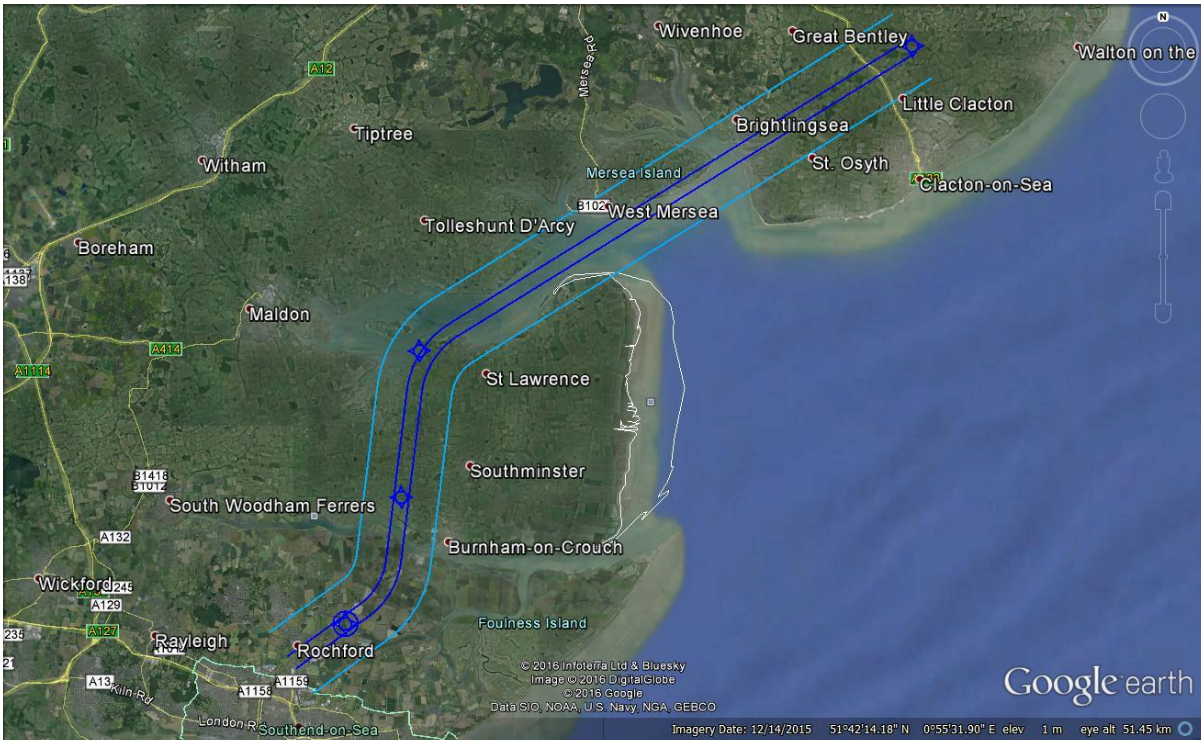
London Southend Airport
Airspace Change Proposal

Introduction of Standard Instrument Departure Procedures
to Routes in the London Terminal Control Area

Sponsor Consultation - 2016

Annex E to Part B
of the Consultation Document
Runway 05 Departures via CLN



Contents of Annex E to Part B

1. Runway 05: Departures to the east (CLN).

1.1. The procedure is known as the **CLN 1G** SID and is not a direct replication of the PDR from runway 05[1]. The PDR was aligned directly towards CLN, entailing inevitable overflight of Burnham-on-Crouch, whereas the SID procedure has been designed to turn left before Burnham-on-Crouch to overfly the sparsely populated areas of the Dengie Peninsular before turning towards CLN over the River Blackwater Estuary.

1.2. CLN is the site (to the north of Clacton-on-Sea) of an historic ground-based navigation facility (Clacton VOR/DME) which defines Airways and eastbound routes from the London-area Airports to the east towards the North Sea. A new navigation position near Osea Island is established (approximately 15.5NM southwest of CLN) to facilitate the design of this procedure.

1.3. Current utilisation of this route (based on Summer 2015 figures) is approximately 30 flights per week when runway 05 is in use. Forecast traffic growth is expected to lead to approximately 90 flights per week by 2021.

1.4. Figure E1 and E2 below show historic tracks of aircraft departing from runway 05 via CLN over comparable 5-week periods in July/August 2014 and 2015 respectively[2].

1.5. Also, as detailed in Section 5 of **Part A** of the consultation document, once aircraft are beyond the end of the NAPs they may be tactically routed by LTC or LSA controllers for integration with other traffic flows.

1.6. It should be noted that since the introduction of controlled airspace at LSA in April 2015 greater use has been made of a tactical routing similar to that proposed in the SID design in order to retain aircraft inside controlled airspace and for traffic integration. This is apparent in Figure E2. (The controlled airspace configuration approved by the CAA would not encompass routing of departing aircraft directly towards CLN at the altitudes available for the SID design.)

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[1] As detailed in the main body of the Consultation Document, prior to November 2015 the runway designation at LSA was Runway 06. From November 2015 the designation is Runway 05 due to magnetic variation changes. For ease of reference, the runway is referenced as Runway 05 throughout this document, notwithstanding that for the presentation of historic data it was then designated Runway 06.

[2] It should be noted that the departures in 2014 took place before the introduction of controlled airspace around LSA and thus may include depiction of track deviations below to avoid unknown aircraft in proximity to their intended route.

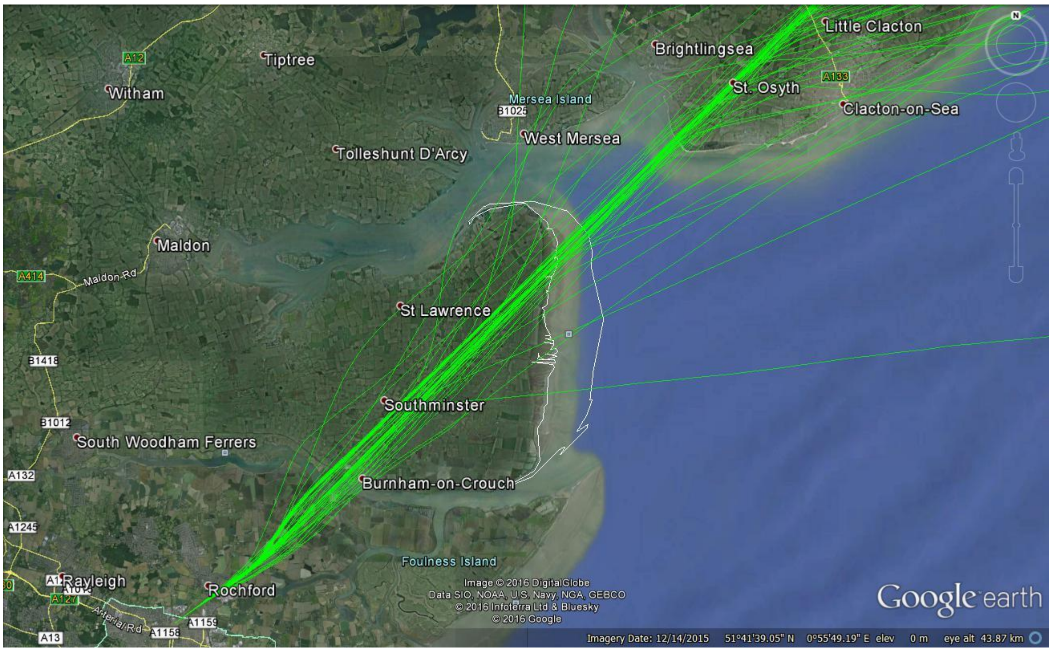


Figure E1: Runway 05. Historic departure tracks 5-week period Jly/Aug 2014 via CLN

