

# Appendix G: Prevalence, Transmission and Control of Bovine Tuberculosis

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## Contents

Key points.....	539
G1 Current bovine tuberculosis (Tb) situation.....	539
G2 Aerial application of substances containing 1080.....	545
G3 Future situation.....	553
G4 Impact on human health .....	554
G5 Views of submitters on possum density as it relates to bovine tuberculosis control .....	555
G6 Agency’s evaluation of aerial application on possum density as it relates to bovine tuberculosis control .....	557

## Key points

The applicants have provided little factual support to demonstrate efficacy of aerial versus ground application of 1080 as it relates to possums control. The Agency considers that this is a possible consequence of the applicants considering an alternative scenario based only on the use of cyanide and trapping and not considering the possibility that only ground based application of 1080 will be continued. The Agency has carried out its own evaluation of the effects of aerial 1080 on possum density as it relates to Tb control but notes that the committee may require a more detailed assessment.

The Agency considers that the applicants have not fully detailed the basis for their forecast of the areas predicted to be occupied by Tb infected wildlife without the continued use of 1080.

## G1 Current bovine tuberculosis (Tb) situation

The applicants detail the current New Zealand *Mycobacterium bovis* (bovine tuberculosis (Tb)) situation in Section F of their application. The applicants state that the five major areas occupied by cattle, deer and possums infected with Tb are the central North Island, the Wairarapa, Westland to Tasman, North Canterbury and Otago, and that these areas are often characterised by farmlands close to extensive forest-pasture margins.

The applicants advise that the major cause of Tb in cattle and deer herds is contact with wild vectors (carriers) of the disease. A key function of the Animal Health Board (AHB) is vector control, mainly aimed at possums and ferrets. The intention of this vector control is to reduce and prevent transmission of the disease from wildlife vectors to farmed herds, to eradicate Tb from areas where vectors are known to be present and to prevent the spread of infected wild animals to areas where Tb wild animals

have not be identified or suspected. The applicants state that the following conditions must be met for the goal of eradicating Tb from wild animals to be achieved:

- uniform reduction of possums to low densities
- density reduction over a large area (more than 1,000 ha)
- reduction occurs within a short time (to prevent movement of infected possums)
- possum densities are maintained at very low densities for a minimum of five years.

The applicants noted that in many situations all these conditions can only be met through aerial control operations with 1080 baits. Ground control is noted to often fail for reasons related to the nature of terrain to be treated, cost and duration of ground control operations.

The Agency notes that the applicants have provided little factual support to demonstrate efficacy of aerial compared with ground application of 1080 as it relates to possums and bovine Tb control. The Agency considers that this is a possible consequence of the applicants considering an alternative scenario based only on the use of cyanide and trapping, and not giving consideration to the possibility that only ground-based application of substances containing 1080 will be continued. Noting the alternative scenario to the current use of 1080 the Agency has identified (see section 4.3.5) involving the discontinuation of aerial application and general opposition to aerial 1080 operations expressed by several submitters, the Agency considers that it is appropriate to evaluate the effects of aerial 1080 on possum density as it relates to Tb control. The Agency considers that this is an area that has not been fully addressed in the application and notes that the applicants have provided very limited supporting information to demonstrate importance of aerial 1080 operations in terms of controlling possums and the subsequent effect on the prevalence of Tb infection in cattle and deer herds. The Agency has, therefore, carried out its own evaluation adopting the following approach.

- 1 To identify evidence supporting that Tb infection does occur in possums (and other wildlife species) and to establish that transmission from possums and other wildlife to deer and cattle is supported.
- 2 To consider the efficacy of aerial application in control possums relative to that of ground-based 1080 control operations (ie, giving consideration future without aerial use of 1080).
- 3 To consider the significance of bovine Tb to human health.

### **G1.1 Prevalence and transmission of bovine tuberculosis**

According to the applicants, possums are the main maintenance host for bovine Tb in New Zealand (p ES-3 of application). The applicants have not referenced this statement. However, the Agency notes that there is support for this statement in published literature. Morris and Pfeiffer

(1995, cited by Coleman et al 2006) note that possums appear to be the primary maintenance host of Tb in most wildlife populations and that epidemics of Tb in possums and cattle are often spatially and temporally contiguous. Brush-tailed possums are also identified by de Lisle et al (1995) as the most important reservoir for Tb infection.

Several studies have been identified by the Agency as addressing Tb prevalence and transmission among wildlife and domestic animal species. The Agency notes that the studies cover both Tb infection in possums and in other wildlife.

Caley et al (2001) studied the habitat-related prevalence of Tb infection in possums at Hohonu Range, Westland. The habitat factors investigated included site-specific characteristics (land form, aspect, slope and altitude), distance from forest-pasture margin and time since infection. Caley et al (2001) found that the prevalence of Tb infection in possums was higher in habitats that supported the highest density of possums. It is noted by Caley et al (2001) that this finding is at odds with previous research which indicated that there was no relationship between population density and prevalence of infection. However, it is acknowledged by Caley et al (2001) that the positive finding of such a relationship is considered to be in line with general epidemiological theory, whereby, disease prevalence should increase with increasing population density. In habitats supporting lower densities of possums the prevalence was lower. Additionally, it was noted by Caley et al (2001) that possum density was influenced by altitude and the prevalence of Tb amongst possums decreased by 20% for every 100 m increase in elevation at the site studied.

