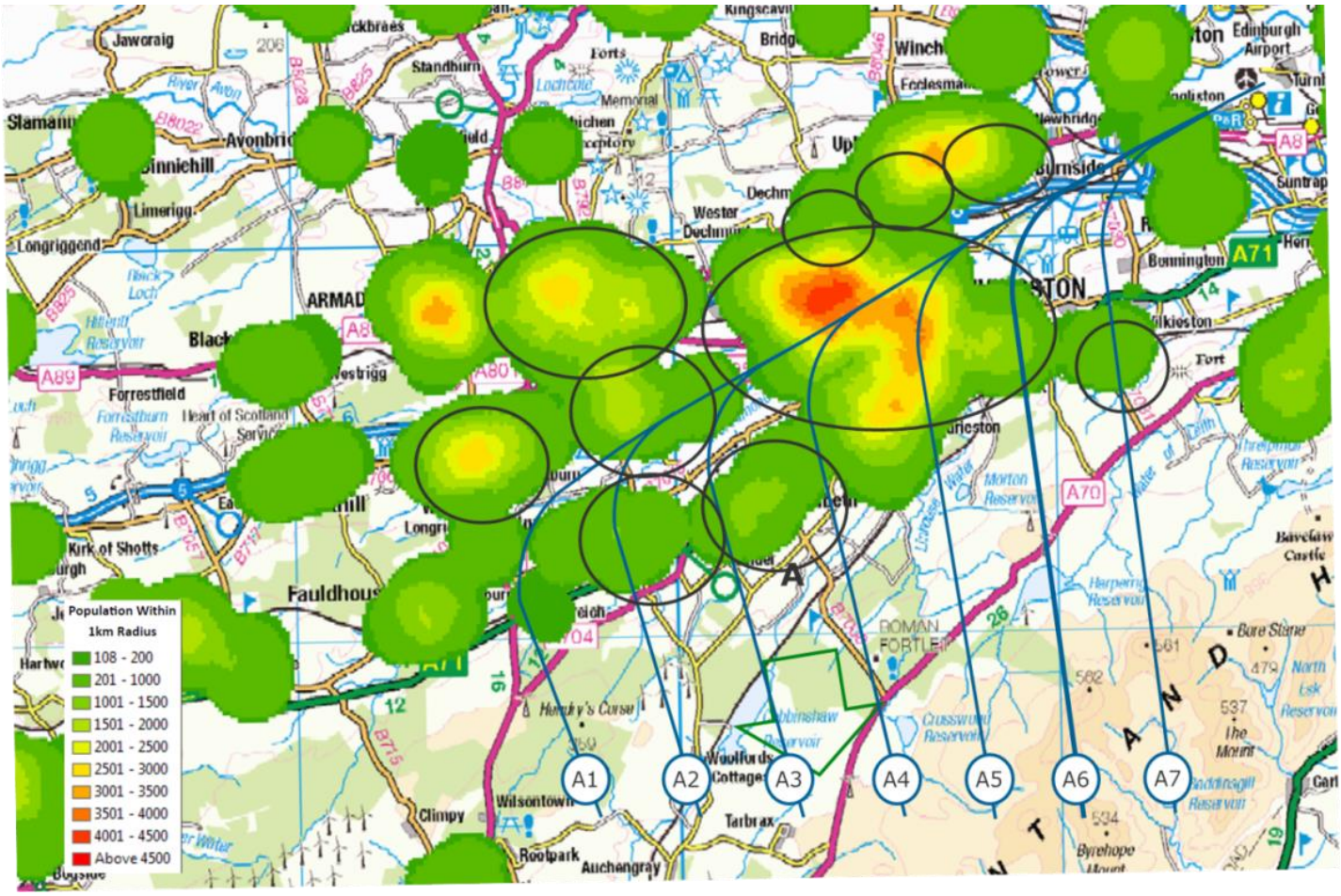
Flight Path Option Design

This paper provides descriptions of the flight path options considered for each route and the rationale for selection or rejection of the various options.

For each route a representative set of options is shown overlaid on a map showing population density. This shows how the areas of greatest population are avoided at lower altitudes where practicable and compares the impacts or benefits of each option for the communities under the possible flight paths.

The proposed RNAV departure procedures will be operated as noise preferential routes (NPRs). As such aircraft would be required to follow the routes until reaching at least 6,000ft. Once above 4,000ft Air Traffic Control is able to direct aircraft (vector) off the route towards their final destination, hence there may be some dispersal of the traffic above 4,000ft on some routes.

Flight path A – Runway 24 departures left turn



Flight path A to the south links Runway 24 to the point TALLA, from where flights join the en-route network

A1 This route extends straight-out from Runway 24 over Livingston and Blackburn before turning south over Stoneyburn. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

A2 This route extends straight-out from Runway 24 over Livingston and turns south over Blackburn. More population are overflown compared to the preferred option, and the track mileage is greater, resulting in increased CO_2 emissions.

A3 This route is a close replication of the existing conventional route. This route extends straight-out from Runway 24 over Livingston and turns south over Addiewell. More population are overflown compared to the preferred option, and the track mileage is greater, resulting in increased CO_2 emissions.