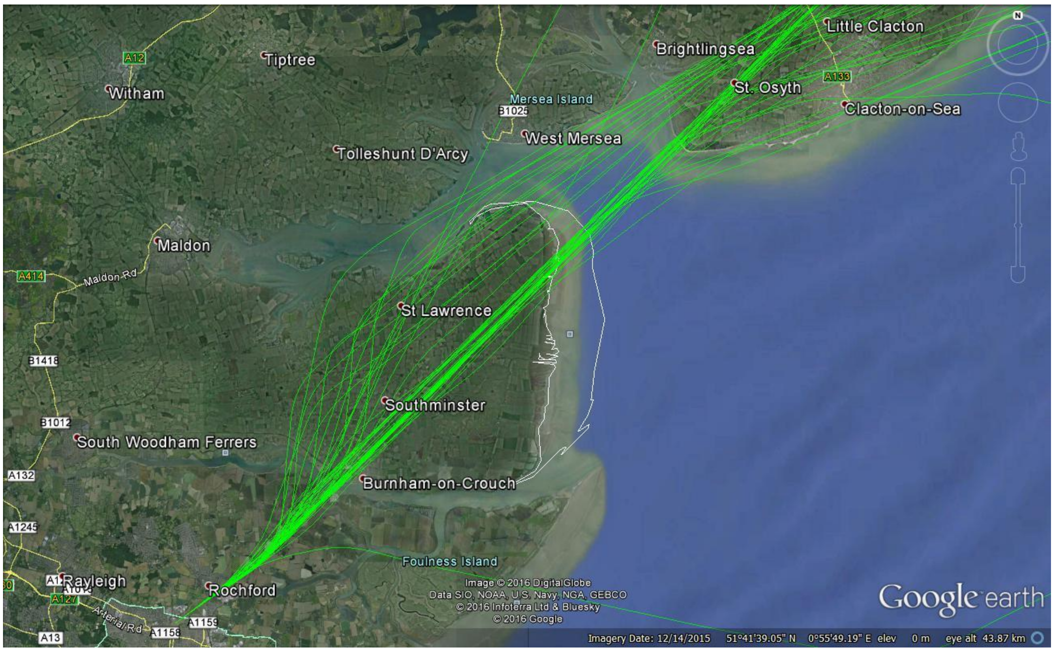


Figure E2: Runway 05. Historic departure tracks 5-week period Jly/Aug 2015 via CLN

2. The CLN 1G SID procedure

2.1. Climb on course 055°M to MCE02[3] to cross MCE02 at or above 900ft (7% minimum climb gradient) then on course 055°M to not below 1500ft. Turn left to MCN06 on course 008°M, then to MCN10, then to CLN. Cross MCN06 at or above 2500ft (7% minimum climb gradient); cross MCN10 at 3000ft; cross CLN at 3000ft. Maximum speed 210kt IAS to MCN06 then maximum speed 250kt to CLN.

2.2. A schematic diagram of the SID is shown in Fig E3 below and a diagram of the SID overlaid on an Ordnance Survey map is shown at Appendix E1.

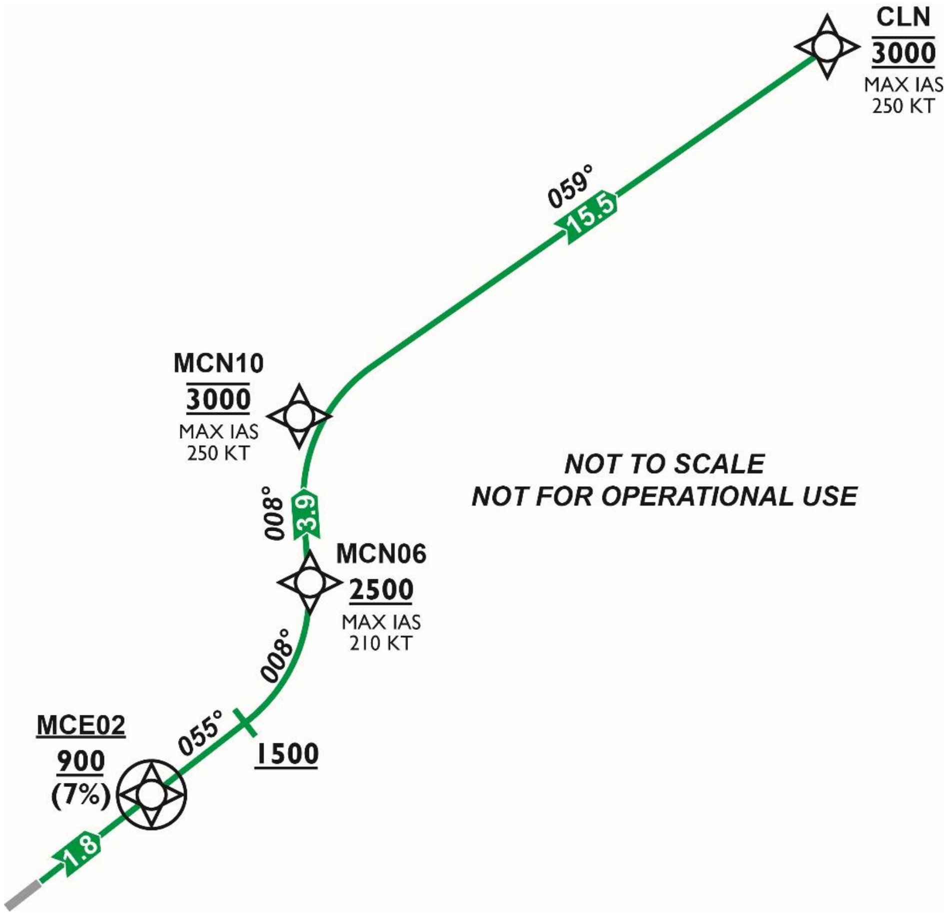


Figure E3: CLN 1G SID

2.3. Waypoint MCE02 is a flyover waypoint located 1.8NM from the end of the runway, which reflects the earliest point at which the NAPs allow a fast- climbing aircraft (i.e. above 1500ft) to turn left, as detailed in paragraph 15.3 of **Part B** of the consultation document. It is necessary to locate the waypoint at 1.8NM instead of at 1.0NM to take account of the Fix Tolerance of the RNAV waypoint to ensure that aircraft, under the worst navigational circumstances, do not start

3 Flyover waypoint designators are always underlined, flyby waypoint designators are not underlined.

to turn before reaching 1NM from the end of the runway. The procedure then requires aircraft to continue to climb straight ahead until a minimum altitude of 1500ft has been reached, which is the lowest turn altitude specified in the NAPs. A minimum altitude of 900ft is specified at MCE02 which is based on a 7% climb gradient.

