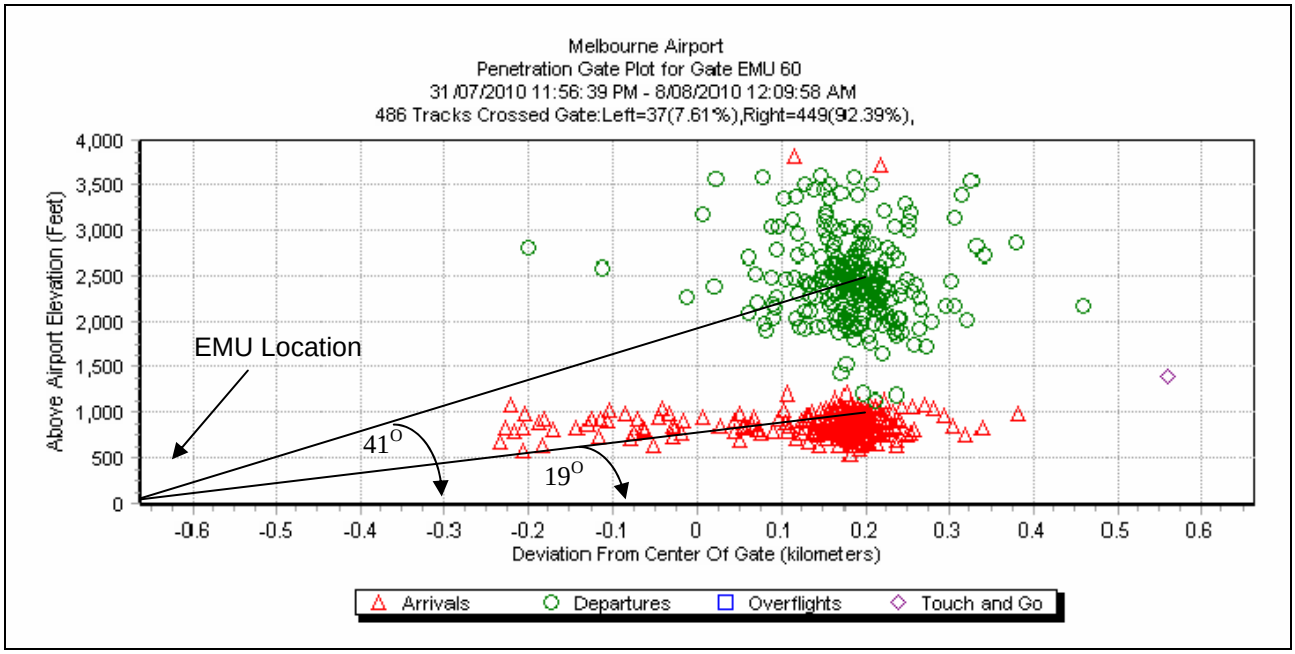
To be in accordance with ISO20906:2009, aircraft captured by the EMU should have a minimum angle of elevation of 30 degrees. This is to reduce any ground attenuation affects on the noise levels. Based on the month of July in 2010, the table below presents the average elevation angle of the aircraft relative to the ground when the aircraft's maximum noise level is recorded (L_{Amax}).

Table 10 Angle of Elevation Summary

	Average Angle of Observation (degrees) at L_{Amax}	Standard Deviation
EMU 2	58.6	11.6
EMU 3	62.6	11.2
EMU 4	36.5	15.8
EMU 6	70.4	11.4
EMU 54	54.9	17.1
EMU 60	24.6	9.3
EMU 61	74.4	10.1
EMU 64	42.6	16

EMU 60 at Keilor Village has the lowest average angle of observation compared to other EMUs. This location is around 1 km off the centerline of the main runway and captures a significant number of arrivals. The arriving aircraft are generally low when they pass the EMU causing a smaller angle of observation as shown below in Figure 17. Usually a very low angle of observation can cause abnormal noise levels.

Figure 17 EMU 60 Observation Angle



The performance of EMU 60 has been further investigated by analysing false positives. To analyse false positive readings from the EMU, the relationship between Sound Exposure Levels (SEL) and distance of the aircraft to the monitor was reviewed. The results of this analysis were slightly abnormal confirming that the location of EMU 60 is not ideal.

11.3 Background noise levels compared to requirements of ISO 20906

ISO 20906 indicates that to provide reliable aircraft noise event detection using a technique based on Sound Level discrimination only; sites should be selected such that the maximum sound pressure level of the quietest aircraft to be detected is at least 15 dB greater than the residual long-term-average sound pressure level (background noise level L_{90} dB(A)). The Noise and Flight Path Monitoring System uses both radar and noise information to correlate

noise events, and therefore the requirements of ISO 20906 do not strictly apply however Airservices Australia generally adopts this criterion for permanent EMUs. The level of 15dB above background is considered a reasonable approach and is the level at which the aircraft sound event will be uncontaminated by background or residual sound. Table 11 presents the background noise levels at each site compared to the minimum L_{Amax} recorded for an aircraft noise event and the average L_{Amax} of aircraft noise events over the year 2010.

