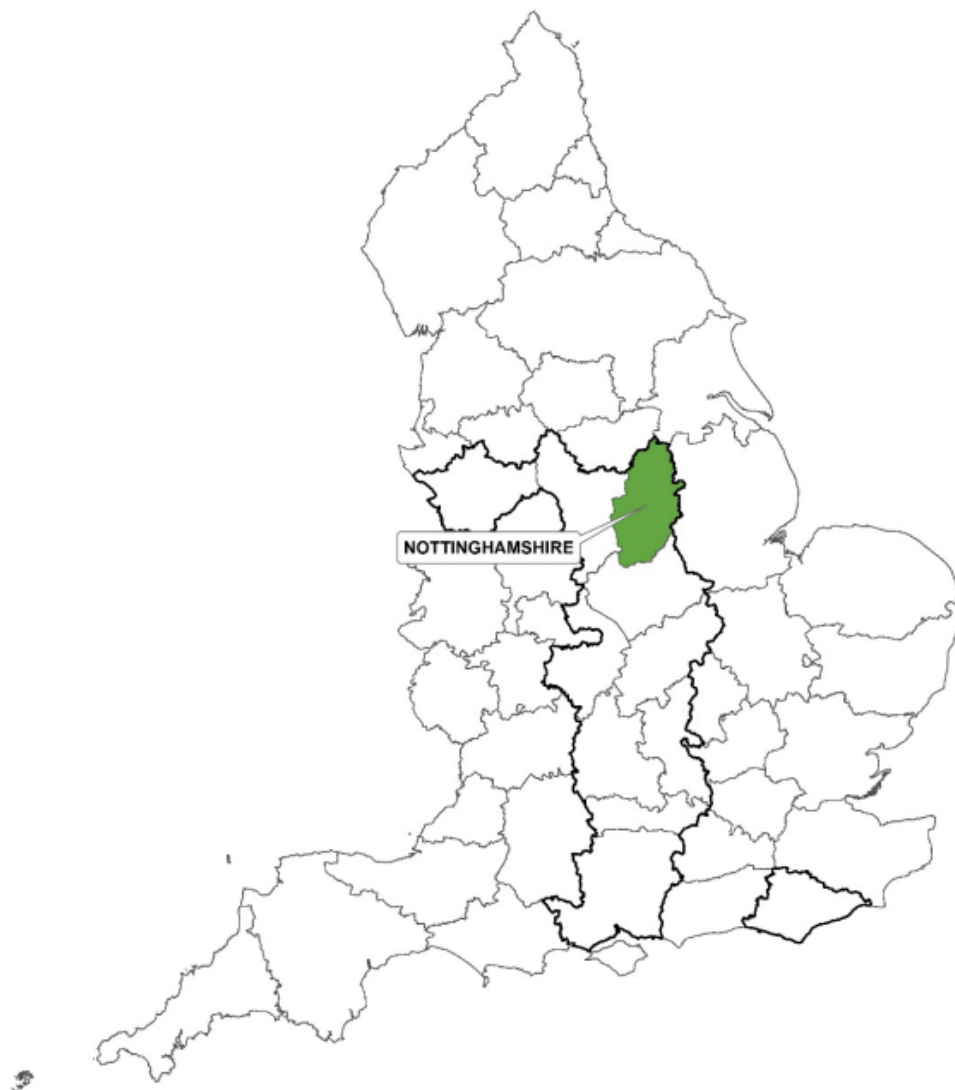




Animal &  
Plant Health  
Agency

# Year End Descriptive Epidemiology Report: Bovine TB in the Edge Area of England 2022 County: Nottinghamshire

TB Edge Area - NOTTINGHAMSHIRE



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## Introduction

The Edge Area was originally established in 2013. In 2014, the bovine tuberculosis (TB) surveillance strategy for this area was incorporated into the UK Government's Strategy to achieve Officially Bovine Tuberculosis-Free (OTF) status for England by 2038. A key action was to recognise the different levels of TB in different parts of the country and to vary the approach to control accordingly. The current aim is to obtain OTF status for the Edge Area as soon as possible.

This report describes the frequency and geographical distribution of TB in cattle herds in Nottinghamshire, an Edge Area county, in 2022. It examines what factors are likely to be driving TB in this area, and the risks the disease in this county may pose to neighbouring areas.

TB in cattle and other mammals is primarily caused by the bacterium *Mycobacterium bovis* (*M. bovis*), and the disease is subsequently referred to in this report as TB. Although other sources may refer to TB 'breakdowns', this report will use the term 'incidents' throughout.

This report is intended for individuals involved in the control of TB, both locally and nationally. This includes, but it is not limited to, farmers, veterinarians, policy makers and the scientific community.

Details of the data handling methodology used in this report, a glossary of terms, and the TB control measures adopted in the Edge Area, can be found in the [explanatory supplement for the annual reports 2022](#).

## Types of TB incident

Unless otherwise specified, this report includes all new TB incidents detected during the reporting period (1 January to 31 December 2022). This includes both 'Officially Tuberculosis-Free Status Withdrawn' (OTF-W) and 'Officially Tuberculosis-Free Status Suspended' (OTF-S) incidents.

OTF-W incidents are those involving at least one skin test reactor positive to the Single Intradermal Comparative Cervical Tuberculin or SICCT test, in addition to either typical lesions of TB identified at post-mortem (PM) meat inspection, or at least one animal with an *M. bovis*-positive culture result from tissue samples collected from carcasses during the PM inspection (or both).

OTF-S incidents are triggered by reactors to the skin test, but without subsequent detection of TB lesions or positive culture results in any of those animals.

TB incidents in [Approved Finishing Units \(AFUs\)](#) without grazing are not included in the prevalence and incidence calculations in this report due to the limited epidemiological impact of these incidents.

Furthermore, the number of TB incidents and designation of those incidents as OTF-W or OTF-S may differ in this report compared to other official TB statistics due to differences in the information available at the time datasets are accessed.

## Cattle industry

Beef herds continue to be predominant and accounted for 69% of the cattle industry in Nottinghamshire in 2022, as shown in Appendix 1. This is partly due to the arable industry providing high-energy by-products for the finishing of beef cattle.

The majority of herds, 54%, continue to be small with up to 50 cattle. Following the closure of Newark Livestock Market in 2019, there are no livestock markets in Nottinghamshire. The closest is Melton Market in Leicestershire. In 2022, there were 12 AFUs in Nottinghamshire, with one new AFU approved in 2022.

## New TB incidents

The number of new TB incidents decreased in 2022 compared to 2021, from 21 to 18 (Figure 1). There was a large reduction in OTF-W incidents from 11 to 6. The number of OTF-S incidents increased by 2, from 10 to 12. Of the OTF-W incidents, 2 were in dairy and 4 in beef herds.

It is positive to see the number of incidents declining and it is hoped that this is the beginning of a downward trend to the pre-2021 numbers.