2.4. From the end of the NAP at 1500ft (or at MCE02 for fast-climbing aircraft) the SID procedure turns left onto a course of 008°M towards a point near Osea Island denoted by a new navigational waypoint MCN10. The position of MCN10 has been determined so that initial departure track overlies the sparsely populated Dengie Peninsular and the subsequent track towards CLN lies over the Blackwater Estuary.

2.5. An aircraft operating speed limit of 210kt has been applied to the turn to limit the radius of turn and limit the spread of the left turn (a turn designed at a higher speed would have a wider radius of turn). The course towards MCN10 has been determined by the nominal procedure design turn radius for a turn at 210kt and 25° bank angle in still air, and so that the nominal ground track for slower climbing aircraft does not overlie Burnham-on-Crouch as far as is practicable.

2.6. An intermediate waypoint MCN06 has been located on the northbound track at a distance from MCE02 compatible with the procedure design criteria. It is at the minimum distance from MCE02 allowed by the design criteria for a track change of 47° at 210kt. A minimum altitude of 2500ft has been specified at MCN06, which is based on a 7% climb gradient. The initial speed limit is relaxed at this point.

2.7. The realigned departure route reduces direct overflight of Burnham-on-Crouch by departing aircraft, which is in accord with DfT environmental guidance. As far as is practicable, departure routes should avoid overflying the more densely populated areas and also the same communities should not be overflown by both arriving and departing aircraft at low altitudes. As Burnham-on-Crouch lies on the extended approach path to runway 23 it is affected by overflight by approximately 70% of arriving aircraft. It is reasonable and in accordance with DfT guidance, therefore, to move departing aircraft away from this area so far as it is practicable to do so.

2.8. Moreover, the realigned departure route is also operationally desirable so that departing aircraft do not have to fly outside controlled airspace and beneath the offshore holding pattern GEGMU[4].

[4] GEGMU is a new arrival routing fix and offshore holding pattern to the south of Clacton-on-Sea for aircraft inbound to LSA from the east and south. It was detailed as part of the previous LSA controlled airspace ACP (provisionally designated "GUNFY" in that ACP) and was introduced in February 2016 as part of the LAMP Phase 1a airspace changes.

2.9. Vertical constraints

2.9.1. An altitude limitation of 3000ft is necessary as far as MCN10 due to LSA inbound traffic from the GEGMU holding area to the east routing towards the left-hand downwind leg for runway 05 crossing above the departure track. Furthermore, aircraft outbound from LCY towards CLN converge above the LSA departures. (See Figure E4 below.)

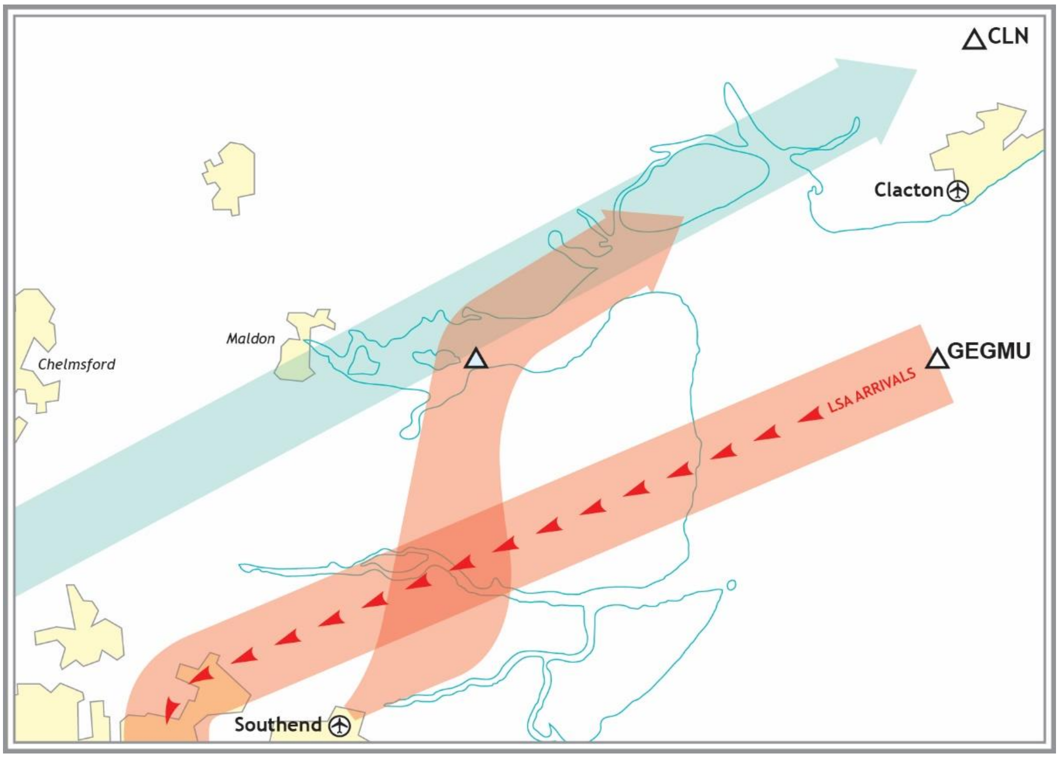


Figure E4: Schematic diagram of LSA procedure conflicts (red) and LCY departures (blue).

2.9.2. It should be noted that with the LAMP Phase 1a airspace arrangements the majority of LSA arriving traffic from the east and the south would be routing to a left-hand traffic pattern above the CLN SID route when inbound to Runway 05. Thus, MCN10 would be the earliest position that it would be procedurally safe for departing aircraft to climb above 3000ft within the safety management requirements for crossing and converging routes.

2.9.3. Similarly, once the procedure is inbound towards CLN and the interaction with LSA and LCY traffic crossing above has reduced, it would normally be acceptable to apply procedurally safe “stepped climbs” above 3000ft to the procedure design.

2.9.4. However, as explained in paragraph 15.3 of **Part B** of the consultation document it is necessary for the published upper limit for the whole SID procedure to remain at 3000ft for airspace safety reasons rather than allowing a “designed-in” stepped climb to a higher level[5].