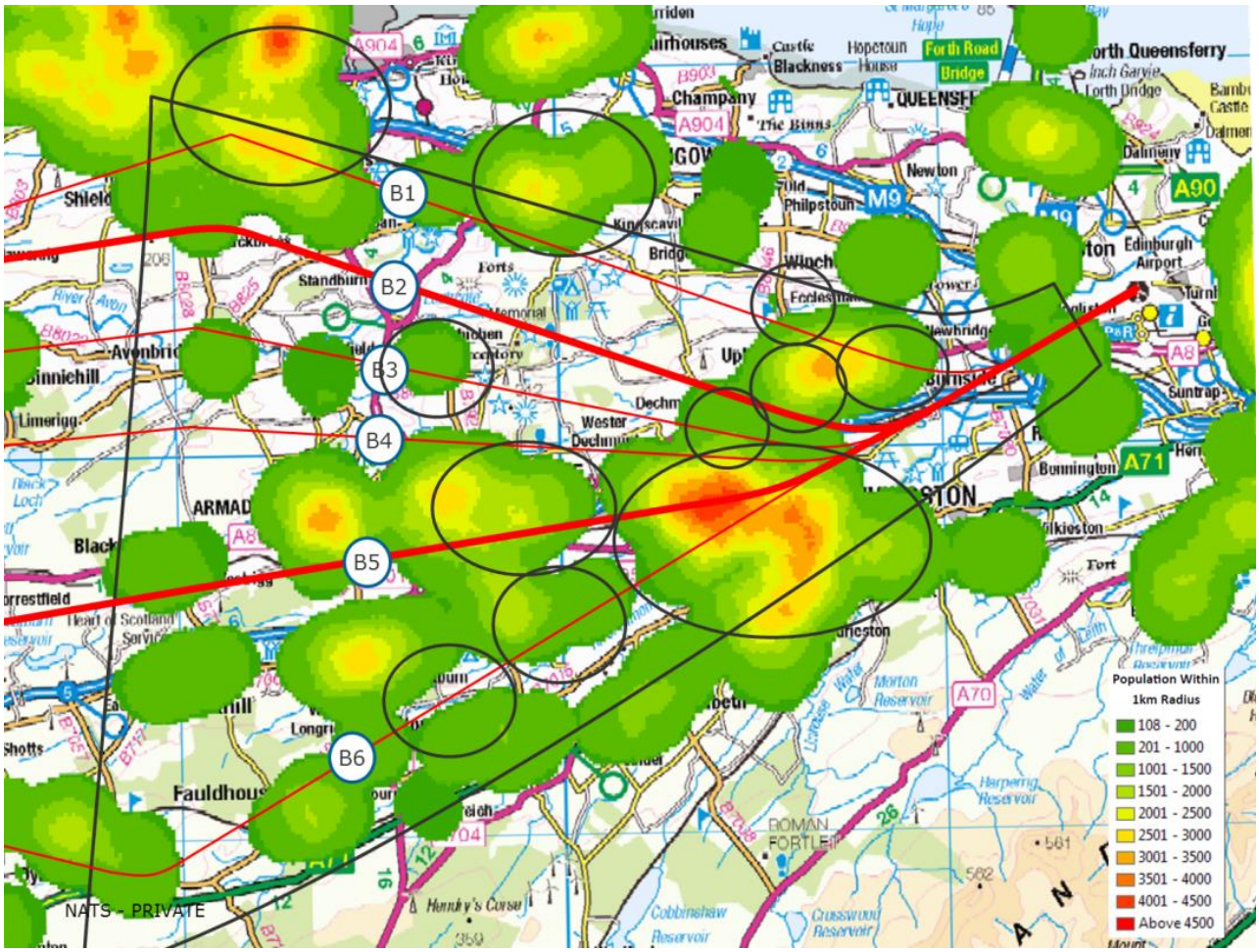
A4 This route extends straight-out from Runway 24 over Livingston and turns south over Polbeth. More population are overflown compared to the preferred option, and the track mileage is greater, resulting in increased CO_2 emissions.

A5 This route extends straight-out from Runway 24 and turns south over the centre of Livingston. More population are overflown compared to the preferred option, and the track mileage is greater, resulting in increased CO_2 emissions.

A6 This route extends straight-out from Runway 24 and turns south over East Calder. The earlier left turn avoids overflying Livingston and the population overflown is the lowest (of the feasible options). The track mileage is minimum, resulting in the lowest CO_2 emissions.

A7 This route extends straight-out from Runway 24 and turns south over Kirknewton. The early left turn avoids overflying Livingston and the population overflown is the low (similar to A6). However to turn this early would not be safe according to PANS-Ops rules (internationally accepted guidelines for safe aircraft procedure design).

Flight path B – Runway 24 departures straight ahead



Flight path B links Runway 24 to the points GOSAM to the west, from where flights join the en-route network.
The design for Runway 24 departures to the west is to keep the existing route to GOSAM (B5) and to introduce an additional, parallel route for departures to the west. This will serve to reduce the number of flights on the existing route, and reduce the noise impact on those living beneath the existing route. The route B options below are contingent on this requirement.

B1 This route extends straight-out from Runway 24 and turns right as early as possible (over industrial areas of Broxburn). The route continues NW to Brightons/Maddiston where it turns west, parallel to the existing route (B5). More population are overflown compared to the preffered option, and the track mileage is greater resulting in increased CO_2 emissions.

B2 This route extends straight-out from Runway 24 and turns right abeam Broxburn. The route continues NW to Maddiston where it turns west parallel to the existing route (B5). The population overflown on this route is the minimum, whilst keeping adequate separation from B5. This option impacts the fewest new people and would reduce the impact on those currently under the flight path (B5).

