NATS

YOUR LONDON AIRPORT Gatwick

Airspace Change Proposal

Gatwick PRNAV SID replications

Issue 1.1

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Action	Role	Name	Signature	Date
Author	Airspace Change Expert	[redacted]	[redacted]	09-Jan-2013
Approved	DEPT HEAD	[redacted]		09-Jan-2013
Accepted	UNIT HEAD	[redacted]		09-Jan-2013
Accepted	GAL Lead	[redacted]		

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Issue History

Issue	Date	Revisions
1.0	30-Nov-2012	Initial Issue to DAP
1.1	09-Jan-2012	Added justification, errata corrections, clarifications resulting from questions from DAP & ERCD. Table 2 two further columns added.

Contents

1 Introduction

This document has been produced by NATS on behalf of Gatwick Airport Limited (GAL). GAL is the sponsor of this change. This document details GAL's compliance with CAP725 requirements regarding this proposal. The purpose of the proposed airspace change is to replicate and eventually replace the current standard instrument departure routes (SIDs) from Gatwick Airport with more accurately defined routes, utilising the improved navigational capabilities of modern aircraft (Precision Area Navigation: P-RNAV).

The proposal is to implement P-RNAV replications of all SID routes from Gatwick Airport's main runway (Runway 26L/08R), for use in parallel with existing, conventional navigation based SIDs. This will enable a managed transition from the conventional to P-RNAV SID structure.

The improved track-keeping ability of PRNAV will result in less dispersal of flights across the NPR swathes. Thus the noise impact of the over-flying aircraft will affect less people. However those who are directly beneath the flight path will experience a greater number of over-flights.

GAL is planning to implement the changes on AIRAC 06/13 (30 May 2013).

2 Justification

Precision Area Navigation (PRNAV) enables aircraft to control their position with far greater accuracy than conventional forms of navigation. Hence the aircraft's position is known with greater certainty, and when operating under "own navigation" ATC have much greater certainty that aircraft are conforming to the defined PRNAV routes within close tolerances.

The introduction of PRNAV replications of the extant SIDs at Gatwick is in line with the CAA Future Airspace Strategy[1], which recommends the transition to performance based navigation (PBN) technologies.

The change is supported by the airlines for the following reasons:

- Procedures designed to PBN specifications allow airlines to use their FMS equipment to its full capability to assure predictable flights paths
- More predictable flight planning
- Improved standardisation of flight profiles in accordance with standard operational procedures
- The move away from reliance on ground nav-aids

Aircraft following P-RNAV SIDs are expected to self-navigate to a greater extent than is the case for those following conventional SIDs. Hence the number of tactical interventions from the air traffic controllers (radio calls) is reduced. In congested airspace, this aids efficiency, expedition and safety.

Due to the increased accuracy of P-RNAV, it's use results in improved track-keeping, with traffic being more concentrated close to the route centreline. This is in accordance with the Department for Transport's recommendations for minimizing the impact of over-flying aircraft on populations (Ref 6).

A trial has been on-going since 27th September 2007 which tested PRNAV replications on four out of the nine SID routes alongside the conventional procedures. This trial was well received by those airlines involved, however this will finish on 20th April 2013. The proposed introduction of the PRNAV replications is intended to formalise the use of PRNAV for all SIDs at Gatwick, and make it available to all airlines.

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[1] http://www.caa.co.uk/docs/33/Policy%20for%20the%20Application%20of%20Performance-based%20Navigation%20in%20UK_Irish%20Airspace%20-%20Signed%20111013.pdf

3 Current Airspace Description

3.1 Departure Routes

The current conventional SIDs from Gatwick airport's primary runway (26L/08R) are listed in Table 1 and shown in Figure 1 below.

Runway 26L	Runway 08R
BIG 7M (Route 4)	BIG 3P (Route 5)
BOGNA 1M (Route 7)	-
CLN 8M (Route 4)	CLN 5P (Route 5)
DVR 8M (Route 4)	DVR 2P (Route 5)
HARDY 5M (Route 7)	-
KENET 2M (Route 1)	**KENET 3P (Route 3)**
LAM 4M (Route 4)	**LAM 5P (Route 4)**
SFD 5M (Route 8)	**SFD 9P (Route 2)**
SAM 2M (Route 1)	**SAM 3P (Route 3)**
TIGER 3M (Route 9)	-
DAGGA 1M (Route 9)	-
WIZAD 4M (Route 9)	-

Table 1 Extant Gatwick SIDs (RWY26L/08R)

When an aircraft departs from Gatwick airport it will follow one of these SIDs depending on the runway in use and its destination. All Gatwick SIDs are contained within Noise Preferential Routes (NPRs) up to an altitude of 4,000 feet[2]. The NPRs are defined as corridors 3km wide (see Figures 2-14). The tracks of aircraft following the conventional SIDs form a swathe up to 3 km wide, and are generally contained within the defined NPR regions. Once the aircraft has passed 4000ft it can be vectored off the SID, which may take it outside of the NPR, otherwise it continues to follow the SID until it reaches the point where it can join an airway for the enroute phase of the flight. The London Terminal Control Area airspace around Gatwick Airport is a major confluence of airways and arrival and departure routes for all the London airports. The mixture of climbing and descending aircraft, holding patterns and transit routes requires dynamic tactical management by the air traffic controllers.

[2] exceptions as per AIP section AD 2-EGKK-1-13 section 8

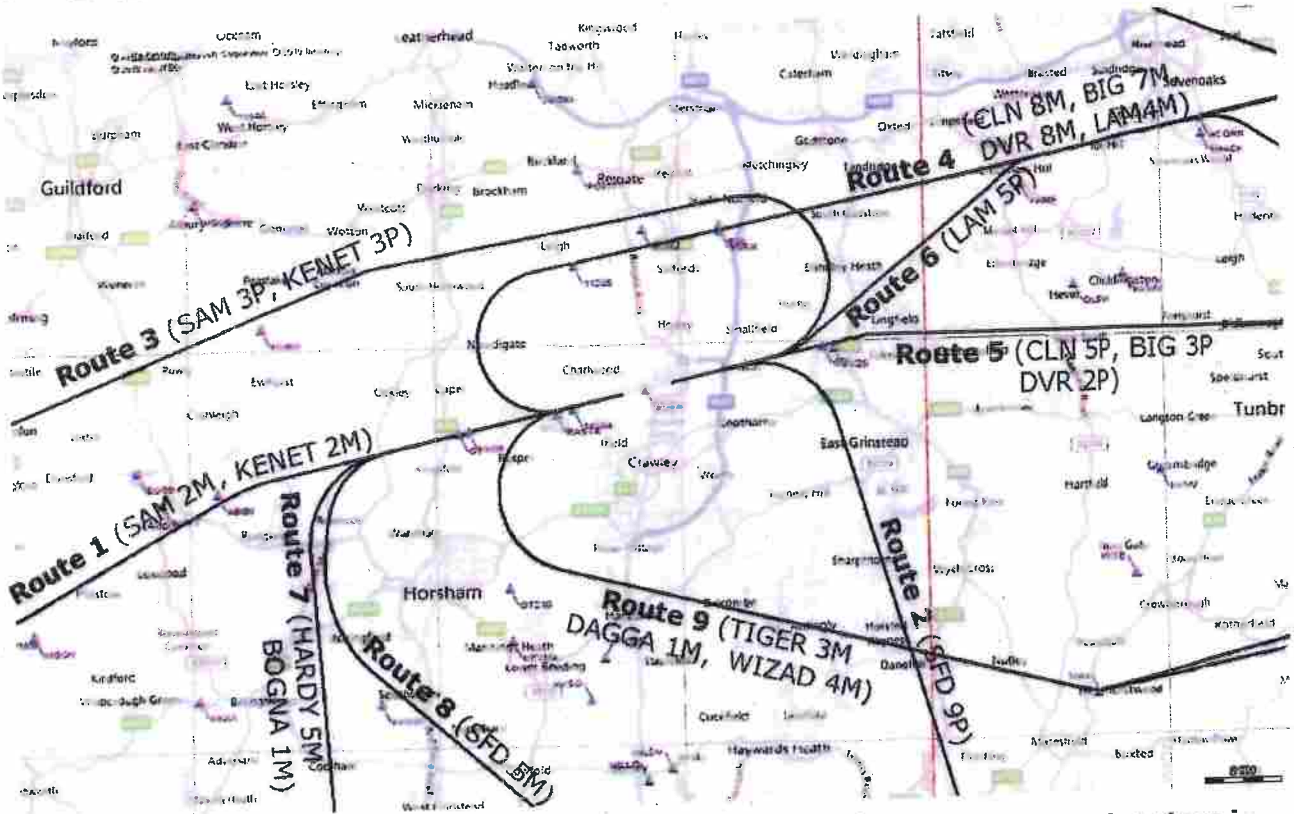

Figure 1 Map showing SIDs proposed to be changed (current SID designators in brackets).

Note: Figure 1 is intended only to give an overview showing all SIDs. For detailed design issues and comparisons of SIDs please refer to the individual technical drawings provided by PDG in Appendix A.

3.2 P-RNAV

Current civil air transport aircraft are able to determine their in-flight position with increasing accuracy using modern navigation aids including ground-based beacons, space-based satellites and on-board inertial navigation systems. Appropriately equipped aircraft can fly a prescribed route with greater accuracy than before.

The capabilities and benefits of the P-RNAV navigation specification are well documented. The background for this change includes the stated CAA policy for adoption of P-RNAV in UK airspace which has already been subject to a separate consultation by the UK CAA (DAP)[1] and is a cornerstone of the Future Airspace Strategy.

3.3 Overview of PRNAV at Gatwick Airport

A trial to study P-RNAV Standard Instrument Departures from Gatwick Airport commenced on 27th September 2007 and has run continuously to the present day. This trial included four P-RNAV SIDs based upon conventional SID centrelines.

Table 1 above lists all of the current conventional SIDs from Gatwick Airport. Four of these were replicated by PRNAV SIDs during the trial, these SIDs followed routes 1-4 hence the SIDs which use the same routes are identified **in bold in** Table 1. The numbers in brackets identify which route number used in the consultation, corresponds with which conventional SID. An overview of the extant SID routes is shown in Figure 1. There are 19 SIDs for the primary runway (26L/08R), and 36 in total, which for the initial part of the SIDs (i.e. while aircraft are below 4000ft) follow one of nine routes (e.g. eight of the Gatwick SIDs follow Route 4 for their initial portion). For simplicity during the consultation the routes were numbered 1 to 9. The proposed routes have been designed, within the limitations of the ICAO PANS-OPS PRNAV design criteria (Refs 1, 2 & 3), to replicate the existing SIDs as closely as possible.

The overall aim of the trial was to determine the operational benefits of using P-RNAV equipment to fly SIDs from Gatwick Airport. The objectives of the trial included the assessment of:

1. Applying P-RNAV procedures in a complex airspace environment.
2. P-RNAV ATC procedures
3. The track-keeping accuracy of vertical and lateral profiles for future applications of P-RNAV.
4. Utilisation of both conventional and P-RNAV procedures for the same departure tracks.
5. Track dispersion and compliance with airport Noise Preferential routes (NPRs) in comparison with conventional procedures.

The trial has run successfully without incident for five years. Data has now been collected and the trial is due to end on 20th April 2013. A report detailing the track-keeping performance of the aircraft participating in the trial is attached as Appendix F.

The trial demonstrated that 100% of aircraft navigating using PRNAV stayed within 1000m of the defined PRNAV centreline, hence showing 100% compliance with the RNP1 standard. A comparison with the observed track-keeping ability of flights using conventional navigation on comparable SIDs, showed that the average performance of P-RNAV aircraft is similar to or better than the average performance of the aircraft using conventional navigation. Overall 'worst-case' performance, as characterised by the maximum measured deviations from the SID, are far higher for flights using conventional navigation. Thus there is evidence to suggest that the track-keeping performance of P-RNAV aircraft is better than that of conventional-navigation aircraft.

The trial has demonstrated that the use of PRNAV procedures in complex and busy airspace can be achieved successfully, and results in more predictable track keeping of the aircraft. Hence all of the objectives stated above were met successfully.

4 Comparison of Current and proposed procedures

Figures 2-14 below show the current and proposed procedures side by side. The proposed procedures for routes 1-4 have been flown during the trial by a large number of aircraft over the course of five years; hence the trajectories shown below (both current and proposed flight paths) are from real radar data[3]. On figures 2-14 the pink lines represent the PRNAV centre-line, the black line shows a track following the conventional procedure based on the radials as promulgated in the AIP, and uses 2nm radii to calculate the turns required to join the published radials.

The source files for Figures 2-14 (high resolution, PDFs with layering) are included in the electronic ACP package.

[3] The PRNAV density plots are derived from one year of trial data. The Conventional density plots are derived from one day (busy summer day 2011).

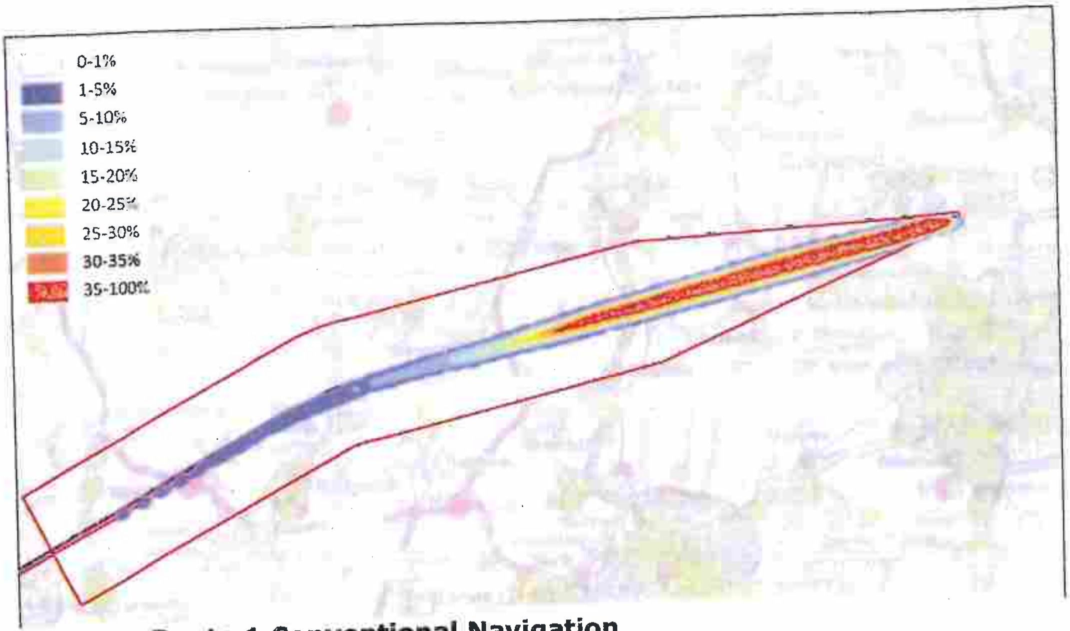

Figure 2 Route 1 Conventional Navigation

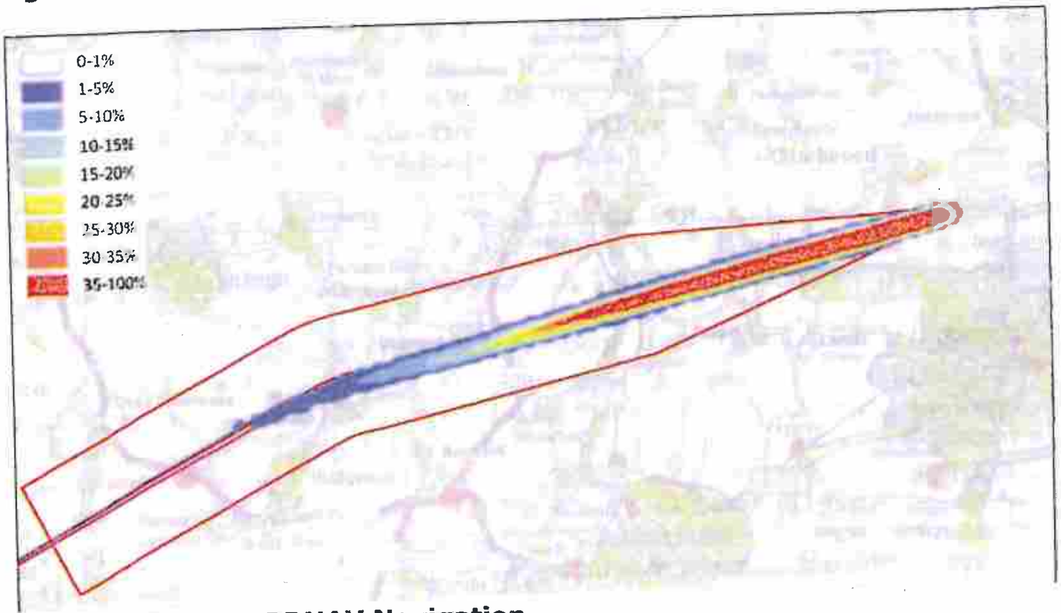

Figure 3 Route 1 PRNAV Navigation

NOTE: The densities illustrated in Figures 2-14 were constructed by calculating the proportion of radar returns within a defined grid square, and colouring according to the relative density of the returns compared to the square with the highest observed density (for example yellow shading indicates radar return density is 20 – 25% of the highest density square). As such the colour coding cannot be related easily to the number of aircraft in a particular defined grid square. However, the number of radar returns in each sample has been taken into account in this calculation, and therefore the plots are all directly comparable.

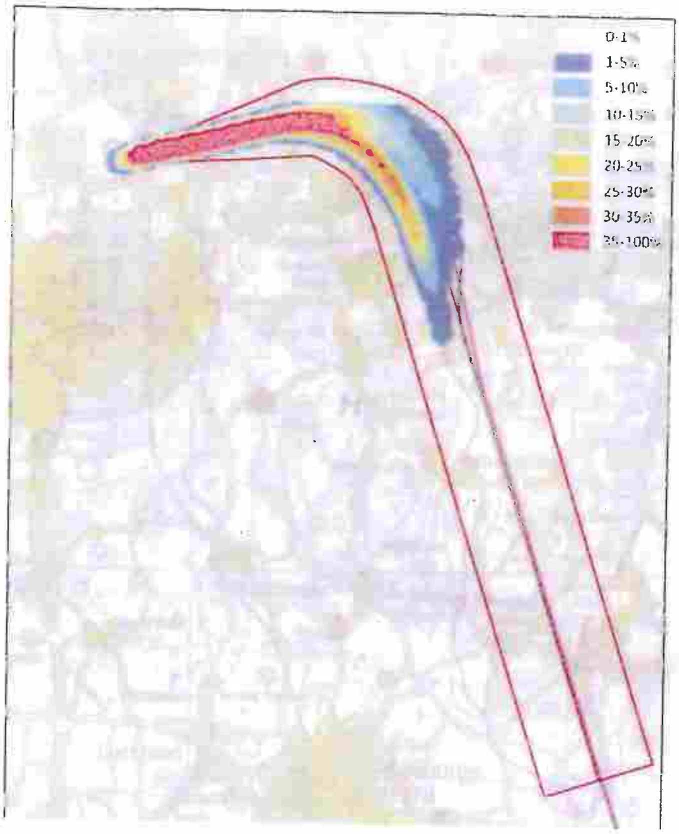

Figure 4 Route 2 Conventional Navigation

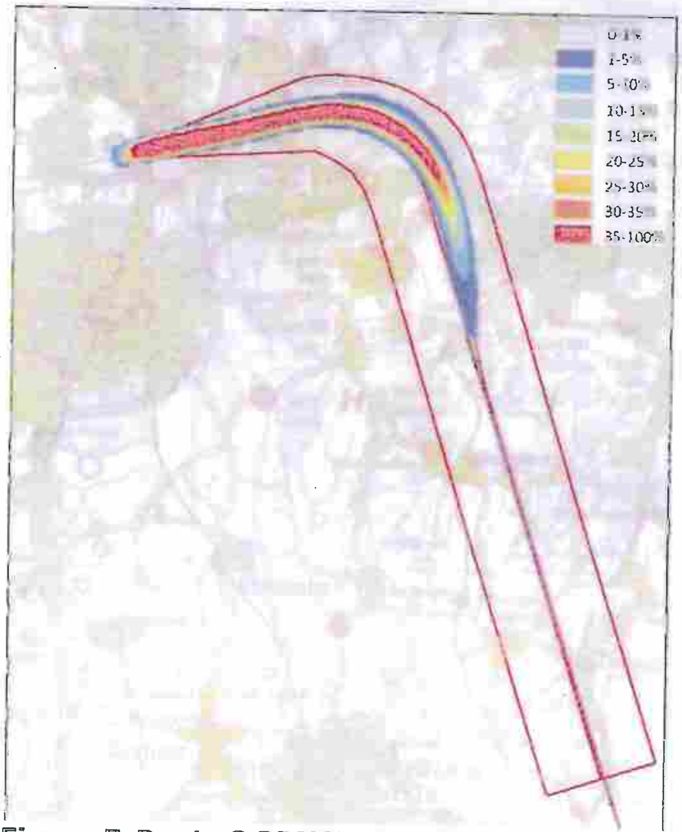

Figure 5 Route 2 PRNAV Navigation

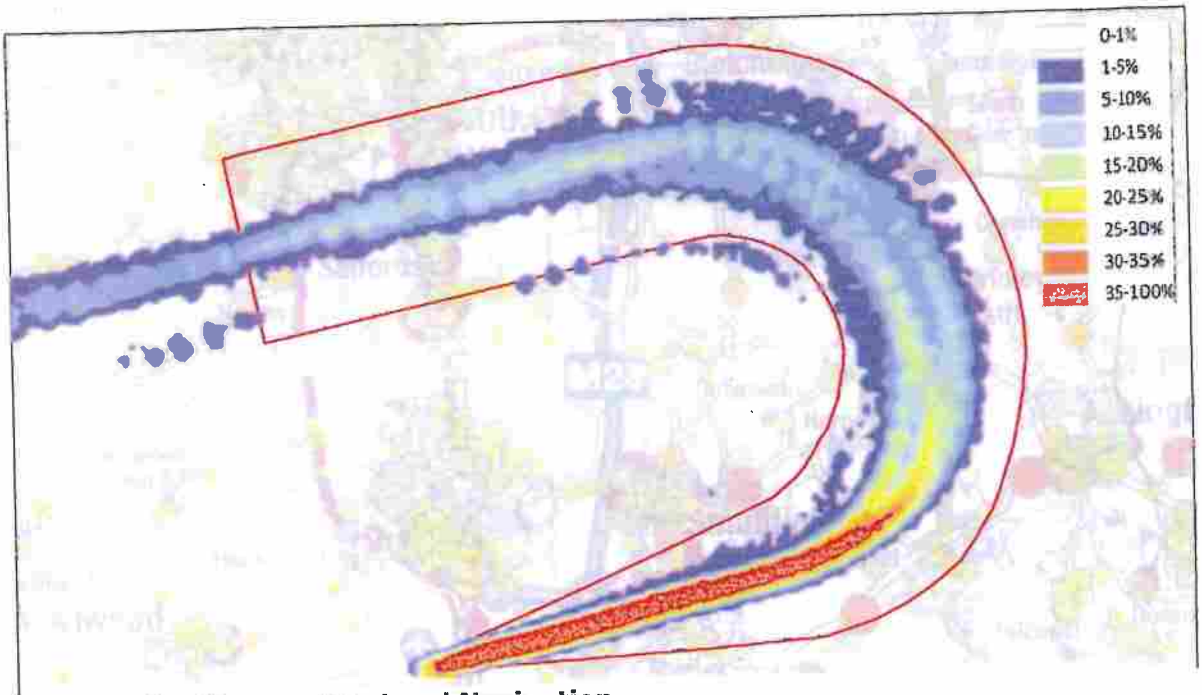

Figure 6 Route 3 Conventional Navigation

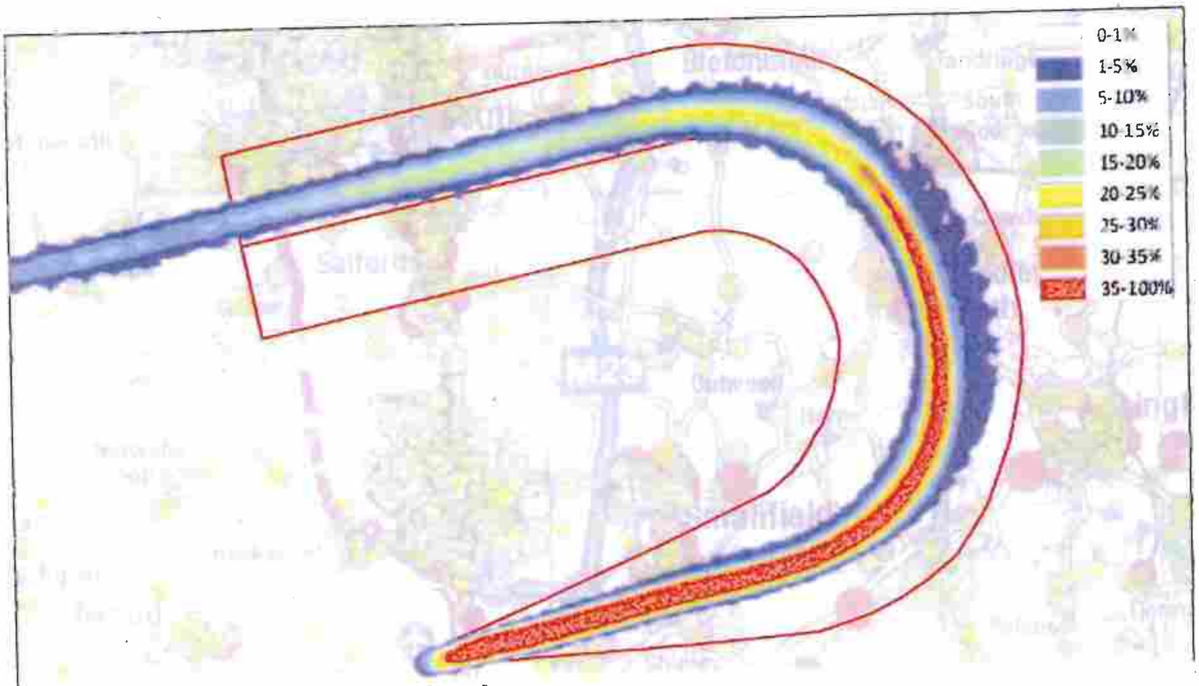

Figure 7 Route 3 PRNAV Navigation

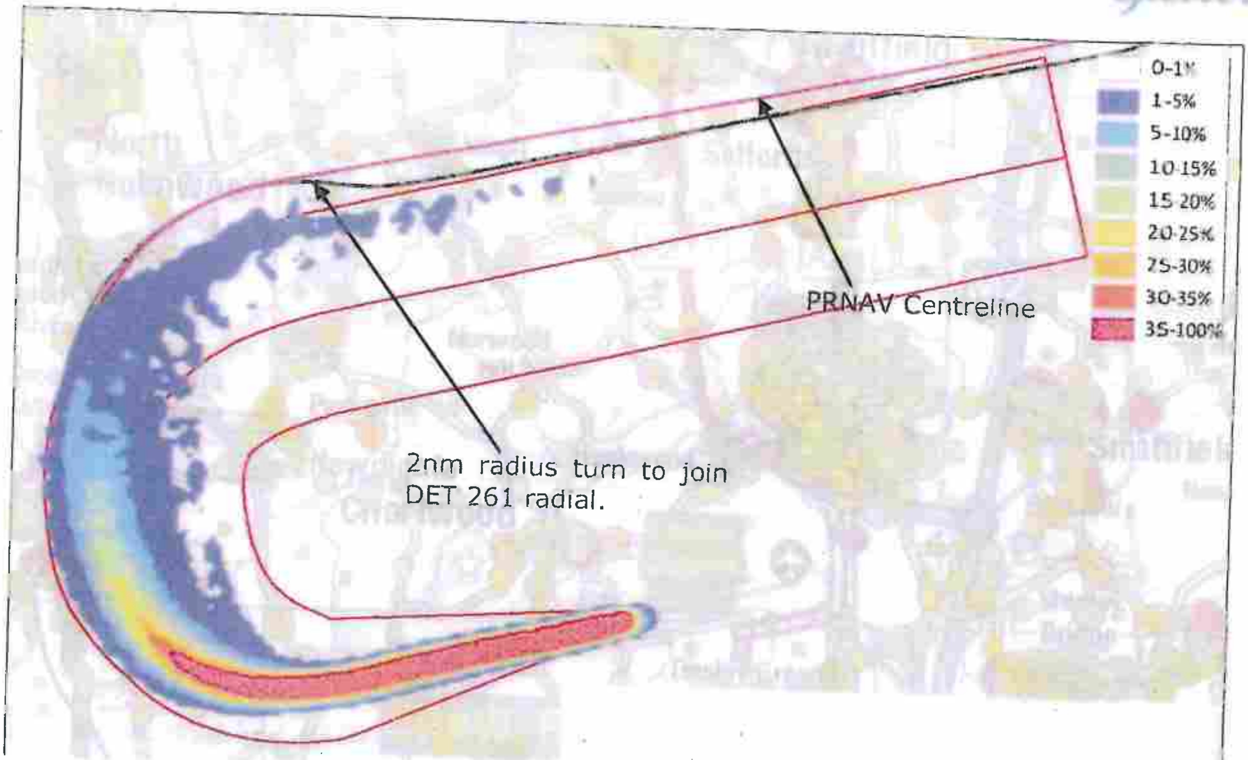

Figure 8 Route 4 Conventional Navigation

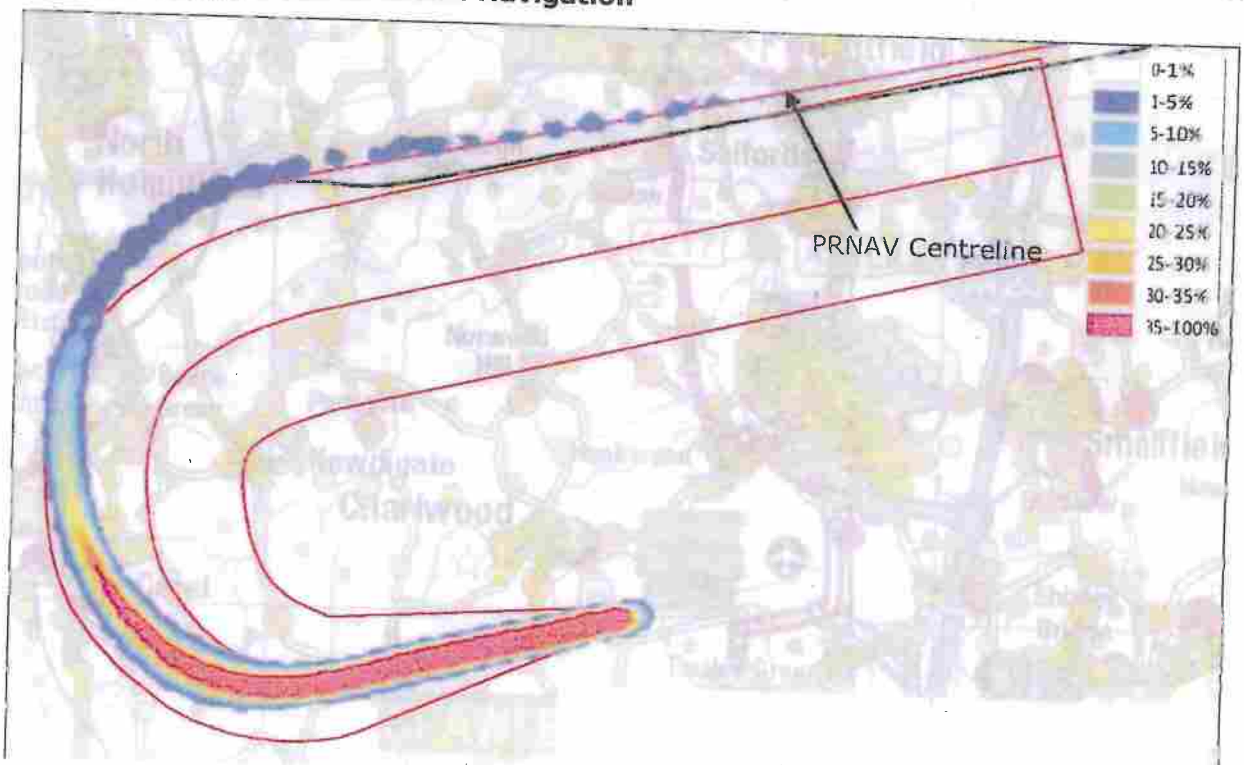

Figure 9 Route 4 PRNAV Navigation

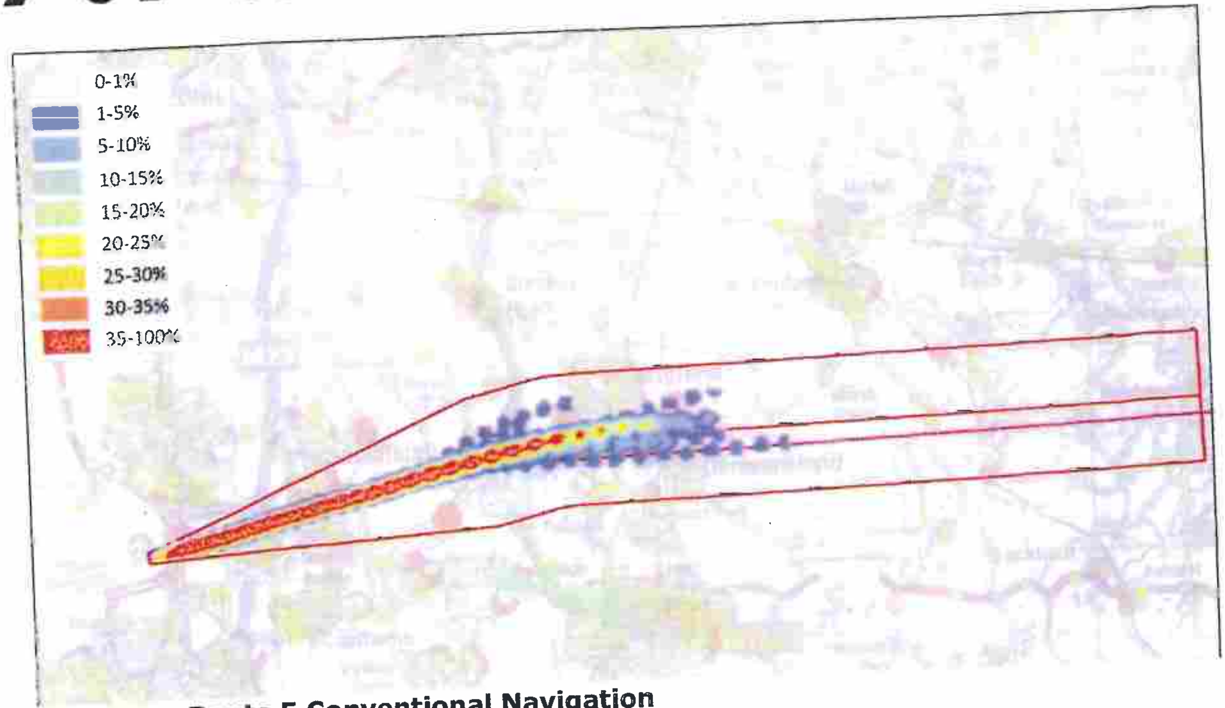

Figure 10 Route 5 Conventional Navigation

The impact regarding noise and track dispersion for route 5 is expected to be identical to that seen from the flight trials of route 1.

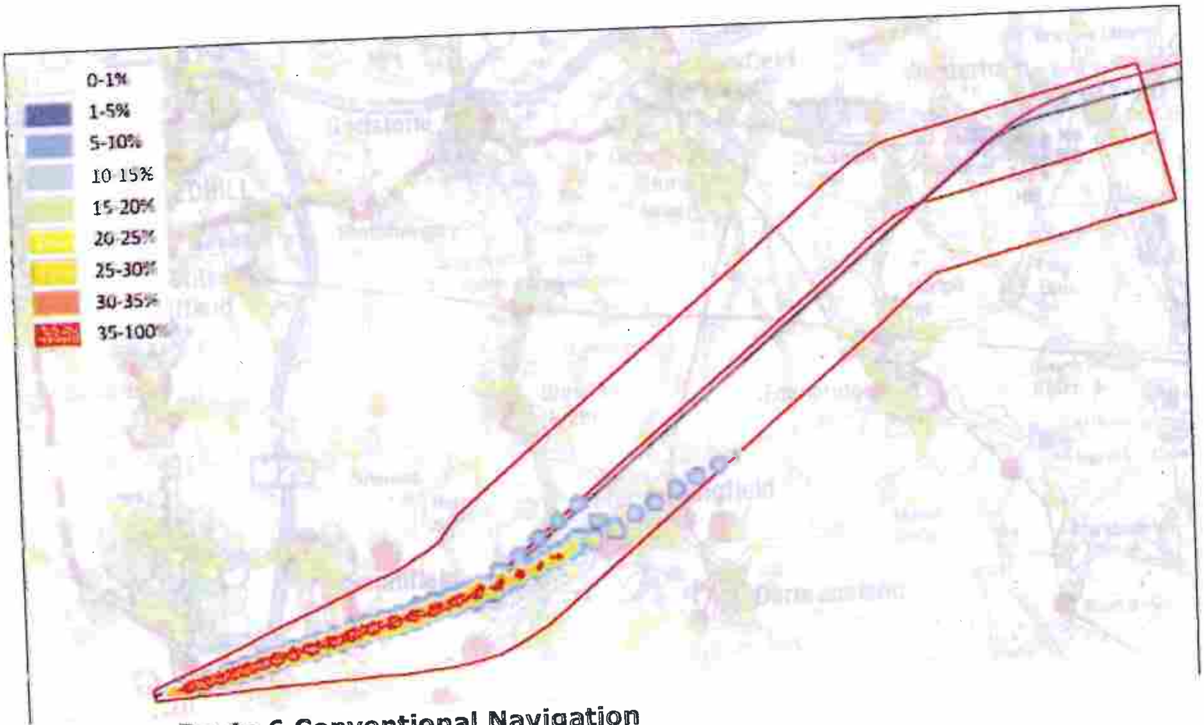

Figure 11 Route 6 Conventional Navigation

The impact regarding noise and track dispersion for route 6 is expected to be identical to that seen from the flight trials of route 1.

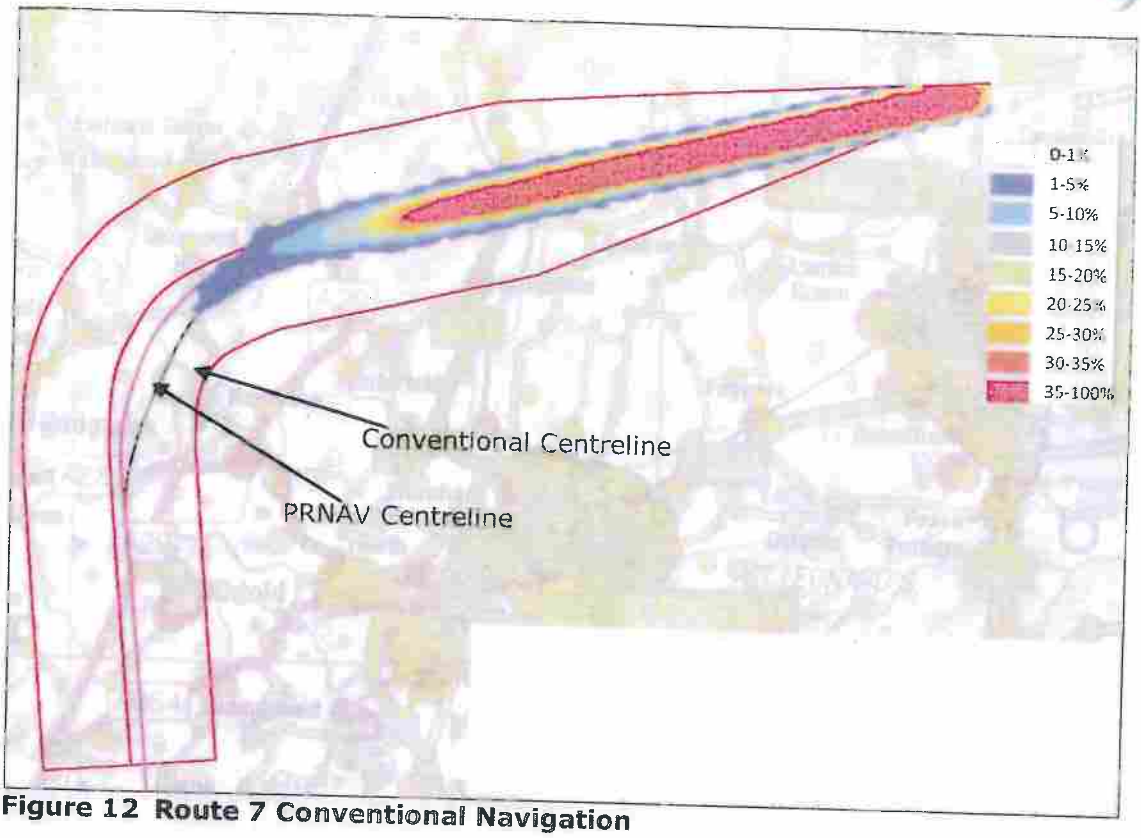

Figure 12 Route 7 Conventional Navigation

The impact regarding noise and track dispersion for route 7 is expected to be identical to that seen from the flight trials of route 2.

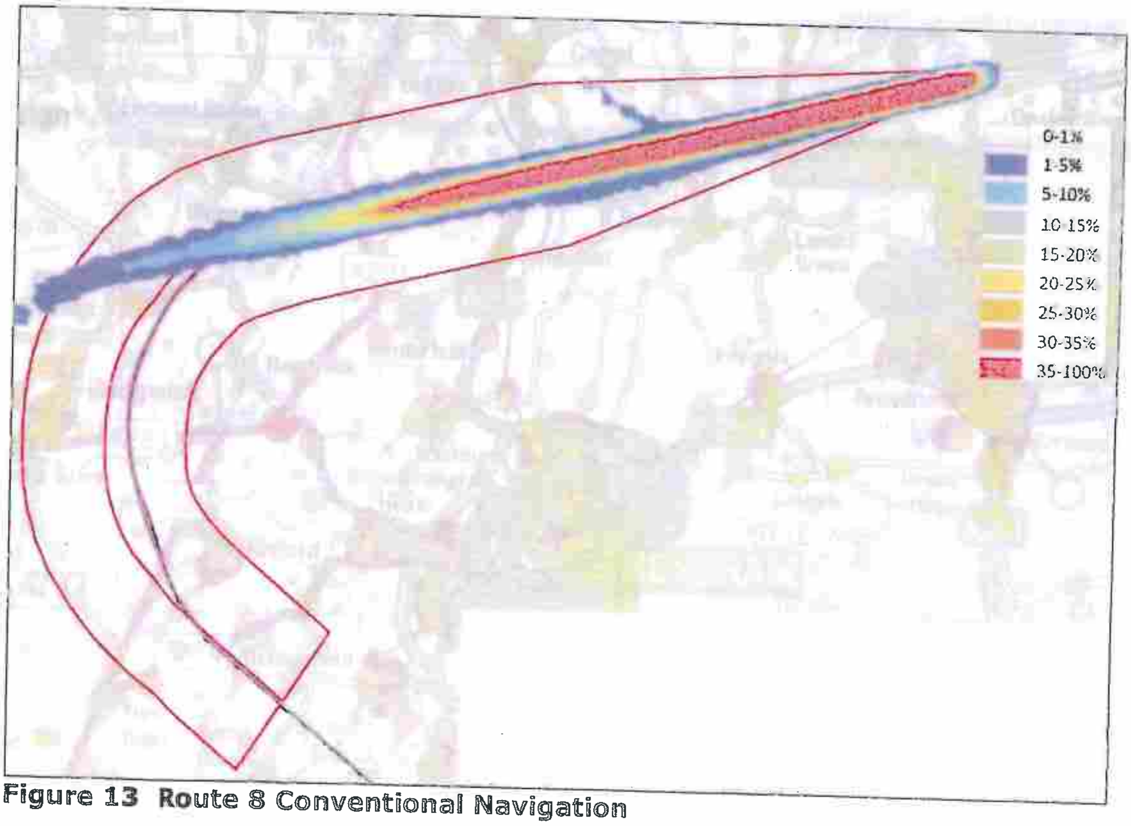

Figure 13 Route 8 Conventional Navigation

The impact regarding noise and track dispersion for route 8 is expected to be identical to that seen from the flight trials of route 2. Note traffic is routinely given a standard radar heading to run it further west on Route 8.

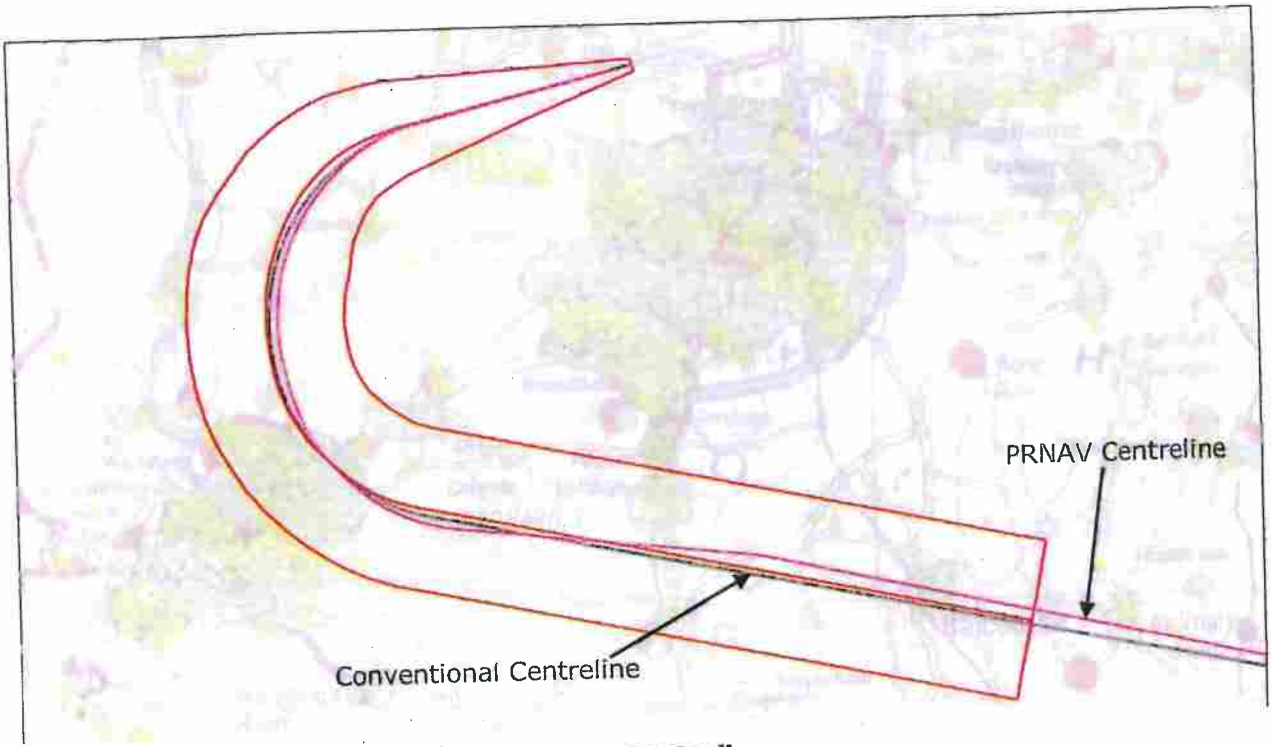

Figure 14 Route 9 Conventional & PRNAV centrelines

The impact regarding noise and track dispersion for route 9 is expected to be identical to that seen from the flight trials of route 3.

Detailed design information for the proposed SIDs is given Appendix A (PDG SID design report).

NOISE PREFERENTIAL ROUTINGS

LONDON GATWICK

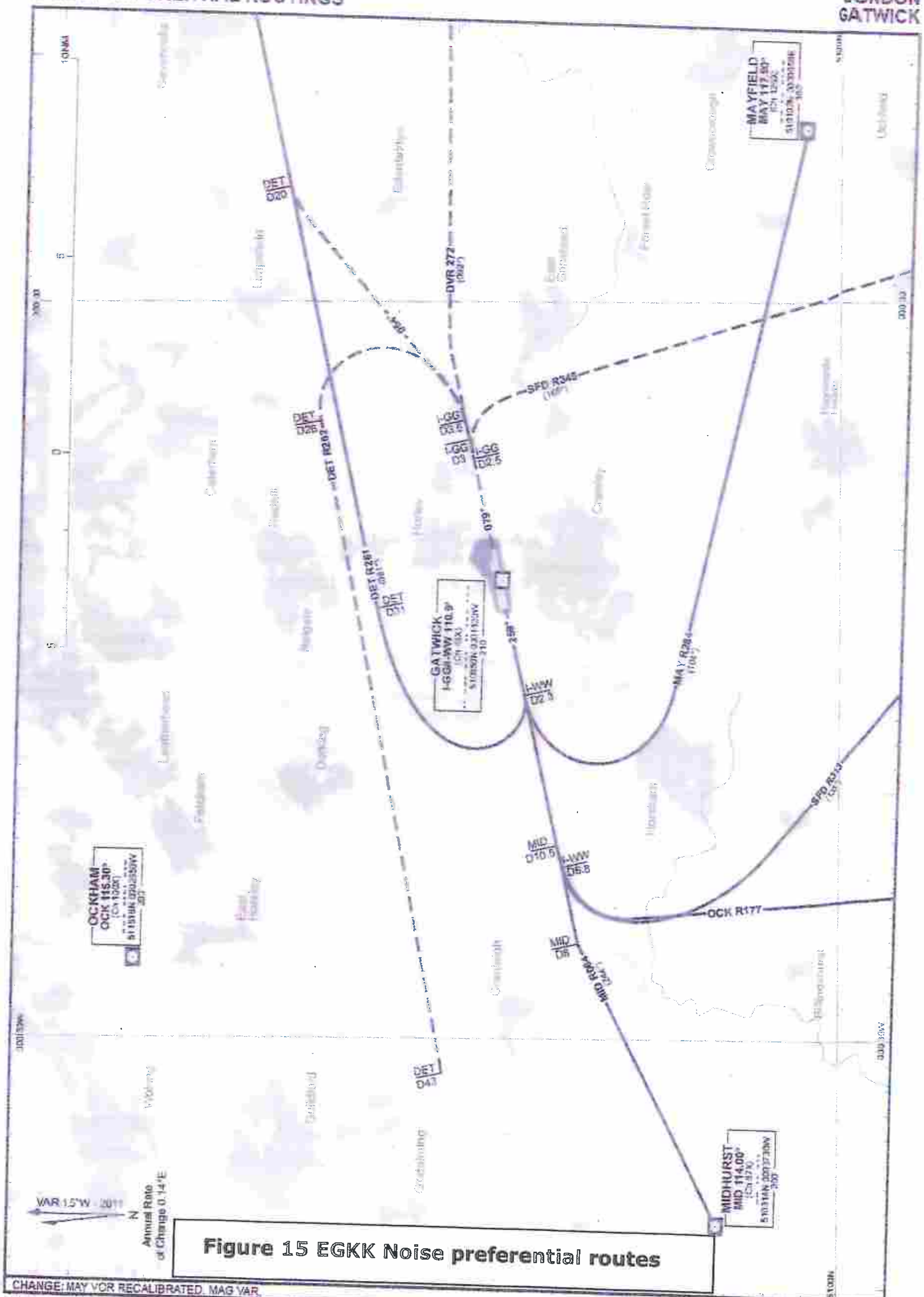

Figure 15 EGKK Noise preferential routes

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5 Environmental Issues

5.1 Emissions

The proposed PRNAV SIDs have been designed to match the extant conventional SIDs as closely as possible, hence there is no claimed benefit and no expected change in terms of emissions. As agreed at the Framework briefing (8-Nov-2011) there is no requirement to perform Local Air Quality or CO_2 emissions analyses.

5.2 Track & NPR analysis

Noise pollution is recognised as being the most significant impact of overflying aircraft at low levels. Government policy for minimizing the impact of noise pollution from aircraft at low level on the population is to encourage concentration of flights in a few narrow corridors as opposed to dispersal across wider areas. Gatwick Airport is designated under section 80 of the Civil Aviation Act 1982 for the purposes of section 78 of that Act, giving rise to the descriptor "designated airports". Section 78 empowers the Secretary of State to regulate noise and vibration connected with aircraft taking off or landing at designated airports. As Gatwick is a designated airport, Noise Preferential Routes (NPRs) have been defined by the Department for Transport, within which aircraft are required to stay until they achieve a given altitude (4000ft for most Gatwick NPRs, exceptions as per AIP section AD 2-EGKK-1-13 section 8). The NPRs are defined as 3km wide swathes. The purpose of the NPRs is to define corridors in which people can expect to see over-flying aircraft.

The proposed PRNAV procedures are designed to replicate the existing SID centreline as closely as possible given PANS-OPS and operational constraints. They are also designed where possible, to remain within the Noise Preferential Routes (see Figures 2-14). Due to the greater accuracy of PRNAV navigation, aircraft will be concentrated within the narrower swathe around the centreline (See Figures 2-9 which compare conventional & PRNAV track-keeping, and Appendix F)

Route	Is current SID within NPR swathe?	Is proposed PRNAV SID within NPR swathe	Max deviation of extant SID from NPR centreline (below 4000ft)	Max deviation of proposed PRNAV SID from NPR centreline (below 4000ft)	Max deviation of proposed PRNAV SID from extant SID centreline (below 4000ft)
1	✓	✓	172m	157m	206m
2	✓	✓	678m	370m	308m
3	✓	✓	811m	455m	355m
4	✗	✗	2081m	2093m	370m
5	✓	✓	453m	453m	16m
6	✓	✓	1017m	1316m	42m
7	✓	✓	845m	387m	475m
8	✓	✓	575m	524m	87m
9	✓	✓	169m	276m	372m

Table 2 Do routes remain within the NPR - Overview

In Table 2 the colour coding in the fifth column indicates:

Green - max deviation of the proposed SID centreline from the NPR centreline is less,

Amber - max deviation of the proposed SID centreline is >20m difference from the conventional SIDs deviation

Red - max deviation of the proposed SID centreline from the NPR centreline is greater

As can be seen from Table 2, only Route 4 does not remain within the defined NPR swathe. However the PRNAV route (route 4) does replicate the existing conventional route reasonably closely, this issue being that the existing route itself is outside the NPR. The cause of the misalignment[4] between the existing SID and the associated NPR is not a matter of record; however this issue is the responsibility of the Department for Transport (who have responsibility for NPRs) and is outside the scope of this ACP (see Framework Briefing Notes section 3, proposal 4).

The feedback from consultation for route 4 was generally positive with 6 responses in support, 57 stating "No objection or no comment" and only 3 objections (see section 11).

The Future Airspace Strategy SID/NPR Taskforce "Recommendations and Guidance Regarding Implementation of PBN SIDs" Version 2.2 Sept 2012, described the recommended "Process for Implementation of PBN SID Procedures in line with CAP 725" (Ref 5). This process dictates that the replication design should be constructed to be as close to the existing SID centreline as possible (not NPR). The process requires that analyses are performed of track-keeping, fleet mix, and NPR conformance (Ref 5). These analyses have been performed and the results are presented in Appendix F. Further evidence of track keeping and NPR conformance is presented by the density plots included herein as Figures 2-14.

The results of the trial show conclusively that aircraft navigating using PRNAV follow the PRNAV SID centrelines with more accuracy than those using conventional navigation are able to adhere to the conventional SID centrelines. Using PRNAV the distribution of aircraft across the swathe is kept closer to the centreline, and aircraft conform to the NPR with greater accuracy.

5.3 Fleet analysis

Operator	Summer 2012 Mvts	% Vol	PRNAV Certification
[redacted]	27245	37.62%	Confirmed
[redacted]	11909	16.45%	Confirmed
[redacted]	5653	7.81%	Confirmed
[redacted]	4969	6.86%	Confirmed
[redacted]	3888	5.37%	Confirmed
[redacted]	2783	3.84%	Confirmed
[redacted]	2456	3.39%	Confirmed
[redacted]	1746	2.41%	Confirmed
[redacted]	1368	1.89%	Confirmed
[redacted]	1100	1.52%	Confirmed
[redacted]	1008	1.39%	Confirmed
[redacted]	684	0.94%	Confirmed
[redacted]	595	0.82%	
[redacted]	552	0.76%	Confirmed
[redacted]	426	0.59%	
[redacted]	396	0.55%	
[redacted]	385	0.53%	
[redacted]	377	0.52%	
[redacted]	368	0.51%	
[redacted]	368	0.51%	Confirmed
[redacted]	368	0.51%	Confirmed
[redacted]	326	0.45%	Confirmed
[redacted]	264	0.36%	
[redacted]	235	0.32%	
[redacted]	186	0.26%	
[redacted]	184	0.25%	
[redacted]	184	0.25%	Confirmed
[redacted]	160	0.22%	
[redacted]	154	0.21%	
[redacted]	144	0.20%	
[redacted]	135	0.19%	

[4] It is likely that this has occurred very gradually over a period of several decades, possibly as a result of gradual change to the magnetic variation.

[redacted]		132	0.18%	
[redacted]		127	0.18%	(no longer operating)
[redacted]		116	0.16%	
[redacted]		108	0.15%	
[redacted]		106	0.15%	
[redacted]		102	0.14%	
[redacted]		100	0.14%	
[redacted]		84	0.12%	
[redacted]		79	0.11%	
[redacted]		70	0.10%	
[redacted]		62	0.09%	
[redacted]		52	0.07%	
[redacted]		52	0.07%	
[redacted]		52	0.07%	
[redacted]		48	0.07%	
[redacted]		46	0.06%	
[redacted]		44	0.06%	
[redacted]		38	0.05%	
[redacted]		36	0.05%	
[redacted]		32	0.04%	
[redacted]		30	0.04%	
[redacted]		29	0.04%	
[redacted]		27	0.04%	
[redacted]		26	0.04%	
[redacted]		26	0.04%	
[redacted]		14	0.02%	
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[redacted]		12	0.02%	
[redacted]		10	0.01%	
[redacted]		10	0.01%	
[redacted]		8	0.01%	
[redacted]		8	0.01%	
[redacted]		7	0.01%	
[redacted]		6	0.01%	
[redacted]		5	0.01%	
[redacted]		5	0.01%	
[redacted]		4	0.01%	
[redacted]		4	0.01%	
[redacted]		4	0.01%	
[redacted]		4	0.01%	Confirmed
[redacted]		4	0.01%	
[redacted]		4	0.01%	
[redacted]		4	0.01%	
[redacted]		3	0.00%	
[redacted]		2	0.00%	
[redacted]		2	0.00%	(no longer operating)
[redacted]		2	0.00%	
[redacted]		2	0.00%	
[redacted]		2	0.00%	
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[redacted]		2	0.00%	
[redacted]		2	0.00%	
[redacted]		1	0.00%	
[redacted]		1	0.00%	
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[redacted]		1	0.00%	

[redacted]	1	0.00%	
[redacted]	1	0.00%	
[redacted]	1	0.00%	
[redacted]	1	0.00%	
[redacted]	1	0.00%	
[redacted]	1	0.00%	
[redacted]	1	0.00%	
[redacted]	1	0.00%	
Grand Total	**72414**	100.00%	
PRNAV Certified Confirmed		92.16%	

Table 3 Analysis of Fleets' PRNAV capability

NOTE:
Operators which are not shown as 'confirmed' or 'NC' have not provided a response Airlines annotated "NC" have responded that they are Not Certified.
Table 3 shows the results of a survey of PRNAV capability of airlines operating from Gatwick airport. This study was undertaken in summer 2012. Airlines representing 92% of the aircraft movements confirmed that they were PRNAV certified. Most of the remainder did not reply, hence the actual figure being PRNAV capable may be higher.

5.4 Noise analysis

As per the e-mail included as Appendix E, the CAA advised that there was no requirement to undertake noise modelling for this ACP because the impacts are beyond the 57 dBA LEq contours and the 90dBA SEL footprint. This is in line with the FAS requirements for replication (Ref 5).

5.5 Traffic growth

The introduction of the P-RNAV SIDs will not have any influence on the rate of growth of traffic operating from Gatwick Airport. Forecast traffic growth figures are included in Appendix H.

6 Design Objectives/Requirements

The objective of this proposal is to replicate the current standard instrument departure routes (SIDs) from Gatwick Airport using PRNAV. This aims to provide an airspace structure in line with modern aircraft navigational capabilities, with more accurately defined routes utilising the improved navigational capabilities of modern aircraft (Precision Area Navigation, P-RNAV). To allow for aircraft which are not yet PRNAV equipped the conventional SIDs will remain available until such time as the PRNAV equipage rate is close to 100%.

The introduction of PRNAV routes is in accordance with the CAA's Future Airspace Strategy (FAS) Deployment Plan (in draft at the time of writing).

7 Implementation Plan

GAL is planning to implement the changes on AIRAC 06/13 (30 May 2013).

To allow for aircraft which are not yet PRNAV equipped the conventional SIDs will remain available until such time as the PRNAV equipage rate is close to 100%.

The introduction of PRNAV routes is in accordance with the CAA's Future Airspace Strategy (FAS) Deployment Plan.

7.1 Proposed (post implementation) Management Oversight Process

NATMAG will be provided with quarterly updates on;

- Percentage use of PRNAV versus conventional SID,
- Noise complaints,
- Track keeping
- Density of flown tracks

for each route and will closely monitor the impact of this implementation of P-RNAV, including the number of noise complaints received attributable to both P-RNAV and conventional navigation based SIDs. Any issues identified through this management process would be discussed with GATCOM.

Should any route, which is part of this proposed P-RNAV implementation, be deemed to be of such detrimental effect that it should be permanently withdrawn, and traffic reverted back to the conventional procedure, this will be communicated to the wider population through GATCOM and other aviation stakeholder groups and the route withdrawn

Similarly, should any conventional SID route, be determined as part of this on-going oversight process to be detrimental in comparison to its P-RNAV version, then the same process of notification and withdrawal may be applied.