Table 11 Background Noise Levels vs L_{Amax}

EMU Location	Average L_{90} dB(A)	Min L_{Amax}	Average L_{Amax}	Min L_{Amax}- L_{90} dB(A)	Ave L_{Amax} - L_{90} dB(A)
EMU 2	32.8	62.2	77.4	29.4	44.6
EMU 3	41.5	62.8	74.1	21.3	32.6
EMU 4	40.8	62.3	73.4	21.5	32.6
EMU 6	42.8	62.3	74.7	19.5	32.0
EMU 54	44.7	60	69.5	15.3	24.8
EMU 60	43.7	59.8	70.1	16.1	26.4
EMU 61	41.3	62.8	69.8	21.5	28.6
EMU 64	36.9	51	63.1	14.1	26.2

The above table indicates that EMU 64 (Diggers Rest) has correlated aircraft noise events that are within 15 dB of the average background levels. This site is set with a low capture threshold of 50 dB because of its remote location. The highlighted number in the above table is generated from the single minimum noise event over the year. The average L_{Amax} noise levels at EMU 4 are well within the requirements of ISO20906. No reason has been found to alter the threshold settings of any EMU.

12 Local Environmental Conditions

Currently, each EMU is not setup to capture meteorological data and therefore the specific local environmental conditions are not available. CATIS weather data is collected at the airport and fed into the NFPMS and is therefore not EMU specific or sufficient for compliance with ISO 20906:2009. The Standard requires that wind speeds at the time of each aircraft noise event are recorded in the reporting of data and that wind speeds above 10 m/s are flagged. The current NFPMS is not compliant with this requirement.

A wind speed of 10 m/s equates to 36 km/hr. Average wind speeds at Melbourne do not exceed this level; however there are periods of high wind that should be flagged. The following table presents a summary of CATIS weather data collected from ANOMS over January to November 2010 for comparison with ISO 20906:2009.

Table 12 Weather Summary Data from ANOMS for 2010

Average wind speed (m/s) at Melbourne Airport	4.8 (m/s)
Total instances of wind events recorded as > = 36 km/hr	304
Total duration of wind events recorded > = 36 km/hr	244 Hours

The table indicates that there is a period of 244 hours over the year 2010 that had recorded wind speeds of 36 km/hr or greater. This equates to a total of around 10.2 days or 2.8% of total available time. The Standard indicates that any correlated noise events captured during this time should have been flagged as having high wind conditions. Although this is a low

number of total days, it is recommended that events during high wind conditions should be flagged.

13 Security and Access for Maintenance

No security incidents were reported for each EMU in 2010. All preventative maintenance activities were performed as scheduled.

The EMU 54 at Braybrook was located at a vacant site from August and therefore was potentially a security risk for theft or vandalism. No such incidents were reported prior to loss of power on 18th August.

14 Licensing Arrangements

The following section details the licensing arrangements for each EMU.

14.1 EMU 2 Bulla

Location: St Johns Road, Bulla

License Agreement: in place with Private Resident

Renewal Date: Term is 1 February 2008 to January 2013

14.2 EMU 3 Keilor East

Location: Penleigh & Essendon Grammar School

License Agreement: Penleigh & Essendon Grammar School

Renewal Date: Commenced 16 May 1994, No formal Expiry date. The License may be terminated by either party on 3 months notice. Property Management are currently negotiating a new agreement with greater security of tenure.

14.3 EMU 4 Essendon

Location: Doutta Galla Bowling Club, Kerferd St, Essendon North

License Agreement: The Doutta Galla Bowling Club

Renewal Date: No formal Expiry date. Property Management are currently negotiating a new agreement with greater security of tenure

14.4 EMU 6 Coolaroo

Location: Broadmeadows Outer Marker, Stockdale Avenue, Dallas.

License Agreement: N/A. Airservices Australia owned site.

Renewal Date: N/A

14.5 EMU 54 Braybrook

Location: Braybrook Primary School

License Agreement: Department of Education (Victoria)

Renewal Date: No current license agreement as the unit has been decommissioned.

14.6 EMU 61 Thomastown

Location: Epping Outer locater, Derrick St, Lalor.

License Agreement: N/A. ASA owned site.

Renewal Date: N/A

14.7 EMU 60 Keilor Village (Portable)

Location: Bonfield Reserve, Keilor.

License Agreement: no formal license agreement held with Airservices Australia Property Management.

Renewal Date: Property Manager to negotiate.

14.8 EMU 64 Diggers Rest (Portable)

Location: Diggers Rest Primary School, 70-88 Plumpton Road, Diggers Rest

License Agreement: Diggers Rest Primary

Renewal Date: Term is 20 November 2009 to 19 November 2011.

15 Configuration of the EMUs

The configuration of each EMU is to be reviewed by the Service Provider B&K and data provided in a Noise Verification Report.

The Service Provider Noise Verification Report is to detail the configuration of each EMU in relation to:

- Threshold settings for each EMU including noise event detection parameters and trigger settings,
- Noise correlation results including missed events and an analysis of false positives, and
- Calibration and preventative maintenance.

The Service Provider's Noise Verification Report is currently in progress.

16 Recommendations

As a result of the above analysis, it is recommended that:

- EMU 54 at Braybrook be reinstalled within a similar location,
- Further data analysis is performed for portable EMU 60. The decision to remove this monitor will be made in consultation with the CACG at a later date.
- Short term monitoring is undertaken north and north east of Essendon Airport and at Caroline Springs.
- The Portable EMU at Diggers Rest is relocated after its license agreement is finished.

The above recommendations take flight paths, complaints and previous noise studies into consideration and an explanation of the rationale follows.

16.1 Relocation of Permanent EMU 54

The EMU 54 site has been decommissioned and cannot be reinstated; however it can be relocated to a similar location. The figures below present the recommended area at a school in Avondale Heights for the relocation of EMU 54. Schools are considered to be sensitive receivers and are favoured because of their security.