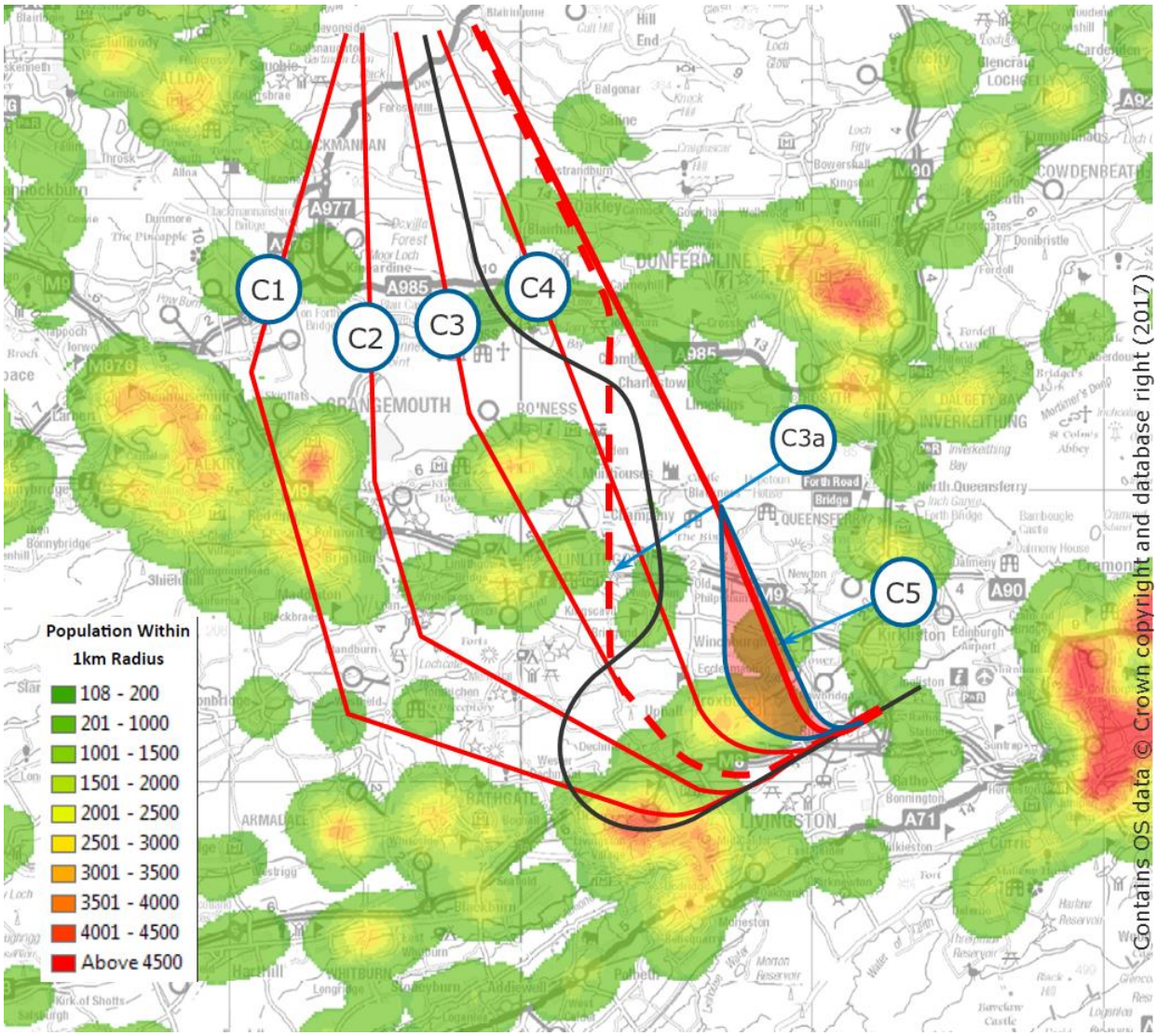
B3 This route extends straight-out from Runway 24 and turns right abeam Uphall. The route continues NW over Dechmont, Torphichen to Avonbridge where it turns west, parallel to the existing route (B5). More population are overflown compared to the preferred option.

B4 This route extends straight-out from Runway 24 and turns right abeam Dechmont. The route continues west over Bathgate after which it turns parallel to the existing route (B5). More population are overflown compared to the preferred option. The route is not sufficiently spaced from B5 for simultaneous operations.

B5 This route is a replication of the current conventional GOSAM standard instrument departure (SID). Traffic currently flies this route to a close tolerance (using RNAV overlays). The route extends straight-out from Runway 24 and turns right over Livingston. It then continues west over Bathgate, Armadale and Blackridge. Our preferred option is that this route will continue to be used, however the traffic departing to the west will be split between this routes and B2. The population overflown by this route will be the same as the current day operations; however the number of flights per day will be reduced.