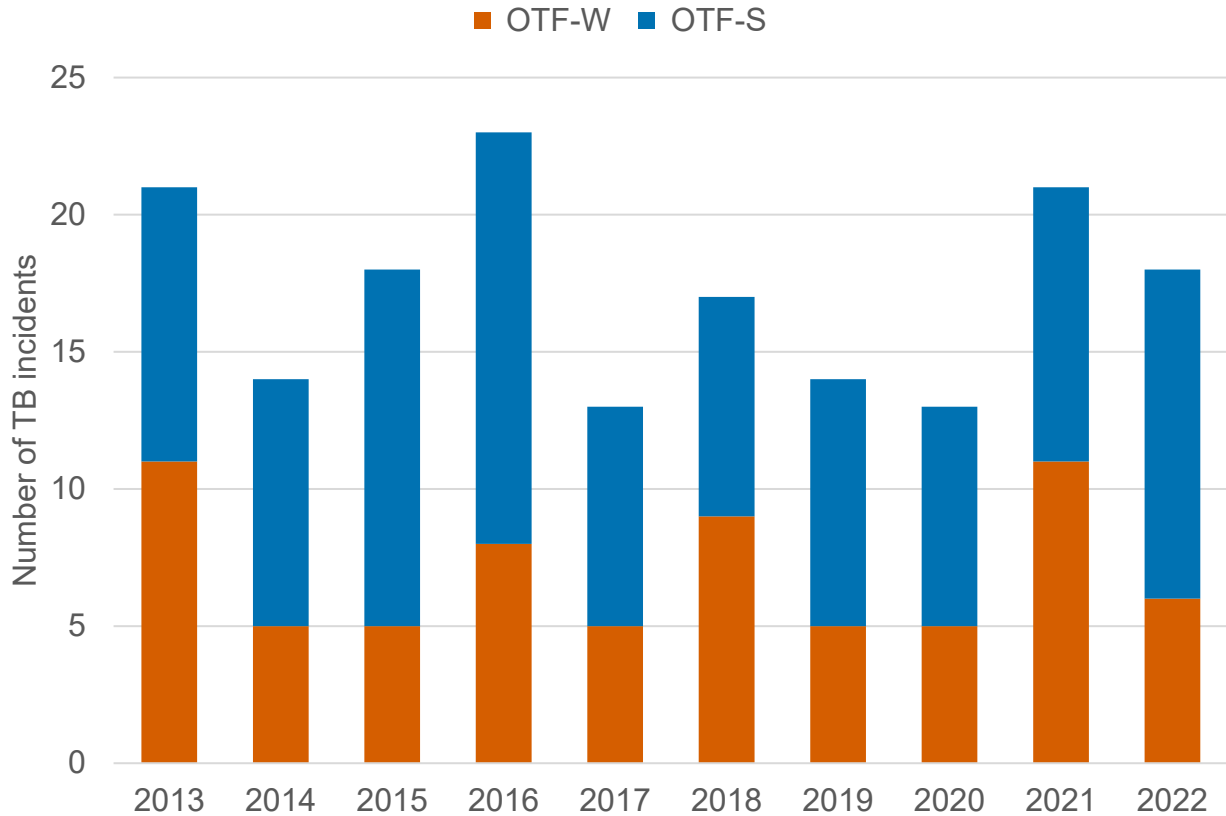


Figure 1: Annual number of new TB incidents in Nottinghamshire, from 2013 to 2022.

## Disclosing test types

As in previous years, Whole Herd Tests (the routine surveillance test type) continued to detect more incidents of TB in Nottinghamshire in 2022 (6) than any other test type. This was followed by radial testing (5) and slaughterhouse testing (3), as shown in Figure 2.

The increase in radial testing as a disclosing test type was likely due to an increase in radial testing, as a result of more OTF-W incidents disclosed in 2021.

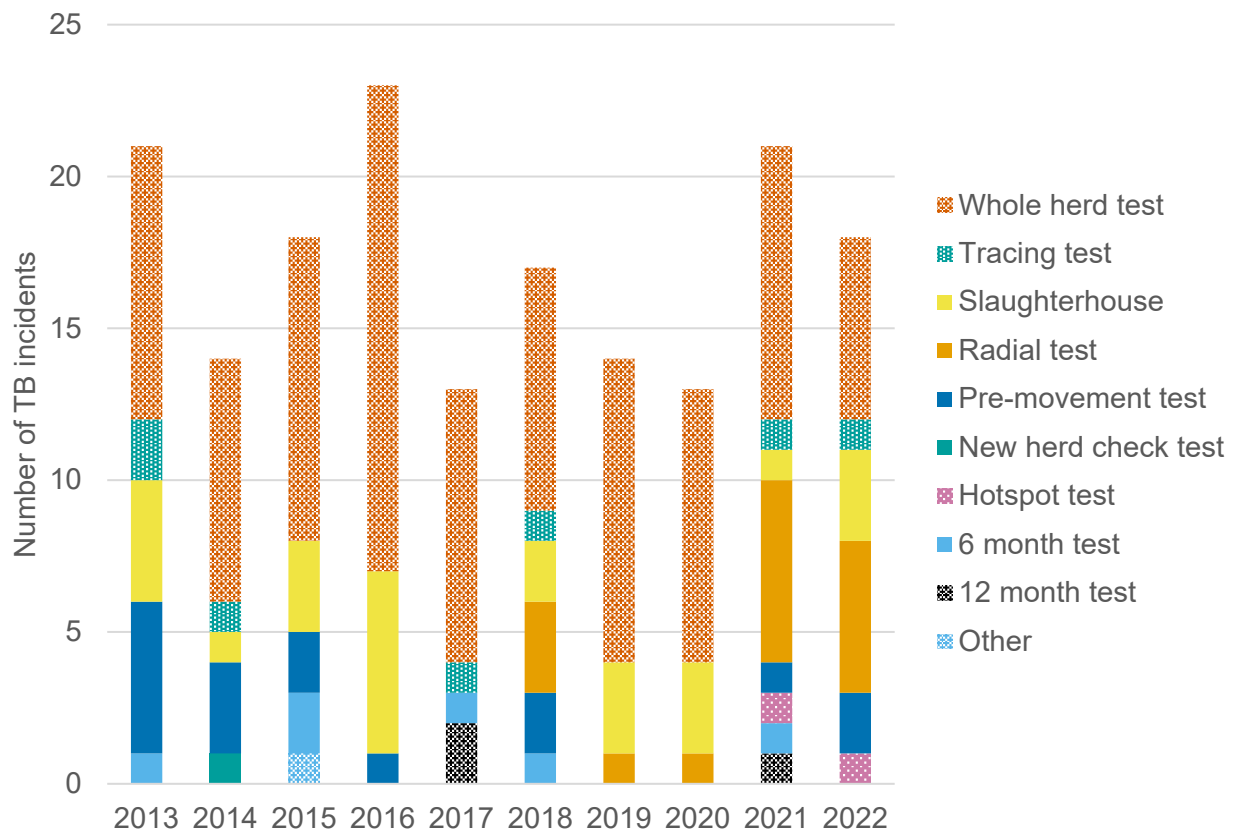


Figure 2: Number of new TB incidents (OTF-W and OTF-S) in Nottinghamshire in 2022, according to the surveillance methods that detected them.

## Duration of TB incidents

A total of 20 TB incidents were resolved in Nottinghamshire during 2022. Of these, 8 were new TB incidents that started in 2022 and 12 started in 2021.

The median duration for OTF-W incidents that ended in Nottinghamshire in 2022 was 220 days (interquartile range (IQR) 178 to 246 days).

Most OTF-S incidents that ended in 2022 (10 out of 11) were resolved within 550 days, and the median was 181 days (IQR 151 to 232).

The median duration for all incidents that ended in Nottinghamshire in 2022 was 194.5 days (IQR 160.5 to 239). This is longer than the duration of incidents that ended in 2021: 175 days (IQR 154 to 236).