Location:

Milleara Primary

76 North Road, Avondale Heights

VIC 3034

Figure 18 Recommended Area to Relocate EMU 54

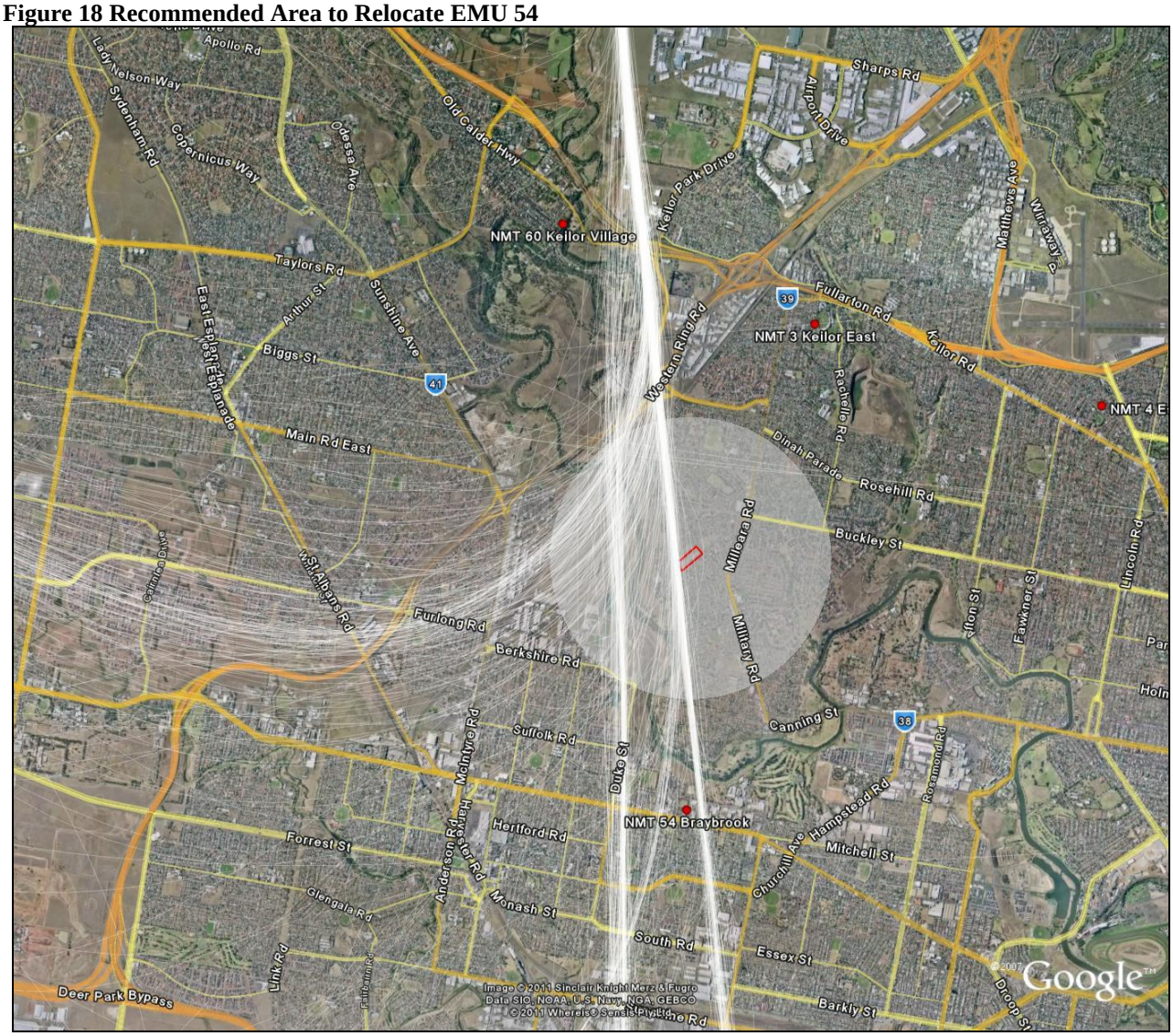


Figure 19 Recommended Area to Relocate EMU 54 – Close up

The above selected area is over flown by high numbers of aircraft and contains a large number of residential receivers. Aircraft within this area are below 5000 ft.

16.2 Relocation of Portable EMU 60 (Keilor Village)

The current location of portable EMU 60 is south west of the airport. At this location very low average elevation angles are experienced for arrivals. False positive analysis confirms that there is some irregularity with measurements at this location.

Following community feedback regarding the removal of this monitor, it is recommended that it remains for the time being with further analysis of data collected. Additional information is to be presented to the CACG at a later date to review the decision to remove the monitor. Data collected from the repositioned EMU 54 will form part of the comparative analysis for this additional reporting.

In addition to the EMU 60 recommendation above, additional filtering of the data collected from the monitor will be performed within the regular quarterly NFPMS report. An indication of average aircraft noise levels captured from the EMU that are outside the requirements of ISO 20906:2009 will be provided. This will mainly apply to arrivals.

16.3 Portable EMU Noise Study Location – Caroline Springs

The following location at Caroline Springs south west of Melbourne airport has been identified as a possible location for a portable noise study.

