



## Review of the Perth Airport Environmental Monitoring Units

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## Version Control

Version Number	Detail	Prepared by	Date
1	Draft for Review	ML	10/12/2010
2	Inclusion of comments from ANMCC and monitoring program for the Perth region	IM	29/6/2011

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# 1 Executive Summary

A review of Perth 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 study has established the following:

- Permanent EMUs are well positioned to capture aircraft noise with high overall correlation results. The aircraft event detection and classification results are well above the required levels of ISO20609:2009.
- Various sensitive areas around Perth exist and have been identified from complaints data and known flight track changes to the east and north of the airport. The main sensitive areas that have not had previous noise monitoring are Glen Forrest, Stoneville, and Roleystone to the east of the airport and Beechboro to the northwest. The suburbs south west of the airport to Victoria Park have been identified as sensitive areas, as well as south to Canning Vale. These locations have been assessed and determined as potential sites for short term noise monitoring.
- Each permanent EMU is positioned well to accommodate Standing Instrumented Procedures (SIDs) and Standard Approach Routes (STARs). As a result, actual aircraft flight tracks generally fly within the capture thresholds of the EMUs.
- Permanent EMU 2 could potentially be relocated to optimise the NFPMS. The location of EMU 2 is directly south of the airport with a capture threshold overlapping that of EMU 1. The capture threshold also covers a large portion of non residential area. To improve overall system coverage, EMU 2 could be relocated west of its current location to cover a larger portion of residential receivers. The social impacts of removing a permanent EMU should be considered.
- Permanent EMU 3 is due for re-licensing. A slight move to the southwest of its current location would cover a greater density of population and potentially capture more aircraft movement and noise data. In its current location, EMU 3 has registered a high number of false positives in comparison to other EMUs. This is most likely because its location is very close to the airport and its capture threshold includes parts of the main runway.
- The remaining permanent sites, EMUs 1, 4 and 5 are recommended to remain as currently positioned.
- The NFPMS is in general compliance with ISO20609:2009, 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 ISO20609:2009. This includes portable units at Chidlow.
- The EMU configuration in terms of threshold settings, correlation zones, false positives and missed noise events are satisfactory for each EMU, with the exception of EMU 3 which recorded a high number of false positives.
- Recommendations have been given to integrate weather stations onto permanent and portable EMUs to enable compliance with ISO20609:2009 with a series of options.

- Short term noise monitoring locations for portable EMUs have been identified at Glen Forrest, Stoneville, Roleystone, Beechboro, Canning Vale and Victoria Park. Current portable EMUs at Chidlow are recommended to be relocated to the other sensitive locations identified.

The review was tabled at the February meeting of the Aircraft Noise Management Consultative Committee (ANMCC), the community forum for Perth Airport, for comment. Airservices provided a response to these comments at the May ANMCC meeting. The ANMCC comments and Airservices responses are listed in Appendix B. No change to the original review recommendations was made.

Following the consultation phase a monitoring program for the Perth region was developed. This is detailed in Section 17.

## 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

To review the performance of the EMUs at Perth Airport against the Airservices Australia's environmental and business requirements for the management of aircraft noise. In performing this function the placement and individual configuration of the each of the EMUs needs to be optimised for the measurement of the impacts of aircraft operations on the local community from operations at Perth Airport. 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 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 20609:2009.
- 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 Perth (including Jandakot) with respect to placement and coverage of noise monitors, and
- 5) The location of each EMU with respects to the population density.

At the completion of the review public comment will be sought. This will be via the Perth Airport Aircraft Noise Management Consultative Committee. The comments received and Airservices responses are detailed in Appendix B. Following this phase a monitoring program will be developed and included in the final version of this report.

## 5 Perth EMU Background

The Perth component of the NFPMS has five permanently installed EMUs which are strategically located around Perth Airport, see Figure 1 below. In addition to the permanent EMUs, there are portable EMUs (EMU 32 and EMU 35) which have been connected to the system to measure aircraft noise at temporary locations. EMU 32 and 35 have been included in this review. The NFPMS has been installed and operating in Perth from 1994.

Figure 1 Perth EMU Locations



## 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. Note that EMU 3 was decommissioned in November 2010 and recommendations for its relocation have been given in this report.

**Table 1 Permanent EMU Locations**

	EMU 1 (Cannington)	EMU 2 (Queens Park)	EMU 3 (Redcliffe)	EMU4 (Greenmount)	EMU5 (Guildford)
Longitude	116° 2'45.96"E	115°56'38.00" E	115°56'49.31" E	116° 2'45.96"E	115°58'19.45" E
Latitude	31°53'45.96"S	31°59'54.28"S	31°56'55.10"S	31°53'45.96"S	31°54'4.79"S
Altitude	53 m	15 m	24 m	53 m	10 m
Main Runways aligned with	03 / 21	03 / 21	06 / 24	06/24	03/21
Distance to Runway end (DL)	7.5 km	4.5 km	1.6 km	7.5 km	3.0 km
Distance to Runway centerline (DS)	0 km	0.38 km	0.3 km	0 km	0.4 km

**Table 2 Portable EMU Locations**

	EMU 32 Chidlow	EMU 35 Chidlow
Longitude	116°13'58.49" E	116°17'29.77"E
Latitude	31°49'54.53"S	31°49'32.11"S
Altitude	294 m	268 m

The portable units at Chidlow were located to measure aircraft noise due to changes in aircraft flight paths. Residents in this area have made a large number of noise complaints as shown in this report.

There are no EMUs specifically positioned to capture noise from operations at Jandakot airport.

## 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. The current locations of permanent monitoring sites have been unchanged since the system was established in 1994. There have been no other permanent or temporary locations monitored since.

## 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 can capture and correlate 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.

Note that high background noise levels will still cause a CNE but it will be corrupt due to extraneous noise.

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

**Table 3 Arrivals – non-correlated / total movements**

Period	Q1 2010	Q2 2010	Q3 2010	Q4 2010
Jets	957 / 10556 (9%)	708 / 10860 (7%)	230 / 11533 (2%)	N/A
Non – Jets	710 / 3880 (18%)	594 / 4033 (15%)	341 / 4192 (8%)	N/A

**Table 4 Departures - non-correlated / total movements**

Period	Q1 2010	Q2 2010	Q3 2010	Q4 2010
Jets	865 / 10586 (8%)	313 / 10854 (3%)	196 / 11551 (2%)	N/A
Non – Jets	2421 / 3888 (62%)	2157 / 4020 (54%)	1876 / 4190 (45%)	N/A

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 less than 10% of jets are missed by the NFPMS. ISO 20609:2009 has aircraft sound event detection and classification requirements of not less than 50%. 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 may produce noise levels that are lower than jets and can be too low to be captured.

## 7 Complaints Analysis

The following sections analyse complaints for Perth and show where the EMUs lie in relation to complaints. The complaints data is gathered from the first two quarters of 2010.

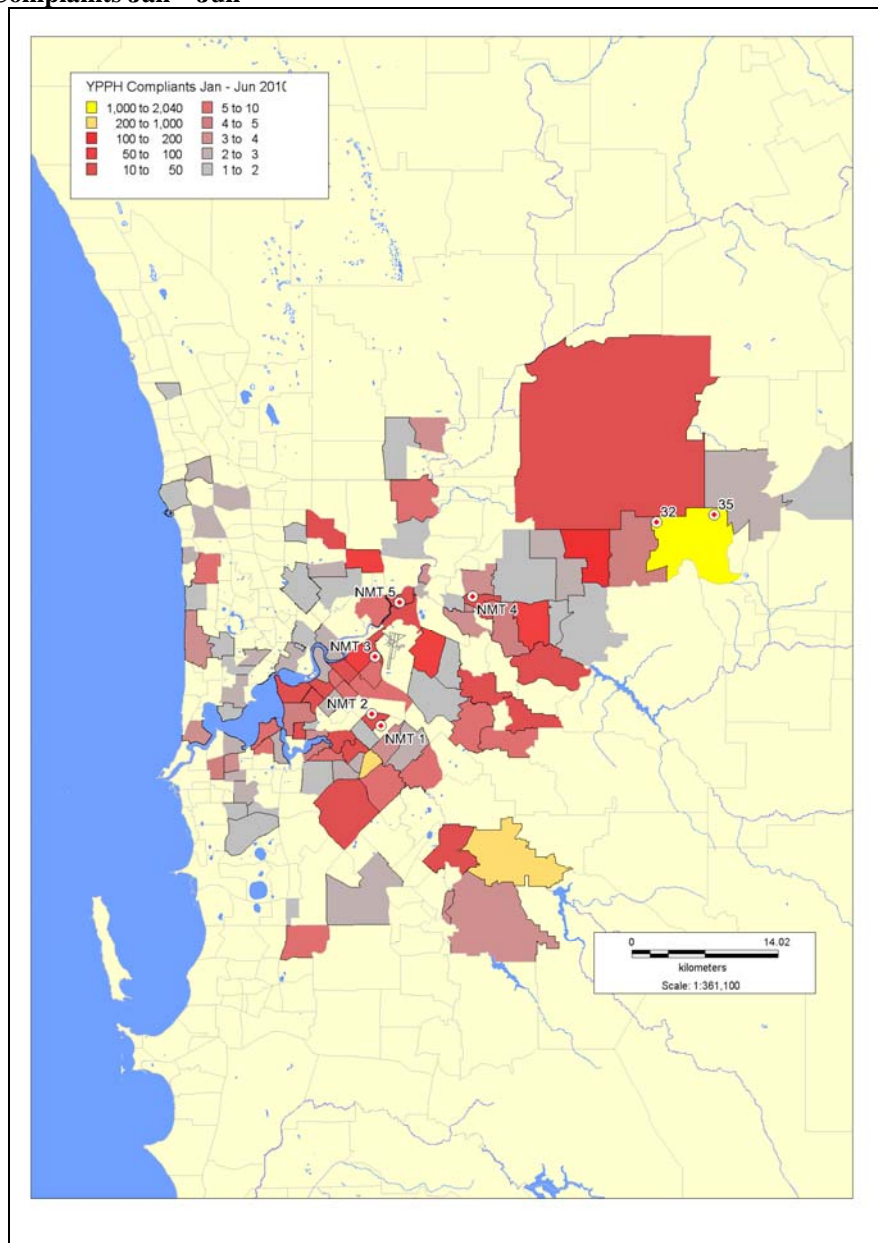
**Table 5 Total Number of Complaints by Airport Q1 and Q2**

Period	Perth Airport	Jandakot Airport
Q1 and Q2 2010	4448	162

### 7.1 Complaints Density

The following figure is a thematic map of complaints data collected over the first two quarters of 2010.

**Figure 2 YPPH Complaints Jan – Jun**



The highest numbers of complaints in the period were received from the suburbs of Chidlow, Langford and Roleystone.

A better measure for 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 levels of 8 or more.