For the whole Edge Area, the median duration of all TB incidents that ended in 2022 was 182 days (IQR 157 to 286).

There were no TB incidents still open at the end of 2022 that had been under movement restrictions for more than 550 days.

## Unusual TB incidents

There was one OTF-S incident with a duration over 550 days. The OTF-S incident occurred in a dairy farm and had a total of 18 reactors removed during 5 short interval tests (SIT) and 2 inconclusive reactor tests (IR) carried out on this herd. The most likely source of disease for this herd was found to be local wildlife, with cattle movement being a possible but unlikely source.

## TB in other species

There is no statutory routine TB surveillance of non-bovine species, apart from Post Mortem Examination (PME) of animals slaughtered for human consumption. Targeted TB testing takes place in non-bovine herds with laboratory confirmed *M. bovis* infection, and in specific herds of camelids, goats and captive deer at an elevated risk of infection.

There were no incidents of TB in other non-bovine species in Nottinghamshire in 2022.

## Incidence of TB

Figure 3 provides the annual incidence rate in Nottinghamshire for all new TB incidents. Of the 11 Edge Area counties, Nottinghamshire had the fourth lowest incidence of TB per 100 herd-years at risk (4.8) in 2022. This was lower than the Edge Area overall (7.6).

The incidence rate in 2022 decreased from a high of 5.3 in 2021.

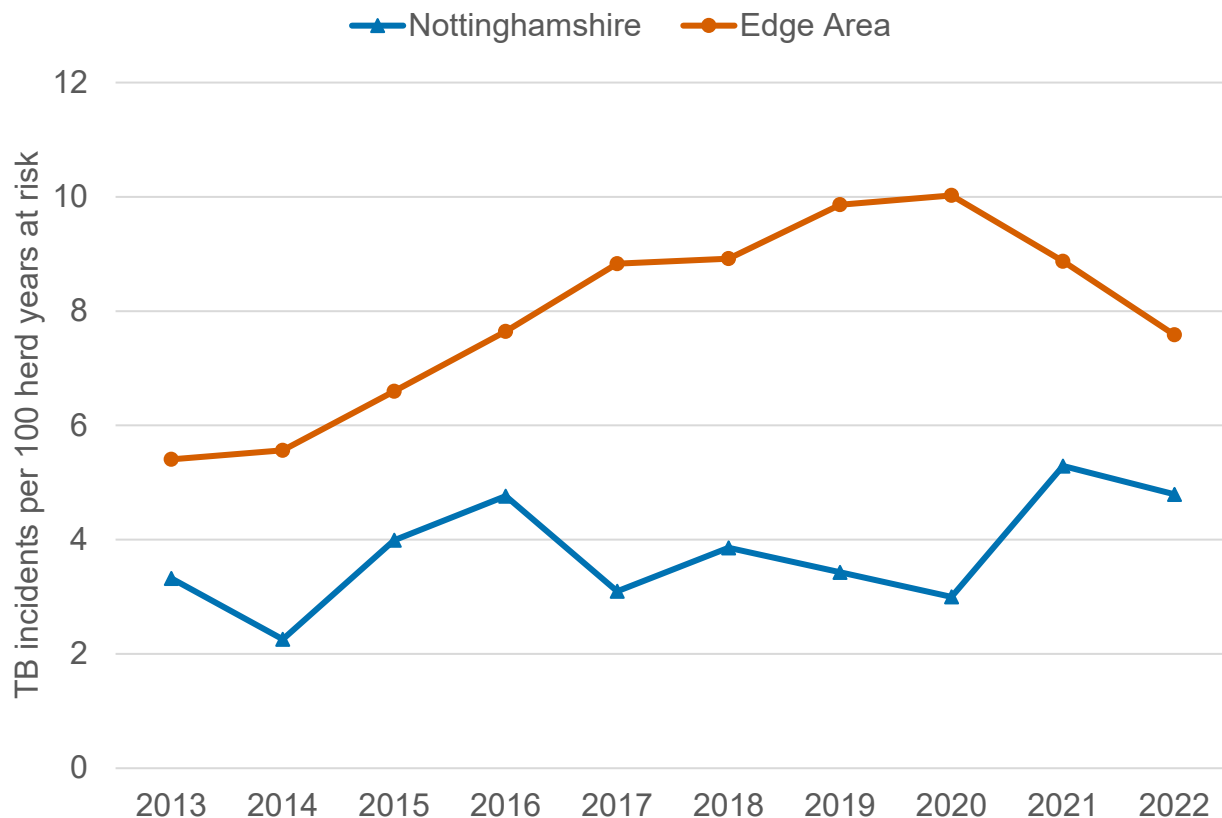


Figure 3: Annual incidence rate (per 100 herd-years at risk) for all new incidents (OTF-W and OTF-S) in Nottinghamshire, from 2013 to 2022.

## Prevalence of TB

Figure 4 shows herd prevalence decreased in Nottingham in 2022 compared to 2021, from 3.0% to 2.3%. This is consistent with the decrease of new TB incidents observed in 2022 and an increase in OTF-S incidents, with a lower incident median duration than OTF-W incidents (see above).



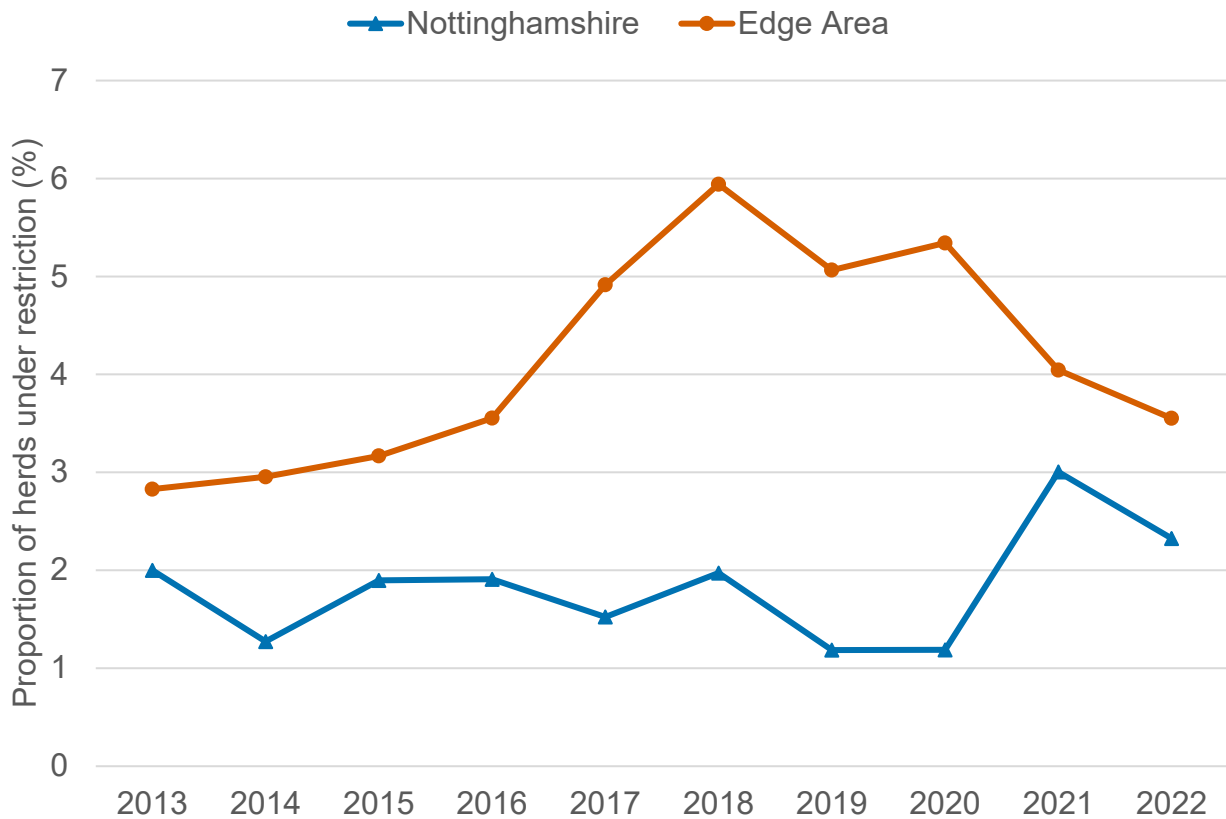


Figure 4: Annual end-of-year prevalence in Nottinghamshire, from 2013 to 2022.

