FOOD AND FARMING GROUP
Veterinary Sciences Core team
EPIDEMIOLOGY REPORT

Highly Pathogenic Avian Influenza H7N7, Oxfordshire, June 2008
Situation at 12.30pm Wednesday 11th June

Prepared by the National Emergency Epidemiology Group (NEEG)

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Highly Pathogenic Avian Influenza H7N7, June 2008. 
Epidemiology Report. Situation at 12.30 Wednesday 11 June

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Executive summary

1. Following a report of suspected avian notifiable disease in laying hens in Oxfordshire on 2 June 2008, highly pathogenic (HP) H7N7 avian influenza (AI) infection was confirmed on 4 June 2008. At the time of writing (11 June), three further reported cases, from across GB, have been negated either on clinical grounds or after laboratory examination of samples, and three are under investigation.

2. On 11 June, it appears that the infection is confined to a single premises. Infection has been ruled out at both premises of origin of the affected birds. Investigations to date have found no evidence of infection on any contact or geographically close premises, and there has been no evidence of spread of infection to any other premises to date, however investigations continue.

3. Clinical evidence, from the farm’s records, supports virology opinion that HPAI infection derived from a pre-existing Low Pathogenic AI infection (LPAI). However the possibility of an HPAI introduction has not been completely ruled out. Further analyses of the virus and on the infected premises (IP) continue.
4. Seven hypotheses for source have been considered and the evidence to date suggest two of these are much more likely than the others.

5. The two likely hypotheses for the source of the outbreak continue to be investigated and are
   i. Unidentified AI in domestic poultry premises in Great Britain, associated either by proximity or potential contact, or
   ii. AI in wildlife in contact with the IP

6. Movements of live domestic birds, which represent a medium to high risk of transmission of AI, have been ruled out as a possible source of infection for the IP, and as a potential means of spread of AI from the IP.

7. The network of contacts associated with the IP that might act as the source of infection, or be at risk of spread of infection, is made up in the main by the other premises connected to the large commercial egg production business of which this farm was a part. The main risk of exposure to AI virus was on premises associated with egg collection routes, feed lorry deliveries, disposal of carcasses/manure and personnel contacts.

8. Investigations to date indicate a good standard of biosecurity is practiced in the chain between egg production and final packaging. At the time of writing, investigations of premises at risk due to potential contact (tracings) or proximity (within the protection zone, PZ) have revealed no further infected premises. The absence of positive findings from this line of inquiry seems to rule out associated premises as the source of infection at the present time. However further investigations including laboratory testing are in progress on premises at risk, in case LPAI has been missed, as clinical signs can be few and non-specific.

9. Wild bird activity in general was low around the IP. However mallard ducks were introduced onto a pond near one of the mobile sheds (shed 1) in 2007. Moreover, shed 1 was moved near to the pond, a public footpath and a stream source immediately before the current batch of 3000 birds were introduced. Current evidence suggests that infection most likely started in Shed 1, and further investigations in to the possibility of a wildlife source are in progress.

**Update at 9am Monday 16 June**

10. Continuing investigations have found no further premises infected with AI. The adjacent premises investigated as a report case were negated based on laboratory results on 13 June.

11. Five pigs were identified on the IP after this report was compiled; they have been restricted and tested for infection with AI. Examinations for both antibody and virus (by PCR) were negative. Final confirmation of the absence of virus by virus isolation methodology is in progress.
Introduction

12. Suspected avian notifiable disease was reported in laying hens in Oxfordshire on 2 June 2008 by the owner following consultation with his private veterinarian. The report stated that two weeks earlier an increased mortality rate and egg drop were noted in one of the four groups. Although this group appeared to recover following treatment with Chlortetracycline, in the last 4 days sick and dying birds were seen in the other groups. Egg drop was also seen in all birds. Sick birds were noted to be lethargic, pyrexic, with swollen combs and wattles (some cyanotic), watery white diarrhoea, sticky mucus in the mouth and a few birds with subcutaneous haemorrhages on legs. Immediate restrictions were imposed and following investigations highly pathogenic (HP) H7N7 avian influenza (AI) infection was confirmed on 4 June 2008.

13. This report describes the results of epidemiological investigations carried out to date, which seek to explain the outbreak of highly pathogenic (HP) H7N7 avian influenza (AI) infection in free-range laying hens on a premises near Banbury, Oxfordshire. The report describes the characteristics and events on the farm itself, the hypotheses for the source of infection to the farm, the possibility of spread of infection from the farm, and the associated investigations. The terminology adopted in this report to describe risk is defined at Appendix 9.