In an earlier study, Caley et al (1999) studied the effects of sustained control of brushtail possums on levels of Tb infection in domestic cattle and possums populations from Hohotaka with the aim of determining whether a causative relationship exists between Tb infection in possums and cattle. Caley et al (1999) compared the prevalence of Tb infection in possums and domestic cattle from three adjacent blocks in Hohotaka. The study spanned a 10-year period over which the blocks underwent possum control operations at differing times. The three blocks treated at Hohotaka were as follows.

- *Hohotaka block*: Intensive possum control was carried out with a combination of aerially applied 1080 cereal baits and 1080 containing paste in 1988. Annual maintenance treatment occurred for following 10 years. Trapping preceded annual control and a variety of methods of annual control occurred including use of 1080 containing paste, cyanide baits and 1080 cereal baits in bait stations and brodifacoum in bait stations.
- *Ngapuke block*: Intensive possum control using ground-based control methods was initiated in 1994 and annual maintenance control was carried out for the following four years.
- *Hauhungarao block*: Intensive control of possums using aerially applied carrot or cereal baits containing 1080 was carried out in 1996.

Caley et al (1999) found reports that following the initial treatment of the Hohotaka block, the percentage kill was found to be 84%. During the maintenance control at this site it is stated that the estimated abundance of trappable possums averaged 22.1% of the pre-control abundance. Caley et al (1999) noted that there was a significant, though slow, decline in the prevalence of Tb infection in possums on the Hohotaka block following the introduction of control in the area. The decline in infection was more pronounced with increasing duration of control.

It is noted by Caley et al (1999) that no decline in prevalence of Tb infection was observed in a 10 year study carried out in Castlepoint at a similar time where culling of possums was not carried out and in the Hohonu Range (Caley et al 2001) where possums were sampled infrequently by kill-trapping. Caley et al (1999) states that the data generated are consistent with possum culling causing a decrease in the prevalence of Tb infection. It was also noted by Caley et al (1999) that their study shows that reducing the abundance of Tb possums causes a reduction in the cumulative incidence of Tb in cattle. Caley et al (1999) monitored the abundance of ferrets incidentally caught in possum traps in the control areas and noted that the abundance of ferrets caught did not differ before and after the start of possum control operations. Caley et al (1999) note arguments of Moller et al (1996 (as cited by Caley 1999)) stating that, with reference to secondary poisoning of ferrets, that declines in the incidence of Tb in livestock following possum control operations using from 1080 containing fruit pastes are not necessarily related to the decline in possum number. The consistent findings in ferret abundance are considered by Caley et al (1999) to demonstrate that these arguments do not hold up in this study.

While Caley et al (1999) demonstrated that a link between Tb infection in ferrets and Tb infection in domestic cattle was not relevant to their study in Hohotaka, the Agency notes that Tb has been isolated from ferrets (de Lisle et al 1995). Ragg et al (2000) identify that feral cats, ferrets and possums are scavengers and address the implications of scavenging behaviour on bovine Tb transmission. It was concluded that the study had demonstrated that scavenging played a potential role in the transmission of Tb among ferrets, possum and feral cats and between these species. The effect of scavenging behaviour on the incidence of Tb in scavenger species was not determined. It is, however, proposed that when identifying sources of Tb infection amongst scavenging species, surveys of prevalence of Tb in prey and carrion species should consider the possibility that the risk of infection is not directly proportional to the prevalence of Tb among the population as a whole; the prevalence of Tb among animals that die and are available as carrion may be more relevant (Ragg et al 2000).

The Mackenzie Basin was considered to be free of bovine Tb before the 1980s on the basis of skin testing and slaughterhouse stock inspection (de Lisle et al 1995). Over a period of 13 years the majority of cattle and deer herds became infected with Tb. DNA restriction endonuclease analyses were used by de Lisle et al, (1995) to study the epidemiology and

transmission of Tb in domestic animals and wildlife in the MacKenzie Basin and surrounding areas.

No evidence was identified by de Lisle et al (1995) to suggest that Tb had spread through the MacKenzie Basin via the movement of infected deer and cattle. The spread of the infection between neighbouring properties was considered to be characteristic of a wildlife reservoir of Tb and the discovery of a Tb infected possum in the area in 1985 provided further evidence of a wildlife reservoir of the infection (de Lisle et al 1995). It is noted by de Lisle et al, (1995) that Tb-infected possums were found in the areas of the Basin with the highest possum density, whereas the lower density areas (the Northern end) of the Basin had a very low possum density so as to make it very unlikely that possums were the source of many infections in domestic animals. Other possible wild animals, identified by de Lisle et al, (1995) as possible reservoirs of infection, include ferrets and cats.