**Figure 3 YPPH Suburbs with 8 or more Complainants Jan - June**

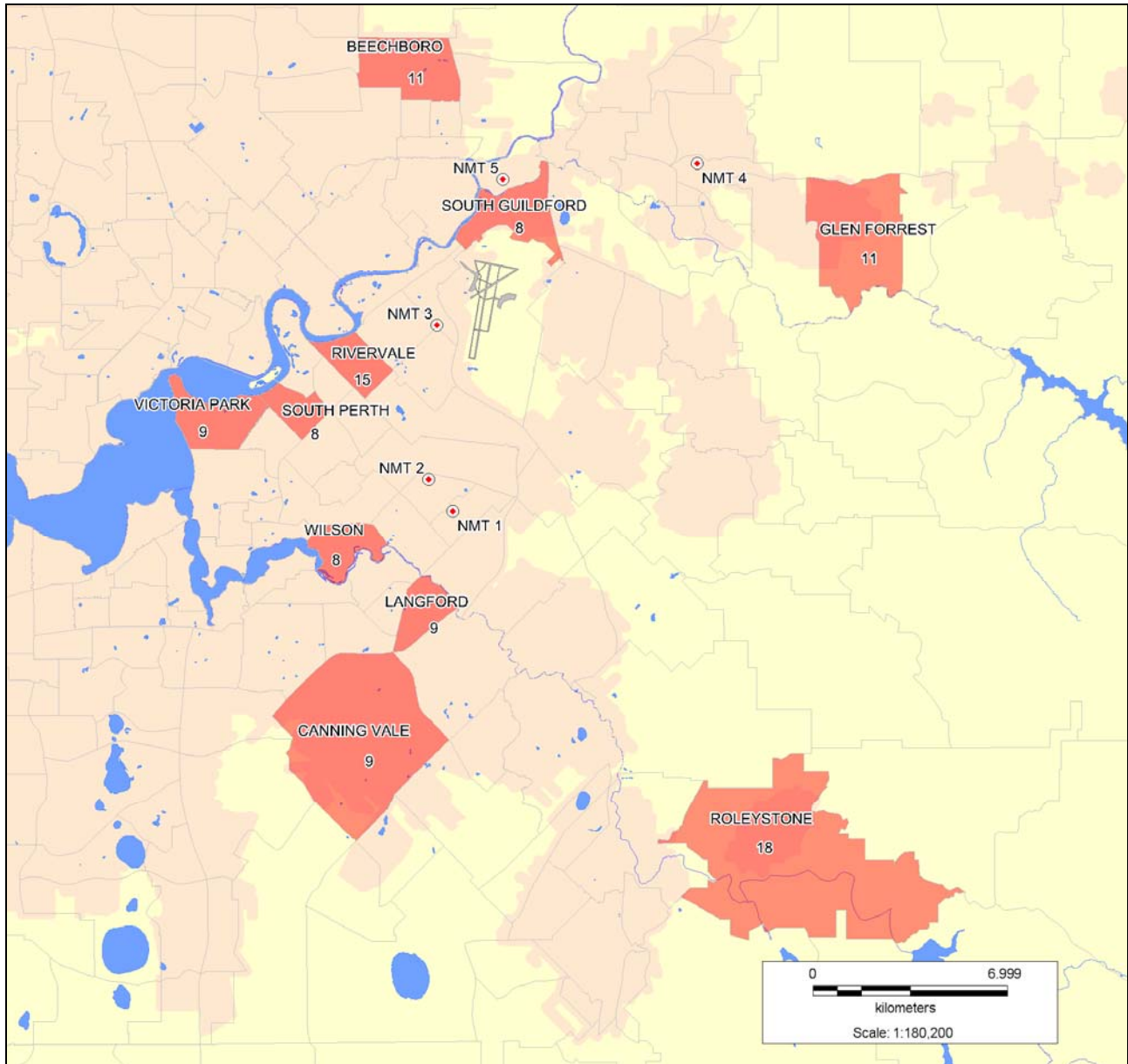
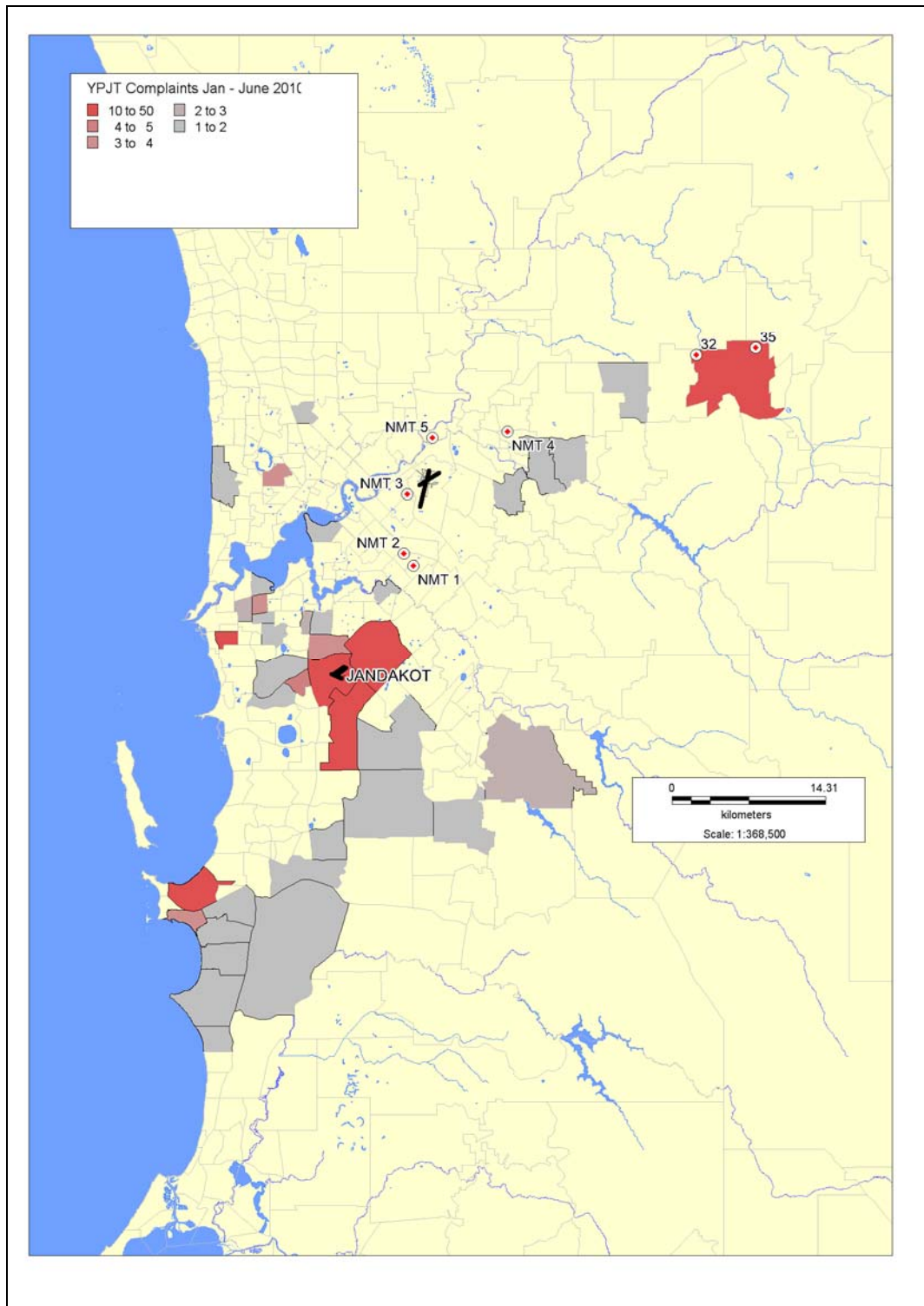


Figure 3 shows suburbs with relatively high numbers of complainants relating to Perth Airport operations. The suburbs of Beechboro, Glen Forrest and Roleystone are generally outside areas covered by current EMU locations. The suburbs with high numbers of complainants that are south of the airport are near to EMUs 1 and 2, and suburbs to the south west are close to EMU 3.

**Figure 4 YPJT Complaints Jan – Jun**



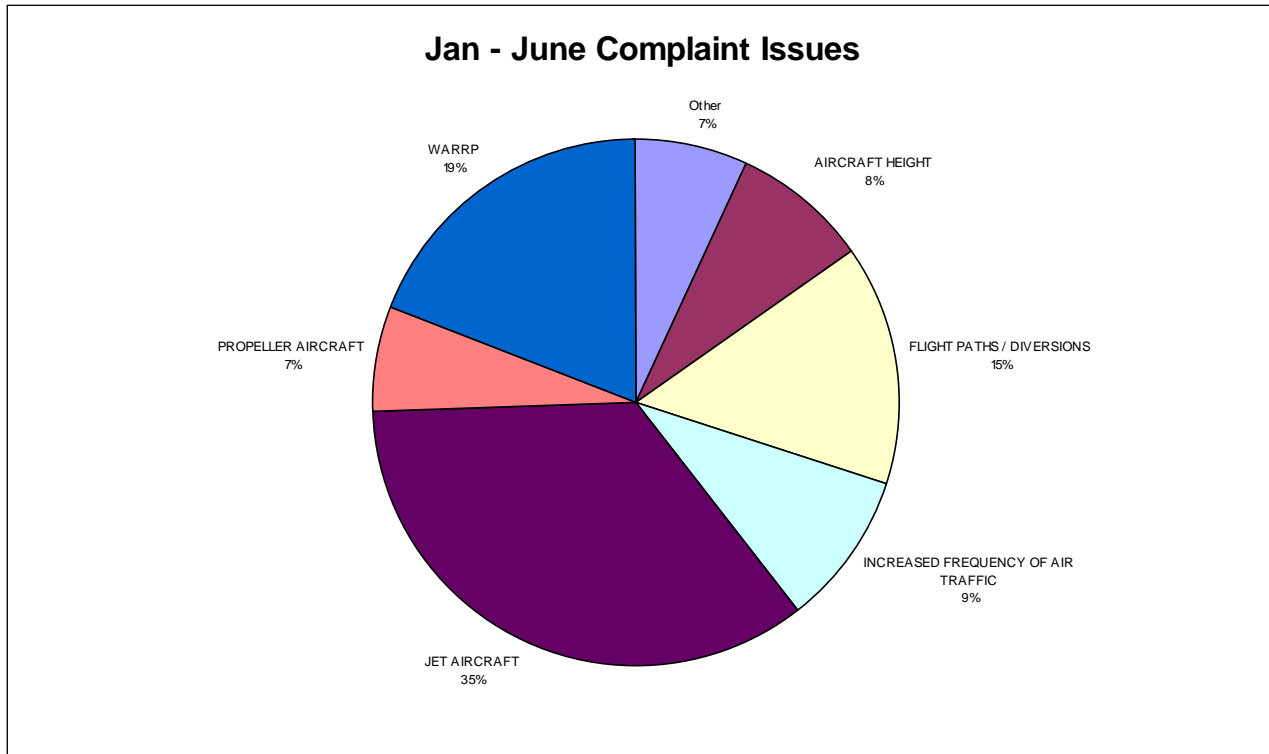
Complaints relating to Jandakot Airport are concentrated around the airport and to the south of Perth. These areas fall outside the range of the existing EMUs.

## 7.2 Key Issues of Complaints

Over the period of 2009 and 2010, one of the key issues of complaints was related to flight path changes due to the West Australian Route Review Project (WARRP).

Each complaint can be related to a number of issues. The table below presents the complaint issues for complaints relating to Perth airport, gathered over January to June 2010.

**Table 6 Perth Airport Complaint Subjects Jan - June 2010**



The bulk of complaints relate to jet aircraft, flight paths and the WARRP changes. Note that flight paths and the WARRP are related. Given that the areas most affected by WARRP are to the east and north of the airport, this highlights the need to perform further portable noise monitoring at locations in these areas.

### 7.3 Complaints with Respect to Flight Paths

Complaints with respect to flight paths during the night have been assessed in the following section due to night time being particularly sensitive and most likely to cause disturbance due to low background noise conditions.

The following figure overlays complaint data about night time operations (22:00 to 06:00) with jet movements and are aligned with the standard flight routes for arrivals and departures.