8 Proposed New Airspace/Route Definition and Usage

The proposed PRNAV procedures have been drawn the by NATS Procedures Design Group, and are included in Appendix A.

CAP725 Appendix A Paragraph 5 Requirements

	"The proposal should provide a full description of the proposed change including the following:"	Evidence of Compliance/Proposed Mitigation
a	The type of route or structure; e.g. Airway, UAR, Conditional Route, Advisory Route, CTR, SIDs/STARs, Holding Patterns, etc.;	SIDs designs are detailed in Appendix A.
b	The hours of operation of the airspace and any seasonal variations;	The SIDs will be available H24, 7 days per week subject to airport operating restrictions..
c	Interaction with domestic and international en-route structures, TMAs or CTAs with an explanation of how connectivity is to be achieved. Connectivity to aerodromes not connected to CAS should be covered;	The PRNAV SIDs will connect to the enroute network at the same points as the extant conventional SIDs.
d	Airspace buffer requirements (if any);	n/a
e	Supporting information on traffic data including statistics and forecasts for the various categories of aircraft movements;	See section 5.5.
f	Analysis of the impact of the traffic mix on complexity and workload of operations;	Analysis of traffic mix is given in Appendix F. The use of PRNAV SIDs has no influence on complexity or ATC workload.
g	Evidence of relevant draft Letters of Agreement, including any arising out of consultation and/or Airspace Management requirements;	n/a
h	Evidence that the Airspace Design is compliant with ICAO Standards and Recommended Practices (SARPs) and any other UK Policy or filed differences, and UK policy on the Flexible Use of Airspace (or evidence of mitigation where it is not);	The SIDs have been designed by licensed Procedures Designers from PDG using software which checks ICAO SARPs & PANS-OPS compliance . See Appendix A
i	The proposed airspace classification with justification for that classification;	There is no change to the airspace classification.
j	Demonstration of commitment to provide airspace users equitable access to the airspace as per the classification and where necessary indicate resources to be applied or a commitment to provide them in-line with forecast traffic growth. 'Management by exclusion' would not be acceptable;	n/a
k	Details of and justification for any delegation of ATS.	n/a

9 ATC Units Affected by the Proposal

The ATC units affected are:

- Gatwick Tower
- NATS Swanwick, London Terminal Control (including Gatwick Approach).

There is not anticipated to be any impact in terms of changes to delay or capacity on the units.

10 Safety Issues/Analysis

10.1 Safety Case

The Safety Case is attached as Appendix B. The safety case concludes that the design criteria, safety objectives and requirements have been satisfied, and the improved navigational accuracy of P-RNAV will not result in any degradation in safety..

The proposed SIDs are designed to replicate the extant procedures closely. Hence there will be no change to complexity of the airspace structure as a result of the change.

The use of PRNAV SIDs has been trialled for 5 years without any incident.

10.2 PDG designs/assurance

A comprehensive design report by the Procedures Design Group is attached at Appendix A.

10.3 Flyability assurance

As part of the trial, the PRNAV procedures have been flown routinely for five years with no difficulty by any aircraft type. It was agreed at the framework briefing that the current trial is evidence of flyability for the proposed PRNAV procedures.

A database coding check of the PRNAV ARINC 424 path terminator data will be performed by [redacted] prior to publication of the procedures.

11 Consultation

During July-November 2012, GAL conducted a formal stakeholder consultation process to solicit feedback on the proposals to modify the current SIDs from Gatwick Airport to use P-RNAV replications of the extant SIDs.

The Stakeholder Consultation Document and Consultation Feedback Report are attached as Appendices C and D.

The consultation was launched through the Gatwick Airport consultative committee (GATCOM). This approach was agreed with the DAP.

The organisations represented on GATCOM are:

East Sussex County Council
Surrey County Council
West Sussex County Council
Kent County Council
Crawley Borough Council
Horsham District Council
Mid Sussex District Council
Mole Valley District Council
Reigate and Banstead Borough Council
Tandridge District Council
Horley Town Council
Burstow Parish Council
Charlwood Parish Council
Rusper Parish Council
South London Business
Association of British Travel Agents
Gatwick Diamond Business
British Air Transport Association
Environmental and Amenity Groups
International Air Carriers' Association
Which? Magazine
London Chamber of Commerce and Industry
Passenger Representative
Trades Union Congress S & E Regional Council
Coast to Capital Local Economic Partnership
Tourism South-East
Gatwick Airline Operators Committee
Dept for Transport's Representative

The following Local Authorities were also sent the information:

Salfords and Sidlow Parish Council
Horley Town Council
Amberley Parish Council
Ashington Parish Council Ashurst:
Billingshurst Parish Council
Bramber PC
Broadridge Heath Parish Council
Coldwaltham PC
Colgate Parish Council
Cowfold Parish Council
Henfield Parish Council
Itchingfield PC
Lower Beeding Parish
North Horsham Parish Council
Nuthurst Parish Council
Parham PC
Pulborough Parish Council
Rudgwick Parish Council
Rusper PC
Shermanbury Parish Council
Shipley Parish Council
Slinfold Parish Council
Southwater PC
Steyning PC
Storrington & Sullington PC
Thakeham Parish Council
Upper Beeding Parish Council
Warnham Parish Council
Washington Parish Council
West Chiltington Parish Council
West Grinstead Parish
Wiston PC
Woodmancote Parish Council
Abinger Parish Council
Betchworth Parish Council
Brockham Parish Council
Buckland Parish Council
Capel Parish Council
Charlwood Parish Council
Headley Parish Council
Holmwood Parish Council
Leigh Parish Council
Mickleham Parish Council
Newdigate Parish Council
Ockley Parish Council
Wotton Parish Council
Bletchingley Parish Council
Caterham Valley Parish Council
Chaldon Parish Council
Dormansland Parish Council
Felbridge Parish Council
Limpsfield Parish Council
Lingfield Parish Council
Nutfield Parish Council
Outwood Parish Council
Oxted Parish Council
Tandridge Parish Council
Tatsfield Parish Council
Titsey parish meeting
Warlingham Parish Council
Woldingham Parish Council
Addington Parish Council
Aylesford Parish Council
Borough Green Parish Council
Birling Parish Council
Burham Parish Council
Ditton Parish Council
East Malling Parish Council
East Peckham Parish Council
Hadlow Parish Council
Hildenborough Parish Council
Kings Hill Parish Council
Leybourne Parish Council
Mereworth Parish Council
Offham Parish Council
Platt Parish Council
Plaxtol Parish Council
Ryarsh Parish Council
Snodland Town Council
Stansted Parish Council
Trottiscliffe Parish Council
Wateringbury Parish Council
West Malling Parish Council
Wouldham Parish Council
West Peckham Parish Council
Wrotham Parish Council
Alciston Parish Meeting
Alfriston Parish Council
Arlington Parish Council
Berwick Parish Council
Buxted Parish Council
Chalvington with Ripe Parish Council
Chiddingly Parish Council
Crowborough Town Council
Cuckmere Valley Parish Council
Danehill Parish Council
East Dean & Friston Parish Council
East Hoathly with Halland Parish Council
Fletching Parish Council
Forest Row Parish Council
Framfield Parish Council
Frant Parish Council
Hadlow Down Parish Council
Hailsham Town Council
Hartfield Parish Council
Heathfield & Waldron Parish Council
Hellingly Parish Council
Herstmonceux Parish Council
Hooe Parish Council
Horam Parish Council
Isfield Parish Council
Laughton Parish Council
Little Horsted Parish Meeting

Long Man Parish Council
Maresfield Parish Council
Mayfield & Five Ashes Parish Council
Ninfield Parish Council
Pevensey Parish Council
Polegate Town Council
Rotherfield Parish Council
Selmeston Parish Meeting
Uckfield Town Council
Wadhurst Parish Council
Warbleton Parish Council
Wartling Parish Council
Westham Parish Council
Willingdon & Jevington Parish Council
Withyham Parish Council

The list of consultation stakeholders targeted for the initial distribution of the consultation material was in was agreed in advance[5] with the CAA.

The consultation was open to everyone, and in order to maximise awareness a press release was issued to local media. This outlined what the consultation was about, the consultation process and the deadlines for feedback. GAL also contacted a number local authorities and parish councils notifying them of the consultation. The consultation material was publically available for download from the GAL website www.gatwickairport.com/prnav and from GATCOM's website, www.gatcom.org.uk.

GAL met with several representative groups to present PRNAV to communities around the airport and to give people the opportunity to ask questions and seek clarification. Meetings were held with GATCOM, Dormansland PC, Leigh PC, Capel PC, Felbridge PC, Domewood PC, East Grinstead TC.

A total of 32 stakeholders were contacted in the initial distribution of the consultation. A full list of these stakeholders is available on page 40 of the Consultation Document. In total 94 stakeholders were involved in the Consultation. 25 of the stakeholder organisations did not respond to the consultation. 69 stakeholders responded, of which 10 responses indicated a neutral position (no comment or no objection). 6 respondents said they supported the proposal and 53 had an objection to at least one of the routes (see Figure 16).

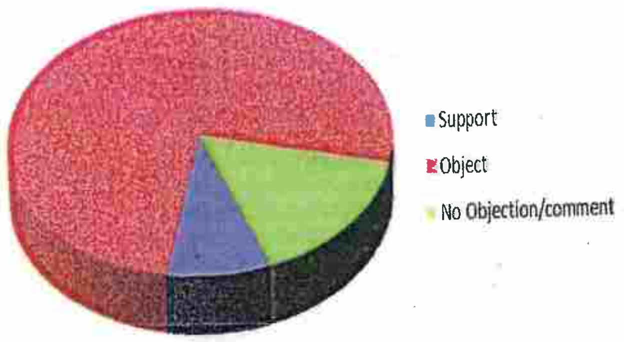

Figure 16. All stakeholders' responses pie chart

Figure 16 shows the breakdown of the responses to the individual routes. This shows that for seven of the routes there was little objection, the majority of the objections were specifically related to route 2.

[5] At the second Framework Briefing with the CAA

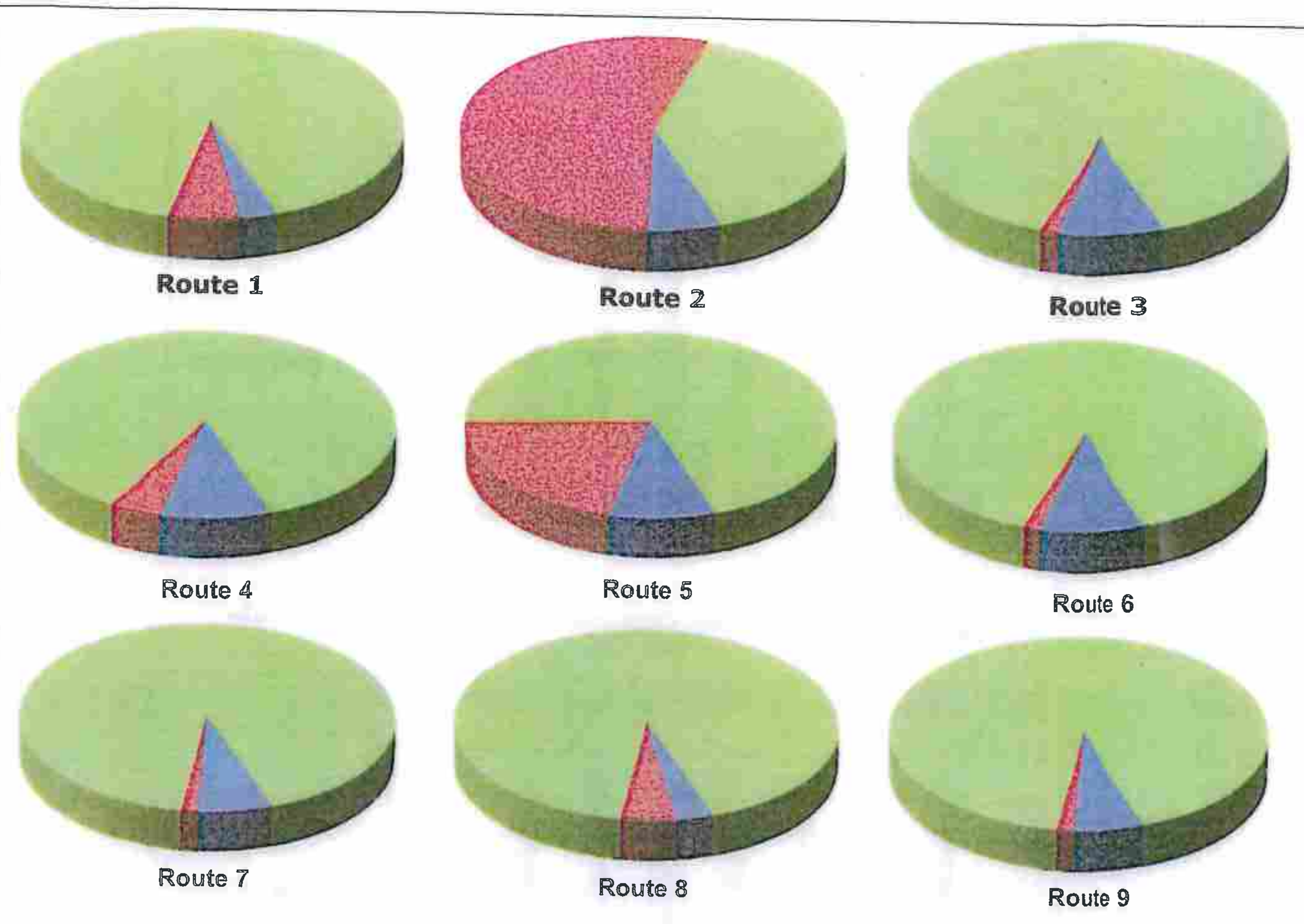

Figure 17. Stakeholder responses to each route

11.1 Key themes arising from objections

Figure 18 and Figure 19 below show the breakdown of the responses from organisations and members of the public respectively. Route 2 and 5 received the majority of the objections, the other routes received only 1 or 2 objections (which includes one stakeholder who objected to all routes).

Route 2

Of the nine routes proposed, route number 2 received the most objections (5 from organisations and 32 from individuals). This route passes just west of East Grinstead. The proposed PRNAV centreline positions aircraft to the east of the NPR centreline (by 370m) whereas previously (utilising conventional navigation) the traffic was more dispersed across the NPR, with the core of concentration slightly to the west of the NPR centreline. Using PRNAV the distribution of traffic is more concentrated, and it is contained entirely within the NPR.

It should be noted that route 2 was one of the routes included in the PRNAV trial, and as such a proportion of aircraft have been flying the PRNAV procedure since 2007.

Note: the PRNAV trial is not related to the change in operations of EasyJet as reported in the East Grinstead Courier & Observer 13-Sept-2012 which claimed that they had recently changed their route.

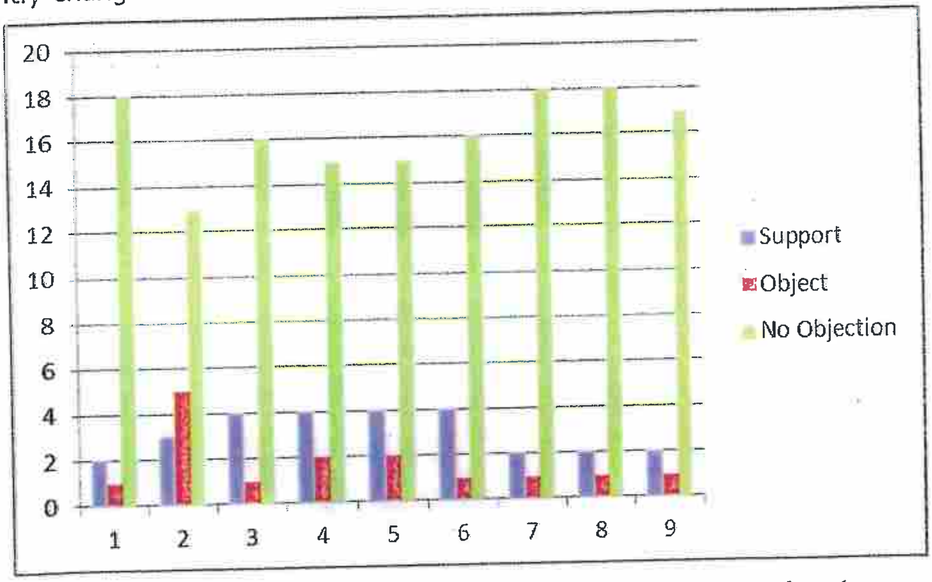

Figure 18 Responses from Organisations to each proposed route

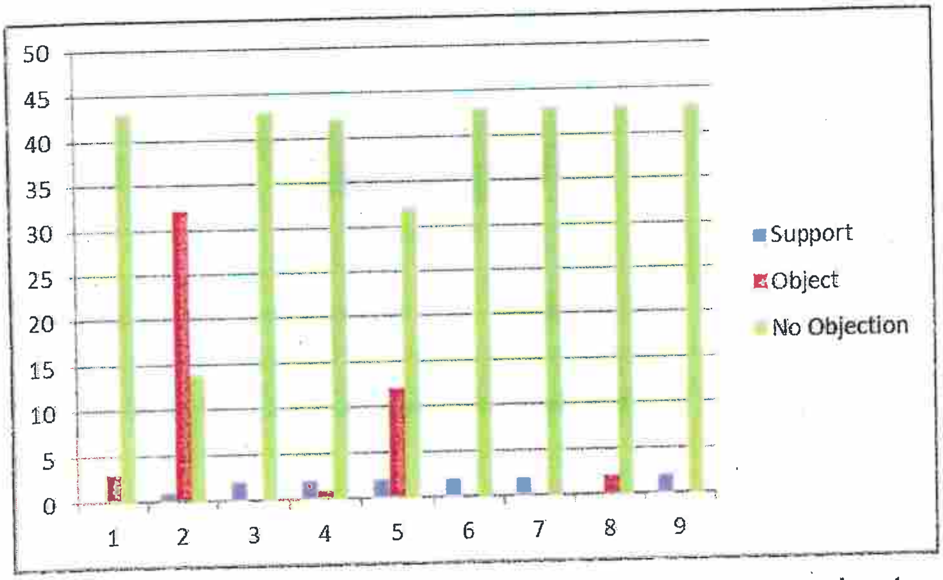

Figure 19 Responses from Members of the Public to each proposed route

11.2 Comments on particular issues

The objections were categorised according to the key themes identified in Figure 20 below. One response could include several themes & hence would be counted in each category. There were five recurring themes for objections, which were (in order of frequency): noise pollution; traffic concentration issues; air pollution /emissions; impact on property prices and process compliance. 53 responses included an objection to one or more of the routes. The pre-eminent reason given for objections was on the grounds of noise pollution. This was cited in almost all responses where any reason for the objection was given.

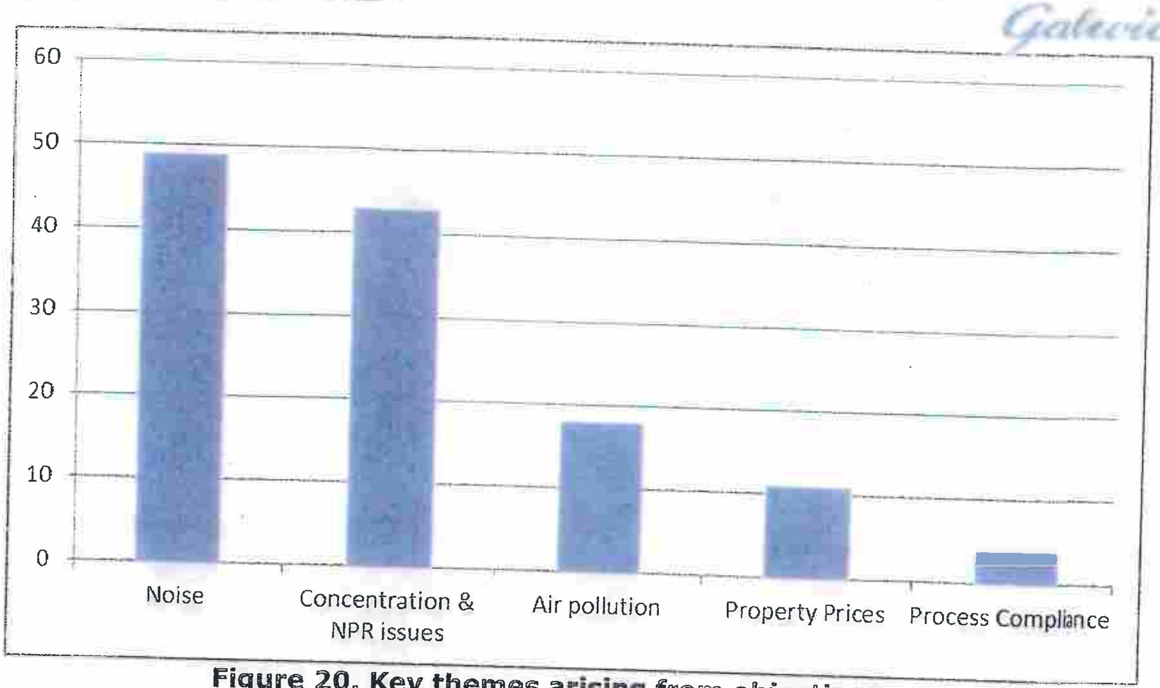

Figure 20. Key themes arising from objections

Within each of the themes, particular and recurring issues could be identified. These are summarised below, with comments.

11.2.1 Noise Pollution

Noise pollution is recognised as being the most significant impact of overflying aircraft at low levels. Government policy[6] for the minimizing the impact of noise pollution from aircraft at low level on the population, is to encourage concentration of flights in a few narrow corridors as opposed to dispersal across wider areas. Gatwick Airport is designated under section 80 of the Civil Aviation Act 1982 for the purposes of section 78 of that Act, giving rise to the descriptor "designated airports". Section 78 empowers the Secretary of State to regulate noise and vibration connected with aircraft taking off or landing at designated airports. As Gatwick is a designated airport, Noise Preferential Routes (NPRs) have been defined by the Department for Transport, within which aircraft are required to stay until they achieve a given altitude[7]. The NPRs are defined as 3km wide swathes. The purpose of the NPRs is to define corridors in which people can expect to see over-flying aircraft.

The PRNAV routes proposed are designed to keep flights within the NPR corridors. Due to the greater accuracy of PRNAV navigation, aircraft will be kept within the NPR with improved reliability.

11.2.2 Changes in traffic concentration

The recurring theme of most of the objections to the proposal for route 2, were centred on the movement of the flight concentration within the NPR swathe. In particular, that if the proposed PRNAV SID that had been trialled, was permanently adopted, the average centreline would be east of the NPR centreline.

6 http://www.caa.co.uk/docs/7/DTLREnvironmentalGuidance.pdf (page 13)
7 4000ft for most Gatwick NPRs, exceptions as per AIP section AD 2-EGKK-1-13 section 8

Figure 21: Route 2 dispersal – all flights

Figure 22 : Route 2 dispersal – PRNAV flights only

Figure 21 shows that using conventional navigation, flights are dispersed more widely across the width of the NPR. Figure 22 shows that flights using PRNAV navigation maintain a much more consistent trajectory, and are concentrated closer to the NPR centreline. While this keeps aircraft close to the centre of the NPR, the change does bring the tracks slightly closer to the outskirts of East Grinstead. Due to the required design constraints for PRNAV procedures[8] it is not possible to match exactly, the NPR centreline (see Figure 23 below). As a result, the PRNAV SID design centreline is positioned slightly to the east just after the initial turn. The maximum distance of the PRNAV procedure centreline from the NPR centreline is 370m.

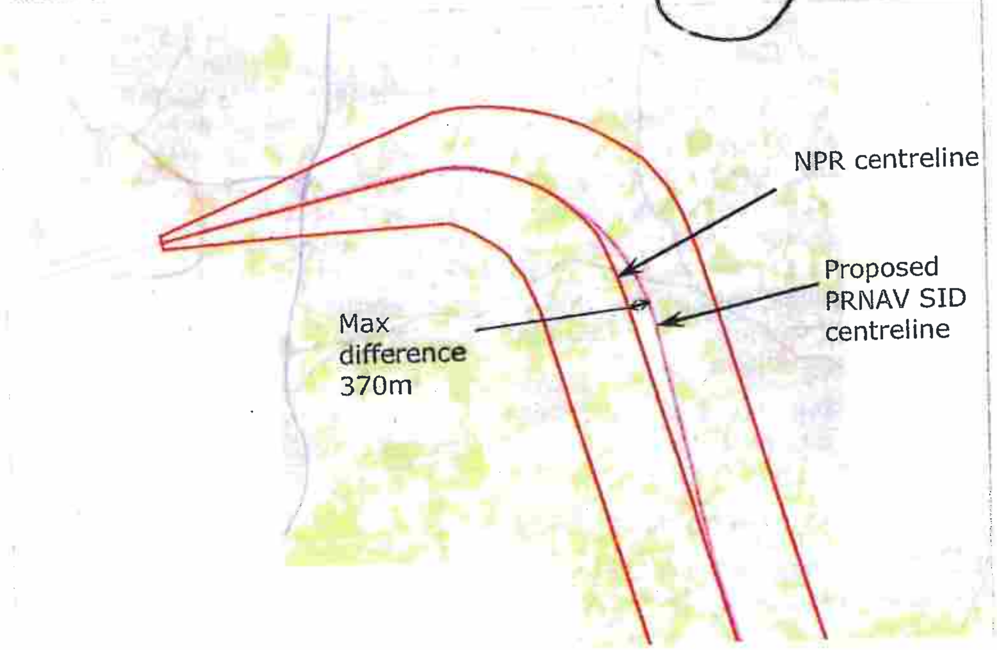

Figure 23 Route 2, NPR & PRNAV SID centrelines

11.2.3 Air pollution (Local Air Quality)

Some members of the public were concerned about possible air pollution resulting from the proposed change in the SIDs. The quality of the air around the UK's major airports is closely monitored. There is one Air Quality Management Area (AQMA) adjacent to

[8] ICAO PANS-OPS, Doc 8168

Gatwick Airport – the Horley Gardens AQMA designated by Reigate and Banstead Borough Council. An AQMA is a legally defined area in which air quality is strictly monitored by the Local Authority and the airport operator. The impact of aircraft operations at the airport, both on the ground and during the take-off and landing cycles, has a potential to impact on the air quality in the AQMAs. However the majority of the impact is due to operations on the ground and at altitudes below 1000ft. Once airborne, due to mixing and dispersion in the atmosphere, the impact of emissions on local air quality of aircraft above 1000ft is much less.

The ICAO Airport Air Quality Manual states that:

"Differences to emissions above 1000 AGL will have little impact on changes in ground-level concentrations."

The design requirement to match the existing conventional SIDs as closely as possible, means that the changes suggested by this proposal would not have an effect on the local air quality at ground level. Local Air Quality assessment was not required by the CAA as agreed at the Framework Briefing.

11.2.4 Property prices

Some respondents expressed concern that the price of their property would be adversely affected by the proposed change. While it is understood that aircraft noise could (amongst many other factors) influence the value of a particular property, property prices on their own (as distinct from noise impact) are not considered when making airspace changes. Government policy directs the sponsors of airspace changes to strive to minimize the noise impact on populations. However since the two are inter-related, the corollary of minimizing the noise impact on the population is also to minimize the impact on property prices.

11.2.5 Process compliance, consultation.

Some respondents to the consultation objected on the grounds that they had not been adequately consulted with. However the list of stakeholders identified as primary recipients of the consultation material was agreed with the CAA in accordance with CAA guidance. The consultation material was distributed to an extensive list of stakeholders and the responses received are evidence that the information has been disseminated widely.

Stakeholders who came forward during consultation were included in the dialogue alongside those who were contacted initially, and their input was been given equal weighting.

11.3 General Aviation Airspace Users Impact and Consultation

The proposal is not considered to have any effect on GA hence they have not been actively engaged during the consultation.

11.4 Commercial Air Transport Impact and Consultation

Ten airline operators were actively involved in the trial of PRNAV SIDs at Gatwick (Appendix F). Those involved included [redacted] The airlines unanimously support the move to PRNAV SIDs.

11.5 CO_2 Environmental Impact and Consultation

No significant change to emissions is expected and therefore no emissions impacts were consulted on for this change.

11.6 Local Environmental Impacts and Consultation

The local environmental impacts capture Noise, Tranquillity, Visual Intrusion, Local Air Quality and Biodiversity.

The PRNAV replication of SIDs should have a very small impact on the local environment since the changes to the flight paths are very small. Should these assumptions about local impact prove to be incorrect, and result in robust challenge to the change process employed, it will be possible to revert to the existing alignment with no operational impact (except the loss of the benefits stated in this proposal).

12 Overall Environmental Impact of the ACP

The proposal will marginally change the position of centreline and increase the concentration of traffic close to the SID centreline below 4000ft. The effects are however, expected to be negligible, and so this proposal is following the guidance for SID replication (Ref 5) which means no noise, CO_2 or local air quality analysis have been undertaken. Increased concentration is in accordance with government guidelines on concentration versus dispersal of air traffic (see Ref 6, section D).

Above 4000ft aircraft would be tactically vectored exactly as they are today[7], therefore there will be no change to environmental performance from aircraft above 4000ft.

12.1 Economic Impact

There are not anticipated to be any short-term economic impacts.

GAL is not aware of any established methodology that is widely accepted as providing a complete and robust economic valuation of the environmental impacts of changes to airspace structure. Furthermore, GAL will not base the case for change on an economic valuation of environmental impact and therefore does not propose to attempt to provide or develop such analysis.

13 Analysis of Options

Initial consultation, resulted in a review of possible options to attempt to use different criteria for P-RNAV SID Route 4, in order to move the track back more into the published NPR.

The revised criteria did not work as it merely served to split the tracks of departing flights, compromising safety, while still resulting in jet traffic running on the edge or outside of the north western edge of the NPR. This option was therefore dropped and the original, flight trialled, design retained as part of this proposal.

13.1 Proposed P-RNAV SID Development

The four P-RNAV SIDs used in the trial that ran from 2007 (routes 1, 2, 3 and 4) were based on four different basic design configurations of FMS navigation defining the lateral tracks and turns associated with four conventional SID tracks. Each of these tracks mirror others not covered by the trial, such that;

- Trialled P-RNAV Route 1 has same design criteria as Route 5 and Route 6 from runway 08R
- Trialled P-RNAV Route 2 has same design criteria as Route 7 and Route 8 from runway 26L
- Trialled P-RNAV Route 3 has same design criteria as the other SID routes turning left on departure from this runway and also Route 9 from runway 26L
- Trialled P-RNAV Route 4 has same design criteria as all other SID routes that turn right on departure from runway 26L

Results of the trial of Routes 1-4 provide assurance that all the conventional Gatwick SID routes could be similarly replicated using P-RNAV SIDs. The proposal, therefore, is to implement a full P-RNAV SID suite (routes 1 to 9) based on the current conventional SIDs whilst retaining all the conventional SIDs for a period of up to 5 years.

The proposed designs of each P-RNAV SID are shown in Appendix A of this document. Figures 2-14 also show actual track plots from operational radar data of departure SID routes flown during 2011.

Route 2 Options

All of the SIDs were designed based on the CAA requirement for aircraft to reach 500ft AAL before commencing any turns. The noise abatement instructions at Gatwick require aircraft to climb at 4% or greater to 3000ft. PDG calculated the distance required for an aircraft to reach 500ft AAL as 3685m. A waypoint was then placed at the "corner" of the NPR and calculated the Turn Initiation Distance required for the 86° turn as 3372m. The waypoint was 7057m away from the DER and the procedure was therefore deemed acceptable by the procedure designer (Phase 1 of PRNAV SID Trial).

When the airlines complained that the 210kt speed restriction was too slow, and asked for it to be increased to 220kts, PDG re-calculated the Turn Initiation Distance as 3789m. This increase of 417m meant that the waypoint needed to move further away from the DER. The catch-22 is that the further away you move the waypoint, the sharper the turn becomes, and therefore the longer the Turn Initiation Distance becomes. PDG determined that moving the turn 691m further away increased the turn angle to 90° but provided the required distance to make the procedure acceptable (Phase 2 of SID trial).

The increase in the speed restriction to 220kt prevented the exact replication the SFD RNAV SID to the conventional SID centreline (308m maximum displacement). As such the resulting SID is a compromise, giving a relatively close match to the extant SID, with a flyable speed restriction while meeting the design criteria.

Route 4 options

In the initial phase of the trial a speed restriction of 210 knots was applied to aircraft on the SIDs following route 4. At 210kts the radius of the first turn can be brought onto the DET 261 radial as per the extant procedure. However the trial demonstrated that adherence to the speed restriction was poor. The reason for this is that at this phase of flight the crew aim to increase speed so that the flaps can be raised. If the speed is kept below 210kts this delays them being able to raise the final few degrees of flaps. Flying with the flaps extended for longer than necessary results in increased fuel burn, CO_2 emissions and noise footprint. Feedback from the airlines indicated a preference for a 220kt speed restriction. This was introduced in phase II of the trial, and as a result the conformance to the speed limit was much improved. Hence a maximum speed of 220 knots was used as the basis for the procedure design criteria.

13.2 Do-nothing option

The alternative to implementing the PRNAV replications of the conventional SIDs would be to "do-nothing" and revert back to conventional-only SIDs at the end of the trial. This will prevent progress towards utilising the improved navigational performance capabilities of PRNAV. This will, in the longer term, limit the possibilities for implementation of more systemised airspace structures, and hence will have long term impact on the efficiency of the airspace. In turn this will restrict the environmental (particularly CO_2 & noise) benefits that can be obtained in future airspace changes (the Future Airspace Strategy).

"Do-nothing" should be considered as a separate option for each of the nine individual routes. i.e. It would be feasible to introduce PRNAV for eight routes, but delay the implementation for one particular route if there were an issue which needed more time to resolve.

Chris Steeper?

14 Supporting Infrastructure/Resources

CAP725 Appendix A Paragraph 6 Requirements

	Paragraph 6 General Requirements:	Evidence of Compliance/Proposed Mitigation
a	Evidence to support RNAV and conventional navigation as appropriate with details of planned availability and contingency procedures.	See Appendix F – trial analysis. Appendix B – safety case.
b	Evidence to support primary and secondary surveillance radar (SSR) with details of planned availability and contingency procedures.	No change to extant radar coverage, which is demonstrably sufficient.
c	Evidence of communications infrastructure including R/T coverage, with availability and contingency procedures.	No change to extant R/T coverage, which is demonstrably sufficient.
d	The effects of failure of equipment, procedures and/or personnel with respect to the overall management of the airspace must be considered.	See Appendix A PDG procedure design report.
e	The Proposal must provide effective responses to the failure modes that will enable the functions associated with airspace to be carried out including details of navigation aid coverage, unit personnel levels, separation standards and the design of the airspace in respect of existing international standards or guidance material.	See Appendix A PDG procedure design report and Appendix B, Safety Case.
f	A clear statement on SSR code assignment requirements is also required.	No changes would be required to the extant methods of SSR code allocation for traffic affected by this proposal.
g	Evidence of sufficient numbers of suitably qualified staff required to provide air traffic services following the implementation of a change.	The affected Unit/s will have suitable numbers of qualified staff available at the time of implementation. No changes in staffing will be required.

15 Operational Impact

CAP725 Appendix A Paragraph 7 Requirements

	"An analysis of the impact of the change on all airspace users, airfields and traffic levels must be provided, and include an outline concept of operations describing how operations within the new airspace will be managed. Specifically, consideration should be given to:"	**Evidence of Compliance/Proposed Mitigation**
a	Impact on IFR General Air Traffic and Operational Air Traffic or on VFR General Aviation (GA) traffic flow in or through the area;	GAT which is PRNAV equipped will be able to take advantage of the capabilities of their PRNAV navigation system. Those not PRNAV equipped & certified will be unaffected & will continue to use the conventional procedures. OAT and GA rarely use the procedures, and will be unaffected.

b	Impact on VFR operations (including VFR Routes where applicable);	No impact
c	Consequential effects on procedures and capacity, i.e. on SIDS, STARS, and/or holding patterns. Details of existing or planned routes and holds;	No effect on capacity or holding or STARs. SIDs described in detail in Appendix A.
d	Impact on aerodromes and other specific activities within or adjacent to the proposed airspace;	No impact
e	Any flight planning restrictions and/or route requirements.	None, see Appendix A (PDG SID design)

16 Airspace and Infrastructure Requirements

CAP725 Appendix A Paragraph 11-14 Requirements

	Paragraph 11 **General Requirements:**	**Evidence of Compliance/Proposed Mitigation**
a	The airspace structure must be of sufficient dimensions with regard to expected aircraft navigation performance and manoeuvrability to fully contain horizontal and vertical flight activity in both radar and non-radar environments.	The proposed airspace meets these requirements see Appendix A (PDG SID design).
b	Where an additional airspace structure is required for radar control purposes, the dimensions shall be such that radar control manoeuvres can be contained within the structure, allowing a safety buffer. This safety buffer shall be in accordance with agreed parameters as set down in DAP Policy Statement 'Safety Buffer Policy for Airspace Design Purposes Segregated Airspace'.	n/a
c	The Air Traffic Management (ATM) system must be adequate to ensure that prescribed separation can be maintained between aircraft within the airspace structure and safe management of interfaces with other airspace structures.	Improved track-keeping accuracy of PRNAV will ensure improved consistency of separation. See Appendix A (PDG SID design) & Appendix B (Safety Case).
d	Air Traffic Control (ATC) procedures are to ensure required separation between traffic inside a new airspace structure and traffic within existing adjacent or other new airspace structures.	n/a
e	Within the constraints of safety and efficiency, the airspace classification should permit access to as many classes of user as practicable.	No change to airspace classification.
f	There must be assurance, as far as practicable, against unauthorised incursions. This is usually done through the classification and promulgation.	No change.

g	Pilots shall be notified of any failure of navigational facilities and of any suitable alternative facilities available and the method of identifying failure and notification should be specified.	Failure of navigational facilities will be promulgated by NOTAM and ATC will provide navigational assistance using radar when necessary. PRNAV system failure cases & redundancy: see Appendix A (PDG SID design) & Appendix B (Safety Case).
h	The notification of the implementation of new airspace structures or withdrawal of redundant airspace structures shall be adequate to allow interested parties sufficient time to comply with user requirements. This is normally done through the AIRAC cycle.	Withdrawal of conventional SIDs will be notified in good time, this will take place only after consultation and once PRNAV equipage rates have achieved close to 100%. Changes will be published via the normal AIRAC cycles.
i	There must be sufficient R/T coverage to support the ATM system within the totality of proposed controlled airspace.	There are no proposed changes to the dimensions of CAS and aircraft already fly the proposed route. R/T coverage is demonstrably adequate for the task.
j	If the new structure lies close to another airspace structure or overlaps an associated airspace structure, the need for operating agreements shall be considered. (Also covers CAP725 Appendix A Paragraph 14)	n/a
k	Should there be any other aviation activity (low flying, gliding, parachuting, microlight site, etc.) in the vicinity of the new airspace structure and no suitable operating agreements or ATC Procedures can be devised, the Change Sponsor shall act to resolve any conflicting interests. (Also covers CAP725 Appendix A Paragraph 14)	n/a
L	Airspace changes in respect of ATS Routes and Terminal Airspace (CTR/CTA) structures are subject to additional requirements as specified in the paragraphs below [Tables referring to CAP725 Paragraphs 12, 13, 14].	See tables below.

	Paragraph 12 General Requirements:	**Evidence of Compliance/Proposed Mitigation**
a	There must be sufficient accurate navigational guidance based on in-line VOR/DME or NDB or by approved RNAV derived sources, to contain the aircraft within the route to the published RNP value in accordance with ICAO/ EuroControl Standards.	The proposed route is contained within airspace currently populated with numerous routes where navigation coverage is well proven and the navaid system is demonstrably appropriate for the task. PRNAV sources described in Appendix A (PDG SID design)
b	Where ATS routes adjoin Terminal Airspace there shall be suitable link routes as necessary for the ATM task.	No change.
c	All new routes should be designed to accommodate P-RNAV navigational requirements.	See Appendix A (PDG SID design)

	Paragraph 13 General Requirements:	Evidence of Compliance/Proposed Mitigation
a	The airspace structure shall be of sufficient dimensions to contain appropriate procedures, holding patterns and their associated protected areas.	See Appendix A (PDG SID design)
b	There shall be effective integration of departure and arrival routes associated with the airspace structure and linking to designated runways and published IAPs.	See Appendix A (PDG SID design)
c	Where possible, there shall be suitable linking routes between the proposed terminal airspace and existing en-route airspace structure.	No change.
d	The airspace structure shall be designed to ensure that adequate and appropriate terrain clearance can be readily applied within and adjacent to the proposed airspace.	See Appendix A (PDG SID design)
e	Suitable arrangements for the control of all classes of aircraft (including transits) operating within or adjacent to the airspace in question, in all meteorological conditions and under all flight rules, shall be in place or will be put into effect by Change Sponsors upon implementation of the change in question (if these do not already exist).	All classes of aircraft in all meteorological conditions & flight rules can be catered for.
f	Change Sponsors shall ensure that sufficient VRPs are established within or adjacent to the subject airspace to facilitate the effective integration of VFR arrivals, departures and transits of the airspace with IFR traffic.	n/a
g	There shall be suitable availability of radar control facilities.	The proposed routes are contained within airspace currently populated with numerous routes where radar coverage is well proven and is demonstrably appropriate for the task.
h	Change Sponsors shall, upon implementation of any airspace change, devise the means of gathering (if these do not already exist) and of maintaining statistics on the number of aircraft transiting the airspace in question. Similarly, Change Sponsors shall maintain records on the numbers of aircraft refused permission to transit the airspace in question, and the reasons why. Change Sponsors should note that such records would enable ATS Managers to plan staffing requirements necessary to effectively manage the airspace under their control.	See Appendix F (detailed statistical analysis of the trial). Radar track keeping data will continue to be gathered. This will enable any further detailed analysis to be required if necessary.
i	All new procedures should, wherever possible, incorporate Continuous Descent Approach (CDA) profiles after aircraft leave the holding facility associated with that procedure.	n/a

17 Formal Documentation and Design Detail

See Appendix A (PDG SID design).

18 Environmental Requirements

This section details the required elements of an Environmental Assessment for the Phase 2 ACP development, based upon CAP725 Appendix B. The requirements in this section are highlighted by the degree of compliance expected from airspace change sponsors. In following this guidance:

Must – change sponsors are to meet the requirements in full when this term is used.
Should – change sponsors are to meet these requirements unless there is sufficient reason, which must be agreed in writing with the DAP case officer and the circumstances recorded in the formal airspace change documentation.
May – change sponsors decide whether this guidance is appropriate to the circumstances of the airspace change.

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
1a	In order to ensure that the various areas for environmental assessment by DAP are addressed, Change Sponsors **should** submit the documentation with the following clearly defined sections: Description of the airspace change (refer to 28 – 33); Traffic forecasts (refer to 34 – 38); An assessment of the effects on noise; An assessment of the change in fuel burn/CO_2 (refer to Section 6); An assessment of the effect on local air quality (refer to Section 7); and An economic valuation of environmental impact, if appropriate (refer to Section 9 of CAP725 Appendix B).	General	2	B-1	Airspace description: See Section 4 and Appendix A. Requirements regarding Noise, Traffic forecasts, emissions, local air quality and environmental impact are discussed in section 5.4
1b	The guiding principles of the latest UK sustainable development strategy are: a) Living within environmental limits; b) Ensuring a strong, healthy and just society; c) Achieving a sustainable economy; d) Promoting good governance; and e) Using sound science responsibly. For a policy to be sustainable, it **must** respect all five of these principles though recognising that some policies will place more emphasis on certain principles than others. Any trade-offs **should** be made in an explicit and transparent way.	General	7-8	B-2	GAL respects these guiding principles and contends that they have been met, and (where priorities compete) that the proposal is fairly balanced.

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
2	It is considered unlikely that airspace changes will have a direct impact on animals, livestock and biodiversity. However, Change Sponsors **should** remain alert to the possibility and **may** be required to include these topics in their environmental assessment.	General	18	B-4	No specific analysis of the effect on animals, livestock or biodiversity has been made. NATS contends that the nature of this airspace change would not affect flora and fauna.
3	Environmental assessment **should** set out the base case or current situation so that changes can be clearly identified.	General	19	B-4	See Section 3
4a	Environmental assessment **should** follow the Basic Principles listed in CAP725.	General	20	B-4	The assumptions/methodology used are included in the proposal.
4b	The principles of rigour and cost-effectiveness together imply that each environmental assessment **should** be proportionate to the airspace change and its impact. Each airspace change is different and a proportional approach ensures that the environmental information is sufficient for purpose but not excessive.	General	21	B-5	The assumptions/methodology used are included in the proposal. See section 5.
5	A technical document containing a comprehensive and complete description of the airspace change including the environmental impact will be required and **must** be produced for all airspace changes.	General	25	B-6	The overall ACP package fulfils this requirement.
6	It **may** be appropriate for Change Sponsors to produce a more general description of the airspace change and the rationale for its proposal in an easy-to-read style for public consumption. If such an additional separate document is produced, it **must** contain details of the environmental impact of the proposal.	General	25	B-6	The consultation material was produced in easy-to-read style for public consumption. See appendix C. FAQs were also published on the GAL website: http://www.gatwickairport.com/business/corporate-responsibility/prnav-consultation/frequently-asked-questions/
7	The environmental assessment **must** include a high quality paper diagram of the airspace change in its entirety as well as supplementary diagrams illustrating different parts of the change. This diagram **must** show the extent of the airspace change in relation to known geographical features and centres of population.	Airspace Design	28	B-7	The overall ACP package fulfils this requirement.

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
8	The proposal **should** consider and assess more than one option, then demonstrate why the selected option meets safety and operational requirements and will generate an overall environmental benefit or, if not, why it is being proposed.	Airspace Design	29	B-7	See Section 13.
9	The Change Sponsor **must** provide DAP with a complete set of coordinates describing the proposed change in electronic format using World Geodetic System 1984 (WGS 84). In addition, the Sponsor **must** supply these locations in the form of Ordnance Survey (OS) national grid coordinates.	Airspace Design	30	B-7	See Appendix A (PDG SID design) Electronic map files can be provided if required. (AutoCAD Map 2008 DWG file) OS coordinates have not been supplied during recent proposal submissions, with such maps taking their place as agreed with DAP.
10	This electronic version **must** provide a full description of the horizontal and vertical extent of the zones and areas contained within the airspace change. It **must** also include coordinates in both WGS 84 and OS national grid formats that define the centre lines of routes including airways, standard instrument departures (SID), standard arrival routes (STAR), noise preferential routes (NPR) or any other arrangement that has the effect of concentrating traffic over a particular geographical area.	Airspace Design	30	B-7	See Appendix A (PDG SID design) Electronic map files can be provided if required. (AutoCAD Map 2008 DWG file) OS coordinates have not been supplied during recent proposal submissions, with such maps taking their place as agreed with DAP.
11	Change Sponsors **should** provide indications of the likely lateral dispersion of traffic about the centre line of each route. This **should** take the form of a statistical measure of variation such as the standard deviation of lateral distance from the centre line for given distances along track in circumstances where the dispersion is variable.	Airspace Design	31	B-7	See Appendix F (statistical analysis of trial) Section 5 and Appendix A (PDG SID design)

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
12	Sponsors **may** supply the outputs from simulation to demonstrate the lateral dispersion of traffic within the proposed airspace change or bring forward evidence based on actual performance on a similar kind of route. It **may** be appropriate for Sponsors to explain different aspects of dispersion e.g. dispersion within NPRs when following a departure routeing and when vectoring – where the aircraft will go and their likely frequency.	Airspace Design	31	B-7	See Section 5 comparison of current & proposed procedures. This uses real flight data taken from the trial.
13	Change Sponsors **must** provide a description of the vertical distribution of traffic in airways, SIDs, STARs, NPRs and other arrangements that have the effect of concentrating traffic over a particular geographical area.	Airspace Design	32	B-7	Density plots at different altitudes provided as part of this ACP package.
14	For departing traffic, sponsors **should** produce profiles of the most frequent type(s) of aircraft operating within the airspace. They **should** show vertical profiles for the maximum, typical and minimum climb rates achievable by those aircraft.	Airspace Design	32	B-7	See Appendix F and density plots from Section 5
15	A vertical profile for the slowest climbing aircraft likely to use the airspace **should** also be produced.	Airspace Design	32	B-8	See Appendix A.
16	All profiles **should** be shown graphically and the underlying data provided in a spreadsheet with all planning assumptions clearly documented.	Airspace Design	33	B-8	n/a due to extensive flight trial data.
17	Change Sponsors **should** explain how consideration of CDA and LPLD is taken into account within their proposals.	Airspace Design	34	B-8	n/a.
18	In planning changes to airspace arrangements, sponsors **may** have conducted real and/or fast time simulations of air traffic for a number of options.	Traffic Forecasts	34	B-8	No simulation necessary due to the real flight trials. See Appendix F.
19	Change Sponsors **must** include traffic forecasts in their environmental assessment.	Traffic Forecasts	35	B-8	See section 5.5

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
20	Information on air traffic **must** include the current level of traffic using the present airspace arrangement and a forecast. The forecast will need to indicate the traffic growth on the different routes contained within the airspace change volume.	Traffic Forecasts	35	B-8	See Appendix F & H & section 5.5
21	The sources used for the forecast **must** be documented.	Traffic Forecasts	35	B-8	As above
22	Typically, forecasts should be for five years from the planned implementation date of the airspace change. There **may** be good reasons for varying this – for example, to use data that has already been made available to the general public at planning inquiries, in airport master plans or other business plans	Traffic Forecasts	36	B-8	As above.
23	It **may** also be appropriate to provide forecasts further into the future than five years: examples are extensive airspace changes or where traffic is forecast to grow slowly in the five-year period but faster thereafter.	Traffic Forecasts	36	B-8	As above.
24	It **may** be appropriate for Change Sponsors to outline the key factors [affecting traffic forecasts] and their likely impact. In these circumstances, Sponsors **should** consider generating a range of forecasts based on several scenarios that reflect those uncertainties – this would help prevent iterations in the assessment process.	Traffic Forecasts	37	B-8	A range of forecasts has not been produced. This change is not sensitive to the degree to which traffic grows.
25	Traffic forecasts **should** contain not only numbers but also types of aircraft. Change Sponsors should provide this information by runway (for arrivals/departures) and/or by route with information on vertical distribution by height/altitude/flight level as appropriate.	Traffic Forecasts	38	B-9	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
26	Types of aircraft **may** be given by aircraft type/engine fit using ICAO type designators. If this is not a straightforward exercise, then designation by the UK Aircraft Noise Contour Model (ANCON) types or by seat size categories would be acceptable.	Traffic Forecasts	38	B-9	Aircraft type data has been taken into account in all analyses.
27	Change Sponsors **must** produce L_{eq}, 16 hours noise exposure contours for airports where the proposed option entails changes to departure and arrival routes for traffic below 4,000 feet agl based on the published minimum departure and arrival gradients. Under these circumstances, at least three sets of contours must be produced: Current situation – these may already be available as part of the airport's regular environmental reporting or as part of the airport master plan; Situation immediately following the airspace change; and Situation after traffic has increased under the new arrangements (typically five years after implementation although this should be discussed with the DAP Project Leader).	Noise	44	B-11	Not applicable – noise analysis is not being undertaken for this development (see Appendix E).
28	The contours **should** be produced using either the UK Aircraft Noise Contour Model (ANCON) or the US Integrated Noise Model (INM) but ANCON **must** be used when it is currently in use at the airport for other purposes.	Noise	46	B-12	n/a
29	Terrain adjustments **should** be included in the calculation process (i.e. the height of the air routes relative to the ground are accounted for).	Noise	47	B-12	n/a
30	Contours **must** be portrayed from 57 dBA L_{eq}, 16 hours at 3dB intervals.	Noise	48	B-12	n/a
31	Contours **should not** be produced at levels below 54 dBA L_{eq}, 16 hours because this corresponds to generally low disturbance to most people.	Noise	48	B-12	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
32	Change Sponsors **may** include the 54 dBA L_{eq}, 16 hours contour as a sensitivity analysis but this level has no particular relevance in policy making.	Noise	48	B-12	n/a
33	A table **should** be produced showing the following data for each 3dB contour interval: Area (km^2); and Population (thousands) – rounded to the nearest hundred.	Noise	49	B-12	n/a
34	It is sometimes useful to include the number of households within each contour, especially if issues of mitigation and compensation are relevant: This table **should** show cumulative totals for areas/populations/ households. For example, the population for 57dBA will include residents living in all higher contours. The source and date of population data used **should** be noted adjacent to the table. Population data **should** be based on the latest available national census as a minimum but more recent updated population data is preferred. The areas calculated **should** be cumulative and specify total area within each contour including that within the airport perimeter.	Noise	50	B-12	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
35	Contours for assessment **should** be provided to DAP in both of the following formats: Electronic files in the form of a comma delimited ASC2 text file containing three fields as an ordered set (i.e. coordinates should be in the order that describes the closed curve) defining the contours in Ordnance Survey National Grid in metres: Field Name Units 1 Level - dB 2 Easting - six figure easting OS national grid reference (metres) 3 Northing - six figure northing OS national grid reference (metres) Paper version overlaid on a good quality 1:50,000 Ordnance Survey map. However, it **may** be more appropriate to present contours on 1:25,000 or 1:10,000 Ordnance Survey maps.	Noise	51	B-13	n/a
36	Contours for a general audience **may** be provided overlaid on a more convenient map (e.g. an ordinary road map with a more suitable scale for publication in documents). The underlying map and contours **should** be sufficiently clear for an affected resident to be able to identify the extent of the contours in relation to their home and other geographical features. Hence, the underlying map **must** show key geographical features, e.g. street, rail lines and rivers.	Noise	53	B-13	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
37	SEL footprints **must** be used when the proposed airspace includes changes to the distribution of flights at night below 7,000 feet agl and within 25km of a runway. Night is defined here as the period between 2300 and 0700 local time. If the noisiest and most frequent night operations are different, then footprints **should** be calculated for both of them. A separate footprint for each of these types **should** be calculated for each arrival and departure route. If SEL footprints are provided, they **should** be calculated at both 90dBA SEL and 80dBA SEL.	Noise	56	B-13	n/a
38	SEL footprints **may** be used when the airspace change is relevant to daytime only operations. If SEL footprints are provided, they **should** be calculated at both 90dBA SEL and 80dBA SEL.	Noise	56	B-14	n/a
39	SEL footprints for assessment **should** be provided to DAP in both of the following formats: Electronic files in the form of a comma delimited ASC2 text file containing three fields as an ordered set (i.e. coordinates should be in the order that describes the closed curve) defining the footprints in Ordnance Survey National Grid in metres: Field Name Units 1 Level - dB 2 Easting - six figure easting OS national grid reference (metres) 3 Northing - six figure northing OS national grid reference (metres) Paper version overlaid on a good quality 1:50,000 Ordnance Survey map. However, it **may** be more appropriate to present footprints on 1:25,000 or 1:10,000 Ordnance Survey maps.	Noise	57	B-14	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
40	SEL footprints for a general audience **may** be provided overlaid on a more convenient map (e.g. an ordinary road map with a more suitable scale for publication in documents). The underlying map and footprints **should** be sufficiently clear for an affected resident to identify the extent of the footprints in relation to their home or other geographical features. Hence, this underlying map **must** show key geographical features, e.g. streets, rail lines and rivers. Calculations should include terrain adjustments as described in the section on L_{eq} contours.	Noise	58	B-14	n/a
41	Change Sponsors **may** use the "percentage highly annoyed" measure in the assessment of options in terminal airspace to supplement L_{eq}. If they choose to use this method, then the guidance on population data for noise exposure contours set out should be followed. Sponsors **should** use the expression and associated results in calculating the number of those highly annoyed. If they wish to use a variant method, then this would need to be supported by appropriate research references.	Noise	65	B-15	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
42	Change Sponsors **may** use the L_{DEN} metric but, if they choose to do so, they **must** still produce the standard L_{eq}, 16 hours contours as previously described. If airspace change sponsors wish to use the L_{DEN} metric they **must** do so in a way that is compliant with the technical aspects of the Directive and any supplementary instructions issued by DEFRA. Sponsors **should** note the requirement for noise levels to be calculated as received at 4 metres above ground level. In particular, the guidance on how contours are to be portrayed, as described in the section dealing with Leq contours applies. Calculations **should** include terrain adjustments as described in the section on Leq contours. An exception regarding L_{DEN} contours is the production of a table showing numerical data on area, population and households which **should** be presented by band (e.g. 55dBA to 60dBA) rather than cumulatively as for UK L_{eq} contours (e.g. >55dBA). Change Sponsors **should** make it clear where areas/counts are by band or cumulative.	Noise	67&69&70	B-15 & B-16	n/a
43	Change Sponsors **may** use the L_{Night} metric within their environmental assessment and consultation. If they do so, SEL footprints must also be produced. Calculations **should** include terrain adjustments as described in the section on L_{eq} contours.	Noise	73	B-16	n/a
44	Change Sponsors **may** use difference contours if it is considered that redistribution of noise impact is a potentially important issue.	Noise	78	B-17	n/a
45	Change Sponsors **may** use PEI as a supplementary assessment metric.	Noise	85	B-19	n/a
46	Change Sponsors **may** use the AIE metric as a supplementary assessment metric. If the sponsor uses PEI as a supplementary metric then AIE **should** also be calculated as both metrics are complementary.	Noise	87	B-19	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
47	Change Sponsors **may** vary the information displayed in Operations Diagrams providing that the diagram is a fair and accurate representation of the situation portrayed.	Noise	88	B-20	n/a
48	Change Sponsors **may** use maximum sound levels (L_{max}) in presenting aircraft noise footprints for public consumption if they think that this would be helpful. This does not replace the obligation to comply with the requirement to produce sound exposure level (SEL) footprints, where applicable.	Noise	95	B-22	n/a
49	Change Sponsors **may** produce diagrams portraying maximum sound event levels (L_{max}) for specific aircraft types at a number of locations at ground level beneath the airspace under consideration. This may be helpful in describing the impact on individuals. It is usual to include a table showing the sound levels of typical phenomenon e.g. a motor vehicle travelling at 30 mph at a distance of 50 metres.	Noise	96	B-22	n/a
50	Change Sponsors **must** demonstrate how the design and operation of airspace will impact on emissions. The kinds of questions that need to be answered by the sponsor are: Are there options which reduce fuel burn in the vertical dimension, particularly when fuel burn is high e.g. initial climb? Are there options that produce more direct routeing of aircraft, so that fuel burn is minimised? Are there arrangements that ensure that aircraft in cruise operate at their most fuel-efficient altitude, possibly with step-climbs or cruise climbs?	Climate Change	102	B-23	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
51	Change Sponsors **should** estimate the total annual fuel burn/mass of carbon dioxide in metric tonnes emitted for the current situation, the situation immediately following the airspace change and the situation after traffic has increased under the new arrangements – typically five years after implementation. Sponsors **should** produce estimates for each airspace option considered.	Climate Change	106	B-24	n/a
52	Change Sponsors **should** provide the input data for their calculations including any modelling assumptions made. They **should** state details of the aircraft performance model used including the version numbers of software employed.	Climate Change	107	B-24	n/a
53	Where the need to provide additional airspace capacity, reduce delays or mitigate other environmental impact results in an increase in the total annual fuel burn/ mass of carbon dioxide in metric tonnes between the current situation and the situation following the airspace change, Sponsors **should** provide justification.	Climate Change	108	B-24	n/a

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
54	Change Sponsors **must** produce information on local air quality **only** where there is the possibility of pollutants breaching legal limits following the implementation of an airspace change. The requirement for local air quality modelling will be determined on a case by case basis as discussed with the DAP Project Leader and ERCD. This discussion will include recommendations of the appropriate local air quality model to be used. Concentrations **should** be portrayed in microgrammes per cubic metre ($\mu g.m^{-3}$). They **should** include concentrations from all sources whether related to aviation and the airport or not. Three sets of concentration contours **should** be produced: Current situation – these may already be available as part of the airport's regular environmental reporting or as part of the airport master plan; Situation immediately following the airspace change; and Situation after traffic has increased under the new arrangements – typically five years after implementation although this **should** be discussed with the DAP Project Leader.	Local Air Quality	115	B-26	No local air quality analysis is being undertaken – see Section 12.
55	Contours for assessment **should** be provided to DAP in similar formats to those used for noise exposure contours. Where Change Sponsors are required to produce concentration contours they **should** also produce a table showing the following data for concentrations at 10 $\mu g.m^{-3}$ intervals: Area (km^2); and Population (thousands) – rounded to the nearest hundred.	Local Air Quality	116	B-26	See above.
56	The source and date of population data used **should** be noted adjacent to the table. Population data **should** be based on the latest available national census as a minimum but more recent updated population data is preferred.	Local Air Quality	117	B-26	See above.

Record number	Requirement	Subject Area	Appx B Para	Appx B Page	Evidence of Compliance or Proposed Mitigation
57	Change Sponsors **may** wish to conduct an economic appraisal of the environmental impact of the airspace change, assessing the economic benefits generated by the change. If undertaken, this **should** be conducted in accordance with the guidance from HM Treasury in the Green Book (HM Treasury, 2003). If Change Sponsors include a calculation of NPV then they **must** show financial discount rates, cash flows and their timings and any other assumptions employed. The discount rate must include that recommended in the Green Book currently set at 3.5%. Additionally, other discount rates **may** be used in a sensitivity analysis or because they are representative of realistic commercial considerations	Economic Valuation	124, 126	B-28	Such an appraisal will not be supplied, see Section 11.

19 References

Ref 1. ICAO Procedures for Air Navigation Services – Aircraft Operations, Volumes I and II (PANSOPS), (Doc 8168)

Ref 2. ICAO Performance-based Navigation (PBN) Manual, (Doc 9613)

Ref 3. ICAO Required Navigation Performance Authorisation Required (RNP AR) Procedure Design Manual, (Doc 9905)

Ref 4. Policy for the application of Performance Based Navigation in UK/Irish Airspace (CAA/IAA)

Ref 5. FAS SID/NPR Taskforce "Recommendations and Guidance Regarding Implementation of PBN SIDs" (Version 2.2 Sept 2012).