Analysis of isolates of *M. bovis* from the MacKenzie Basin found that they could be divided into two groups (an 'O Group' and 'W Group') based on similarity of the DNA restriction patterns (de Lisle et al 1995). Analysis also showed the most common DNA restriction types were present in both wildlife and domestic animals in the MacKenzie Basin indicating that the infection had spread between the two types of animals. Restriction endonuclease analysis also found that *M. bovis* was introduced to the MacKenzie Basin from at least two separate sources (de Lisle et al 1995). Otago was identified by de Lisle et al (1995) as a probable source of the infection in the MacKenzie Basin. Some of the DNA restriction types isolated from the MacKenzie Basin are only found at this site and also in Otago. It is noted by de Lisle et al (1995) that there is insufficient evidence to identify whether wildlife or domestic animals were responsible for the introduction of the Tb into the MacKenzie Basin.

Identical restriction types have also been isolated from possums on the West Coast as well as the southern border of the MacKenzie Basin. An explanation provided by de Lisle et al (1995), as to how this group of isolates entered the MacKenzie Basin, is that they came from the introduction of infected deer to the area. Furthermore, farmed deer in the region may have been a source of infection for wild animals such as possums and ferrets (de Lisle et al 1995). It is concluded by de Lisle et al (1995) that eradication of bovine Tb from cattle and deer herds will only be achieved when the cycle of infection between wildlife and domestic animals is broken.

The finding by de Lisle et al (1995) that Tb-infected possums were found in the areas of the MacKenzie Basin with the highest possum density appears to be consistent with the finding of Caley et al (2001) that the prevalence of Tb infection in possums was higher in habitats that supported the highest density of possums.

Further evidence for the potential role of scavenging in transmission of Tb, as investigated by Ragg et al (2000) is also highlighted by de Lisle et al

(1995) who report that in 1988 and 1989, 47 ferrets from the MacKenzie Basin were examined for Tb. No Tb was detected in these animals, however, a further two ferrets were discovered in 1989 25 km south of the Mackenzie Basin which were infected with Tb. Ferrets on the property where these Tb ferrets were found had been observed scavenging a deer carcass; deer at this property had been found to be infected with Tb.

ECAN, 2002 (applicants' reference ME-10) cites Ragg et al (1995) and notes that control of rabbit predators (ferrets, stoats and feral cats) for Tb may result in rabbit population increases. The link between rabbit predators and Tb in cattle, while poorly understood, provides additional support for increased rabbit control.

The Agency notes that Coleman et al (2006) state that effective management of possums is a key component in the management of Tb infection in livestock in New Zealand. The applicants specify that aerial 1080 operations have been a key technique for controlling possums for the purpose of controlling Tb due to the difficulty and cost of ground control over much of New Zealand.

## **G1.2 Movement of animals and bovine tuberculosis transmission**

Several submitters refer to the movement of domestic stock being a bigger risk than contact with wild animals in terms of the transmission of bovine Tb among herds. The Agency notes that the AHB acknowledges that one way bovine Tb is spread is via the uncontrolled movement of stock (AHB no date). Under the Biosecurity (National Bovine Tuberculosis Pest Management Strategy) Order 1998, made pursuant to section 68 of the Biosecurity Act 1993, the AHB is responsible for implementing this strategy. This order puts in place requirements to identify animals with bovine Tb (identification is done using ear tags) and for animals to be accompanied by a declaration when they are being moved. The declaration should be provided on an industry standard Animal Status Declaration form.

In addition to identification and declaration requirements, the Agency notes from information provided on the AHB website that Movement Control Areas have been developed by the AHB. The Agency considers that the declaration of the movement controlled areas will have been made under section 131 of the Biosecurity Act 1993 and that certain movement restrictions apply to these areas. Where cattle or deer from a Movement Control Area are to be moved, there is a requirement for a pre-movement Tb test to be carried out within 60 days before movement if the animals are over 90 days old.

Additional conditions apply to movements from herds with an infected status and for some herds with a suspended status (suspended status, for example, is applied to a herd that has received an animal from a herd with infected status). The additional controls are detailed by the AHB on its website. All cattle and deer being moved from infected herds, and in some cases from herds with suspended status, must be clear to pre-movement

tests, tagged with official white movement control ear tags and issued with a written Permit to Move

For cattle herds, clear to pre-movement tests means:

- if there has been a clear herd test following the last Tb case, all animals to be moved must be clear to a further skin test applied within 60 days before movement
- if the herd has not had a clear test, or if reactors are found at a pre-movement test, all animals to be moved must be clear to a skin test and blood test
- cattle less than six weeks old may be moved from infected herds without a Tb test.

For deer herds, clear to pre-movement tests means:

- if there has been a clear test following the last Tb case, all animals to be moved must be clear to a further skin test applied within 60 days before movement
- if the herd has not had a clear test, or if reactors are found at a pre-movement test, animals may only be moved direct to slaughter.