Description of the outbreak

The infected premises (IP)

14. The IP is a 150-acre free-range laying hen farm near Banbury, North Oxfordshire. Approximately 25,000 hens were kept in four groups, each with a shed for shelter. Each shed is situated about 200m apart from its closest neighbour on hilly permanent pasture, and has a dedicated paddock of land around it (Figure 1). The hens were housed during the night in the four sheds. Field epidemiological information suggests that the birds did not usually move far from their sheds. Sheds 1, 2 and 3 are mobile units each holding 3,000 birds. Shed 4 is a large static barn holding 16,000 birds with a packing bay and office at the front end, and is a new addition to the farm, having been completed at the beginning of March 2008.

15. The IP sourced its birds and feed and marketed its eggs through the same large commercial enterprise (Company A). Nine thousand birds in sheds 1, 2 and 3 were bought in on 25/02/2008 at 16 weeks of age from a premises belonging to Company A. Similarly, the 16,000 birds in shed 4 were bought in on 06/03/2008 at 16 weeks of age from a second premises also part of Company A.

16. Avian influenza viruses are well adapted to water fowl which may carry the virus without showing clinical evidence, and can persist in environmental water for some time. They can also persist in moist faecal contamination, for example on clothing, and footwear (fomites). Some geographical features around the IP, of epidemiological interest (Figure 1), include:
   - a small pond frequented by ducks and other wild waterfowl approximately 100m from Sheds 1 and 3
o a public footpath that passes about 20m from Shed 1
o a stream which runs alongside Shed 1
o a landfill site within 2km of the IP.

17. The pond was populated by a small flock of mallard ducks that were reared for sport shooting; 100 ducks were placed on the pond in May 2007, with approximately 30 ducks, one coot and one moorhen observed at the time of the outbreak.

18. However, the IP is in an area of Oxfordshire farmlands with no major water sources nearby. Investigations are in progress to establish whether these features are unusual among poultry farms in this area, or are coincidental findings that are unrelated to this farm’s risk of infection.

Figure 1: Disposition of the shed units on the IP

Farm Routine

19. Two people participate regularly in the daily collection of the eggs. Two further people participate occasionally. The pattern of movements within the farm related to the collection of eggs is shown in Figure 2. In summary, the collection of eggs starts in Shed 4, moves to the other sheds and ends at the egg packing area at the end of Shed 4. Figure 2 also shows the layout of all the buildings on the IP including the proximity of Shed 4 to structures nearby (i.e. house and barn) together with a description of all movements of personnel, materials and feed stuff
onto and off the IP. Figure 1 shows the location of the main vehicular access adjacent to Shed 4.

20. Feed deliveries occurred approximately every week. They all came from a mill part of Company A in dedicated lorries. Feed lorries park on the concrete hard standing area at the end of shed 4. Feed is blown by pipe into three silos located at the end of shed 4. Shed 4 is fed directly from two of the silos whereas sheds 1 to 3 receive their feed twice a week by means of a trailer fitted with an auger.

Figure 2: Identified network of contacts posing risks of introduction of infection, and then risks of spread within and off the IP.
Thin arrows show direction of personnel movements and are colour coded by worker number

21. The bird range is encircled by an electric fence, however, ducks from the pond have been seen in the hen range close to shed 1. Likewise, a few hens from the IP appear to cross the electric fence and range either towards the pond or nearby the footpath. Foxes entered the premises regularly. Dedicated clothing and footwear was available and a disinfectant footbath is placed outside the door of Shed 4 where the packing of eggs was carried out.

22. An ornithological inspection of the IP’s surroundings reported limited wild bird activity. The landfill nearby the IP attracted corvids but not gulls. There were no active rookeries around the IP or the landfill site. Furthermore, there were no large concentrations of gulls or wild fowl on the day of inspection. This was
expected at this time of the year with typically very low levels of movements. Expert opinion indicated that the likelihood of longer distance (>2 Km) transfer of infection by wild birds was low.

23. The IP is located in an area with a relatively low density of poultry premises (Appendix 1), with premises in the surrounding area more likely to keep birds permanently housed than with access to the outdoors (Appendices 2 and 3).

24. A meteorological assessment was conducted to investigate the weather conditions during the period 28/02/2008 to 04/06/2008 and, more specifically, those in the last two weeks of May, this being the estimated time of infection with HPAI. Meteorological data was obtained from the Royal Air Force (RAF) Brize Norton station located approximately 28 km to the south and west of the IP. The most significant feature of the last two weeks of May was the heavy rainfall which occurred between 25 and 28 May (Appendix 4). Rainfall was recorded on 66 hours out of a maximum of 96 hours. On these four days alone around 130% of an average May rainfall was recorded.

25. This high rainfall may be a contributing factor and is considered further in the section below in source investigations. A further assessment is in progress, covering the first half of May, when LPAI is believed to have been introduced.