Ref 6. Guidance to the Civil Aviation Authority on Environmental Objectives Relating to the Exercise of its Air Navigation Functions, (DfT January 2002).

20 Appendices

Appendix A: PDG SID design report

- Attached as separate document

Appendix B: Safety Case

- Attached as separate document

Appendix C: Stakeholder Consultation Document

- Attached as separate document

Appendix D: Consultation Feedback Document

- Attached as separate document

Appendix E: Noise analysis requirement

Email from [redacted] CAA DAP to [redacted] ATS Gatwick

From: [redacted]@caa.co.uk]

Sent: 30 May 2012 15:14

To: [redacted]

Cc: [redacted]

Subject: Framework Briefing Action Response 23/04/12

[redacted]

Regarding an action from the mtg on 23 April 2010, we undertook to advise you if there was a requirement to provide Leq contours and SEL footprints for the GATCOM consultation on the proposed implementation of P-RNAV SIDs at Gatwick. Following review by ERCD, we can confirm there is no requirement to undertake noise modelling because the impacts are likely to be beyond the 57 dBA contours and the 90 SEL footprint (but see further comment below).

However, whilst the P-RNAV/Conv SID designs and NPR compliance issues of the LAM/BIG/CLN/DVR Rwy 26 SIDs are subject to the outcome of the GATCOM consultation, should P-RNAV, and Conventional SID designs, and the NPR portrayal of this profile need to be revised, you will need to advise us what the revised designs will entail, and what their impact on the noise contours will be. We can then advise whether any further consultation (with associated noise contours if applicable) is required.

Regards,

[redacted]

Appendix F: Statistical Analysis of Trial Data

- Attached as two separate documents:

OA report 0849 "Gatwick P-RNAV SID Trials - Final Analysis of Phases I and II (10/11/2008)

OA report 1039 "Gatwick P-RNAV SID Trials – Update to Analysis of Phase II (Jun 2010)

Appendix G: Record of consultation

- Attached as Excel Spread sheet. Note Excel cannot be opened from PDF version of this document, the Excel file is included in the electronic ACP package.

EGKK SIDs Consultation Respons

Appendix H: Traffic Growth Forecast

Year	Business Plan Forecasts Base Case (Jan 2012) Total UK Flights (x1,000)	Forecast growth	Base case using 2012 as 100%	Notes
2011	2,174	3.2%	100.0%	Data Sample (Actuals)
2012	2,169	-0.2%	99.8%	
2013	2,216	2.2%	101.9%	Propd. implementation
2014	2,310	4.2%	106.3%	
2015	2,394	3.7%	110.1%	
2016	2,469	3.1%	113.6%	
2017	2,530	2.5%	116.4%	
2018	2,588	2.3%	119.0%	Implementation + 5yrs
2019	2,647	2.3%	121.8%	
2020	2,703	2.1%	124.3%	
2021	2,766	2.3%	127.2%	
2022	2,834	2.5%	130.4%	
2023	2,906	2.6%	133.7%	Implementation + 5yrs

APPENDIX A

APPENDIX B

APPENDIX C

YOUR LONDON AIRPORT
Gatwick

PRNAV Departure SID Implementation at LGW

Consultation Document

Final Version

19 July 2012

Prepared by:
Gatwick Airport Limited

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Table of contents

Appendices

Appendix A – Figures 1 to 13 showing population density and over flight routes
Appendix B – Consultation response form and questions
Appendix C – List of consultees
Appendix D – UK Aeronautical Information Package extract

Glossary

B-RNAV	Basic Area Navigation
FMS	Flight Management System
GAL	Gatwick Airport Ltd
NPRs	Noise Preferential Routes
P-RNAV	Precision Area Navigation
RNAV	Area Navigation
SIDs	Standard Instrument Departures
LTMA	London Terminal Area (airspace encompassing the main London area airports, including Gatwick)
NATS	National Air Traffic Services
NATMAG	Noise And Track Monitoring Advisory Group
GATCOM	Gatwick Airport Consultative Committee
FLOPSC	(Gatwick Airport) Flight Operations Performance and Safety Committee
CAA (DAP)	Civil Aviation Authority (Directorate of

	Airspace Policy)

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1 INTRODUCTION

This document is produced by Gatwick Airport Ltd. as a consultative measure and describes our proposal to replicate, implement and eventually replace, within the next five years, the current standard departure routes from Gatwick Airport with more accurately defined routes utilising the improved navigational capabilities of modern aircraft (P-RNAV).

Departure Routes

When an aircraft departs from Gatwick it will follow one of a number of routes depending on the runway in use and its destination. These routes are designated Standard Instrument Departures (SIDs). The purpose of a SID is to define a route that takes an aircraft from the point at which it departs from the runway to the point where it can join an airway. All Gatwick SIDs are contained within Noise Preferential Routes (NPRs) until reaching an altitude of 4,000 feet. NPRs were set by the Department for Transport several decades ago and are intended to ensure that departing aircraft avoid centres of population as far as possible. The tracks of aircraft following NPRs form a swathe up to 3 km wide. Once the aircraft has reached the top of the NPR, it continues to follow the SID until it reaches the point where it can join an airway for the en route phase of the flight.

The airspace between Gatwick and the airway joining point is the London Terminal Control Area, a major confluence of airways and arrival and departure routes for all the London airports. The mixture of climbing and descending aircraft, holding patterns and transit routes requires dynamic tactical management by the air traffic controllers.

Navigation Methods

Current civil air transport aircraft are able to determine their in-flight position with increasing accuracy using modern navigation aids including ground-based beacons, space-based satellites and on-board inertial navigation systems. Appropriately equipped aircraft can fly a prescribed route with greater accuracy than before.

P-RNAV

P-RNAV stands for Precision Area Navigation. It is a navigation specification that uses the benefits of improved airborne navigation capabilities to require a track-keeping accuracy of ±1 nautical mile (compared with ±5 nautical miles for the next best standard) for at least 95% of the flight time, together with high integrity navigation data requirements. Such P-RNAV capability can be achieved using inputs from ground-based, satellite or on-board systems. An aircraft must be certificated as having the appropriate navigation systems and flight crew procedures before it can fly P-RNAV routes; and P-RNAV routes are specifically designed to make best use of this improved navigational accuracy.

Benefits of P-RNAV

In addition to the benefit of an aircraft position being known with more certainty at any given time, there are other, wider benefits to be gained from the implementation of P-RNAV. Since the same track can be flown consistently and accurately, airspace designers can use this facility to improve the capacity of congested airspace by accommodating large numbers of aircraft routes. As aircraft following P-RNAV SIDs are expected to self-navigate to a greater extent than the case with those following conventional SIDs, there should be only the minimum of radio calls and tactical interventions from the air traffic controller. In congested airspace, where a single controller may be responsible for a large number of aircraft at one time, this aids efficiency, expedition and safety.

In future, it may be possible to design P-RNAV routes using the increased accuracy of the flight profile and resultant narrower swathes of departure tracks to improve the avoidance of centres of population to greater effect than that achieved by the current NPRs.

The background for this change is also described within this document, including the international policy for adoption of P-RNAV in UK airspace which has already been subject to a separate consultation by UK's CAA(DAP)

The proposed routes are numbered 1 to 9 and shown in diagrammatic form in Appendix A.

The potential impact of this change in relation to the density of flights on each route relative to geographical locations/population is also shown.

You are invited to comment on the proposed routes 1 to 9 individually and a standard consultation response form is included.

1.1 Overview of PRNAV at Gatwick Airport

P-RNAV Departure Procedures Trial (2007 to present day)

A project to enable trials and studies of RNAV applications in London Terminal Airspace was implemented in 2007.

The RNAV applications subject to trial and study included P-RNAV Standard Instrument Departures (SIDs) from Gatwick Airport based upon four conventional SID centrelines.

The table below shows the relationship between runway direction and the corresponding P-RNAV SID trial procedure.

Runway 26L

Conventional SID	P-RNAV SID
CLN 8M	CLN 2X (Route 4)
SAM 2M	SAM 1X (Route 1)

Runway 08R

Conventional SID	P-RNAV SID
SFD 8P	SFD 2Z (Route 2)
SAM 3P	SAM 2Z (Route 3)

The trial of P-RNAV Standard Instrument Departures commenced on 27th September 2007 and has run on a 24 hour basis to the present day.

The overall aim of the trial was to determine the operation benefits of using P-RNAV equipment to fly Standard Instrument Departures (SIDs) from Gatwick Airport. The objectives of the trial included the assessment of:

- Applying P-RNAV procedures in a complex airspace environment.
- P-RNAV ATC procedures
- The accuracy of vertical and lateral profiles for future applications of P-RNAV.
- Utilisation of both conventional and P-RNAV procedures for the same departure tracks.
- Track dispersion and compliance with airport Noise Preferential routes (NPRs) in comparison with conventional procedures.

Data has now been collected and **the trial is currently due to end on 20th April 2013.**

What is P-RNAV?

RNAV (Area Navigation) is the ability of an aircraft's Flight Management System (FMS) to navigate by means of waypoints defined by latitude and longitude, rather than by conventional ground based navigational aids.

Basic Area Navigation (B-RNAV – navigational accuracy ± 5nm) capability is mandated in UK controlled airspace.

Airline operators are eager for the potential advantages offered by existing equipment to be fully utilised. It is anticipated that the deployment of RNAV will realise a number of operational benefits. These will be dependant upon the type of RNAV application and the target environment. Potential generic benefits include reduced controller and pilot workload, improved situational awareness, noise reduction, reduced emissions, fuel savings and decreased engine maintenance costs.

The Precision Area Navigation (P-RNAV) standard is intended for use in Terminal Airspace and requires that an aircraft is capable of a track-keeping accuracy of ±1NM for 95% of its flight time.

CAA policy is that Precision Area Navigation (P-RNAV) should be the standard applied in terminal airspace, and in accordance with this, P-RNAV capability is expected to be mandated in the future for flight in the London Terminal Airspace (LTMA) and conventional navigation procedures (including SIDs) will be withdrawn from around 2018 onwards.

The Proposal

This document details the consultation process and proposal for the introduction of P-RNAV replications which match the existing Standard Instrument Departure (SID) routes as closely as possible given the RNAV safety/design criteria. **No change will be made to vertical/climb profile of departure routes**

In the case of the trial procedures it is proposed to fully implement the extant trial procedures.

For those SIDs not previously subject to trial, new P-RNAV SIDs have been generated which match the existing conventional SID centreline as closely as possible while meeting the RNAV design criteria.

The conventional SIDs will initially remain in place alongside the P-RNAV; these will be withdrawn at some stage in the future as part of the wider P-RNAV roll out.

No changes are proposed to the current published Noise Preferential Routes (NPRs), or to ATC operating practices.

This proposal is being progressed in line with CAA guidance on the process for airspace change as detailed in their CAP725 document, and with reference to agreed process requirements established through briefings on the development to the CAA.

When the whole London (LTMA) airspace network is upgraded to the RNAV standard, it is likely that some the procedures being proposed here may require further adaptation. If/when this occurs it will be subject to a separate development and consultation activity as required by the CAA's CAP725 process.

This proposal is being put forward by Gatwick Airport Ltd. NATS (Airports) is assisting Gatwick Airport Ltd in the technical aspects and consultation for this airspace change proposal.

2 CONSULTATION

2.1 Purpose of consultation

The purpose of this consultation is to allow stakeholders (NATMAG, GATCOM and the constituencies members rpresent, aircraft operators etc) to provide feedback on these proposals to convert extant SIDs to the P-RNAV standard.
There is no proposal to change to existing controlled airspace boundaries nor air traffic control practices, only the method by which certain procedures (SIDs) are defined within the UKs Aeronautical Information Publications (AIP) and the on board navigation system of aircraft operating from Gatwick Airport.

Subject to the consultation process, following submission of an airspace change proposal to the CAA, and subsequent regulatory approval, the P-RNAV SID procedures will be implemented in parallel with current conventional SID procedures from Gatwick and a continual review process, agreed from the feedback of this consultation, will be followed with the aim to withdraw conventional SIDs at an appropriate time in the future.

Consultation Process

The CAA requires that this proposal is the subject of a 12 week consultation, and has confirmed that this consultation may be conducted through NATMAG, GATCOM and the Gatwick aviation stakeholders.
Matters raised that have not been adequately considered during development may require further changes and depending on the impact, some form of re-consultation may be required.
Gatwick Airport Ltd will be required to produce evidence to the CAA that consultation has been conducted and will therefore provide a copy of the consultation documentation, feedback and conclusions reached, together with the feedback report.

Scope of Consultation

This consultation is focussed on NATMAG and GATCOM membership and specifically those districts/parishes which may experience a change in concentration of over flying aircraft during the departure phase of flight as a result of the implementation of the proposed P-RNAV SID routes. These areas can easily be identified on the over flight density maps shown in Appendix A. A full list of consultees is presented in Appendix C

This consultation document is available for download on the GATCOM and Gatwick Airport websites.

Review of Consultation Document and Providing Feedback

An initial consultation commenced on 29 March 2012 with GATCOM Steering Group and, following early feedback, it was determined that points of clarification were required. The consultation document of 29 March 2012 has been withdrawn and this document should be considered as the definitive version.

This latest period of consultation commences on 19 July 2012 and closes on 19 October 2012; a period of 13 weeks, although we will accept responses up until the 12th November.

You are invited to submit your feedback on the form presented in Appendix B
Please complete and return the form as per the instructions provided on the form.

When responding, consultees must specify the grounds for supporting or objecting to the proposal. Feedback, either in favour of or objecting to the proposal, without supporting reasons will be reported to the CAA but Gatwick Airport Ltd will not be in a position to consider the merits of such feedback.

Consultation Feedback

The feedback will be analysed by Gatwick Airport/NATS and summarised in a post consultation report. This will be made available to NATMAG, GATCOM and published on the Gatwick Airport website.

This report will update stakeholders on subsequent phases of the change process, such as any further consultation required, the submission of a formal proposal to the CAA and its consideration of that proposal, all of which depend on the outcome of this consultation exercise

Airspace change proposal and implementation

Details of the consultation exercise will form part of the airspace change proposal that NATS will submit on behalf of Gatwick Airport Ltd (the airspace change sponsor) to the CAA for its consideration. Copies of all responses will be provided to the CAA, including any personal information in them, except where a response requests otherwise.

The airspace change proposal submitted to the CAA following the consultation exercise will present a design for each SID route that constitutes the overall proposal. Through the case study process, the CAA may determine that the case for going ahead with some elements may be stronger than others. The proposal may therefore be implemented in part, or in phases, if there are outstanding issues associated with elements that require further work before the CAA is prepared to approve them for implementation.

Once the entire proposal is, or elements of the proposal are accepted by the CAA, NATS will (on behalf of Gatwick Airport Ltd) implement the airspace change at an appropriate opportunity. Implementation is planned for summer 2013 onwards. Implementation of the changes may be phased on the basis of;

a) The length of time taken by CAA in reaching its decision,
b) The need for any revision of the airspace change proposal identified by the consultation process and any further period of consultation required for such revisions and
c) Operational constraints

References; CAP 725, CAA Guidance on the Application of the Airspace Change Process, CAA Directorate of Airspace Policy

3 PROPOSED IMPLEMENTATION

The proposal is to implement P-RNAV based versions of all SID departure routes from Gatwick Airport for use in parallel with existing conventional navigation based SID, enabling a managed transition from conventional to P-RNAV SID structure.

The proposed routes are referred to in simple numeric terms (Route 1 etc), rather than by their operational nomenclature, in this consultation document for ease of identification and comment by consultees.

This proposal includes detail of the proposed local management of this transition, reviewing the impact of the concentration of aircraft tracks to smaller swathes in order to optimise the future SID designs to provide evidence to influence improved routings from Gatwick as part of the wider P-RNAV roll out in LTMA airspace.

Consultees are invited to comment on both the proposed P- RNAV versions of conventional SIDs (Routes 1- 9) and also the proposed management process.

Options.

Initial consultation, noted above, resulted in a review of possible options to attempt to use different criteria for P-RNAV SID **Route 4** (see page 26), in order to move the track back more into the published NPR.

The revised criteria did not work as it merely served to split the tracks of departing flights, compromising safety, while still resulting in jet traffic running on the edge or outside of the north western edge of the NPR.

This option was therefore dropped and the original, flight trialled, design retained as part of this proposal.

Proposed P-RNAV SID Development

The four P-RNAV SIDs used in the trial that ran from 2007 (referred to here on in as routes 1,2, 3 and 4) were based on four different basic design configurations of FMS navigation defining the lateral tracks and turns associated with four conventional SID tracks. Each of these tracks mirror others not covered by the trial, such that;

... Trialled P-RNAV **Route 1** has same design criteria as **Route 5 and Route 6** from runway 08R **(see figure 7, page 20)**

... Trialled P-RNAV **Route 2** has same design criteria as **Route 7 and Route 9** from runway 26L **(see figure 10, page 22)**

... Trialled P-RNAV **Route 3** has same design criteria as the other SID routes turning left on departure from this runway and also **Route 9** from runway 26L **(see figure 4, page 16)**

... Trialled P-RNAV **Route 4** has same design criteria as all other SID routes that turn right on departure from runway 26L **(see figure 13, page 28)**

Results of the trial of Routes 1- 4 provide assurance that all the conventional Gatwick SID routes could be similarly replicated using P-RNAV SIDs.

The proposal, therefore, is to implement a full P-RNAV SID suite (ROUTES 1 to 9) based on the current conventional SIDs whilst retaining all the conventional SIDs for a period of up to 5 years

The proposed designs of each P-RNAV SID track are shown in Appendix A of this document.

Appendix A also shows actual track plots from NATS operational radar data of departure SID routes flown during 2011

Objective

To design departure routes to match conventional SID track/meet P-RNAV design standards/maintain high level of NPR compliance at low level;

Implement P-RNAV SIDs with a similar design layout on current conventional (ground based navigational aid) SID tracks.

Benefits and Impacts

Analysis of flight tracking plots from ATC radar derived data during the trial shows that there is improved track keeping with less divergence from the prescribed route when aircraft follow a P-RNAV SID when compared against those that follow the conventional SID. **See Appendix A for track density plots of conventional and P-RNAV SIDs flown which indicate impact on population densities around Gatwick of P-RNAV versus conventional navigation**

It should be noted that by its very definition, P-RNAV SIDs will mean that the dispersion of departing aircraft will become more concentrated than before (until aircraft are subsequently 'vectored' by Air Traffic Control once above the vertical limits of the NPR, as per current operational practice – see **Appendix D**) with the result that some residents will be over flown less, while others will be over flown more and therefore noise impact will be redistributed. It should also be noted that as this P-RNAV SID implementation retains the conventional SID, on which each P-RNAV version is based, the likely result will be that there is some element of dispersion within the NPRs with both conventional and P-RNAV SIDs track keeping. It is, therefore, considered that existing noise contours will not be affected by these changes in the short to medium term.

There were 125,000 flights which departed Gatwick Airport (on all SID routes) in 2011, of these 2552 flights departed via one of the 4 trial P-RNAV SIDs (Routes 1 – 4).

It is expected that over the 5 years from implementation of the procedures detailed in this document that there will be a general rise in percentage take up until the whole LTMA network is upgraded to the RNAV standard.

This P-RNAV SID implementation is therefore designed to provide an 'organic' shift in track/noise concentration. The management/oversight process discussed in paragraph 3.1.5 provides opportunity to address any issues caused by this redistribution.

It should be noted that, as the P-RNAV SID designs included in this implementation proposal are replications of conventional SID routes, **there is no increase in airport runway capacity, nor is there likely to be a measurable change in emissions from aircraft flying these routes.**

Continual monitoring and analysis of the effects of more aircraft using P-RNAV SIDs will provide a greater understanding of potential problems and experience in developing future solutions for departure routes. As already noted, it is likely that some of the procedures being proposed here may require further adaptation. If/when this occurs it will be subject to a separate development and consultation activity as required by the CAA's CAP725 process.

3.1.5 Proposed (post implementation) Management Oversight Process

NATMAG will be provided with quarterly updates on;

- ... Percentage use of PRNAV versus conventional SID,
- ... Noise complaints,
- ... Track keeping
- ... Density of flown tracks

for each route and will closely monitor the impact of this implementation of P-RNAV, including the density of the population over flown on each of the P-RNAV routes, the number of noise complaints received attributable to both P-RNAV and conventional navigation based SIDs and whether the route(s) being flown within a swathe is/are the one(s) that cause least annoyance for local communities.

Any issues identified through this management process would be fed by Gatwick Airport into development of the wider P-RNAV roll out expected to take place from around 2018 (see section 1.1.3).

Should any route, which is part of this proposed P-RNAV implementation, be deemed to be of such detrimental effect that it should be permanently withdrawn, and traffic reverted back to the conventional procedure, this will be communicated to the wider population through GATCOM and other aviation stakeholder groups (FLOPSC etc) and the route withdrawn

Similarly, should any conventional SID route, be determined as part of this ongoing oversight process to be detrimental in comparison to its P-RNAV version, then the same process of notification and withdrawal may be applied.

Your comments and suggestions are welcomed as part of the feedback to this consultation (via the form as shown in Appendix B) on the proposals for oversight, monitoring criteria and withdrawal/notification process.

Appendix A

The following diagrams show population density (see figure 1 and 2) overlaid with track plots of departing flights from Gatwick Airport (where available) from NATS RADAR data.

This includes track plots of flights on the four flight trialled P-RNAV replications of conventional SID departure routes which have been flown since 2007 as part of the trial detailed in section 1.1.1 and which form Route 1, 2, 3 and 4 of this implementation proposal.

All radar data track plots are shown to a vertical limit of 4000 feet Above Mean Sea Level (AMSL) as this is the maximum vertical limit of the published NPR and the point at which ATC can direct flights onto any compass heading required to provide safe separation from other air traffic operating within the LTMA airspace (see Appendix D for full detail)

All **proposed P-RNAV SID** departure routes are **shown (in pink)** on separate population density diagrams so that the route can be clearly seen.

Notes have been included for all proposed SID routes to explain the expected effect on track keeping as a result of increased usage of P-RNAV by departing flights on that route.

The centreline/lateral limits of the **published NPRs** are **shown (in red)** for reference. It should be noted from the diagrams that it is not possible for the current **conventional SID** centrelines **(shown in blue)** to exactly match the NPR centrelines. P-RNAV SID routes have been designed to replicate (as near as possible) the conventional SID route.

NOTE: The detail of the following maps is best viewed in electronic format, in “full screen” and with the zoom increased to 150%

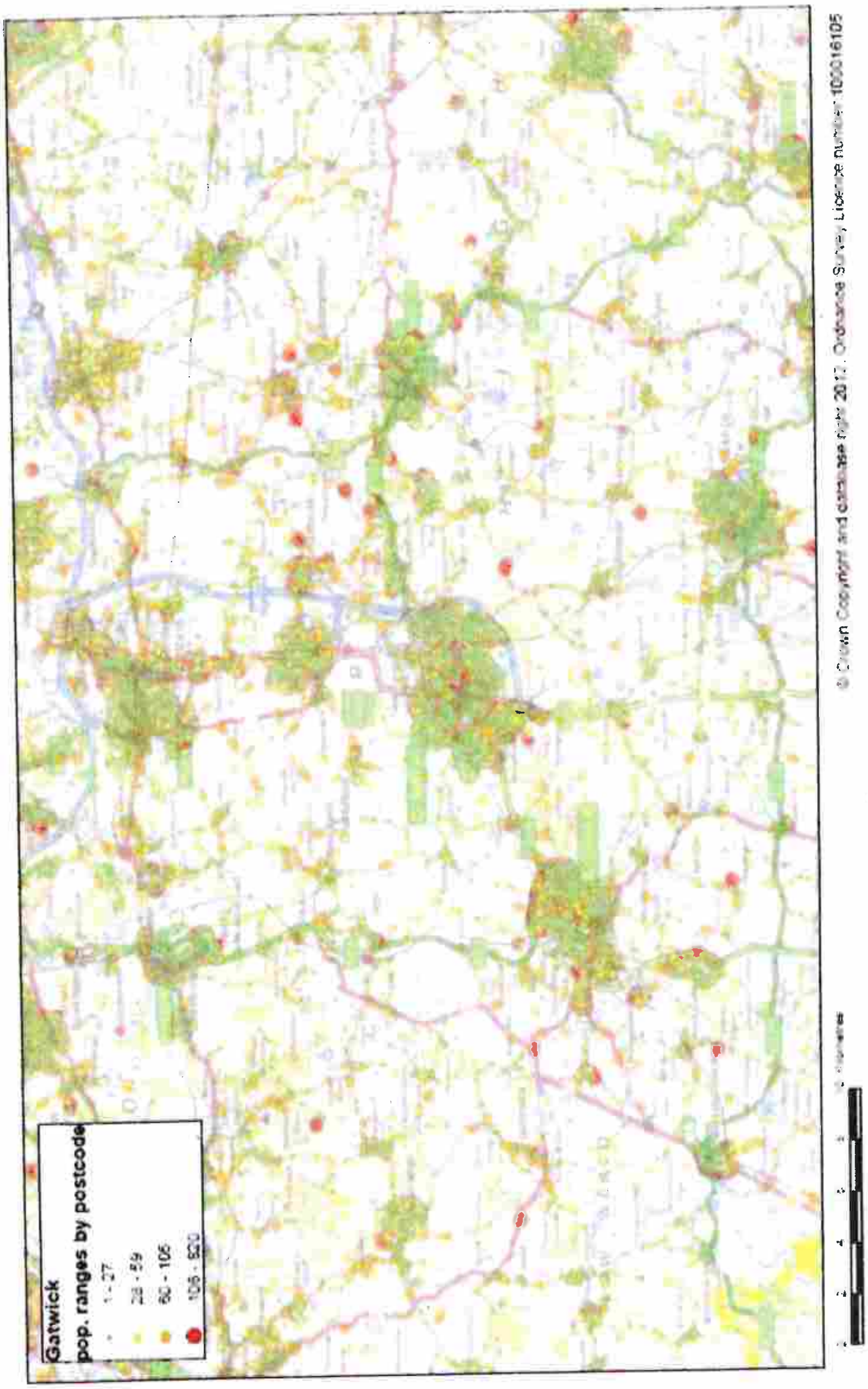


Figure 1) Population density map (Source: CAA/ERCD)

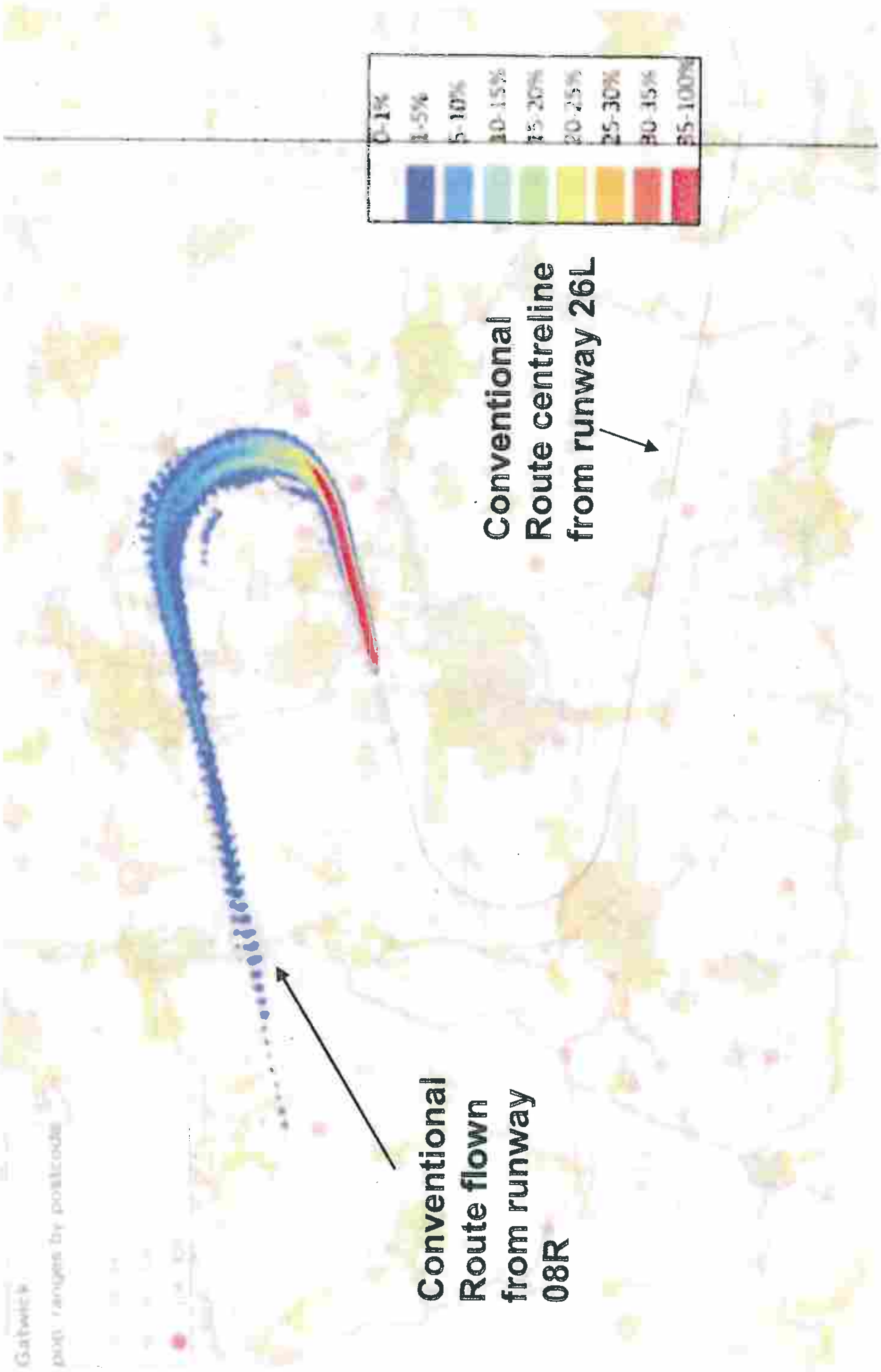


Figure 2) Density of aircraft tracks (up to 4000 feet AMSL) following **Conventional SID departure** from runway 08R (no track density plots are available for SIDs turning left (between Crawley and Horsham) from runway 26L as there was insufficient radar track data available)

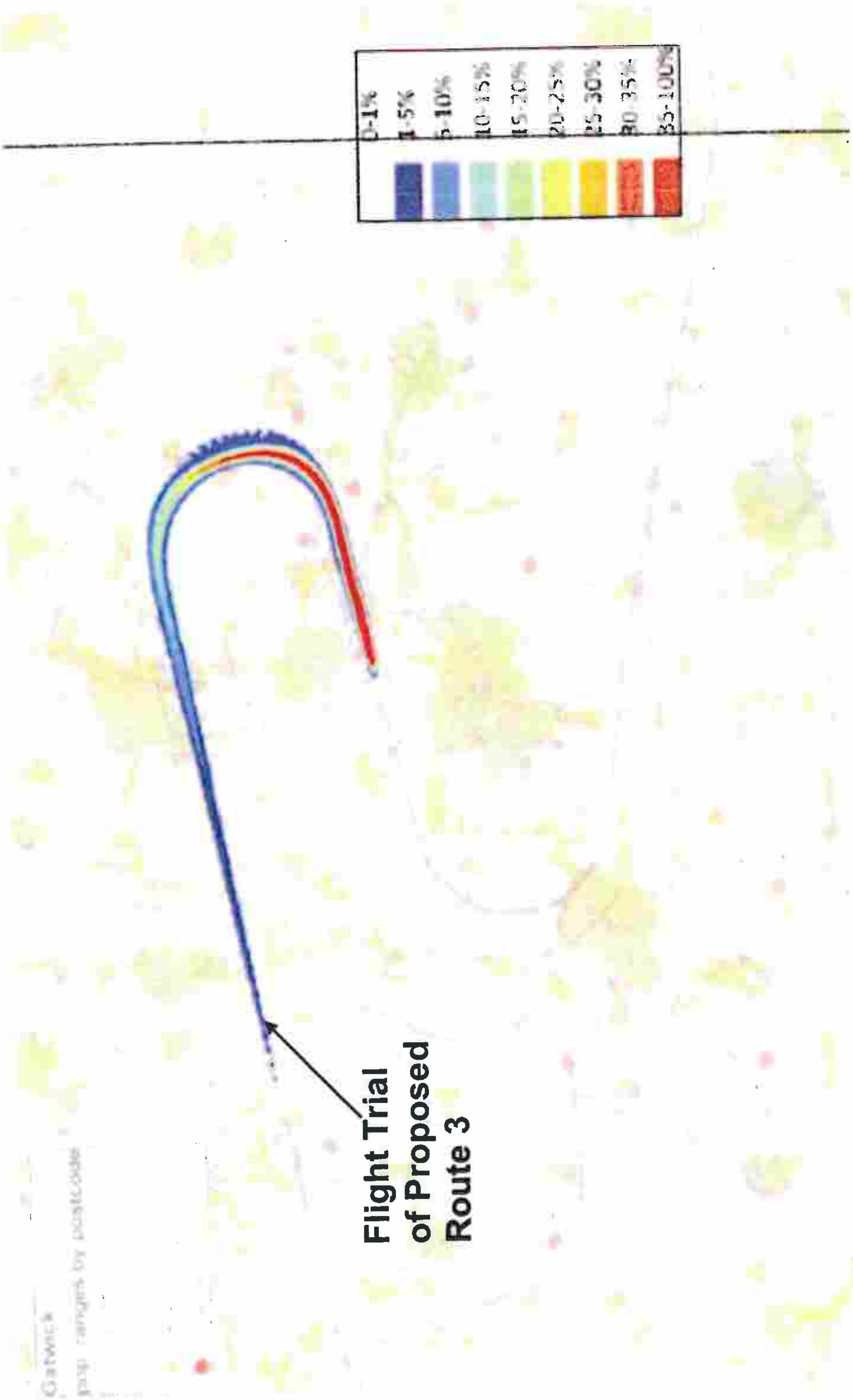


Figure 3) Density plot of aircraft tracks (up to 4000 feet AMSL) following P-RNAV (**ROUTE 3**) departure SID from runway 08R

Figure 2 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the conventional departure SID route overlaid onto population density map shown at figure 1.

Figure 3 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the flight trialled P-RNAV version of this SID to provide a view of the **impact of the implementation of the P-RNAV version of the same SID (ROUTE 3).**
ROUTE 3 is shown as the pink line which is obscured by the density plot until this can be seen again at the western end of the track plot as the aircraft passes through 4000' AMSL

Figure 4, shows the centreline of ROUTE 3 (un-obscured by RADAR data track plots), which has exactly the same design as the other SID routes turning left on departure from this runway and also **ROUTE 9** from runway 26L which share the same design criteria.
As such, the impact of track keeping along these centrelines is expected to be identical to that seen from actual flight trials of ROUTE 3

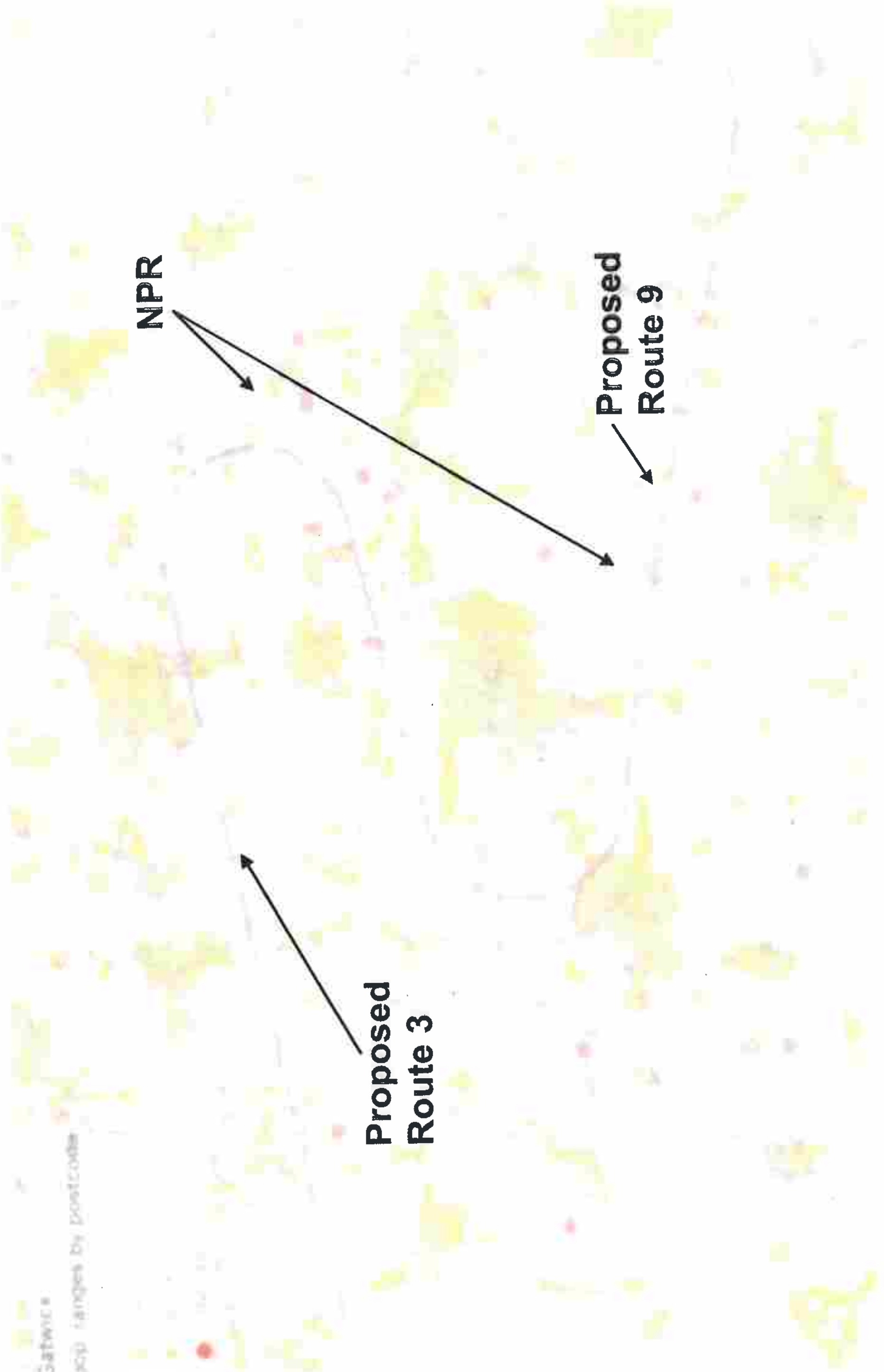


Figure 4) Proposed centrelines of P-RNAV SID routes for **ROUTE 3** (already flight trialled since 2007) and all other proposed P-RNAV SID routes which turn left from Runway 08R and **ROUTE 9** SIDs from runway 26L (which all share the same design criteria as ROUTE 3. The centreline/lateral limits of the published NPRs are shown for reference

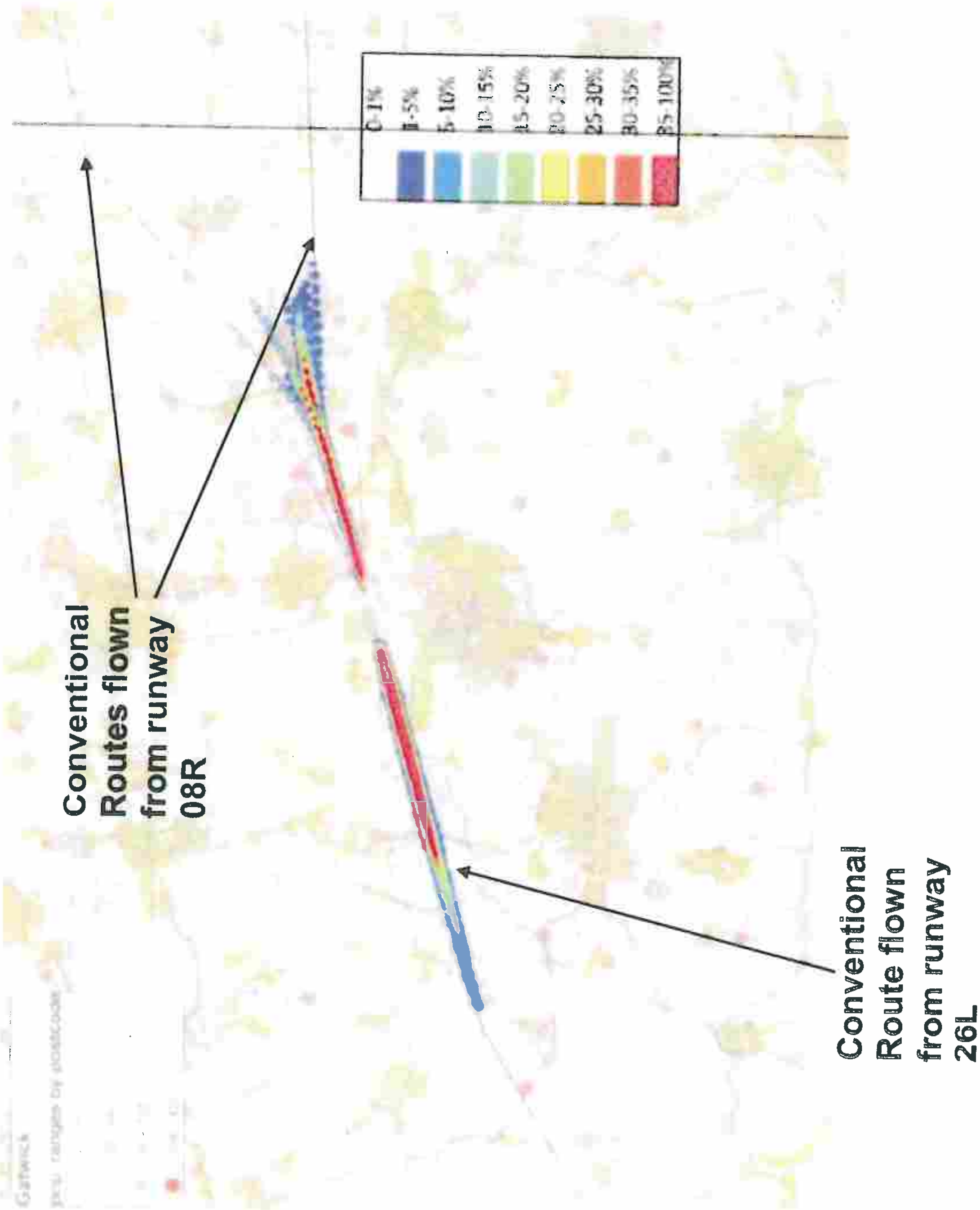


Figure5) Density plots of aircraft tracks (up to 4000 feet AMSL) following the **conventional departure SID** from Runway 26L and conventional (DVR/LAM) departure SID routes from runway 08R

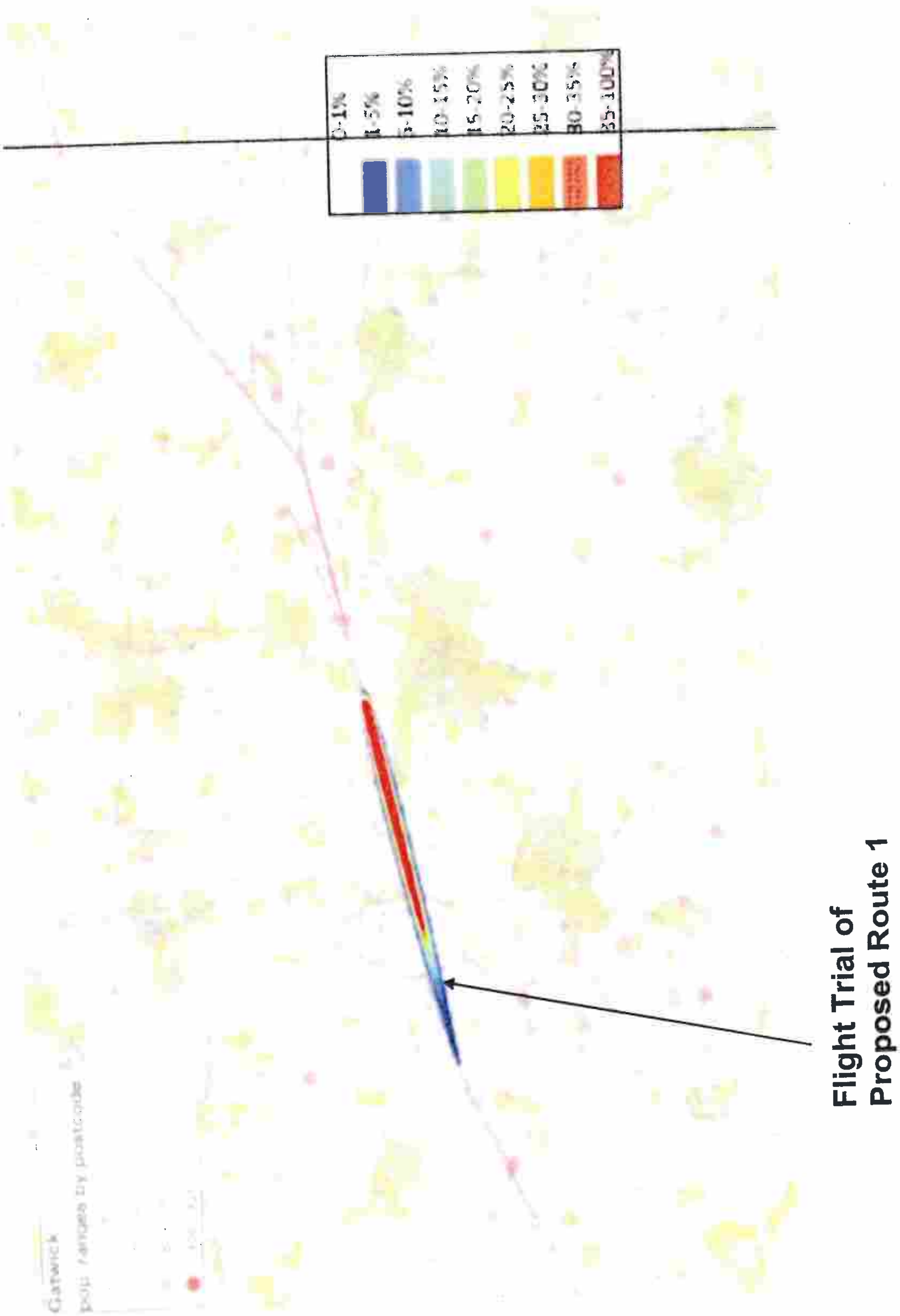


Figure6) Density plot of aircraft tracks (up to 4000 feet AMSL) following **ROUTE 1** P-RNAV SID from Runway 26L

Figure 5 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the **conventional departure SID** from Runway 26L and conventional (DVR/LAM) departure SID routes from runway 08R overlaid onto population density map shown at figure 1.

Figure 6 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the P-RNAV SID **(ROUTE 1)** to provide a view of the impact of the implementation of this P-RNAV SID.
ROUTE 1 is shown as the pink line which is obscured by the density plot until this can be seen again at the western end of the track plot as the aircraft passes through 4000' AMSL

As can be seen, the route is replicated easily in P-RNAV and track dispersion is virtually identical to conventional SID defined route. It is expected that the P-RNAV replications of the departure SID routes from runway 08R (ROUTE 5 and ROUTE 6) will, therefore, result in virtually identical track dispersion as the conventional route shown in figure 5.

Figure 6, shows the centreline of **ROUTE 1** (un-obscured by RADAR data track plots), which has exactly the same design as **ROUTE 5 and ROUTE 6** departure SID routes from runway 08R also shown

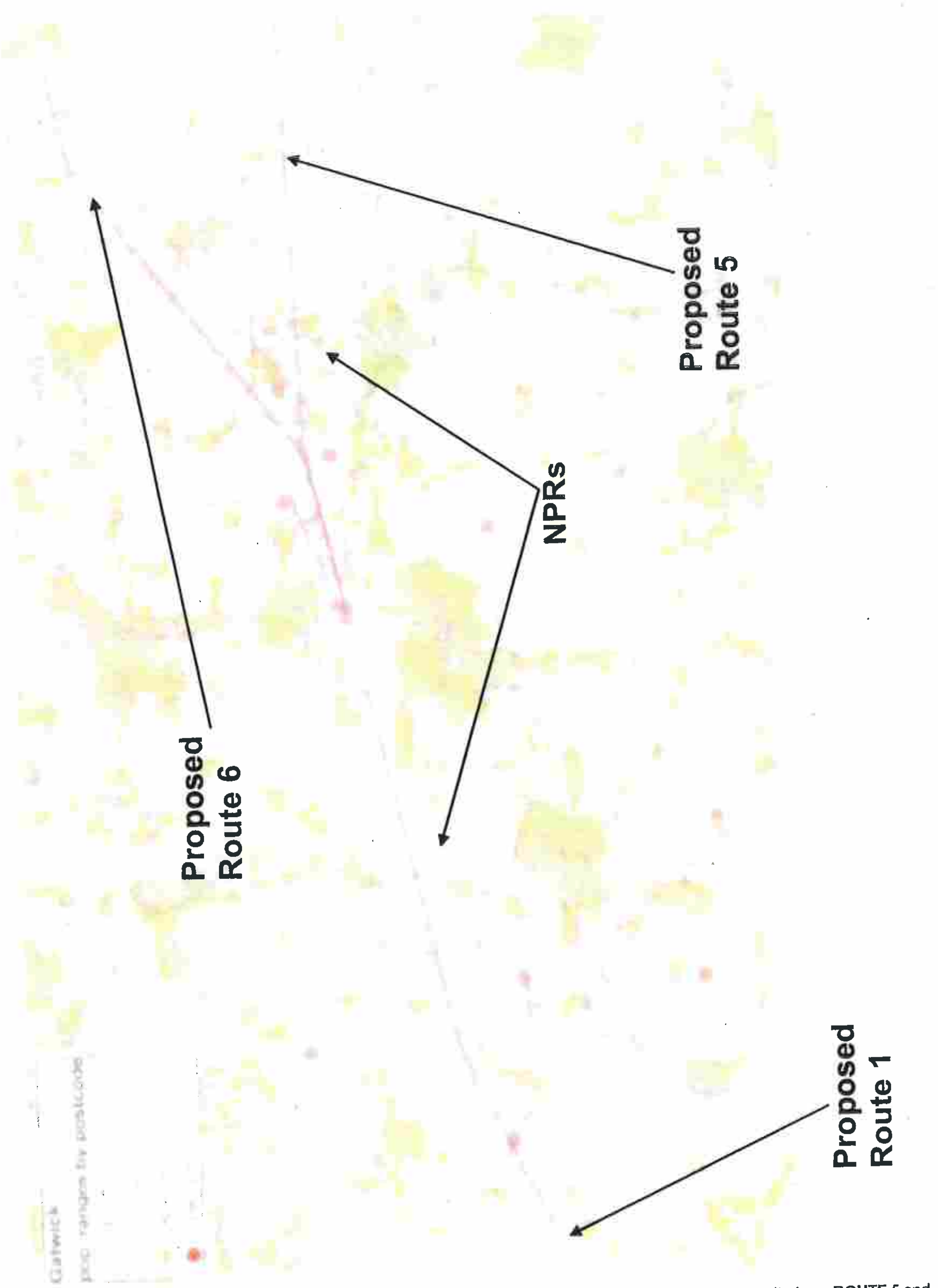


Figure7) Proposed centrelines of P-RNAV SID routes for **ROUTE 1** (Trialled since 2007) has same design criteria as **ROUTE 5** and **ROUTE 6** departure SID routes from runway 08R.

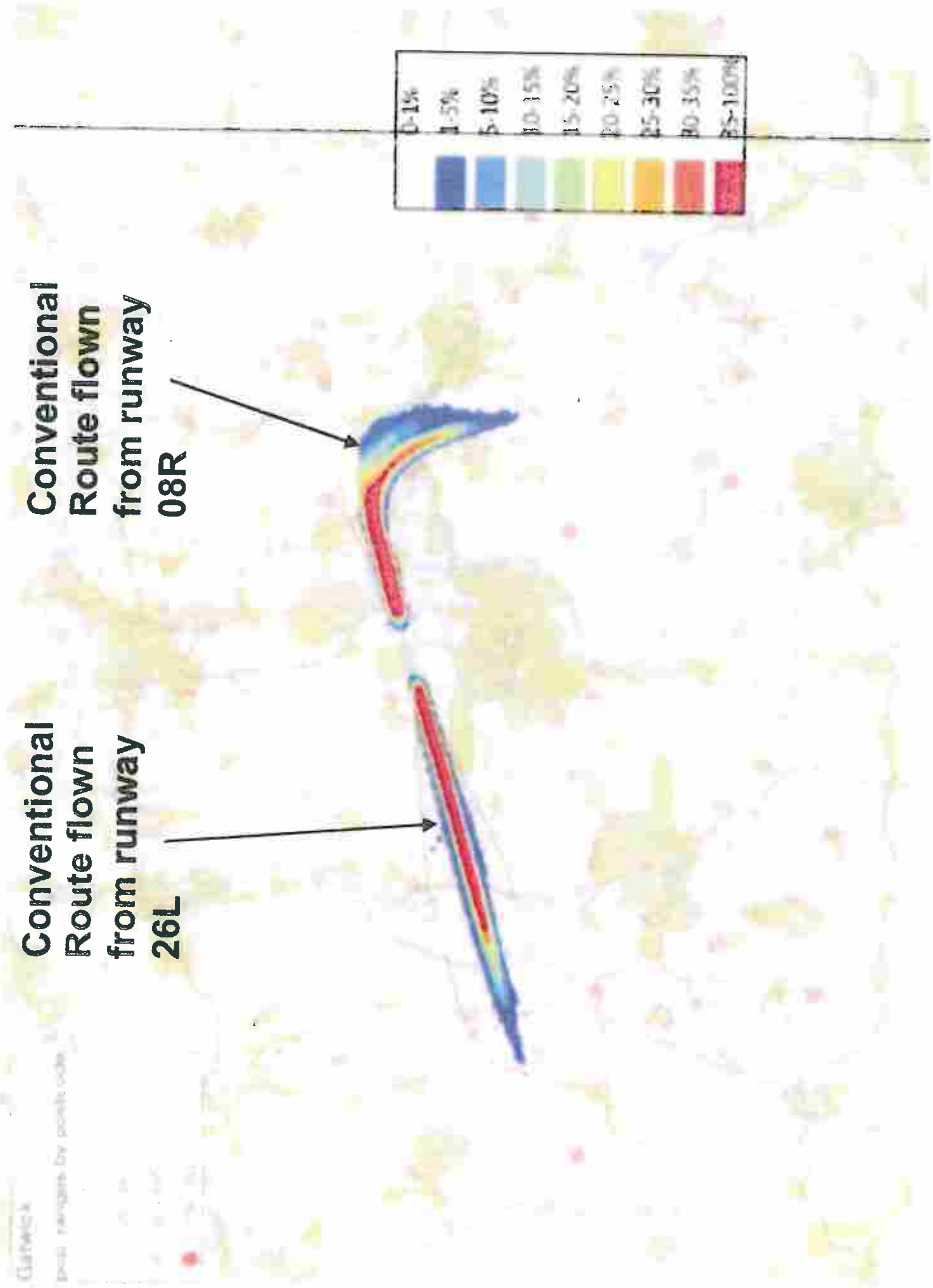


Figure8) Density plots of aircraft tracks (up to 4000 feet AMSL) following the **conventional** (SFD) **SIDs** from Runway 08R, and Runway 26L (HARDY and BOGNA) SIDs

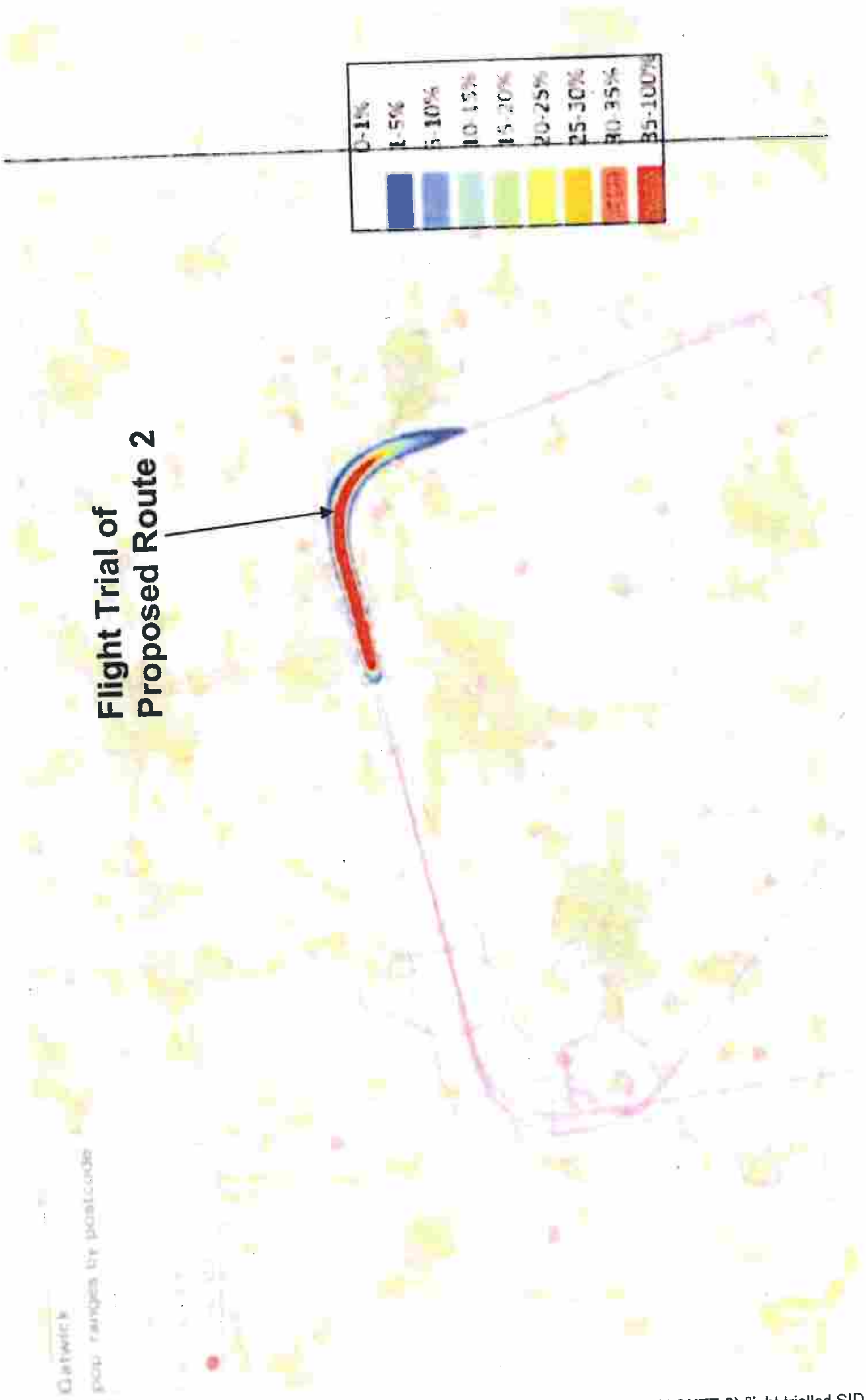


Figure9) Density plot of aircraft tracks (up to 4000 feet AMSL) following the PRNAV **(ROUTE 2)** flight trialled SID route from Runway 08R

Figure 8 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the **conventional SIDs** from Runway 08R (SFD) and conventional (HARDY and BOGNA) SID from Runway 26L overlaid onto population density map shown at figure 1. Track keeping on the conventional SID departures from runway 26L via these routes are dense along the conventional SID centreline as no turns are required until 7 nautical miles from the airport, so most traffic is above NPR/radar vectoring limits* (*see Appendix D). The track plots of the conventional SID route from runway 08R is a perfect example of the issue caused by magnetic variation on conventional SID routes and the updates required to on board navigation systems to fly these. There were two very distinct tracks flown by aircraft following conventional SID navigation (one slightly right of the NPR centreline and one, to the east along the centreline of the conventional SID track, which is very slightly right of the NPR centreline)

Figure 9 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the PRNAV SID **(ROUTE 2)** from Runway 08R to provide a view of the impact of the implementation of the P-RNAV version of the same SID.
ROUTE 2 is shown as the pink line which is obscured by the density plot until this can be seen again at the southern end of the track plot as the aircraft passes through 4000' AMSL

As can be seen, **the conventional route is replicated easily in P-RNAV and track dispersion is virtually identical to the easterly of the two track swathes on the conventional SID defined route – following, precisely the SID centreline.** It should be noted that P-RNAV is not susceptible to the effects of magnetic variation and eradicates secondary tracks appearing as a result

It is expected that ROUTE 7 and ROUTE 8, the P-RNAV replications of the conventional departure SID routes from runway 26L, will result in virtually identical track dispersion as the conventional route shown in figure 8.

Figure 10, shows the centreline of **ROUTE 2** (un-obscured by RADAR data track plots), which has exactly the same design as **ROUTE 7** and **ROUTE 8** P-RNAV departure SID routes from runway 08R also shown (though, obviously the distance of the turn to the south is approximately twice the distance from the airport on these westerly departures.