The Agency's understanding of the requirements detailed by the AHB relating to animal movement is that where cattle or deer from a Movement Control Area are to be moved they must first be shown to be Tb free. The Agency notes that these movement restrictions are specifically in place to control the movement of infected animals and considers that this will limit the potential for the infection to spread between animals in different herds. The Agency considers that where the conditions on movement specified by the AHB are followed the risk of transmission of bovine Tb due to animal movements should be minimal. If, however, the conditions are not adhered to and Tb-infected animals are moved, the Agency considers that, based on the information available, the risk of transmission between animals will be higher.

The Agency notes that some submitters consider that current regulations relating to stock movement have not been implemented and enforced by the AHB appropriately or are not strict enough.

## **G2 Aerial application of substances containing 1080**

### **G2.1 Current use patterns**

The applicants specify that the majority of 1080 applied by the Department of Conservation (DoC), the AHB and regional councils is applied via aerial application. It is stated in the application that 1080 is primarily used in large forested areas where access and terrain make ground control expensive, difficult or impossible. The total area of indigenous forest being treated aurally by the three agencies, on an annual basis, is estimated by the applicants to be over 580,000 ha, with the majority

(approximately 68%) being treated by the AHB to reduce infected possum populations. Noting that the three Agencies have an area under sustained management (AUSM) of 2,782,000 ha for aerial control methods, the Agency has determined that the 580,000 ha treated annually is equivalent to the three agencies treating approximately 21% of the total AUSM subject to aerial control methods on an annual basis.

## **G2.2 Objectives of aerial application**

The applicants state that only aerial application can achieve the following four objectives simultaneously.

- 1 Reduction of possum densities below a residual trap catch index (RTCI) measure of 5% for conservation purposes or 2% for eradicating Tb.
- 2 Reduction of several other pest populations at the same time
- 3 Reduction in density over a large area in very short time-frames. Achieving rapid reduction to low possum densities over very large areas (more than 1,000 ha) is stated by the applicant as being important in stopping new outbreaks of Tb.
- 4 Uniform reduction of possum densities to low levels.

The Agency has considered each of these objectives in terms of their impact on Tb control in the following sections:

### **G2.2.1 Reduction of possum densities below a residual trap catch index measure of 5% for conservation purposes or 2% for eradicating bovine tuberculosis**

Maintaining an RTCI below 2% is stated by the applicants to be necessary for eradicating bovine Tb in local possum populations. The Agency requested further information from the applicants to support the use of this value. The applicants clarified that the RTCI must be maintained below 2% for five years or more to achieve local eradication of Tb from possums in the absence of significant immigration of infected wildlife. The applicants state that supporting information for this is as follows.

- Modelling data from an AHB contract report (Ramsey and Efford 2005). The applicants supplied a copy of this report, which the Agency discusses below.
- Intensive testing and slaughterhouse surveillance of cattle and deer from an operational area continually identifies zero findings of Tb. The same results are found through intensive wildlife surveys (lethal sampling, post-mortem examination and laboratory culture of tissues that are most likely to be infected by Tb). While the applicants state these negative findings of Tb, no results of such surveys or surveillance have been provided to enable the Agency to verify the applicant's assertions.
- The AHB has confidence that Tb has been eradicated from possums and other wildlife in the Banks Peninsula, Kaipara South Head, Te Puna,

Kaiwhaiki, and Fortification. Reduction in vector risk areas (VRAs) has occurred in Waiapawa/Tikokino and northwestern Wairarapa. No data or references have been supplied by the applicants to verify that this eradication was achieved through the maintenance of an RTCI value lower than 2%.

Ramsey and Efford (2005) detail research carried out to model the cost-effectiveness of various RCTI targets. The objectives of this research included predicting:

- the probability of eliminating Tb from possum populations within any given time (duration) and intensity (level) of control
- the likely cost-effectiveness of RTCI for monitoring these levels.

Ramsey and Efford (2005) used spatially explicit stochastic modelling to investigate the specified objectives. A set of three scenarios were modelled: (1) uniform habitat with a high carrying capacity (possum population density), (2) uniform habitat with a low carrying capacity, and (3) farmland/scrub (possum density varies throughout the area). Results obtained from the research include the following.

- The probability of Tb extinction within a given time did not vary substantially between aerial and ground-based controls methods. The cost of achieving an RTCI value less than 5% and less than 2% was, however, higher for ground based application versus aerial application
- Generally, possum populations reduced and maintained at an RTCI value of less than 5% had a 95% probability of Tb extinction within five to seven years.
- Where a lower RTCI value is maintained the time until a 95% probability of Tb extinction was reduced. For an RTCI value of less than 2% the time was three to five years, for an RTCI value of less than 1% the time was three to four years
- The cost of control was identified as being greater for the high density possum population than the lower density possum population. It is noted that a greater intensity of control is required to meet the RTCI target for the higher population density
- The benefit of adopting an RTCI value less than 5% appears to be entirely time related (ie, it is quicker to reach 95% probability of Tb extinction when a lower RTCI value is maintained).