**Figure 5 Complaints with Respect to Flight Paths and Jet Operations at Night**

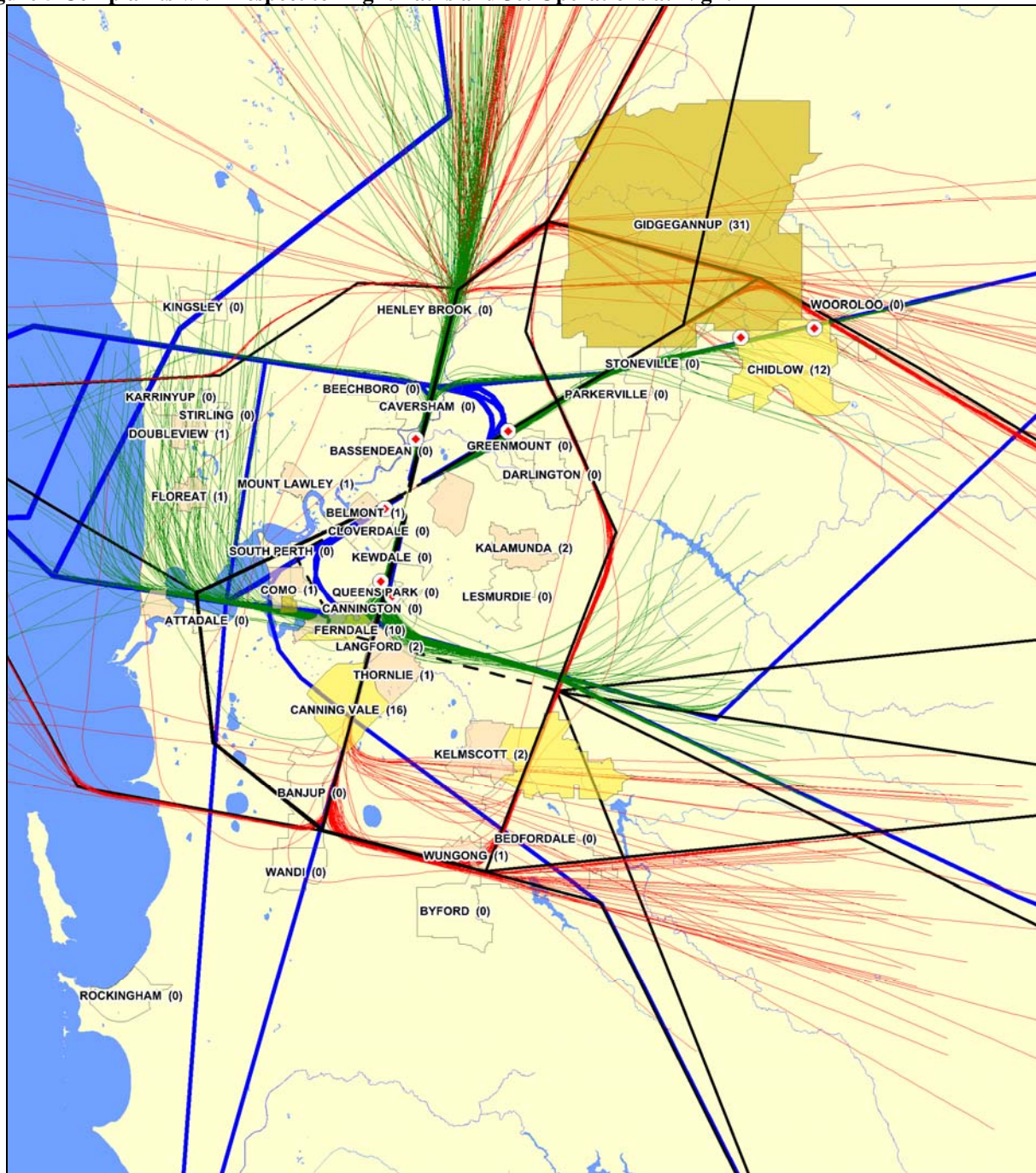


Figure 5 shows that actual flight paths of aircraft correlate well with Standard Approach Routes and Standard Instrument Departures (in bold lines above) during this period.

## 7.4 Complaints in Relation to EMU Locations

When reviewing the thematic maps provided above, no major reason to move permanent EMUs has been found when considering complainants and main flight paths. The maps provide information as to where sensitive areas are that would benefit from a short to medium term monitoring using portable units. Such areas are Roleystone, Stoneville, Glen Forrest, Beechboro, Canning Vale, Rivervale and Victoria Park. The suburb of South Perth has also been identified as an area with a high number of complainants; however this area would be covered by monitoring in Victoria Park.

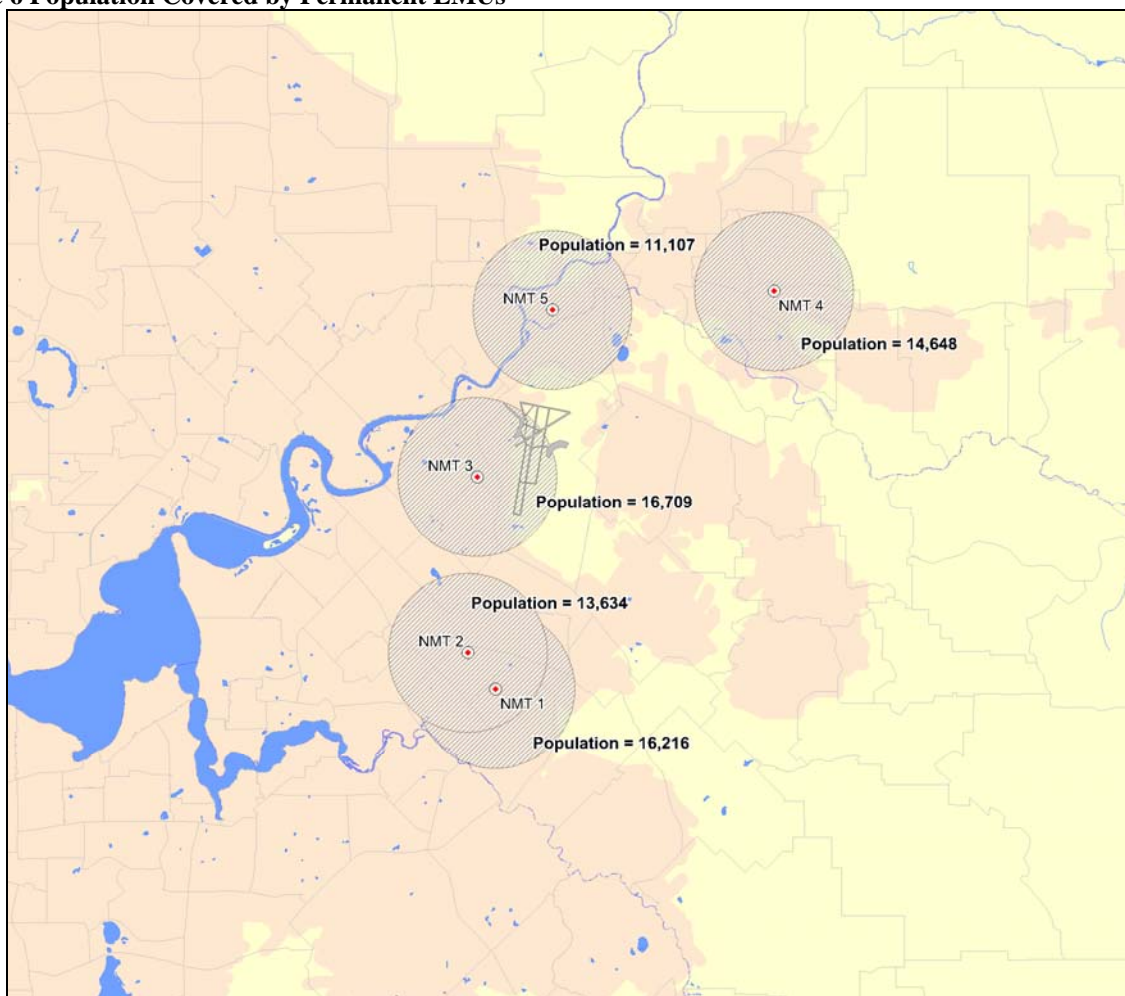
When assessing the complainant density, suburbs with high numbers of complainants were identified and shown to roughly be captured by permanent EMUs. Areas to relocate EMU 3 when licensing expires were established to the south west and discussed further below in Section 16.

## 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.

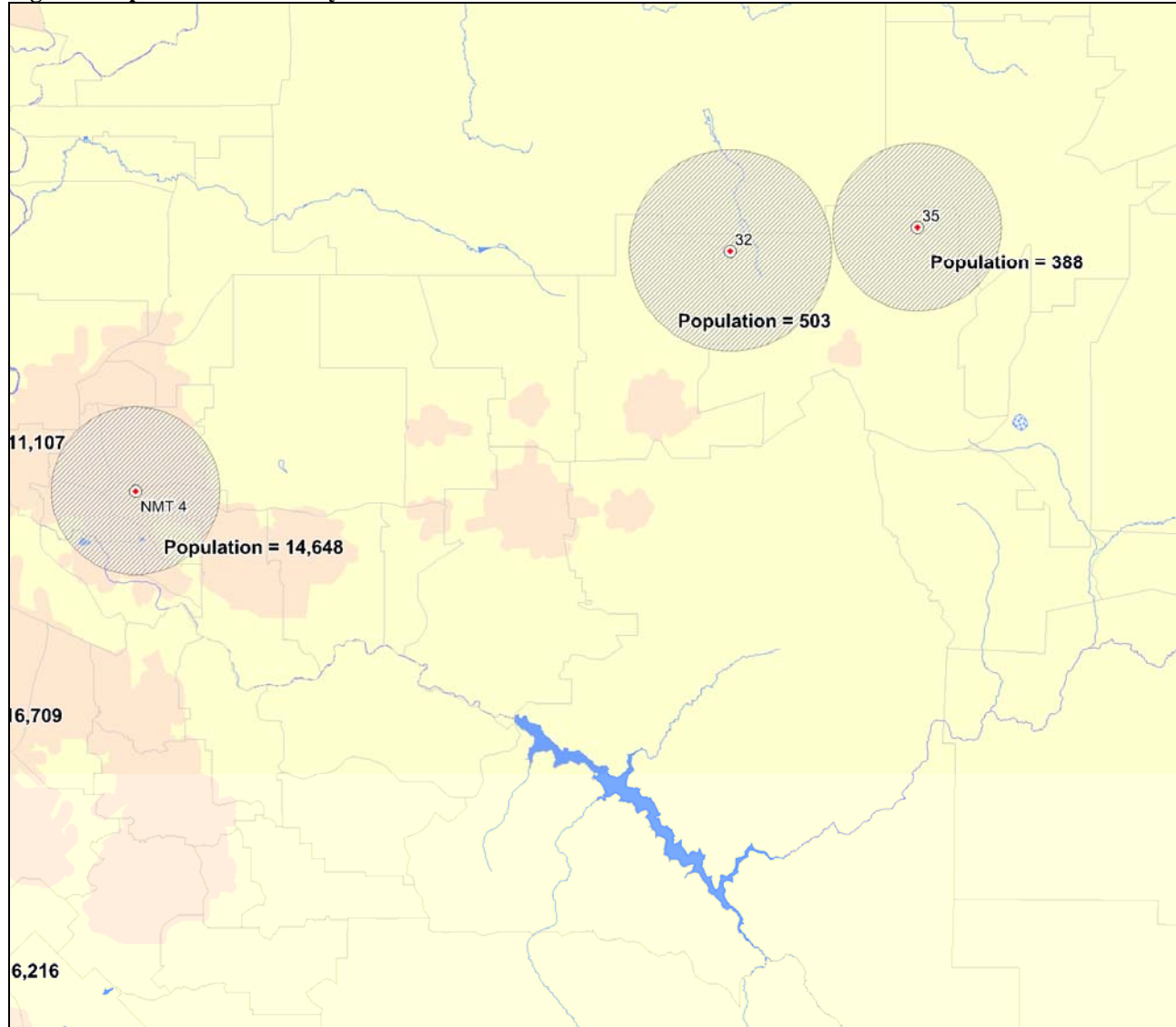
The population around each EMU has been calculated using available 2006 census data from the Australian Bureau of Statistics (ABS). The settings of each EMU have been used to determine the population within each capture zone. The capture zones are highlighted below.

**Figure 6 Population Covered by Permanent EMUs**



The highest population coverage is from EMU 3. A large portion of the EMU 2 coverage area is light industrial and does not contain residential receivers. The main residential part of the EMU 2 threshold capture zone is overlapped by that of EMU 1.