## Re-occurring TB incidents

As is shown in Figure 5, of the 18 new TB incidents in Nottinghamshire in 2022, 17 occurred in herds that had not had a TB incident in the previous 3 years. The one re-occurring incident occurred in a dairy herd and was OTF-W in 2022, preceded by an OTF-W incident in 2021. The most likely source of disease in the 2021 incident was movement of cattle from the TB High Risk Area (HRA). There was no veterinary investigation into the source of infection for the TB incident in 2022, but the cattle movement algorithm indicated that the risk to this farm from cattle movements was high.

Compared to the whole of the Edge Area where 50% of herds experienced re-occurring incidents, Nottinghamshire had the lowest re-occurrence (6%).

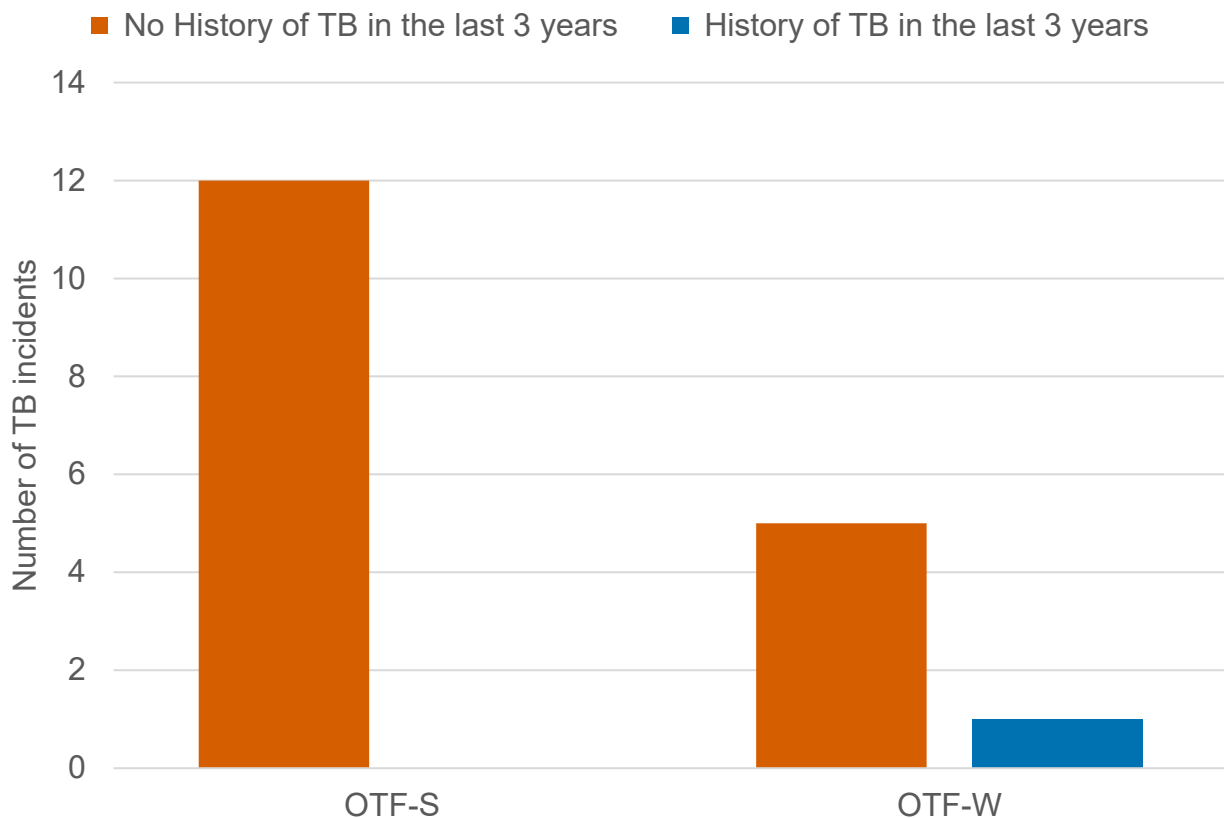


Figure 5: Number of herds with a TB incident (by OTF-W and OTF-S) in Nottinghamshire in 2022, with and without a history of any TB incident in the previous three years.

## Geographical distribution of TB incidents

Figure 6 shows TB incidents in 2022 were concentrated in the south and centre of the county, which mirrors the higher density of cattle holdings in these areas. This was similar to the distribution of incidents in 2020 and 2021.

Incidents in the south of the county were clustered within confirmed TB hotspot 23 (HS23), along the Leicestershire and Lincolnshire borders. HS23 is associated with Whole Genome Sequence (WGS) clade B3-11 of *M. bovis* (previously identified as genotype 25:a). HS23 was declared in a contiguous area of south-west Lincolnshire and north-east Leicestershire in 2018.

Compared to previous years, there was an increase in the number of incidents in the west of the county bordering the six-monthly testing portion of Derbyshire. These were all OTF-S incidents with negative culture results and hence without *M. bovis* genomic information. Further investigation is required to elucidate the cause of these incidents and if it is potential spread from Derbyshire.