2.9.5. On a day-to-day basis, however, if there was not another aircraft in direct conflict, then aircraft departing from LSA would be given climb clearance to a higher level. Standing Agreements will be in place between LSA ATC and LTC Sectors to ensure that climb clearance above the initial altitude limit is given to the aircraft at the earliest opportunity.

2.9.6. Furthermore, standard ATC operating rules require that aircraft within controlled airspace must be retained at least 500ft above the controlled airspace base level. Thus it is incumbent upon LTC and LSA controllers to ensure that climb clearance is given to departing aircraft in good time so that they can reach at least 6000ft by CLN.

2.9.7. Empirical evidence indicates that aircraft would regularly be expected to be above 5000ft before reaching the vicinity of MCN10, notwithstanding that this cannot be specified within the procedure. Figure E5 below provides a colour-coded plot of historic climb performance of departing aircraft routing towards CLN over a 5-week period in July/August 2015.

[5] It should be noted that the basic procedures, as published, form a vital part of the Loss of Communication procedures and thus must be “procedurally” safe with respect to other procedures and flight paths in the airspace. In the “live” traffic situation, where air traffic controllers and pilots remain in communication with each other, the controllers are able to improve on both the vertical profile and the nominal routing of the SID procedure and thereby achieve the most effective use of the airspace and efficient flight profiles for all aircraft.

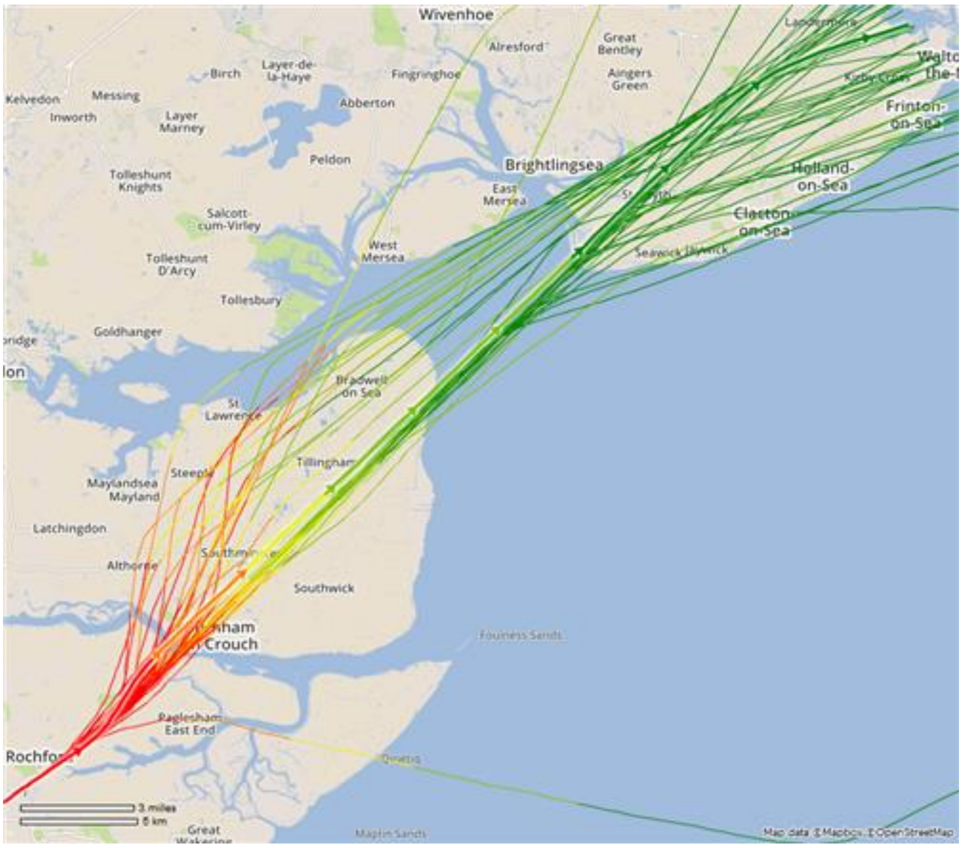


Figure E5: Colour coded climb profile of departing flights Summer 2015
[Colour coding: Below 3000ft red; 3000 – 4000ft orange; 4000 – 5000ft yellow; 5000 – 7000ft light green; above 7000ft dark green.]

2.9.8. It can be seen from these plots that the majority of aircraft that have been tactically routed on a similar route to the proposed SID have been given climb clearance above 3000ft before reaching the Blackwater Estuary and are generally in the level band 4000ft to 7000ft by the Blackwater Estuary[6].

2.10. Radar Vectoring

2.10.1. As noted in Section 5 and paragraph 9.4 of **Part A** of the consultation document it is essential that controllers retain the operational flexibility to integrate aircraft flight paths with one another to achieve the most effective and efficient overall traffic flow and to get departing aircraft climbing to their cruising levels as quickly as possible. The NAPs at LSA place no constraints on the routing of aircraft beyond 1.0NM from the end of the runway or above 1500ft. Therefore,

[6] It should be noted that whilst some aircraft have continued to use the "direct to CLN" route of the PDR since the introduction of controlled airspace, the GEGMU arrival routing and offshore holding pattern did not exist until the implementation of NATS LAMP Phase 1a changes to the LTMA arrangements in February 2016. The introduction of the GEGMU routeing and holding pattern will substantially preclude the direct routing towards CLN and so tactical routing comparable with the proposed SID procedure will become more routine operating practice until the formal implementation of SID procedure detailed in this document.

once aircraft have completed the NAP segment of the SID procedure, controllers may use radar vectoring where necessary to achieve the most efficient and expeditious flight profiles of aircraft at the lower levels of the TMA airspace.

2.10.2. The proposed SID procedure introduces formal track guidance to the route and speed control to reduce the variation in turning performance. The alignment of the SID is compatible with the LAMP Phase 1a arrangements in the eastern part of the LTMA, whereas the previous PDR alignment is neither compatible with the LTMA configuration nor does it retain aircraft within controlled airspace.

2.10.3. With the introduction of the formal SID procedure there will be a lesser operational requirement for ATC tactical intervention in the routing of aircraft in the earlier stages of departure. The operational interface between LSA ATC and LTC Sectors will be focussed more on leaving the aircraft on the SID route rather than radar vectoring. However, the option of radar vectoring must remain available to ensure that controllers can achieve the most effective flight profiles and give climb clearance at the earliest opportunity.

3. Differences between the CLN 1G SID and the PDR

3.1. An important environmental consideration has been taken into account in the development of the SID procedure towards CLN. The environmental objective has been to reduce direct overflight of Burnham-on-Crouch by departing flights towards CLN. This is in accordance with DfT guidance that departure procedures should, wherever practicable, avoid overflight of built-up areas and also that communities should not, as far as practicable suffer from overflight by both departing and arriving aircraft at low altitude. Burnham-on-Crouch lies on the approach path to Runway 23 and so it experiences overflight by approximately 70% of arriving flights to LSA It is not possible to alter the alignment of the approach path over Burnham-on-Crouch, whereas it has been possible to alter the alignment of the departure path.