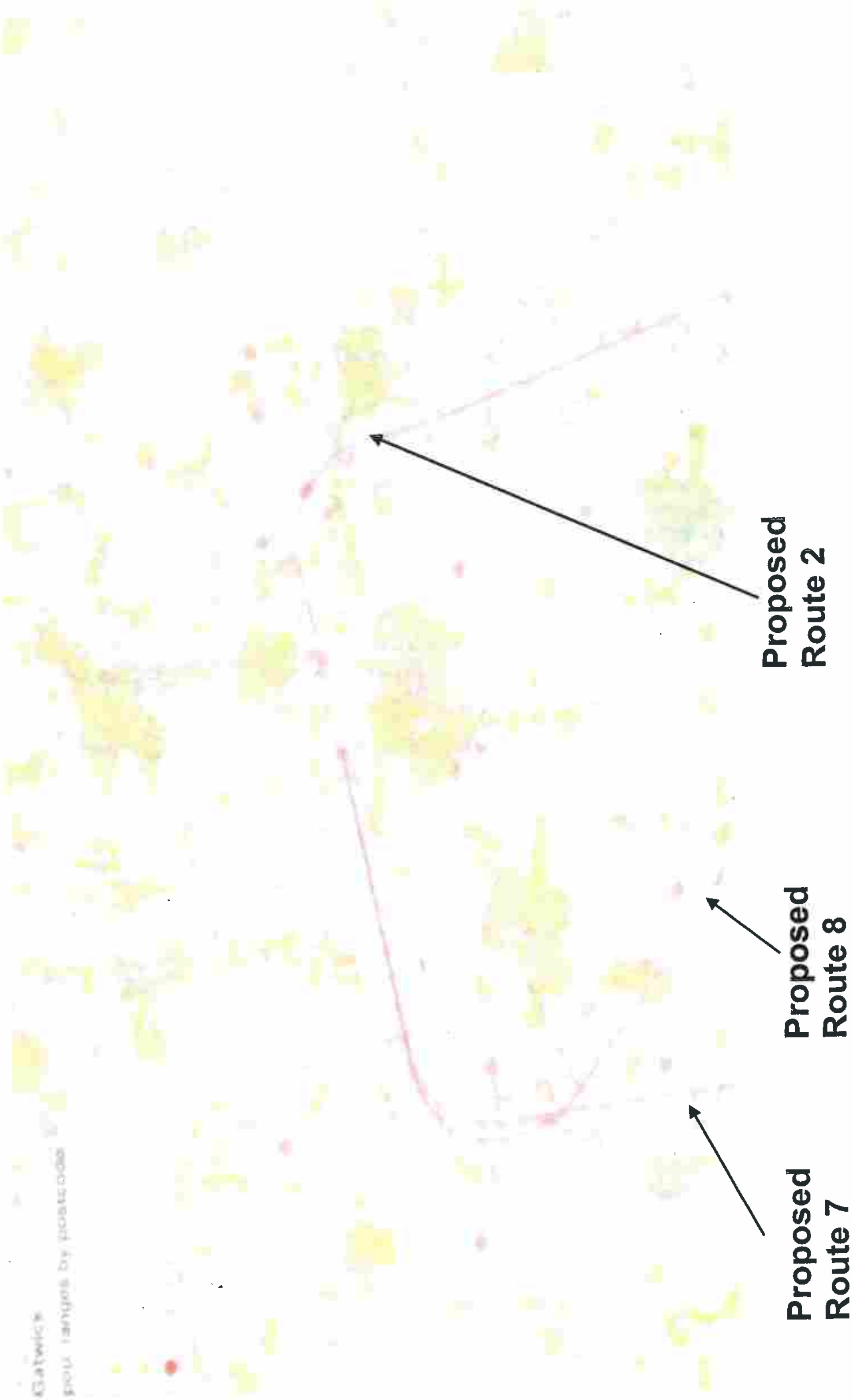


Figure10) Proposed centrelines of P-RNAV SID routes for **ROUTE 2** (Trialled since 2007) and **ROUTE 7** and **ROUTE 8** departure SID routes from runway 26L which have the same design criteria as ROUTE 2.

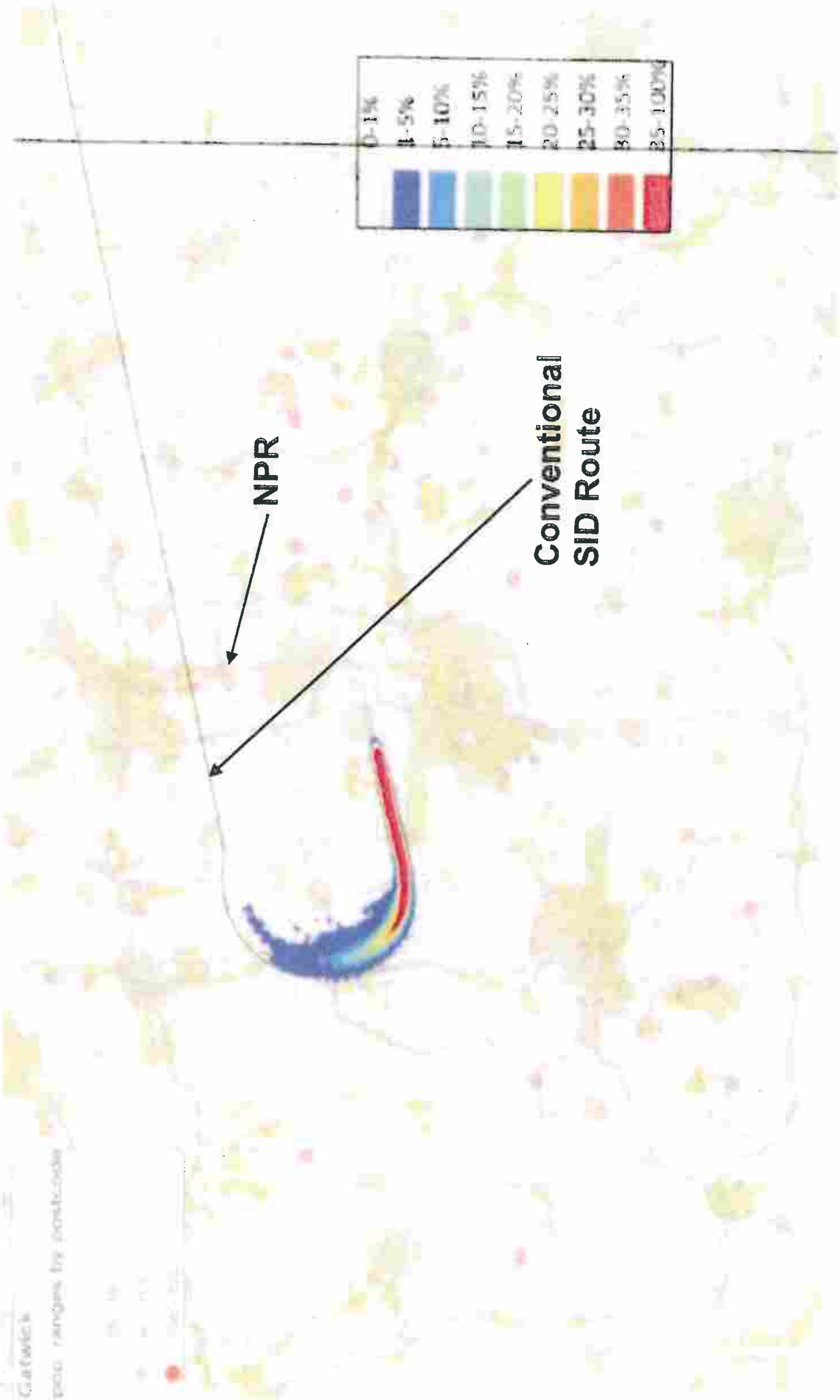


Figure11) Density plots of aircraft tracks (up to 4000 feet AMSL) following the conventional right turn out SID routes from Runway 26L

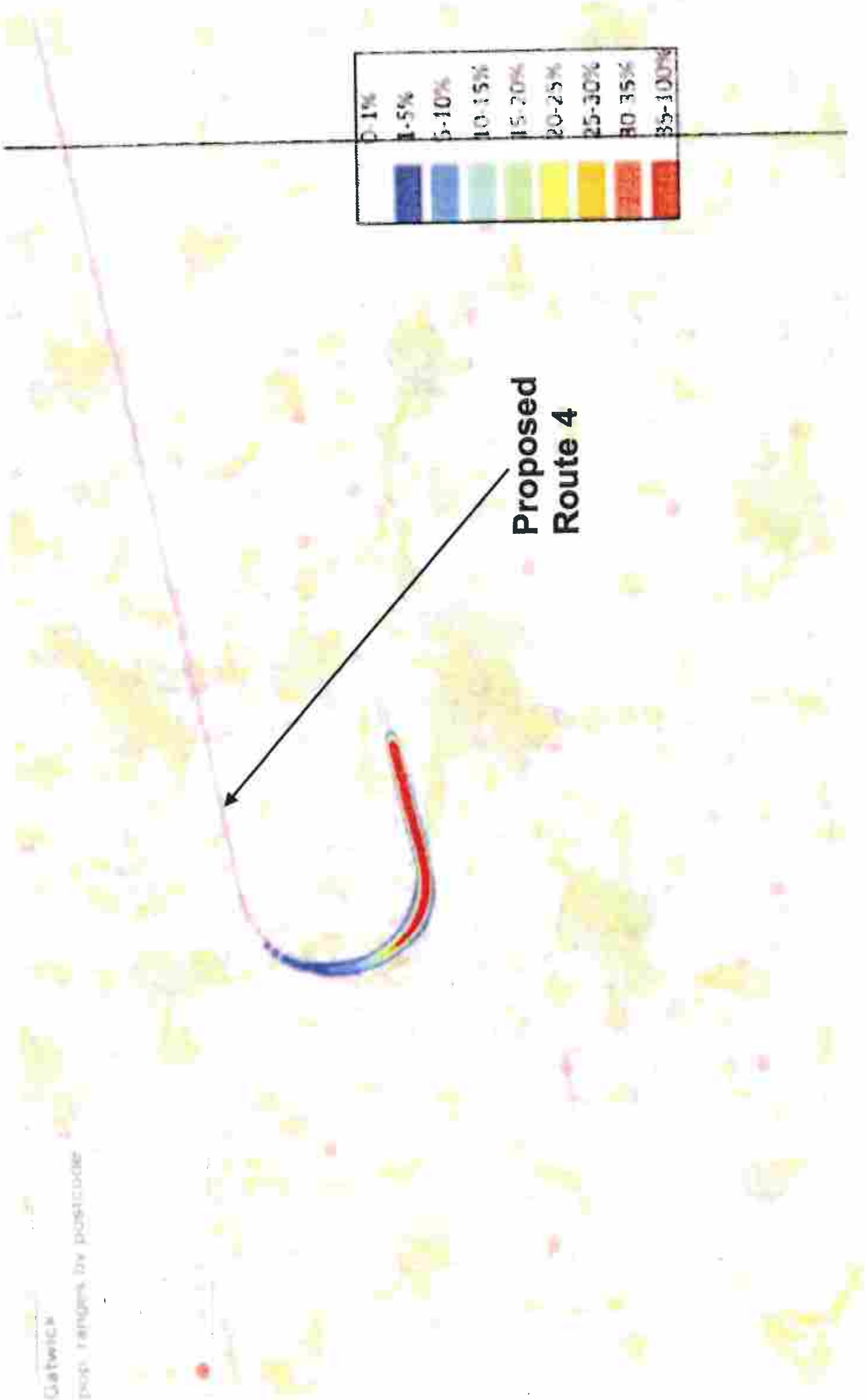


Figure12) Density plot of aircraft tracks (up to 4000 feet AMSL) following the PRNAV (**ROUTE 4**) SID route (flight trialled since 2007) which has same design criteria as all other SID routes that turn right on departure from runway 26L.

Figure 11 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following the **conventional right turn out SID routes** from Runway 26L overlaid onto population density map shown at figure 1. The centreline of the conventional SID route can be seen (in blue) at the northern and eastern end of the track plot as the aircraft passes through 4000' AMSL. As can be seen, **the conventional SID has shifted to the northern edge of the NPR due to magnetic variation (a natural shift of magnetic north) and the SID cannot be accommodated within the NPR** (as modern aircraft speed and aerodynamic performance preclude them from making standard rate turns onto such a tight radius without manual intervention by the flight crew (increasing the rate of turn/anticipating the start of turn point. This manual intervention can be seen by the resulting wide swathe of tracks in the turn and the variance in commencement of the initial right turn

Figure 12 shows the concentration of actual tracks (taken from 2011 radar data) of aircraft following **ROUTE 4** to provide a view of the impact of the implementation of **ROUTE 4**. **ROUTE 4** is shown as the pink line which is obscured by the density plot until this can be seen again at the northern and eastern end of the track plot as the aircraft passes through 4000' AMSL

As can be seen, **the route cannot be replicated exactly in P-RNAV (the eastbound leg is slightly north of the conventional SID route), as the turn rate has to be constant and standard. However, track dispersion is much less widely spread and the commencement of the first turn (at lowest altitude) is very uniform.**

All proposed SID routes which turn right on departure from runway26L will follow EXACTLY this same route until beyond the easterly limits of the map shown. In reality all traffic is turned eastbound onto compass heading when above the vertical limit of the NPR (in this case 4000 feet AMSL whatever time of day) for separation purposes from other aircraft operating within the LTMA airspace, such that the **track density is expected to be replicated exactly as shown in figure 12 as there will be no change in ATC operational practice as a result of the implementation of ROUTE 4.**
Figure 13 below, shows the centreline of **ROUTE 4** (un-obscured by RADAR data track plots)

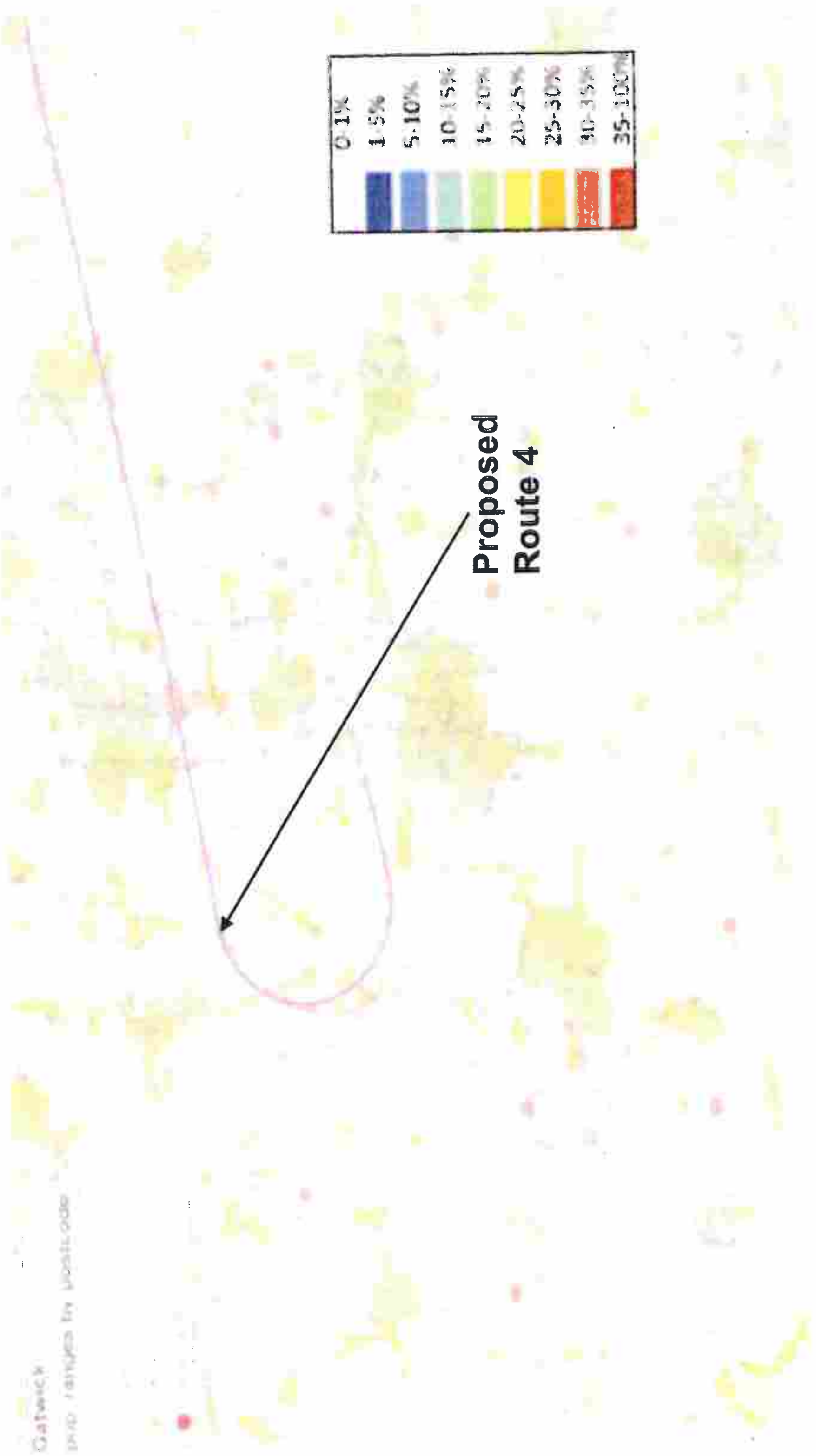


Figure13) Proposed centrelines of **ROUTE 4**, the P-RNAV SID routes (Trialled since 2007) and all other PRNAV SID routes that turn right on departure from runway 26L

Appendix B.

Response Form

Please return this form via e-mail to:

PRNAVconsultation@gatwickairport.com

Name:

e-mail:

Organisation (Please state "individual" if the response is from a personal point of view rather than a formal response from an organisation or group):

Postal Address:

Data Protection Compliance: Please tick this box ☐ if you **do not agree** that any personal details contained in your response may be sent to the CAA as part of the Airspace Change Proposal

Note that comments regarding our compliance with the consultation process as set out in CAA's guidelines for airspace change (CAP725) should be directed to CAA at:

Business Coordinator
Directorate of Airspace Policy
CAA House
45-59 Kingsway
London WC2B 6TE
e-mail: businessmanagement@caa.co.uk

THIS CAA ADDRESS IS FOR COMMENTS ON PROCESS, NOT FOR RESPONSES WITH REGARD TO THE PROPOSED CHANGES

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 1** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 1** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 2** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 2** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 3** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 3**

Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 4** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 4** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 5** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 5**

Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 6** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 6** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 7** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 7** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 8** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 8** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for **ROUTE 9** P-RNAV SID developments described in section 3.1.2 (and shown in Appendix A) of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **ROUTE 9** Grounds for my/our response

Question: is there any information that Gatwick Airport Ltd should consider when finalising the proposal for the management and oversight process for transition to P-RNAV based route navigation on departure from Gatwick Airport, described in section 3.1.5 of P-RNAV Departure SID Implementation at LGW – Consultation Document

I/we support / object / do not object to proposal for **the management and oversight process** Grounds for my/our response

Appendix C.

List of Consultees

GATCOM Members

Gatwick Airport Limited
East Sussex County Council
Surrey County Council
West Sussex County Council
Crawley Borough Council
Mid Sussex District Council
Reigate and Banstead Borough Council
Horley Town Council
Charlwood Parish Council
South London Business
CADIA – The Gatwick Diamond Business Association
Environmental and Amenity Groups – Gatwick Airport Conservation Campaign (GACC)
International Air Carriers Association
Passenger Representative
Coast to Capital Local Economic Association
Gatwick Airline Operators Committee
Kent County Council
Horsham District Council
Mole Valley District Council
Tandridge District Council
Burstow Parish Council
Rusper Parish Council
Association of British Travel Agents
British Air Transport Association
Which ?
London Chamber of Commerce and Industry
Trades Union Congress Southern and Eastern Regional Council
Tourism South East
Department for Transport

NATMAG Members

Gatwick Airport Limited
Kent County Council
Environmental and Amenity Groups (GACC)
Horley Town Council
Mid Sussex District Council
Tandridge District Council
Horsham District Council
Charlwood Parish Council
Department for Transport
National Air Traffic Services (NATS)
British Airline Pilots Association (BALPA)
Reigate and Banstead borough Council
Crawley Borough Council

Appendix D.

The following is an extract from the UK Aeronautical Information Publication (AIP) and details the requirements for compliance with Noise Preferential Routes. It is for reference only and is not subject to any change as part of the proposals in this consultation.

Aircraft which have attained an altitude of 4000 ft (Above Mean Sea Level) may be directed by air traffic controllers onto a different heading and commanders complying with any such direction will not by reason of so complying be deemed to have departed from the Noise Preferential Routeing.

This applies:

a. *between 2330 and 0600 hours (local time) to all take-offs, and*
b. *between 0600 and 2330 hours (local time) to:*
- ***i.*** *all departures from Runway 26L/R, other than those cleared via KENET or Southampton SIDs.*
- ***ii.*** *take-offs from Runway 08L/R cleared via Seaford.*

Between 0600 and 2330 hours (local time) aircraft which have taken off from Runway 26L/R cleared via KENET or Southampton SIDs or from Runway 08L/R (other than those cleared via Seaford) and which have attained an altitude of 3000 ft (Gatwick QNH) may be directed by air traffic controllers onto a different heading and commanders complying with any such direction will not by reason of so complying be deemed to have departed from the Noise Preferential Routeing.

NOTES FOR VIEWING THE PDF DIAGRAMS IN FLAG G ROUTES 1-9

- G1-9 reflect the Route Numbers in the Consultation and ACP.

- The PDFs (non selectable) were added to the Gatwick Website on 1 Oct 12.

- The NPR delineations are shown in Red.

- The conventional CL is shown in Black and is drawn based on a radius of turn of 2 nms and at a speed of 250kts. These CLs do not reflect the NPR CL, nor do they necessarily reflect how the procedure is flown, as there are no speed restrictions on the conventional SIDs other than the generic comment in the SID chart General Information of not above 250kts below FL 100 unless authorised by ATC.

- The RNAV CLs are based on the speed restrictions which vary with the SID design will not be above 220kts in the early turns.

- The Conventional Heat Plots are colour coded. The % key reflects the % in relation to the total number of departures; as can be seen, the dominant red swathe for example, along the SAM SIDs is very identical for both conv and RNAV SIDs as it is a straight ahead departure.

- On Route 2, extra diagrams are included from the Framework Briefing – these show altitude filtering.

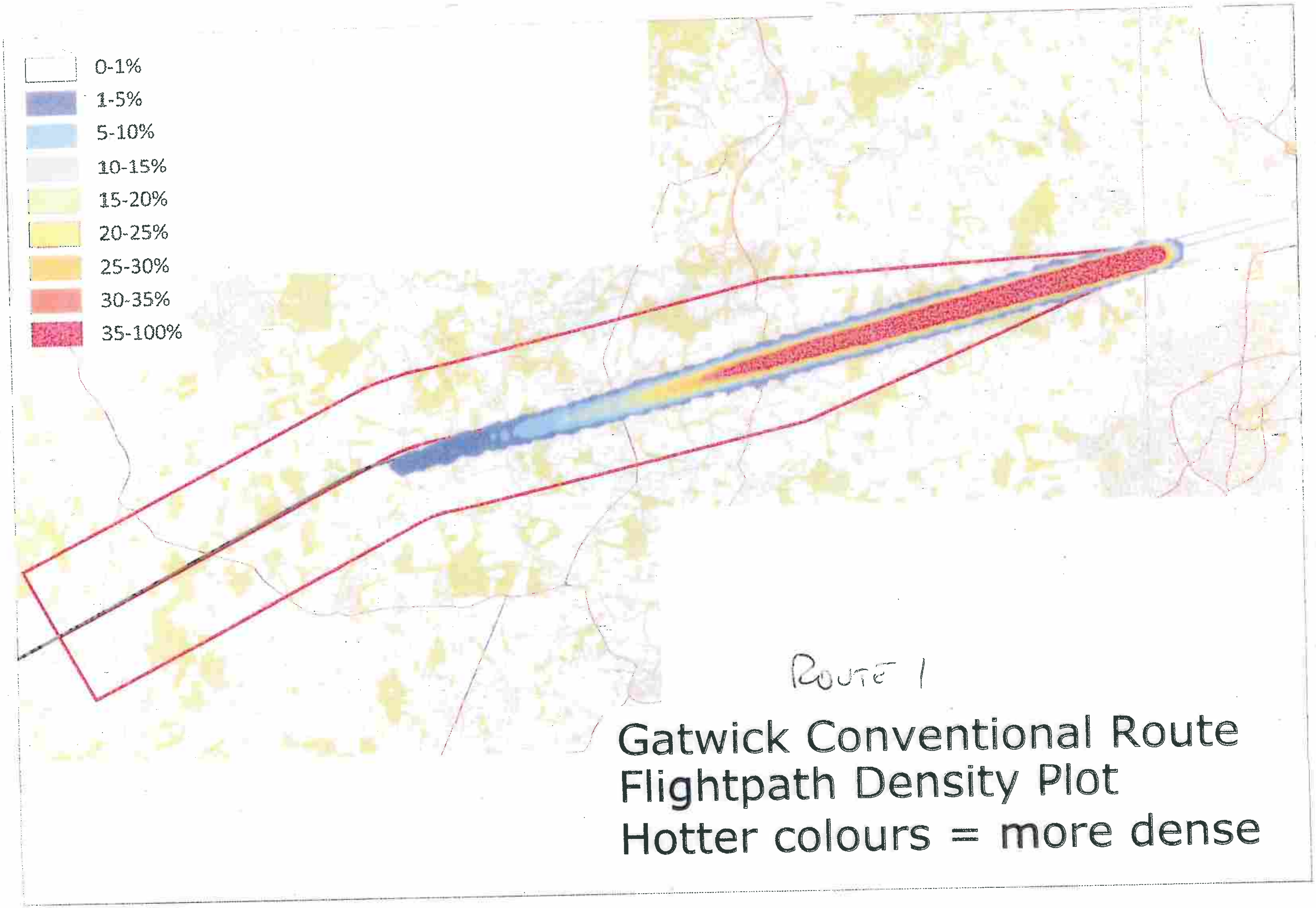
  -- The track data is just one day for conventional procedure; for the RNAV diagram it is traffic from Jan – Dec 10 (this seems odd, however the diagrams are intended to show a like for like comparison with the same number of aircraft).

  -- Locations of feedback from the public around East Grinstead are shown on the RNAV diagram with reference to their Consultation Feedback reference number – this can illustrate where residents who complain reside (based on postcode).

- On Route 4 extra diagrams are included from the Framework Briefing – these show altitude filtering.

  -- The track data is for March 2011 for conventional procedure; for the RNAV diagram it is traffic from Jan – March 2011 (the diagrams are intended to show a like for like comparison with the same number of aircraft).

APPENDIX C1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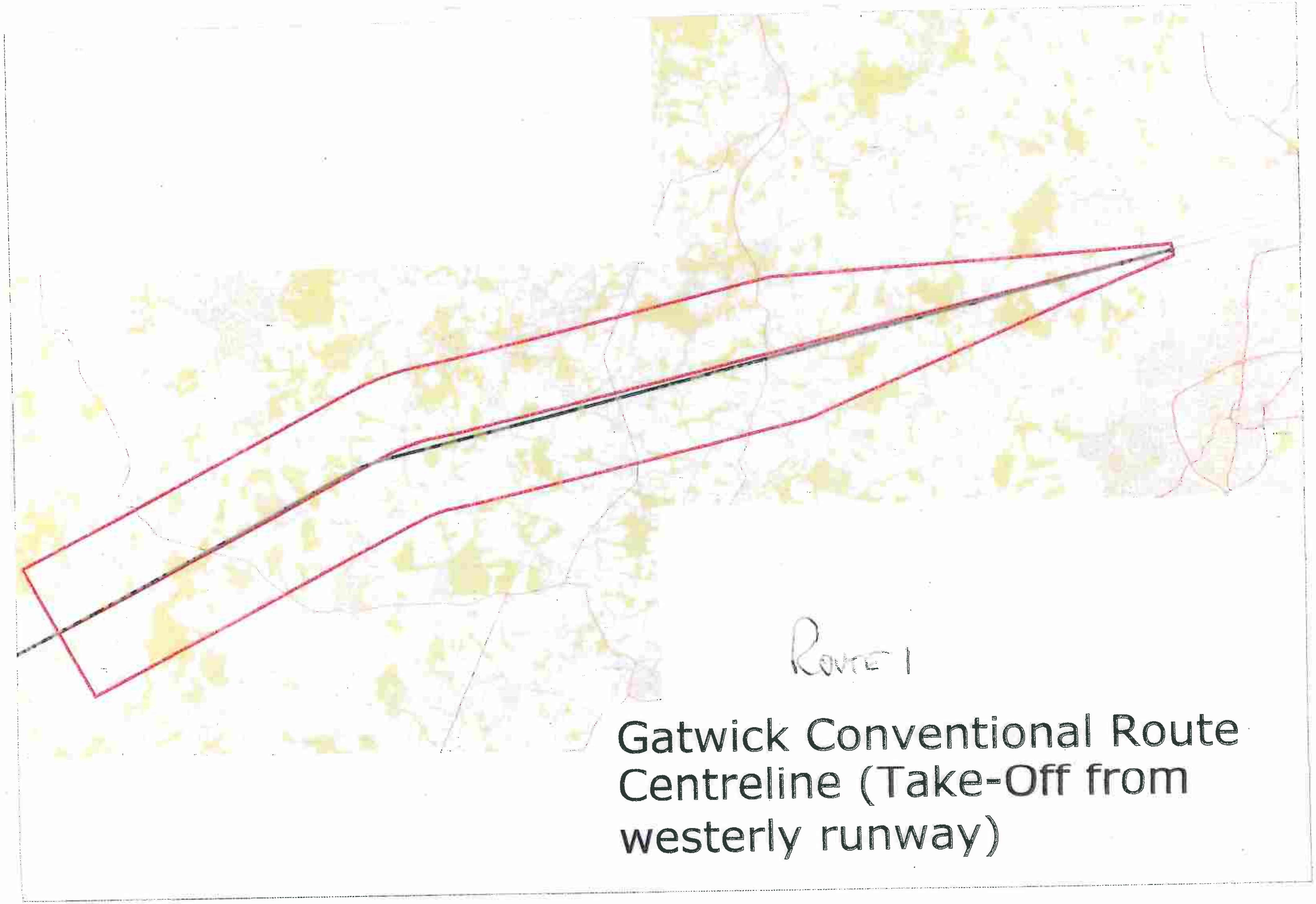
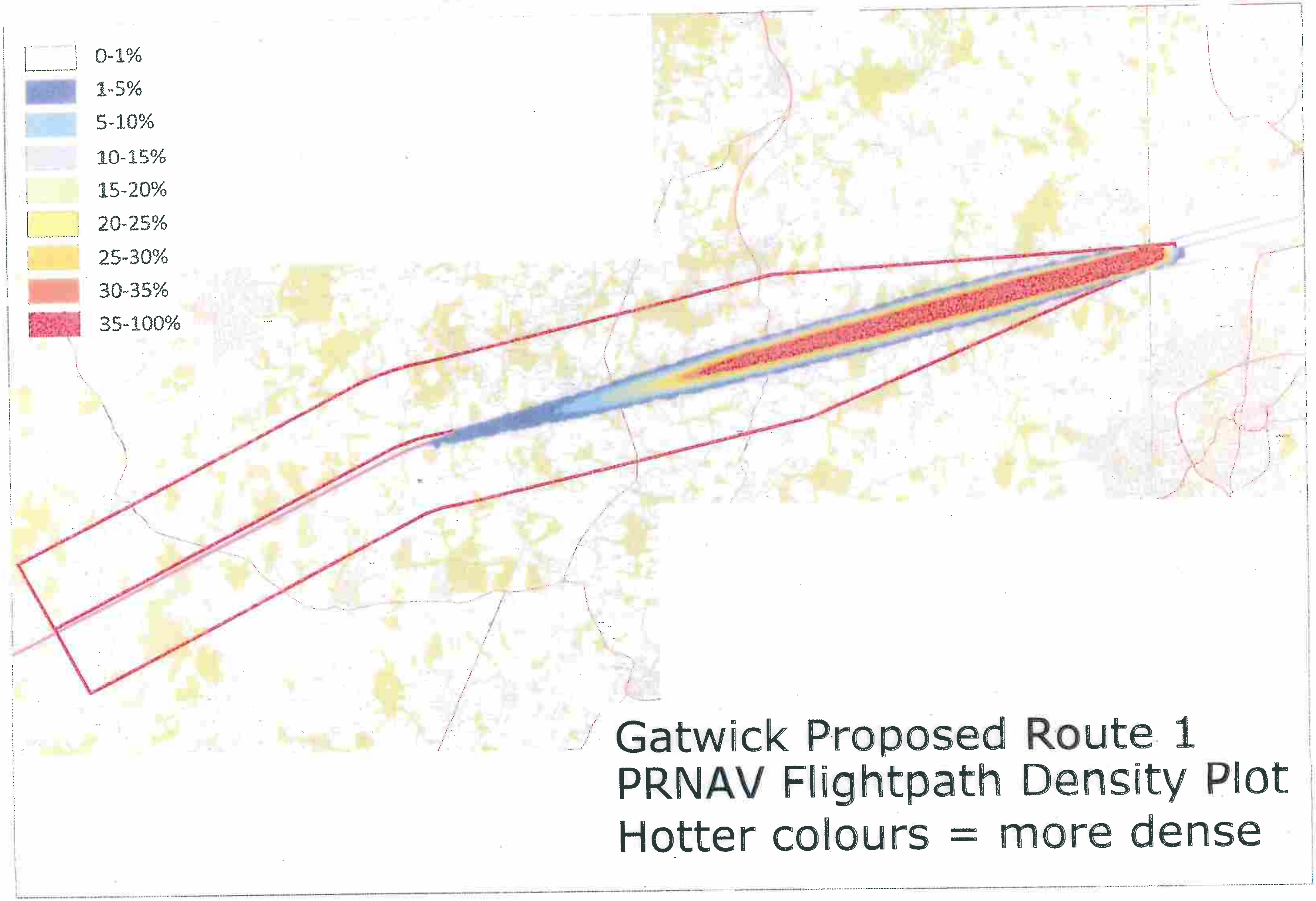
Route 1
Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense


Route 1
Gatwick Conventional Route Centreline (Take-Off from westerly runway)

Gatwick Proposed PRNAV
Route 1 centreline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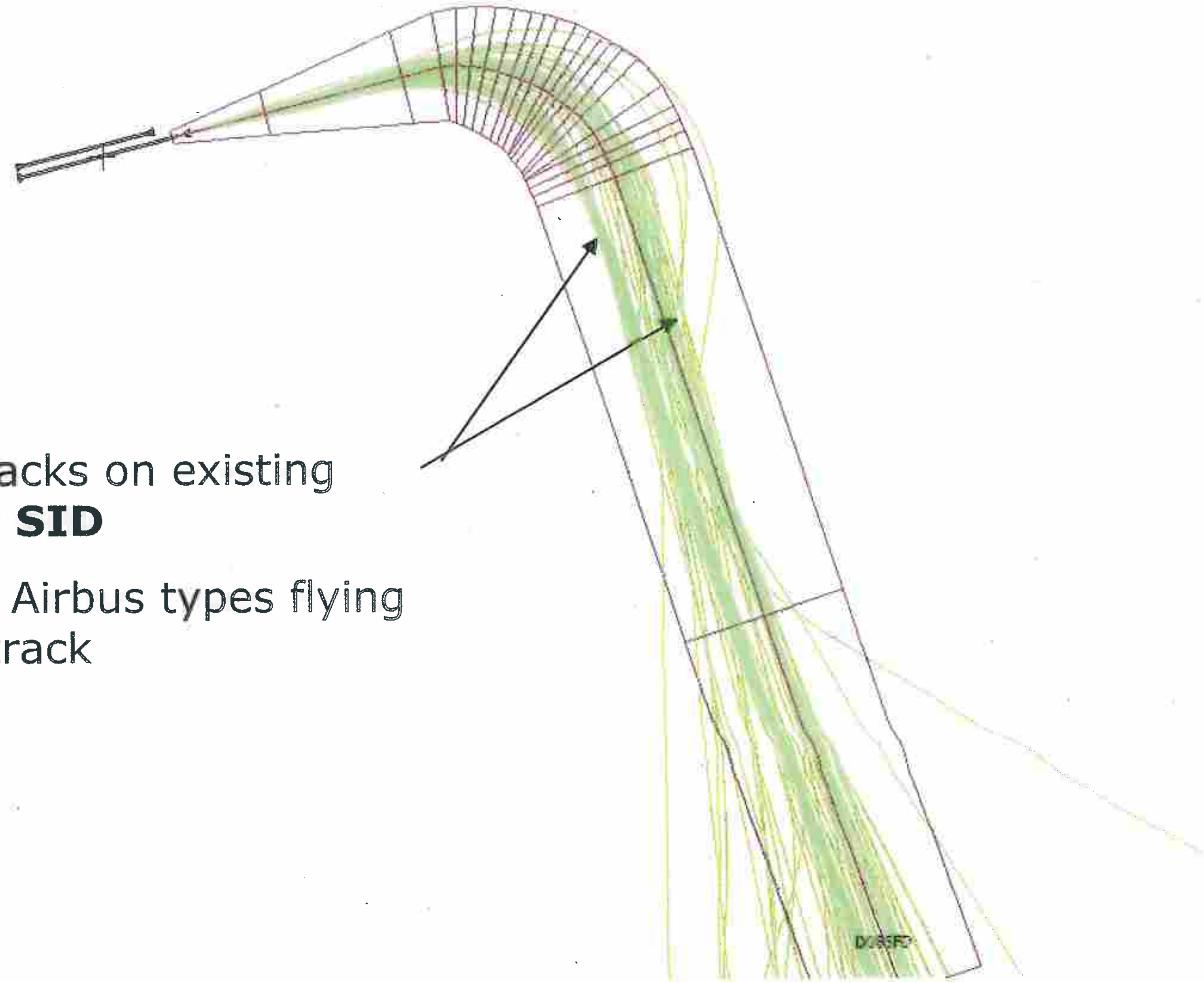
Gatwick Proposed Route 1
PRNAV Flightpath Density Plot
Hotter colours = more dense

APPENDIX C2

SFD8P track NTK data

Conventional SID Departures – 04 June 2010 – (SFD8P) no vertical cut off track plot

Note; 4000' ALT is upper limit of NPR track compliance requirement



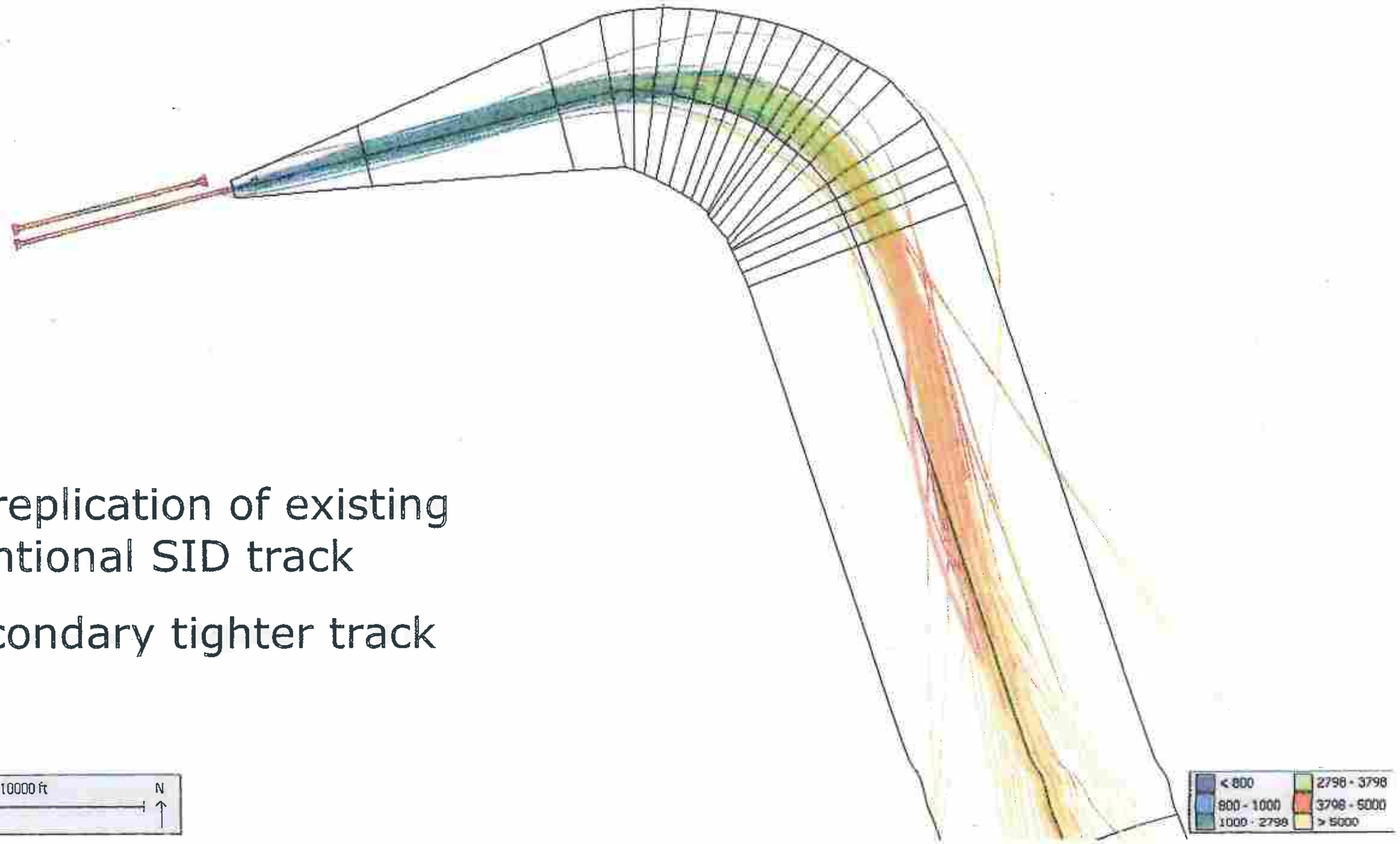
Two distinct tracks on existing **Conventional SID**

Departing EZY Airbus types flying tighter inside track

SFD2Z track NTK data

PRNAV Departures – Jan to Dec 2010 – (SFD2Z) no vertical cut off track plot

Note; 4000' ALT is upper limit of NPR track compliance requirement

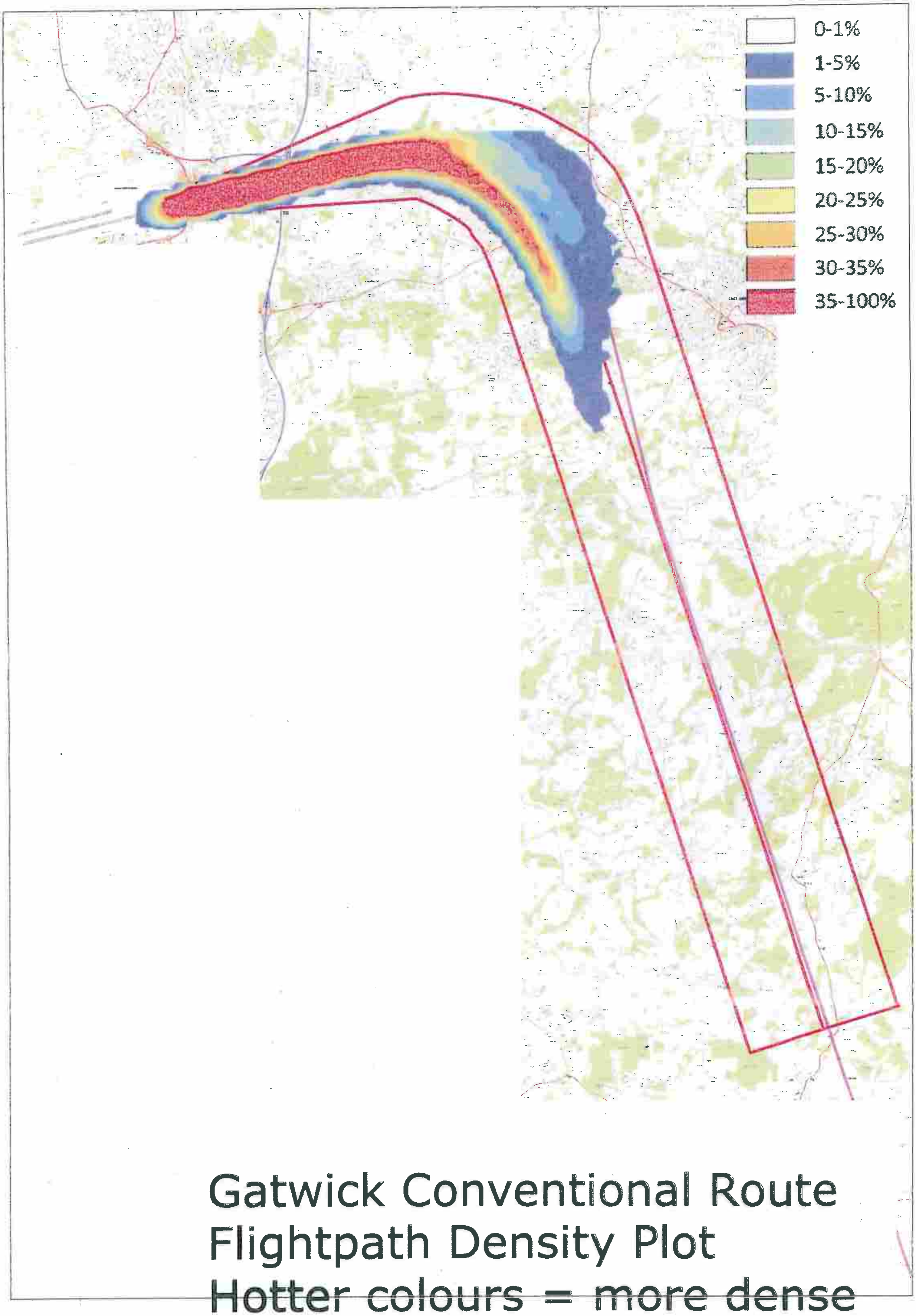


Good replication of existing conventional SID track

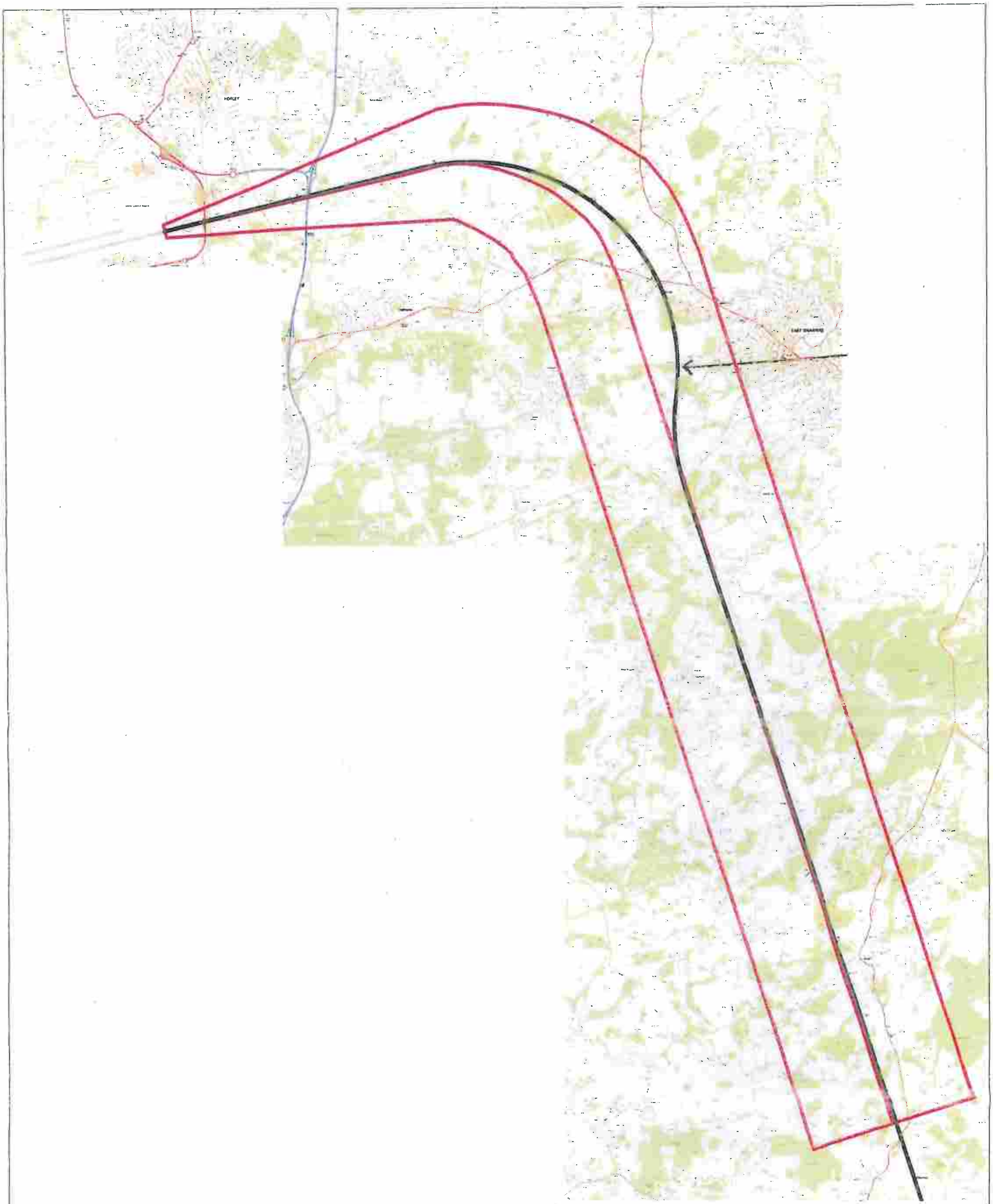
No secondary tighter track

10000 ft
N

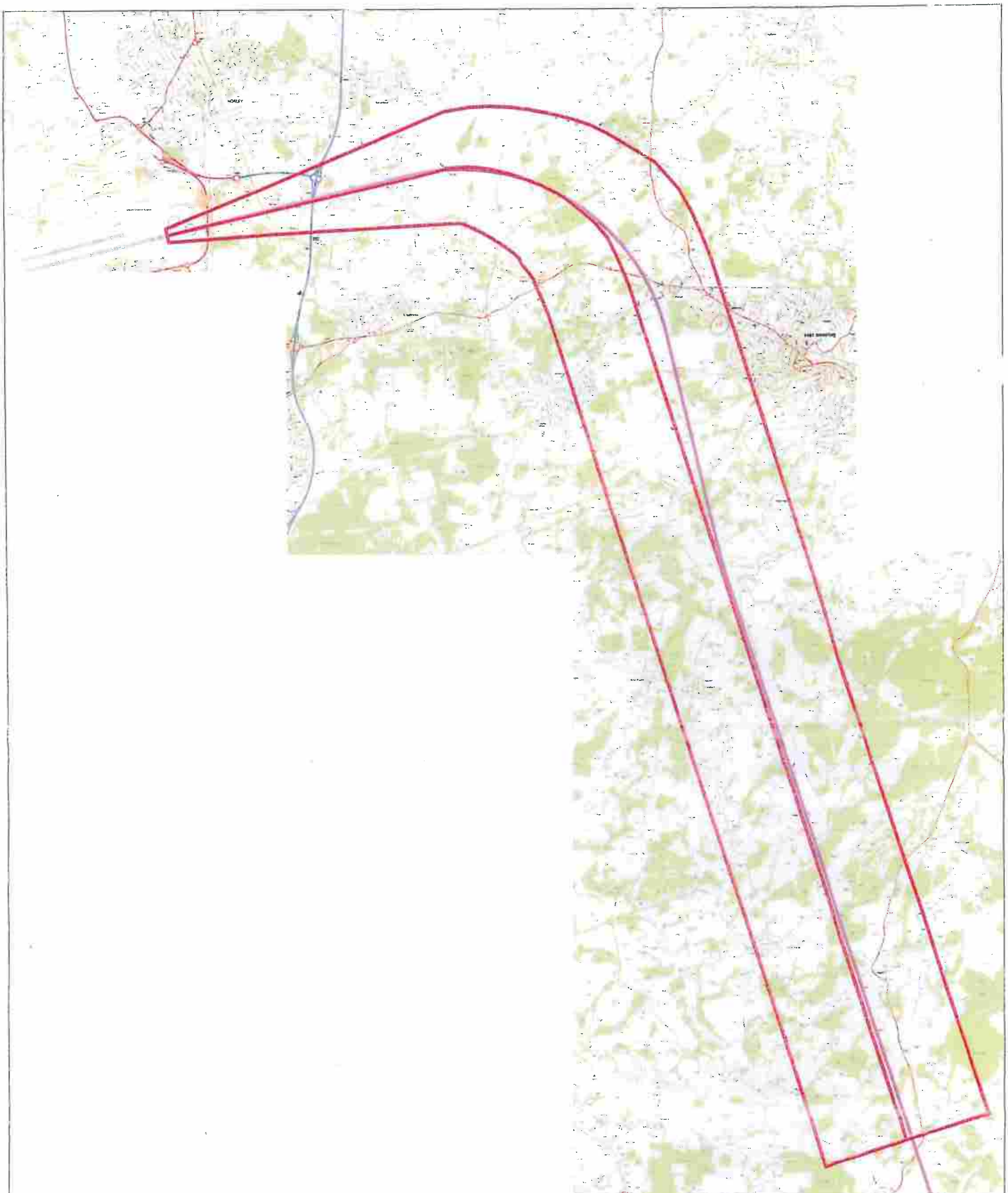
NATS



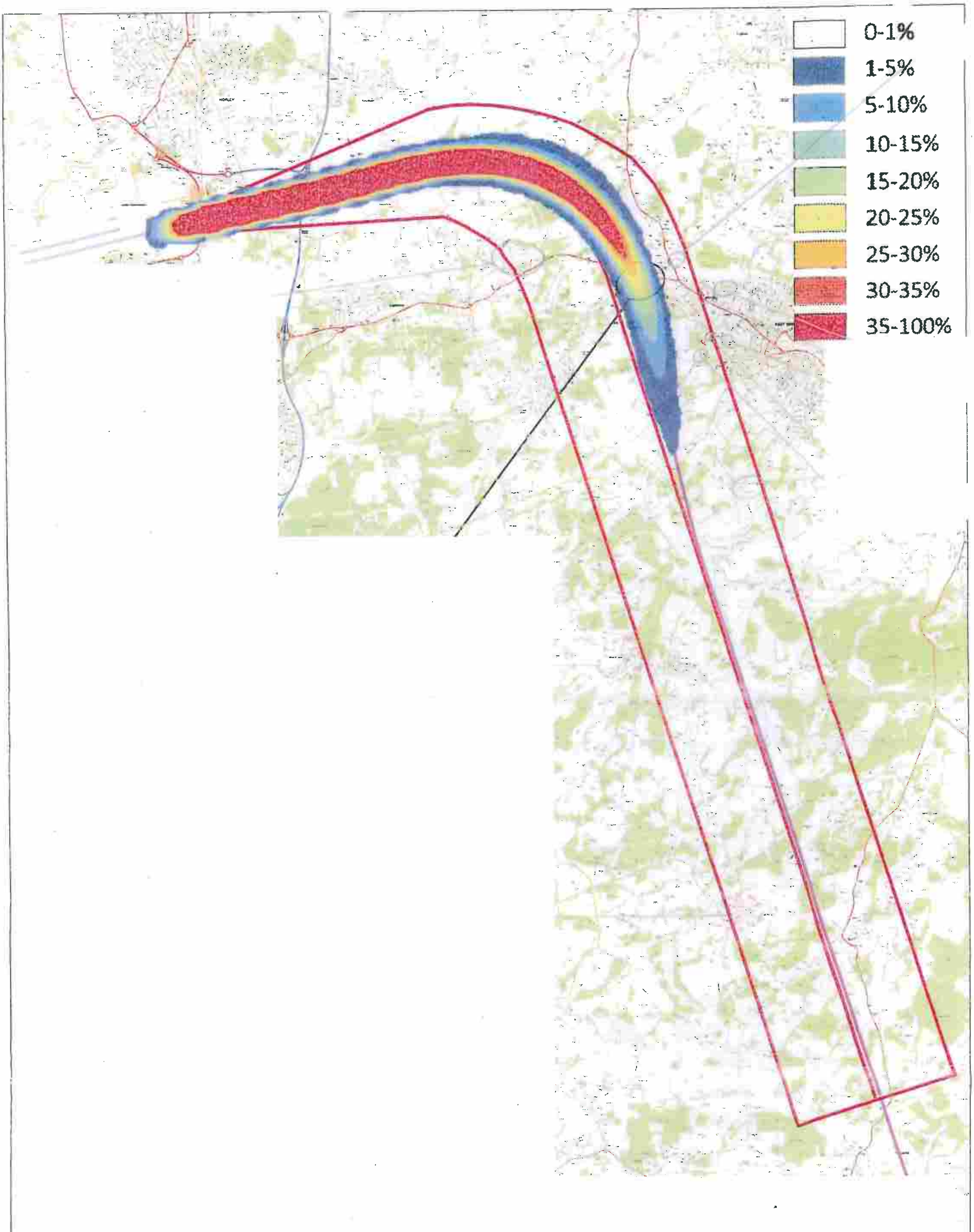
Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense



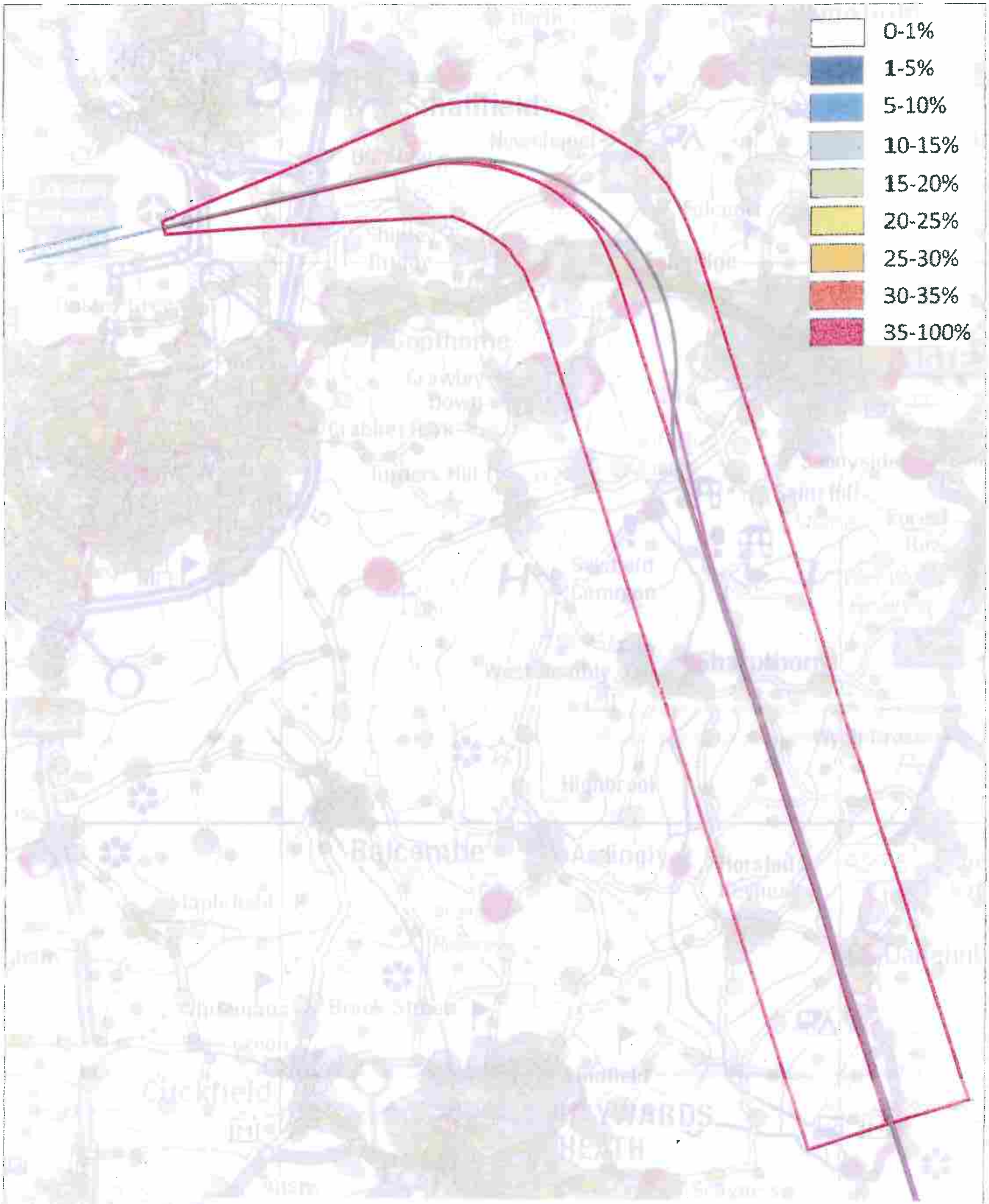
Gatwick Conventional Route Centreline (Take-Off from easterly runway)