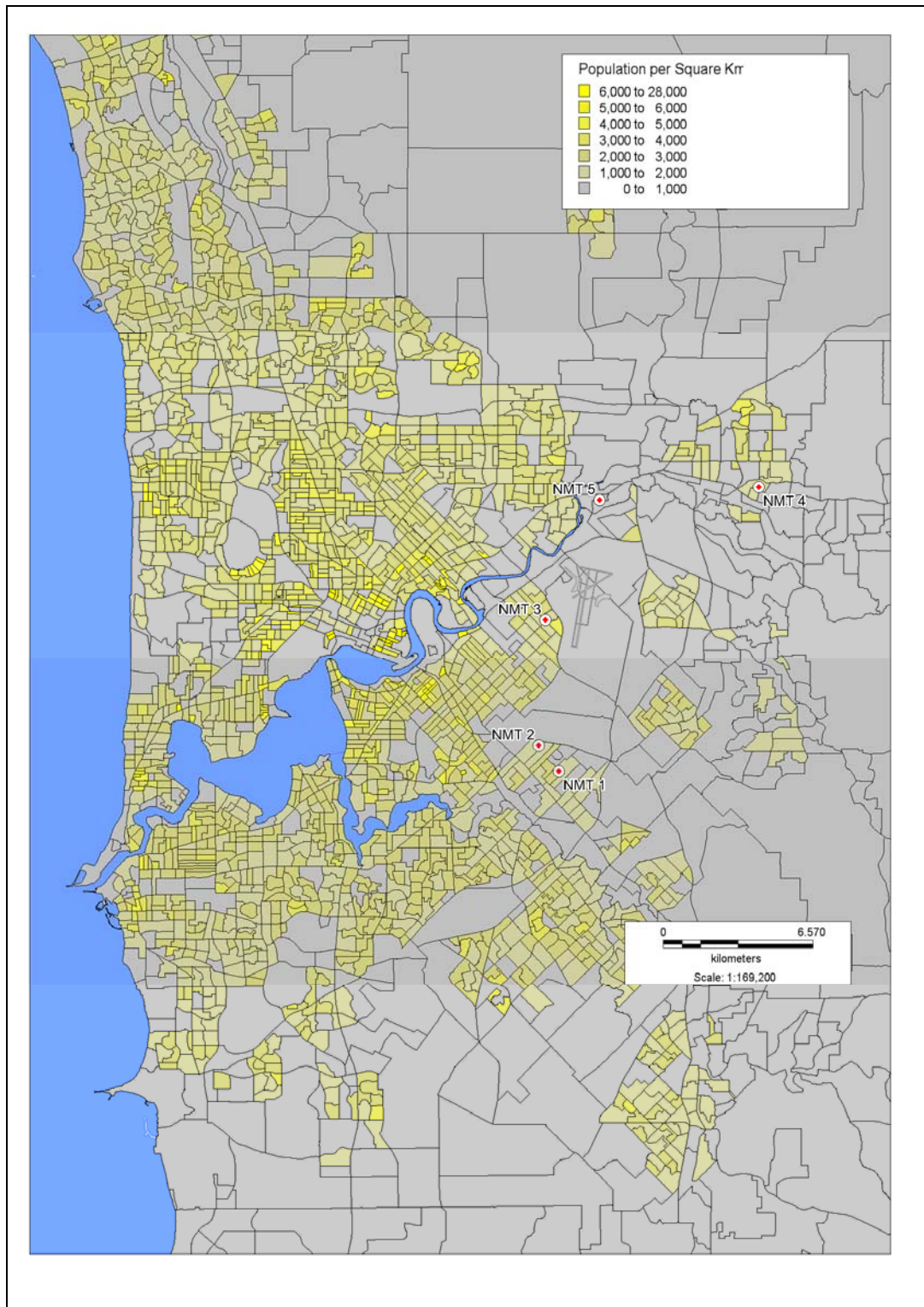
**Figure 7 Population Covered by Portable EMUs**



EMUs 32 and 35 cover a relatively low population compared to other EMUs.

To determine the overall population density for Perth, a thematic map has been created and shown below for population per square km.

**Figure 8 Overall Population per Square Km**



The population per square km figure above shows the heavily populated areas west of the airport however these areas are not regularly over flown by aircraft. The area to the south west of EMU 3 is relatively densely populated when compared to other areas near EMUs. If EMU 3 is replaced, an area to the south west is likely to be appropriate as discussed below in Section 16.

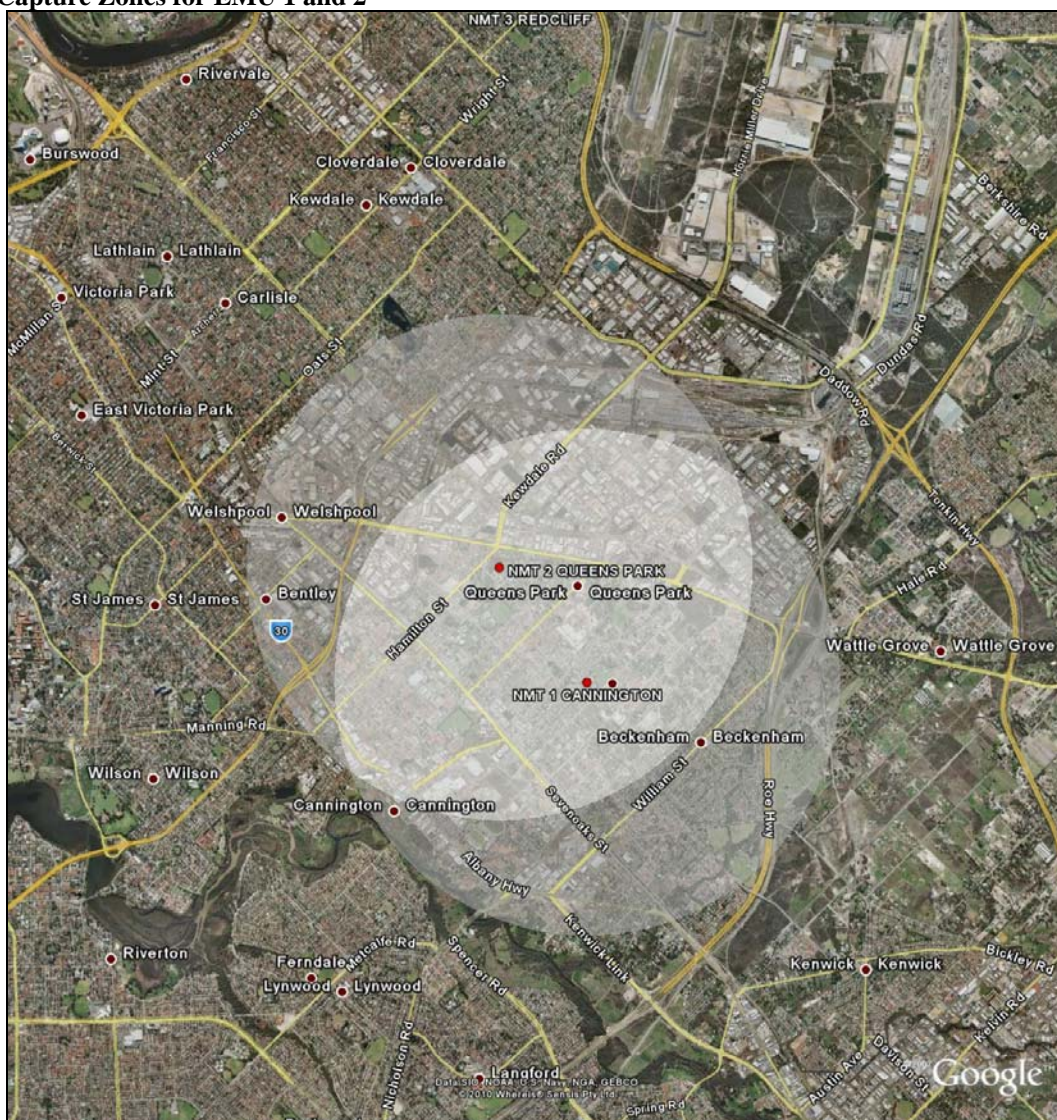
## 7.6 Comparison of EMU 1 and EMU 2

A comparison of data from the NFPMS quarterly reports for average maximum noise levels has been completed. Over the course of quarter three, both EMU 1 and EMU 2 captured mainly the same aircraft types. 19 of the top 25 aircraft types with the highest average noise levels were the same.

The comparison of average maximum noise levels found that:

- Higher levels were generally detected at EMU 2.
- The top 25 aircraft at EMU 1 are mainly departure aircraft, whereas EMU 2 contains a mix of departure and arrival aircraft.

**Figure 9 Capture Zones for EMU 1 and 2**



The above image shows how EMU 2 thresholds mainly cover light industrial areas. A large portion of the residential area within the EMU 2 threshold is covered by the EMU 1.

This suggests that the permanent EMU 2 could be re-located and the capture zone for EMU 1 could be increased without any major loss in system fidelity. Suggested areas for the relocation of EMU 2 are given in Section 16 below.

## 8 Analysis of Sensitive Areas

The following section analyses sensitive areas of Perth in relation to aircraft noise.

### 8.1 Roleystone

The suburb of Roleystone has been considered as a sensitive area due to the large number of noise complaints received and flights over the area. In the month of July a total of 332 complaints from 9 complainants were received.

The table below presents the total number of movements that flew over Roleystone in July, indicating that 68% of flights were associated with YPPH (mainly associated with the main runway 03/21). Approaching aircraft to Perth airport cross over Roleystone (north to south) before turning to final approach.

**Table 7 Flights over Roleystone with Respect to Airport (July 2010)**

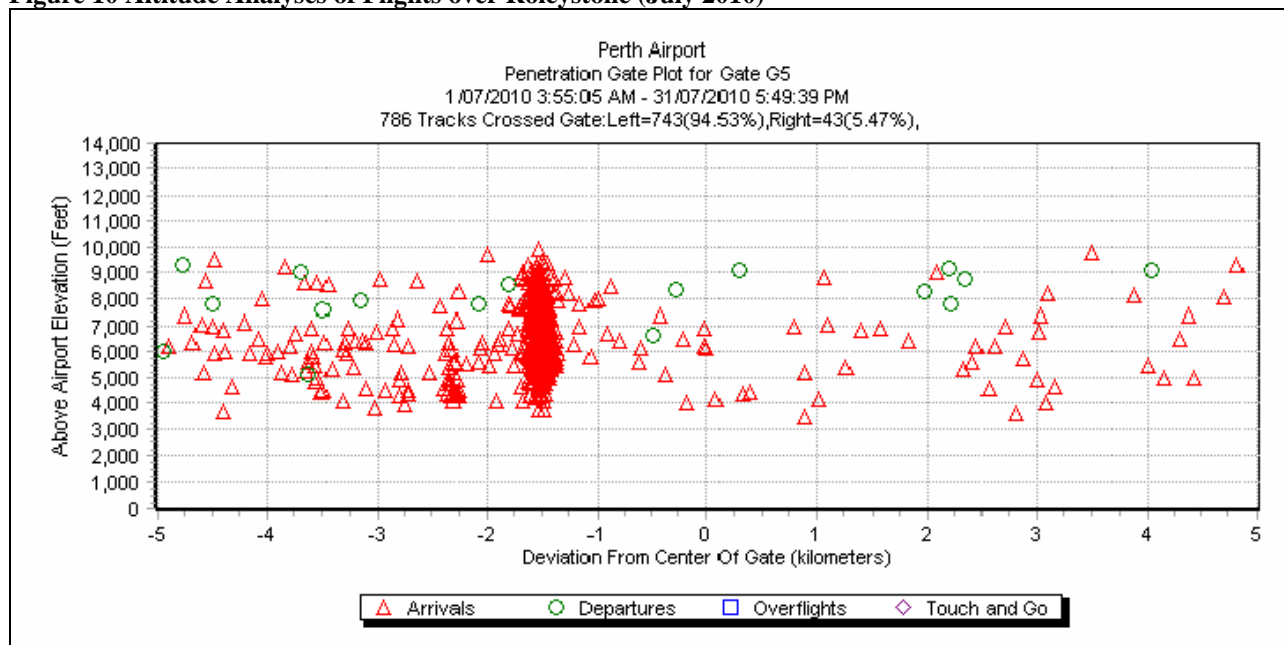
Airport	Total	%
Jandakot Airport	320	21.7
Perth Airport	998	67.7
Other / Unknown	157	10.6

Note that "unknown" represents aircraft movements that may not have a flight plan retained in the traffic control system.