3.2. A diagram showing the proposed CLN 1G SID in comparison with the tracks of aircraft flying on the previous CLN PDR is shown at **Appendix E2**. The widths of the swathes depicted in **Appendix E2** are ±1NM from the nominal route centre-line for the outer swathe, which represents the "worst case" flight safety navigational tolerance used for procedure design, and ±0.2NM for the inner swathe, which represents what we expect to be the day-to-day navigation accuracy expected on RNAV-1 routes (based on experience of other ATM applications of RNAV-1 operations elsewhere).

3.3. It should be noted that the PDRs were, historically, not designed to any formal procedure design criteria and tracks to be flown were not specified with reference to the navigation infrastructure. Nor were speed constraints (other than the standard international speed limit of 250kt outside controlled airspace) applied to PDRs. Conversely, SID procedures are designed to ICAO PANS-OPS procedure design criteria and specify tracks to be flown and, in this case, speed control is used to assist in development of the track to be flown.

3.4. As can be seen from **Appendix E2**, the historic PDR routing outside controlled airspace was directly towards CLN after completion of the Noise Abatement requirement. This, effectively, resulted in overflight of Burnham-on-Crouch by all departing aircraft on this route unless ATC had an operational reason (such as other aircraft in the area) to route them further to the north or south.

3.5. However, retention of a route directly towards CLN is not viable within the volume of controlled airspace at LSA approved by the CAA in 2015 or the revised configuration of routes in the eastern part of the LTMA for the LAMP Phase 1a arrangements. It would result in the SID procedure routing directly beneath the offshore GEGMU holding pattern to the north-east of LSA thereby resulting in departing aircraft being held down at low altitudes, below arriving aircraft, for a longer period. Furthermore, it would not be possible for LSA or LTC controllers to comply with the ATM requirement to ensure aircraft are retained within the boundaries of the recently granted controlled airspace. Indeed, since the introduction of controlled airspace in 2015 LSA ATC and LTC have been regularly routing departing aircraft further to the north on a tactical basis (see Figure E2) which has enabled climb clearance to higher levels to be given within controlled airspace.

3.6. Given the development of the offshore holding pattern GEGMU over the sea (as detailed in the previous airspace change consultation) and the inbound routing of aircraft from GEGMU towards their approach to runway 05, together with the other changes to the airspace arrangements associated with NATS LAMP Phase 1a project, it is operationally beneficial for aircraft departing from LSA via CLN to join the eastbound leg of their flight to the north of the GEGMU holding pattern; thus the revised departure route has been established for that purpose.

3.7. Therefore, the SID is configured to provide an environmental advantage by its alignment over the sparsely populated areas of the Dengie Peninsular instead of directly over Burnham-on-Crouch.

3.8. We have used a speed limit for the procedure design to reduce the dispersion of the initial turn by faster aircraft as detailed in paragraph 2.4 above. Speed limits were not applied to the previous PDR design. Selecting an appropriate speed limit is a fine balance between the preferred operating speeds and configurations of the variety of aircraft using the route and the ATM and environmental objectives. In this case we have used 210kt and a nominal bank angle of 25° in the nominal procedure design, which is acceptable for jet aircraft and will not impede slower non-jet aircraft at this stage of the flight.

3.9. The immediate post-departure leg of the procedure design preserves the dispersion of initial turn point afforded by the NAP for aircraft of differing climb performance. Only a few aircraft will have reached 1500ft before reaching MCW02. Most aircraft, therefore, will start their turn when they reach 1500ft, which is a variable position dependent on the climb rate of the aircraft rather than a fixed ground position. This ensures that faster-climbing jet aircraft will make their left turn well before reaching Burnham-on-Crouch.

4. Other options considered

4.1. **Use of flyby waypoints**:

4.1.1 The use of flyby waypoints throughout the procedure design is the preferred methodology for aircraft navigation systems and was considered in the outline development of the procedure design.

4.1.2 However, the positioning of an initial flyby waypoint (to define the start of the first turn following noise abatement) which would meet both the procedure design criteria and the definition of the noise abatement procedure would result in the track "rolling out" of the turn towards MCN10 being substantially to the east of the desired routing. The initial waypoint would need to be close to Burnham-on-Crouch (due to the constraints of the procedure design criteria), resulting in a greater number of faster-climbing aircraft flying closer to Burnham-on-Crouch before starting to turn.

4.1.3 Conversely, using a flyover waypoint, together with a Course to Altitude (CA) leg, to define the start of the turn allows the dispersion of departing aircraft of differing climb performance, as provided for in the NAP, to be retained.

4.1.4 Therefore, LSA has elected to utilise the flyover waypoint configuration, together with a CA leg to enforce the minimum turn altitude requirement, for the procedure design configuration rather than flyby configuration.

4.2. **Directly towards CLN**: Whilst this option would effectively replicate the previous PDR arrangement it would result in continued overflight of Burnham-on-Crouch by all eastbound departing aircraft. From the ATM perspective maintaining the route directly towards CLN would require departing aircraft to remain below inbound aircraft via the GEGMU holding pattern for a longer period and would not allow ATC to meet the requirement to retain aircraft within the recently granted controlled airspace. It would result in complex ATC interactions and service provision arrangements and would most likely result in delayed climb clearance for departing aircraft, with the associated environmental impact on fuel burn and flight efficiency.

4.3. **Further east than MCN10**[7]: In the development of the proposed controlled airspace arrangements for the LAMP Phase 1a project NATS and LSA together tested a number of airspace and route configurations for flights departing from LSA via CLN against those inbound from both the west and the east and other LTMA routes. It was determined, on balance, that the route should be as outlined in this Annex and the position of the routing waypoint located

[7] In the airspace and route alignment studies the routing fix was allocated a provisional 5Letter Name Code (5LNC) ARPIK. However, allocation of a 5LNC is no longer necessary and the waypoint is now allocated an alphanumeric designator in accordance with RNAV waypoint naming policy.

accordingly in the vicinity of Osea Island. Notwithstanding the ATM requirements, if MCN10 was positioned further to the east, closer to CLN, then the SID route would be more likely to result in some overflight of Burnham-on-Crouch and would also require procedural resolution against the Bradwell Restricted Area (R156)[8].

4.4. **Higher procedure altitudes**: As noted above, an initial procedural limitation of 3000ft must be applied to ensure separation between the SID procedure and other flight paths crossing above (See Figure E4 above.) The safety management requirements with respect to "stepped climbs" and SSR Mode S depiction on LTC radar controllers data displays (as explained in paragraph 15.3 of **Part B** of the consultation document) has precluded the specification of higher levels in the published procedure. However, as detailed in paragraph 2.8 above, climb clearance above 3000ft will be issued as soon as it is operationally safe and practicable to do so and Standing Agreements between LSA ATC and LTC Sectors to facilitate this will be in place. Empirical evidence shows that on a day-to-day basis most aircraft will have achieved levels above 5000ft before reaching MCN10.