**Description of the events and management of the outbreak**

26. Clinical signs, a reduction in the egg production and increased mortality, were observed in Sheds 1, 2 and 3 shortly after 21 May 2008 with shed-specific variations (Figure 3). At this time, animals in these three sheds were 28 weeks old. The daily mortality in Shed 1 peaked at 74 birds (2.5% of the population) on 25 May and then declined to a single death on 1 June. Increased mortality started on approximately 30 May in Shed 4; as the birds in this shed were a week younger, they were also about 28 weeks old at the time of first clinical signs. Daily mortality in Shed 4 reached approximately 1000 deaths on 2 June (>6% of the population) before becoming too high to be recorded. Egg-production records for shed 4 show a clear drop on 31st May with 11,900 eggs from a earlier baseline of around 15,000 eggs. Note that in Shed 4 there were more than five times as many birds (16,000) as in each of the other sheds.
Figure 3: Mortality and egg-production in each shed (except shed 4, only deaths shown)

27. Considering the observed clinical signs, under the assumption that they are attributable to AI, and the scientific evidence and recommendations by the OIE, a time window for the prioritisation of tracings and the identification of the different stages in the course of the outbreak was built (Figure 4). The likely dates of infection were estimated as follows:

- Most likely date of infection - HPAI: 25 - 28 May 2008
- Most likely date of infection for LPAI: 9 May 2008 (range 6 – 10 May)
- Precautionary earliest date for HPAI (21 day incubation period): 9th May 2008.
- Precautionary earliest date for LPAI (21 day incubation period): 30th April 2008.

The estimated dates of spread risk were:

- High risk: 19 May 2008 (LPAI) or 28 May 2008 (HPAI) – 3 June 2008
- Lower risk 4 June 2008 – 7 June 2008 (completion of preliminary C&D)

28. It is important to note that data regarding egg production must be treated with caution due to variations in the time of egg collections. These variations, and consequently the variable time at which the flocks were inspected, may also add uncertainty around the mortality data. This uncertainty will affect the estimates of risk spread, likely date of entry of infection in the IP and tracings window.
Figure 4: Summary diagram to show estimated dates of disease risk and progression, and outbreak management events.

<table>
<thead>
<tr>
<th>DATE</th>
<th>DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-Apr</td>
<td>0</td>
</tr>
<tr>
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<td>02-May</td>
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<td>03-May</td>
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<td>04-May</td>
<td>4</td>
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<td>05-May</td>
<td>5</td>
</tr>
<tr>
<td>06-May</td>
<td>6</td>
</tr>
<tr>
<td>07-May</td>
<td>7</td>
</tr>
</tbody>
</table>

The paler colour of the bar represents a lower risk.
TCZ = temporary control zone
SZ = surveillance zone
PZ = protection zone
D.o.Inf = Date of Infection
CS = Clinical signs

Laboratory investigations including analysis of the virus

29. Initial samples from the IP comprised 20 oropharyngeal swabs, 20 cloacal swabs and 20 clotted blood samples collected from birds in Shed 3 and Shed 4, and 20 clotted blood samples collected from birds in Shed 1 and Shed 2. In addition to these samples, three carcasses were collected from Shed 3 and Shed 4 respectively. Further samples were received from the Infected Premises (IP) that had been collected at the time of statutory culling on 4 June 2008. This sampling included the collection of oropharyngeal swabs, cloacal swabs and clotted blood samples from 100 birds in each of the four sheds on the IP. The sample size was calculated to achieve detection of a 50% prevalence of infection, with 10% precision at the 95% confidence level.

30. Early laboratory results are presented here; analysis of these to assess their representativeness of each shed’s population, and in conjunction with the clinical picture at slaughter and other epidemiological findings, is in progress.

31. The presence of Notifiable Avian Influenza (NAI) due to infection by a type A influenza virus of the H7 subtype was confirmed following positive results for both H7 haemagglutination inhibition (HI) serological testing and H7 real time reverse transcription PCR (RRT-PCR) of the submitted swab samples and carcase tissues. The presence of a Highly Pathogenic Avian Influenza (HPAI) H7 virus was confirmed by molecular pathotyping. The presence of H7N7 HPAI virus was confirmed in all four sheds. To date no other pathotype of Al virus has been identified from the IP.