A series of recommendations are listed by Ramsey and Efford (2005) and include the following points.

- An RTCI value of 5% should be adopted for control over areas of high density possum populations.
- An RTCI value of 2% should be adopted for control over areas of low possum density and farmland/scrub.
- In continuous forest, at an RTCI value of 5%, at least seven years of monitoring and control is required to achieve Tb eradication. At an

RTCI value of 2% at least five years of monitoring and control is required to achieve Tb eradication.

- In farmland/scrub, at an RTCI value of 6%, at least seven years of monitoring and control is required to achieve Tb eradication. At an RTCI value of 2% at least four years of monitoring and control is required to achieve Tb eradication.

The Agency notes that maintenance of an RTCI value of 2% or lower is the target for Tb eradication used in New Zealand. Based on Ramsey and Efford (2005), the Agency notes that a RTCI of either 2% or 5% could be used to eradicate Tb. On the basis of Ramsey and Efford (2005), the Agency assumes that the 2% RTCI value has been selected to achieve Tb eradication more quickly.

### **G2.2.2 Reduction of several other pest populations at the same time**

Tb occurs in feral cats and ferrets (Ragg et al 2000). Tb has been isolated from ferrets and feral cats, although their importance as significant reservoirs of Tb infection for farmed deer and cattle is unknown (de Lisle et al 1995). ECAN (2002) notes that Tb is present in many predator populations, in particular ferrets, stoats and cats. ECAN (2002) cites Ragg et al (1995), noting that while no method of transmission from these predators to domestic livestock has been identified, the high correlation between Tb in domestic livestock and Tb in predators indicates that some sort of relationship exists.

### **G2.2.3 Reduction in density over a large area in very short time-frames**

Achieving rapid reduction to low possum densities over very large areas (> 10000 ha) is stated by the applicant as being important in stopping new outbreaks of Tb.

The applicants note that operations need to be done on this scale for the following reasons.

- It is not economic to try and detect the small areas where foci of Tb-infected possums actually occur.
- Control over large areas kills juvenile possums that can move several kilometres to establish new foci.
- It minimises the immigration of non-Tb juvenile possums into newly established Tb foci, in which the infection may be maintained if repopulated quickly.

The Agency notes that Coleman et al (2006) provide support for the short time-frames proposed by the applicant. Coleman et al (2006) note it is generally more cost effective to eradicate a wildlife disease rapidly rather than slowly. Additionally, Speedy (2003) determined that aerial application of 1080 resulted in a target RTCI value being achieved more quickly than for application of 1080 in baits stations (8 days compared

with 115 days). The applicants suggest that it is important to prevent the migration of juvenile possums both with and without Tb infection.

The Agency has identified that Porphyre et al (2005) reference the issue of possum migration in relation to Tb infection. Porphyre et al (2005) refer to two potential sources of Tb possums in the Featherston area. The first is possums whose home ranges are in the forest-pasture margin, overlapping or adjacent to farmland. The second source of infected possums is those that migrate in long distance movements from forest onto farms. It is noted by Porphyre et al (2005) that the proportion of infection in cattle associated with the second possum source is considerably lower than from the first source and tends to be more sporadically distributed around farms independent of their proximity to the forest and generally reflect the variable distances over which migrating possums may move.

#### **G2.2.4 Uniform reduction of possum densities to low levels**

The Agency notes that Coleman et al (2006) studied trends in the incidence of Tb in possums and livestock associated with differing control intensities applied to possum populations. It was concluded by Coleman et al (2006) that their results, although limited due to the duration of their study, indicated that reducing possum populations uniformly to nationally-targeted levels results, over time, in a slow decline in levels of Tb in both possums and livestock. Ramsey and Efford (2005) explored the implication of patchy control on eliminating Tb from possum populations using stochastic modelling. Where a 30 ha high-density area containing infected possums within a 859 ha area of farmland/scrub was missed by control, Tb would not be eliminated from the area within 10 years.

Caley et al (1999) noted that Tb infection persisted at Hohotaka throughout five years of possum control and stated that it appeared probable that persistence of the infection in the western part of the area studied was a consequence of this area receiving little or no effective control after the initial intensive control. This is stated by Caley et al (1999) to emphasise the importance of possum control being applied in a uniform manner.

#### **G2.3 Case study: Bovine tuberculosis vector control in the Hauhungaroa Range**

The applicants detail vector control work that has been carried out in the Hauhungaroa Range in a case study provided in Section I of their application. The Agency considers that the main points detailed in this case study are as follows.

- Tb-infected possum populations in the range are stated by the applicants as being associated with Tb infection in cattle and deer herds. Possum control had previously been carried out (with the aim of reducing herd infection rates) in parts of the range adjacent to infected herds. This is reported by the applicant to have provided short term relief but infection persisted around the range.