[8] Bradwell Restricted Area R156. Flight is prohibited within a radius of 2nm, surface to 2000ft ALT, except for aircraft making an approach to LSA.

5. Environmental impact

5.1. It can be seen from the diagram at **Appendix E1** that the nominal route of the SID passes over the sparsely populated areas to the north-west of LSA in the initial turn and then routes substantially over the Blackwater Estuary whereas the majority of aircraft departing on the PDR have historically routed directly over Burnham-on-Crouch. The noise impact of departing aircraft on the more densely populated areas is reduced by the alignment of the SID.

5.2. The dispersion of the initial turn of departing aircraft towards less populated areas by aircraft of different climbing performance afforded by the NAP has been retained.

5.3. The Airport Noise Contours are not affected by the change from PDR to SID as detailed in **Part A** Section 7. The increase in contour size from 2014 to 2021 would occur irrespective of whether the departure procedures remain as current or are changed to SIDs.

5.4. The introduction of a speed limit for the initial turn of the SID, together with a specified track towards Osea Island, will reduce the overall spread of aircraft tracks around the turn.

5.5. Although within the procedure design it is necessary for safety management purposes to place a procedural altitude limitation of 3000ft at the routing waypoint near Osea Island, it is expected on a day-to-day basis most aircraft would be above 4000ft by this point. Typically, an A319 given unrestricted climb clearance by ATC would be generally above 5000ft by the Blackwater Estuary.

5.6. The revised alignment of the departure route to CLN enables compliance with DfT guidance that departure routes should, as far as practicable, avoid overflight of the more densely populated areas and also that, wherever practicable arrival and departure flight paths should not overfly the same communities at low level.

5.7. The SEL Chart at **Appendix E3** shows a slight change to the alignment of the "far out" extremity of the 80dB(A) SEL contour. This is due to the position of the first flyover waypoint which defines the NAP as a consequence of the PANS-OPS procedure design criteria.

5.8. **Table E1** below shows the area and population within the 80 and 90 dB(A) SEL footprints for departures by the Airbus A319 on the PDR and the proposed SID procedure.

SEL Value	Runway	Route	Area (Km^2)		Population (thousands)	
			Current route	SID	Current route	SID
90 dB(A)	05	CLN	2.4	2.4	0.9	1.0
80 dB(A)			12.3	12.4	8.5	8.6

Table E1: SEL Footprints CLN PDR and CLN 1G SID

5.9. The Chart at **Appendix E4** shows the departure swathes against which population counts have been made. The criteria against which the swathe widths and length have been determined are detailed in **Part A** paragraph 9.5 of the consultation document. Whilst the swathe widths reflect the general practice used at other UK airports it should be noted that we expect the day-to-day track-keeping performance for departing aircraft using the RNAV-1 SID procedures to be better than the 2km swathe width used for this analysis.

5.10. **Table E2** below provides a comparative count of the number of people within the respective swathes for the historic PDR and the proposed CLN 1G SID.

Runway	Route	Population (thousands)	
		Current Route (PDR) (nominal 3km width)	SID (nominal 2km width)
05	CLN	12.6	1.5

Table E2: Population Count for PDR and SI

5.11. This shows a substantial reduction in the number of people overflown as a consequence of the proposed SID new northerly route.

5.12. The introduction of properly constructed RNAV SIDs with a navigation standard of RNAV-1 will result in improved repeatability of tracks in accordance with CAA Policy and DfT guidance. The SID, in conjunction with the recently introduced controlled airspace and the improved airspace efficiency resulting from the recently introduced LAMP Phase 1a airspace arrangements, will enable earlier climb clearance to be given to most departing aircraft above the 3000ft initial limitation of the SID procedure. Furthermore, it is anticipated that the more efficient airspace arrangements will reduce the need for ATC to radar vector aircraft away from the SID route at low altitude in the early stages of departure.

5.13. It is therefore concluded that the impact of changing the PDR to a formal SID procedure brings a substantial overall environmental benefit to communities on the ground as well as improved flight profiles and reduced fuel burn for aircraft operators.

Appendix E1 Diagram of CLN 1G SID overlaid on OS topographical map

CLN 1G SID: Diagram showing the anticipated maximum track dispersion (±0.2NM; solid red lines) and the maximum navigation tolerance (± 1.0NM; dashed red lines) overlaid on Ordnance Survey map.

Appendix E2 Diagrams of CLN 1G SID and historic tracks of aircraft flying on the CLN PDR.