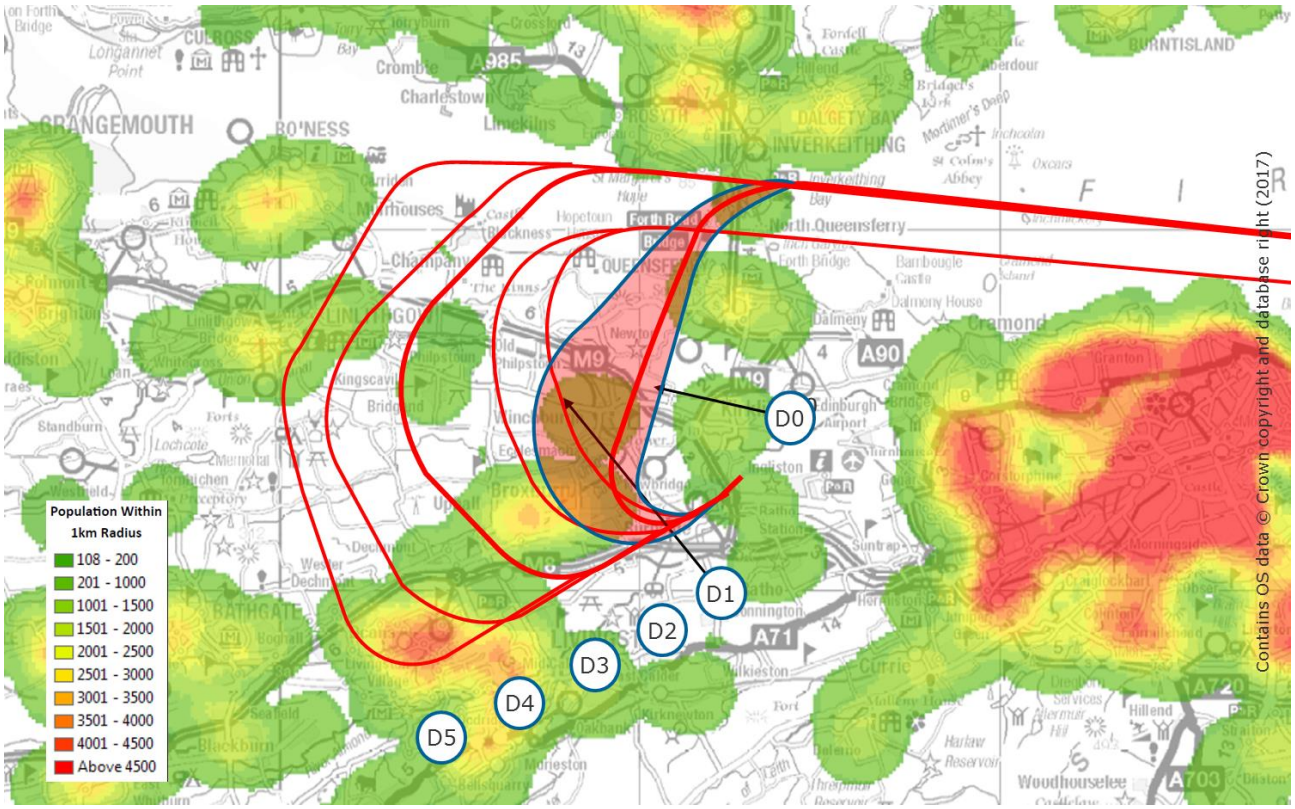
B6 This route extends straight-out from Runway 24 and continues along the extended runway centreline over Livingston, Whitburn and Fauldhouse. More population are overflown compared to the preferred option, and the straight-out route does not give any operational benefit.

Flight path C – Runway 24 departures right turn to north



Flight path C to the north links Runway 24 to the point GRICE, from where flights join the en-route network.
C1 This route extends straight-out from Runway 24 and turns right over Livingston. The route continues NW to Westfield where it turns north and passes over Maddiston and Grangemouth. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.
C2 This route extends straight-out from Runway 24 and turns right abeam Uphall and over Dechmont. The route continues NW and turns north between Linlithgow, Bo'ness and Grangemouth. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.
C3 This route extends straight-out from Runway 24 and turns right abeam Broxburn. The route continues north over Linlithgow, Bo'ness and Grangemouth. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.
C3a This route follows the same path as C3 for the first turn but then routes due north between Philipstoun and Linlithgow (dotted red line) before joining route C5 over Crombie. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.
C4 This route extends straight-out from Runway 24 and turns right over Broxburn. The route continues north over Philipstoun and Champany. This route turns later than the preferred option and tracks directly over Broxburn.
C5 This route turns right as early as possible after take-off. Smaller and slower aircraft will be able to turn over the industrial area on the east side of Broxburn and hence avoid the centre of Broxburn. Larger, faster aircraft will turn with a wider radius which will take them over the centre of Broxburn. The route continues north over Winchburgh and Blackness and over the Firth of Forth. By the time the flights cross the north coast of the Forth at Cromie flights will be above 7000ft. This option overflies the lowest population (even accounting for proposed development in Winchburgh). The track mileage is minimum, resulting in the lowest CO_2 emissions.

Flight path D – Runway 24 departures right turn to south



Flight path D links Runway 24 to the points HAVEN and TALLA to the south, from where flights join the en-route network. This route will be used predominantly by jet aircraft.

D0 This route turns right as early as possible after take-off. Smaller and slower aircraft e.g. turbo-props will be able to turn over the industrial area on the east side of Broxburn and hence avoid the centre of Broxburn. Larger, faster jet aircraft will turn with a wider radius which will take them over the centre of Broxburn. The route continues north-east over Winchburgh to South Queensferry, it then routes along the Firth of Forth before turning south. By the time flights cross the coast at at Cockenzie and Port Seaton they will be above 12,000ft. This option overflies the lowest population (including proposed development in Winchburgh).

D1 This route turns right as early as possible after take-off and routes via Winchburgh, Hopetoun, then along the Firth of Forth before turning south. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