- The Hauhungaroa Range covers approximately 83000 hectares and due to the size and difficulty in accessing many parts of the range, control operations covering the entire area were not considered until 2004 when the AHB committed to eradicating Tb from the area.
- The applicants state that after considering all possum control options, and given the size of the operation and nature of the terrain, aerial application of 1080 was considered to be the most efficient and cost effective control method.
- Aerially pre-feeding was carried out twice followed by aerial application of the bait containing 1080. The applicants note that deer repellent was applied to the toxic bait as the area was popular with deer hunters.
- The performance target for this operation was and RTCI of 2%. The RTCI achieved was 0.047%.
- The applicants state that:
  - uniform reduction of possum density to such a low level may well achieve Tb eradication as there will be insufficient hosts for the disease to be maintained
  - conservation benefits are also expected
  - the use of deer repellent resulted in the deer population not being adversely affected
  - since the operation there have been positive signs for local farmers with the number of infected herds declining
  - local residents have commented that on the number of native birds being greater than in previous years.

The Agency notes that the case study provided by the applicants is unreferenced. The Agency requested that the applicants supply the references used to compile this case study. In response the applicants advised that there have been no published reports on the Hauhungaroa operation as yet and provided pages from the post-operation report. The pages provided by the applicant confirm the method of bait application used during the operation at Hauhungaroa Range. Additionally, the report confirms that one deer assumed to have been poisoned by 1080 was identified. The applicant has provided no information to support declining numbers of infected herds. The Agency notes that on the basis of the information relating to RTCI values supplied by the applicant the area will need to be maintained at an RTCI value of less than 2% for a period of five years for it to be considered that Tb has been eradicated from the area.

A number of regional animal health committees have provided data relating to herd infection rates in their regions in the submissions they have submitted on this reassessment application. Southland Regional Animal Health Committee, for example, notes that herd infection rates have been reduced from 54 in the 1960s to two in 2005, a reduction that it attributes to successful AHB vector control operations. Additionally, the Agency notes that Waikato Regional Animal Health Committee reports that 40 Tb-

infected herds in 1992/93 has been reduced to eight infected cattle herds and one in 2006, although the Agency notes that Waikato Regional Animal Health Committee does not link this decrease to any change in 1080 operations in the region.

#### **G2.4 Frequency of aerial operations**

The applicants specify that effective aerial control can lengthen the time interval before a treated area needs to be revisited for possum control and notes that areas that are ground treated require control at more frequent intervals. In their application, the applicants provide an indication of the time interval before an area needs to be revisited following aerial control operations (six to seven years) and following ground based operations (one to three years). The Agency requested that the applicants further detail how the time interval between control operations is determined and the relationship between the treatment interval and previous history of control.

The applicants confirm that the time interval between control operations is dependent on both the effectiveness of the initial operation and also on the RTCI value that has been determined for the specific operational area. Additionally, the decision as to whether an area requires possum control operations is stated by the applicant to take into consideration the following factors:

- the vector control objective for the area (eradication or reduction in number of infected herds)
- the length of time that possums have been maintained at low densities
- the length of time since the previous control operation in the area
- the RTCI value recorded following the previous control operation
- the probability the possum density has increased to and RTCI value more than 2% since it was last monitored (this may lead to a pre-monitor being undertaken to check the density)
- whether vector related infection has been diagnosed in a herd within the control area over the previous three years or within four to five years
- the risk of possums immigrating into the control area from surrounding areas
- the risk of Tb-infected possums migrating into the area
- the extent, distribution and type of possum habitat in the potential control area
- the suspected species of Tb vectors that may be involved in spreading infection to cattle and deer
- the presence of other scavenging species in the area (for example feral pigs).

The applicants advise that because aerial application of 1080 provides such a low density of possums relative to ground application methods it takes

longer for the possum population to recover to a density that requires further control. With ground control operations, the quality of the control is lower and the RTCI value obtained following control is higher, leading to the possum population density increasing more rapidly post-control. The applicants note that generally areas are treated on an annual basis in the first instance and then control becomes less frequent as information on where to target more intensive control becomes available.

## **G2.5 Comparison of aerial and ground-based application of substances containing 1080**

Epro Ltd (Speedy 2003) looked at the operational effectiveness (including standardised cost per hectare and time-frames to complete) of controlling possums to meet AHB-specified RTCI values using a range of control methods. The methods trialled included application of aerial 1080 baits, application of 1080 baits via bait stations and other ground control methods. The operational area over which the study was conducted is described as being typical of the control areas that may be managed by AHB for bovine Tb vector control using aerial application of 1080 baits. The operational area is stated to be moderately large (5,241 ha) heavily forested with difficult and/or remote access to parts. The RTCI performance targets for this study were specified as 3% with no individual trap line catching more than four possums (Speedy 2003).

Speedy (2003) concluded that aerial application of 1080 was found to be the most operationally, time and cost effective control method included in the trial. The data reported by Speedy (2003) indicate that the standardised cost for aerial application was determined to be \$26.25/ha (including the cost of the deer repellent used in the trial) compared with \$43.45/ha for bait station application of the 1080 baits. In terms of time taken to complete the aerial operation, aerial application was reported by Epro (2003) to have taken eight days compared with 115 days for bait station application. Monitoring of the sectors treated via bait station application of the baits identified that additional work was required. All sectors treated by both aerial and bait station application were found to have RTCI values below 3% following completion of the operation with no individual trap line catching more than four possums.