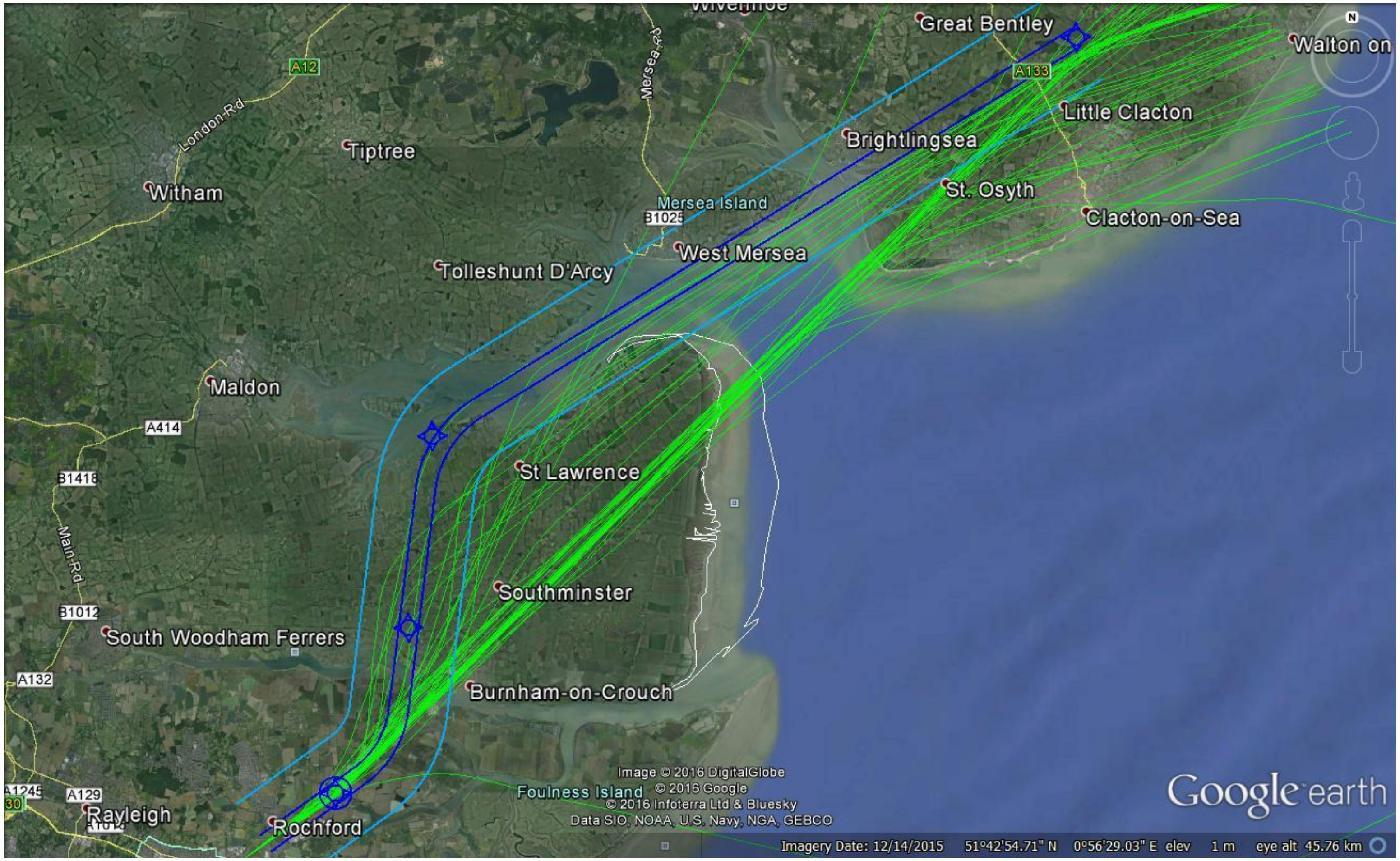


Diagram showing the anticipated maximum track dispersion (±0.2NM; dark blue) and the maximum navigation tolerance (± 1.0NM; light blue) for the CLN 1G SID against historic NTK tracks (green) for departing aircraft July/August 2015.