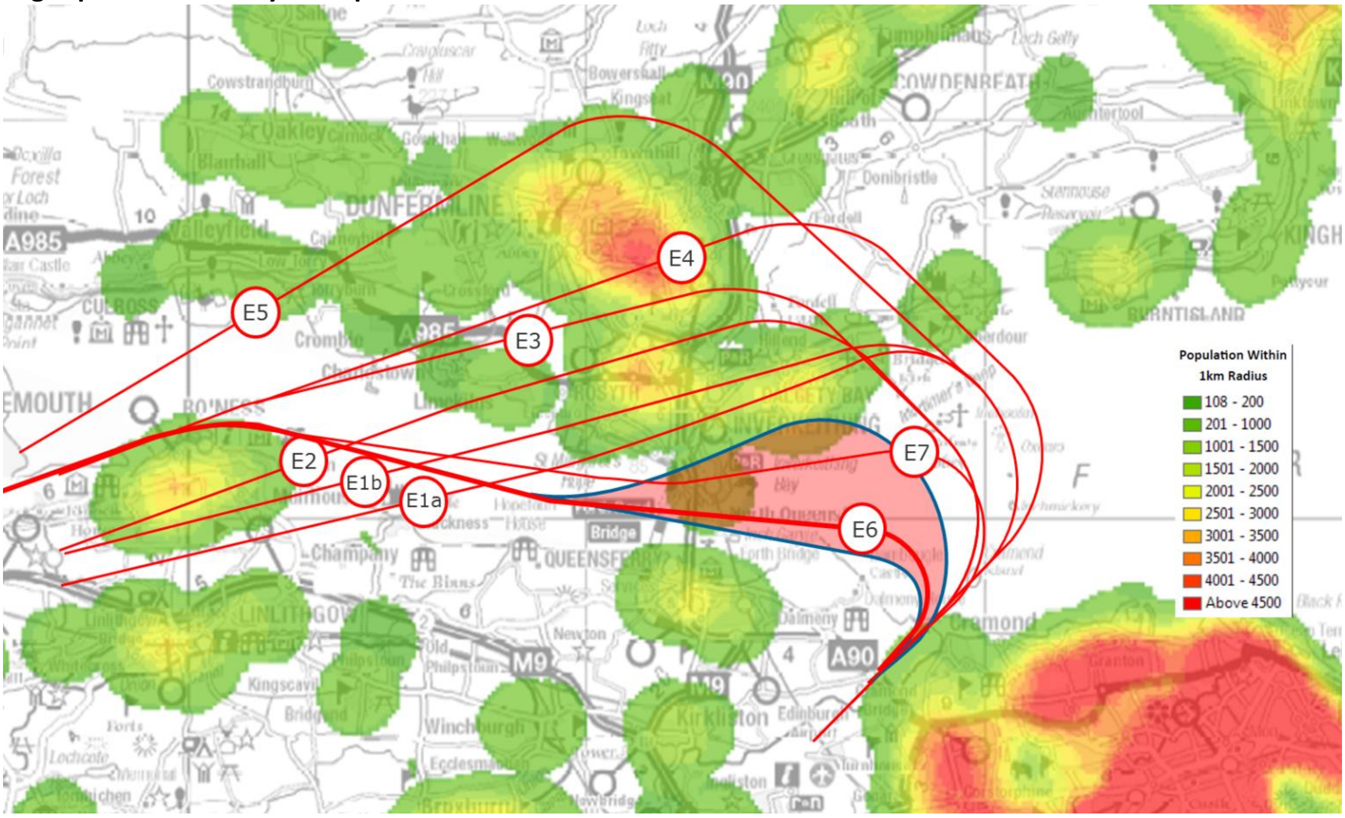
D2 This route turns right over Broxburn, then routes via Winchburgh, Philipstoun, Abercorn, then along the Firth of Forth before turning south. This route is based on a different RNAV coding (Fly-by, Turn to fix) to the preferred option D0. This would result in more concentration in the first turn, but gives a later/wider first turn. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

D3 This route turns right over Uphall, then routes via, Philipstoun, Abercorn, then along the Firth of Forth before turning south. This route is based on a different RNAV coding (Fly-by, Turn to fix) to the preferred option D0. This would result in more concentration in the first turn, but gives a later and wider first turn. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

D4 This route extends straight-out from Runway 24 and turns right over Livingston, then routes via, Dechmont, Kingscavil, Blackness then along the Firth of Forth before turning south. This route is based on a different RNAV coding (Fly-by, Turn to fix) to the preferred option D0. This would result in more concentration in the first turn, but gives a later and wider first turn. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

D5 This route extends straight-out from Runway 24 and turns right over Livingston, then routes via, Dechmont, Kingscavil, Blackness then along the Firth of Forth before turning south. This route is based on a different RNAV coding (Fly-by, Turn to fix) to the preferred option D0. This would result in more concentration in the first turn, but gives a later and wider first turn. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

Flight path E – Runway 06 departures left turn west



Flight path E links Runway 06 to the point GOSAM to the west, from where flights join the en-route network.

E1a This route replicates the existing conventional procedure. The route turns left after take-off, over Inverkeithing and Dalgety Bay, then the Firth of Forth to Blackness and Bo'ness. By the time flights cross the coast at Blackness they will be above 7,000ft. More population are overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

E1b This route is currently flown by some aircraft as an RNAV overlay of the current conventional GOSAM SID. It replicates the existing conventional procedure (but less precisely than E1a). The route turns left after take-off, over Inverkeithing and Dalgety Bay, then the Firth of Forth to Blackness and Bo'ness. By the time flights cross the coast at Blackness they will be above 7,000ft. More population are overflown compared to the preferred option.

E2 This route was explored with the aim of routing around Inverkeithing and between Rosyth and Dunfermline. However this would result in more population being overflown compared to the preferred option.

E3 This route was explored with the aim of routing wider around Rosyth and routing north of Bo'ness. However this would result in more population being overflown compared to the preferred option.