32. Preliminary molecular analyses have shown that phylogenetically the virus clusters with known, contemporary poultry and wild bird H7 isolates from Europe and that the haemagglutinin gene of the virus has undergone progressive mutations with successive rounds of replication and adaptation in the poultry host.
33. We suggest that after a period of approximately 7-10 days following the observed onset of clinical signs in Shed 1 a mutation to virulence of the presumed LP H7 virus to the highly pathogenic form occurred in Shed 3 during successive rounds of viral replication and transmission cycles in a partially immune poultry population. During these replication and transmission cycles random mutations to the virus genome can occur. Whether or not these mutations become fixed in the population depends on a number of factors, some described below. Acquisition of this genotype may have been driven by synergistic host: pathogen interactions, including:

i. Adaptation and selection of the virus by serial passage within the poultry host population.
ii. The combination and inter-relationship of viral genes, not least the HA and NA.
iii. Host immune function and status - a partially immune poultry population providing a further selection pressure in proximity to a fully susceptible poultry population

This presumed progressive mutation and host adaptation of the LP virus during onward transmission from Shed 1 to other Sheds was also proposed during the LPAI H7N3 outbreak in Dereham, Norfolk during May 2006 (Defra, 2006).

34. Spread of H7N7 HPAI virus may then have occurred between Shed 3 and Shed 4, infecting a fully susceptible population with the resultant acute and severe clinical presentation. Coincident with the spread of HP virus infection from Shed 3 to Shed 4, spread of the HP virus apparently also occurred to (and possibly between) Shed 1 and Shed 2 resulting in H7 super-infection.

35. Analysis to confirm the order of infection of the sheds, considering the virology results, the seroprevalence at the time of culling in comparison to that two days earlier, and the husbandry routine on farm is in progress. Further hypotheses, i.e. the unique introduction of HPAI in the premises without involvement of LPAI, have not been ruled out at the time of writing.

**Control Measures**

36. Suspicion of avian notifiable disease was reported on 2 June 2008, and immediate restrictions, to reduce the risk of spread of disease, were placed on the suspected premises. On 3 June 2008 a Temporary Control Zone (TCZ) with an inner zone with a minimum radius of 3km, and an outer zone with a minimum radius of 10 km, from the premises, was established around the IP after preliminary tests were positive for H7 AI. This temporary measure was replaced by a protection zone (PZ) and a surveillance zone (SZ), respecting the same boundaries as the temporary measures, on 4 June 2008 after HPAI H7N7 was confirmed.

37. These zones define and oblige specific disease control measures to be implemented by all keepers of susceptible stock within the zones. These measures include control of the movements of species susceptible to AI and, in the PZ, require keepers of birds to house or otherwise minimise the potential for contact between wild birds and domestic birds.
38. Slaughter of the birds commenced on Wednesday 4 June and finished on Thursday 5 June. The carcasses were transported under licence and strict biosecurity measures to be destroyed at an incinerator in Warwickshire. These actions substantially reduced the risk of spread of virus from the infected birds. Preliminary cleaning and disinfection (C&D) of the IP was completed on 7 June, further reducing the risk of spread of virus from the premises.

39. All premises within the PZ and known to have poultry are:
   - Clinically inspected by an Animal Health veterinary officer who also checks production and medicines records in order to identify any possible manifestation of infection with AI virus, and
   - Advises owners to remain vigilant and to report any possible clinical manifestation in their birds which might be suggestive of avian notifiable disease.
   - Premises are re-visited every 5 days during which time they remain under the restrictions extant on declaration of the PZ which was made under article 28(1) of the Avian Influenza and Influenza of Avian Origin in Mammals (England) (No. 2) Order 2006.
   - If the records are poor, inadequate or not available, to allow the VO to fully assess the clinical history then sampling for laboratory investigation for AI is carried out.

40. Action Within the Surveillance Zone (SZ):
   - A census is compiled from records of known commercial poultry premises within the SZ
   - Owners listed on the census will be reminded of the signs of avian influenza (LPAI and HPAI) and
   - Advised to remain vigilant and to report any possible clinical manifestation in their birds which might be suggestive of avian notifiable disease.
   - All premises remain under the restrictions extant since the declaration of the SZ which was made under article 28(1) of the Avian Influenza and Influenza of Avian Origin in Mammals (England) (No. 2) Order 2006.

41. Appendix 6 describes the sampling strategy for premises within the PZ (this includes any tracings identified (see below) within the PZ). Visits by officials to poultry premises within the PZ started on 8 June. Table 1 shows the number of poultry premises within the PZ and SZ by species and type of production. To date, all the premises in the PZ have been visited and no evidence of infection has been found.
Table 1. Description of the susceptible domestic bird population in the PZ and SZ
(PZ derived from GBPR and foot patrols, SZ derived from GBPR, census in progress)

<table>
<thead>
<tr>
<th></th>
<th>Protection Zone</th>
<th>Surveillance Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of premises</td>
<td>Number of birds</td>
</tr>
<tr>
<td>Outdoor premises</td>
<td>5</td>
<td>2,842</td>
</tr>
<tr>
<td>Indoor premises</td>
<td>4</td>
<td>47</td>
</tr>
<tr>
<td>Unknown housing premises</td>
<td>4</td>
<td>54</td>
</tr>
<tr>
<td>TOTAL</td>
<td>63</td>
<td>3,168</td>
</tr>
<tr>
<td>Ducks &amp; geese present</td>
<td>7</td>
<td>657</td>
</tr>
<tr>
<td>Game birds present</td>
<td>1</td>
<td>2,150</td>
</tr>
</tbody>
</table>

**Awareness**

42. Six suspect cases of notifiable avian disease were reported between confirmation of the IP and 10 June, a higher rate of notifications than in previous weeks (see Figure 5). On 11 June, three of them had been negated either on clinical grounds or after laboratory investigation. Results from the laboratory are awaited for the remaining three cases.