Enlarged segment of previous diagram

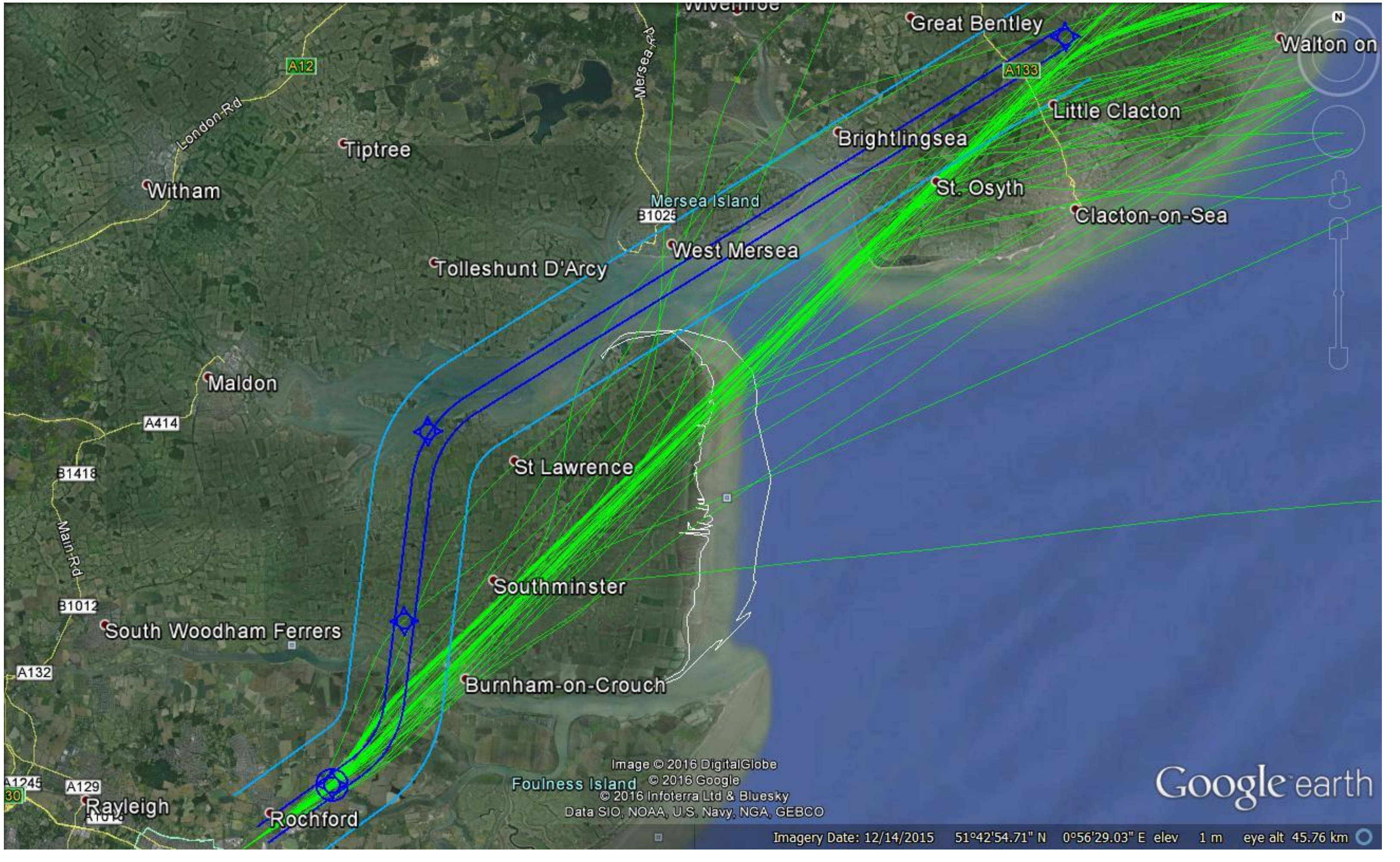
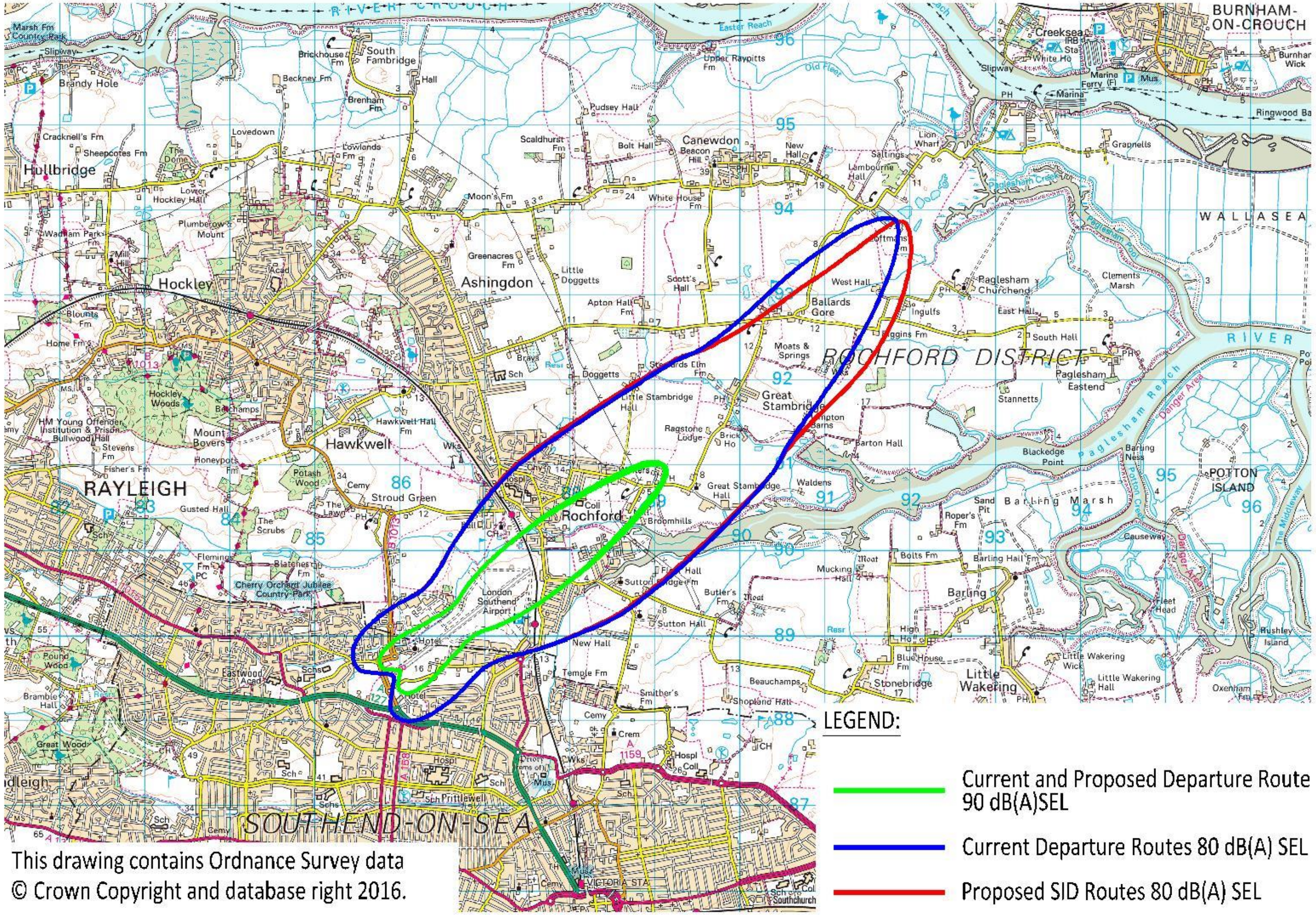
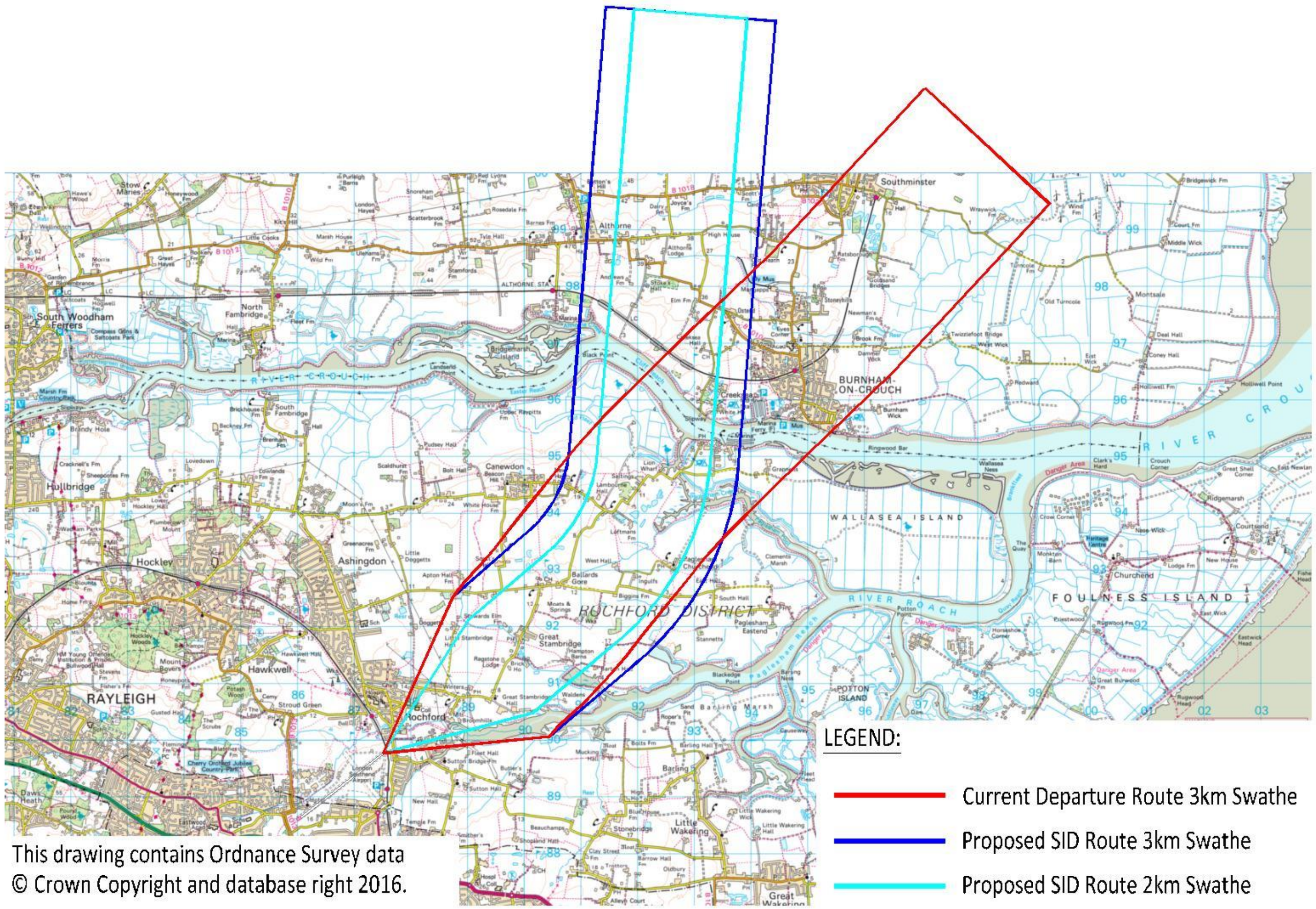


Diagram showing the anticipated maximum track dispersion (±0.2NM; dark blue) and the maximum navigation tolerance (± 1.0NM; light blue) for the CLN 1G SID against historic NTK tracks (green) for departing aircraft July/August 2014.

Appendix E3 SEL Chart for A319 aircraft.



Appendix E4 Departure swathes for CLN PDR and CLN 1G SID



(See Part A paragraph 9.6 for explanation of swathe widths and length.)