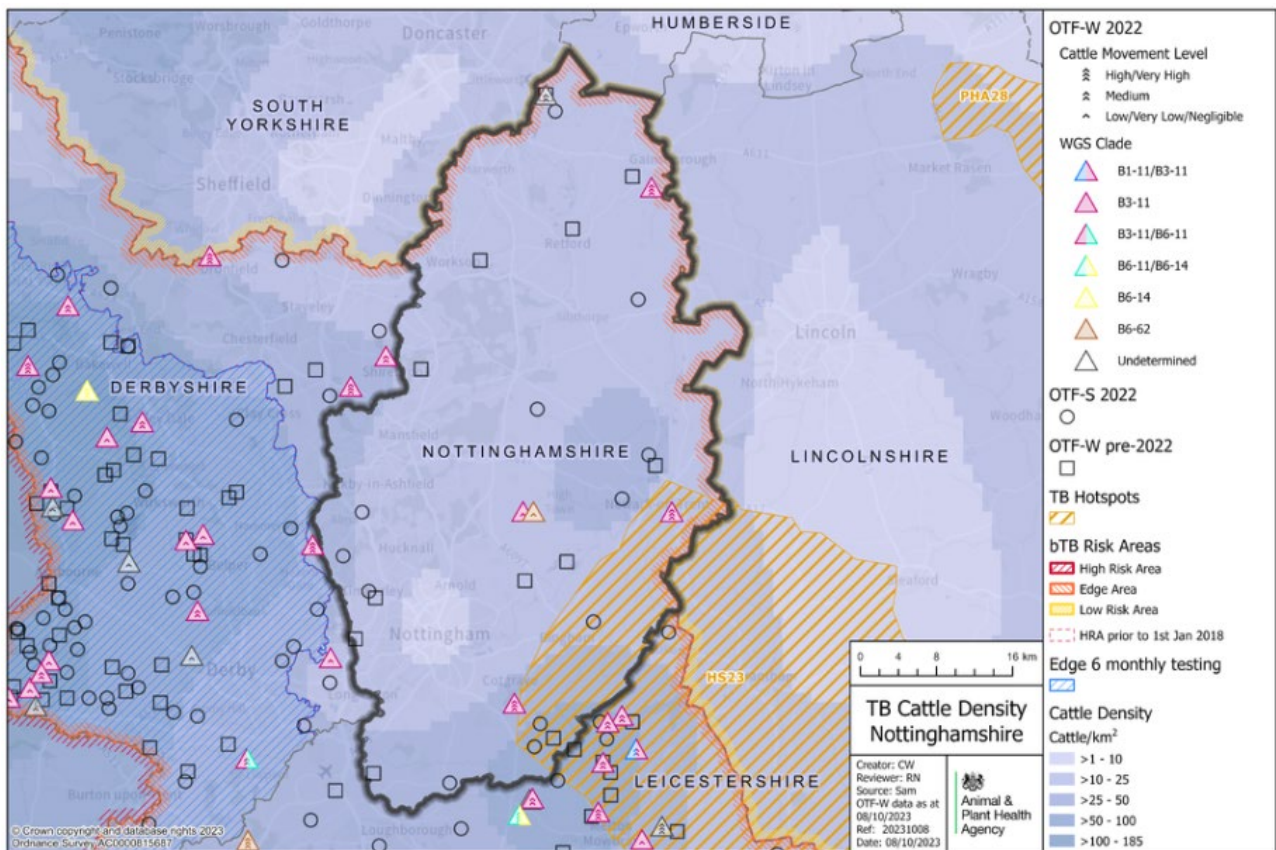


Figure 6: Location of cattle holdings in Nottinghamshire with new TB incidents (OTF-W and OTF-S) in 2022 and of cattle holdings with pre-2022 OTF-W incidents still ongoing at the beginning of 2022, overlaid on a cattle density map. The movement score for each farm is symbolised with 3 chevrons for cattle movements associated with a high likelihood of infection, 2 chevrons for a medium likelihood and one chevron for a low likelihood.

### Skin test reactors and interferon gamma test positive animals removed

Appendix 2 provides a summary of headline cattle TB statistics in Nottinghamshire. In 2022, there was a total of 79 test positive animals in Nottinghamshire, as shown in Figure 7. This was less than the number of test-positive animals removed from herds in 2021 (106).

Of the 79 test positive animals in 2022, 57% were skin test reactors and 43% were interferon gamma (IFN-γ) test positive, which was similar to 2021. This highlights the ongoing importance of IFN-γ testing in OTF-W herds.

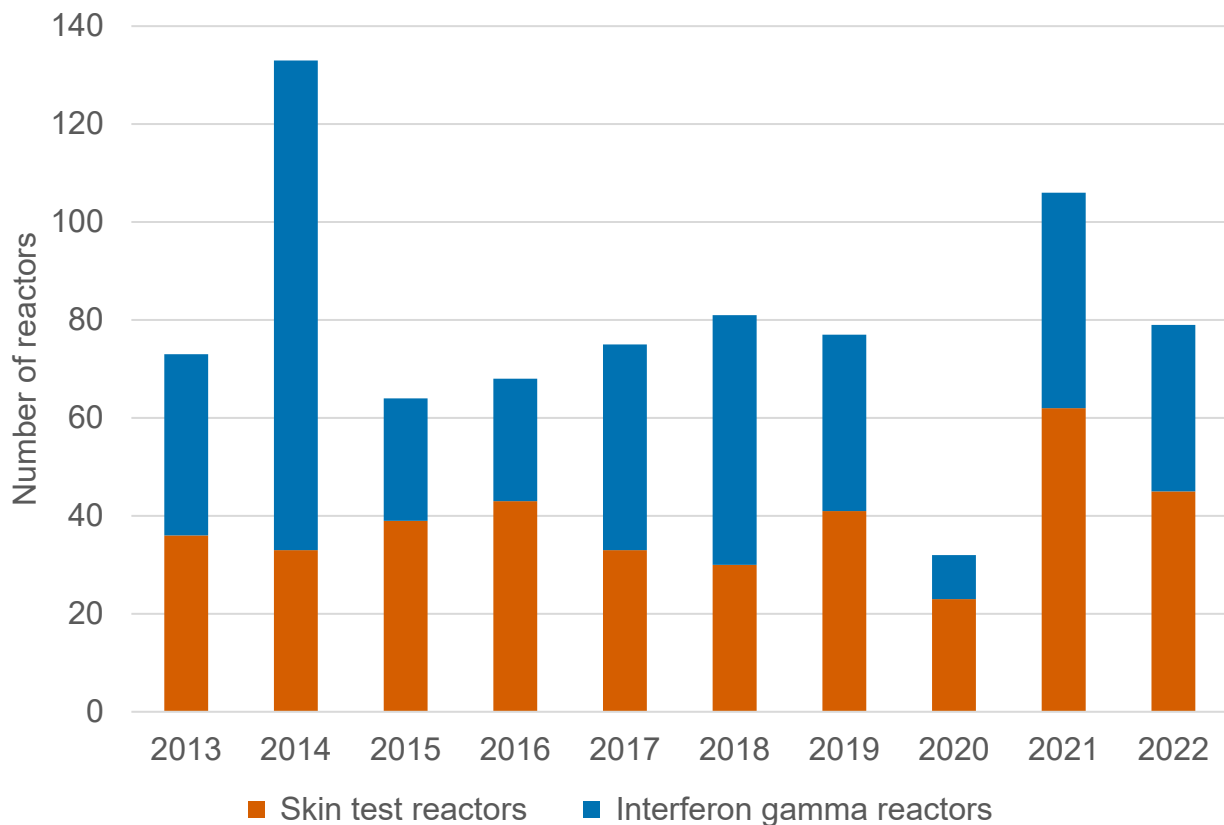


Figure 7: Number of skin test (SICCT) reactors and interferon gamma (IFN- $\gamma$ ) test positive cattle removed by APHA for TB control reasons in Nottinghamshire, from 2013 to 2022.

## Main risk pathways and key drivers for TB infection

It is important to try to understand the risk pathways and key drivers that are likely to have introduced TB infection into a herd. This information can help identify mitigations that may reduce TB risk for individual businesses.

Implementing practical measures can help to reduce the risk of TB incursion into a herd that is TB free ([biosecurity](#)), as well slowing disease spread within a herd where TB is present (biocontainment).

Furthermore, the [ibTB](#) online tool can be used to inform purchasing choices, reducing the risk of introducing undetected infection when moving cattle into a herd.

In 2022, 2 out of 18 (11%) new TB incidents in Nottinghamshire received a preliminary or final APHA veterinary investigation to identify the source of infection. The results of these investigations are reported in Appendix 3. The small number of investigations carried out in 2022 was mainly due to the diversion of field resources to the large avian influenza outbreaks which occurred in 2021 and 2022.