Location:

The Bookside School

Federation Way, Caroline Springs

Vic 3023

Figure 20 Recommended Area for Portable Unit Caroline Springs

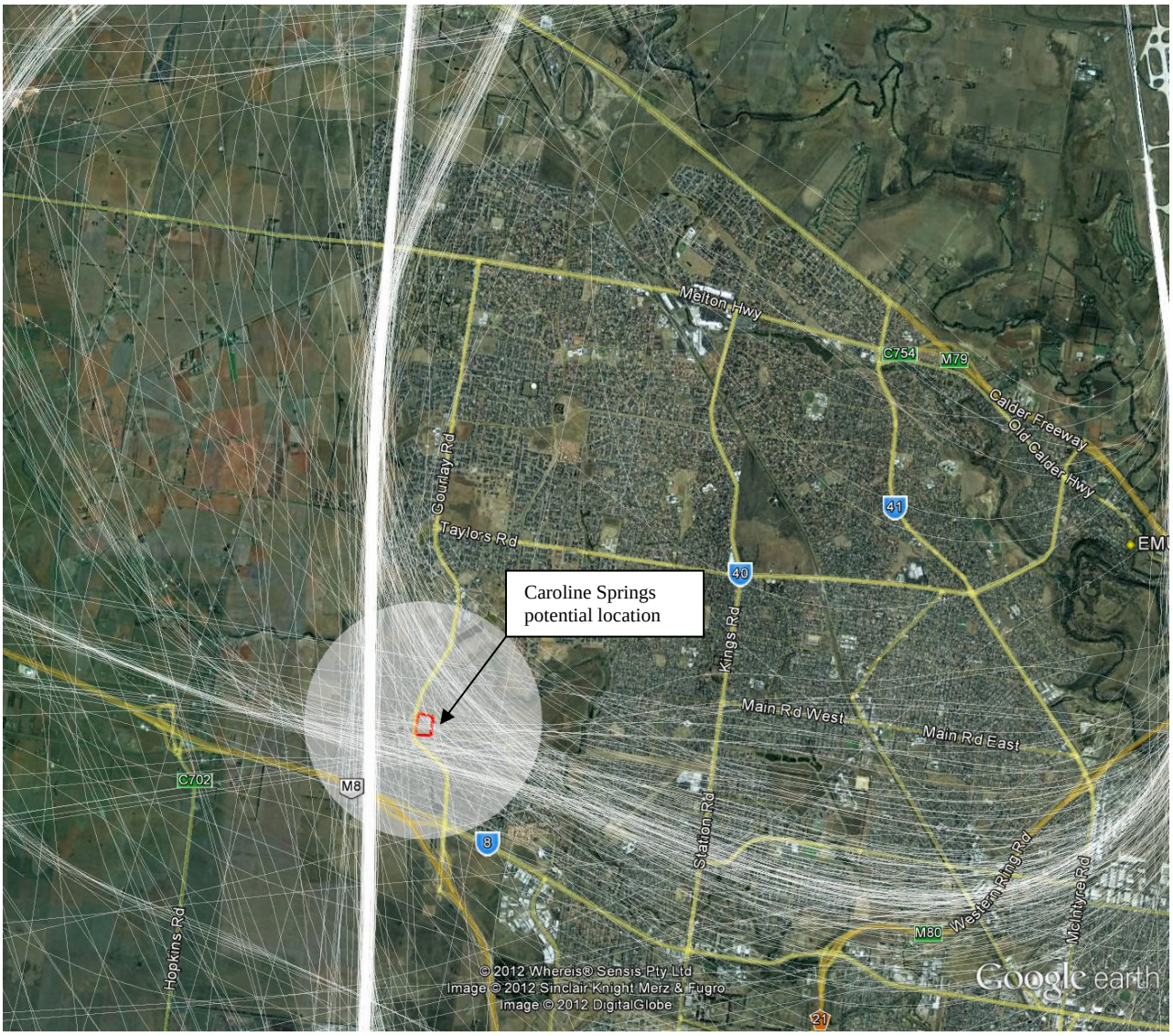
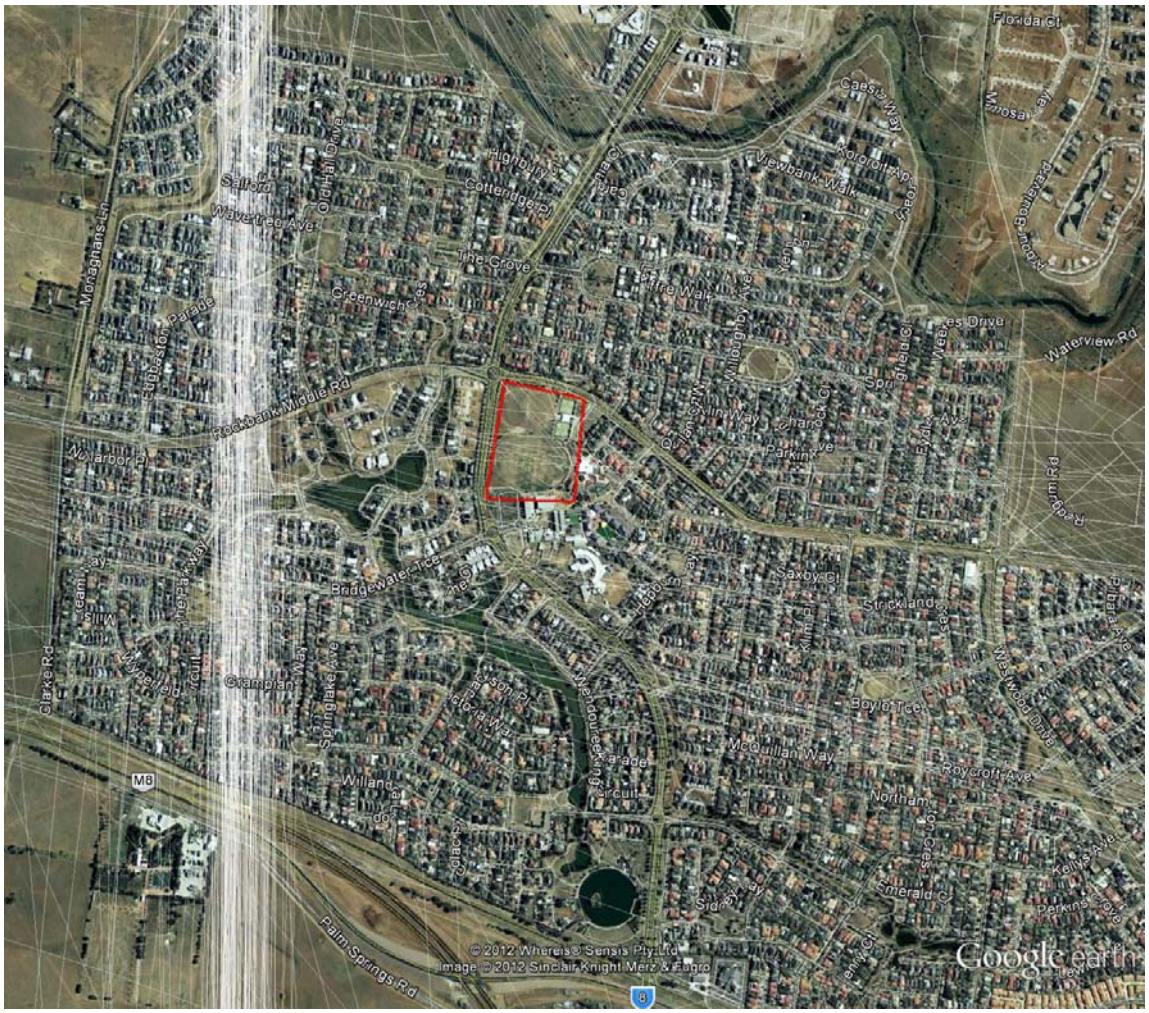
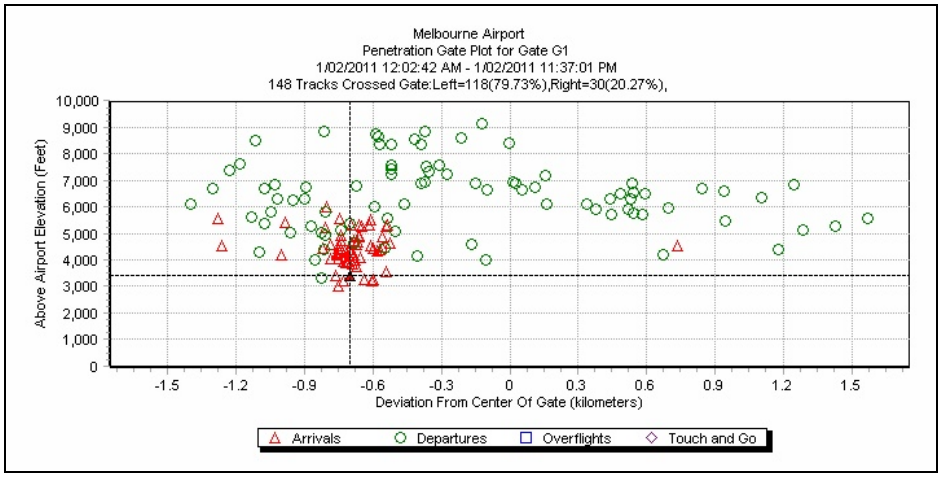