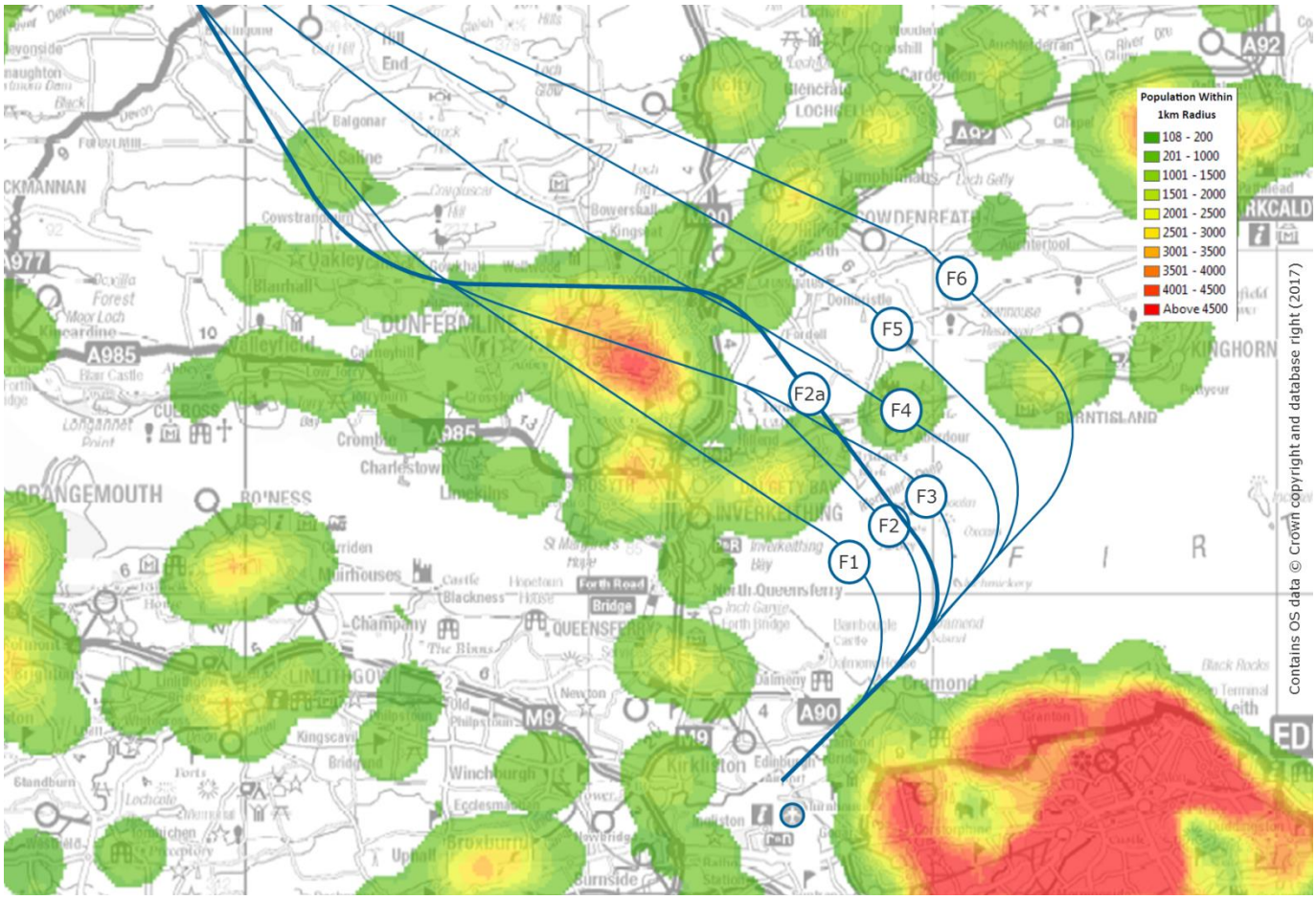
E4 This route was explored with the aim of routing wider around Inverkeithing, Dalgety Bay and Rosyth, passing over Dunfermline at above 7000ft and routing north of Bo'ness. This would result in more population being overflown compared to the preferred option, and the track mileage is greater resulting in increased CO_2 emissions.

E5 This route was explored with the aim of routing wider around Inverkeithing, Dalgety Bay and Dunfermline. This would result in increased track mileage resulting in increased CO_2 emissions.

E6 This route turns left as early as possible after take-off. The earlier turn is achieved by using a different RNAV coding sequence (fly-over, course to fix). This different coding allows smaller, slower aircraft e.g. turbo-props to turn more tightly, and hence avoid overflying Dalgety Bay and Inverkeithing. Larger, faster jet aircraft will turn with a wider radius which will bring them closer to Dalgety Bay and Inverkeithing. After the first turn the route is kept over the Firth of Forth until past Bo'ness at which point the aircraft will be above 10,000ft. This option overflies the lowest population.

E7 This route is similar to E6 but the first turn is initiated later. This option was investigated in order to assess whether the later turn reduced noise impact on Cramond (see L_{max} noise contour comparison). Both option E6 and E7 were been evaluated for noise impact and there was little difference in impact on Cramond.

Flight path F – Runway 06 departures left turn to north



Flight path F to the north links Runway 06 to the point GRICE, from where flights join the en-route network.

F1 This route extends from Runway 06 following the Cramond noise abatement offset. The route turns left 90 degrees to the north west at the earliest point (at the coastline). The route continues NW over Dalgety Bay, then Dunfermline and then on to Saline. More population are overflown compared to the preferred option.

F2 This route extends from Runway 06 following the Cramond noise abatement offset. The route turns left 90 degrees abeam Cramond Island, then tracks over Dalgety Bay, then Dunfermline and then on to Saline. More population are overflown compared to the preferred option.

F2a This route is designed to avoid direct overflight of Dunfermline. The route extends from Runway 06 following the Cramond noise abatement offset. The route turns left 80 degrees over Inchmickery Island, then tracks between Dalgety Bay and Aberdour. At the junction of the M90/A92 it turns west to over Wellwood to the north of Dunfermline. At Carnock it turns north west to GRICE. The dog-leg in this route is required to stay inside controlled airspace. The route cannot track from Townhill direct to GRICE without transgressing the airspace buffer requirements. The edge of controlled airspace is in the vicinity of Knockhill racing circuit. However in practice once above 9000ft (FL90) aircraft can be routed direct to GRICE by Air Traffic Control. This option overflies the minimum population.