New data driven methods to quantify the likelihood of risk pathways for TB infection have been developed by APHA. These include the:

- Cattle Movement Algorithm
- WGS Local Reservoir Indicator

The Cattle Movement Algorithm uses cattle movement data to identify individual animals that were moved into a herd as having a negligible, very low, low, medium, high or very high likelihood of being the source of the TB infection. At the herd level, the cattle movement score is dictated by the highest risk animal movement into that herd. Herds are classified as having either:

- cattle movements associated with a high likelihood of infection (a herd with any movements scored as a high or very high likelihood)
- no cattle movements with a high likelihood of infection (the highest likelihood score was negligible, very low, low or medium).

The WGS Local Reservoir Indicator uses whole-genome sequence (WGS) data from cattle *M. bovis* isolates to identify TB incidents that are linked by genetics, time and space. A TB incident where at least one other TB incident is identified that satisfies all the following 3 criteria is considered to have evidence of a local reservoir of infection:

- it has a WGS with no more than 3 single nucleotide polymorphism (SNP) differences relative to the TB incident of interest
- it is within 4 years before or 6 months after the start date of the TB incident of interest
- it is within a 9km radius of the incident of interest.

Further details about the methodology used can be found in the [explanatory supplement to the annual reports 2022](#).

There is always a variable degree of uncertainty about the estimated routes of TB infection into a herd. The absence of a local reservoir, or cattle movements associated with a high likelihood of infection does not completely negate these pathways. Nonetheless, the evidence provided by the cattle movement and WGS data, when combined, can provide valuable insights into the possible risk pathways.

Figure 8 provides the percentage of herds where each risk pathway combination was identified. The spatial distribution of these categories are presented in Figure 9. Each category is described in greater detail in the following text.

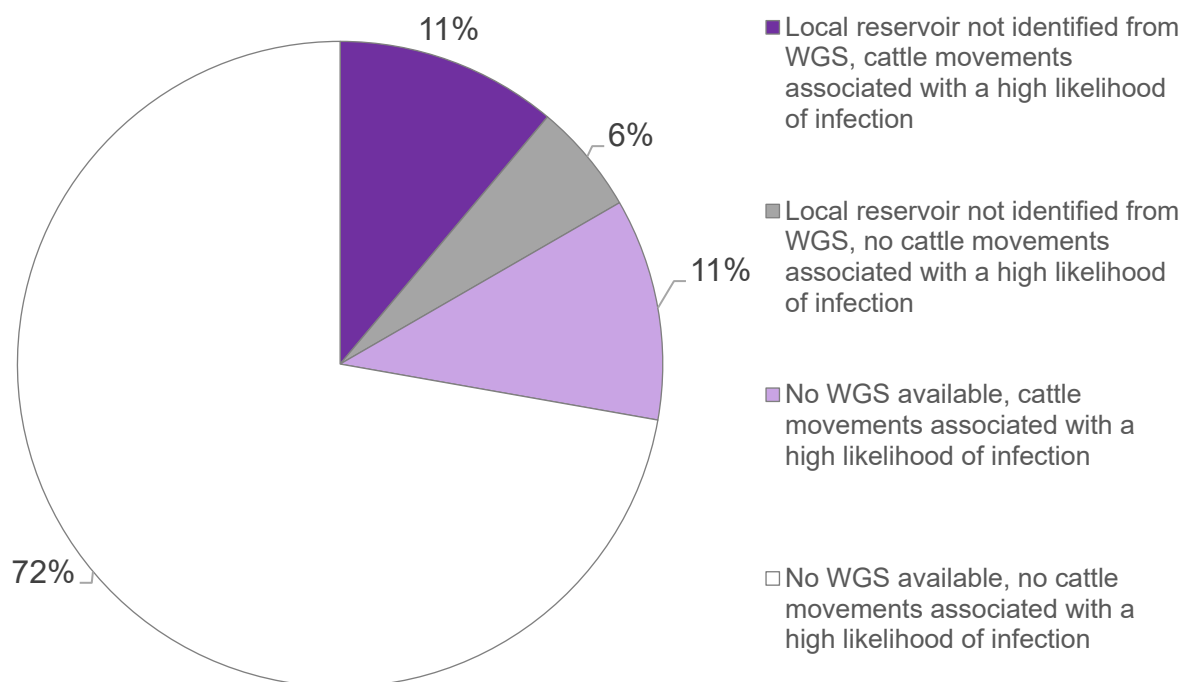


Figure 8: Risk pathway combinations identified by the WGS local reservoir indicator and cattle movement algorithm for all 18 new TB incidents in Nottinghamshire in 2022

WGS data with a suitable quality to analyse for a reservoir indicator was available for 3 (17%) of all new TB incidents in Nottinghamshire. The WGS Local Reservoir indicator did not identify a local reservoir of infection for any of them.

Where TB incidents have a local reservoir identified, which does not apply to any of the new TB incidents in Nottinghamshire in 2022, a broad spectrum of local pathways cannot be ruled out, including:

- residual infection in the herd
- contiguous contact with infected cattle
- direct or indirect contact with potentially infected wildlife
- local cattle movements.

In Nottinghamshire, 2 TB incidents (11%) had evidence of cattle movements associated with a high or very high likelihood of TB infection, and no evidence of a local reservoir where WGS was available. For those herds it was considered more likely than not that cattle movements played a part in the introduction of infection (dark purple symbols, Figure 9).

A further 2 incidents had cattle movements associated with a high likelihood of TB infection, but WGS data was not available to look for a local reservoir. These are depicted in light purple in Figure 9 due to the lack of genetic evidence.



For one TB incident, the WGS Local Reservoir Indicator did not find evidence of a local reservoir, and there was no evidence of cattle movements associated with a high likelihood of TB infection. The source of infection is unclear for this incident (grey symbol).

There was no evidence of cattle movements associated with a high likelihood of TB infection and no WGS available to explore the presence of a local reservoir for 13 of the 18 (72%) TB incidents. These are shown as white dots in Figure 9, as there is insufficient evidence to determine a likely infection pathway.