Comparative rodent tracking indexing was also undertaken as part of the Epro Ltd (Speedy 2003) study. Speedy (2003) report that post operational rat indices of 0% were determined for both aerial and bait station application of 1080 baits. The other ground based control methods included in the study were determined to be less efficient in terms of post operational rat indices determined.

Porphyre et al (2005) looked at identifying the cause of, solutions to, vector-related Tb persistence near Featherston. The Featherston vector control area is identified by Porphyre et al (2005) as having been under going vector control since 1992. It is stated by Porphyre et al that there is evidence of an ongoing Tb in infection in wildlife both on farmland and in

the surrounding forest area, which is thought to be the major source of infection for herds in the area.

Possum control on farmland and the surrounding bush-pasture margin was carried out on alternate years from 1992 until 1999/00. Control operations are reported by Porphyre et al (2005) to have been carried out on alternate years due to low RTCI values in the area. Since 2000/01 control has been carried out on an annual basis and aerial control operations in the forest parks surrounding the farmland were conducted in 1996 and 2000. Additionally, ferret control operations were also reported by Porphyre et al (2005) to have been carried out for the three year period running from 2001/02 to 2003/04. Porphyre et al (2005) note that the farmland and bush-pasture border control operations appeared to have no significant impact on the incidence of Tb either at a farm level or animal level. Aerial control of the forest park surrounding the farmland area was found to have the most pronounced effect on Tb incidence. It was also noted that the effect of aerial control on Tb incidence levels off after about three years.

### **G3 Future situation**

The applicants have provided forecasts of the areas predicted to be occupied by Tb-infected wildlife in 2015 with and without the continued use of 1080 (see pp 21 and 22 of the application). The Agency requested additional information to clarify how these map forecasts were derived.

The 'without 1080' forecast, the applicants advise, is based on past history that indicates that the quality of ground control able to be undertaken in large areas of bush and forest will be insufficient to maintain a possum density near or below the RTCI of 2%. As noted above, maintenance of a 2% RTCI value or lower is required for the eradication of bovine Tb from the possum population (and wild animal population).

The applicants forecast that in the absence of 1080 application Tb-infected wild animals, particularly possums, will continue to remain as a source of infection for wild and domestic animals. The applicants state that the extent of some of the large areas that will require ground based control methods (for example the Central North Island Hauhungaroa Range, the Puerora Forest and Rangitoto Range) mean they are too expensive to treat by ground based methods given current budgets. As a consequence the total possum population will increase and the absolute number of Tb-infected possums will rise. It is stated by the applicants that this will place pressure on the low density possum buffers surrounding these forested areas that are maintained through ground based control operations resulting in possums and Tb-infected possums leaking through the buffer onto adjacent farmland and through bush corridors to farmland some distance away from the large forested areas. The applicants advise that this pattern of events was observed in the late 1980s when only ground based margin control was carried out in the Central North Island.

Additionally, it is noted by the applicants that in some large areas where Tb-infected possums are currently located in discreet parts (eg, the southern end of Te Urewera National Park, without aerial 1080 application, the Tb infected possums will spread into parts of the large area where they are not currently present. The applicant states that observations in the 1970s and 1980s indicated that Tb-infected possums appear to spread at a rate of 4 km per year—this rate is based on herd breakdown data). Assuming that the observed rates hold, the applicants forecast that the spread of Tb-infected possums north from Te Urewera will reach into the Raukumara Range and possibly Rotorua.

With continued use of aerially applied 1080, the applicants forecast that, given the quality of control and the overall low possum density currently being achieved in large forested areas, Tb will be eradicated from possums and other wild animals in these areas (ie, the RTCI will be maintained below 2% for a minimum of five years). The applicants state that there will be a gradual reduction in the land area containing Tb wild animals; consequently, this will lead to a reduction in the number of infected cattle and deer herds.

The Agency considers that this additional explanation provided by the applicants does not fully detail the basis of the model for the “without 1080” scenario. Nevertheless, some terrain is not amenable to cyanide and trapping and is expected by the Agency to remain a source of Tb-infected possums.

#### **G4 Impact on human health**

The applicants state three benefits to human health and safety pertaining to the continued use of 1080 for the purposes of controlling and eradicating bovine Tb.

- Reduced chance of contracting Tb from close contact with infected animals (herds or feral) resulting in inhalation of contaminated aerosols (H-B1).
- Reduced chance of contracting Tb from consumption of milk and dairy products from infected herds (H-B2).
- Reduced chance of contracting Tb through consumption of meat (farmed or feral) from infected animals (H-B3).