Figure 21 Recommended Area for Portable Unit Caroline Springs



The above area experiences both arrival and departure air traffic and has a large number of residential receivers.

Figure 22 Aircraft Height at Caroline Springs

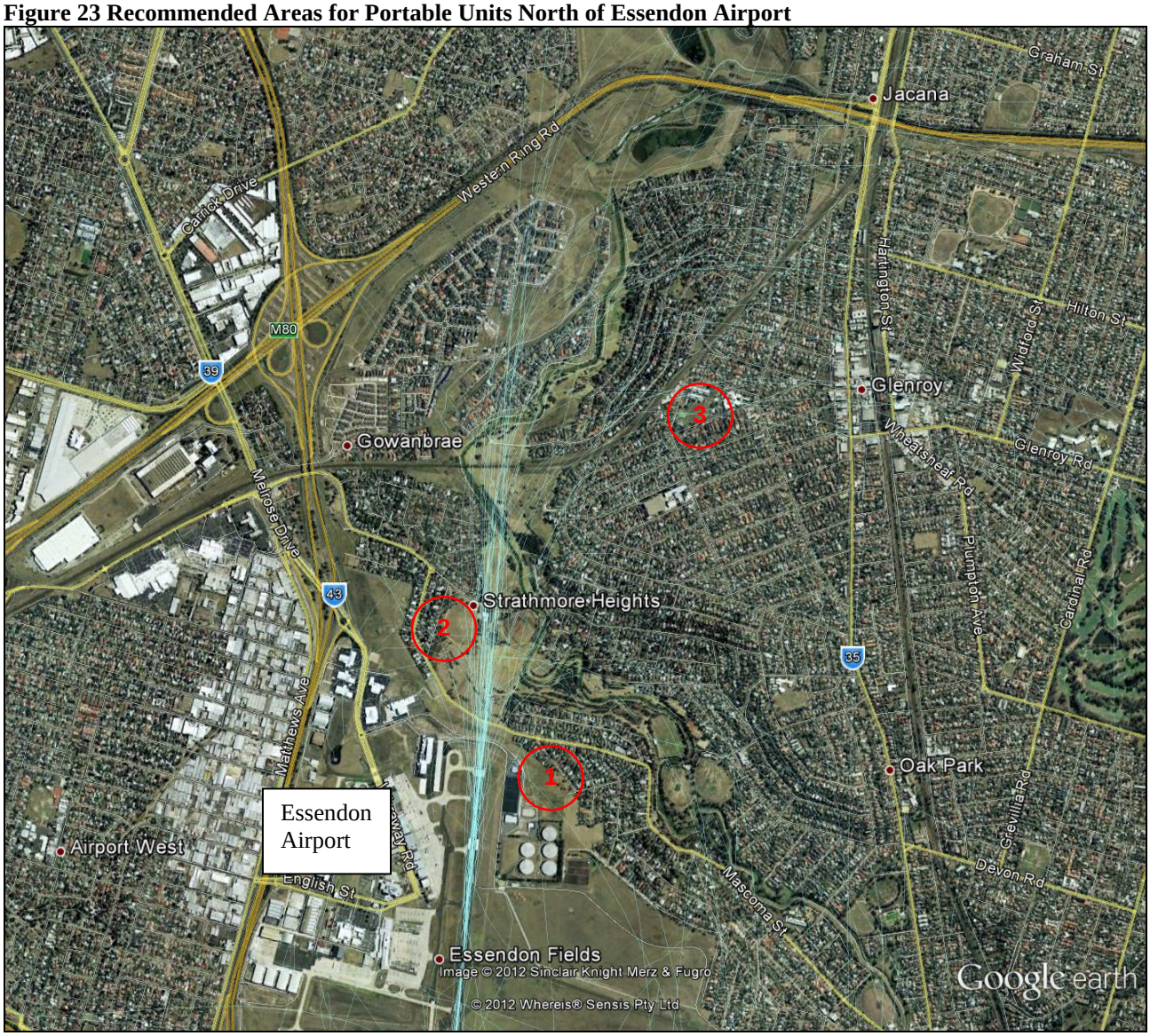


Aircraft heights at Caroline Springs range from around 3,000 ft above sea level to 9,000 ft.

16.4 Portable EMU Noise Study Location – Essendon Airport

To better service residents around Essendon airport, it is recommended that portable units are placed north of the airport. Potential locations are provided below. A portion of noise complaints from Essendon Airport relate to ground running and helicopter movements. To monitor these issues it is recommended that a portable unit is placed on the airport boundary as shown below in Figure 23.

Figure 23 Recommended Areas for Portable Units North of Essendon Airport



Location: 1

Essendon Airport North East Boundary.

Possibly located on Airservices Property and therefore would be a secure location.

Location: 2

Strathmore Heights playing fields. This location is good for capturing noise, however may have security issues once established.

Location: 3

Originally Glenroy Primary (50 Wheatsheaf Road, Glenroy VIC 3046) was chosen as a potential monitoring location, however following feedback from the Melbourne Airport NAC and CACG an alternate location at Oak Park Primary School was identified as a better location.

Oaks Primary School has been included within the short term monitoring plan.

16.5 Capturing Weather Data

Weather data is currently not captured at any EMUs at Melbourne. Weather station equipment is available through the Service Provider. It is recommended that a weather station is integrated onto at least one permanent EMU to enable the NFPMS to achieve full compliance with ISO20906.

Options for weather station implementation on permanent EMUs in order of preference for best data accuracy include:

- Weather stations placed on every EMU.
- Two weather stations, one placed south of the airport at EMU 3 and east at EMU 6. (The area north of the airport has not been chosen as it has less population.)
- One weather station placed at EMU 3. (This location is most central to all other EMUs).

A cost benefit analysis should be considered when determining the best option. Each option would enable full compliance with ISO20906.

In addition to the above, a weather station should be implemented to a portable unit. Portable units are generally placed within areas that are some distance from the airport and other permanent EMUs. Wind speeds and meteorological conditions may vary greatly at portable locations and therefore a weather station is essential.

17 Portable and Short Term Monitoring Program for the Melbourne Region.

Taking into consideration recommendations concerning regional airports in the Commonwealth Government's Aviation White Paper, the proposed monitoring locations contained in this document and the comments from the Melbourne Airport CACG and Essendon Airport CACG, Airservices has developed a program of aircraft noise monitoring for the Melbourne region. Within this program some monitoring sites are marginal (where the aircraft noise is less than 15 dBA above the background and do not meet the detection requirements of ISO 20906). For these sites a more flexible short term monitoring study would be appropriate. Recommendations for short term (up to 4 weeks) and longer term (6+ months) have been made based on the rationale for each monitoring location.