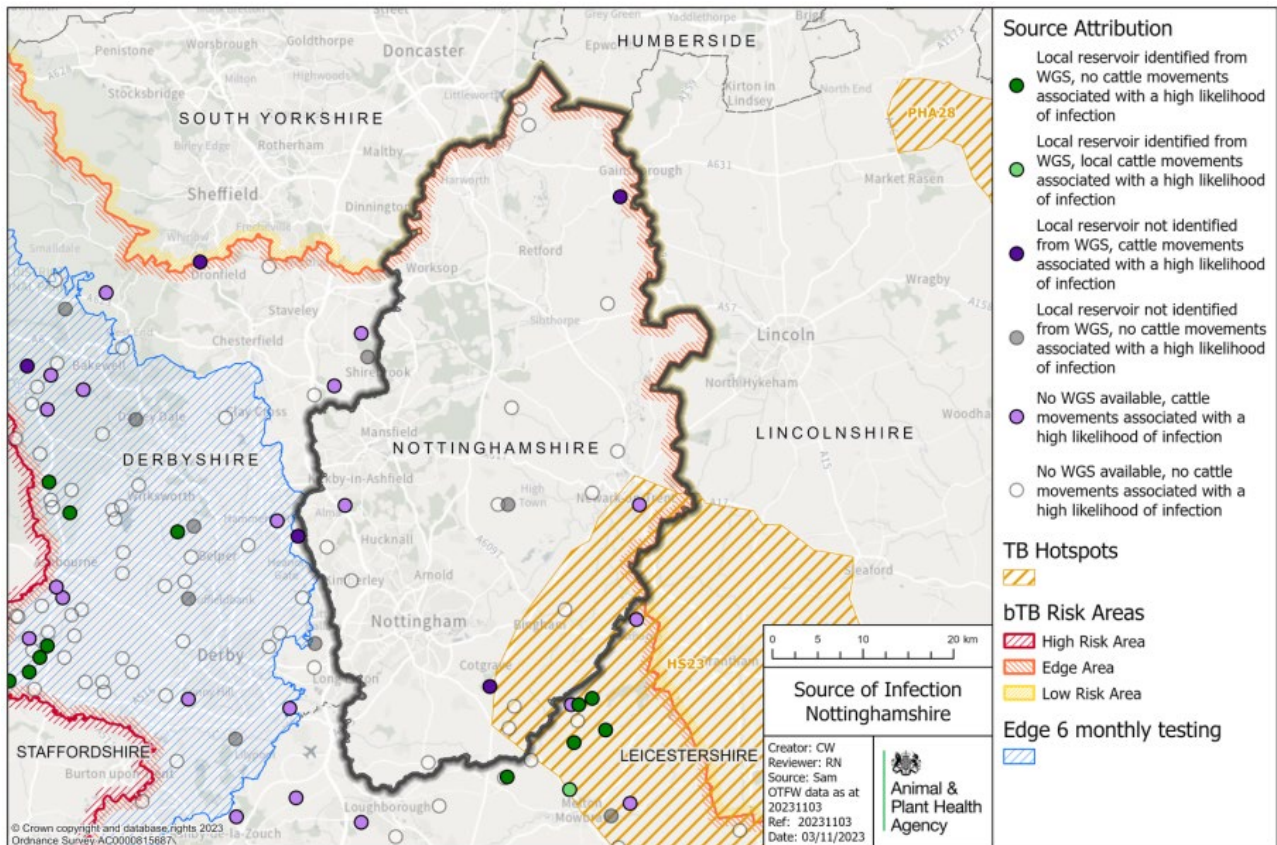


Figure 9: Map of the available evidence for risk pathways of TB infection into the herd, for all TB incidents (OTF-W and OTF-S) in Nottinghamshire that started in 2022.

New TB incidents identified as having a local reservoir by the WGS Local Reservoir Indicator over the past 4 years are presented in Figure 10. There were no incidents of this kind in Nottinghamshire in 2022. However a cluster of B3-11 in north Leicestershire, at Nottinghamshire’s southern border, has been established over the time period. This area belongs to the HS23 hotspot above mentioned, and more information can be found in the [Leicestershire TB epidemiology report](#).

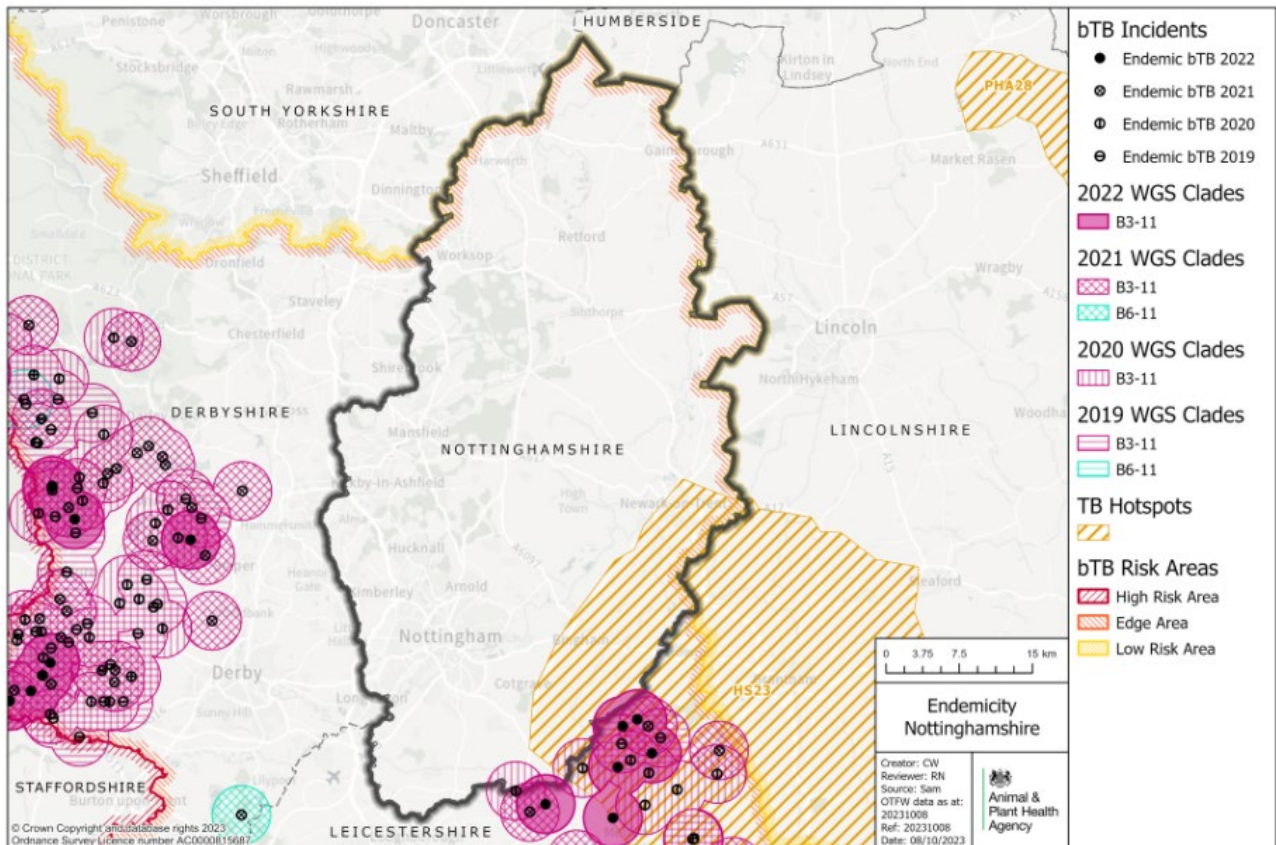


Figure 10: WGS clades of *M. bovis* detected in Nottinghamshire between 2019 and 2022, where the WGS identified in the infected herd was within 3 SNPs of another TB incident in the past 4 years and 9km (OTF-W incidents only).

## Forward look

Despite the number of incidents decreasing from 2021, the number of incidents in 2022 is still higher than pre-2021. With this increase over the last 5 years and new incidents in 2022 located both in the south and also extending to the east and north of the county, there is concern about the future of TB control in Nottinghamshire.

It may be a cyclical event, but it may also deteriorate further with the possibility of infection becoming established in the south, centre and north of the county. It seems unlikely for Nottinghamshire to become eligible for OTF status by 2025, as set out in the Strategy for achieving OTF status for England, published in 2014.

There are several measures that would help address the most common risk pathways for TB infection in Nottinghamshire. These include:

- further work by APHA and stakeholders to determine the most likely risk pathways for incidents with an uncertain pathway at present, this may include looking further at local wildlife sources and encouraging farmers in the HS23



portion to engage in the specific control measures established as part of this hotspot, like continuing to report badger and deer carcasses

- managing the TB risks posed by cattle movements to reduce the risk of spread of TB within and between farms - this is particularly relevant in the central area and north areas, which has had imported disease in previous years
- continuation and further adoption of measures to prevent the spread of TB between cattle and wildlife, including biosecurity, badger culling or vaccination, and local control of the wild deer population, where appropriate.