**Figure 5: Number and status of holdings reporting suspicion of AI since 1 April 2008**

![Bar chart showing number of reports, negated, positive, pending by date of notification]

**Source investigations**

43. The source investigations are designed to answer three standard epidemiological questions about disease occurrence:
   i. How might the particular birds on the IP have got infected in the first place?
   ii. Why at this particular time?
   iii. Why this farm?
44. A key part of the investigation is therefore to identify unusual events that might have precipitated the occurrence of the disease in the IP as well as the infection dynamics within the IP. The latter will help to define the potential point of entry of AI and the time window to assess potential sources of infection and risks of spread. Weather-related events, for example, may be relevant. These investigations continue, however evidence gathered to date is presented here.

45. The clinical evidence, supported by laboratory results, suggests the entrance of AI infection initially into Shed 1. This shed is distant from the main egg management activity in Shed 4, and from the vehicular access to the site. It may also be more exposed to wild animals and birds than the other sheds. Field epidemiological reports highlighted the presence of wild birds and signs of predatory activity around this shed. The proximity of cover, water (stream and pond) and being most distant from the farmhouse may make the area around Shed 1 more prone to wild bird incursions. Further investigations to assess this with expert ornithologists are in progress.

46. Appendix 7 shows the timing of key events of relevance plotted against the daily mortality as an indication of how they relate to the disease progression. In answer to the second question, it is possible that the significant rainfall which occurred between 25 and 28 May might have contributed to the spread of the virus both between birds due to seeking shelter from the rain, and between the units in the IP due to surface water accumulation.

47. In answer to question 3, epidemiological investigations on the IP focused on the identification of possible sources of infection derived from the known epidemiology of AI, and potential risk factors unique to this farm. The latter investigation is ongoing, however the hypotheses for source that were identified were:

i. AI in associated premises in Great Britain, either by proximity or other contacts
ii. AI in wildlife in contact with the IP
iii. Introduction by purchased birds from the source farms
iv. Unidentified infection in product at local slaughterhouse or similar premises, moved to the IP by wildlife.
v. Infected imports from other countries of live poultry, hatching eggs or poultry products into the locality around the IP, or otherwise epidemiologically associated with the IP
vi. Escape or reversion of virus used for vaccine, as inactivated H7N7 vaccine can be licensed for use in zoo birds
vii. Escape from laboratories licensed to use live virus for research and/or diagnosis.

48. Investigations to date have indicated that either of the first two hypotheses listed above are the most likely explanation of the source and investigations continue.

49. Summary results of the source investigations are as follows:

i) Unidentified infection in another domestic flock in GB in contact with the IP through:
a. Egg-collection routes: The likelihood of other premises on the egg collection route being the source of infection for the IP is considered medium to low. The risk is mitigated by the position of the IP at the beginning of the collection round and the spread mitigation factors described in detail in Appendix 8. The three premises on the egg collection route, two of which have susceptible stock at present, have been inspected and restricted, and to date there is no evidence of AI on them. The risk of these premises being infected with AI is now considered to be low.

b. Proximity I: The adjacent premises keeps 2150 pheasants and 600 ducks (cattle and sheep also on the premises). This farm is one of the reported cases described earlier. Based on clinical inspection the risk was considered low. Samples were collected for laboratory investigations.

c. Proximity II: Protection zone premises are being visited; there has been no evidence of AI on any of these to date. The risk of these premises being infected with AI is now considered to be low to very low.

d. Lorry route for feed deliveries: four feed deliveries took place in the relevant time window and tracings are in progress; to date no evidence of AI has been found on premises exposed to this risk, which is currently assessed as low to very low.

e. Premises identified as a result of people in contact with poultry entering into the IP within the tracing window. These premises were included in the tracing prioritisation and tracing visits are in progress. To date no evidence of AI has been found on premises exposed to this risk, which is currently assessed as low to very low.

f. Other people contacts. These were assessed as negligible risk as they did not have any contact with poultry.