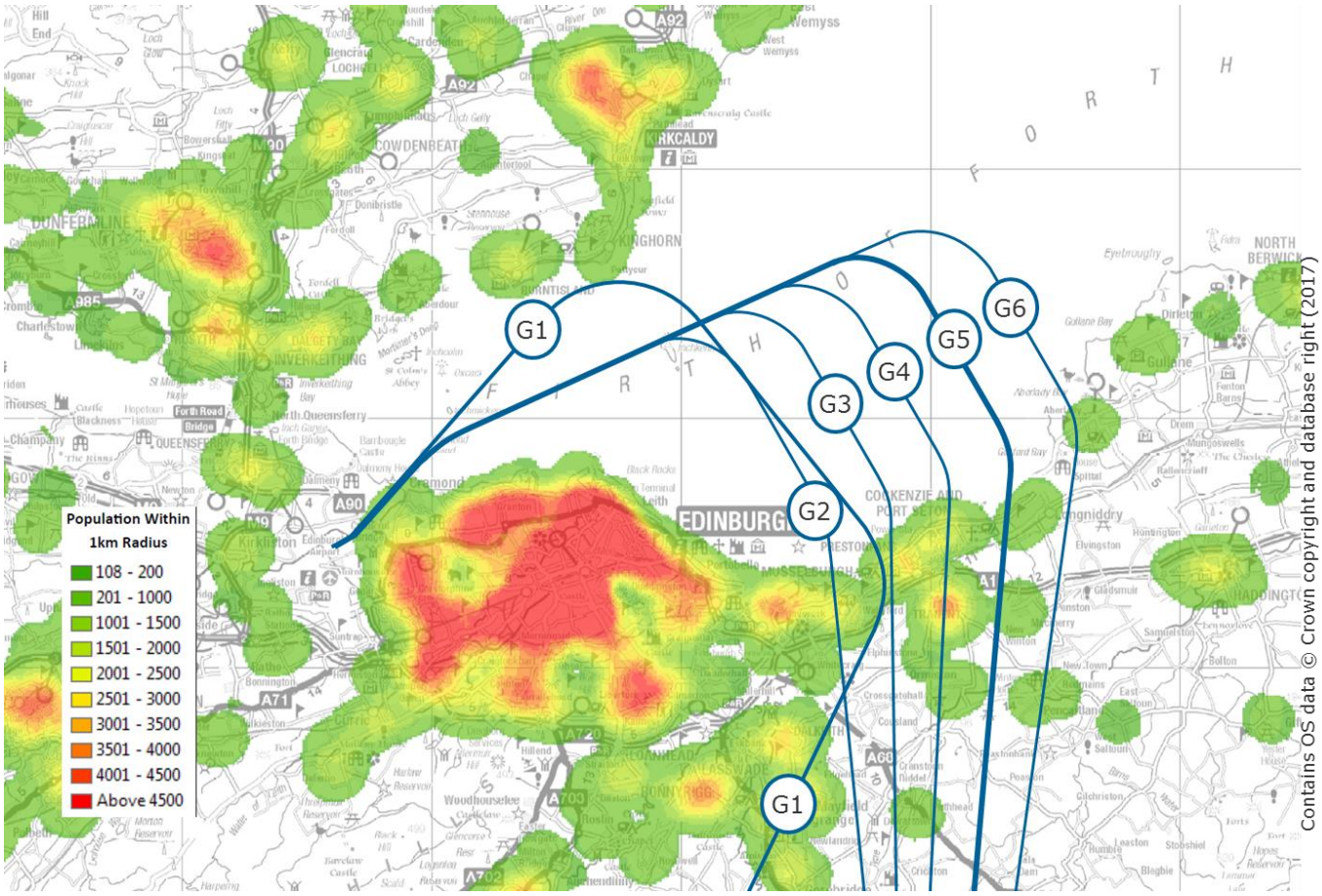
F3 This route is a close replication of the existing conventional route. This route extends from Runway 06 following the Cramond noise abatement offset. The route turns left 90 degrees over Inchmickery Island, then tracks over Dalgety Bay, then Dunfermline and then on to Saline. More population are overflown compared to the preferred option.

F4 This route extends from Runway 06 following the Cramond noise abatement offset. The route continues north east beyond Inchmickery Island then turns left 90 degrees over Aberdour, Townhill and Knockhill. This route does not give sufficient buffer with the edge of controlled airspace.

F5 This route extends from Runway 06 following the Cramond noise abatement offset. The route continues north east beyond Inchmickery Island then turns left 90 degrees between Aberdour and Burntisland, over Hill of Beath. This route does not give sufficient buffer with the edge of controlled airspace.

F6 This route extends from Runway 06 following the Cramond noise abatement offset. The route continues north east beyond Inchmickery Island then turns left 90 degrees over Burntisland then Cowdenbeath. This route does not give sufficient buffer with the edge of controlled airspace.