Gatwick proposed PRNAV
Route 2 centreline

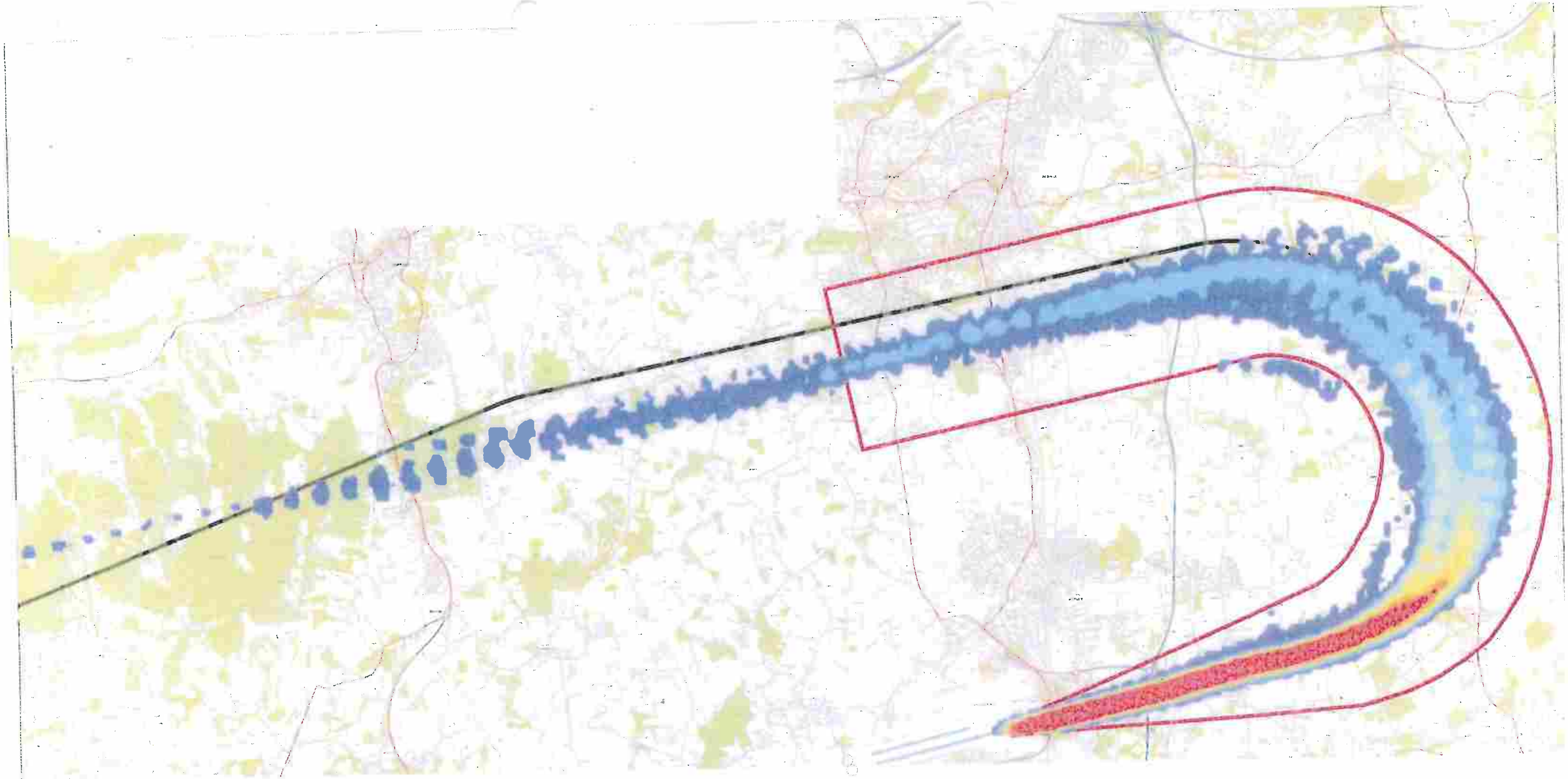


Gatwick Proposed Route 2
PRNAV Flightpath Density Plot
Hotter colours = more dense



Gatwick P-RNAV SID Proposal
Route 2: 08 SFD NPR
SFD 9P, SFD 3Z

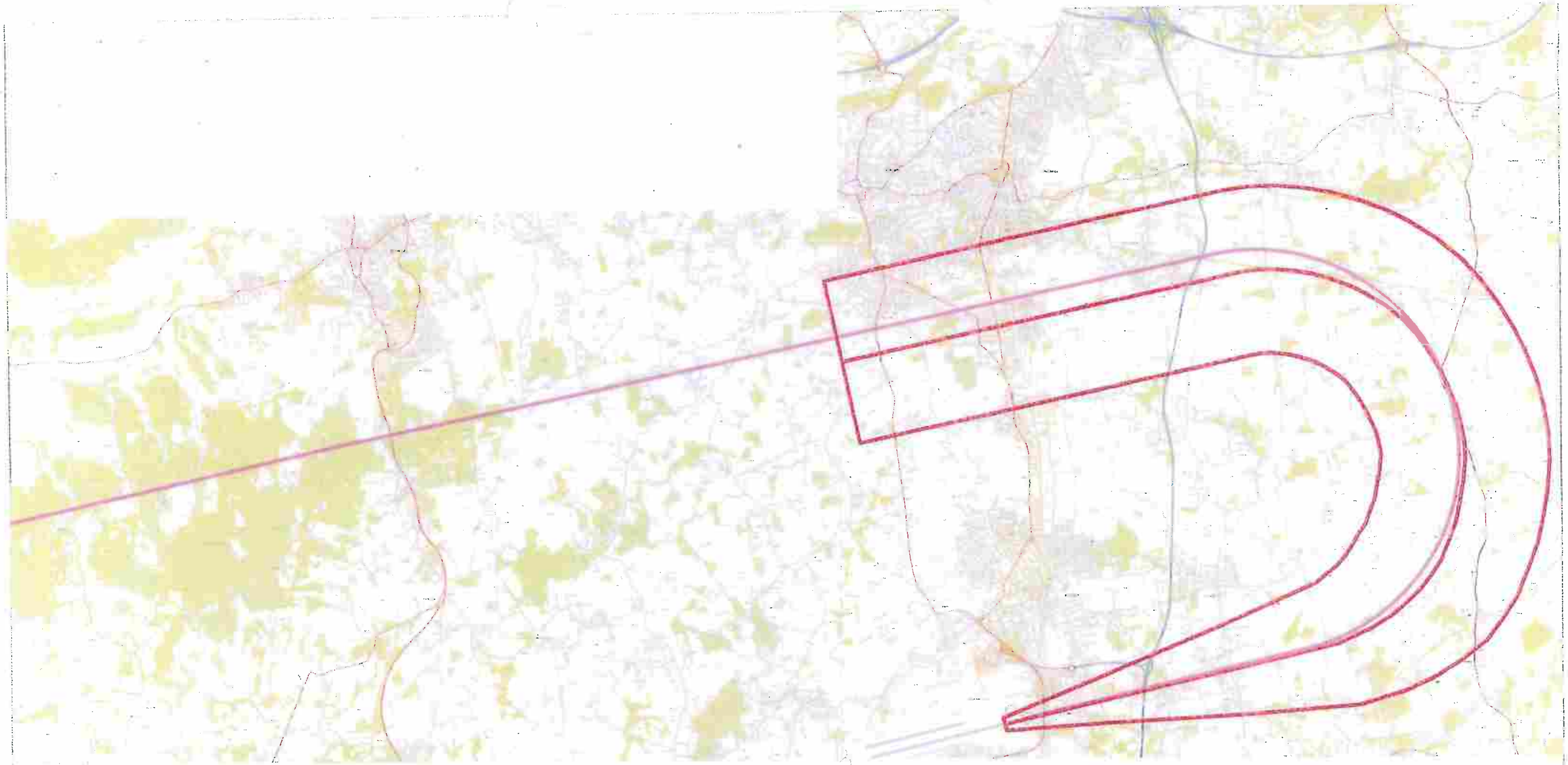
APPENDIX C3



Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense

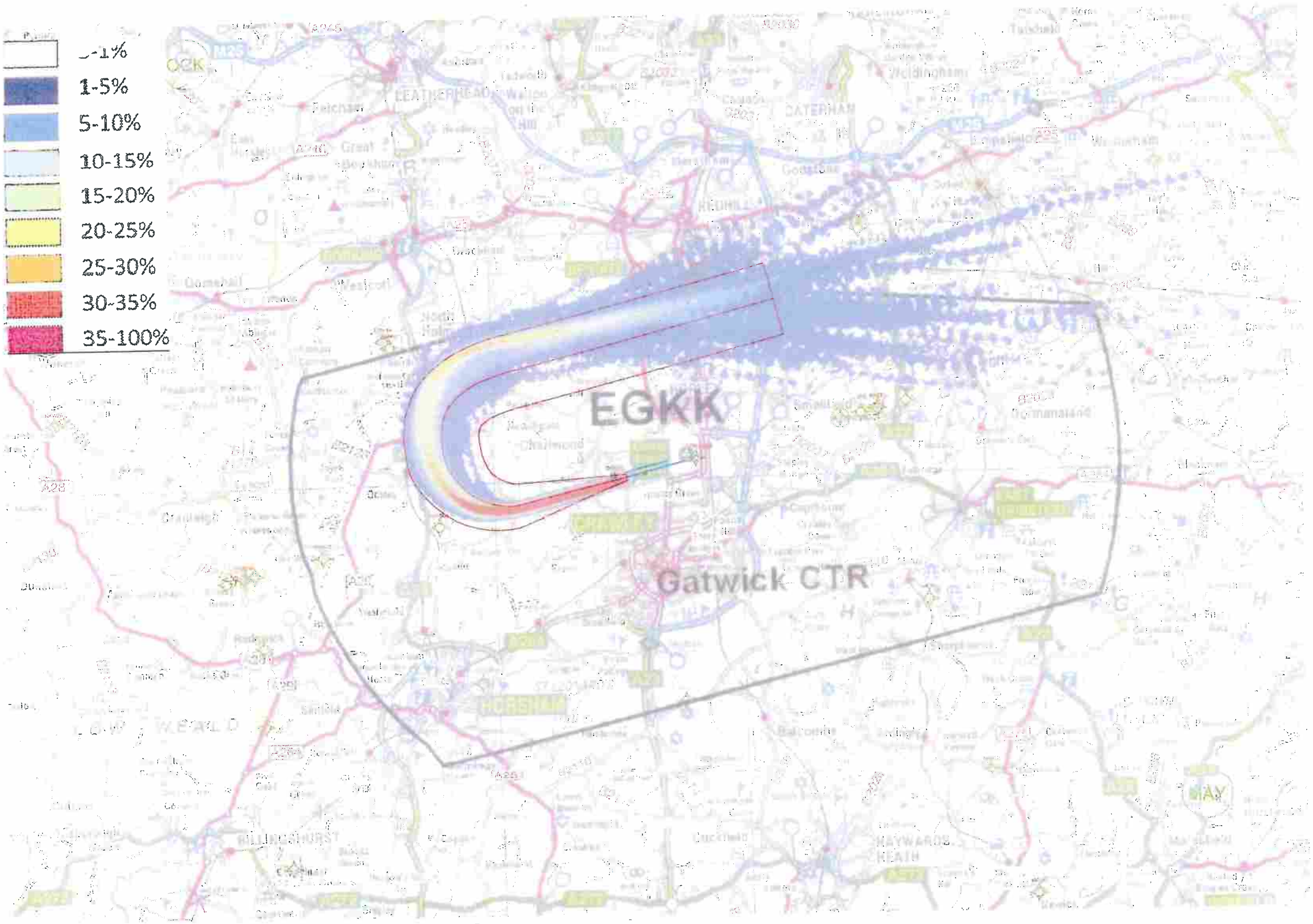
Gatwick
Conventional Route Centreline
(Take-Off from easterly runwa

Gatwick Proposed PRNAV
Route 3 Flightpath Density Plot
Hotter colours = more dense



Gatwick Proposed PRNAV
Route 3 centreline

APPENDIX C4



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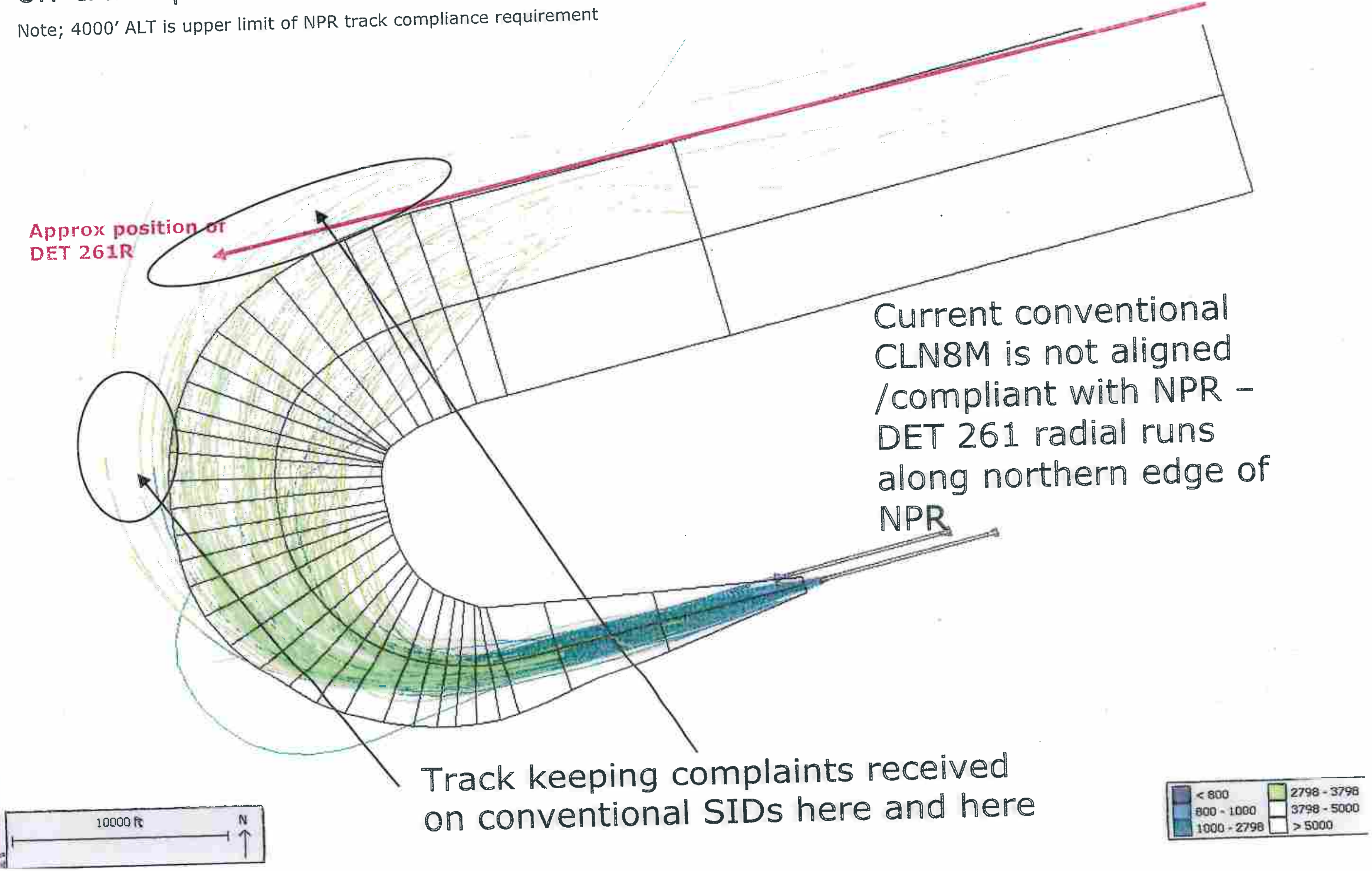
REDHILL
CRAWLEY
HORSHAM
BILLINGSHURST
HAYWARDS HEATH
Westcott
Godstone
Cranleigh

CLN8M track NTK data

Conventional SID Departures – Mar 2011 – (CLN8M) no vertical cut off track plot

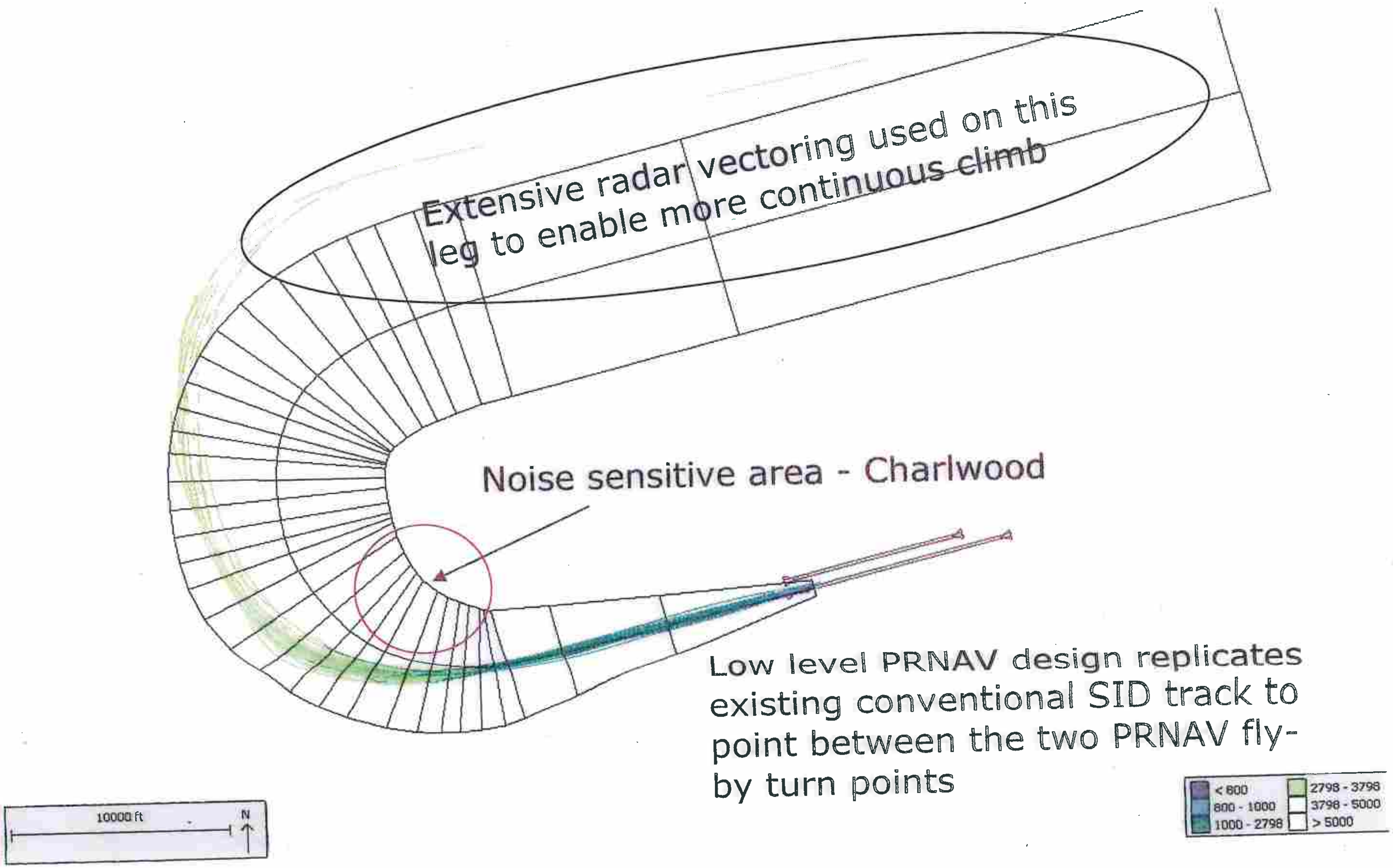
Note; 4000' ALT is upper limit of NPR track compliance requirement

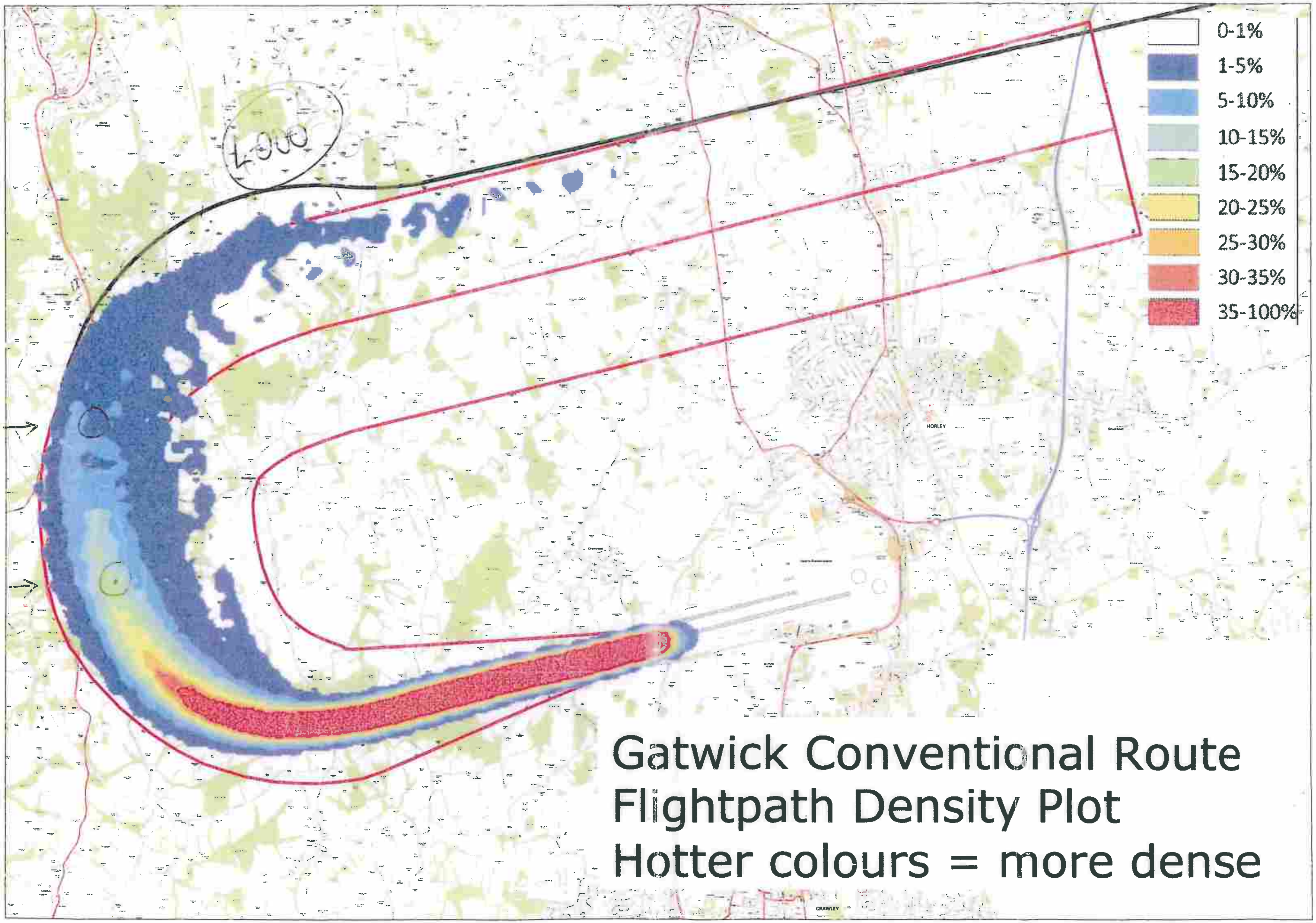


CLN2X track NTK data

PRNAV Departures – Jan to Mar 2011 – (CLN2X)

Note; 4000' ALT is upper limit of NPR track compliance requirement





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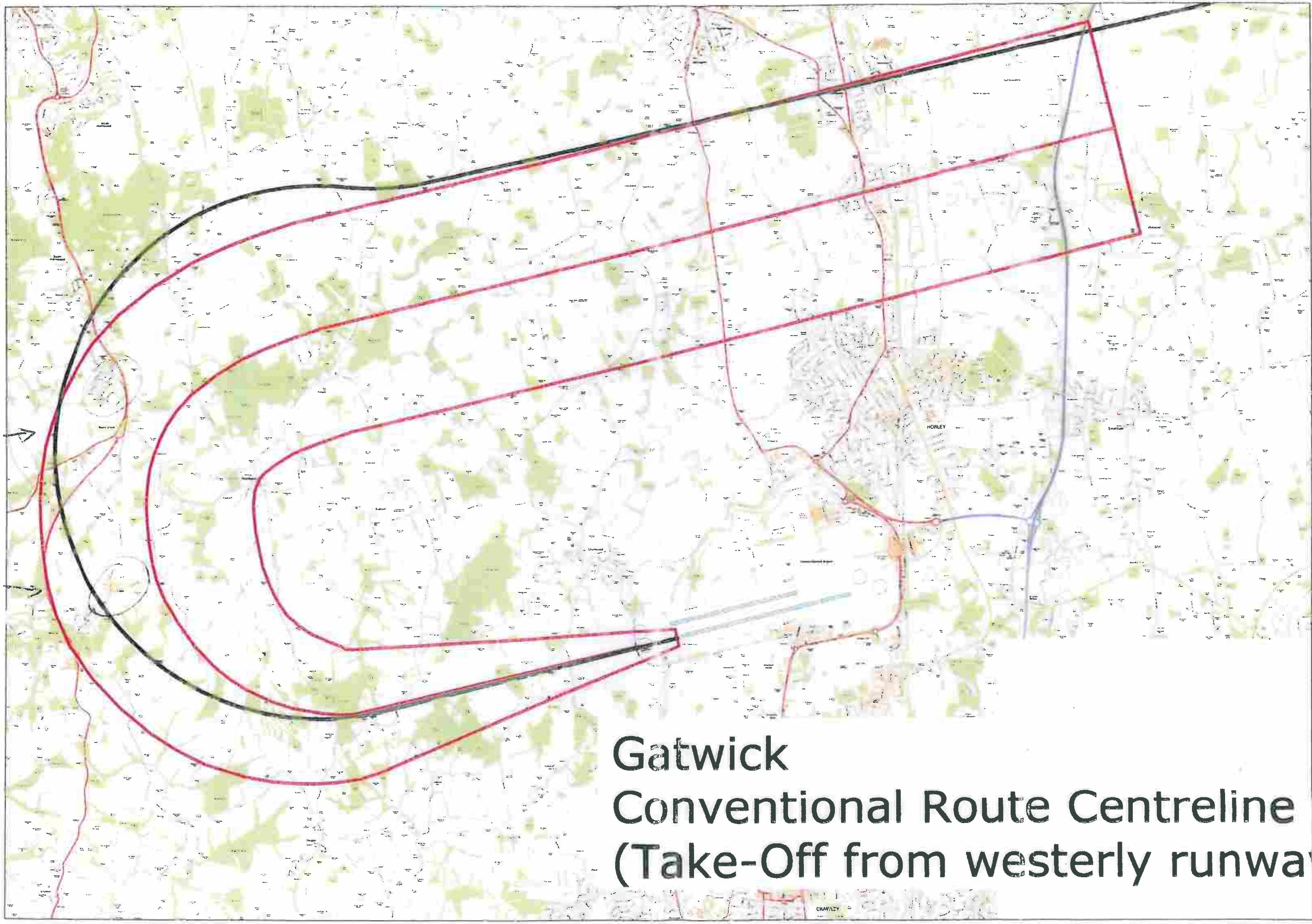
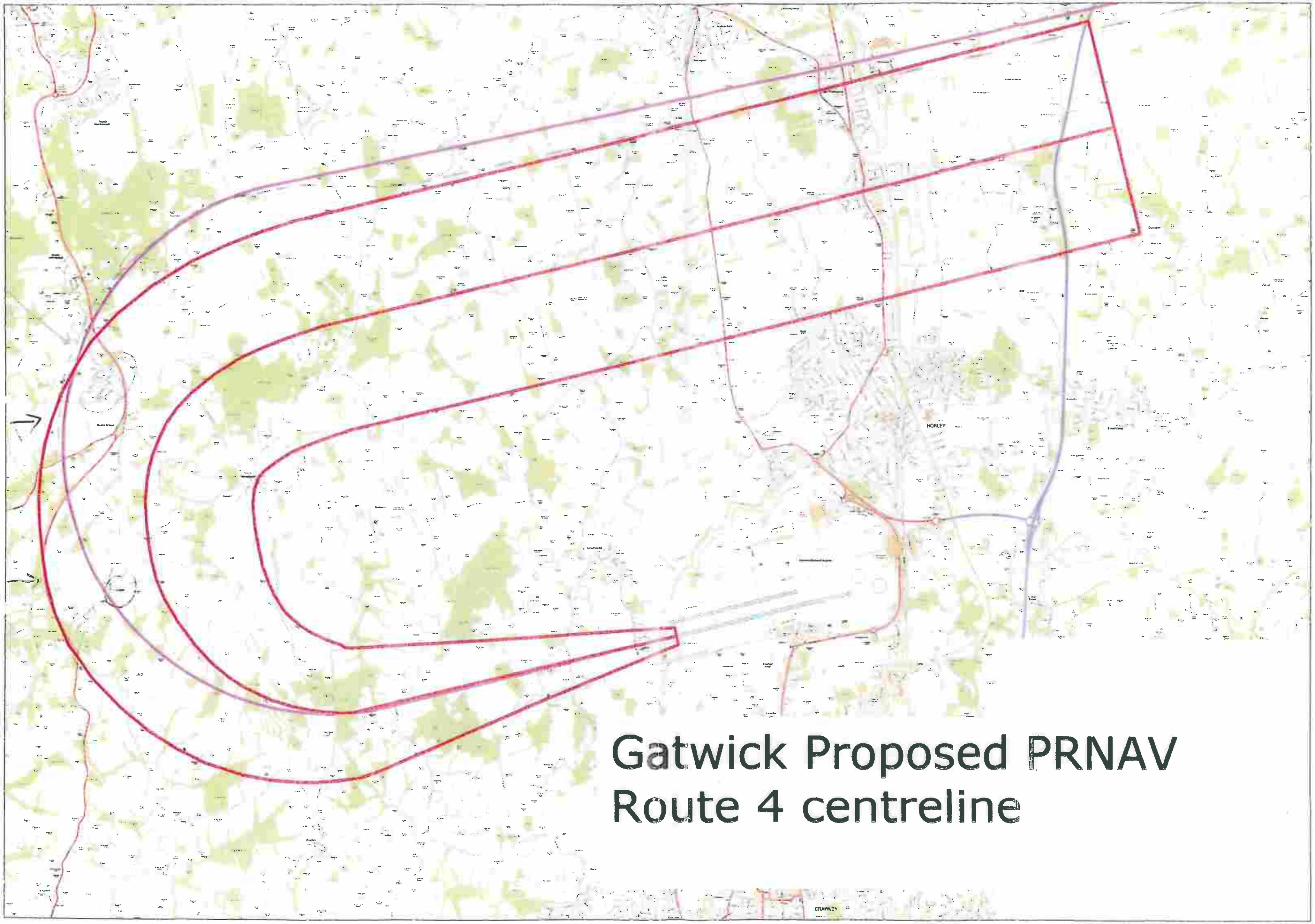
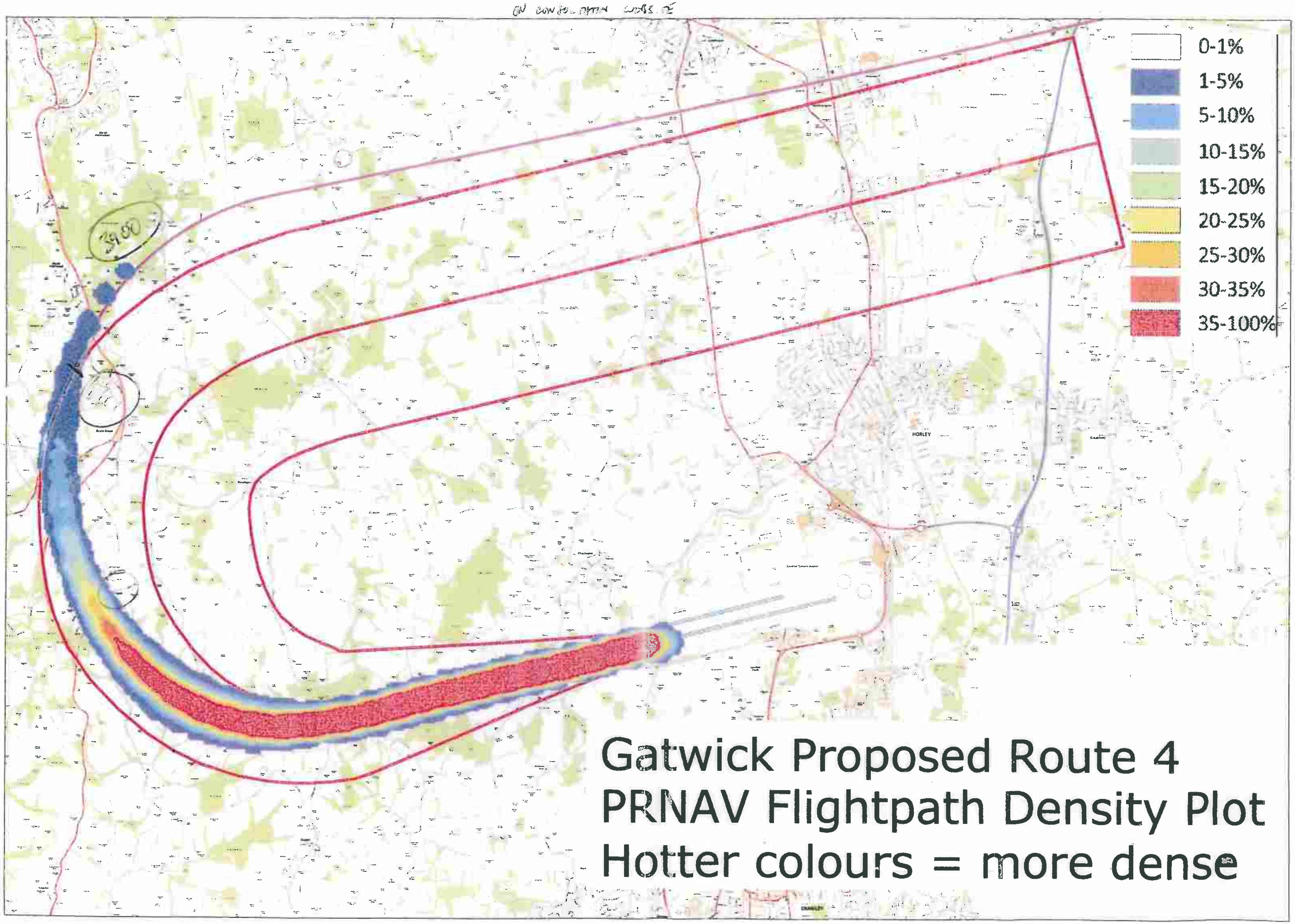
Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense



Gatwick
Conventional Route Centreline
(Take-Off from westerly runway)



Gatwick Proposed PRNAV
Route 4 centreline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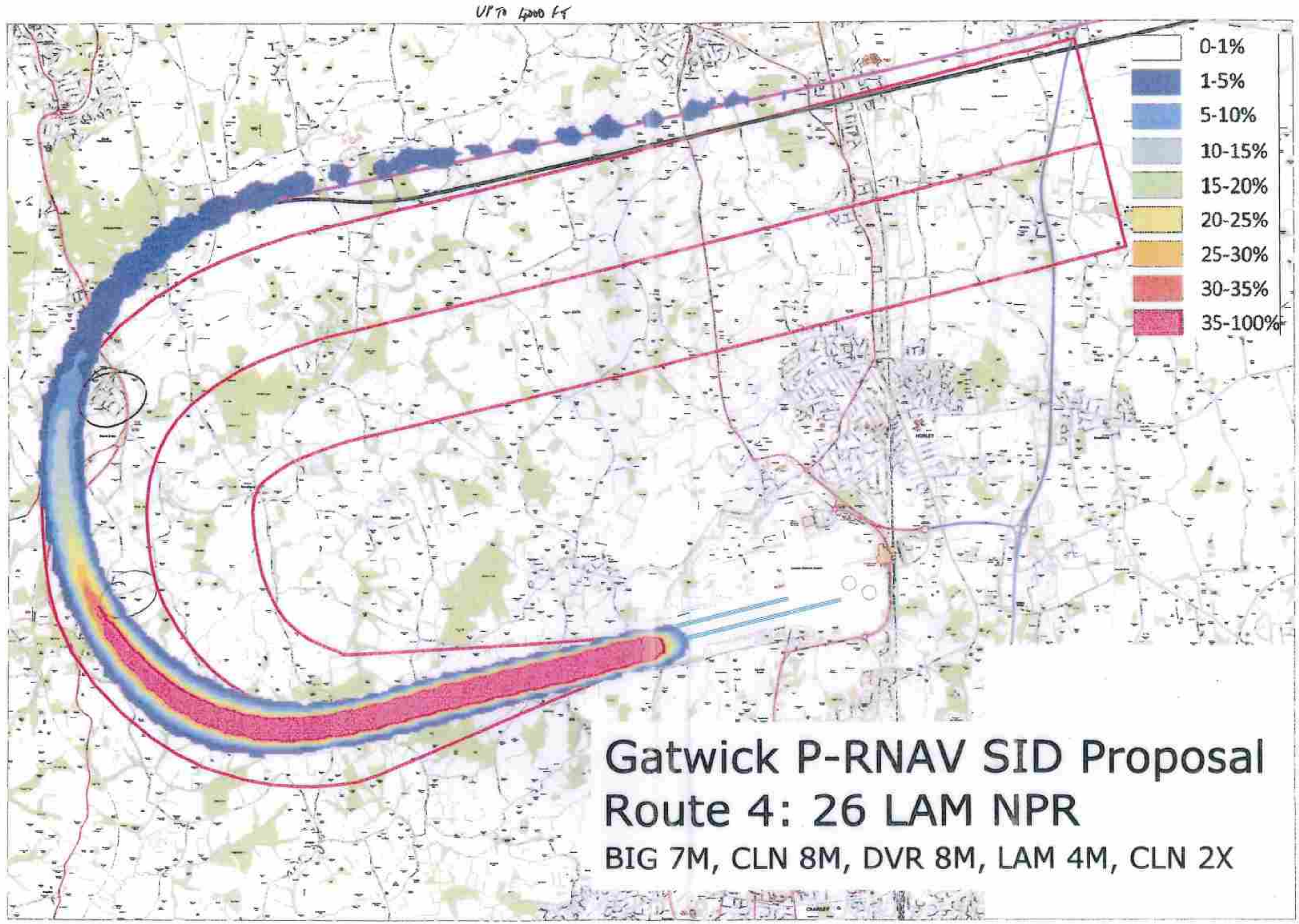
Gatwick Proposed Route 4
PRNAV Flightpath Density Plot
Hotter colours = more dense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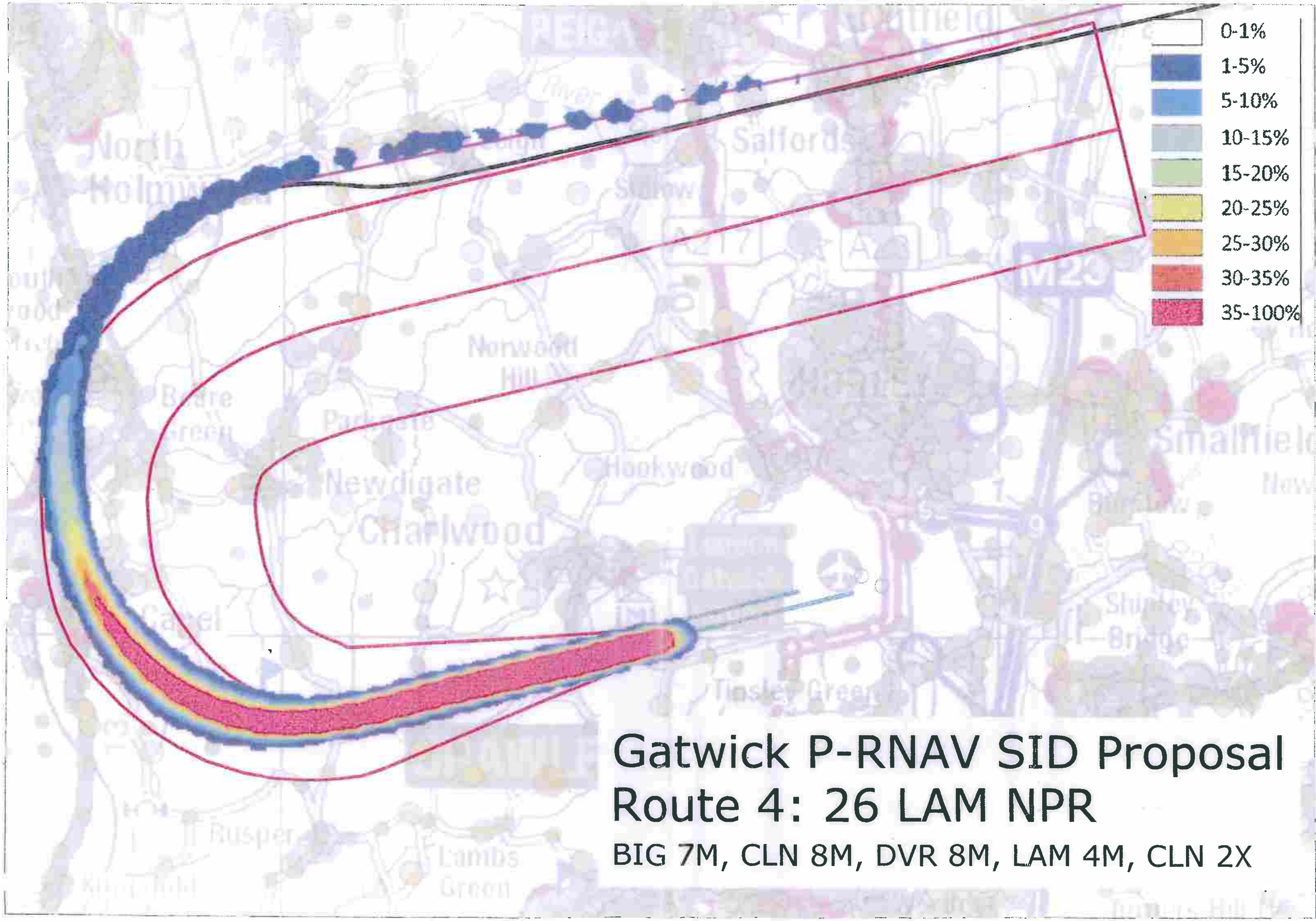
Gatwick P-RNAV SID Proposal
Route 4: 26 LAM NPR
BIG 7M, CLN 8M, DVR 8M, LAM 4M, CLN 2X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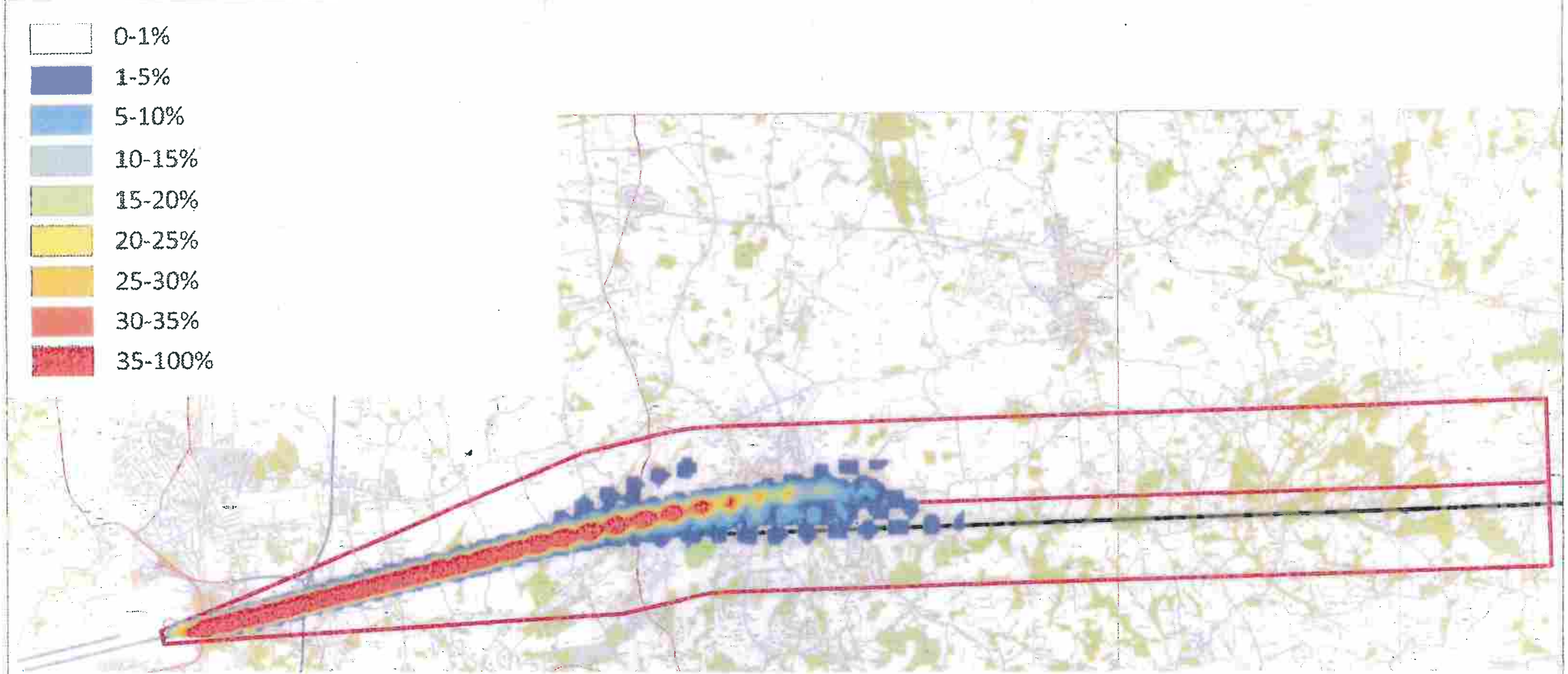
Norwood Hill
Parkgate
Newdigate
Charlwood
Hookwood
Smallfield
Rusper
Lambs Green
Tinsley Green
A217
M23
Gatwick P-RNAV SID Proposal
Route 4: 26 LAM NPR
BIG 7M, CLN 8M, DVR 8M, LAM 4M, CLN 2X

APPENDIX C5

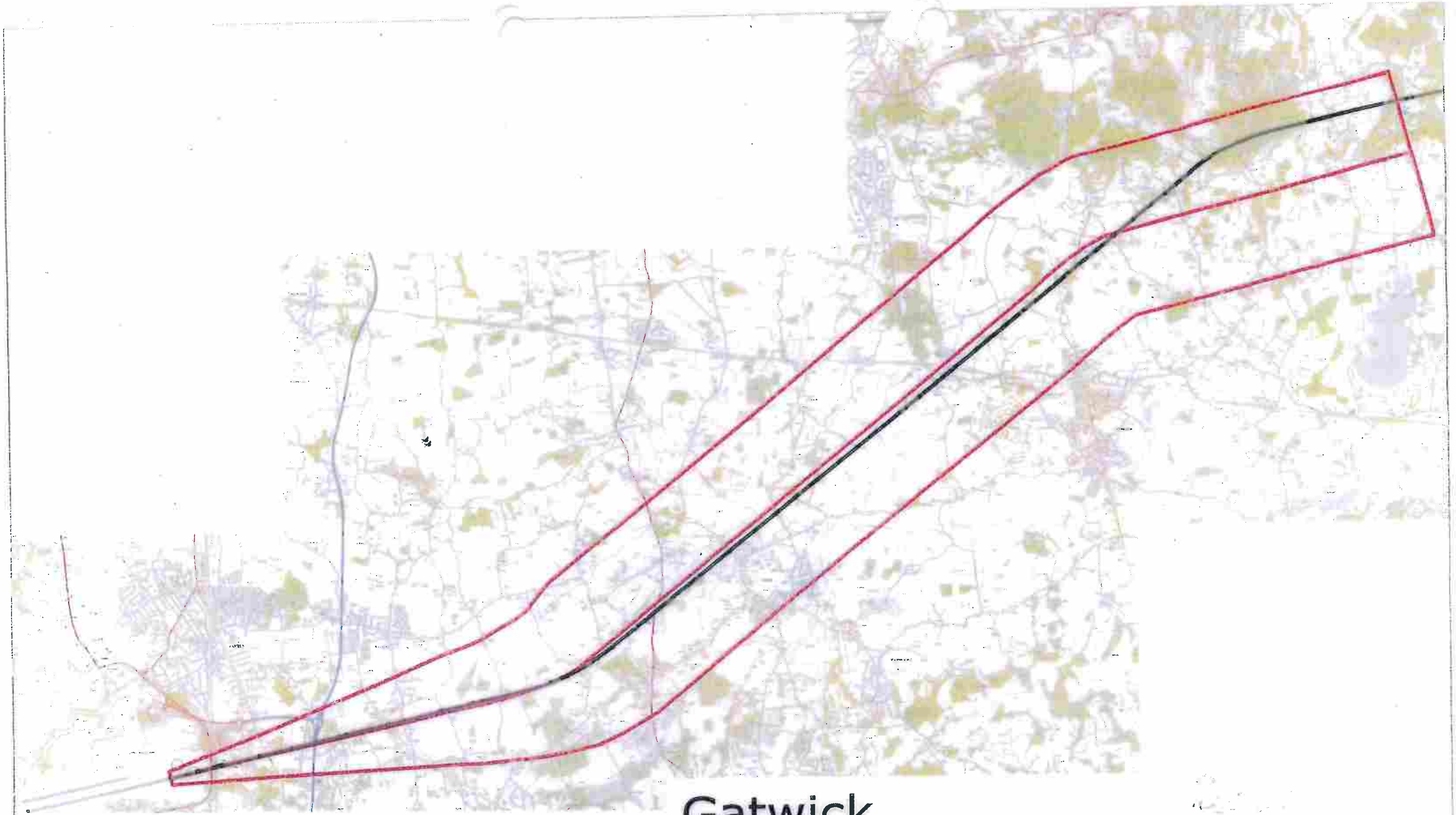
Gatwick
Conventional Route Centreline
(Take-Off from easterly runway



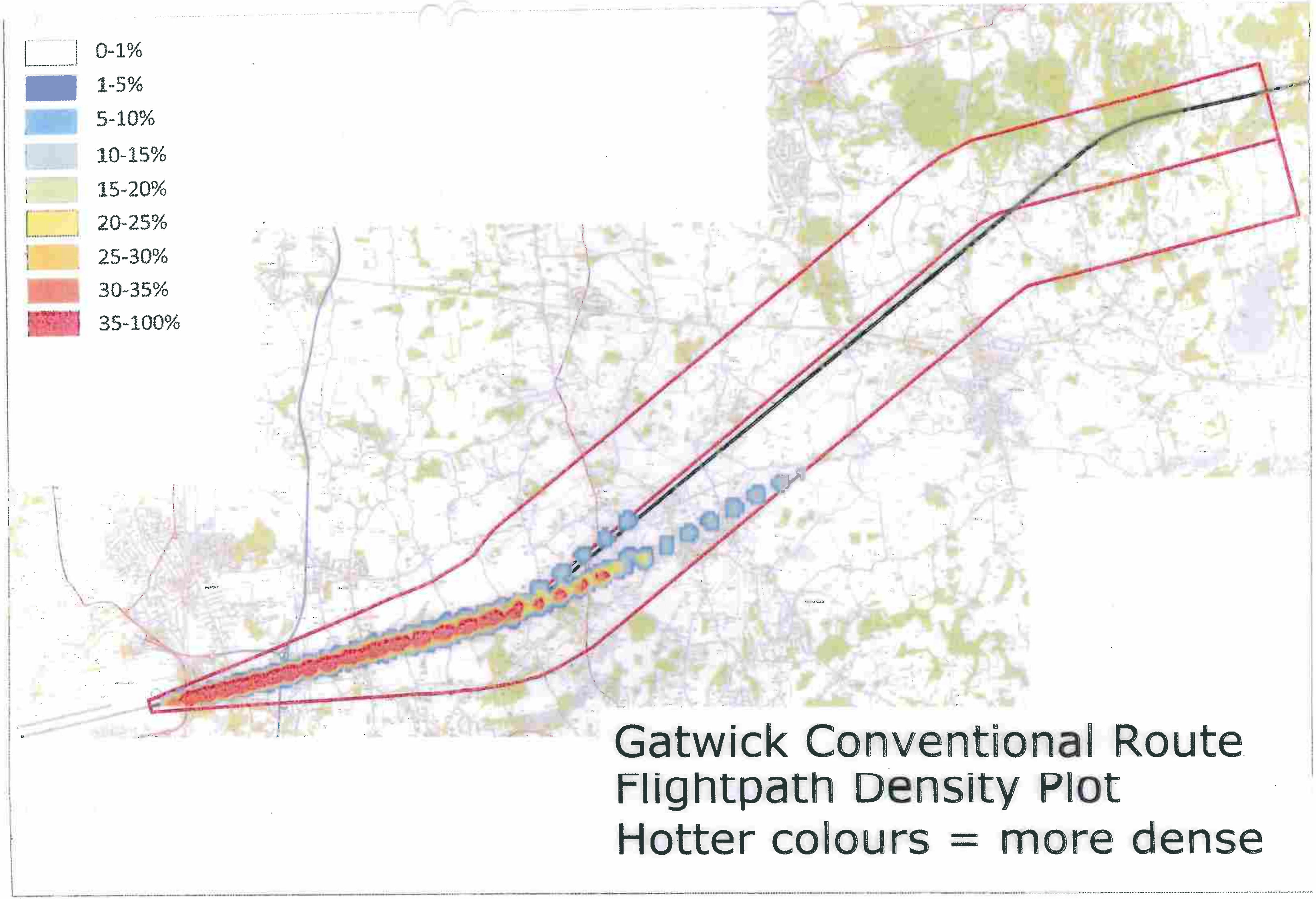
Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense


Gatwick Proposed PRNAV
Route 5 centreline

APPENDIX C6



Gatwick
Conventional Route Centreline
(Take-Off from easterly runway



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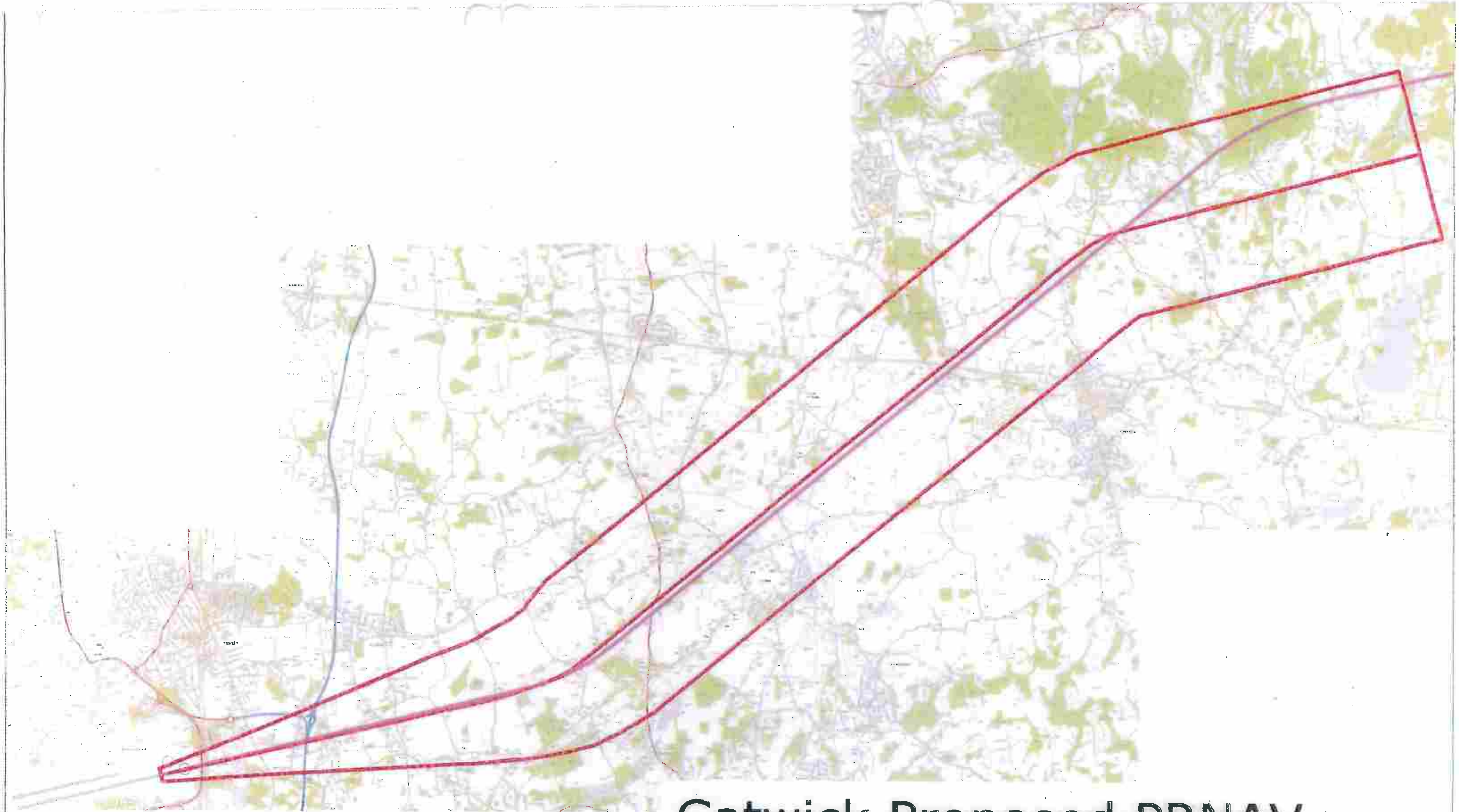
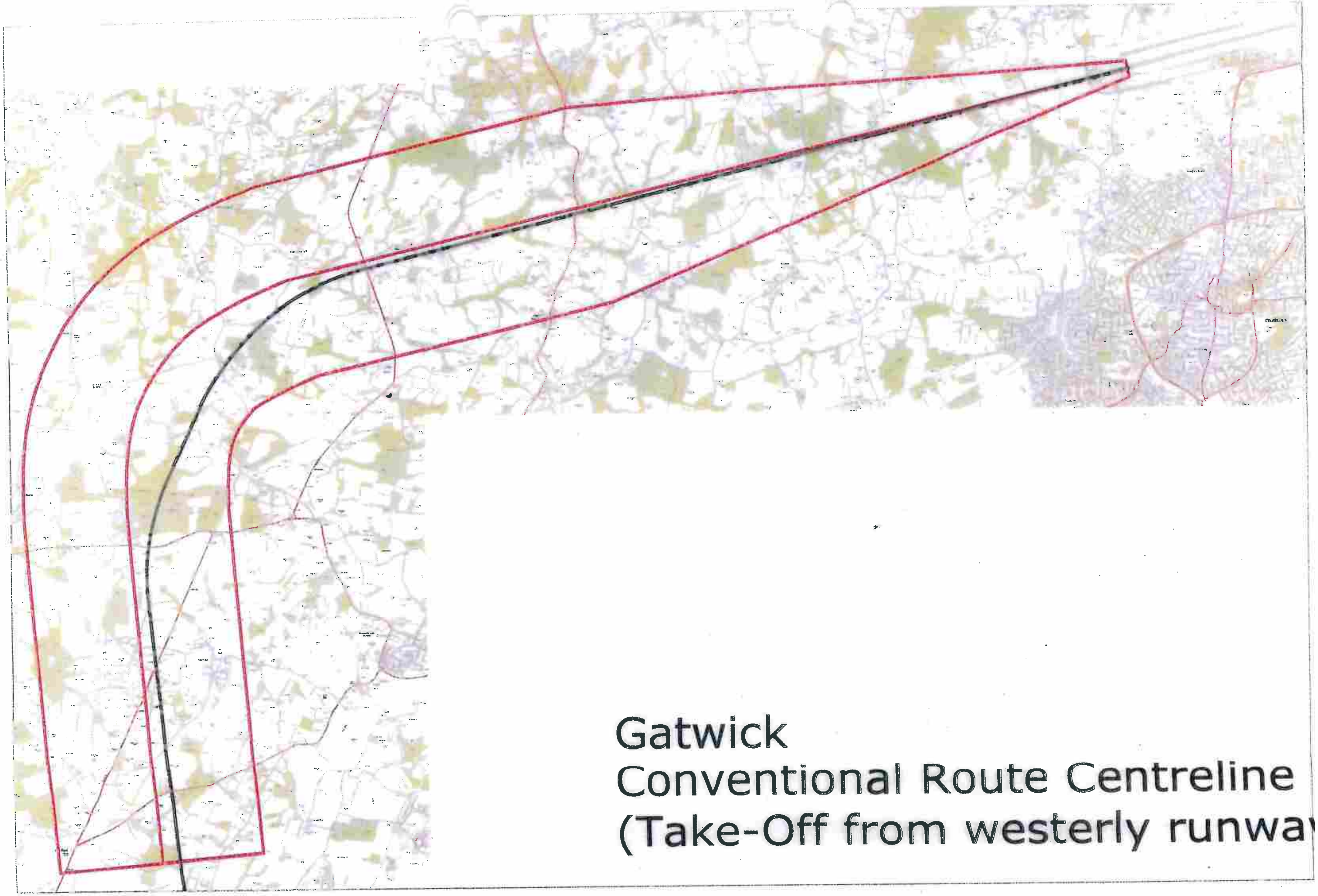
Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense

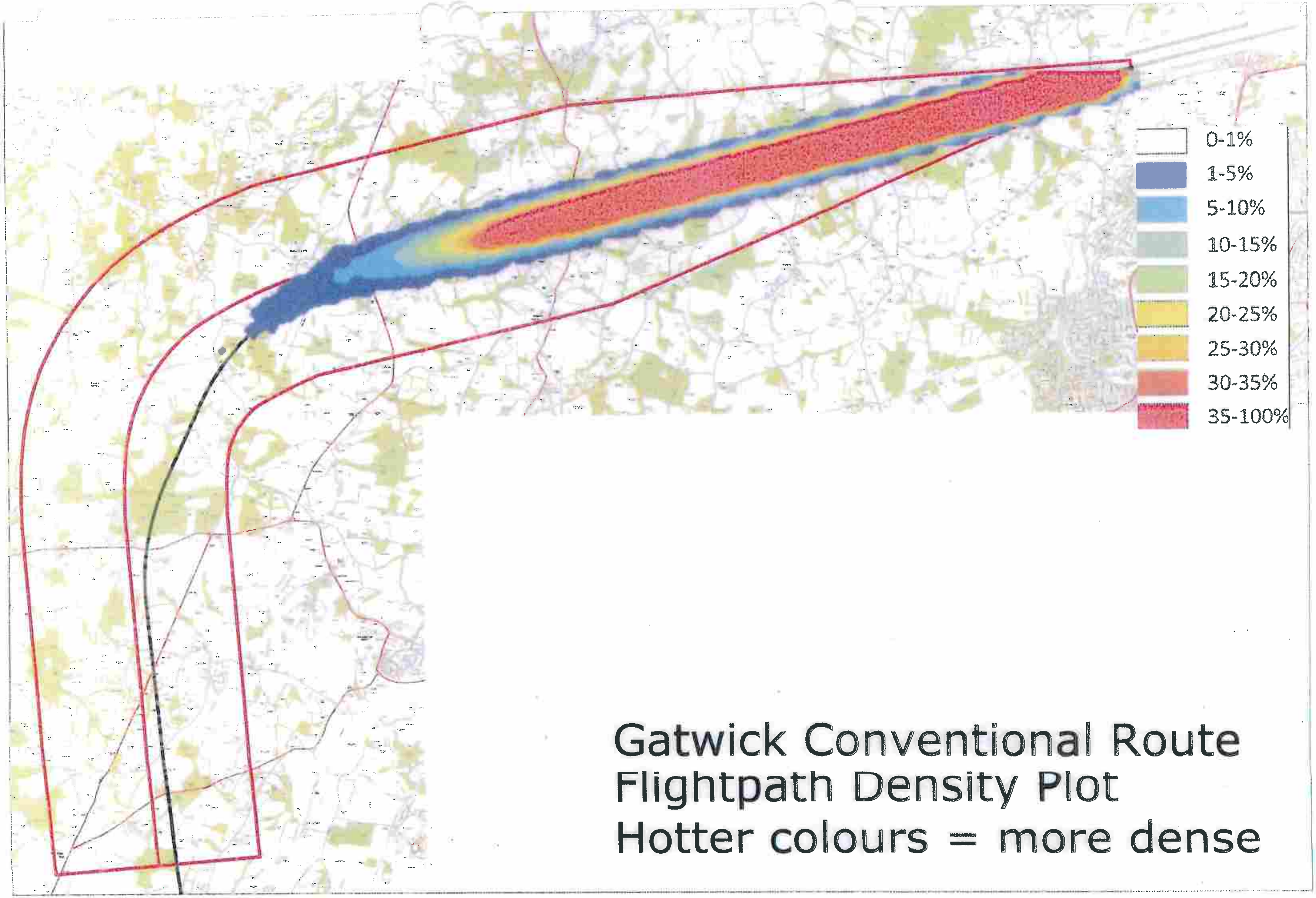


Gatwick Proposed PRNAV Route 6 centreline

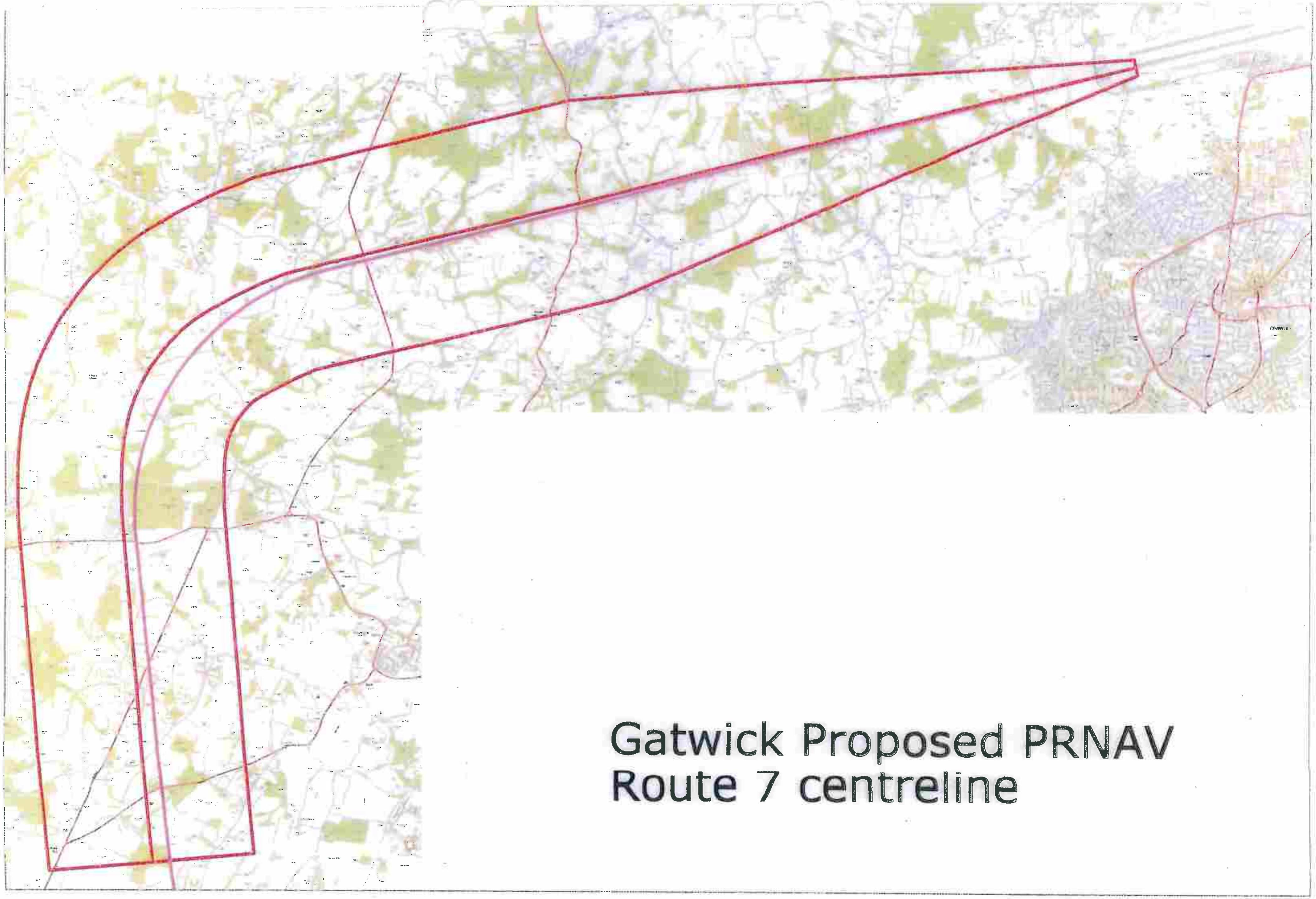
APPENDIX C7



Gatwick
Conventional Route Centreline
(Take-Off from westerly runwa

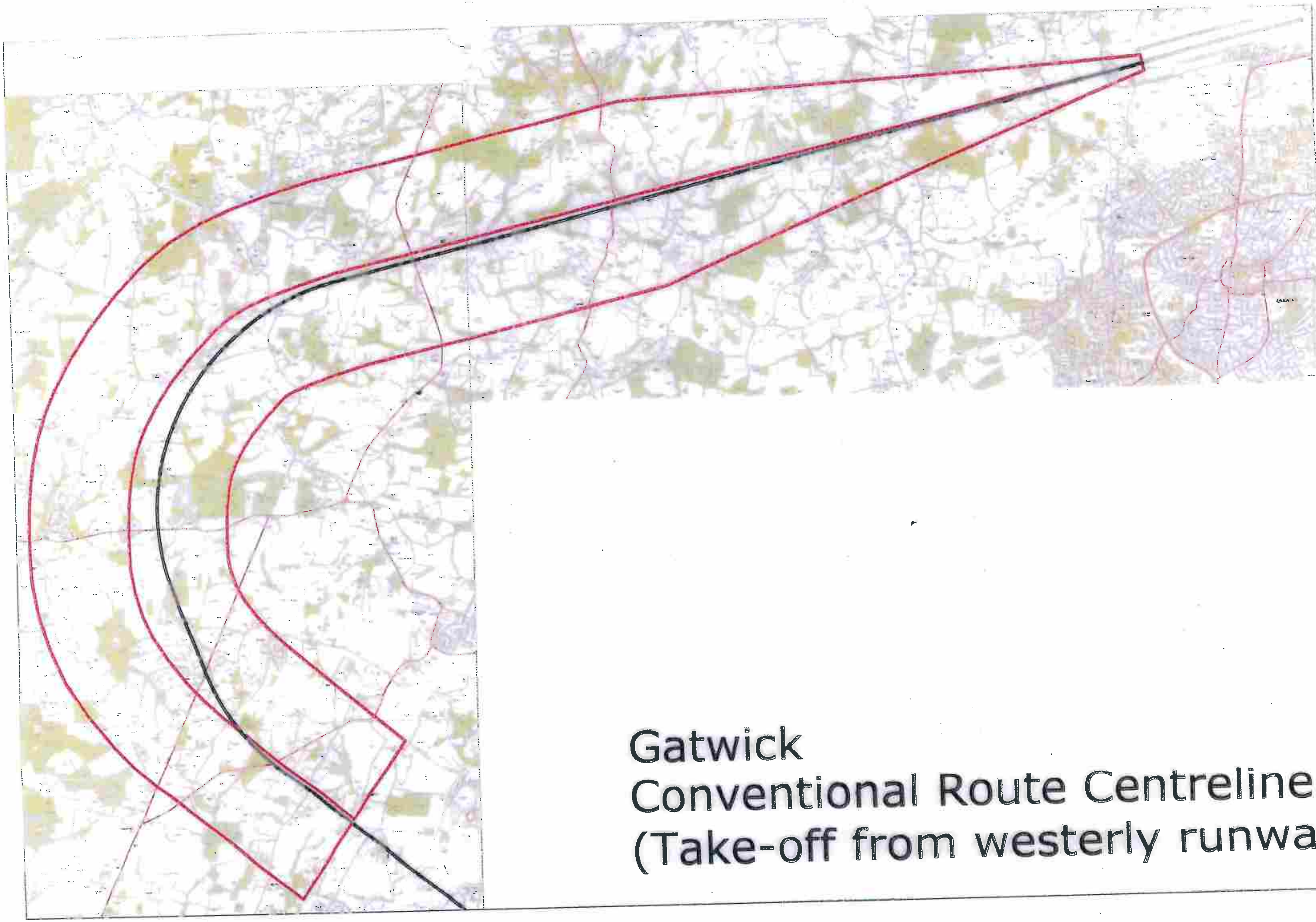


Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense

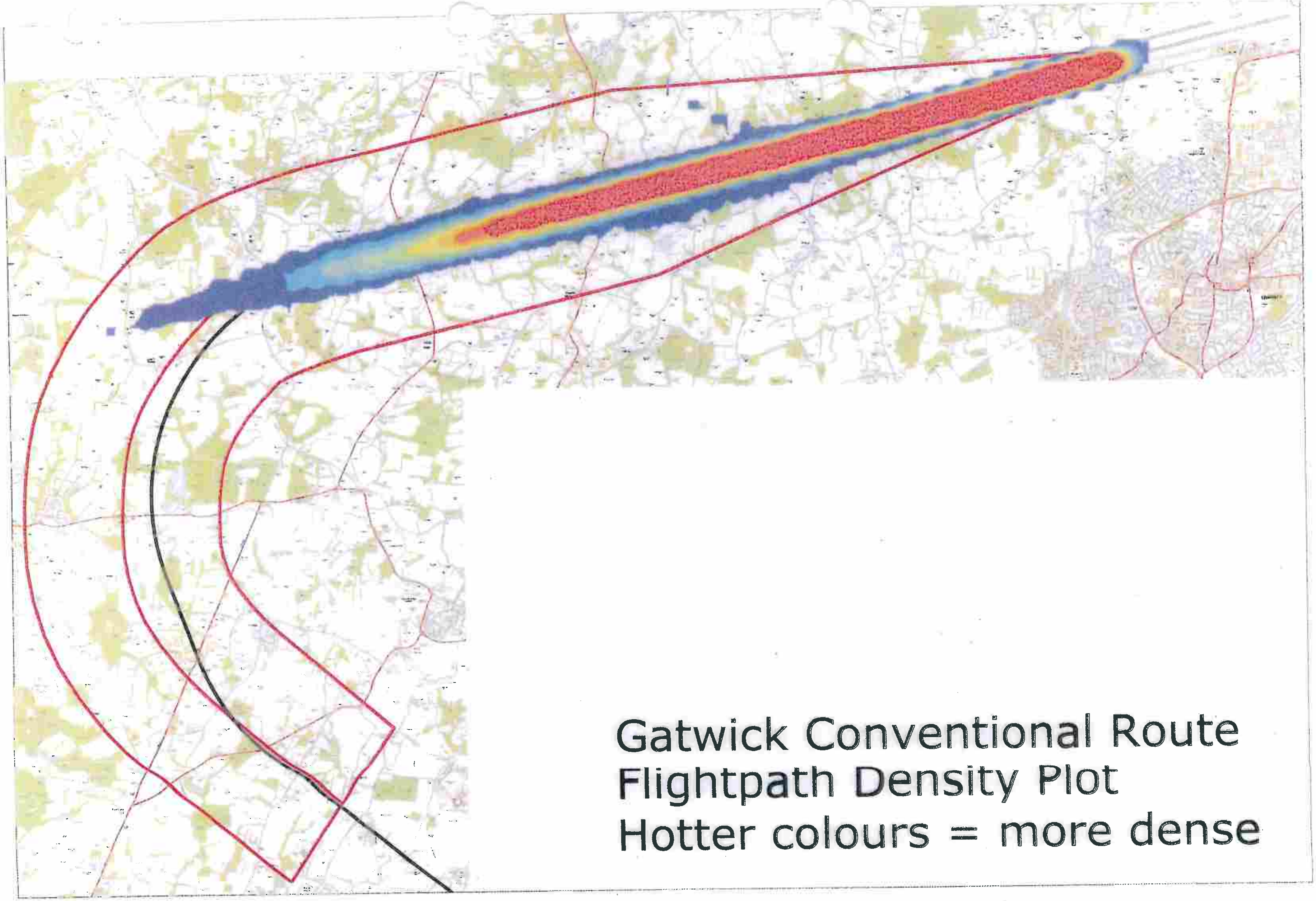


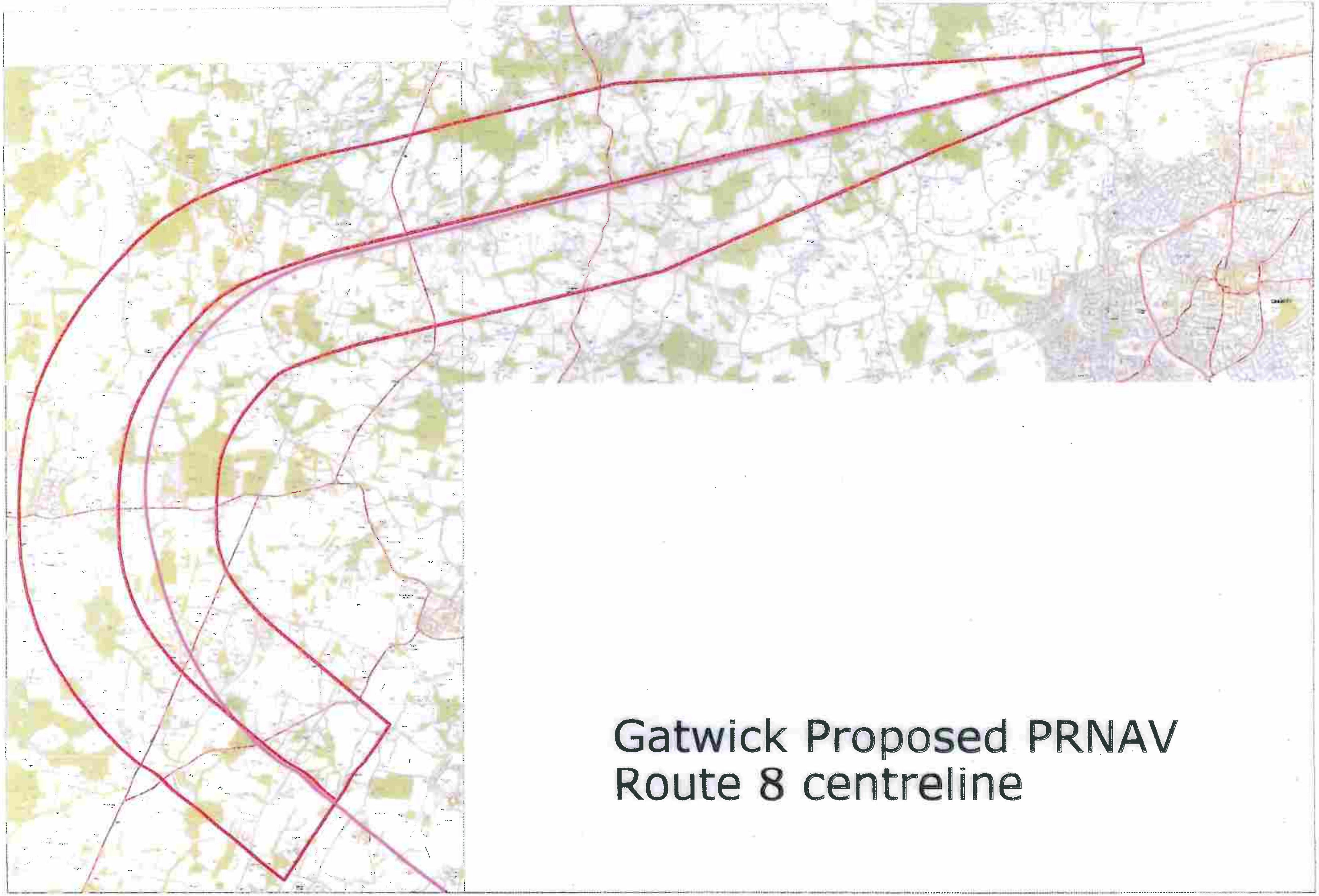
Gatwick Proposed PRNAV Route 7 centreline

APPENDIX C8



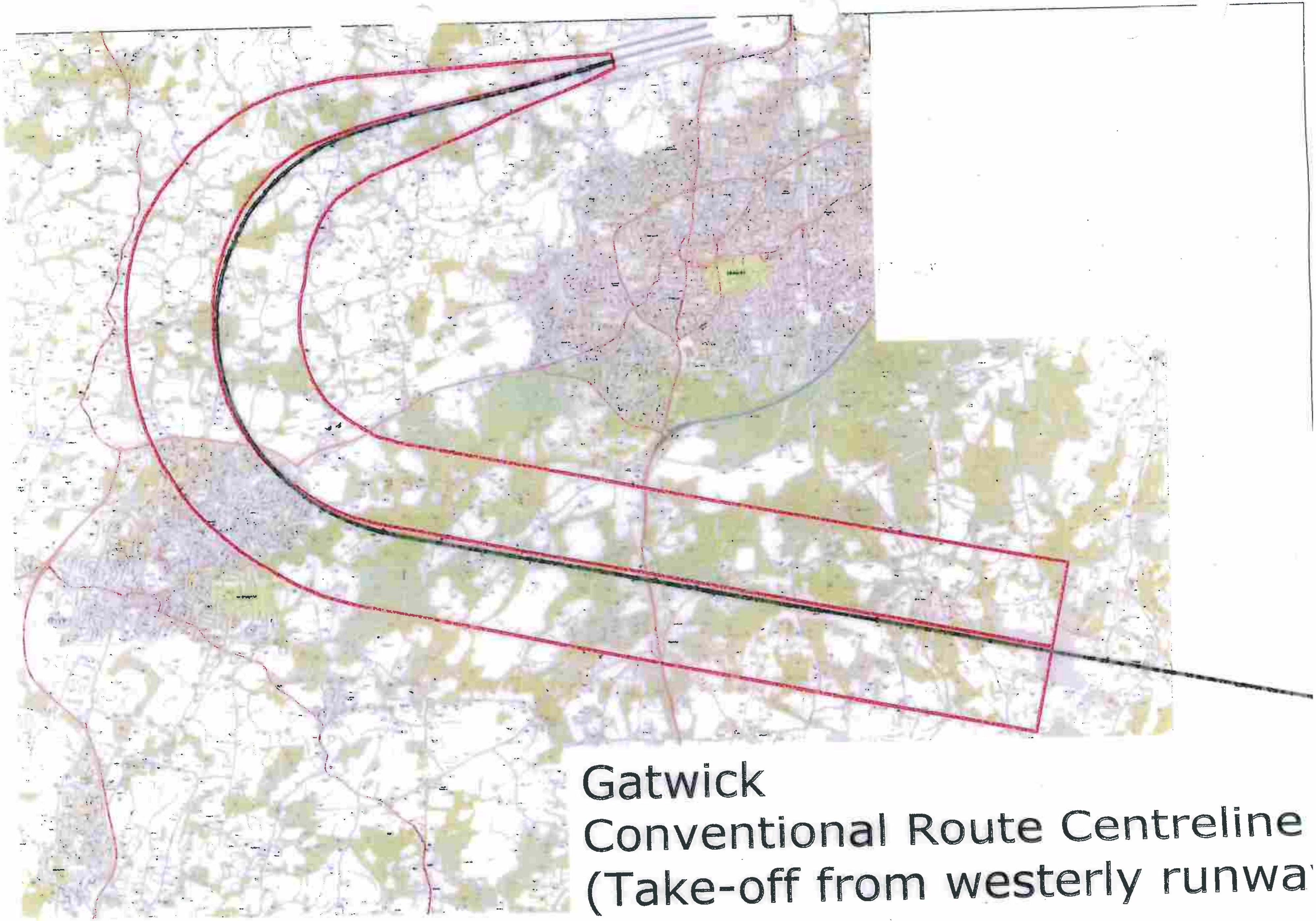
Gatwick
Conventional Route Centreline
(Take-off from westerly runway)


Gatwick Conventional Route
Flightpath Density Plot
Hotter colours = more dense

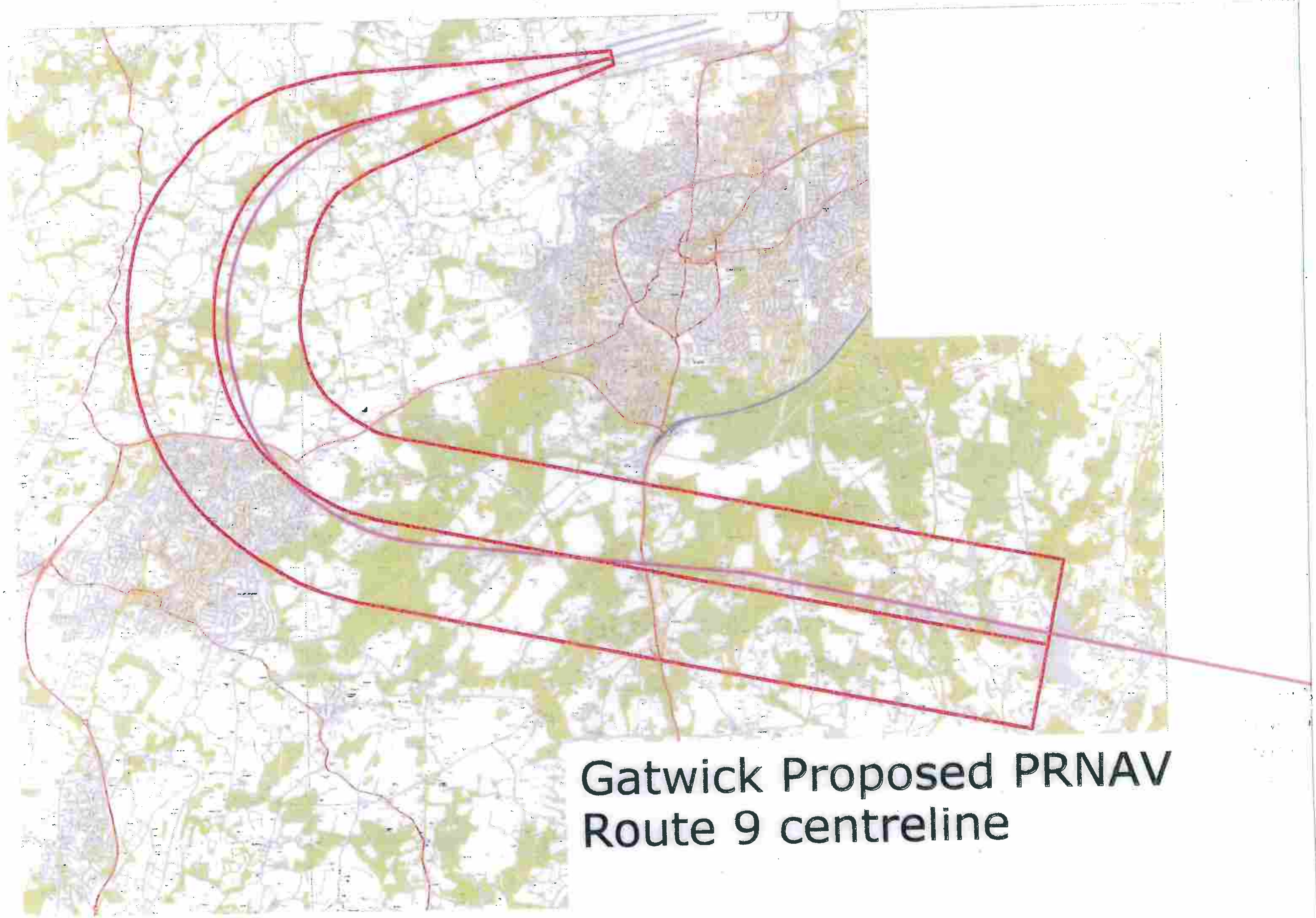


Gatwick Proposed PRNAV Route 8 centreline

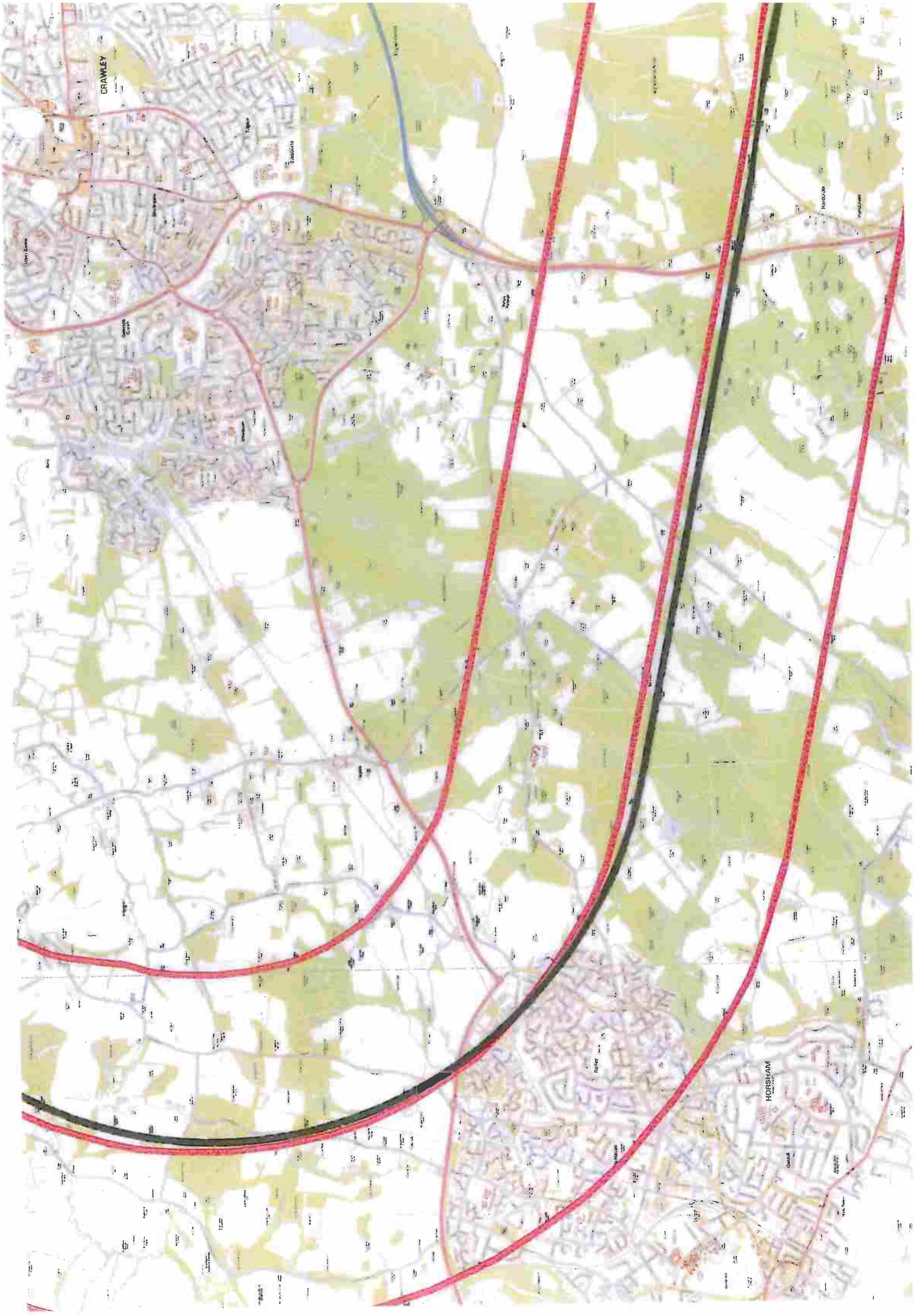
APPENDIX C9



Gatwick
Conventional Route Centreline
(Take-off from westerly runwa



Gatwick Proposed PRNAV Route 9 centreline


CRAWLEY
HORSHAM

APPENDIX D

YOUR LONDON AIRPORT
Gatwick

PRNAV Standard Instrument Departure Implementation at LGW

Consultation Feedback

Issue 1

Prepared by:
Gatwick Airport Limited

Table of contents

1. Executive Summary

Gatwick Airport Limited (GAL) is currently developing an airspace change proposal (ACP) to replicate the current standard instrument departure routes (SIDs) from Gatwick Airport. The aim of this is to provide an airspace structure in line with modern aircraft navigational capabilities, with more accurately defined routes utilising the improved navigational capabilities of modern aircraft (Precision Area Navigation, P-RNAV). To allow for aircraft which are not yet PRNAV equipped the conventional SIDs will remain available until such time as the PRNAV equipage rate is close to 100%. This document provides feedback to all stakeholders who participated in the consultation. (Note the consultation document can be viewed at http://www.gatwickairport.com/prnav/)

The Consultation ran for a period of 13 weeks commencing on the 19th July 2012 and concluding on the 19th October 2012. Responses received after the 19th October up to the 12th November 2012, have also been included in the statistics and analysis. A minimum twelve week consultation period is recommended[1] in order to allow organisations to solicit feedback from their members, and to allow the proliferation of the consultation material. The consultation was initially distributed to a total of 32 stakeholder organisations. The list of stakeholders who were sent the consultation material is available in Appendix C of the consultation document. A further 46 stakeholders who were not on the original list also contributed.

In total 71 responses to the consultation were received. The sentiment of responses from those who responded are shown in Figures 2 and 3.

As a result of careful consideration of all the feedback, GAL will be proceeding with the proposed implementation of P-RNAV replications of the existing SIDs as described in the original consultation document. The airspace change proposal will be submitted to the CAA DAP for consideration.

In the event that a stakeholder wishes to present **new** evidence or data to the Director of Airspace Policy, for consideration prior to making his decision; the representative Organisation must submit the information in writing, to the following address:

The Director (ref Gatwick PRNAV SID replications)
Directorate of Airspace Policy
CAA House
45-59 Kingsway
London
WC2B 6TE

[1] http://www.bis.gov.uk/files/file47158.pdf Government Code of Practice for consultation.

2. Introduction

During July-October 2012, GAL conducted a consultation process soliciting feedback on proposals to modify the current SIDs from Gatwick Airport to use more accurately defined routes, utilising the improved navigational capabilities of modern aircraft (P-RNAV). This document provides feedback to stakeholders who participated in this Consultation exercise. It will be sent to all stakeholders who participated in the Consultation, and will be published on the GAL website at **http://www.gatwickairport.com/prnav/.**

This document should be read in conjunction with the Stakeholder Consultation document (available from the above website). All technical terms and acronyms are explained in full in the stakeholder consultation document.

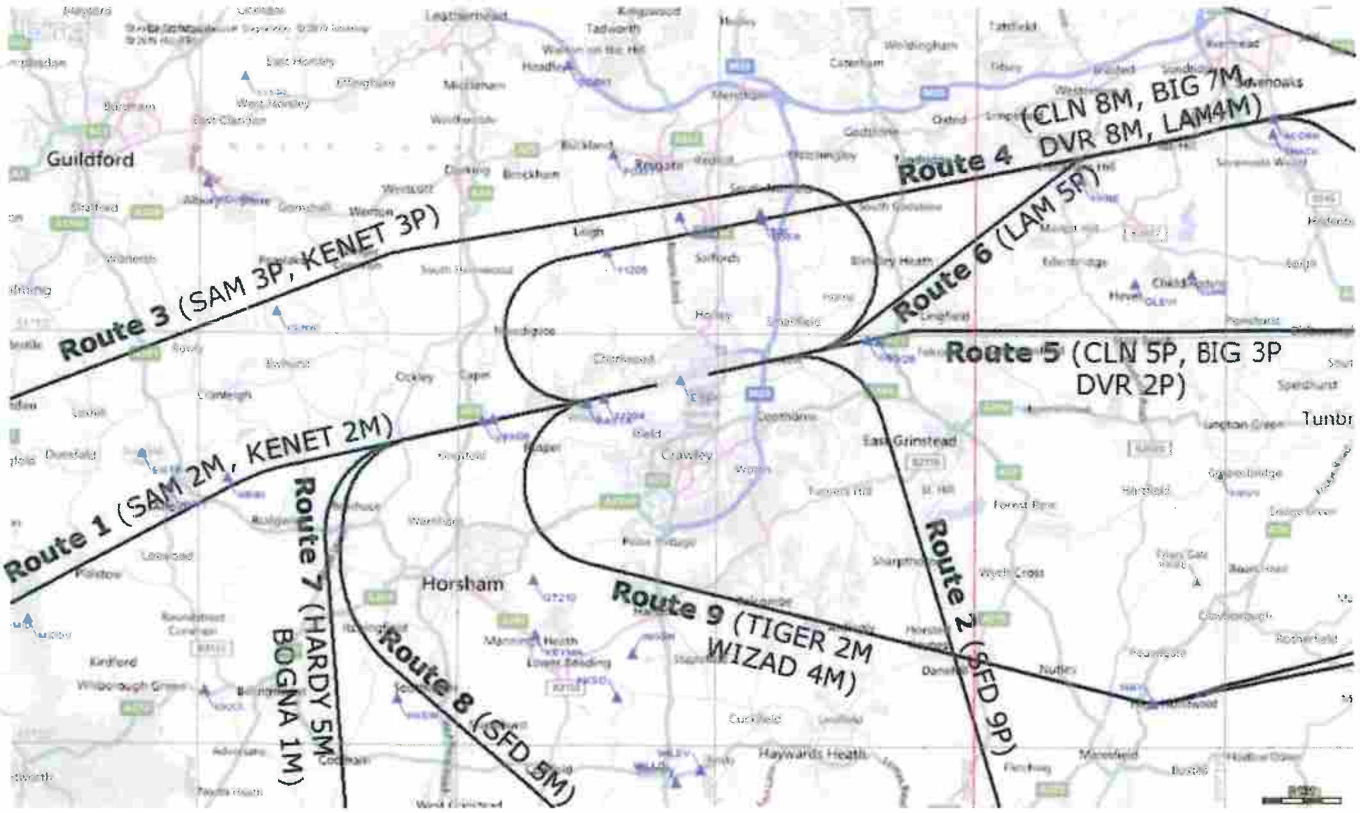


Figure 1 Map showing all of the SIDs proposed to be changed (current SID designators in brackets).

Figure 1 shows the routes which are the subject of the proposal. The route numbers shown correspond with the numbers used in the consultation material.

3. Overview of Responses

The consultation was launched through the Gatwick Airport consultative committee (GATCOM).

The organisations represented on GATCOM are:

East Sussex County Council
Surrey County Council
West Sussex County Council
Kent County Council
Crawley Borough Council
Horsham District Council
Mid Sussex District Council
Mole Valley District Council
Reigate and Banstead Borough Council
Tandridge District Council
Horley Town Council
irstow Parish Council
Charlwood Parish Council
Rusper Parish Council
South London Business
Association of British Travel Agents
Gatwick Diamond Business
British Air Transport Association
Environmental and Amenity Groups
International Air Carriers' Association
Which? Magazine
London Chamber of Commerce and Industry
Passenger Representative
Trades Union Congress S & E Regional Council
Coast to Capital Local Economic Partnership
Tourism South-East
Gatwick Airline Operators Committee
Department for Transport's Representative:

The following Local Authorities were also sent the information:

Salfords and Sidlow Parish Council
Horley Town Council
Amberley Parish Council
Ashington Parish Council Ashurst:
Billingshurst Parish Council
Bramber PC
Broadridge Heath Parish Council
Coldwaltham PC
Colgate Parish Council
Cowfold Parish Council
Henfield Parish Council
Itchingfield PC
Lower Beeding Parish
North Horsham Parish Council
Nuthurst Parish Council
Parham PC
Pulborough Parish Council
dgwick Parish Council
sper PC
Shermanbury Parish Council
Shipley Parish Council
Slinfold Parish Council
Southwater PC
Steyning PC
Storrington & Sullington PC
Thakeham Parish Council
Upper Beeding Parish Council
Warnham Parish Council
Washington Parish Council
West Chiltington Parish Council
West Grinstead Parish
Wiston PC
Woodmancote Parish Council
Abinger Parish Council
Betchworth Parish Council
Brockham Parish Council
Buckland Parish Council
Capel Parish Council
Charlwood Parish Council
Headley Parish Council
Holmwood Parish Council
Leigh Parish Council
Mickleham Parish Council
Newdigate Parish Council
Ockley Parish Council
Wotton Parish Council
Bletchingley Parish Council
Caterham Valley Parish Council
Chaldon Parish Council
Dormansland Parish Council
Felbridge Parish Council
Limpsfield Parish Council
Lingfield Parish Council
Nutfield Parish Council
Outwood Parish Council
Oxted Parish Council
Tandridge Parish Council
Tatsfield Parish Council
Titsey parish meeting
Warlingham Parish Council
Woldingham Parish Council
Addington Parish Council
Aylesford Parish Council
Borough Green Parish Council
Birling Parish Council
Burham Parish Council
Ditton Parish Council
East Malling Parish Council
East Peckham Parish Council
Hadlow Parish Council
Hildenborough Parish Council
Kings Hill Parish Council
Leybourne Parish Council
Mereworth Parish Council
Offham Parish Council
Platt Parish Council
Plaxtol Parish Council
Ryarsh Parish Council
Snodland Town Council
Stansted Parish Council
Trottiscliffe Parish Council
Wateringbury Parish Council
West Malling Parish Council
Wouldham Parish Council
West Peckham Parish Council
Wrotham Parish Council
Alciston Parish Meeting
Alfriston Parish Council
Arlington Parish Council
Berwick Parish Council
Buxted Parish Council
Chalvington with Ripe Parish Council
Chiddingly Parish Council
Crowborough Town Council
Cuckmere Valley Parish Council
Danehill Parish Council
East Dean & Friston Parish Council
East Hoathly with Halland Parish Council
Fletching Parish Council
Forest Row Parish Council
Framfield Parish Council
Frant Parish Council
Hadlow Down Parish Council
Hailsham Town Council
Hartfield Parish Council
Heathfield & Waldron Parish Council
Hellingly Parish Council
Herstmonceux Parish Council
Hooe Parish Council
Horam Parish Council
Isfield Parish Council
Laughton Parish Council
Little Horsted Parish Meeting
Long Man Parish Council
Maresfield Parish Council
Mayfield & Five Ashes Parish Council
Ninfield Parish Council
Pevensey Parish Council
Polegate Town Council
Rotherfield Parish Council
Selmeston Parish Meeting
Uckfield Town Council
Wadhurst Parish Council
Warbleton Parish Council
Wartling Parish Council
Westham Parish Council
Willingdon & Jevington Parish Council
Withyham Parish Council

The list of consultation stakeholders targeted for the initial distribution of the consultation material was in was agreed in advance[2] with the CAA.

The consultation was open to everyone, and in order to maximise awareness a press release was issued to local media. This outlined what the consultation was about, the consultation process and the deadlines for feedback. GAL also contacted a number local authorities and parish councils notifying them of the consultation. The consultation material was publically available for download from the GAL website www.gatwickairport.com/prnav and from GATCOM's website, www.gatcom.org.uk.

GAL met with several representative groups to present PRNAV to communities around the airport and to give people the opportunity to ask questions and seek clarification. Meetings were held with GATCOM, Dormansland PC, Leigh PC, Capel PC, Felbridge PC, Domewood PC, East Grinstead TC.

A total of 32 stakeholders were contacted in the initial distribution of the consultation. A full list of these stakeholders is available on page 40 of the Consultation Document. In total 94 stakeholders were involved in the Consultation. 25 of the stakeholder organisations did not respond to the consultation. 69 stakeholders responded, of which 10 responses indicated a neutral position (no comment or no objection). 6 respondents said they supported the proposal and 53 had an objection to at least one of the routes (see Figure 2).

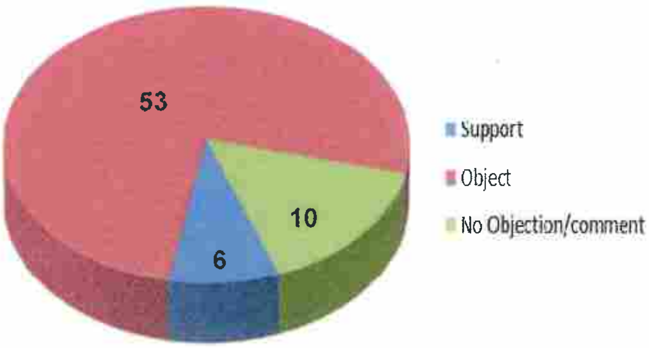


Figure 2. All stakeholders' responses pie chart

Figure 3 shows the breakdown of the responses to the individual routes. This shows that for seven of the routes there was little objection, the majority of the objections were specifically related to route 2.

[2] In accordance with the Future Airspace Strategy process agreed with the CAA. (Policy for the Application of Performance-based Navigation in UK_Irish Airspace - Signed 111013.pdf)

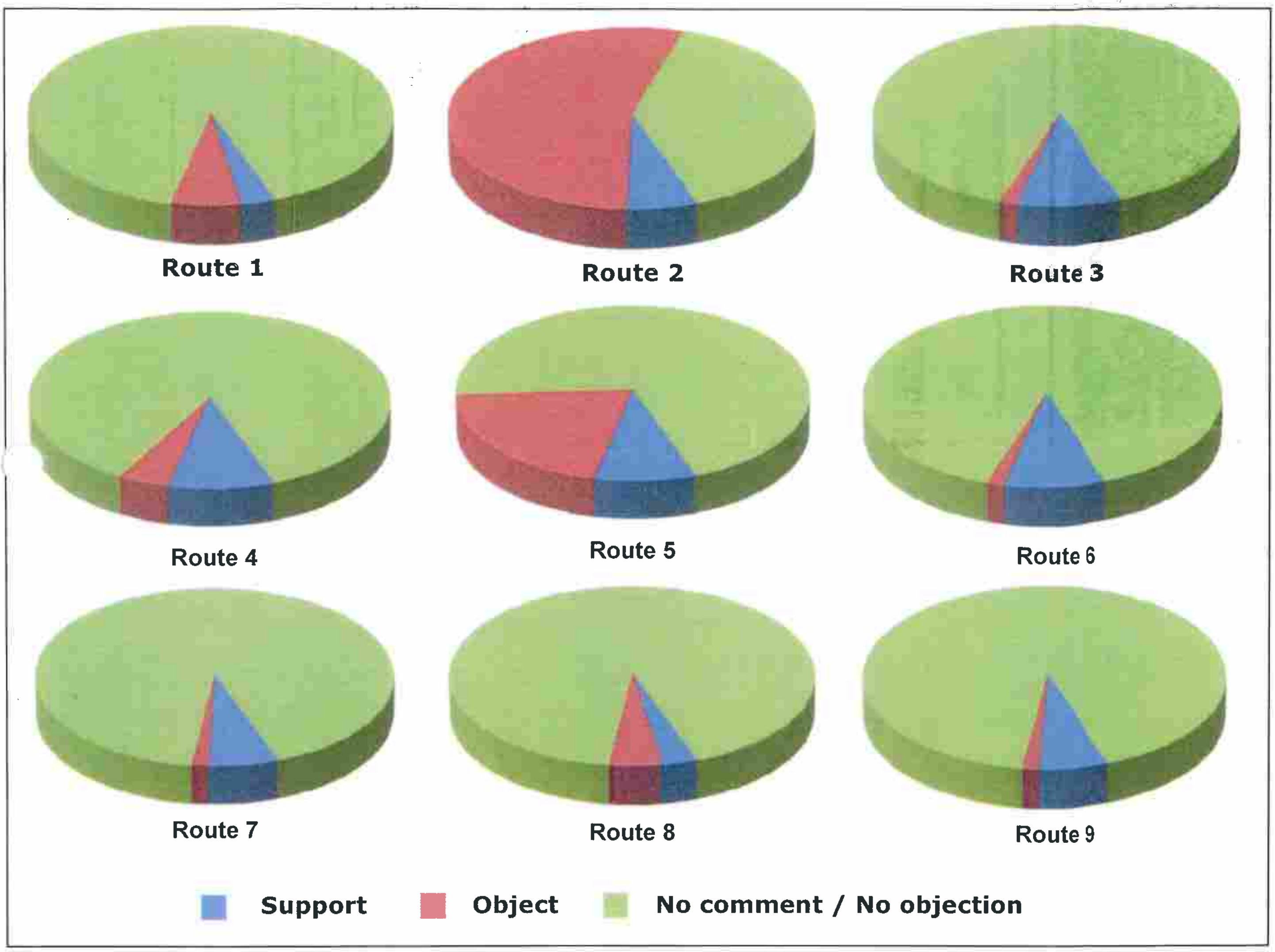


Figure 3. Stakeholder responses to each route

3.1 Key themes arising from objections

Figure 4 and Figure 5 below show the breakdown of the responses from organisations and members of the public respectively. Route 2 and 5 received the majority of the objections, the other routes received only 1 or 2 objections (which includes one stakeholder who objected to all routes).

Route 2

Of the nine routes proposed, route number 2 received the most objections (5 from organisations and 32 from individuals). This route passes just west of East Grinstead. The proposed PRNAV centreline positions aircraft to the left of the NPR centreline whereas previously (utilising conventional navigation) the traffic was more dispersed to the right of the NPR centreline. Using PRNAV the distribution of traffic is more concentrated, and it is contained entirely within the NPR.

It should be noted that route 2 was one of the routes included in the PRNAV trial, and as such a proportion of aircraft have been flying the PRNAV procedure since 2007.

Note: the PRNAV trial is not related to the change in operations of EasyJet as reported in the East Grinstead Courier & Observer 13-Sept-2012 which claimed that they had recently changed their route.

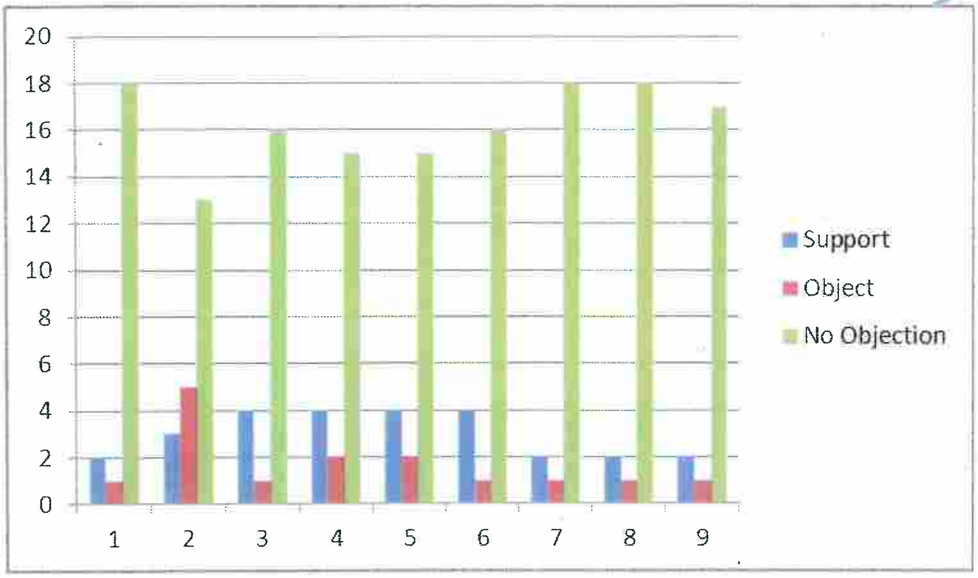


Figure 4 Responses from Organisations to each proposed route

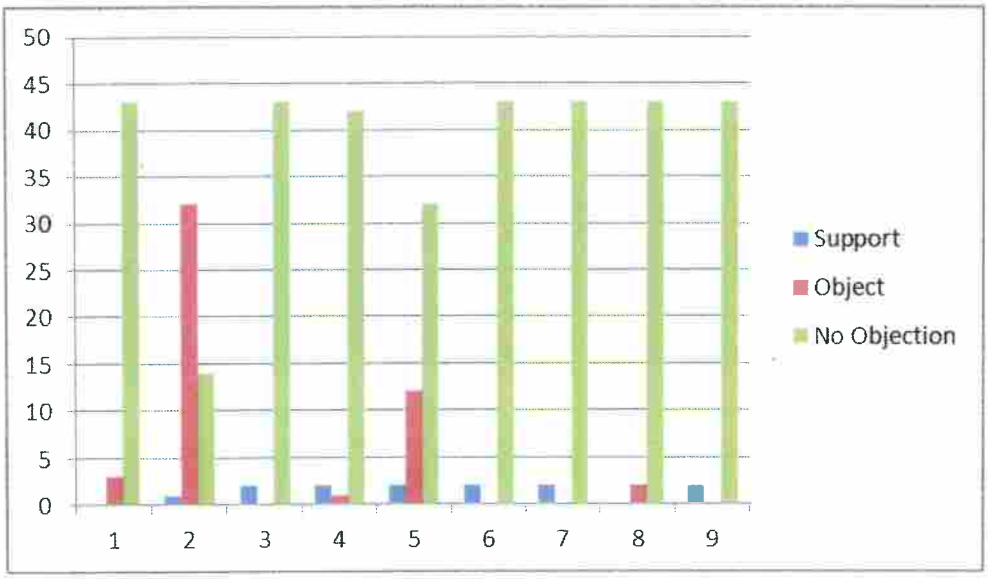


Figure 5 Responses from Members of the Public to each proposed route

4. Comments on particular issues

The objections were categorised according to the key themes identified in Figure 6 below. One response could include several themes & hence would be counted in each category. There were five recurring themes for objections, which were (in order of frequency): noise pollution; traffic concentration issues; air pollution /emissions; impact on property prices and process compliance. 53 responses included an objection to one or more of the routes. The pre-eminent reason given for objections was on the grounds of noise pollution. This was cited in almost all responses where any reason for the objection was given.

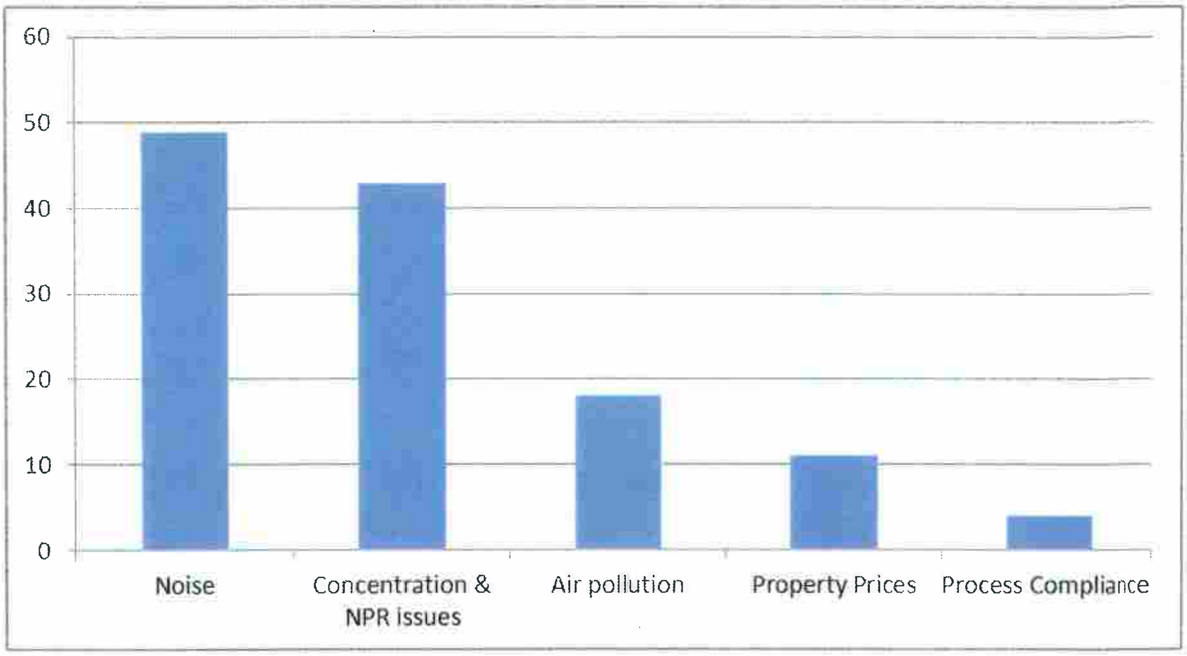


Figure 6. Key themes arising from objections

Within each of the themes, particular and recurring issues could be identified. These are summarised below, with comments.

4.1 Noise Pollution

Noise pollution is recognised as being the most significant impact of overflying aircraft at low levels. Government policy[3] for the minimizing the impact of noise pollution from aircraft at low level on the population, is to encourage concentration of flights in a few narrow corridors as opposed to dispersal across wider areas. Gatwick Airport is designated under section 80 of the Civil Aviation Act 1982 for the purposes of section 78 of that Act, giving rise to the descriptor "designated airports". Section 78 empowers the Secretary of State to regulate noise and vibration connected with aircraft taking off or landing at designated airports. As Gatwick is a designated airport, Noise Preferential Routes (NPRs) have been defined by the Department for Transport, within which aircraft are required to stay until they achieve a given altitude (4000ft for the Gatwick NPRs). The NPRs are defined as 3km wide swathes. The purpose of the NPRs is to define corridors in which people can expect to see over-flying aircraft.

The PRNAV routes proposed are designed to keep flights within the NPR corridors. Due to the greater accuracy of PRNAV navigation, aircraft will be kept within the NPR with improved reliability.

4.2 Changes in traffic concentration

The recurring theme of most of the objections to the proposal for route 2, were centred on the

[3] http://www.caa.co.uk/docs/7/DTLREnvironmentalGuidance.pdf (page 13)

movement of the flight concentration within the NPR swathe. In particular, that if the proposed PRNAV SID that had been trialled, were permanently adopted, the average centreline would be east of the NPR centreline.

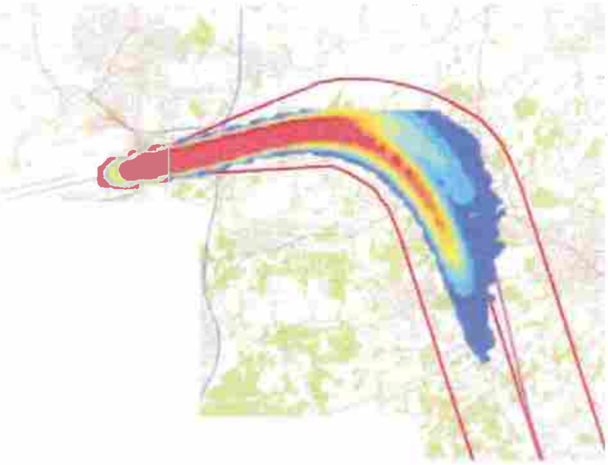


Figure 7: Route 2 dispersal – all flights

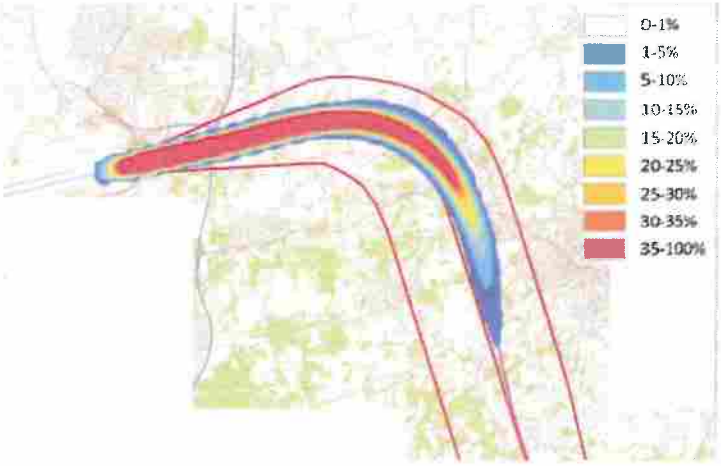


Figure 8 : Route 2 dispersal – PRNAV flights only

Figure 7 shows that using conventional navigation, flights are dispersed more widely across the width of the NPR. Figure 7 shows that flights using PRNAV navigation maintain a much more consistent trajectory, and are concentrated closer to the NPR centreline. While this keeps aircraft close to the centre of the NPR, the change does bring the tracks slightly closer to East Grinstead. Due to the required design constraints for PRNAV procedures[4] it is not possible to match exactly, the NPR centreline (see Figure 9 below). As a result, the PRNAV SID design centreline is positioned slightly to the east just after the initial turn. The maximum distance of the PRNAV procedure centreline from the NPR centreline is 370m.

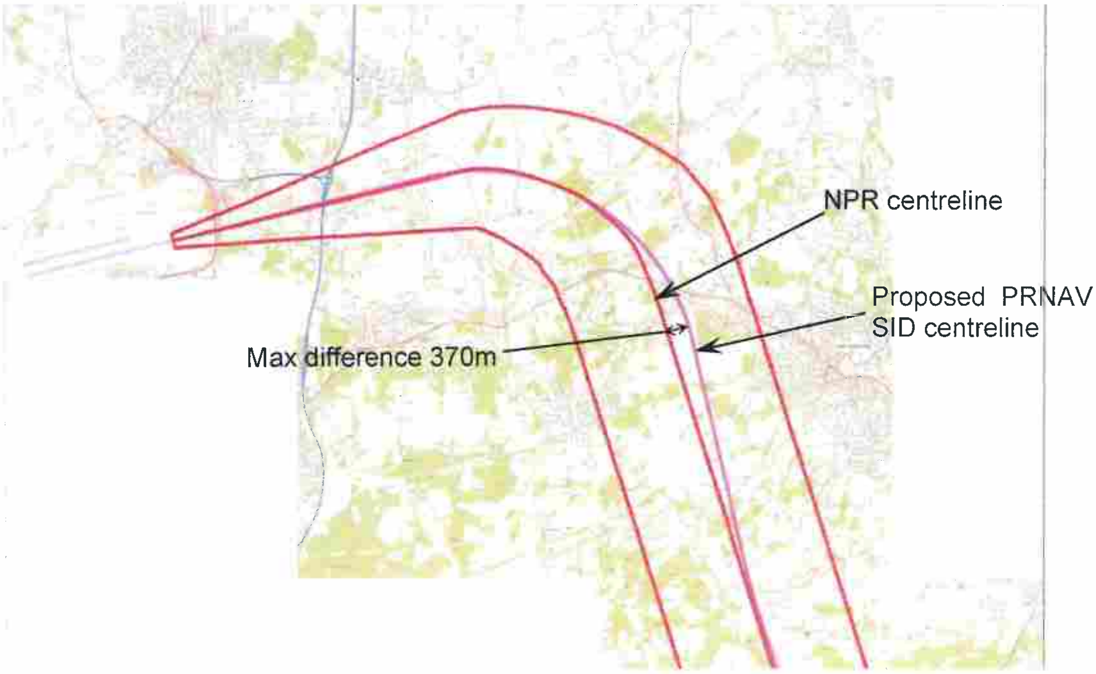


Figure 9 Route 2, NPR & PRNAV SID centrelines

[4] ICAO PANS-OPS, Doc 8168

4.3 Air pollution (Local Air Quality)

Some members of the public were concerned about possible air pollution resulting from the proposed change in the SIDs. The quality of the air around the UK's major airports is closely monitored. There is one Air Quality Management Area (AQMA) adjacent to Gatwick Airport – the Horley Gardens AQMA designated by Reigate and Banstead Borough Council. An AQMA is a legally defined area in which air quality is strictly monitored by the Local Authority and the airport operator. The impact of aircraft operations at the airport, both on the ground and during the take-off and landing cycles, has a potential to impact on the air quality in the AQMAs. However the majority of the impact is due to operations on the ground and at altitudes below 1000ft. Once airborne, due to mixing and dispersion in the atmosphere, the impact of emissions on local air quality of aircraft above 1000ft is much less.

The ICAO Airport Air Quality Manual states that:

"Differences to emissions above 1000 AGL will have little impact on changes in ground-level concentrations."

The design criteria for PRNAV procedures require that aircraft climb straight, along the runway extended centreline to more than 1000ft agl before turning. Hence the changes suggested by this proposal would not have an effect on the local air quality at ground level. For this reason detailed Local Air Quality assessment was not required by the CAA.

4.4 Property prices

Some respondents expressed concern that the price of their property would be adversely affected by the proposed change. While it is understood that aircraft noise could (amongst many other factors) influence the value of a particular property, property prices on their own (as distinct from noise impact) are not considered when making airspace changes. Government policy directs the sponsors of airspace changes to strive to minimize the noise impact on populations. However since the two are inter-related, the corollary of minimizing the noise impact on the population is also to minimize the impact on property prices.

4.5 Process compliance, consultation.

Some respondents to the consultation objected on the grounds that they had not been adequately consulted with. However the list of stakeholders identified as primary recipients of the consultation material was agreed with the CAA in accordance with CAA guidance. The consultation material was distributed to an extensive list of stakeholders and the responses received are evidence that the information has been disseminated widely.

Stakeholders who came forward during consultation have been included in the dialogue alongside those who were contacted initially, and their input has been given equal weighting.

5. Summary of intended Airspace Change Proposal

As a result of careful consideration of all Consultation responses, GAL intends to proceed to submit an Airspace Change Proposal (ACP) to the CAA. The basis of this proposal will be for the introduction of new PRNAV SIDS which replicate the existing conventional SIDs as closely as possible (as described in the consultation document). This ACP will be considered by the CAA and they will reach a decision in spring 2013.