Note that the risk status of the sources above may change in time with the gathering of new evidence. This has already happened from the initial risk classification shown in Table 2 (below).

ii) Wild bird or/and wildlife source.

a. Around 30 mallard ducks remained in the farm pond from the initial 100 released by the owner, and mixed with small numbers of wild birds. These ducks were fed by the owner and, as explained earlier in the report, managed to get very close to the hens’ range. Sampling has been carried out and tests are in progress. The risk that wild waterfowl could be the source of AI on the IP is assessed as low.

b. Predatory incursions by wildlife (e.g. foxes) occurred occasionally, however expert advice is that they will have a range limited to a few kilometres and most likely within the area covered by the PZ. This risk is assessed as very low.

iii) Introduction by purchased birds from the source farms. The timing of infection on the IP and the differing levels of disease in each shed make it very unlikely that the birds were infected on arrival. In addition, the two farms were visited by veterinary officials and 29 birds were sampled at each (sample calculated to detect a prevalence of 10% at the 95% level of confidence). There was no evidence of clinical disease either from clinical examination or inspection of
production records. All samples were seronegative. This source has been assessed as negligible.

iv) Unidentified infection in product at local slaughterhouse or similar premises. The closest slaughterhouse is located more than 20Km away and there is no evidence of contact between those premises and the IP. Fomite transfer by wild animals has been assessed as unlikely. Therefore this possible source was assessed as very low to negligible.

v) The possibility of imports from other countries of live poultry, hatching eggs and poultry products into the locality around the IP was assessed. No links between imports and the IP have been established. The risk of introduction to the IP via this route was considered very low to negligible.

vi) Inactivated H7N7 vaccine licensed for zoo birds. There is no AI vaccine production plant in the UK, and infection from birds vaccinated with purchased vaccine is considered unlikely due to the nature of the vaccine. There are no zoo premises within the PZ and SZ, and investigations have confirmed that none of the zoos to whom a licence has been issued are within 50km of the IP. The risk of introduction to the IP via this route is considered negligible.

vii) Escape from laboratories licensed to use live virus for research and/or diagnosis. At the time of writing, a list of laboratories licensed to use the virus is being compiled. However there are no such laboratories within the PZ or SZ, and investigations have not revealed any links to any such facilities, so the risk is assessed as very low.

50. Figure 6 shows the network of exposure risks being explored to identify the potential source and spread of infection under these hypotheses.
Figure 6: Network of exposure risks for source and spread of infection

51. Risk assessments were carried out to prioritise resources. The need for this was clear in the case of the egg collection rounds. A summary is shown in Appendix 8.

Spread Investigations
Potential routes of spread outside the IP.

52. The greatest risk of spread of AI from an infected premises would be through the movement of live infected birds. No such movements have taken place since the farm was stocked with the flock that became infected. A less likely, but possible mechanism of spread is through fomite transmission to premises associated with the IP.

53. Such premises are identified by ‘tracing’. Tracing data (Table 2) shows the number of premises possibly put at risk of infection through potential contact with the various people, vehicles & products that have left the IP in the risk period. An assessment has been made to categorise their likely risk of leading to onward spread of disease. (Note that classifying tracings by the number of times a premises is put at risk rather than by the risky events, such as egg collection lorry visits, resulted in a much simpler and manageable approach to risk classification, than initial tracing lists would suggest.)
Table 2. Tracing data classification showing the premises potentially put at risk of infection due to contact with the IP

<table>
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<th>Zones</th>
<th>Risk assessment</th>
<th>Premises traced</th>
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<td>Outside restricted area</td>
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<td></td>
</tr>
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<td>Low</td>
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<td>Very low</td>
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<td></td>
</tr>
<tr>
<td>Protection zone (PZ)</td>
<td>Medium</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Surveillance zone (SZ)</td>
<td>Medium</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

54. Appendix 10 provides additional details about the geographic distribution of premises put at potential risk of infection due to identified links to the IP (tracings). The number of premises at risk is small compared to the size of the poultry population, however they are widely geographically dispersed. Most have been visited and to date no evidence of spread of infection has been found.

55. Spread risk from disposal of manure: Manure in shed 4 is collected using an automated belt system and fed into a muck trailer situated at the end of the shed. Manure from shed 1 to 3 drops through the raised mesh floor onto the ground below. This is only removed at the end of the flock when the units are moved to a fresh site. Only manure from shed 4 has left the IP to a nearby premises currently under investigation.

56. Spread risk from disposal of dead birds: unlikely. These are transported in a leak proof sheeted plastic crate, placed in a lidded waste skip at the local kennel and disposed of by incineration.

57. In summary there has been no evidence of spread of infection to date, however investigations continue.

**Update at 9am Monday 16 June**

58. Further investigations and tracing visits carried out between 12.30pm 11 June and 9.00am 16 June have found no evidence of infection with AI on any other premises. This includes the adjacent premises to the IP reported as a case for which laboratory results found no evidence of infection.