Issue	Type/purpose for monitoring	Status
Relocation of EMU 54 (Braybrook) to Avondale Heights	Main monitor south of airport. Needs to be re-instated. Established as a portable monitor initially. This site will likely become permanent.	Potential new location identified at Avondale Heights as part of review.
Noise Monitoring at Caroline Springs	Portable unit. Purpose to establish aircraft noise levels in an area previously not monitored. Potentially could be short term duration for 4 weeks to establish suitability for longer term monitoring.	Potential location identified at The Bookside School Federation Way, Caroline Spring's Vic 3023
Noise Monitoring at Moorabbin Airport.	Monitor aircraft noise around Moorabbin Airport. Short term monitoring 4 week period.	Proposed area: Dingley Village, VIC
Noise Monitoring at Avalon Airport.	Monitor aircraft noise around Avalon Airport. Short term monitoring 4 week period.	Proposed area: Clifton Springs, Lara or Little Village, VIC
Noise Monitoring at Essendon (portable)	Portable Unit. Location 1 identified at the airport boundary. Portable noise monitoring is required over at least a 6 month period. Location will monitor ground aircraft activities.	Potential location at airport boundary.
Noise Monitoring at Essendon (short term)	Short term monitoring unit. Location 2. Strathmore Heights playing fields. Duration of monitoring for 4 weeks.	Proposed location at Strathmore Heights Playing fields.
Noise Monitoring at Essendon (short term)	Short term monitoring unit. Location 3. Oak Park Primary. Duration of monitoring for 4 weeks.	Proposed location at Oak Park Primary.

Appendix A Terms of Reference

Airservices Australia Review of the Melbourne/Essendon Environmental Monitoring Units

Terms of Reference

Context

Airservices Australia has a legislated obligation, via the Air Services Act (1995), to regard the safety of air navigation as its most important consideration. Subject to that requirement it also has obligations to, as far as practicable; protect the environment from the impact of the operation and use of aircraft. Further, a Ministerial Direction made under this Act requires Airservices to maintain and operate a noise and flight monitoring system (NFPMS) at major Australian airports. At present this system operates around Perth, Adelaide, Melbourne/Essendon, Canberra, Sydney, Gold Coast, Brisbane and Cairns airports.

The NFPMS comprises a number of components, including environmental monitoring units (EMUs) that collect noise data. Airservices Australia periodically conducts a review of the location of the EMUs. This is a key element of the quality management of the NFPMS.

Purpose

To review the performance of each EMU around Melbourne and Essendon airports against Airservices Australia's environmental and business requirements for the management of aircraft noise. In performing this function the placement and individual configuration of each of the EMUs needs to be optimised for the measurement of the impacts of aircraft operations on the local community from operations at the airports.

This review will assess the location of the current EMUs and make recommendations about the future use of the EMUs.

Scope

The review will address:

1. Current location of EMUs
    a. With respect to complainants
    b. With respect to sensitive regions
    c. With respect to flight paths
    d. With respect to communications coverage and reliability
    e. With respect to ISO 20906
    f. Against local environmental conditions
    g. For security and access for maintenance
2. Licensing - are there any ongoing licensing issues?
3. Configuration of the EMUs
    a. For noise event detection parameters; threshold, pre-trigger, duration
    b. For calibration and preventative maintenance
    c. Correlation zone
    d. For false positives
    e. For missed noise events

Consultation with Interested Parties

Airservices will consult with interested parties via the airport community consultative committees convened by airport management.

Review Process

Terms of Reference
The Terms of Reference for the review will be agreed between Airservices and the Department of Infrastructure, Transport, Regional Development and Local Government, following consideration by members of the airport community consultative committees at their May 2010 meetings. The Terms of Reference will be circulated to committee members for comment by 31 May 2010. Comments are to be sent to ian.mcleod@airservicesaustralia.com

Review Report
A final draft of Airservices report will be provided to members of the airport community consultative committees for discussion at their committee meetings in late 2010.

Final Report
The final report will be produced by 31 December 2010.

Appendix B Melbourne Airport Approach and Departure Routes

The Melbourne airport has the following standard operating procedures:

Table 13 Melbourne Airport Standard Arrival Routes (STAR)s

STAR ARBEY ONE A B D ARRIVALS (RNAV)
STAR ARBEY ONE M P U ARRIVALS (RNAV)
STAR ARBEY ONE Z ARRIVALS (RNAV)
STAR BADGR SIX A D V ARRIVALS (RNAV)
STAR BADGR SIX U ARRIVALS (RNAV)
STAR BADGR SIX Z ARRIVALS (RNAV)
STAR BOYSE FIVE A D V ARRIVALS (NON-JET) (RNAV)
STAR BOYSE FIVE Z ARRIVALS (NON-JET) (RNAV)
STAR DYTES FIVE B Z ARRIVALS (RNAV)
STAR DYTES FIVE P ARRIVALS (RNAV)
STAR LIZZI FIVE A D V ARRIVALS (RNAV)
STAR LIZZI FIVE U ARRIVALS (RNAV)
STAR LIZZI FIVE Z ARRIVALS (RNAV)
STAR MICHM SEVEN B Z ARRIVALS (RNAV)
STAR MICHM SEVEN P ARRIVALS (RNAV)
STAR MONTY FIVE B Z ARRIVALS (RNAV)
STAR MONTY FIVE P ARRIVALS (RNAV)
STAR PORTS FOUR B Z ARRIVALS (RNAV)
STAR PORTS FOUR P U ARRIVALS (RNAV)
STAR WAREN THREE A D V ARRIVALS (RNAV)
STAR WAREN THREE U ARRIVALS (RNAV)
STAR WAREN THREE Z ARRIVALS (RNAV)
STAR WENDY SEVEN A B ARRIVALS (RNAV)
STAR WENDY SEVEN D Z ARRIVALS (RNAV)
STAR WENDY SEVEN P U ARRIVALS (RNAV)