## Appendix 1: cattle industry demographics

Table 1: Number of cattle herds by size category in Nottinghamshire as of 31 December 2022 (RADAR data)

Size of herds	Number of herds in Nottinghamshire
Undetermined	3
1 to 50	219
51 to 100	65
101 to 200	57
201 to 350	35
351 to 500	12
Greater than 500	14
Total number of herds	405
Mean herd size	103
Median herd size	40

Table 2: Number (and percentage of total) of animals by breed purpose in Nottinghamshire as of 31 December 2022

Breed purpose	Number (and percentage of total) cattle in Nottinghamshire
Beef	28,770 (69%)
Dairy	11,688 (28%)
Dual purpose	1,144 (2%)
Unknown	(0%)
Total	41,602

## Appendix 2: summary of headline cattle TB statistics

Table 3: Herd-level summary statistics for TB in cattle in Nottinghamshire between 2020 and 2022

<b>Herd-level statistics</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
(a) Total number of cattle herds live on Sam at the end of the reporting period	515	476	483
(b) Total number of whole herd skin tests carried out at any time in the period	478	464	493
(c) Total number of OTF cattle herds having TB whole herd tests during the period for any reason	394	396	372
(d) Total number of OTF cattle herds at the end of the report period (herds not under any type of Notice Prohibiting the Movement of Bovine Animals (TB02) restrictions)	481	436	439
(e) Total number of cattle herds that were not under restrictions due to an ongoing TB incident at the end of the report period	506	459	469
(f.1) Total number of new OTF-S TB incidents detected in cattle herds during the report period (including all Finishing Units)	8	10	12
(f.2) Total number of new OTF-W TB incidents detected in cattle herds during the report period (including all Finishing Units)	5	11	6
(g.1) Of the new OTF-W herd incidents, how many can be considered the result of movement, purchase or contact from or with an existing incident based on current evidence?	2	0	N/A
(g.2) Of the new OTF-W herd incidents, how many were triggered by skin test reactors or two-time inconclusive reactors (2xIRs) at routine herd tests?	1	4	0

<b>Herd-level statistics</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
(g.3) Of the new OTF-W herd incidents, how many were triggered by skin test reactors or 2xIRs at other TB test types (such as forward and backward tracings, contiguous or check tests)?	0	6	3
(g.4) Of the new OTF-W herd incidents, how many were first detected through routine slaughterhouse TB surveillance?	3	1	3
(h.1) Number of new OTF-W incidents revealed by enhanced TB surveillance (radial testing) conducted around those OTF-W herds	1	3	1
(h.2) Number of new OTF-S incidents revealed by enhanced TB surveillance (radial testing) conducted around those OTF-W herds	0	3	4
(i) Number of OTF-W herds still open at the end of the period (including any ongoing OTF-W incidents that began in a previous reporting period, but not including TB incidents in non-grazing Approved Finishing Units)	2	9	5
(j) New confirmed (positive <i>M. bovis</i> culture) incidents in non-bovine species detected during the report period (indicate host species involved)	0	0	0
(k.1) Number of grazing approved finishing units active at end of the period	0	0	0
(k.2) Number of non-grazing approved finishing units active at end of the period	10	10	10
(k.3) Number of grazing exempt finishing units active at end of the period	0	0	0
(k.4) Number of non-grazing exempt finishing units active at end of the period	0	0	0

Table 4: Animal-level summary statistics for TB in cattle in Nottinghamshire between 2020 and 2022

<b>Animal-level statistics (cattle)</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
(a) Total number of cattle tested in the period (animal tests)	53,743	58,457	62,631
(b.1) Reactors detected by tuberculin skin tests during the year	23	62	45
(b.2) Reactors detected by additional IFN- $\gamma$ blood tests (skin-test negative or IR animals) during the year	9	44	34
(c) Reactors detected during year per incidents disclosed during year	2.5	5.0	4.4
(d) Reactors per 1,000 animal tests	0.6	1.8	1.3
(e.1) Additional animals slaughtered during the year for TB control reasons (dangerous contacts, including any first time IRs)	4	1	3
(e.2) Additional animals slaughtered during the year for TB control reasons (private slaughters)	1	5	1
(f) Slaughterhouse (SLH) cases (suspect tuberculous carcasses) reported by Food Standards Agency (FSA) during routine meat inspection	6	3	4
(g) SLH cases confirmed by culture of <i>M. bovis</i>	4	1	3

Note (c) Reactors detected during year per incidents disclosed during year. Reactors may be from incidents disclosed in previous years, as any found through testing during the report year count here.

Note (g) SLH cases confirmed by culture of *M. bovis*, not all cases reported are submitted for culture analysis. All cases reported are from any period prior to or during restrictions.

## Appendix 3: suspected sources of *M. bovis* infection for all the new OTF-W and OTF-S incidents identified in the report period

In 2022, 2 out of 18 (11%) new TB incidents in Nottinghamshire received a preliminary or final APHA veterinary investigation to identify the source of infection. The small number of investigations carried out in 2022 was mainly due to the diversion of field resources to the large avian influenza outbreaks which occurred in 2021 to 2022.

Each TB incident could have up to 3 potential risk pathways identified. Each risk pathway is given a score that reflects the likelihood of that pathway bringing TB into the herd. The score is recorded as either:

- definite (score 8)
- most likely (score 6)
- likely (score 4)
- possible (score 1)

The sources for each incident is weighted by the degree of certainty ascribed. Any combination of definite, most likely, likely, or possible contribute to the overall picture for possible routes of introduction into a herd.

If the overall score for a herd is less than 6, then the score is made up to 6 using the 'Other or unknown source' option. Buffering up to 6 in this way helps to reflect the uncertainty in assessments where only 'likely' or 'possible' sources are identified.

Table 5 combines the data from multiple herds and provides the proportion of pathways in which each source was identified, weighted by its certainty. The output does not show the proportion of herds where each pathway was identified (this is skewed by the certainty calculation). WGS of *M. bovis* isolates can be a powerful tool in identifying a likely source of infection, however WGS clades are not available for OTF-S herds and are limited by the number of positive culture results as well as policy considerations (usually only one per incident). As a result of varying levels of uncertainty, only broad generalisations should be made from these data. A more detailed description of this methodology is provided in the [explanatory supplement for the annual reports 2022](#).

Table 5: Suspected sources of *M. bovis* infection for 2 incidents with a preliminary or a final veterinary assessment in Nottinghamshire in 2022

<b>Source of infection</b>	<b>Possible (1)</b>	<b>Likely (4)</b>	<b>Most likely (6)</b>	<b>Definite (8)</b>	<b>Weighted contribution</b>
Badgers	0	1	0	0	22.2%
Cattle movements	1	0	0	1	55.6%
Contiguous	0	0	0	0	0.0%
Residual cattle infection	0	0	0	0	0.0%
Domestic animals	0	0	0	0	0.0%
Non-specific reactor	0	0	0	0	0.0%
Fomites	0	0	0	0	0.0%
Other wildlife	0	1	0	0	22.2%
Other or unknown source	0	0	0	0	0.0%

Please note that each TB incident could have up to three potential pathways, so totals may not equate to the number of actual incidents that have occurred.



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