To allow for aircraft which are not yet PRNAV equipped, the conventional SIDs will remain available until such time as the aircraft PRNAV equipage rate is close to 100%. This will facilitate a gradual, managed transition to PRNAV. The proposed implementation date for the PRNAV SIDs to be introduced is 04 April 2013. However this is dependent on many factors, including CAA approval of the proposed change.

The consultation period for this airspace change proposal closed on 19th October 2012, if you have any further comments you may wish to make, these will still be accepted, and if they present new evidence, may still influence the final airspace change proposal. All responses submitted will be forwarded to the CAA Directorate of Airspace Policy who will consider the merits of this proposal.

APPENDIX E

Annexe E

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APPENDIX F

NATS

Operational Analysis Report 0849

Gatwick P-RNAV SID Trials – Final Analysis of Phases I and II

Action	Role	Name	Signature	Date
Author	Analyst	[redacted]		10/11/2008
Approved	Reviewer	[redacted]		
Authorised				

Signature box only required for Issue 1 Documents; signatures NOT required on subsequent issues

Notices

Any copies printed from the online version are to be treated as uncontrolled.

Publication history

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Reviewers [Optional – in draft]

Reviewers	Name of individual
Mandatory (signatories)	
Optional	

Referenced documents

Contents

1 Executive Summary

The purpose of the Gatwick SID trials was to assess the track-keeping ability and speed conformance of P-RNAV flights. Four SIDs were flown during these trials, with the trials split into two phases. Phase I ran from 27th September 2007 to 7th May 2008 and had a 210kt speed restriction on three of four SIDs. Phase II then ran from 8th May 2008 onwards and had an increased speed restriction of 220kt. Performance of all aircraft participating in Phase I, and of aircraft participating during Phase II up until 16th September 2008 is analysed.

During Phase I, the average speed observed was greater than or equal to the 210kt speed restriction, and more than 50% of flights on two of the SIDs with this restriction were observed to have been speeding. In contrast, during Phase II speeding was reduced, with the average speed observed to be less than or equal to the 220kt restriction, and with less than 50% of flights observed to be speeding. Statistical analysis suggests that some differences in percentages observed to be speeding during Phases I and II are significant. Based on the limited information available, it would appear that there is little relationship between the speed conformance of an aircraft and aircraft type.

The trials have shown that P-RNAV equipped aircraft clearly comply with (and, in the trials, are better than) the RNP1 standard for track-keeping. This was observed in both Phases I and II. No pattern between aircraft type and track-keeping was identified.

One aspect under consideration in the study is the ability of P-RNAV flights to conform to their noise preferential routes (NPRs). Three of the SIDs coincide with their associated NPRs in both Phase I and in Phase II, and so conclusions are as for the SID track-keeping ability. However, one of the SID centrelines (CLN1X/CLN2X) is not in the same location as the corresponding NPR centreline, hence no conclusions are reached about the ability of P-RNAV aircraft to fly this NPR.

Finally, comparative analysis with aircraft flying non P-RNAV SIDs during the trials shows that larger deviations from the centreline of the tracks were observed for non P-RNAV aircraft. This implies that the track-keeping ability of P-RNAV aircraft is an improvement on that of non P-RNAV aircraft.

2 Introduction

The purpose of the Gatwick P-RNAV trials was to assess the track-keeping ability and speed conformance of P-RNAV flights. There are four SIDs participating in these trials, with the trials split into two phases. Phase I ran from 27th September 2007 to 7th May 2008, with Phase II beginning on 8th May 2008. The most recent update of flights participating in the trials during Phase II includes information up until 16th September 2008. Hence almost one year of data is analysed. A separate analysis of both Phases I and II, and also a comparative analysis, is included.

The trials are concerned with the speed conformance of P-RNAV flights, and with their track-keeping ability. In particular, the analysis addresses:

1. What percentages of aircraft flying the P-RNAV SIDs do not conform to the published speed restriction at a nominated survey point?
   - 1.1 What is the distribution of speeds at the survey point?
   - 1.2 How does speed conformance compare between Phases I and II?
   - 1.3 Is there a relationship between airline/aircraft type and speed non-conformance?
2. How accurately do aircraft fly the P-RNAV SID nominal track?
   - 2.1 How do the track-keeping results compare between Phases I and II?
   - 2.2 Is there a difference between track-keeping to the SID and NPR nominal tracks?
   - 2.3 How does the accuracy of P-RNAV flights during Phases I and II compare to non P-RNAV flights on similar SIDS over the same periods of time?

During Phase I, there was a 210kt speed restriction imposed on three of the four SIDs participating in the trials. For Phase II this restriction was increased to 220kt. Figure 2.1 shows the SID centrelines for Phase I and for Phase II, and the corresponding speed analysis points for each of the SIDs. The survey points used for speed analysis are:

CLN1X/CLN2X	51 10 38N	000 20 04W
SAM1X	51 07 17N	000 23 00W
SAM1Z/SAM2Z	51 13 16N	000 03 58W
SFD1Z/SFD2Z	51 09 47N	000 04 23W.

The SIDs marked CLN1X, SAM1Z and SFD1Z are Phase I SIDs with a speed restriction of 210kt. Those marked CLN2X, SAM2Z and SFD2Z are Phase II SIDs with a speed restriction of 220kt. The SID named SAM1X is used in both phases and has a speed restriction of 250kt. The change in centreline shown for CLN1X, SAM2Z and SFD2Z in comparison to their Phase I counterparts is a consequence of the increased speed restriction.

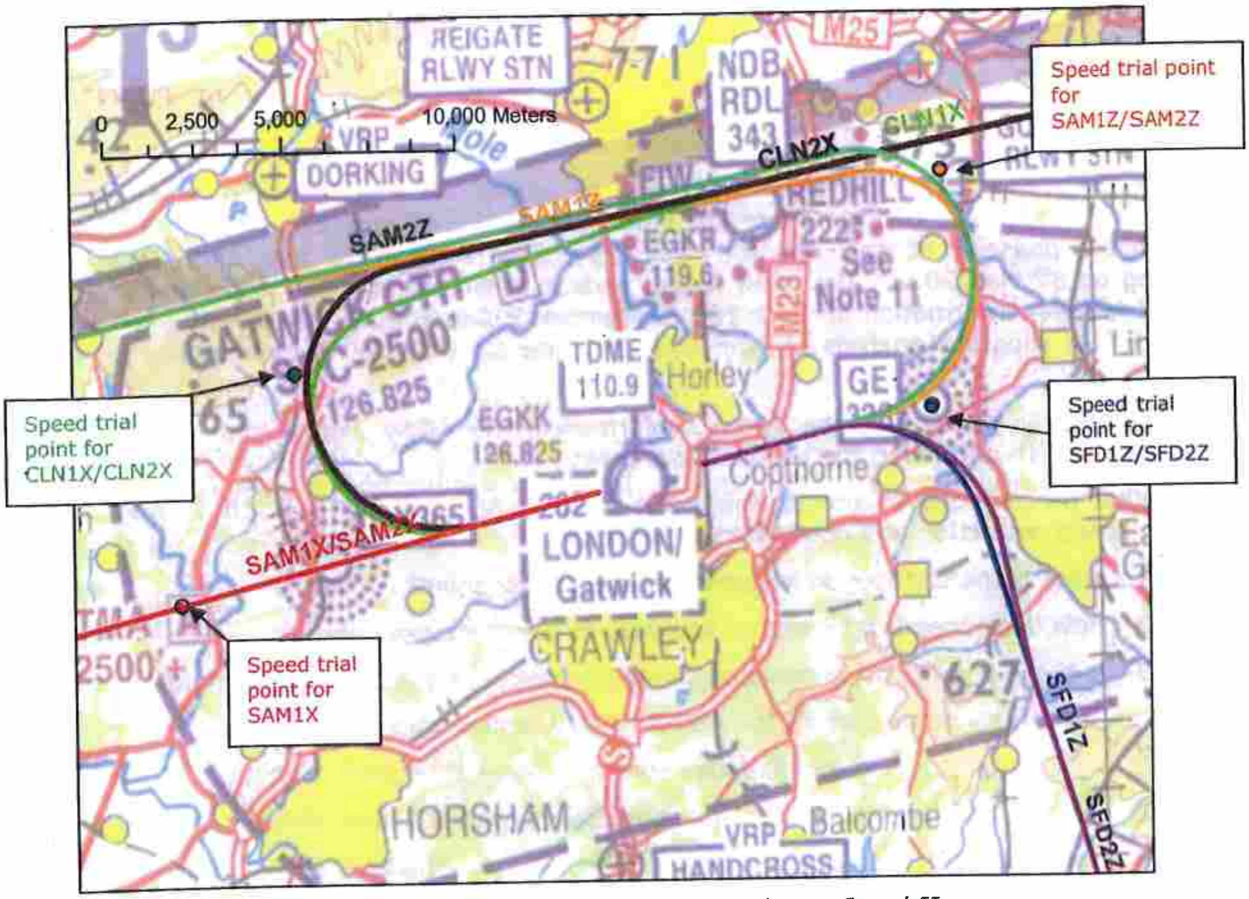


Figure 2.1: P-RNAV SID centrelines and speed trial points, Phases I and II.

Between 27th September 2007 and 7th May 2008 (Phase I) there were 383 flights participating in the P-RNAV trials, broken down over the four SIDs as shown in Table 2.1. Uptake for the trials was lower during Phase II despite the increase in speed restriction, with 149 flights participating in total. A breakdown by SID for this phase is given in Table 2.1. This table also shows the percentage of flights on each SID. The increase in uptake on SAM1X during Phase II is perhaps due to the late introduction of SAM1X as a P-RNAV SID during Phase I (SAM1X was not flown P-RNAV until November 2007).

SID	Phase I	Phase II
CLN2X/CLN1X	42 (11%)	7 (5%)
SAM1X	95 (25%)	59 (40%)
SAM2Z/SAM1Z	101 (26%)	31 (21%)
SFD2Z/SFD1Z	145 (38%)	52 (35%)
Total	*383*	*149*

Table 2.1: Breakdown of P-RNAV flights split by SID, Phases I and II (to 16th September 2008)

Analysis of track-keeping ability and of speed conformance is based on radar track data for each flight. This radar data is plotted in ArcView to show the track taken by each aircraft in comparison to the designated centreline of the SID. The radar data also contains information on the IAS of each flight, used for analysis of speed conformance.

3 Speed Trial Analysis

3.1 Overview

For each of the four SIDs there is a designated survey point for speed analysis. Figure 2.1 shows that the speed trial survey points do not lie directly on the SID centrelines of either CLN1X/CLN2X, SAM1Z/SAM2Z or SFD1Z/SFD2Z. Hence not every aircraft will fly directly over the speed trial point. Similarly, on SAM1X although the speed analysis point lies on the centreline of the SID, deviations from track and the time between radar observations mean that IAS readings will not be available for every aircraft whilst directly at this point. Therefore the speed of an aircraft at the speed trial point is taken as the IAS of that aircraft at its closest point of approach to the survey point. Taking a reading for each aircraft at this closest point of approach gives a distribution of the speeds observed for each SID.

3.2 Summary of Results

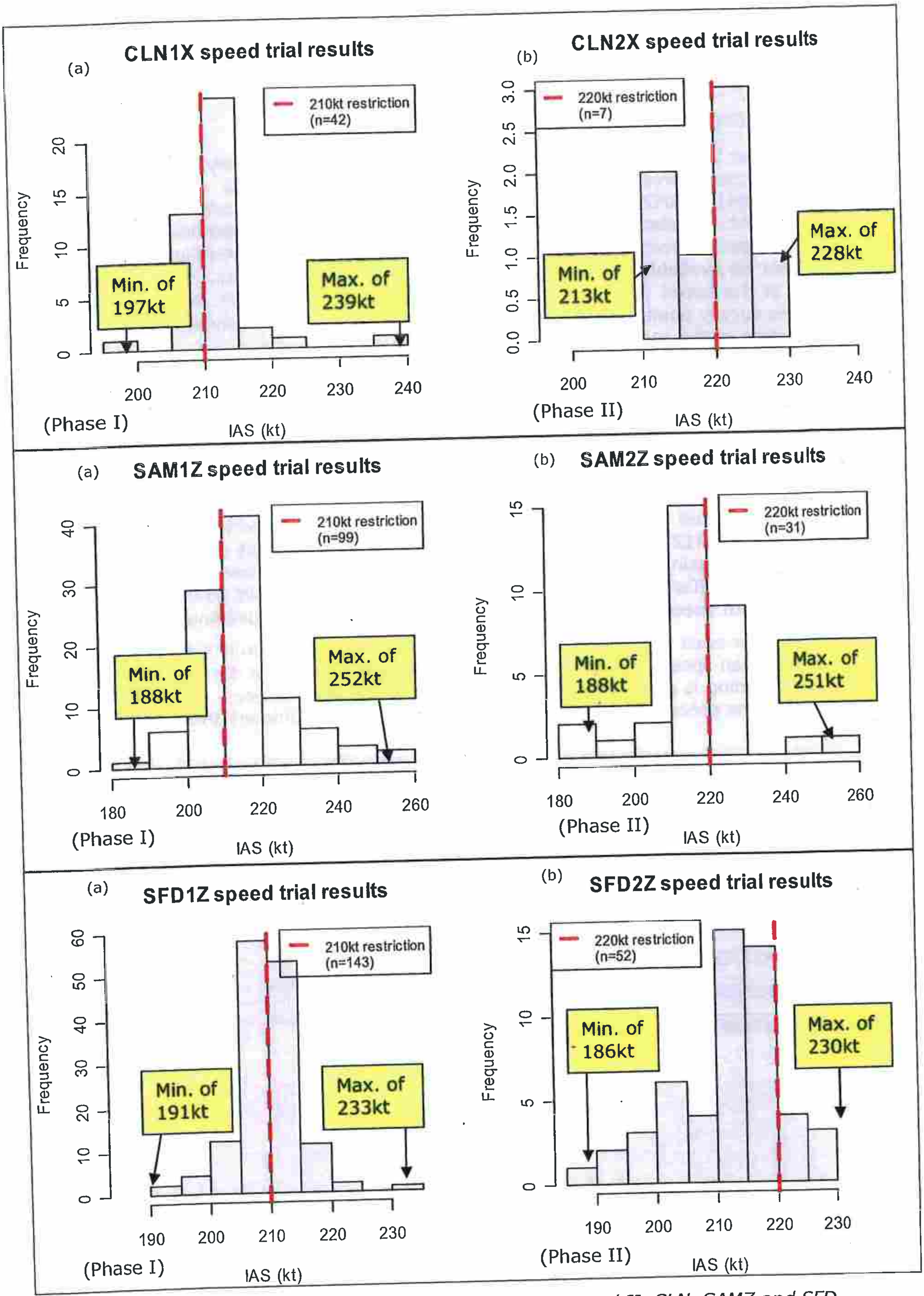
3.2.1 Phase I – CLN1X, SAM1Z and SFD1Z

During Phase I there was a 210kt speed restriction on CLN1X, SAM1Z and SFD1Z. Figures 3.1(a), 3.2(a) and 3.3(a) show the distribution of observed speeds for each of these SIDs during this phase. Also marked on these figures is the range of speeds observed for each SID – the widest range is on SAM1Z (from 188kt to 252kt). The maximum speed observed on any of the three SIDs is 252kt, again attributable to SAM1Z. Also note that the maximum speeds observed for each of the three SIDs are greater than the speed restriction of 210kt (marked on each of the graphs). Flights with speeds lying above this line are those which are speeding.

The mean speed for each SID, and the percentages speeding, are given in Table 3.1. On CLN1X and SAM1Z the mean speeds are greater than the speed restriction, and the percentage observed to have been speeding is greater than 50% (67% and 64%, respectively). On SFD1Z the mean speed is equal to the speed restriction, and just under half of all flights are observed to have been speeding (47%).

	Mean		**% Exceeding Restriction**	
	Phase I	*Phase II*	*Phase I*	*Phase II*
CLN1X/CLN2X	212	220	67%	57%
SAM1X	248		34%	
SAM1Z/SAM2Z	215	218	64%	35%
SFD1Z/SFD2Z	210	212	47%	13%

Table 3.1: Speed trial summary results, Phases I and II



Figures 3.1, 3.2 and 3.3: Speed trial distributions, Phases I and II, CLN, SAMZ and SFD.

3.2.2 Phase II – CLN2X, SAM2Z and SFD2Z

An increase in speed restriction to 220kt on CLN1X, SAM1Z and SFD1Z was allowed for Phase II. This increased speed restriction changed the track profiles to be flown, and the SIDs were re-named CLN2X, SAM2Z and SFD2Z, respectively. The distribution of observed speeds for these SIDs at the survey point for speed analysis are shown in Figures 3.1(b), 3.2(b) and 3.3(b). As before, the range of speeds is also illustrated, as is the speed restriction during this phase of the trials. The widest range of speeds is from 188kt to 251kt on SAM2Z. This observed speed of 251kt is also the highest speed on any of the three SIDs with the 220kt restriction. Note the similarity between the range of speeds observed on SAM1Z and SAM2Z. Of more interest, however, is whether the shape of the distribution of speeds between these limits is the same for the 220kt speed restriction as for the 210kt speed restriction, or whether this shape has changed. Here, statistical testing[1] suggests that there is a significant difference between the distribution of speeds on SFD1Z and SFD2Z, at the 95% confidence level. So changing the speed restriction has not simply kept the distribution of speeds the same and shifted the boundary above which aircraft are said to be speeding; it has changed the behaviour of the pilots in aiming for the 220kt restriction and consequently changed the overall shape of the speed distribution.

Statistical testing for the distributions of speeds on CLN1X/CLN2X and SFD1Z/SFD2Z return similar results. That is, the distribution of speeds has changed significantly by introducing the higher speed restriction. The mean speed from each of the distributions from Phase II, and the percentage of flights speeding during this phase, are given in Table 3.1. It can be seen from this that the mean speed on each of the three SIDs with the 220kt restriction is at or below this restriction (in comparison to during Phase I where the mean was at or above the speed restriction of 210kt). The percentages of aircraft observed to have been at speeds of above 220kt have decreased from the percentages observed on comparable SIDs during Phase I. Yet on CLN2X the observed percentage of speeding aircraft remains above 50%. Note, however, that the total number of aircraft taking part in Phase II of the trials on this SID is very small (only 9 aircraft).

Statistical testing[2] is used to determine whether these observed decreases in the percentage of speeding aircraft are significant. This testing suggests that the percentage of aircraft speeding during Phase I is significantly larger than the percentage of aircraft speeding during Phase II on SAM1Z/SAM2Z and SFD1Z/SFD2Z. Hence an increase to 220kt reduced the incidence of speed non-conformance. Testing for CLN1X/CLN2X is inconclusive given the small sample of aircraft for Phase II.

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[1] A Kolmogorov-Smirnov test for significant differences between the cumulative distribution function of distributions, implemented in R (ks.test()).

[2] A test for significant differences between two proportions, implemented in R (prop.test()).

3.2.3 Phases I&II – SAM1X

A 250kt restriction was applied to SAM1X throughout both Phases I and II. The distribution of speeds observed on this SID is illustrated in Figure 3.4. The mean of the distribution of observed speeds (see Table 3.1) was 248kt, with 34% observed to be speeding when at the survey point. The largest speed observed on this SID was only 10kt higher than the speed restriction.

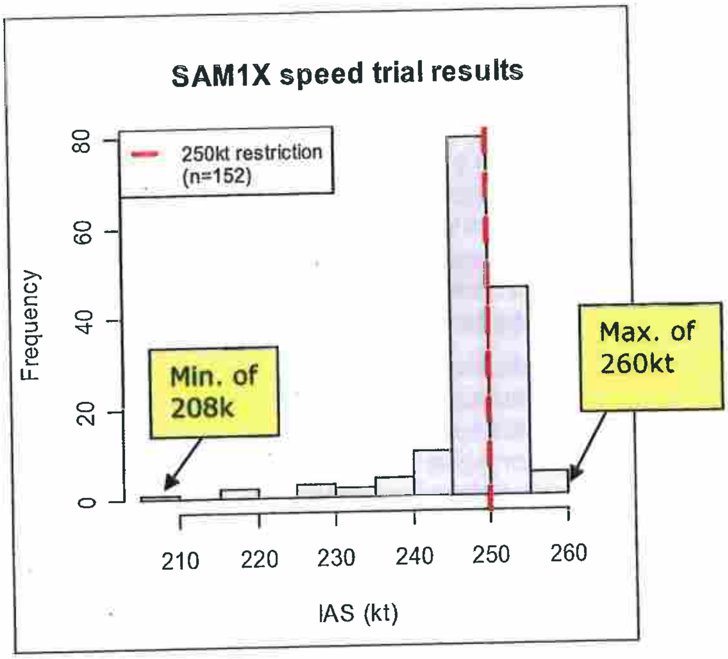

Figure 3.4: Speed trials distribution, SAM1X.

3.3 Speed Analysis by Operator

An illustration of speeding with respect to airline operator for Phases I and II combined is given in Figure 3.5 (corresponding values in Table 3.2). This shows that the highest incidence of speeding was for [redacted] and [redacted] where all aircraft were speeding. However, reference to Table 3.2 shows that only one aircraft from both airlines participated in the trials and so these percentages should not be considered a good indicator of behaviour of these operators. For operators with a reasonable number (>20, say) of flights participating in the trials the highest incidence of speeding was recorded for XL Airways (70%).

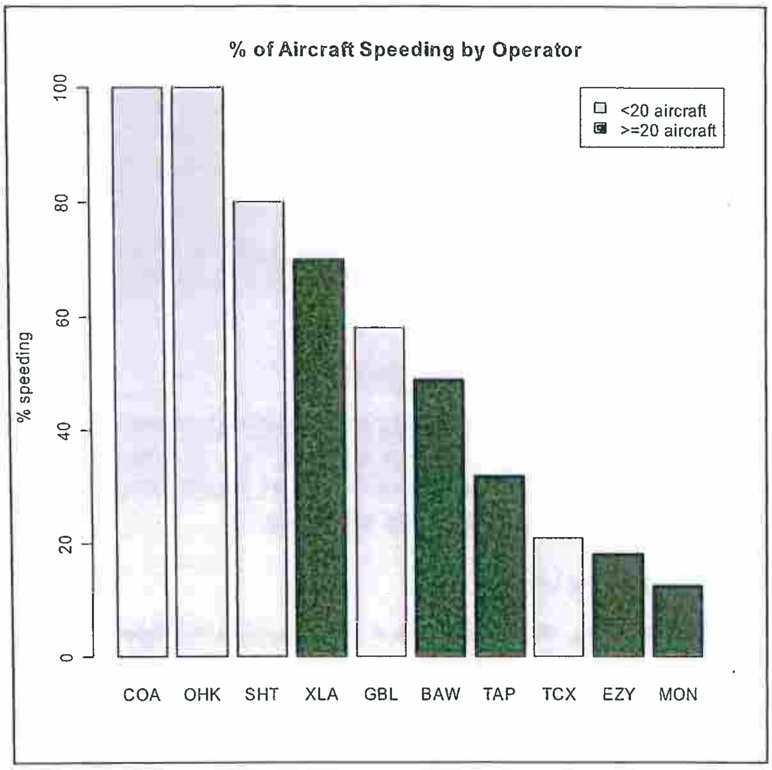

Figure 3.5: Percentage of aircraft speeding, by operator

Callsign (Operator)	Total Aircraft Participating	Percentage Speeding
[redacted]	1	100%
	1	100%
	5	80%
	20	70%
	12	58%
	372	49%
	25	32%
	14	21%
	44	18%
	32	13%

Table 3.2: Number of participating aircraft, and percentage speeding, by operator.

3.4 Speed Analysis by Aircraft Type

Wake vortex classifications are used to analyse speed conformance with reference to aircraft type. This gives the following categories:

Medium Aircraft (M): A319, A320, A321, B733, B734, B735, B738

Heavy Aircraft (H): A306, A332, B744, B772.

3.4.1 Phase I – CLN1X, SAM1Z and SFD1Z

During Phase I of the trials there were 38 aircraft on either CLN1X, SAM1Z or SFD1Z which were classified as heavy. Of these, 37 were attributable to SAM1Z and only 1 was attributable to CLN1X; no heavy aircraft flew on SFD1Z. The total number of medium weight aircraft was 134, of which 38 flew on CLN1X, 54 flew on SAM1Z and 134 flew on SFD1Z. There were also 19 flights for which no aircraft type data had been recorded in the P-RNAV log files. Given this, the only SID for which a split of speed conformance by aircraft type is informative is SAM1Z.

Of the heavy aircraft flying on SAM1Z, 67% (25 of 37) were at speeds of greater than 210kt; of the medium aircraft flying this SID, 59% (32 of 54) were at speeds of greater than 210kt. Statistical testing shows that the difference between these proportions is not significant, at the 95% confidence level.

3.4.2 Phase II – CLN2X, SAM2Z and SFD2Z

During Phase II of the trials 10 heavy aircraft participated; all were on SAM2Z. The further 21 flights on this SID were all classified as medium weight. Of the heavy aircraft, 40% (4 of 10) were speeding whilst of the medium aircraft, 33% (7 of 21) were speeding. Statistical testing is not appropriate here given the small sample sizes involved.

3.4.3 Phases I & II – SAM1X

During Phases I and II there were 76 heavy and 73 medium weight aircraft on SAM1X (plus 3 unclassified). Of the heavy aircraft, 38% were speeding whilst of the medium aircraft 29% were speeding. As before, this is not found to be a significant difference.

3.4.4 Phases I & II – All Data

The total number of heavy aircraft during both Phases I and II of the trials combined was 125. The total number of medium-weight aircraft during both phases was 379. In addition, there were 22 flights for which the aircraft type was not recorded. Of the heavy aircraft, 59 (47%) were observed to have been speeding at the analysis points. Of the medium aircraft, 160 (42%) were observed to have been speeding at the analysis points.

Based on these proportions, statistical testing finds no evidence to support the hypothesis that there is a significant relationship between aircraft type and speed non-conformance at the 95% confidence level.

4 Track-Keeping Accuracy of P-RNAV Flights

4.1 Overview

Radar tracks of all flights participating in Phase I of the Gatwick P-RNAV trials are shown in Figure 4.1. These tracks have been filtered to the height at which an aircraft may be vectored away from the SID by the controller. So on CLN1X, SAM1X and SFD1Z a height filter has been applied at 4,000ft. On SAM1Z a lower height filter, of 3,000ft, has been applied as departures on this Easterly SID can be vectored at this lower level. Although some may stay on the SID up to 4,000ft, filtering at 3,000ft gives the best objective cut-off for purposes of analysis.

One anomalous flight path on SAM1X can be identified on this Figure (relating to flight BAW2167 on 12th April 2008). It is known that on this date an infringement in the Gatwick zone led to aircraft being tactically vectored from their SIDs, and so this radar track is not included in any further analysis. On CLN1X there is one flight which appears to under-cut the line of the first turn. This is BAW2690 on 4th April 2008. Further investigation into this flight may be useful, although it has not been removed from analysis.

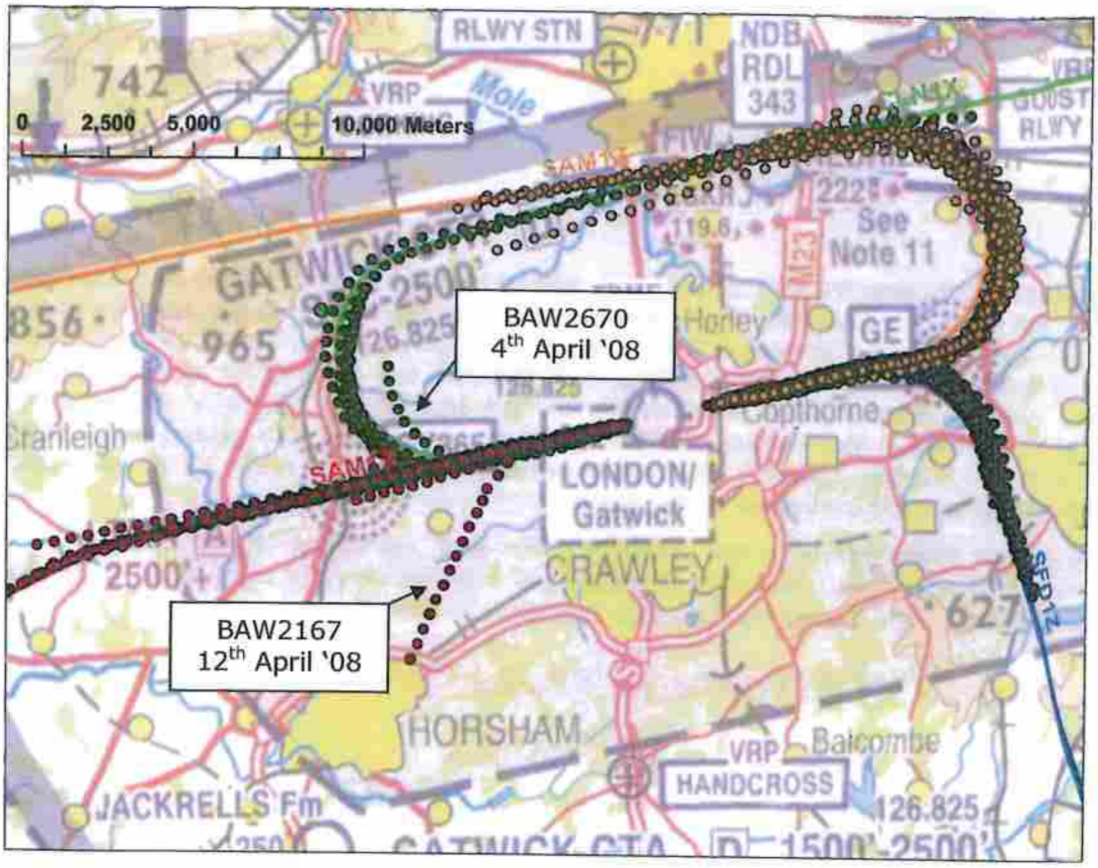

Figure 4.1: Filtered radar tracks of P-RNAV flights, Phase I

Radar tracks of all flights participating in Phase II of the Gatwick SID trials from 8th May to 16th September 2008 are shown in Figure 4.2. Here all tracks have been filtered at 4,000ft as the increased speed restriction means that climbs are faster and 4,000ft is reached more quickly.

Two unusual flight paths can be identified from these tracks – one on SFD2Z (EZY13D on 20th May) and one on SAM1X (BAW8033 on 3rd July). Radar replay for BAW8033 shows that the flight was directed to leave the SID early due to weather conditions. It is also likely that EZY13D was put on a heading, as other cases where an aircraft has deviated early from the SID have been found to be due to controller intervention. Therefore both aircraft have been removed from the track-keeping analysis.

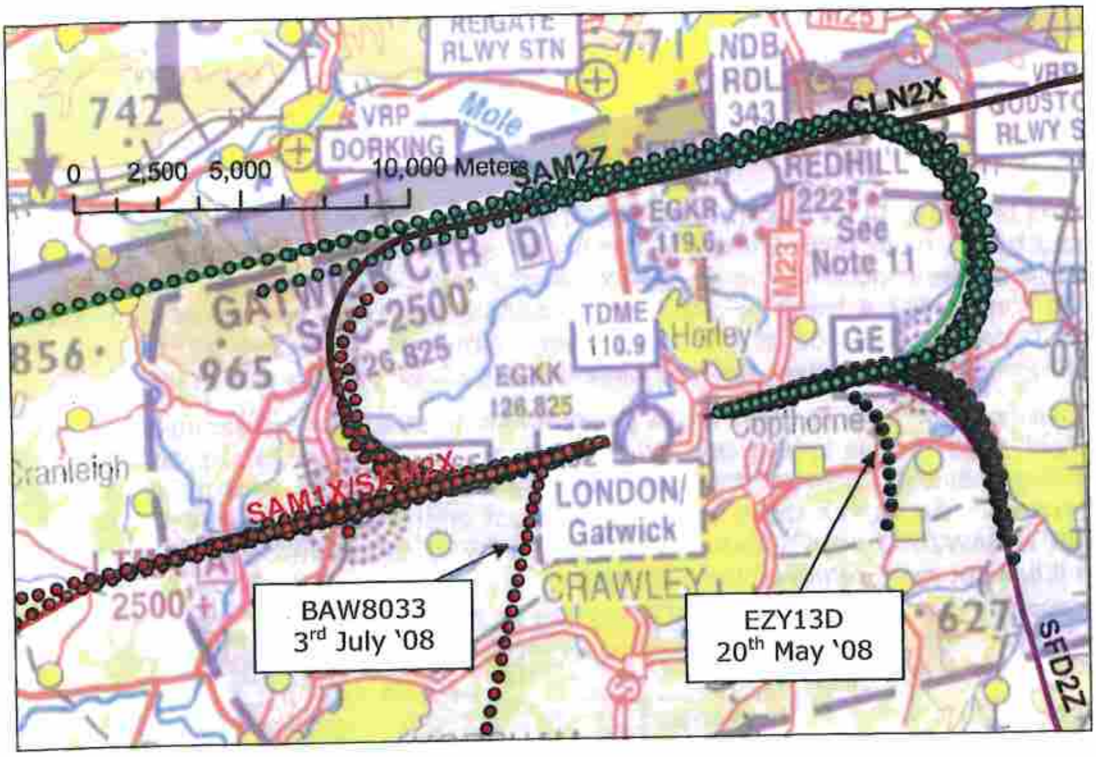

Figure 4.2: Filtered radar tracks of P-RNAV flights, Phase II

Analysis of track-keeping for both phases is based on the distances between the radar points and the SID. For each individual flight the distance between each radar point and the centreline of the SID is measured (the 'deviation' from track). This gives a distribution of distances for that flight. To summarise track-keeping ability, two statistics are derived for each individual flight. First, the median measurement is taken as an indicator of the 'average' deviation from the centreline of the track - the median signifies the point above (and also below) which 50% of the measured deviations lie. Second, the maximum measurement is taken as an indicator of the worst deviation from the centreline of the track.

Note that both measurements are calculated for each individual flight. For each SID the distribution of median and maximum deviations is then formed, by combining the readings for each flight on that SID. Summary statistics are then calculated.

4.2 Track-Keeping Results for Phases I and II

4.2.1 Median (Average) Deviations from Track

Table 4.1 gives the range of median distances observed for flights on each SID during both Phases I and II of the P-RNAV trials. This table also gives the 95th percentile of the distribution of median distances. That is, 95% of the distribution of median deviations lies between the smallest measurement and the 95th percentile measurement. For illustration, Figure 4.3 shows the shape of the distributions and the location of the 95th percentile for SFD1Z and SFD2Z.

			Median distance from centreline (m)			
SID	*Phase*	*No.*	*Smallest*	*Largest*	*Range*	*95th Percentile*
CLN1X	I	42	8	163	155	137
CLN2X	II	7	49	253	204	241
SAM1X	I&II	151	9	241	232	87
SAM1Z	I	101	12	472	460	158
SAM2Z	II	31	34	460	426	320
SFD1Z	I	145	21	358	337	205
SFD2Z	II	51	32	361	329	277

Table 4.1: Median measurements from SID centreline, P-RNAV Phases I and II

During Phase I of the trials the largest of the median deviations on any of the three SIDs with the 210kt speed restriction was observed on SAM1Z (472m). During Phase II the largest median deviation (460m) was attributable to the 220kt counterpart to this SID, SAM2Z. These SIDs also have the largest ranges of median measurements for Phases I and II respectively, which illustrates that there was more variation in average track-keeping than for the other SIDs. So this is the P-RNAV route with the worst 'average' track-keeping during both phases of the trials. The smallest range in median deviations from the track is for CLN1X, implying that this is the SID for which track-keeping was best for Phase I of the trials. The best track-keeping for Phase II only was for CLN2X, based on the ranges calculated. These are also the SIDs associated with the lowest of the largest median deviations from track during their trial phases.

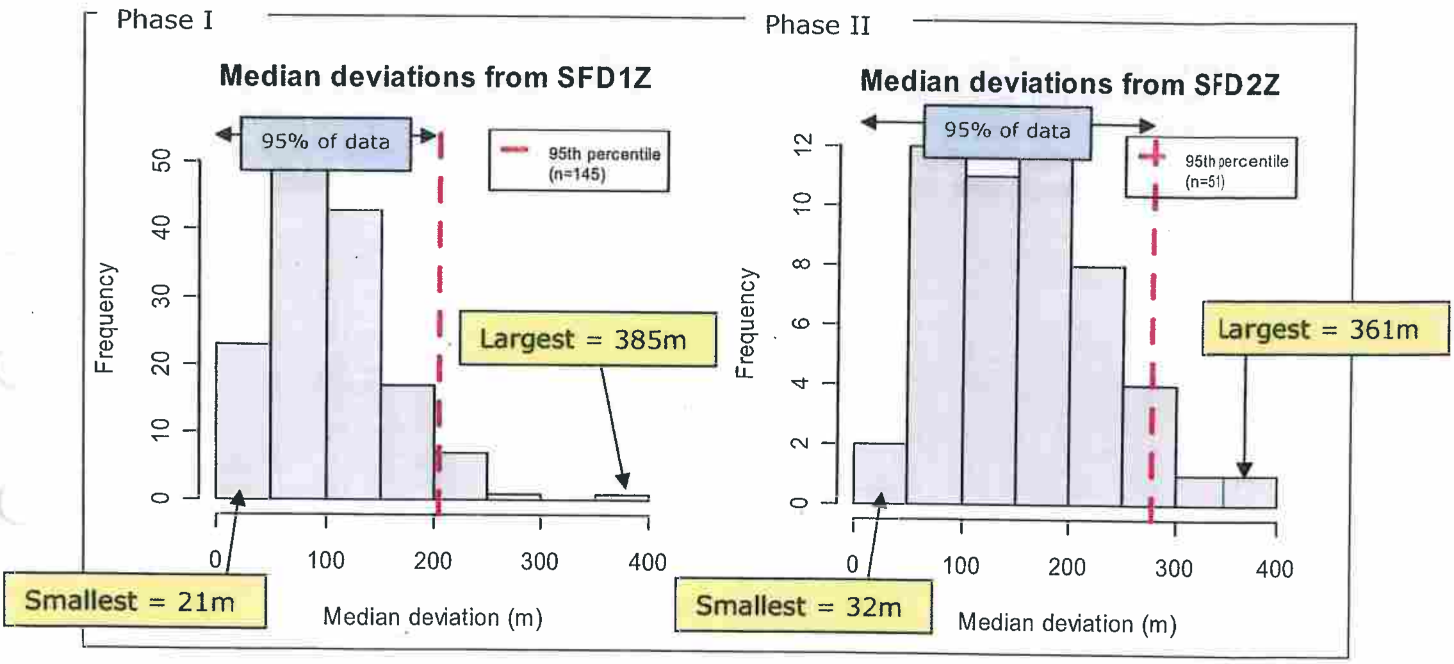

Figure 4.3: Distributions of median deviations from SID centreline, Phases I and II, SFD1Z and SFD2Z.

4.2.2 Maximum (Worst-Case) Deviations from Track

Table 4.2 gives the ranges of maximum distances observed from the track for flights on each of the SIDs during both phases of the trials. The 95th percentile is also given. For an illustration of the distribution of maximum deviations from track for SFD1Z and SFD2Z, see Figure 4.4.

			Maximum distance from centreline (m)			
SID	*Phase*	*No.*	*Smallest*	*Largest*	*Range*	*95th Percentile*
CLN1X	I	42	147	1,365	1,318	641
CLN2X	II	7	163	848	685	803
SAM1X	I&II	151	27	923	896	199
SAM1Z	I	101	44	1,606	1,562	851
SAM2Z	II	31	489	983	494	951
SFD1Z	I	145	117	873	756	683
SFD2Z	II	51	344	876	532	762

Table 4.2: Maximum measurements from SID centreline, P-RNAV Phases I and II

The largest of the maximum deviations is 1,606m, observed on SAM1Z. For Phase II, the largest of the maximum deviations was 983m, observed on SAM2Z. So these are the SIDs for which track-keeping is worst overall, based on deviations from track although is worth noting that the largest deviation from track is also high for CLN1X (1,318m).

Note that although there are some large deviations from track observed during both Phases I and II, the 95th percentile of each of the individual distributions is less than 1,000m. That is, 95% of the maximum deviations from track are within 1km from the SID at all times up until the height filter at 4,000ft (or 3,000ft on SAM1Z) is applied. Further, all deviations from the SID including the 5% of the distribution which lies in the tail above the 95th percentile are within 1Nm (1,852m) of the centreline. That is, all of the flights which took part in the P-RNAV trials which have been included in the final analysis were within 1Nm of the SID for 100% of the flight time up until they could have been vectored from the SID by the controller. Hence the flights have conformed to RNP1 standard.

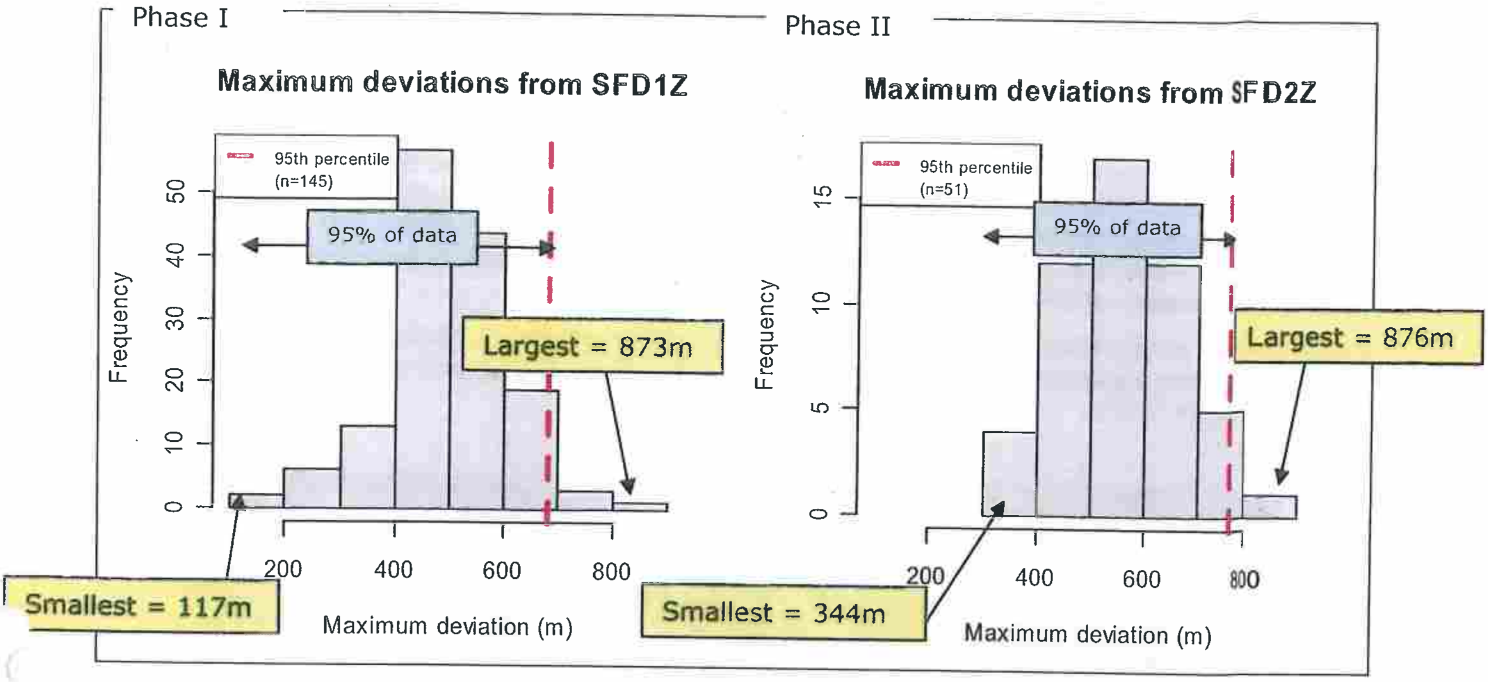

Figure 4.4: Distributions of maximum deviations from SID centreline, Phases I and II, SFD1Z and SFD2Z.

4.3 Track-Keeping Accuracy by Aircraft Type

To separate the track-keeping results by aircraft type the wake vortex classifications given in Section 3.4 have been applied. Again the analysis is only useful for SAM1Z during Phase I, SAM2Z during Phase II, and SAM1X over Phases I and II combined, given the limited number of heavy aircraft flying any of the other SIDs.

Table 4.3 splits the maximum deviations from the centrelines of each of these three SIDs by aircraft type.

				Maximum (m)			
	Phase	*Type*	*No.*	*Smallest*	*Largest*	*Range*	*95th Percentile*
SAM1Z	I	Medium	37	48	1,606	1,558	748
		Heavy	56	44	974	930	856
SAM2Z	II	Medium	21	489	875	386	813
		Heavy	10	603	983	380	982
SAM1X	I & II	Medium	72	27	924	897	196
		Heavy	76	28	294	266	199

Table 4.3: Maximum measurements from SID centreline split by aircraft type.

On SAM1Z and SAM1X, the worst off-track deviations of 1,606m and 924m, respectively, were observed for medium-weight aircraft, whilst on SAM2Z the worst off-track deviation of 983m was attributable to a heavy aircraft. Further, the 95th percentiles of the distributions of off-track deviations for medium and heavy aircraft take similar values for each of the three SIDs examined. It is therefore difficult to identify whether there is a pattern to track-keeping performance which can be associated with aircraft type.

5 NPR/SID Centreline Comparison

An additional objective of the Gatwick P-RNAV trials is to assess conformance of P-RNAV flights to the NPR centreline. On Figure 5.1 the SID and corresponding NPR for each of the Phase I P-RNAV routes is marked. In three of four cases (SAM1X, SAM1Z and SFD1Z) the SID and the NPR are similar. For CLN1X, this figure shows that the centrelines of the SID and the NPR are not the same. This implies that if flights are accurate in holding the centreline of the SID they will not be flying the NPR. This is a consequence of the design of the SID and not a consequence of the track-keeping ability of P-RNAV flights.

Track-keeping to the NPRs mapped close to the SIDs will be similar to track-keeping for the SIDs themselves. This applies to both Phases I and II, as the Phase II SIDs are similar to the Phase I SIDs (see Figure 2.1).

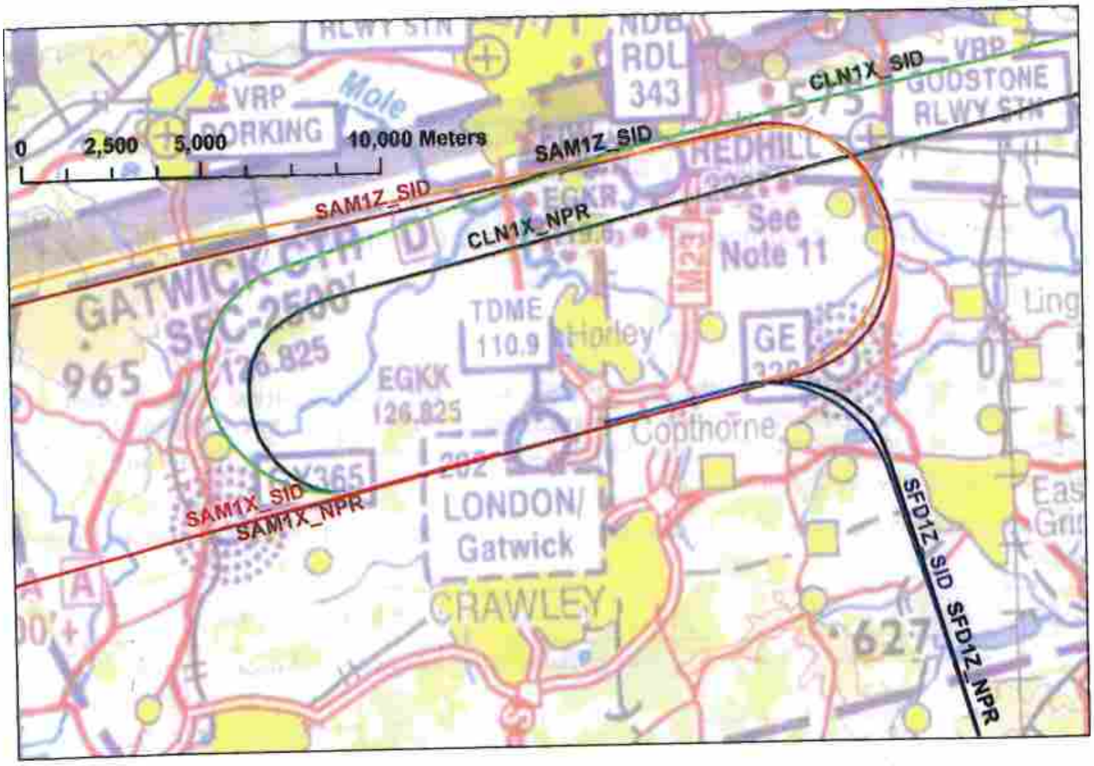

Figure 5.1: NPR comparison with Phase I SIDs

6 Track-Keeping Accuracy of Non P-RNAV Flights

The track-keeping accuracy of P-RNAV flights is compared to that of non P-RNAV flights on similar SIDs. The centreline of the non P-RNAV SIDs is the same as the Phase I centreline of the P-RNAV SIDs for all but the CLN route. Detailed route information for this SID is unavailable, and so the centreline used for analysis is a sketch. Any distances measured with reference to this centreline are estimates only. Figure 6.1 illustrates the centrelines used.

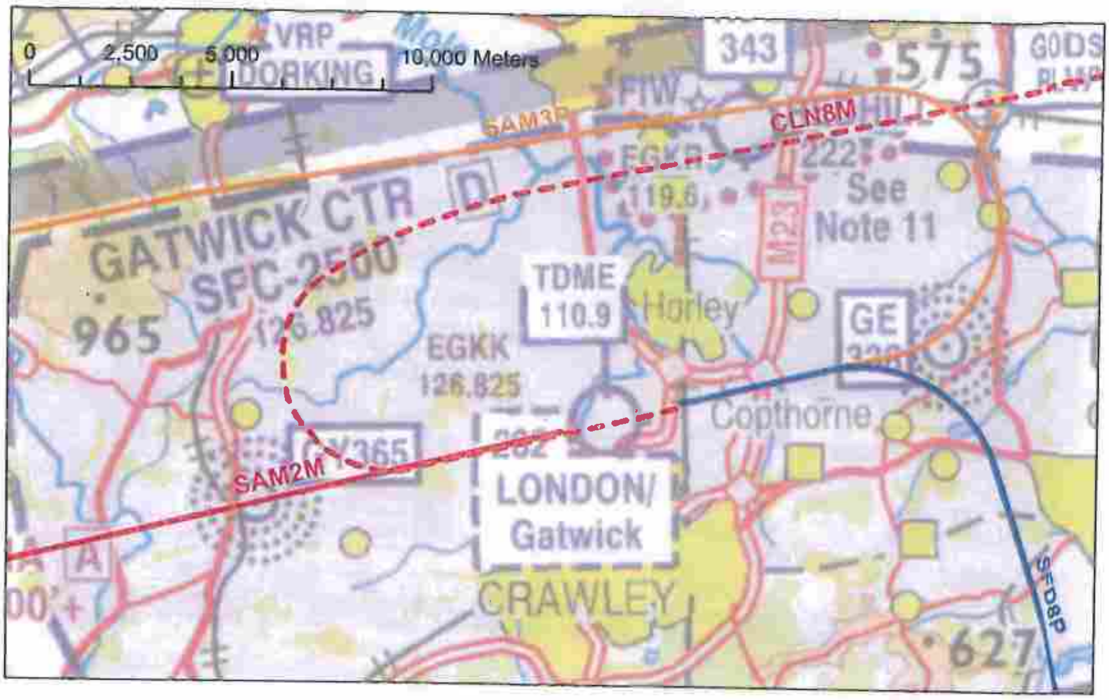

Figure 6.1: Non P-RNAV SID centrelines

For Phase I, non P-RNAV flight data was available for 27th September 2007 to 30th November 2007 for CLN8M (CLN1X), SAM3P (SAM2Z) and SFD8P (SFD1Z), and for 1st-30th November 2007 for SAM2M (SAM1X). In Phase II the way in which the radar track data was provided was changed, so that if there was at least one P-RNAV flight on a given day, radar tracks for non P-RNAV flights on each of the four SIDs for that day were also extracted. This means that the non P-RNAV dataset for Phase II consists of only of selected days of the month, but covers the same time period as the P-RNAV Phase II data. The number of non P-RNAV flights in the datasets used for the comparative analysis is given in Tables 6.1 and 6.4. Note that the dataset for both Phases I and II of non P-RNAV flight data is large, and that the number of non P-RNAV flights during both phases of the trials is far larger than the number of flights that have flown P-RNAV.

Note that the non P-RNAV pilots would not have been aware that their performance was to be observed, hence there may be a behavioural aspect that cannot be measured. Nonetheless, a comparison is interesting.

6.1 Phase I – Non P-RNAV

Figure 6.2: Non P-RNAV filtered radar tracks, Phase I dataset

The same method is applied to the radar data of non P-RNAV flights as was applied to P-RNAV flights – the radar tracks are filtered by height, and then measurements of the radar points from the centreline are taken for each flight. The filtered tracks for Phase I are illustrated in Figure 6.2, with summary statistics relating to the median measurements from the centreline, and the maximum measurements from the centreline, given in Tables 6.2 and 6.3 respectively. Tracks on SAM3P (comparable to SAM1Z) have been filtered at 3,000ft whilst those on each of the other three SIDs have been filtered at 4,000ft. This to allow a comparison between the track-keeping of P-RNAV flights to non P-RNAV flights at up to the same heights as applied in Section 4.

P-RNAV SID	Comparative Non P-RNAV SID	No. of Non P-RNAV flights in sample dataset
CLN1X	CLN8M	494
SAM1X	SAM2M	1,155
SAM1Z[3]	SAM3P	2,424
SFD1Z	SFD8P	2,711

Table 6.1: Summary of Phase I non P-RNAV dataset

Table 6.2 shows the median measurements of off-track deviations for these non P-RNAV flights. The best average performance is observed on SAM2M (comparable) to SAM1X where 95% are within 164m of the SID for 50% of the flight time up until the height filter is applied. By comparison with Table 4.1 it can be seen that the largest median deviations from the centrelines of the SIDs are higher for non P-RNAV flights in comparison to P-RNAV flights, and that the 95th percentiles of the non P-RNAV distributions of median distances are also higher than the 95th percentiles of the distributions of median deviations from track of P-RNAV flights. This implies that average track-keeping for P-RNAV flights is better than for non P-RNAV flights during Phase I of the trials. Statistical testing identifies only one case where the distributions of median deviations for P-RNAV and non P-RNAV flights can be considered the same – SFD1Z/SFD8P. These distributions are shown below. Also shown is the distribution of median deviations from SAM2Z/SAM3P as an illustration of a case where statistical testing returns a result to suggest that the distributions are significantly different from one another. In this case the difference in shape of the distributions arises from the longer tail to the right in the distribution of the non P-RNAV dataset. This tail represents larger median deviations from the SID.

	Median Distances (m)			
SID	Smallest	Largest	Range	95th Percentile
CLN8M	11	1,074	1,063	441
SAM2M	6	869	863	164
SAM3P	6	2,628	2,622	595
SFD8P	5	1,341	1,336	294

Table 6.2: Median distances from SID centreline, non P-RNAV flights, Phase I

[3] Filtered at 3,000ft for Phase I analysis

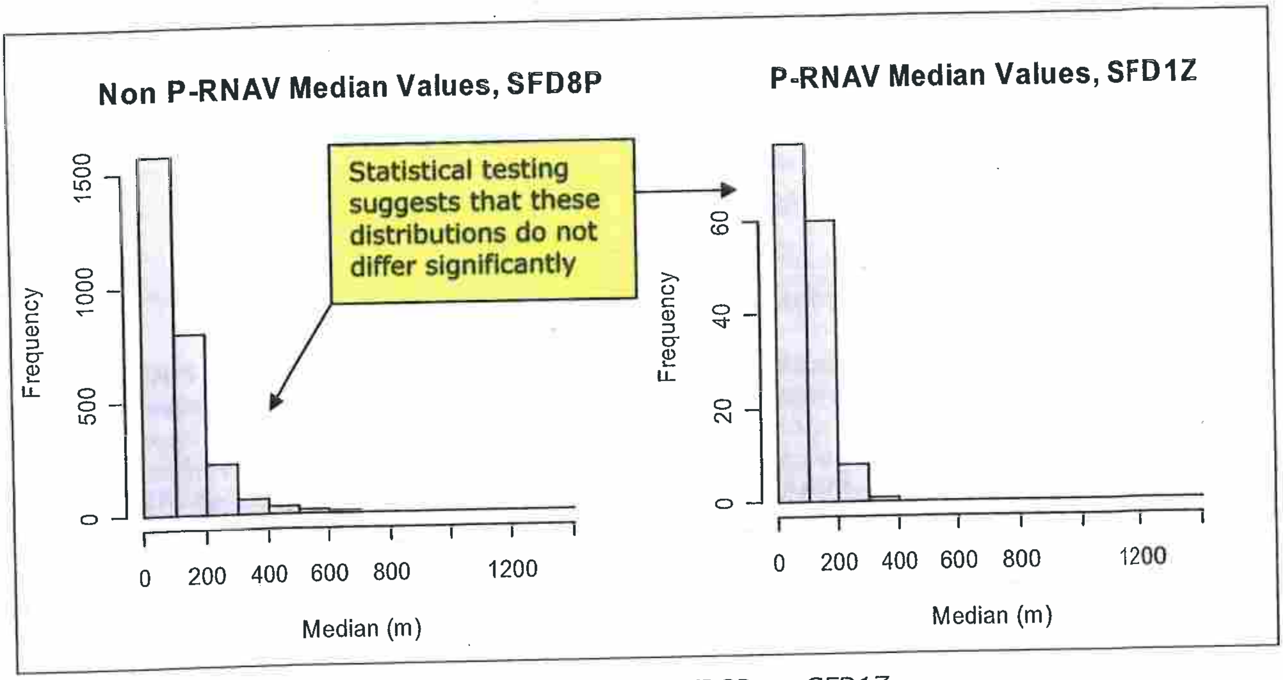

Figure 6.3: Non P-RNAV vs. P-RNAV distributions, SFD8P vs. SFD1Z

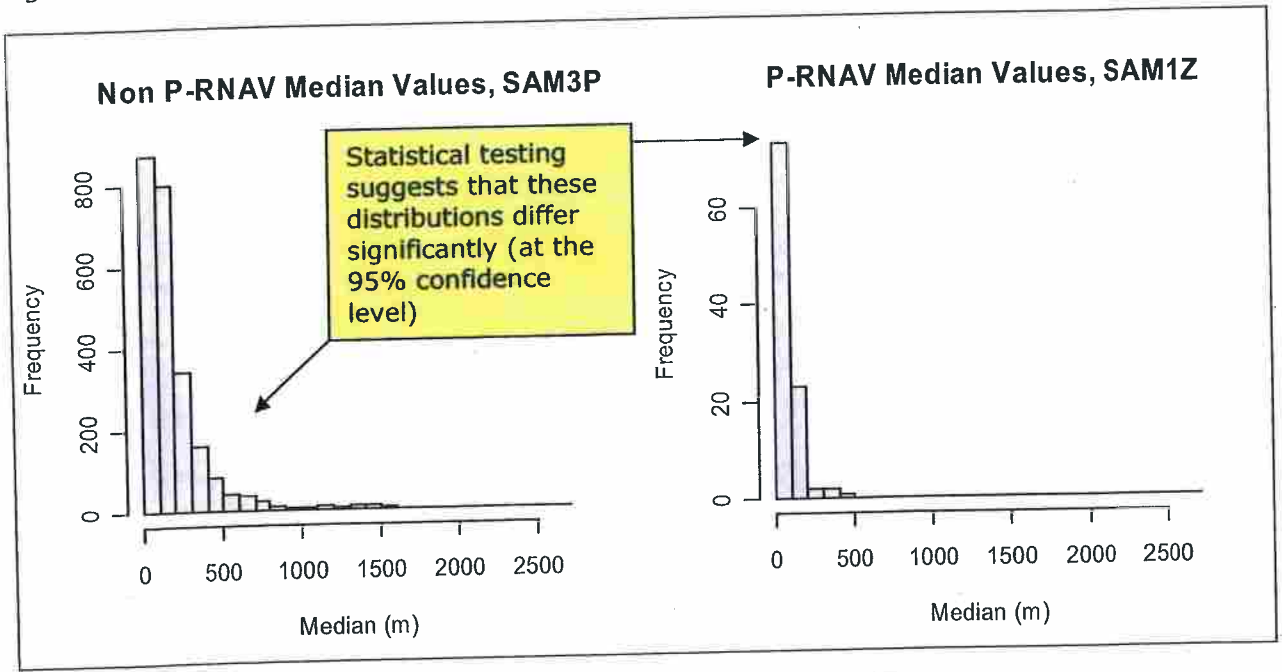

Figure 6.4: Non P-RNAV vs. P-RNAV distributions, SAM3P vs. SAM1Z

Table 6.3 gives the maximum deviations from the centreline of the non P-RNAV SIDs for the flights shown in Figure 6.2. There are some very large deviations measured from each of the tracks, however it is worth bearing in mind that some of the flights in this dataset may have been vectored away from the SID earlier than the height filter would suggest. The 95th percentile of the distribution is likely to be a better indication of performance under these circumstances. A comparison with Table 4.2 shows that the 95th percentiles of the distributions of maximum deviations from the SID are lower for P-RNAV flights on comparable SIDs than they are for the non P-RNAV flights in this dataset. Hence overall track-keeping is better for P-RNAV flights during Phase I than for non P-RNAV flights during this same phase.