The topography of Roleystone is elevated up to 260m (853 ft) above sea level which causes aircraft to traverse the suburb at altitudes of 5100 ft to 6100 ft above ground level.

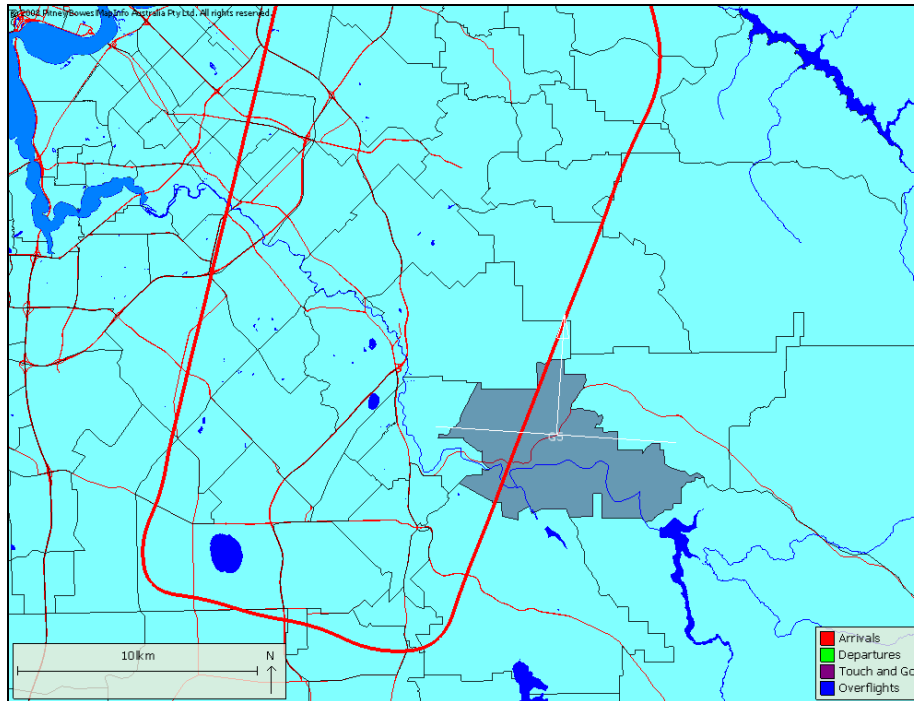
The community of Roleystone has a heightened sensitivity to noise from Perth airport movements due to the recent change to flight path for aircraft approaches.

**Figure 10 Altitude Analyses of Flights over Roleystone (July 2010)**



The relatively high concentration of approaches over the Roleystone suburb can be seen above. This is the likely cause of complaints.

**Figure 11 Gate Location and Example Movement over Roleystone**



The gate location is shown above. Roleystone is the highlighted suburb. The gate is shown in white with a north facing arrow showing the centre of the gate.

## 8.2 WARRP Post Implementation Review Recommendations

The WARRP PIR performed in May 2010 highlighted various noise sensitive suburbs including Glen Forrest and Stoneville. These suburbs have been identified as locations where portable noise monitoring should be performed to quantify the noise exposure experienced by these communities in order to assist the development of further potential mitigation measures.

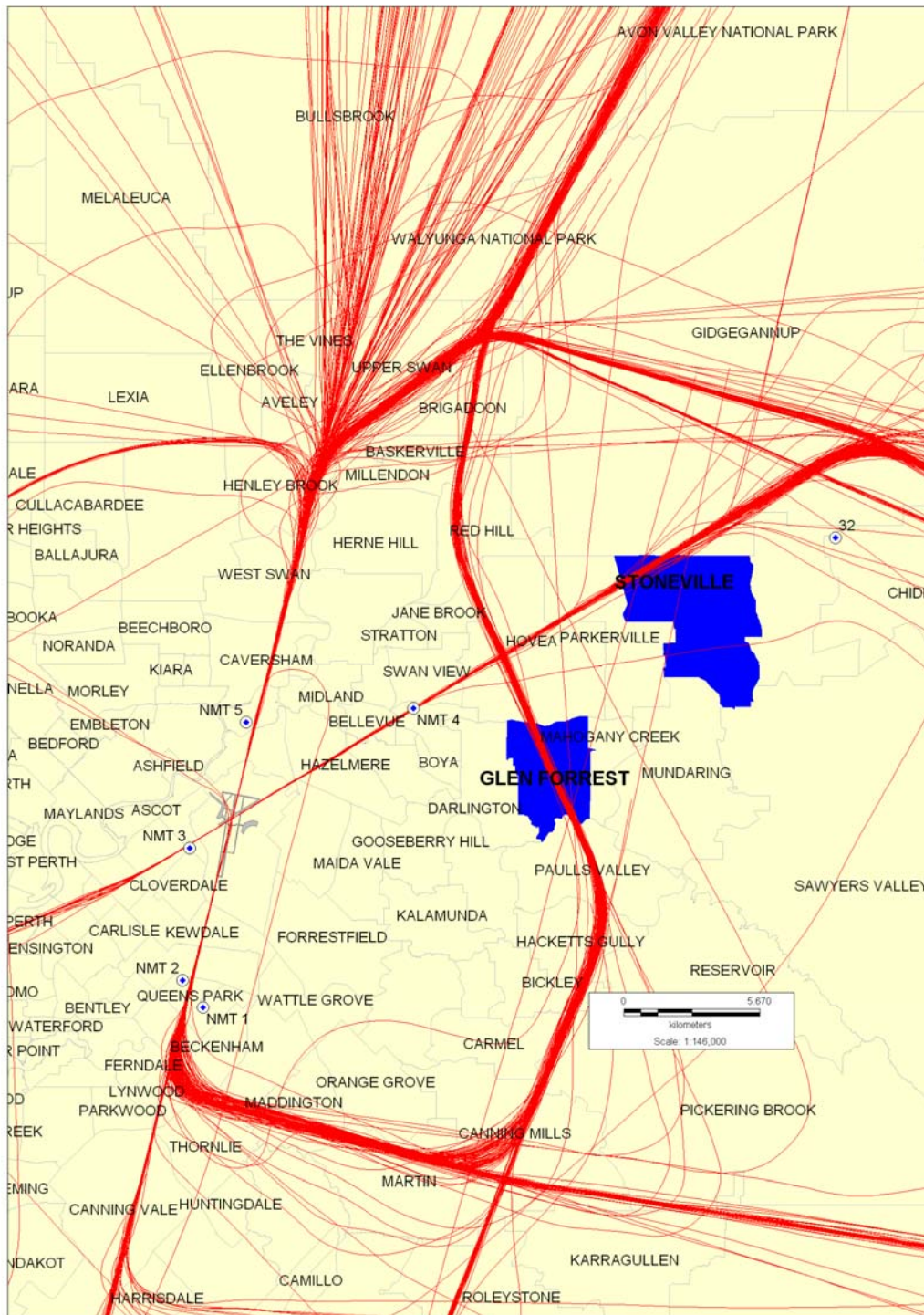
The population of Glen Forrest is 2839 people in accordance with 2006 Census data. Stoneville has a population of 2840 people. Both suburbs have relatively low population densities per Sq km compared to other areas covered by permanent EMUs. Glen Forrest and Stoneville register a high number of complaints as shown in Figure 2 and are affected by arrival aircraft.

The expected noise levels at these locations vary greatly, however are relatively low when compared with noise levels detected at permanent EMU locations. Noise modeling undertaken as part of the WARRP study established potential single event maximum noise levels of:

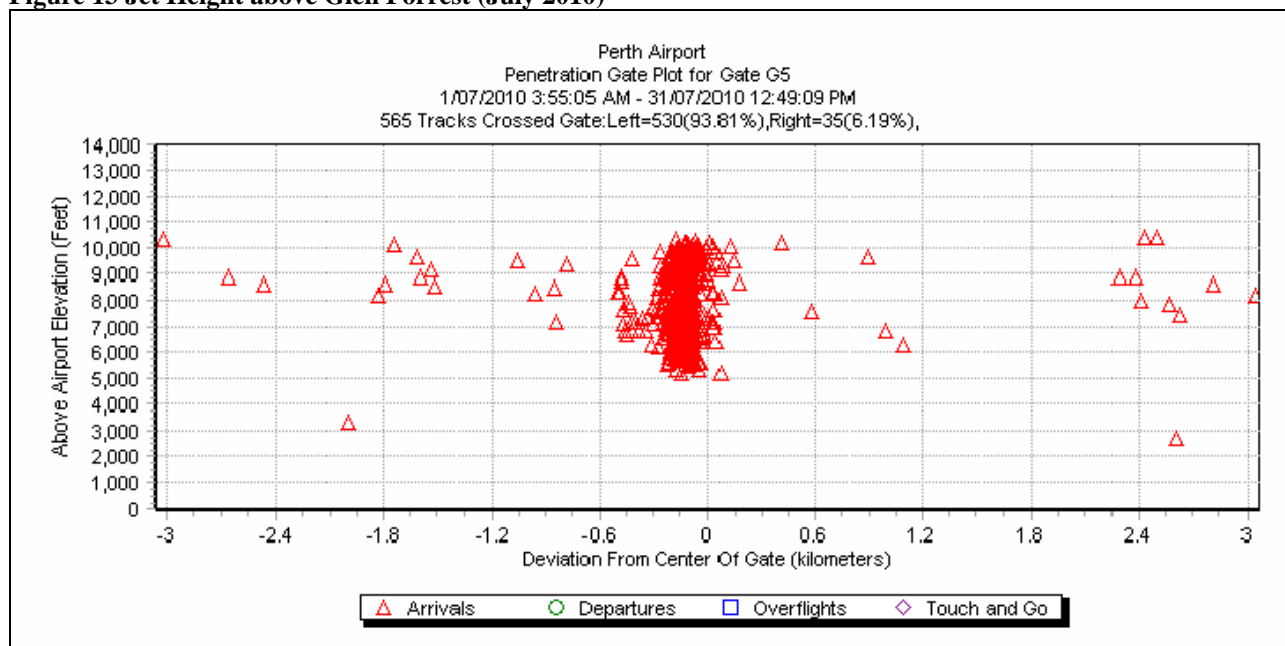
- up to 72 dB(A) for arrival jet aircraft at Glen Forrest, and
- up to 79 dB(A) for departure jet aircraft at Stoneville.

Actual flight tracks for typical weekday jet arrivals are shown below in Figure 12.