59. Five pigs were identified on the IP on Friday 13 June and were reported to have been fed on waste eggs. Further investigation revealed these pigs to be kept on a separate area of the property; they were apparently fed waste eggs until mid-May, before clinical signs of AI were seen in any of the poultry. The pigs have been restricted; clinical examination has revealed no evidence of disease.

60. All five pigs have been tested by the HI test for the presence of antibody and by PCR on naso-pharyngeal swabs for evidence of AI virus. These tests were all negative; attempted virus isolation is in progress to confirm these results.
Final remarks

61. It is well recognised in the published literature that the clinical signs associated with LPAI infection vary greatly from none to a high mortality rate. This variation is dependent on many factors, including age, host species, the strain and virulence of the infecting virus, concurrent infections and husbandry. However as LPAI affects production parameters, infection, particularly in laying flocks, may be detected through the inspection of production records.

62. Equally, LPAI may be confused with, or complicated by, many diseases with respiratory or enteric signs. Notifiable avian disease including LPAI must be suspected in any poultry disease outbreak that persists despite the application of preventive and therapeutic measures for other diseases.

63. The awareness of flock owners, particularly of free-range flocks, and their veterinary surgeons is important to ensure that the possibility of infection with avian influenza viruses, both LPAI as well as HPAI infection, is included in their differential diagnosis. Characteristic clinical signs include reduced egg production and egg quality, an increased mortality rate, reduced feed and water intakes in the absence of conclusive evidence of an alternative diagnosis.

64. Good quality record keeping by poultry keepers of daily visitors and movements, egg production and mortality statistics, together with data on feed and water intake is also strongly advised as part of overall flock biosecurity measures.

65. Biosecurity is always challenging in free-range enterprises, and this outbreak in common with the recent outbreak in November 2007 of HPAI H5N1 (Defra, 2007) further emphasises the potential hazard of locating a free-range poultry production unit in close proximity to open water, both likely to attract wild birds and predispose to an increased likelihood of contact and risk of transmission of avian influenza viruses.

Acknowledgements

66. We would like to thank members of the NEEG’s Ornithological Expert Panel, expert ornithologists of the British Trust for Ornithology, and John Gloster from the Meteorological Office for their prompt participation and very useful reports that have helped clarify the epidemiology of the outbreak.

67. The National Emergency Epidemiology Group includes members from Defra’s Food and Farming Group, the Veterinary Laboratories Agency and the Animal Health Agency.

National Emergency Epidemiology Group
12 June 2008
Appendix 1. Density of all poultry around the IP

Appendix 2. Density of indoor poultry around the IP.
## Appendix 3: Density of outdoor poultry around the IP

![Map showing density of outdoor poultry around the IP]

### Appendix 4: Rainfall recorded at closest weather station (Brize Norton) in late May

<table>
<thead>
<tr>
<th>Likely date of HPAI infection in shed 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/05</td>
</tr>
<tr>
<td>0.0</td>
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</tbody>
</table>
Appendix 5: Samples from wild birds and environmental samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>Blood</th>
<th>Carcasses</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild Birds</td>
<td>9</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Faeces</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

*Blood is tested for serology, carcasses and environmental samples are tested by PCR for virus. Testing is in progress. All results negative to date

Appendix 6: Sampling strategy for tracings (including premises within the PZ)

Spread investigations aim at clarifying any sort of relevant epidemiological links either:
- By proximity with the IP – this applies to all premises within 3km of the IP, i.e. within the PZ or
- Others: subject to case by case evaluation by officials

The following action path is followed:
1. Clinical inspection of susceptible stock
2. For non-waterfowl: careful and close examination of production records over previous few months looking for low level disease. If found, follow sampling protocol below. If no evidence of disease but there is a high risk of exposure then follow sampling protocol below.
3. If waterfowl: follow sampling protocol below.

**Sampling protocol:**
- The aim is to identify seropositive farms. A minimum of 14 days from exposure was estimated sufficient to allow time for detectable seroconversion.
- Sampling aims to detect 15% or greater seroprevalence. This design prevalence was estimated coherent based on the evidence from other AI outbreaks and the EU AI Diagnostic Manual recommendation of a minimum of 20 birds sampled per production unit.
- A minimum of 20 animals to be sampled per holding and a minimum of 6 animals per epidemiological group.
- If any of the samples from a holding are seropositive, the flock is examined for the presence of virus.
## Appendix 7: Timeline of farm risks and counts of deaths.