	Maximum Distances (m)			
SID	Smallest	Largest	Range	95th Percentile
CLN8M	82	2,584	2,502	1,471
SAM2M	16	6,170	6,154	892
SAM3P	16	4,582	4,566	2,111
SFD8P	30	2,849	2,819	978

Table 6.3: Maximum distances from SID centreline, non P-RNAV flights, Phase I

6.2 Phase II – Non P-RNAV

Figure 6.5: Non P-RNAV filtered tracks, Phase II dataset

Filtered radar tracks for non P-RNAV flights during Phase II of the trials are shown in Figure 6.5, with the corresponding number of flights on each SID given in Table 6.4. Again the non P-RNAV dataset is far larger than the P-RNAV flight dataset for the same phase.

P-RNAV SID	Comparative Non P-RNAV SID	No. of Non P-RNAV flights in sample dataset
CLN2X	CLN8M	1,484
SAM1X	SAM2M	2,666
SAM2Z[4]	SAM3P	2,920
SFD2Z	SFD8P	3,341

Table 6.4: Summary of Phase II non P-RNAV dataset

Table 6.5 gives the median distances measured from the centreline for non P-RNAV flights during Phase II. As with Phase I, the 95th percentiles of these distributions are higher for non P-RNAV flights than for P-RNAV flights (by comparison with Table 4.1). Statistical analysis suggests that the distributions of median distances from the SID are similar for P-RNAV and non P-RNAV flights on CLN2X/CLN8M and SAM2Z/SAM3P, whilst those of the remaining two SIDs are significantly different. Overall, average track-keeping is either similar or better for P-RNAV flights in comparison to non P-RNAV flights.

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4 Filtered at 4,000ft for Phase II analysis

	Median Distances (m)			
SID	Smallest	Largest	Range	95th Percentile
CLN8M	10	1,520	1,510	431
SAM2M	3	954	951	287
SAM3P	8	1,948	1,940	481
SFD8P	4	1,946	1,942	370

Table 6.5: Median distances from SID centreline, non P-RNAV flights, Phase II

The maximum deviations from the SID centreline for non P-RNAV flights during Phase II are given in Table 6.6. The range of deviations observed is again wider for these flights than for the non P-RNAV flights, however there are a far higher number of aircraft flying these SIDs, so a wider range of deviations is perhaps inevitable. In each case, the 95th percentile of the distribution is higher than the 95th percentile of the P-RNAV distribution; hence we conclude that the overall observed track-keeping performance of flights during Phase II of the trials was better for P-RNAV flights than for non P-RNAV flights.

	Maximum Distances (m)			
SID	Smallest	Largest	Range	95th Percentile
CLN8M	19	3,573	3,554	1,399
SAM2M	11	4,859	4,848	538
SAM3P	47	3,904	3,857	1,935
SFD8P	20	4,136	4,116	1,036

Table 6.6: Maximum distances from SID centreline, non P-RNAV flights, Phase II

7 Conclusions

The Gatwick SID trials have shown that P-RNAV aircraft are capable of conforming to speed restrictions whilst performing to the RNP1 track-keeping standard.

During Phase I the mean speed observed on the three SIDs with a 210kt speed restriction was greater than or equal to this restriction. On two of the three SIDs the percentage of aircraft speeding was greater than 50%. During Phase II, with the increased speed restriction of 220kt, the mean speed observed on these SIDs was less than or equal to this restriction, with less than 50% of aircraft on all SIDs found to be speeding. Statistical testing has confirmed that the distribution of speeds has changed as a consequence of the increased speed restriction, and that the decrease in speeding on SAM1Z/SAM2Z and SFD1Z/SFD2Z is significant. Given the small number of aircraft participating in the trials on CLN2X during Phase II, testing for a difference between CLN1X/CLN2X is inconclusive.

Splitting the aircraft flying each SID into categories of 'Medium' and 'Heavy' based on their wake vortex classifications has allowed us to consider the effect of aircraft type on speed conformance. Here, statistical analysis implies that there is no significant difference between categories of aircraft in this respect.

Track-keeping to the SID centreline for P-RNAV flights during both Phases I and II is shown to be within the limits of RNP1. For those flights which participated in the trials, this standard has been met. On splitting the aircraft on each SID into the categories of 'Medium' and 'Heavy' it is not possible from the data to identify any pattern to suggest that track-keeping for a certain aircraft type on a certain SID is significantly better or worse than others.

Finally, a comparison with the observed track-keeping ability of non P-RNAV flights during the same time periods as Phases I and II, and on comparable SIDs, shows that the average performance of P-RNAV aircraft is similar to or better than the average performance of non P-RNAV aircraft. Overall 'worst-case' performance, as characterised by the maximum measured deviations from the SID, are far higher for non P-RNAV aircraft. Thus there is evidence to suggest that the track-keeping performance of P-RNAV aircraft is better than that of non P-RNAV aircraft.

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Operational Analysis Report 1039

Gatwick P-RNAV SID Trials: Update to Analysis of Phase II

Action	Role	Name	Signature	Date
Author	Author	[redacted]		15th June 2010
Approved	Reviewer	[redacted]		15th June 2010
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Contents

1 Executive Summary

This report provides an update to the analysis reported in the study Gatwick P-RNAV SID Trials: Final Analysis of Phase I and Phase II (OA Report 0849). Phase II trials began on 8 May 2008 and the previous report analysed flights from this date to 16 September 2008. This report provides the results of analysis conducted on flights taking part in the SID trials from 24 September 2008 to 25 September 2009. There were four participating SIDs in the Phase II trial, namely CLN2X, SAM1X, SAM2Z and SFD2Z.

The purpose of the Gatwick P-RNAV trials is to determine the benefits of deploying P-RNAV SIDs at Gatwick Airport. The objectives include an assessment of the ability of P-RNAV flights to adhere to the lateral SID profile, given speed restrictions. Phase II of the trials has a speed restriction of 220kt for the initial turn in each SID, with the exception of SAM1X which has a speed restriction of 250kt.

The analysis on the Gatwick P-RNAV SID trials has shown that from the Phase II trials during the period from 24 September 2008 to 25 September 2009, P-RNAV aircraft are capable of conforming to speed restrictions whilst performing to the RNP1 track-keeping standard.

Speed trial analysis showed that for three of four SIDs (CLN2X, SAM1X and SFD2Z) the average speed observed at the survey point for speed analysis is less than the speed restriction of 220kt and 250kt for SAM1X. Less than 50% of flights were speeding for all three SIDs. For the remaining SID (SAM2Z) the proportion of flights observed to speed is less than 50%, and the average speed observed (221kt) was slightly greater than the speed restriction of 220kt.

Track-keeping to the SID centreline for P-RNAV flights was shown to be within the limits of RNP1 at heights of up to 4,000ft.

The centreline of the SID for CLN2X does not correspond to the centreline of the NPR for this route. Hence deviations from the NPR are inevitable.

A comparison of the track-keeping ability of P-RNAV flights to non P-RNAV flights on similar SIDs showed that large deviations were more frequently observed for non P-RNAV aircraft. The range of median and maximum deviations from the centreline was much wider for non P-RNAV flights and the 95th percentile was higher in all cases with one exception, the median distance from centreline for SID SFD2Z.

2 Introduction

This report provides an update to the analysis reported in the study Gatwick P-RNAV SID Trials: Final Analysis of Phase I and Phase II (OA Report 0849). Phase II trials began on 8 May 2008 and the previous report analysed flights from this date to 16 September 2008. This report provides the results of analysis conducted on flights taking part in the SID trials from 24 September 2008 to 25 September 2009. There were four participating SIDs in the Phase II trial, namely CLN2X, SAM1X, SAM2Z and SFD2Z. The path of each of these SIDs is illustrated in Figure 2.1 below.

The purpose of the Gatwick P-RNAV trials is to determine the benefits of deploying P-RNAV SIDs at Gatwick Airport. The objectives include an assessment of the ability of P-RNAV flights to adhere to the lateral SID profile, given speed restrictions. Phase II of the trials has a speed restriction of 220kt for the initial turn in each SID, with the exception of SAM1X which has a speed restriction of 250kt. The designated speed trial point for each SID, marked by a small circle in the same colour as the centreline, is shown in Figure 2.1. In addition to measuring the adherence of aircraft to the centreline of the track, the speed conformance has been considered at these nominated points.

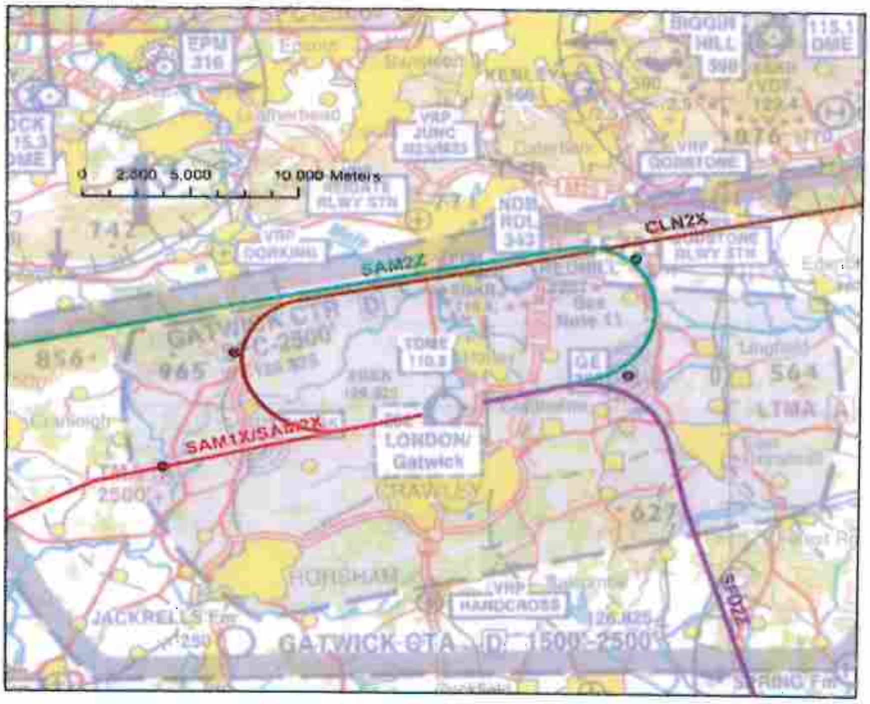

Figure 2.1: P-RNAV SID centrelines and speed trial points.

During the time period, there were 206 flights which participated in the P-RNAV trials. A breakdown split by SID, is shown in Table 2.1.

SID	Number of participating flights
CLN2X	10
SAM1X	76
SAM2Z	34
SFD2Z	86
Total	*206*

Table 2.1: Count of P-RNAV trial participants, split by SID.

The analysis of track-keeping ability and of speed conformance was based on radar track data for each flight. This radar data was plotted in ArcView to show the track taken by each aircraft in comparison to the designated centreline of the SID. The radar data also contained information on the IAS of each flight, used for analysis of speed conformance.

3 Speed Trial Analysis

For each of the four SIDs there was a designated survey point for speed analysis. As the speed trial survey points do not lie directly on the SID centrelines in three of the SIDs, not every aircraft flew directly over the speed trial point. Therefore, the speed trial reading of an aircraft at the speed trial point has been taken as the IAS of that aircraft at its closest point of approach to the survey point. Taking a reading for each aircraft on each SID at this closest point of approach provided a distribution of the speeds observed for each SID.

As SAM1X has a higher speed restriction than the other three SIDs, the mean (average) of the distribution is different from the other three SIDs. The mean speed for each SID and the percentages speeding are shown in Table 3.1.

An improvement has been noted from the results of the previous Phase II trial in the percentage of aircraft speeding in excess of the restriction of each SID as there were no incidences of more than 50% of aircraft found to be speeding at the nominated survey point in any of the SIDs. In all of these cases, except SAM2Z, the mean of the distribution of observed speeds is lower than the speed restriction imposed. The largest percentage of speeding aircraft (43%) is observed on SAM1X. For the remaining SID (SAM2Z), the mean observed speed of 221kt only slightly exceeded the restriction of 220kt.

	Observed Speed (IAS, kt)			
SID	Min	Max	Mean (Average)	% in excess of restriction
CLN2X	204	222	216	10
SAM1X	228	260	249	43
SAM2Z	205	251	221	38
SFD2Z	186	229	217	35

Table 3.1: Outcome from speed trial analysis, all SIDs

The largest speed observed on each SID was within 10kt of the speed restriction apart from the SID SAM2Z where a flight exceeded the speed restriction by 31kt. It should be noted however that the deviations from the restriction may represent the speed control performance of the aircraft navigation systems rather than deliberate speeding.

Table 3.2 gives a breakdown of the number of flights found to be speeding and not speeding on all SIDs when split by operator

Callsign	Speeding	Not Speeding	Total
[redacted]	61	78	139
[redacted]	2	0	2
[redacted]	6	18	24
[redacted]	1	14	15
[redacted]	4	7	11
[redacted]	2	12	14
Total	76	129	205

Table 3.2: Speed conformance split by operator.

4 Track-Keeping Accuracy of P-RNAV Flights

Radar tracks of selected flights participating in the Gatwick SID trials were plotted in Arcview and are shown in Figure 4.1. A height filter has been applied at 4,000ft as this is the height at which aircraft can be vectored away from the SID by the controller.

One anomalous flight path on SAM1X was identified (relating to flight BAW17PA on 14 July 2009) and there is no obvious reason why this flight did not keep to its SID. As this flight did not comply with the SID line, it has not been included it in the track-keeping analysis. Further investigation into why this flight vectored off route may be useful.

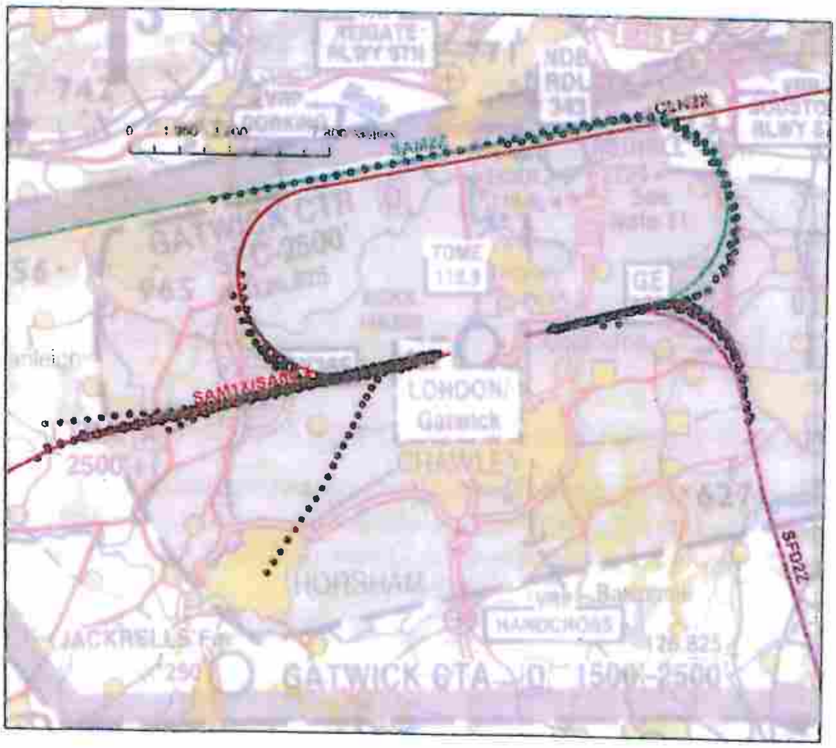

Figure 4.1: Filtered radar tracks for P-RNAV flights.

For each individual flight, the distance between each radar point and the centreline of the SID was measured (the 'deviation' from track). This provided a distribution of distances for that flight. To summarise track-keeping ability, two statistics have been derived for each individual flight. These are the median measurement; an indicator of the 'average' deviation from the centreline of the track (the median signifies the point above (and also below) which 50% of the measured deviations lie) and the maximum measurement; an indicator of the worst deviation from the centreline of the track.

Note that both measurements are calculated for each individual flight. For each SID the distribution of median and maximum deviations was then formed, by combining the readings for each flight on that SID. Summary statistics have been calculated, and are given in Tables 4.1 and 4.2.

Median (Average) Deviations from Track

Table 4.1 shows the range of median distances observed from the centreline of the tracks split by SID. The minimum and maximum values give the lower and upper bounds between which all of the median deviations from the centreline lie. This table also gives the 95th percentile of the distribution of median distances. That is, 95% of the observed median deviations lie between the minimum measurement and the 95th percentile value, with the remaining 5% falling between the 95th percentile and the maximum value. For example, Table 4.1 indicates that for those flights on CLN2X the 'average' performance is for aircraft to be within 53m to 255m of the centreline, and that 95% of aircraft are within 180m of the centreline for 50% of the time at heights of up to 4,000ft. This implies that the average track-keeping ability of flights on this SID is accurate.

The average track-keeping on the other SIDs is also reasonably accurate, with the 95th percentile of median values all within 500m of the centreline of the track. The largest median was 634m for SFD2Z however when looking at the 95th percentile value we can conclude that the median distance rarely goes above 500m for this SID.

	Median distance from centreline (m)		
SID	Smallest	Largest	95th Percentile
CLN2X	53	255	180
SAM1X	11	156	120
SAM2Z	48	429	319
SFD2Z	48	634	330

Table 4.1: P-RNAV track-keeping summary, median measurements from centreline.

Maximum (Worst-Case) Deviations from Track

Although the median distances characterise 'average' performance they do not give an indication of the overall track-keeping of P-RNAV flights at all times up until the height filter is applied. The maximum deviations from the centreline, as given in Table 4.2, are therefore more useful in describing the 'worst-case' observations of performance.

	Maximum distance from centreline (m)		
SID	Smallest	Largest	95th Percentile
CLN2X	199	724	530
SAM1X	37	978	459
SAM2Z	362	1,977	1,053
SFD2Z	301	1,169	810

Table 4.2: P-RNAV track-keeping summary, maximum measurements from centreline.

The largest of the maximum deviations was 1,977m from the SID, which was observed on SAM2Z. However, this was the only occasion which the maximum distance exceeded 1Nm. Note that although there are some large deviations from the track, the 95th percentile of each of the individual distributions was less than 1Nm.. Histograms of the median and maximum deviations from the track may be viewed in Figures A.1 to A.8 in Appendix A.

The results shown in Tables 4.1 and 4.2 indicate that track-keeping to the SID centreline for P-RNAV flights was shown to be within the limits of RNP1 (i.e. 95% of flight time spent within ±1Nm of the centreline of the track), the at heights of up to 4,000ft.

5 SID/NPR Centreline Comparison

An additional objective of the Gatwick P-RNAV trials is to assess conformance of P-RNAV flights to the NPR centreline. In Figure 5.1 the SID and corresponding NPR for each of the P-RNAV routes are marked. In three of four cases (SAM1X, SAM2Z and SFD2Z) the SID and the NPR are similar. For CLN2X, Figure 5.1 shows that the centrelines of the SID and the NPR are not the same. This implies that if flights are accurate in holding the centreline of the SID they will not be flying the NPR. This is a consequence of the design of the SID and not a consequence of the track-keeping ability of P-RNAV flights.

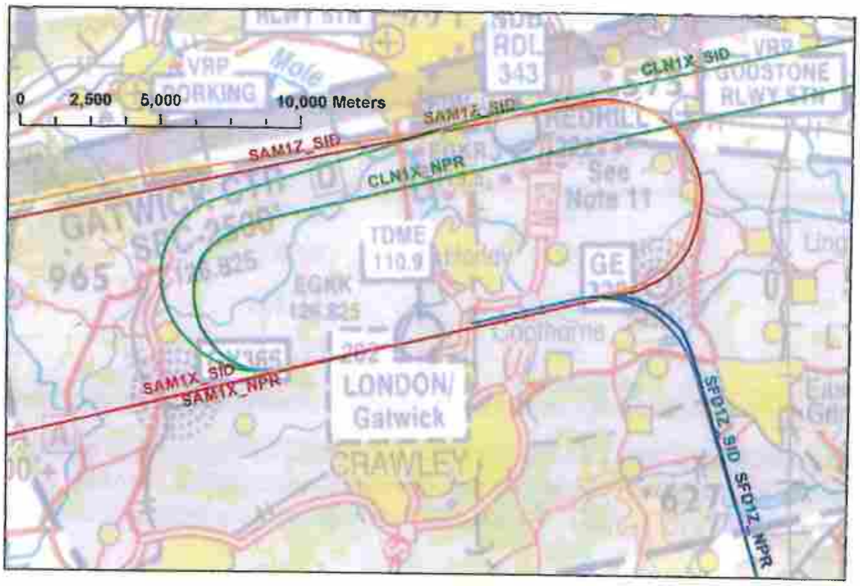

Figure 5.1: SID and NPR centreline comparison for P-RNAV flights.

6 Track-Keeping Accuracy of Non P-RNAV Flights

The track-keeping accuracy of P-RNAV flights was compared to that of non P-RNAV flights. If there was at least one P-RNAV flight on a given day, radar tracks for non P-RNAV flights on each of the four SIDs for that day was also extracted (CLN8M, SAM2M, SAM3P and SFD8P). This means that the non P-RNAV dataset for Phase II consisted only of selected days of the month but covers the same time period as for the P-RNAV Phase II data. The number of non P-RNAV flights is much larger than the number of P-RNAV flights. The number of flights on each SID during the time period is shown in Table 6.1.

Note that the non P-RNAV pilots would not have been aware that their performance was to be observed, hence there may be a behavioural aspect that cannot be measured. Nonetheless, a comparison is interesting.

P-RNAV SID	Comparative Non P-RNAV SID	Number of Non P-RNAV observed flights in sample dataset
CLN2X	CLN8M	1,657
SAM1X	SAM2M	3,725
SAM2Z	SAM3P	5,953
SFD2Z	SFD8P	5,224

Table 6.1: Number of flights in non P-RNAV dataset, by SID

Again, the radar tracks of selected flights for the SIDs were filtered at 4,000ft.

As in Section 4, the median and maximum measured distances from the centreline of the relevant SID were recorded for each flight. Summary statistics for both are given in Tables 6.2 and 6.3. A comparison of Tables 6.2 and 6.3 with Tables 4.1 and 4.2 showed that the range of median and maximum deviations from the centreline was much wider for non P-RNAV flights and the 95th percentile is higher in all cases with one exception, the median distance from centreline for SID SFD8P which had 286m for non P-RNAV flights but 330m for P-RNAV flights (this could be due to the small sample size of P-RNAV flights for this SID). Therefore, the overall observed track-keeping performance of flights during Phase II of the trials (during the period for which data was analysed) was better for P-RNAV flights than for non-PRNAV flights for SIDs CLN2X, SAM1X and SAM2Z. Please note – the previous data has not been re-analysed for the update to this report.

	Median Distances (m)		
SID	Smallest	Largest	95th Percentile
CLN8M	10	1,535	283
SAM2M	5	9,927	327
SAM3P	5	7,222	644
SFD8P	5	3,787	286

Table 6.2: non P-RNAV track-keeping summary, median measurements from centreline.

The large maximum distances from the centreline reported in Figure 6.2 indicates that information is included from some flights when they are not actually on the SID. The 95th percentile measure reported in Tables 6.2 and 6.3 therefore provides a more representative result than the largest distance.

	Maximum Distances (m)		
SID	Smallest	Largest	95th Percentile
CLN8M	36	3,579	1,332
SAM2M	19	27,671	1,094
SAM3P	5	8,807	2,106
SFD8P	25	8,206	895

Table 6.3: non P-RNAV track-keeping summary, maximum measurements from centreline.

Histograms of the median and maximum deviations from the track may be viewed in Figures B.1 to B.8 in Appendix B.

7 Conclusions

The analysis on the Gatwick P-RNAV SID trials has shown that from the Phase II trials during the period from 24 September 2008 to 25 September 2009, P-RNAV aircraft are capable of conforming to speed restrictions whilst performing to the RNP1 track-keeping standard.

Speed trial analysis shows that for three of four SIDs (CLN2X, SAM1X and SFD2Z) the average speed observed at the survey point for speed analysis is less than the speed restriction of 220kt and 250kt for SAM1X. Less than 50% of flights were speeding for all three SIDs. For the remaining SID (SAM2Z) the proportion of flights observed to speed is less than 50%, and the average speed observed (221kt) was slightly greater than the speed restriction of 220kt.

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A comparison of the track-keeping ability of P-RNAV flights to non P-RNAV flights on similar SIDs showed that large deviations were more frequently observed for non P-RNAV aircraft. The range of median and maximum deviations from the centreline was much wider for non P-RNAV flights and the 95th percentile was higher in all cases with one exception which was the median distance from centreline for SID SFD2Z.

8 Appendix A – Track-keeping accuracy of P-RNAV flights

The histograms in Figures A.1 to A.8 show the distributions (median and maximum) of distances for each SID line for P-RNAV aircraft.

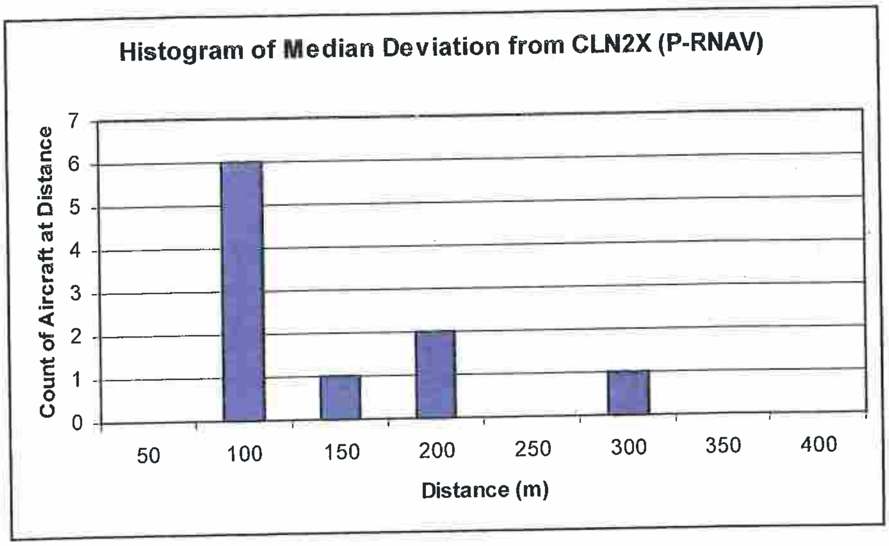

Figure A.1: Histogram of Median Distances from CLN2X of P-RNAV flights

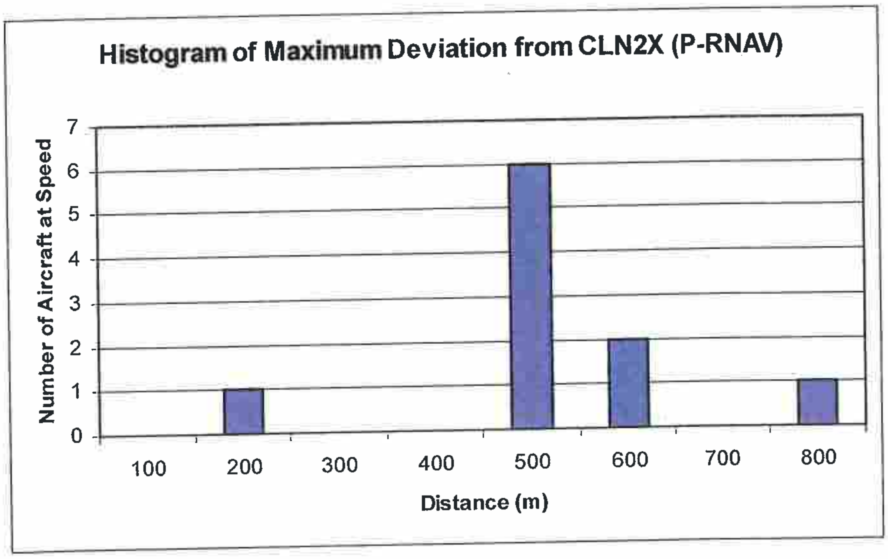

Figure A.2: Histogram of Maximum Distances from CLN2X of P-RNAV flights

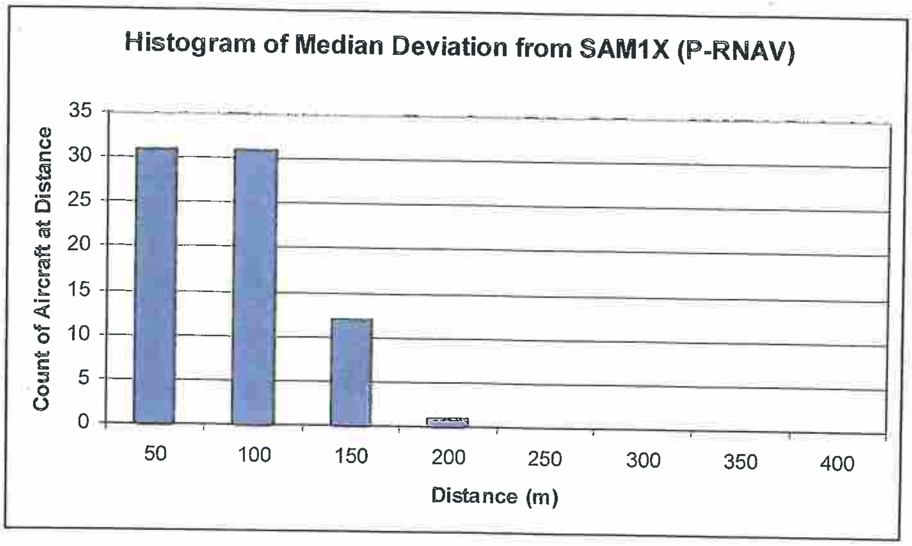

Figure A.3: Histogram of Median Distances from SAM1X of P-RNAV flights

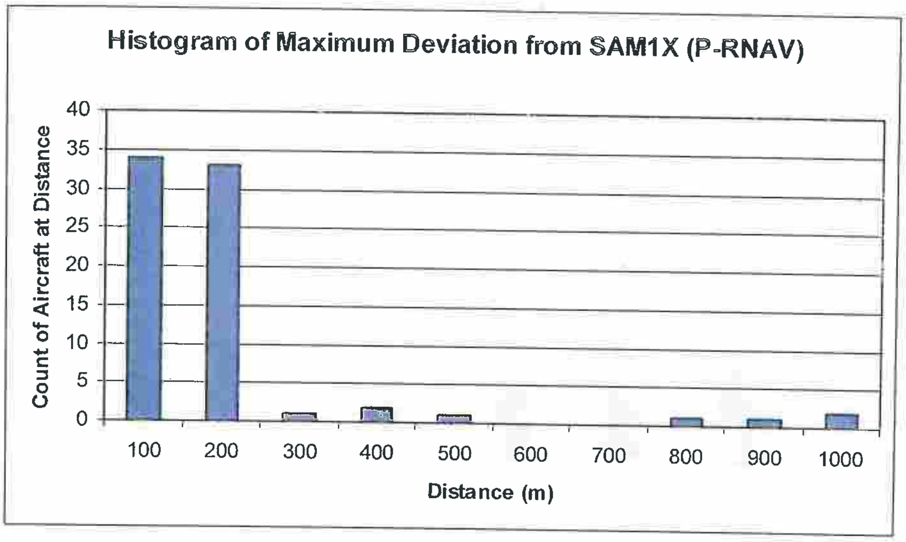

Figure A.4: Histogram of Maximum Distances from SAM1X of P-RNAV flights

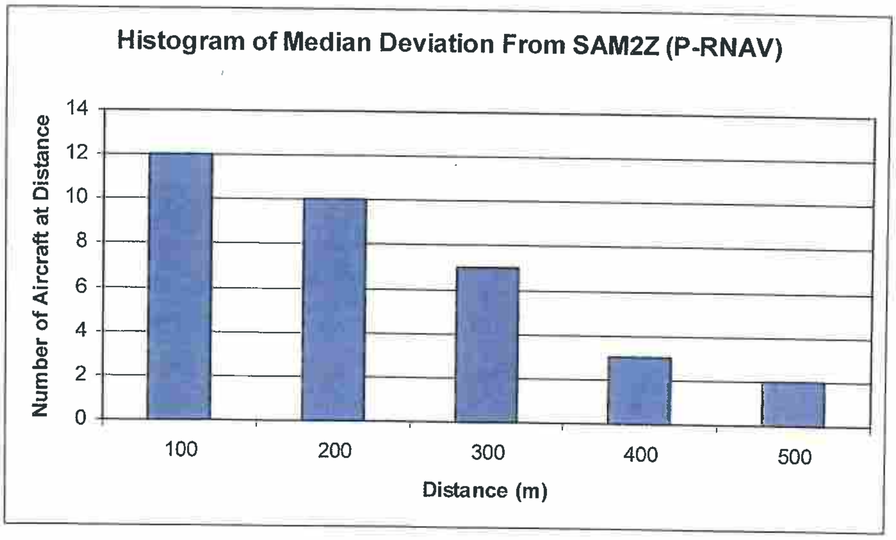

Figure A.5: Histogram of Median Distances from SAM2Z of P-RNAV flights

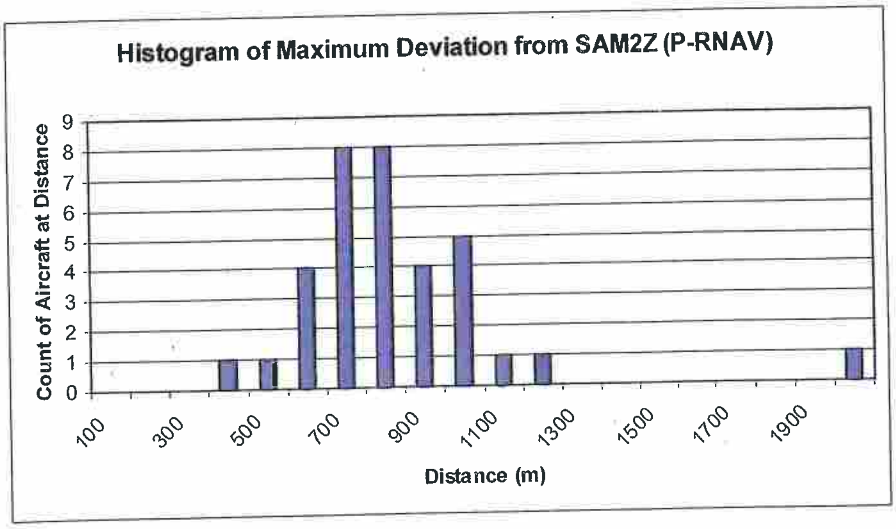

Figure A.6: Histogram of Maximum Distances from SAM2Z of P-RNAV flights

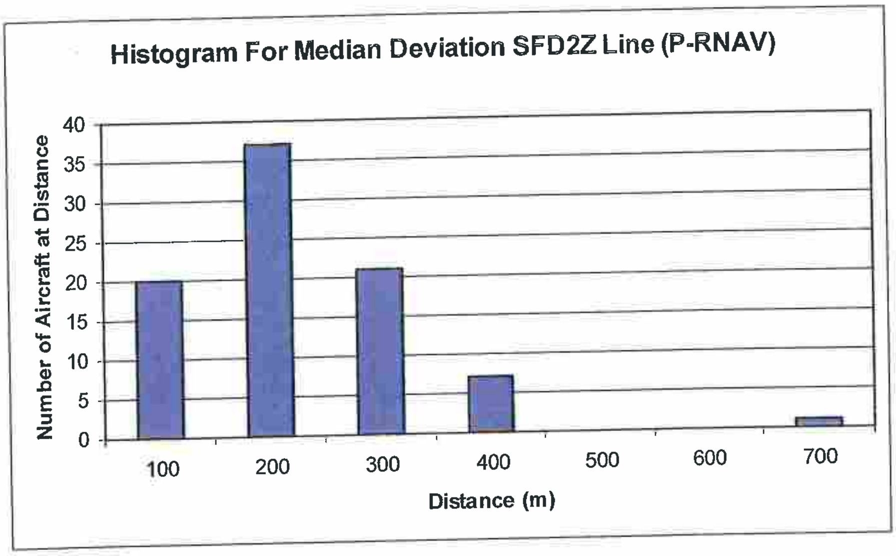

Figure A.7: Histogram of Median Distances from SFD2Z of P-RNAV flights

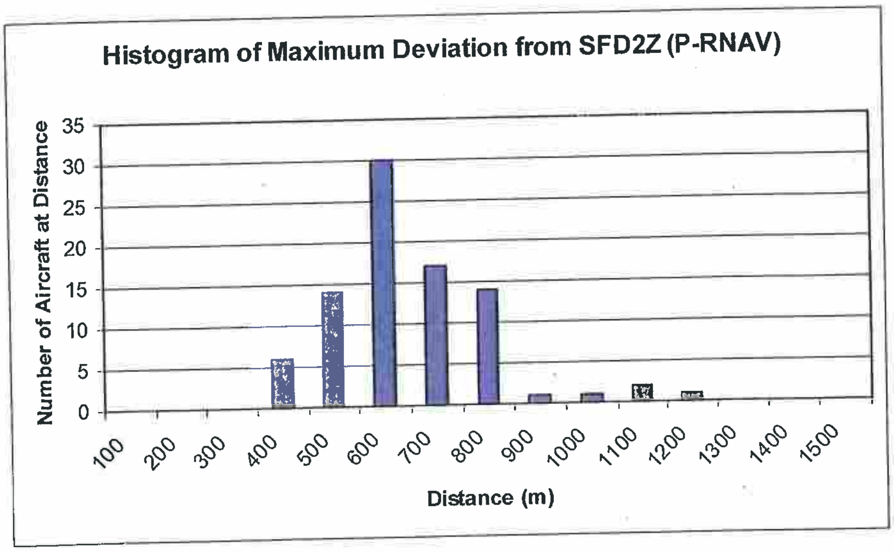

Figure A.8: Histogram of Maximum Distances from SFD2Z of P-RNAV flights

9 Appendix B – Track-keeping accuracy of non P-RNAV flights

The histograms in Figures B.1 to B.8 show the distributions (median and maximum) of distances for each SID line for non P-RNAV aircraft.

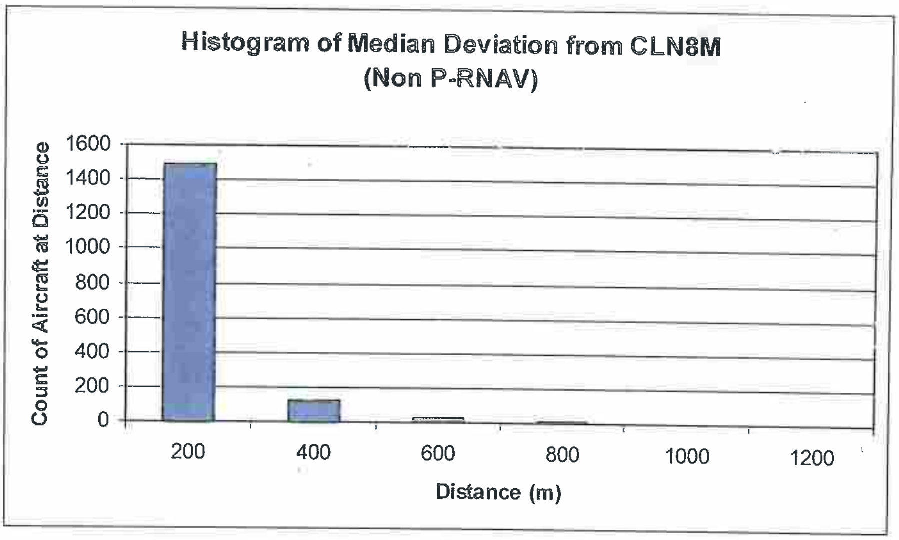

Figure B.1: Histogram of Median Distances from CLN8M of non P-RNAV flights

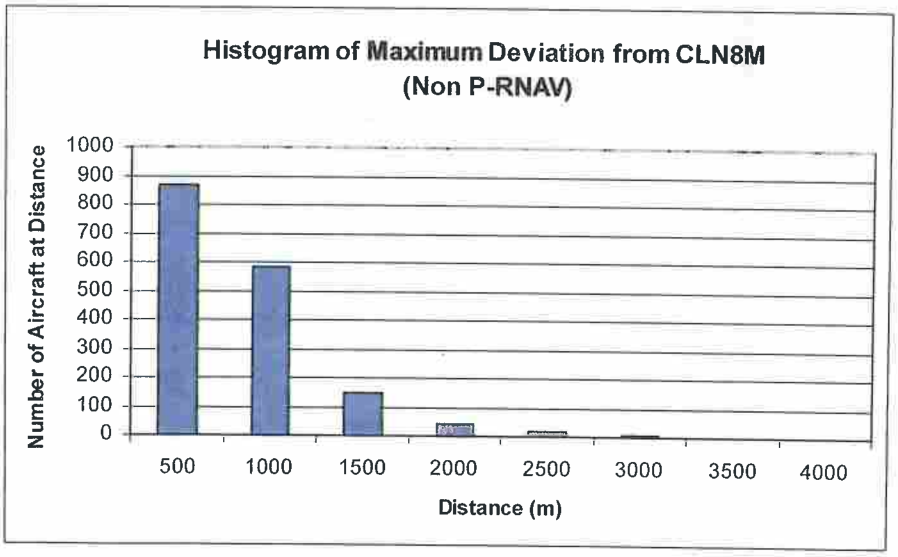

Figure B.2: Histogram of Maximum Distances from CLN8M of nNon P-RNAV flights

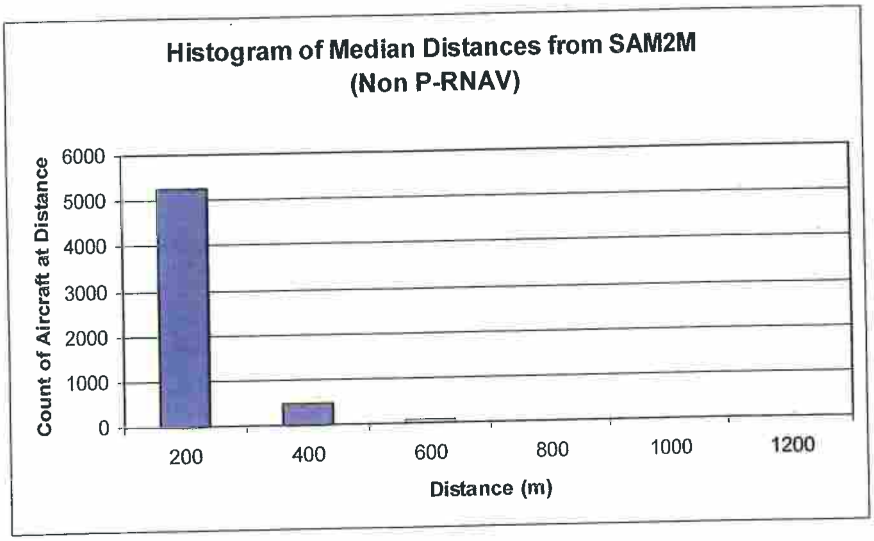

Figure B.3: Histogram of Median Distances from SAM2M of non P-RNAV flights (168 outliers not shown)

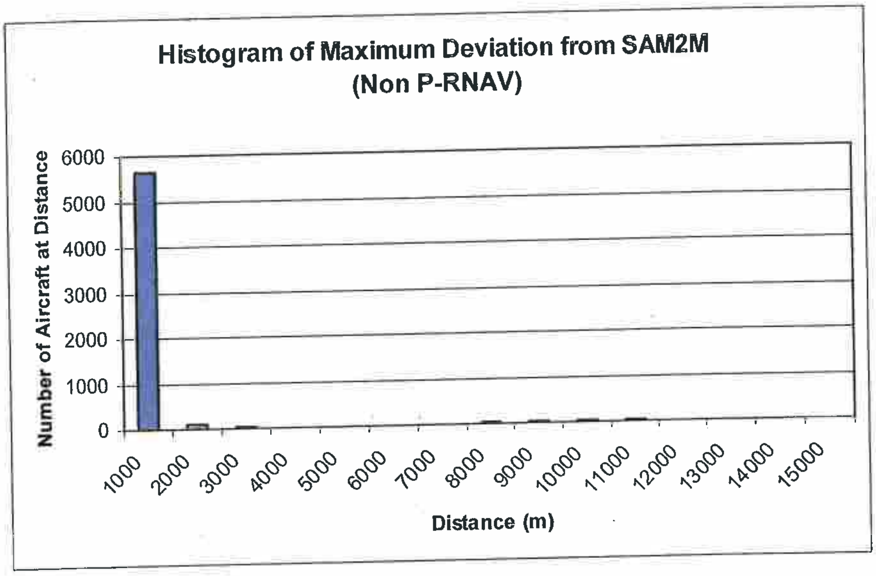

Figure B.4: Histogram of Maximum Distances from SAM2M of non P-RNAV flights (6 outliers not shown)

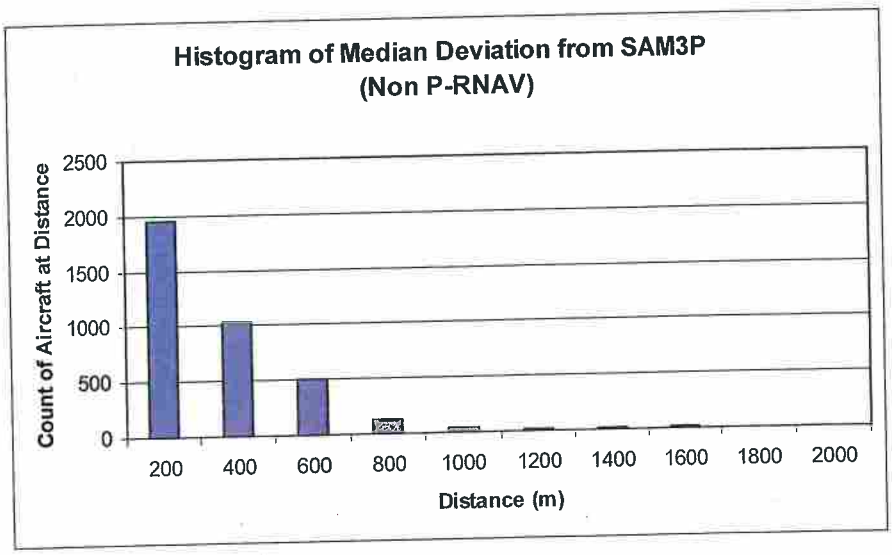

Figure B.5: Histogram of Median Distances from SAM3P of non P-RNAV flights (14 outliers not shown)

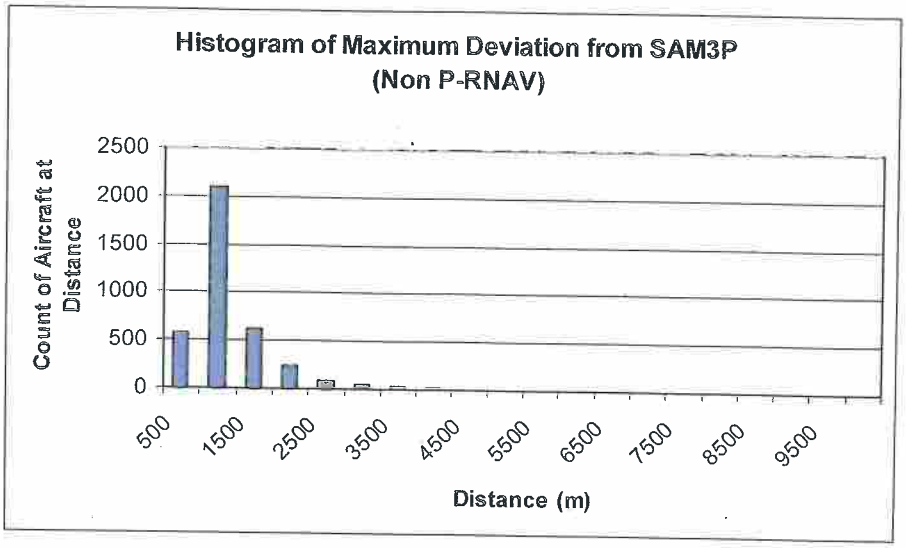

Figure B.6: Histogram of Maximum Distances from SAM3P of non P-RNAV flights

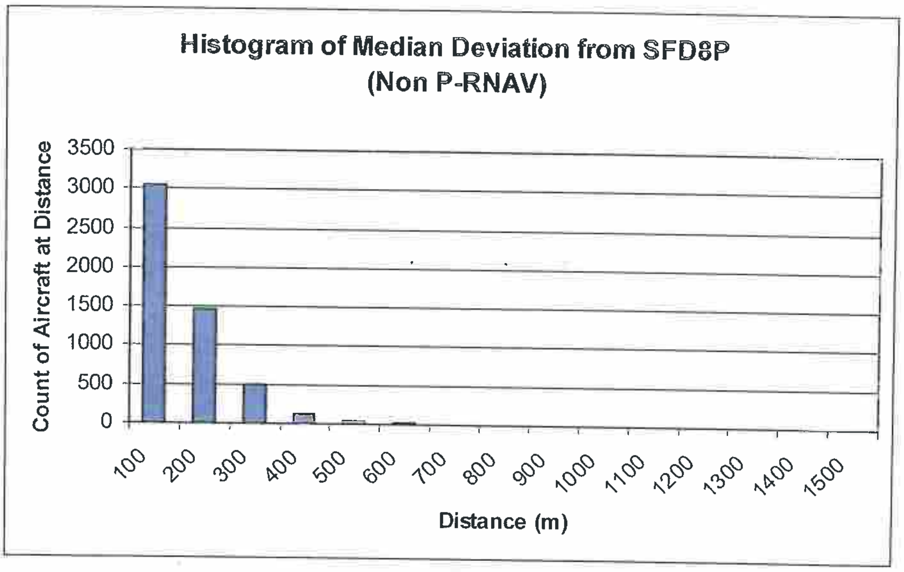

Figure B.7: Histogram of Median Distances from SFD8P of non P-RNAV flights (2 outliers not shown)

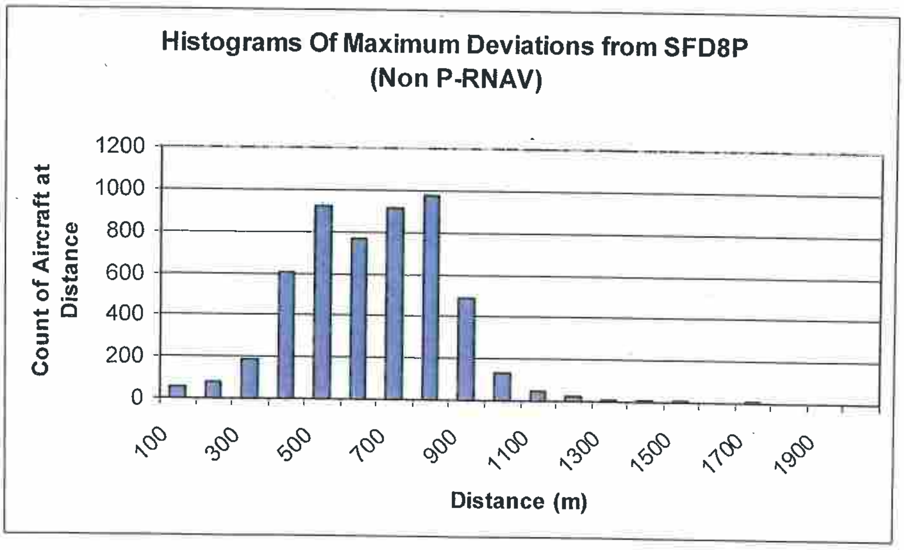

Figure B.8: Histogram of Maximum Distances from SFD8P of non P-RNAV flights (12 outliers not shown)

APPENDIX G

ORG number	Corr suffix	Name	Surname	Organisation	Received/Contact Notes	Title, Department	EmailAddress
ORG01	A	[redacted]	[redacted]	Horne PC			[redacted]
ORG02	A	[redacted]	[redacted]	Horsted Keynes PC			[redacted]
ORG03	A	[redacted]	[redacted]	Gatwick Can Be Quieter (GATCAN)			[redacted]
ORG04	A	[redacted]	[redacted]	Horley TC			[redacted]
ORG05	A	[redacted]	[redacted]	Tandbridge DC			[redacted]
ORG06	A	[redacted]	[redacted]	Rotherfield PC			[redacted]
ORG07	A	[redacted]	[redacted]	Maresfield PC			[redacted]
ORG08	A	[redacted]	[redacted]	Furpine RA			[redacted]
ORG09	A	[redacted]	[redacted]	West Hoathly PC			[redacted]
ORG10	A	[redacted]	[redacted]	East Grinstead TC			[redacted]
ORG11	A	[redacted]	[redacted]	Imberhorne RA			[redacted]
ORG12	A	[redacted]	[redacted]	GATCOM			[redacted]
ORG13	A	[redacted]	[redacted]	Three Woods Group			[redacted]
ORG14	A	[redacted]	[redacted]	Kent County Council			[redacted]
ORG15	A	[redacted]	[redacted]	Bletchingley Parish Council			[redacted]
ORG16	A	[redacted]	[redacted]	Balcombe Parish Council			[redacted]
ORG17	A	[redacted]	[redacted]	Surrey County Council			[redacted]
ORG18	A	[redacted]	[redacted]	Dormansland Parish Council			[redacted]
ORG19	A	[redacted]	[redacted]	Mole Valley Distict Council			[redacted]
ORG20	A	[redacted]	[redacted]	Capel Parish Council			[redacted]
ORG21	A	[redacted]	[redacted]	Aurigny Airlines			[redacted]
Totals							
GATCOM members							

ORG number	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Support	Object	No Comment / No Objection	Opt Out?	No significant effect	Process Compliance	Justification	Concentration	Env (noise)	Env (air pollution/emissions)	Support	Object	No Comment	NATS Response (1, 2, 3...)
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ORG03		1			1			1			1			1			1			1			1			1				1	1		1			1		
ORG04			1			1			1	1					1			1			1			1			1								1			
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ORG06			1			1			1			1			1			1			1			1			1							1			1	
ORG07			1			1			1			1			1			1			1			1			1										1	
ORG08			1		1				1			1			1			1			1			1			1					1				1		
ORG09			1			1			1			1			1			1			1			1			1					1					1	
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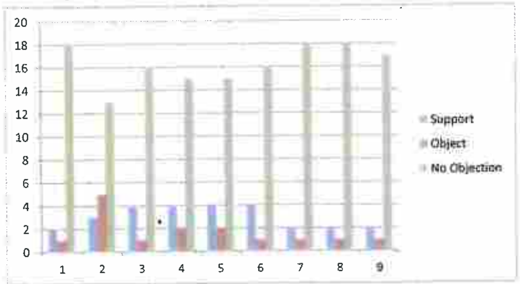
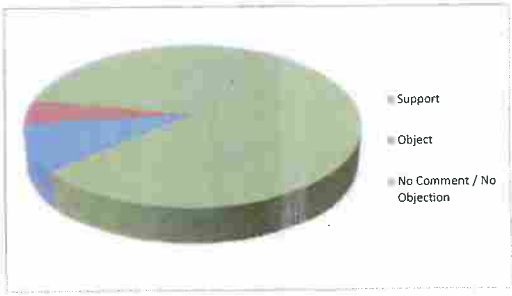
ORG12	1			1			1			1			1			1			1			1			1							1	1		1			
ORG13			1	1			1					1	1			1					1			1			1								1			
ORG14	1			1			1			1			1			1			1			1			1							1	1		1			
ORG15			1			1			1			1			1			1			1			1			1					1	1	1		1		
ORG16			1			1			1			1			1			1			1			1								1	1				1	
ORG17			1			1			1			1			1			1			1			1			1					1	1			1		
ORG18			1			1			1			1		1				1			1			1			1			1		1	1	1		1		
ORG19			1			1	1			1					1			1			1			1			1					1	1		1			
ORG20			1			1			1		1				1			1			1			1			1					1	1			1		
ORG21			1			1			1			1			1			1			1			1			1										1	
Totals	2	1	18	3	5	13	4	1	16	4	2	15	4	2	15	4	1	16	2	1	18	2	1	18	2	1	17	0	0	2	2	13	11	5	5	10	7	
GATCOM members																																						

Blue background idicates response by letter.





/No Comment

Organisations

This workbook summaries the consultation responses.

The workbook contains a number of separate worksheets which can be accessed via the coloured tabs at the bottom of this page.

The 'Summary' worksheet summarises the number of notifications sent and responses received.

Separate worksheets are provides for groups of consultees as follows:

Organisations
Members of Public

Each worksheet contains cells, rows and columns that may be multicoloured. These colours are for NATS admin purposes and may or may not have a "key".

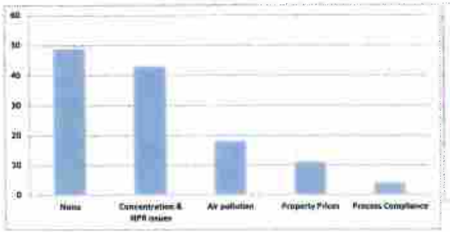
Each consultee in each group is given an individual reference code in Column A of the approprate sheet, e.g. ORG03
Correspondence is given a letter for each subsequent item e.g. ORG03A (first response), ORG03B (stakeholder relpy) etc

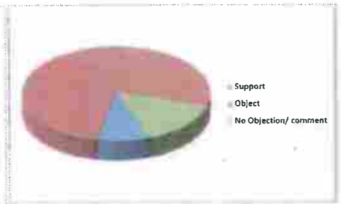
EGKK PRNAV SID replication	Notification emails sent	Responses received (includes those from respondees not directly notified by email)			Totals
	No response	Support	Object	No Objection/ comment	
Organisations		5	10	7	22
Members of Public		1	43	3	47
TOTAL	25	6	53	10	69
			Total involved		94

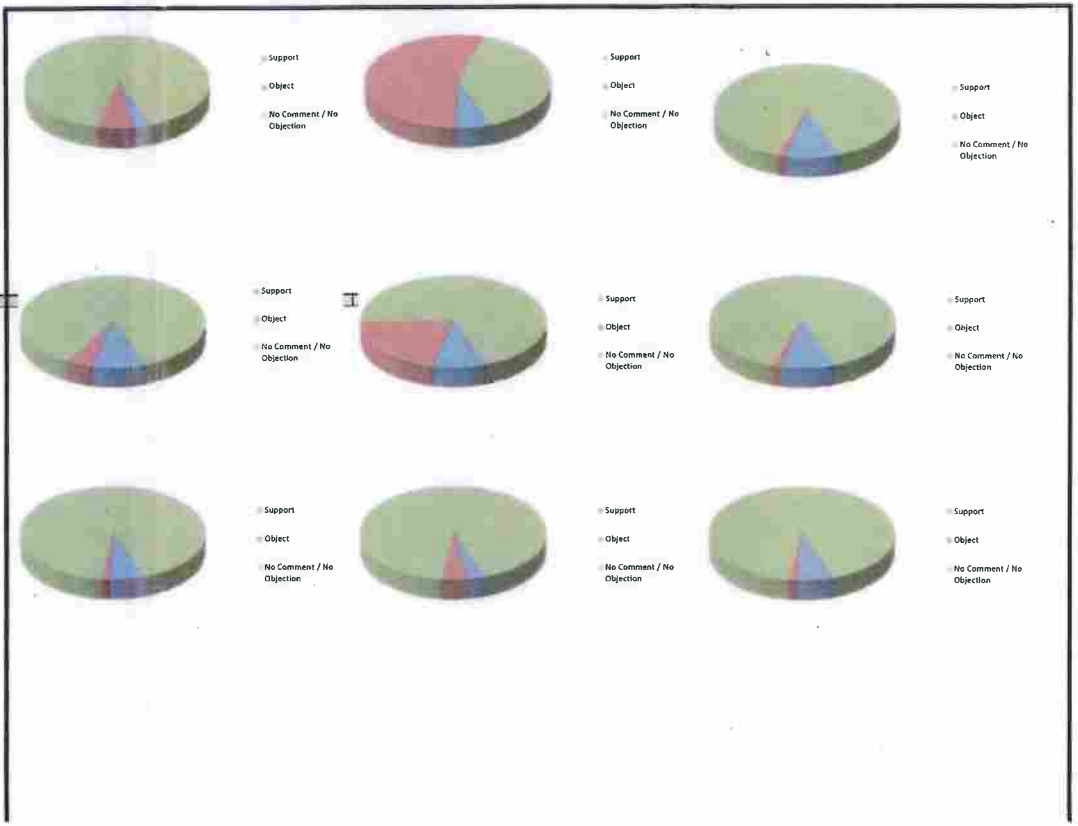
Noise	Concentration & NPR Issues	Air pollution	Property Prices	Process Compliance
49	43	18	11	4

number of 3rd party responses
44

	Support	Object	No Comment / No Objection	Supt 2	Obj 2	No Comment/No Obj 2	Supt 3	Obj 3	No Comment/No Obj 3	Supt 4	Obj 4	No Comment/No Obj 4	Supt 5	Obj 5	No Comment/No Obj 5	Supt 6	Obj 6	No Comment/No Obj 6	Supt 7	Obj 7	No Comment/No Obj 7	Supt 8	Obj 8	No Comment/No Obj 8	Supt 9	Obj 9	No Comment/No Obj 9
	2	1	18	3	5	13	4	1	16	4	2	15	4	2	15	4	1	16	2	1	18	2	1	18	2	1	17
	0	3	43	1	32	14	2	0	43	2	1	42	2	12	32	2	0	43	2	0	43	0	2	43	2	0	43
totals	2	4	61	4	37	27	6	1	59	6	3	57	6	14	47	6	1	59	4	1	61	2	3	61	4	1	60







MOP Number	Prefix	First Name	Last Name	Email	Supt 1	Obj 1	No Comment/No Obj 1	Supt 2	Obj 2	No Comment/No Obj 2	Supt 3	Obj 3	No Comment/No Obj 3	Supt 4	Obj 4	No Comment/No Obj 4	Supt 5	Obj 5	No Comment/No Obj 5	Supt 6	Obj 6	No Comment/No Obj 6	Supt 7	Obj 7	No Comment/No Obj 7	Supt 8	Obj 8	No Comment/No Obj 8	Supt 9	Obj 9	No Comment/No Obj 9	Opt Out?	No significant effect	Process Compliance	Justification	Consultation	Env (noise)	Env (air pollution/emissions)	Property Prices	Support	Object	No Comment
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