**Figure 12 Flight tracks over Glen Forrest Stoneville (Typical Weekday Jet Arrivals)**

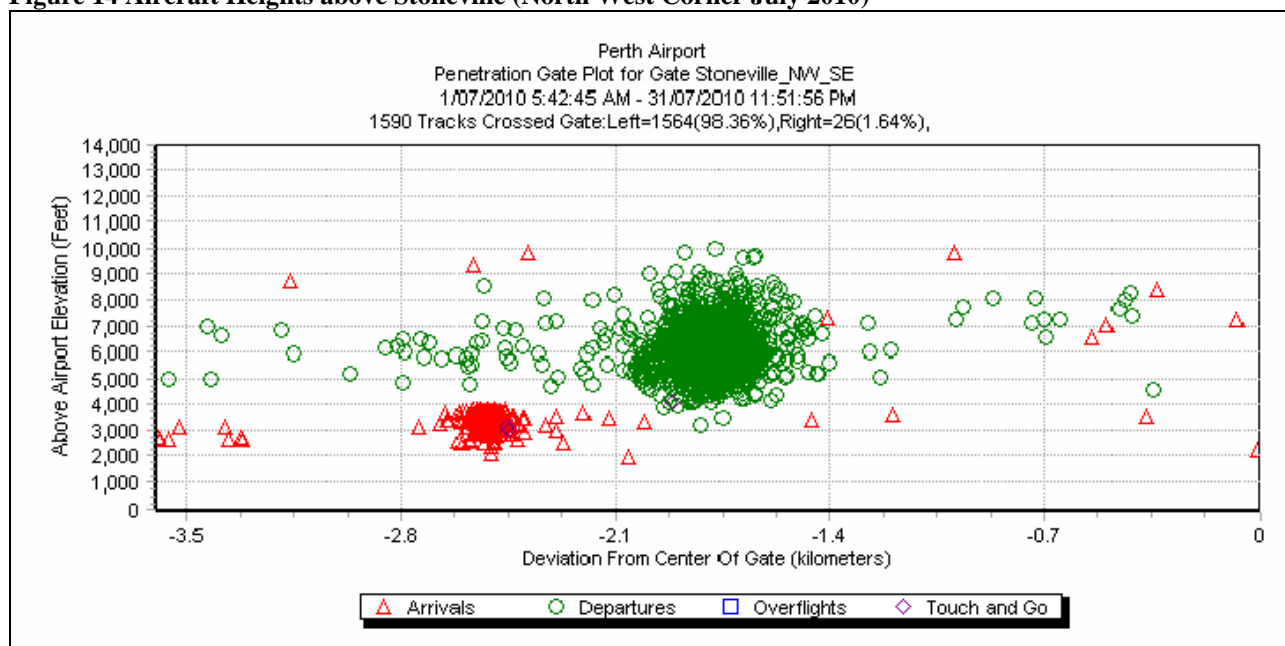


**Figure 13 Jet Height above Glen Forrest (July 2010)**



The above figure presents jet arrivals through Glen Forrest for the month of July 2010. Glen Forrest has an elevation of around 230m (721 ft) above sea level. The average height of aircraft was 7200 ft above the sea level, generally ranging from 5000 to 10000 ft which means that they are 4279 to 9279 ft above the ground. The arrival aircraft were tightly bunched with a lateral spread of around 500 m. Aircraft noise levels on approach at this altitude will be relatively low. As a result, if a portable EMU were located there, the lower threshold noise settings may be required.

**Figure 14 Aircraft Heights above Stoneville (North West Corner July 2010)**



The above figure shows aircraft movements over the north west corner of Stoneville. This area receives a high concentration of air traffic with both departures off the cross and main runways, and arrivals. The average height of departures was around 6000 ft above sea level and ranged from 4000 to 10000 ft. The average height of arrivals was around 3000 ft ranging

from 2500 to 4000 ft above sea level. Stoneville has an altitude of around 270 m (885 ft), and therefore the average height of departures was 5115 ft and arrivals were 2115 ft above the ground.

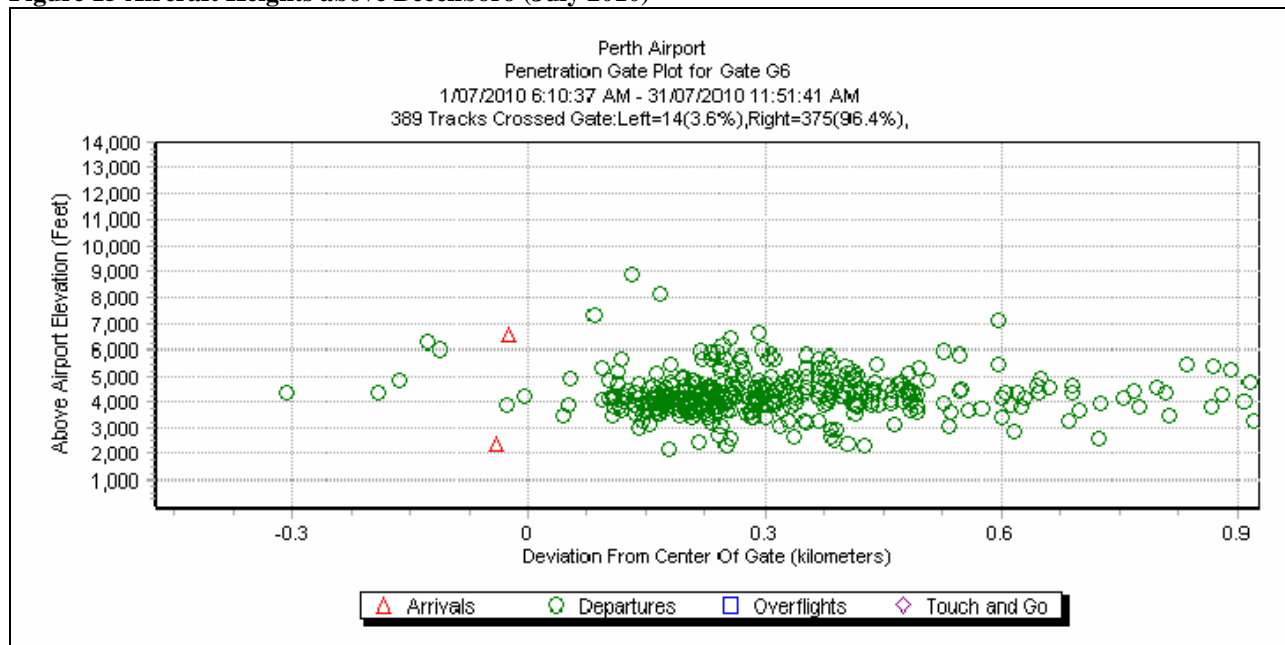
The north west corner of Stoneville would be a good location for measuring aircraft noise; however similar aircraft movements have potentially already been assessed using the Chidlow portable EMUs.

### 8.3 Beechboro

High levels of complaints have been received from the suburb of Beechboro. This suburb has a population of 12,867 people in accordance with 2006 Census data, which is much greater than the previous sensitive areas assessed.

The main aircraft movements over Beechboro are from 03 departures and 06 departures tracking north then turning to the west.

**Figure 15 Aircraft Heights above Beechboro (July 2010)**



The above figure shows aircraft movements in July that track over the suburb of Beechboro. The average height of these departures is 4100 ft above sea level ranging from around 2000 to 6000 ft. This would be a prime location for a portable EMU as:

- The capture zone would cover a high number of people,
- There is a concentrated number of departures tracking through the suburb, and
- The noise data captured could be used to help complaint investigations.

Noise modeling undertaken as part of the WARRP study established potential single event maximum noise levels of up to 79 dB(A) for departure jet aircraft at Beachboro.

## 9 Overall Flight Path Analysis

EMU locations have been assessed against the current Standard Arrival Routes (STARs) and Standard Instrument Departures (SIDs). The following section shows how the current EMU locations closely match the procedures.

Perth airport has the following main Standard Arrival Routes (STAR)s:

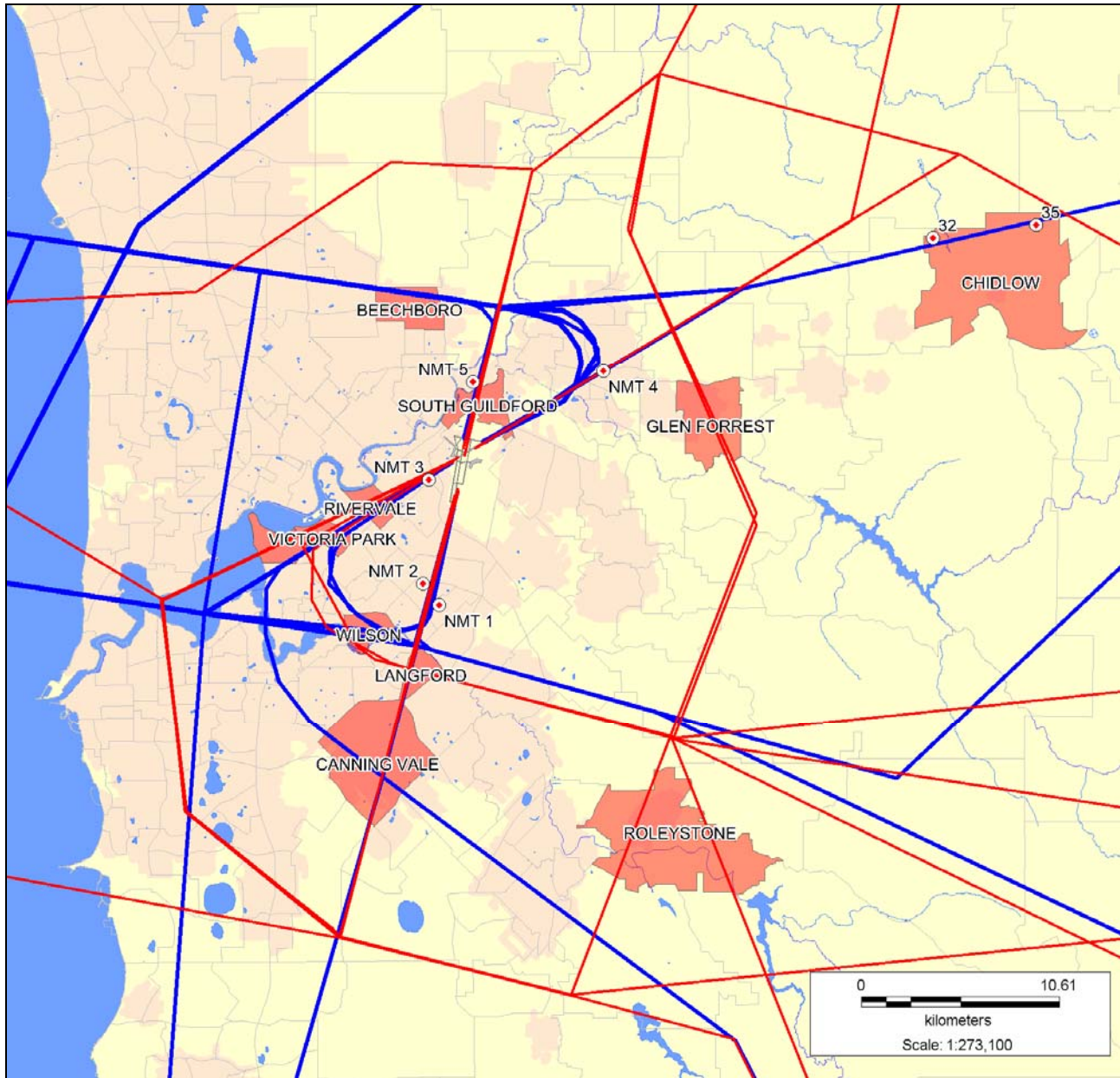
- STAR BEVLY FOUR ARRIVAL (JET) (RNAV)
- STAR CONNI THREE ARRIVAL (NON-JET) (RNAV)
- STAR DAYLR THREE ARRIVAL (NON-JET) (RNAV)
- STAR GOSNL TWO ARRIVAL (RNAV)
- STAR GRENE FOUR ARRIVAL (NON-JET) (RNAV)
- STAR JULIM FOUR ARRIVAL (JET) (RNAV)
- STAR SOLUS THREE ARRIVAL (RNAV)
- STAR WAVES FIVE ARRIVAL (RNAV)
- STAR WOORA ONE ARRIVAL (RNAV)

Perth airport has the following main Standard Instrumented Departure (SID)s:

- SID AMANA TWO DEPARTURE (JET) (RNAV),
- SID GURAK FOUR (RNAV),
- SID KEELS FOUR (RNAV),
- SID PERTH FOUR DEPARTURE (RADAR) - ALL RWYS,
- SID RAVON TWO (NON-JET) (RNAV),
- SID RWYS EAST (JET) (RNAV),
- SID RWYS EAST (NON-JET) (RNAV),
- SID RWYS SOUTH (RNAV),
- SID RWYS WEST (NON-JET),

The jet STARs and SIDs are presented in 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 16 All Jet SIDs and STARs**



The above figure includes all jet SIDs and STARs with suburbs highlighted that have 8 or more complainants from Jan to June 2010. The figure shows the following:

- All EMU locations are closely aligned with flight paths,
- Some high complainant areas such as Beechboro, Glen Forrest, Roleystone and Canning Vale are directly beneath the flight paths and would benefit from noise monitoring.
- A high number of SIDs and STARs are grouped to the south west of the airport over areas such as Riverdale Victoria Park and Wilson. These suburbs have a high number of complainants and may benefit from noise monitoring.