Table 14 Melbourne Airport Standard Instrumented Departure (SID)s

SID CORRS SIX DEPARTURE (RNAV)
SID MELBOURNE THREE DEPARTURE (RADAR)
SID RWY 16 BISON THREE DEPARTURE (RNAV)
SID RWYS NORTH EAST (JET) (RNAV)
SID RWYS NORTH WEST (JET) (RNAV)
SID RWYS NORTH WEST (NON-JET)
SID RWYS SOUTH (RNAV)
SID RWYS WEST
SID SIMON THREE DEPARTURE (NON-JET) (RNAV)
SID STRATHBOGIE FIVE DEPARTURE (NON-JET)

Appendix C Public Comments via the Melbourne and Essendon Airport Noise Abatement Committees and the Community Aviation Consultation Groups (CACG) Including Airservices Responses

The Melbourne EMU review established a number of recommendations regarding the relocation of the portable EMU at Keilor, re-instating the permanent EMU at Braybrook in a new location, and several new monitoring areas. The review was tabled at the May CACG meetings for Melbourne and Essendon airports and feedback from the groups was received. Below is a summary of comments received and Airservices responses, the latter in bullet points.

1. Brimbank City Council.

The Brimbank City Council has raised concerns relating to the Keilor Village monitor and the recommendations to move the monitor. Concerns have been raised over how the false positives have occurred and what impact they have had. Keilor residents are concerned with low-level aircraft within the area and indicate that moving the portable monitor to another location, namely Caroline Springs, will capture aircraft that are significantly higher above sea level then at the existing Keilor site. The Council strongly supports the location of a permanent EMU within the Keilor locality.

- The scope of the EMU review was not to specifically analyse data collected by the Keilor monitor in terms of the cause of the abnormal noise events. The scope involved the review of the monitor location in relation to the ISO20906:2009 standard. The recommendation to move the monitor was made with consideration of numerous factors including data capture, issues of concern to complainants, complainant and complaint distribution patterns, flight locations, requirements of ISO20906:2009, and the location of other EMUs, including the relocation of the former Braybrook EMU.
- Following community feedback regarding the removal of this monitor, it is recommended that it remains for the time being with further analysis of data collected. Additional information is to be presented to the CACG at a later date to review the decision to remove the monitor. Data collected from the repositioned EMU 54 will form part of the comparative analysis for this additional report.
- The average height of aircraft passing the Keillor Village area can be determined without the use of the portable noise monitor. An additional report is to be presented to the CACG that provides information of aircraft height over the Keillor Village area.

2. Member for Wills

The Member for Wills has raised concerns that the existing EMUs do not accurately reflect the concerns of the Strathmore community. Out of the three suggested areas for EMU placement, the Member for Wills agrees with the first two locations, namely the North East Boundary of the Airport and in Strathmore Heights fields, however disagrees with the suggested location of Glenroy Primary School. An alternate site of Oak Park Primary is suggested as it receives a high number of complaints.

- The suggested areas around Essendon airport are based on an order of priority with the Airport Boundary being the highest. The alternate location of Oak Park Primary is suitable and will be implemented into the short term monitoring program.

3. Melbourne Airport Planning consultant

Concerns have been raised with the proposed re-location of EMU 54 at Avondale Heights and placement of an EMU at Caroline Springs. Suggests that an EMU be located somewhere between the suburbs of St Albans and Sunshine. The consultant indicates that the proposed Avondale Heights location should be moved slightly to the West. The consultant also raises the suggestion that an EMU should remain within the Diggers Rest area.

- In response to the proposed Avondale Height location for EMU 54, EMU locations are a compromise between security, licensing, facilities, background noise level and flight path. Airservices always tries to locate a monitor as close to the flight path as is possible. In general private residences are not used for permanent monitoring locations as these are more likely to change ownership, increasing the risk of having to relocate the monitor. The proposed site is suitable considering the above issues.
- Supplementary noise studies have been conducted in Sunshine North in 2004. A detailed report was produced that presented the results of noise data collected over a period of almost seven months (23/7/2004 to 21/2/2005). The report demonstrated that the average noise data was similar to what was collected at nearby EMUs at Braybrook and Keilor East. Moving the EMU to an area such as Caroline Springs presents the opportunity to assess aircraft noise levels at a new area that has both a high volume of aircraft traffic overhead and receives complaints.
- The portable monitoring units have been located within the Diggers Rest area from November 2009. A full analysis of the current location's data will be done in the form of a Post Implementation Review. Airservices has the requirement to assess other noise sensitive areas around the Melbourne airport and therefore the monitor is to be removed.

4. Chair - Melbourne Airport Community Aviation Consultation Group

The CACG want reassurance from Airservices Australia that the relocated EMU 60 will still have the capabilities to monitor and assess the noise levels in Keilor Village and the surrounding region. The question has also been raised whether the capture threshold radius of the EMU 64 at Diggers Rest could be increased to ensure that all aircraft movements on the flight path surround the area are recorded.

- Following community feedback regarding the removal of EMU 60, it will remain for the time being with further analysis of data collected. The aircraft movements currently captured by the Keilor Village EMU will be captured by the re-instated EMU 54 (Braybrook EMU). The aircraft height over EMU 54 will be higher than when over the current EMU 60 location. The noise levels will therefore be lower. Concurrent measurement with the existing Keilor Village monitor and the re-instated Braybrook EMU will be performed. Analysis of this data will help provide future predictions of noise levels in the Keilor Village area and help decide whether the monitor is relocated.
- EMU 64 at Diggers Rest already has a capture radius of 2.5km and a reduced noise threshold of 50 dB(A) to enable it to record noise from aircraft at low noise levels. These parameters have been set and reviewed to increase the accuracy of the data. It is not preferable to increase the capture radius at this location due to the height of aircraft in this area and low noise levels. Inaccurate results may be obtained.