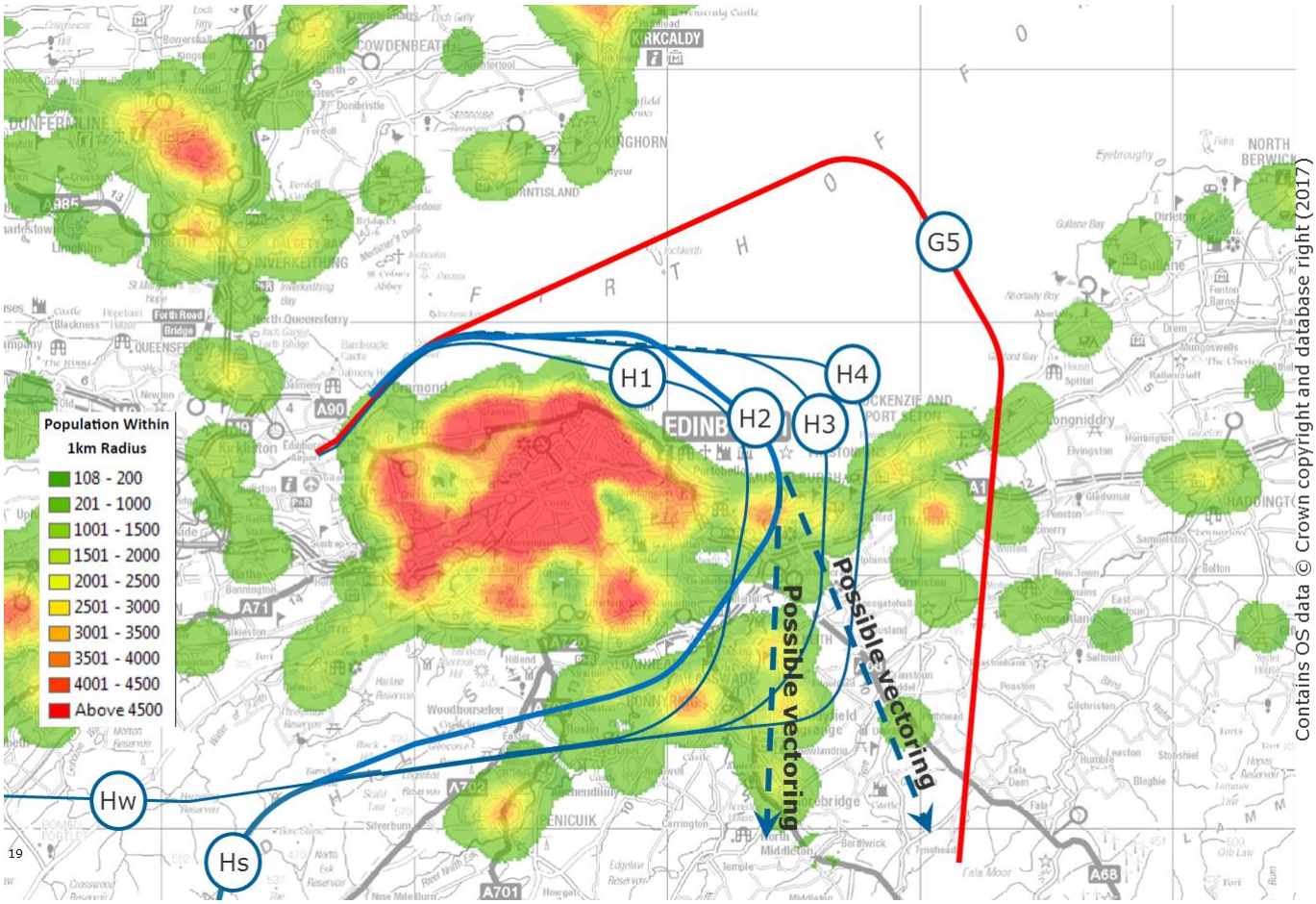
Flight path G – Runway 06 departures right turn to south



Flight path G to the south links Runway 06 to the points TALLA and HAVEN, from where flights join the en-route network.

G1 This route closely matches the current conventional departure. The route extends from Runway 06 following the Cramond noise abatement offset, then continues straight before turning right 90 degrees abeam Burntisland. It then continues to the south east crossing back over the coastline at Prestonpans, by this point the aircraft would be at least 9,000ft. This route does not give adequate separation from the preferred flight path for route H.
G2 This route extends from Runway 06 following the Cramond noise abatement offset, then continues straight before turning right 90 degrees abeam Burntisland. It then continues to the south east crossing back over the coastline at Prestonpans. By this point the aircraft would be at least 9,000ft. This route does not give adequate separation from the preferred flight path for route H.
G3 This route extends from Runway 06 following the Cramond noise abatement offset, then turns right 20 degrees over Cramond Island before turning right 90 degrees beyond Inchkeith. It then continues to the south east crossing back over the coastline at Cockenzie. By this point the aircraft would be at least 10,000ft. This route does not give adequate separation from the preferred flight path for route H.
G4 This route extends from Runway 06 following the Cramond noise abatement offset, then turns right 20 degrees over Cramond Island before turning right 90 degrees beyond Inchkeith. It then continues to the south east crossing back over the coastline at Port Seton. By this point the aircraft would be at least 10,000ft. This route does not give adequate separation from the preferred flight path for route H.
G5 This route extends from Runway 06 following the Cramond noise abatement offset, then turns right 20 degrees over Cramond Island before turning right 90 degrees beyond Inchkeith. It then continues to the south east crossing back over the coastline at Seton Sands. By this point the aircraft would be at least 10,000ft. This route does give adequate separation from the preferred flight path for route H, and also gives an acceptable buffer with the edge of controlled airspace to the east.
G6 This route extends from Runway 06 following the Cramond noise abatement offset, then turns right 20 degrees over Cramond Island before turning right 90 degrees beyond Inchkeith. It then continues to the south east crossing back over the coastline at Craigielaw. By this point the aircraft would be at least 10,000ft. This route does not give acceptable buffer with the edge of controlled airspace to the east.

Flight path H – Runway 06 departures right turn to south west



Flight path H links Runway 06 to the points GOSAM and TALLA, from where flights join the en-route network.

H1 This route extends from Runway 06 following the Cramond noise abatement offset, then turns right over Cramond Island. It then continues to the south east crossing back over the coastline at Portobello. By this point the aircraft would be at least 7,000ft. This route passes closer to the Leith coastline than the preferred route.

H2 This route extends from Runway 06 following the Cramond noise abatement offset, then turns right over Cramond Island. It tracks along the Leith, Portobello coast 2km offshore and crosses back over the coastline at Musselburgh. By this point the aircraft would be at least 7,000ft. This route has been positioned further from the coastline in order to minimise impact on the coastal area and the city. Route spacing between H2 and route G5 is in accordance with CAA route separation guidelines.

H3 This route extends further to the east before crossing the coastline at Musselburgh. However the distance between H3 and G5 does not give adequate route spacing in accordance with CAA route separation guidelines.

H4 This route extends further to the east before crossing the coastline at Prestonpans/Cockenzie. However the distance between H3 and G5 does not give adequate route spacing in accordance with CAA route separation guidelines.