Aircraft flight paths generally track the SIDs and STARs closely and can be seen above in

Figure 5.

## 10 Communications Coverage and Reliability

The following table presents the number of days that each EMU was available to collect data over the first two quarters of 2010. The total possible number of days is 90 days for Q1 and 91 days for Q2.

**Table 8 Analysis of Operational Days**

EMU Location	Q1 (90)	Q2 (91)
EMU 1 (Cannington)	90.0	91.0
EMU 2 (Queens Park)	90.0	91.0
EMU 3 (Redcliffe)	90.0	91.0
EMU4 (Greenmount)	90.0	91.0
EMU5 (Guildford)	90.0	91.0
EMU32 (Chidlow)	N/A	78.2
EMU35 (Chidlow)	N/A	74.0

Each permanent EMU achieved good availability over the first two quarters of 2010. EMUs were partially operational only during brief periods of preventative maintenance. EMU 32 and 35 were commissioned during April 2010; hence the result is less than for other monitors; however both portable units achieved full availability throughout Q2 once commissioned.

The NFPMS experienced a radar data outage from 13<sup>th</sup> May 2010 to 14<sup>th</sup> May 2010. During this data outage, each EMU was still operational and collecting data. However the noise events at this time could not be correlated to aircraft.

## 11 ISO 20609:2009 Requirements

ISO 20609:2009 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 Aircraft Noise Monitoring System (ANOMS) 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 than 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 24<sup>th</sup> April 2010 and contained the following summary:

**Table 9 Preventative Maintenance Summary 2010**

EMU	Location	Date	Details
01	Gibbs St Primary School	29/04/10	Replaced Microphone
02	Queens Park	29/04/10	Replaced Microphone
03	Redcliffe	12/04/10	Replaced Microphone and windscreen
04	Black Bay Hill (Greenmount)	12/04/10	Replaced Microphone and windscreen
05	Guildford	29/04/10	Replaced Microphone

Automatic calibration checking is performed daily using an electrostatic calibration test. Daily calibration is performed on average 3 times a day for permanent sites and 4 times for non-permanent. Calibration checking can also be performed adhoc as required.

Annual acoustic calibration is performed at each site. For 2010, all microphones at permanent EMUs were replaced at Perth 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).

In 2009, all existing 'EMU1' units were replaced with 'EMU2' monitors in March 2009. Therefore maintenance was not required in 2009.

## 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 a single day of operation, 20/07/2010, 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**

Location ID	Average Angle of Elevation (degrees)	Standard Deviation
1	32	12
2	45	10
3	8	15
4	67	12
5	46	11
32	64	13
35	69	7

EMU 3 threshold settings cover areas that are very close to the cross runways and therefore pick up movements on these runways at low elevation angles. The relative low height of aircraft on takeoff/land could contribute to low elevation angles. Note that EMU 3 was decommissioned in November 2010.

### 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)). ANOMS uses both radar and noise information to correlate noise events, and therefore the requirements of ISO 20906 do not strictly apply however are used for this review. 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 Quarters 1 to 3.

**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)
1	39.6	61.7	71.2	22.1
2	41.2	62.8	74.2	21.6
3	44.4	62.6	73.6	18.2
4	38.4	63.2	73.8	24.8
5	39.5	63.3	72.3	23.8
32	25.0	48.3	59.3	23.3
35	24.4	48.5	57.1	24.1

The above table indicates that average background levels are at least 15dB below the minimum aircraft  $L_{Amax}$  recorded for each site. This is in accordance with ISO20906.

## 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 Perth do not exceed this level; however there are periods of high wind that should be flagged. The following table presents a summary of weather data collected from ANOMS over January to November 2010 for comparison with ISO 20609:2009.

**Table 12 Weather Summary Data from ANOMS Jan – Nov 2010**

Average wind speed (m/s) at Perth Airport	16.7 (m/s)
Total instances of wind events recorded as $\geq 36$ km/hr	301
Total duration of wind events recorded $\geq 36$ km/hr	257.3 Hours

The table indicates that there is a period of 257.3 hours over the period January to November 2010 that had recorded wind speeds greater than 36 km/hr. This equates to a total of around 10 days. The Standard indicates that any correlated noise events captured during this time should have been flagged as having high wind conditions.

## 13 Security and Access for Maintenance

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

## 14 Licensing Arrangements

The following section details the licensing arrangements for each EMU.

### 14.1 EMU 1 Cannington

Location: East Cannington School, 108 Gibbs Street, East Cannington, WA.

The current license agreement is in place with the School Registrar. License agreement is due for renewal in 31<sup>st</sup> December 2010 and will be renewed for another 12 months.

### 14.2 EMU 2 Queens Park

Location: Queens Park Primary School, 202 Treasure Road Queens Park.

The current license agreement is in place with the School Principal. The license agreement is of a permanent nature with an option for termination with 3 months notice. The current payment is up to date for another 12 months.

### 14.3 EMU 3 Redcliffe

Location: Redcliffe Child Care Centre, Cnr Epsom Avenue and Sydenham Street Redcliffe

The current license agreement is in place with the centre's management. The license agreement for Redcliffe is currently due for renewal. The owner asked that AsA vacate the site by the beginning of November 2010. Therefore this site has been decommissioned and a new site location for the monitor is required.

### 14.4 EMU 4 Greenmount

Location: AsA owned site Gallipoli Drive Greenmount

EMU 4 is located on an Airservices Australia site and managed through the Perth Facility Management Services Manager. No license agreement is required.

### 14.5 EMU 5 Guildford

Location: Private Property 10 Meadow Street, Guildford

The current license agreement is in place with a Private property owner. Currently, the Airservices Property section does not have a license agreement for the site.

### 14.6 EMU 32 and 35 at Chidlow

Location: Private Property

The Chidlow portable EMUs are on private properties. The license agreements have recently been extended for 6 months with an expiry date of 30<sup>th</sup> March 2011.

## 15 Configuration of the EMUs

The configuration of each EMU has been reviewed by the service provider B&K and data provided in their Noise Verification Report dated September 2010. The following section provides a brief overview of their findings in relation to the requirements of the Terms of Reference for the Perth review.

The Service Provider Noise Verification Report detailed 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.

### 15.1 Service Provider Report Summary

All Noise Monitors were examined and based on the noise threshold and noise correlation analysis performed, no changes to the configuration parameters are recommended.

EMU 3 was found to have a significant number of false positive correlations, but as this monitor has now been decommissioned no recommendation has been made.

There were 4 arrival aircraft that did not detect a noise event when on final at EMU 1 and 2 arrival aircraft at EMU 2. This small number of undetected noise events does not validate a change and it is not recommended that the thresholds be decreased as this in turn can result in the increase of false positive correlations.

The results indicate the Noise Monitors are working as intended and the system is correlating aircraft correctly to Noise Events that occur at the Noise Monitors.

### 15.2 Service Provider Report Discussion

The Service Provider Report established that a significant number of false positives were received at EMU 3. This is most likely due to the threshold capture zones covering an area that includes the airport.

The reason why there were four arrival aircraft that did not detect a noise event when on final at EMU 1 and 2 is unknown, however the very low number of this missed event is considered acceptable.

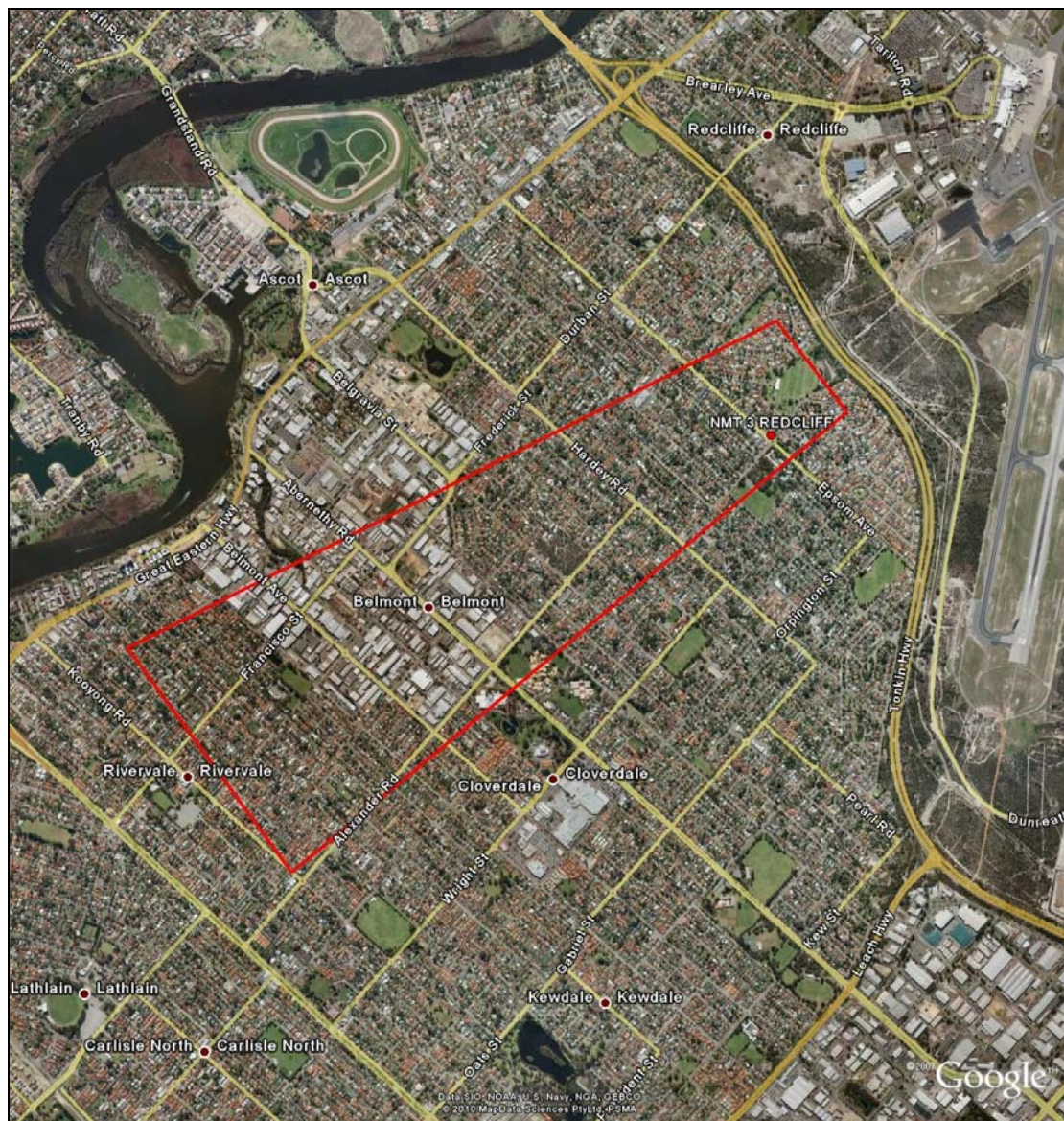
## 16 Recommendations

As a result of the above analysis, it has been established that permanent EMUs 2 and 3 could be relocated to optimise the NFPMs, and that weather data should be captured at various EMUs.

### 16.1 Relocation of EMU 3

As the EMU 3 site is due for re-licensing, The EMU can be relocated to a more suitable location. In its current position, EMU 3 has a large number of false positives and on average captures aircraft with a low angle of elevation. The figure below presents the recommended area for relocation of EMU 3.