### Event Timeline

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bird arrival</td>
<td>03/05</td>
<td>16000</td>
</tr>
<tr>
<td>Egg collection</td>
<td>12/00</td>
<td></td>
</tr>
<tr>
<td>Feed delivery</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Carcass collection</td>
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<td></td>
</tr>
<tr>
<td>Manure collection</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### Risk Events

- **High Temp.** (°C)
- **Heavy Rain (mm)**

### Other Events

- **Predation** (no. died)
- **Estimated Most Likely Infection Date**
- **Onset of Clinical Signs**
- **Report Case Taken**

### Mortality Count

- Mort/day Shed 1
- Mort/day Shed 2
- Mort/day Shed 3
- Mort/day Shed 4

### Total Number of Deaths

- 70
- 75
- 73
- 444
- 484
- 733
- 1185

### Risk Indicators

- **Risk Indicator**
- **Risk Factor**
- **Risk Evaluation**

---

**Legend:**
- Mort/day Shed 1
- Mort/day Shed 2
- Mort/day Shed 3
- Mort/day Shed 4
Appendix 8: Veterinary and epidemiological risk assessment of egg collection and potential for disease spread.

There is potential for the transmission of fomite to other farms; however, this appears to be confined to farms on the same egg collection round as the IP (indicated within the shaded area in the figure below). It is possible that the forklift truck that travelled with the collection lorry may not routinely have received acceptable levels of cleansing and disinfection (C&D) between farms. The three farms on this route were priority for investigation; one has no poultry at present and the others have been restricted to reduce the risk of further spread of infection. No evidence of infection has been detected on either farm to date.

Onward transmission from the collection centre appears to be a much smaller risk. Features that mitigate the likelihood of all forms of spread are as follows:

1. The IP is at the beginning of an egg collection round, which generally takes place on alternate days.
2. All eggs, both table-grade and second grade are sold to one company.
3. At the end of the collection round, the eggs initially pass through a dedicated collection centre in Hertfordshire, where there are no poultry on site. After consolidation into large batches that are cling-wrapped on pallets, the collected eggs are taken to Lincolnshire for grading and packaging.
4. Table-grade eggs are packaged and despatched for retail sale, second grade eggs are shrink wrapped and stored before despatch for processing.

Source risk factors: The likelihood of the egg collection being the source of infection for the IP is mitigated by its position at the beginning of the collection round and the spread mitigation factors described below.

Spread risk factors: The likelihood of spread from the IP is otherwise mitigated by: (1) the use of a regular, routine collection round, confines the potential for spread; (2) the general standard of routine C&D e.g. of lorries and of the blue plastic trays used for table grade eggs, that are sanitised after each use; (3) the post-outbreak increased level of C&D; (4) the fact that the lorry, its forklift truck and trays have no direct contact with the poultry sheds on the farms visited; (5) after arriving at the collection centre, there is no further contact with poultry establishments without C&D of lorries, trays etc; (6) eggs that leave the grading and packing centre are either clean, table-grade for retail sale, or if second-grade are sent for processing (heat treatment); (7) normal industry practice ensures that any eggs contaminated by faecal matter will be down-graded to second-grade eggs that are stored on green fibre trays - these trays are processed for recycling and not re-used; and (8) despite their inherently low risk, all unsold first grade eggs from the IP have been traced, recalled and sent for processing. Eggs sold through the retail market are likely to have been cooked and consumed by this time.

In the event of the worst case scenario, i.e. collected eggs were contaminated with infected faecal matter, normal industry practice and standards ensures that the level of contamination is likely to be minimal; there is no direct contact with other poultry on the collection round and there is a one-way flow of eggs and trays off each farm.
Figure 1: Flow diagram showing egg movement related to IP
(N.B. triangles represent premises on the route; the shaded area indicates the area to which source and spread risks are likely to be confined)

Appendix 9 . Risk terminology used in this report
(derived from EFSA, 2006)

‘Risk’ in this report follows the epidemiological definition of likelihood or probability, and does not include the impact or consequences of infection. References to levels of risk in this report refer to probability outcomes, and follow the terminology below. Note that the assessment of risk can change as investigations progress and more information becomes available.

<table>
<thead>
<tr>
<th>Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>So rare that it does not merit to be considered</td>
</tr>
<tr>
<td>Very low</td>
<td>Very rare but cannot be excluded</td>
</tr>
<tr>
<td>Low</td>
<td>Rare but does occur</td>
</tr>
<tr>
<td>Medium</td>
<td>Occurs regularly</td>
</tr>
<tr>
<td>High</td>
<td>Occurs very often</td>
</tr>
<tr>
<td>Very high</td>
<td>Events occur almost certainly</td>
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### Appendix 10: Number, status and geographic distribution of premises identified as at risk (tracings)

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<thead>
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<th>ACTION</th>
<th>STATUS</th>
<th>Total</th>
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</table>

**Total number of tracings allocated**: 76

**Notes**

NFA: final risk assessed as ‘negligible’, no further action
Cancelled: no follow up required as investigations revealed there had been no exposure