**Figure 17 Recommended Area to Relocate EMU 3**



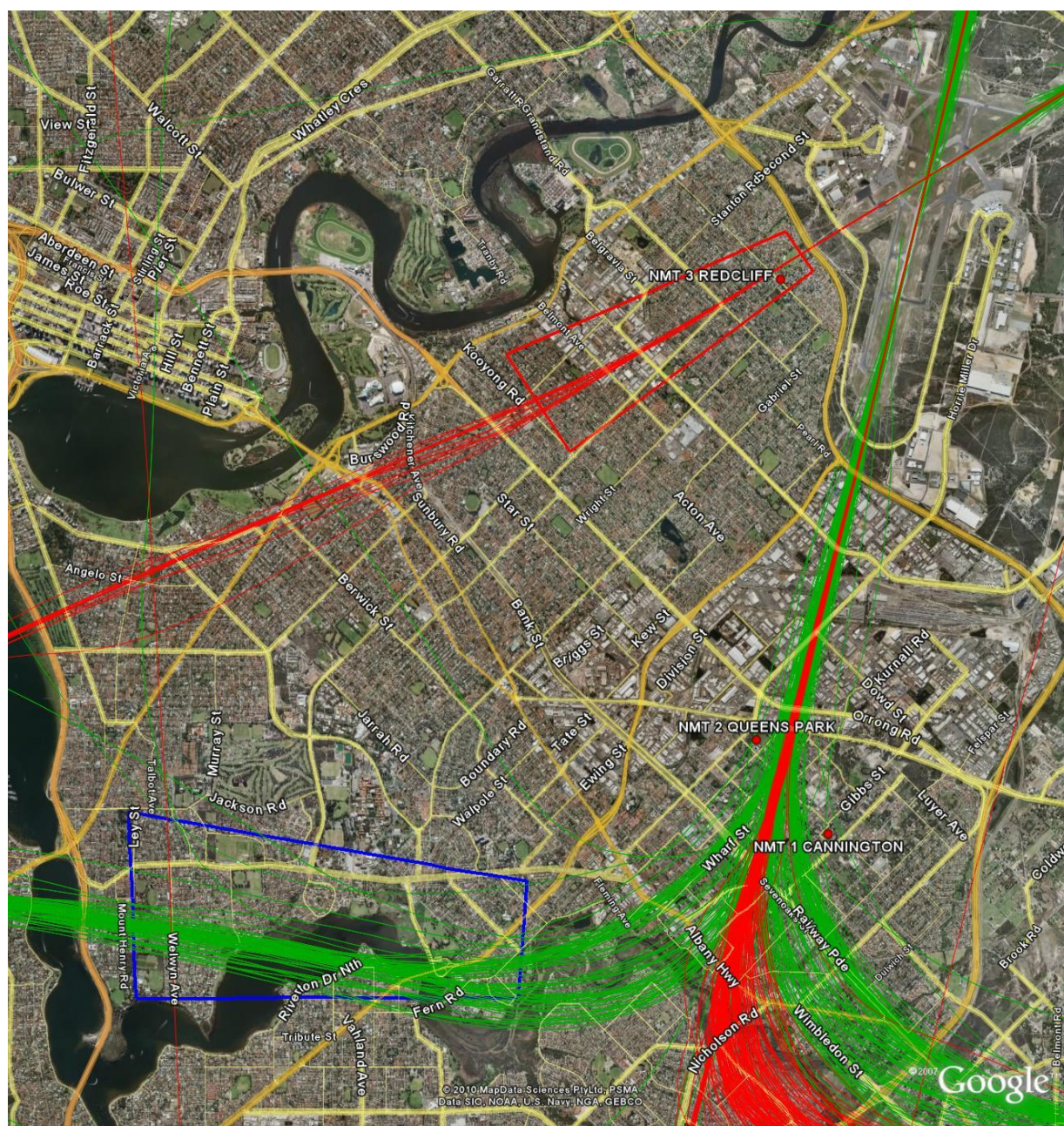
The above selected area contains high aircraft traffic and a large number of residential receivers. Aircraft within this area are below 5000 ft. This area captures aircraft departures

before they turn to the south, maximising correlation. Note that a location in Rivervale would correspond well with complainant data shown above.

## 16.2 Relocation of EMU 2

EMU 2 could be relocated due to redundancy with EMU 1. The figure below presents a potential area where the EMU could be relocated in blue. This area captures a high concentration of weekday jet departures off the main runway 21/03 and contains a high density of residential population.

**Figure 18 Potential EMU relocation Areas with Weekday Jet Movements**



The social impact on the community of replacing a permanent EMU should be carefully considered. Noise sensitive people within close proximity to the current location of EMU 2 may dispute the change.

### 16.3 Portable EMU Noise Studies

Noise monitoring at Beechboro, Roleystone, Glen Forrest, Stoneville, Canning Vale and Victoria Park is required. A similar approach to the Chidlow monitoring should be undertaken where two monitors are used to capture noise events simultaneously. The period of study may lead to permanent EMUs at one or more locations.

### 16.4 Capturing Weather Data

Weather data is currently not captured at any EMUs at Perth. 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 ISO20609.

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 north of the Airport at EMU 5 and south at EMU 1.
- One weather station placed at EMU 3. (This location is most central to all other EMUs).

A cost vs benefit analysis should be considered when determining the best option. Each option would enable full compliance with ISO20609.

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 Perth Region

As well as the recommendations for the Perth Airport based EMUs there are monitoring needs for Jandakot Airport in the south-western suburbs of Perth. Although smaller aircraft operate at Jandakot Airport it is one of the busiest airports (in terms of number of movements) in Australia. There are several training school based at Jandakot which pose very different noise issues than at Perth Airport. Airservices regularly receives aircraft noise complaints for operations based out of Jandakot Airport. Since the upgrade of Airservices Noise and Flight Path Monitoring System (NFPMS) in late 2009 there is a much-improved coverage of Jandakot operations. Two short term locations about Jandakot Airport are therefore proposed for implementation during 2011.

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 Perth Airport ANMCC Airservices has developed a program of aircraft noise monitoring for the Perth 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 20609). For these sites a more flexible short term monitoring study would be appropriate. Recommendations for short term (4 weeks) and longer term (6+ months) have been made based on the rationale for each monitoring location.

Issue	Type/purpose for monitoring	Status
<b>Noise monitoring at Beechboro</b>	This could be a good permanent site. Currently there are no monitors capturing noise in the northwest suburbs. Installation of a portable for 6+ months	A site has been identified this is a local school. Arrangements for a license followed by installation to be progressed Q2 & Q3 of 2011.
<b>Noise monitoring at Roleystone</b>	Short term monitoring (4 weeks).	Site yet to identified. A formal license agreement is not required for this site. Monitoring is scheduled for the latter part of 2011.
<b>Noise monitoring at Glen Forest</b>	As above. Short term monitoring (4 weeks)	Site yet to identified. A formal license agreement is not required for this site. Monitoring is scheduled for the latter part of 2011.
<b>Noise monitoring at Stoneville</b>	As above. Short term monitoring (4 weeks)	Site yet to identified. A formal license agreement is not required for this site. Monitoring is scheduled early 2012
<b>Noise monitoring at Victoria Park</b>	A suitable site to the west at approximately 6-10 km from the runway. Portable monitor (6+ months).	A site has been identified this is a local school in Lathlain. Arrangements for a license followed by installation to be progressed Q3 & Q4 of 2011.
<b>Replacement for the Redcliffe EMU</b>	As above.	
<b>Alternative for the Queenspark EMU</b>	In the longer term this monitor could be relocated to another site to the west or north of the airport. Maintain current location pending a more useful site west or north of the airport. Portable monitor (6+ months).	A site has been identified this is a local school in the suburb of Manning. Arrangements for a license followed by installation to be progressed during 2011.
<b>Noise monitoring at Jandakot #1-Canning Vale</b>	This site is overflowed by arrivals by operations at Jandakot Airport and arrivals into Perth Airport. Short term monitoring (4 weeks).	Site yet to identified. A formal license agreement is not required for this site. Monitoring is scheduled during 2012
<b>Noise monitoring at Jandakot #2 - TBA</b>	Under the circuit or underneath one of the arrival paths.	Site yet to identified. A formal license agreement is not required for this site. Monitoring is scheduled during 2012
<b>Decommissioning of Queenspark EMU</b>	This will depend on the outcome of monitoring at Manning and Beechboro.	TBA

## Appendix A Terms of Reference

### **Airservices Australia Review of the Perth Airport 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 at Perth Airport against the Airservices Australia's environmental and business requirements for the management of aircraft noise. In performing this function the placement and individual configuration of the each of the EMUs needs to be optimised for the measurement of the impacts of aircraft operations on the local community from operations at Perth Airport.

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 20609
  - 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 Perth Airport Aircraft Noise Management Consultative Committee 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 Perth Airport's Aircraft Noise Management Consultative Committee at its June 2010 meeting. The Terms of Reference will be circulated to Committee members for comment by 30 June 2010. Comments are to be sent to [ian.mcleod@airservicesaustralia.com](mailto:ian.mcleod@airservicesaustralia.com)

### *Review Report*

A final draft of Airservices report will be provided to members of the Airport's Community Consultation Committee for discussion at a Community Consultative Committee meeting in late 2010.

### *Final Report*

The final report will be produced by 31 December 2010.

## Appendix B Public Comments Via the Perth Airport Aircraft Noise Management Consultative Committee and Airservices Responses

The EMU review for Perth Airport identified two EMU locations requiring relocation as well as several new monitoring areas. This review was tabled at the December 2010 ANMCC meeting and feedback from the committee was sought. Below is a summary of the comments received and Airservices response. The latter is in italics.

1. It would be preferable to keep EMU 2 in its location and relocate EMU 1. The concerned raised was that the noise levels detected at EMU 2 are higher than that at EMU 1 and are more representative of the worst case scenario for the area.

*Airservices response: The rationale for choosing EMU 2 is based on a better coverage of the local residential area. EMU 1 and 2 are expected to stay in their respective locations for the next 12 months until the portable monitoring at Beechboro, Lathlain and Manning have been completed.*

2. That EMUs should be located directly under the flight path as a measure of the worst case scenario. This is a concern for the relocation of EMU 3, and at the Guildford monitor EMU 4.

*Airservices response: 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 residence 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 Guildford monitor was originally installed on Public land that was later sold to a private individual. The location of EMU 3 is close to being under the arrival flight path on runway 06-24. Initially the installation of the replacement of EMU will be as a portable to fully assess the suitability of the site as a permanent monitoring location.*

3. EMU 3 replacement: Parallel monitoring between the old EMU 3 location and its new location.

*Airservices response: This is not possible as Airservices was asked to remove the monitor from this site October 2010.*

4. The replacement site should be as close as possible to the old site at Redcliffe.

*Airservices response: The old EMU 3 site resulting in many false positives due to its close proximity to the main runway. More useful noise data can be obtained from a location further east.*

5. Relocation of EMU 3 should be located further away from the airport than it was to avoid the large number of false positives.

*Airservices response: The proposed site in Lathlain addresses this concern.*

6. Table 1 EMU 5 is aligned with runway 03/21 not 06/24.

*Airservices response: Table 1 has been corrected for this.*

7. EMU 32 and 35 to remain for a full year of data collection.

*Airservices response: EMU 32 and 35 were removed April 2011 after a year of operation.*

8. The NFPMS should be capturing detailed weather data such as BOM data.

*Airservices response: Options are being explored to obtain detailed weather data.*

9. Portable monitoring should be done at Glen Forrest, Stoneville, Roleystone, Beechboro, Canning Vale and Victoria Park, Manning and Salter Point.

*Airservices response: Portable noise monitoring at Beechboro, Manning and Lathlain are programmed for commencement during 2011.*

10. Table 11 should contain maximum aircraft levels.

*Airservices response: The purpose of Table 11 is to determine compliance with the detection criteria of ISO20609 for which the minimum value is the relevant value.*

11. Should indicate minimum and maximum noise values rather than just averages.

*Airservices response: It is assumed this comment is directed at the quarterly NFPMS Reports rather than the Perth EMU Review. It is Airservices usual practice to present average and the standard deviation values for aircraft noise levels. This is used to eliminate the possibility of the results being influenced by a single false positive.*