The Ministry of Health (MoH 2002) notes that since 1988, when incidence of Tb infection in humans reached its lowest point, there have been between 300 and 500 cases notified annually. Exposure to cattle, deer, possums and certain animal products is recognised by the Ministry of Health (MoH 2002) as a risk factor for the development of bovine Tb infection in humans. It is noted that around 3% of all human Tb cases are *M. bovis* (MoH 2002); the Agency notes that this equivalent to between 9 and 15 cases per year. The Ministry of Health (MoH 2002) attributes these low rates to herd testing and the widespread pasteurisation of milk.

The Agency notes that Regional Public Health has addressed the issue of human Tb infection in its submission and states that tuberculosis is increasing in importance as a human health issue. However, infection is stated by Regional Public Health to be due to *M. tuberculosis* rather than *M. bovis*. Regional Public Health notes that even if bovine Tb were prevalent in cattle it would not present a real risk to human health. The cases of Tb notified in Wellington are stated to likely be due to reactivation of latent Tb in elderly whose primary infection would have been through drinking unpasteurised milk in their youth.

The applicants' reference Lake et al (2000) and not that no evidence has been found that would implicate foods other than milk in the transmission of bovine Tb to humans. The Agency notes that Lake et al (2000) aimed to estimate the number of cases of infectious disease caused by foodborne pathogens in New Zealand. Lake et al (2000) identified 10 pathogens as particularly important in New Zealand, a list which did not include bovine Tb. The Agency has not identified any evidence that would implicate the consumption of farmed meat in the transmission of bovine Tb to humans.

Taking into consideration that only a very low proportion of human Tb cases are attributed to bovine Tb the Agency considers that the benefits proposed by the applicant, relating to use of 1080 in controlling and eradicating Tb, are insignificant. Additionally, the Agency considers that widespread pasteurisation of milk and herd testing (rather than the control and eradication of the infection in herds) is considered by the Ministry of Health to be responsible for the low rates observed. On this basis, and noting that Regional Public Health considers that if bovine Tb were prevalent among cattle it would not present a real risk to public health, the Agency does not consider that any potential increase incidence of bovine Tb among cattle if 1080 were not used for vector control, would significantly impact on human health.

#### **G5 Views of submitters on possum density as it relates to bovine tuberculosis control**

The Agency notes that many of the submission received on this application addressed the issue of possum control and its implications for bovine Tb control. The Agency notes that submitters are divided, in terms of their opinions, as to whether control of possums is necessary to control bovine Tb.

As noted in an earlier section, several submitters refer to the movement of domestic stock being a bigger risk than contact with wild animals in terms of the transmission of bovine Tb. Additionally, the Agency notes one submitter who identifies poor animal husbandry as a contributing factor to the cause of Tb in dairy herds. Several submitters note that they have not identified Tb in any possums they have killed/trapped or the carcasses of wild animals. One submitter notes that, while Tb infection in herds may be falling at the moment, within the time-frame of 1080 use Tb infection in herds has in recent times increased. The submitter notes that this indicates

that possums may not be the main vector for the infection. The Agency acknowledges that there are other potential methods by which the infection may spread, for example other wildlife (such as cats, ferrets and stoats) and through movement of deer and cattle without adherence to the movement control restrictions. The Agency notes that some submitters identify sheep and pigs as potential sources of infection.

Several submitters state that Tb is found in farmland rather than in forested areas and question the value of large scale operations in forests located away from farmland. One submitter notes that there is no conclusive evidence in literature that bovine Tb infection exists to any extent in the rugged inaccessible areas where the AHB applies 1080 aerially and that intensifying control operations at forest-pasture margins could be more likely to bring about control of cattle bovine Tb infections than a broader blanket approach. The Agency has not identified any studies comparing the efficacy of such an approach with aerial control. The Agency notes however, that Porphyre et al (2005) did identify that aerial application of 1080 into forest surrounding a vector control area was found to have the more significant effect in terms of reducing prevalence of Tb infection amongst cattle than ground control carried out at the forest-pasture margin and on farmland. The Agency also notes that this study does not compare the efficacy of increased intensity of control at the forest-pasture margin with the previous level of control in the area or aerial application. The submitter notes a study (Coleman et al 1999) which looked at determining how deep into the forest possums and deer should be controlled to manage bovine Tb. Forest buffer zones of 1, 3 and 7 km were aerially treated with carrot baits containing 1080. With regard to possums it was noted that in the 3 and 7 km buffer, after four years the possum densities had recovered to 25% and 10% of the pre-control densities respectively. At the 1 km buffer densities were considered to have recovered to unacceptable levels. In terms of Tb prevalence in herds adjacent to the buffers, at 3 km where the density of possums was greatest, 0.23% of herds were found to have lesions, at 7 km the prevalence was reduced to 0.09–0.13%. Coleman et al (1999) conclude that it is unclear whether the slightly greater benefits of increasing the buffer to 7 km are sufficient to warrant the expense of control over the wider area.

Several submitters consider that there is a link between possum control operations and the prevalence of Tb in herds; the Agency notes one submitter who states that they had a positive reactor to bovine Tb on their farm but following ground and aerial control operations on their property and the surrounding national park they see very few possums and have not had another Tb case. Additionally, some submitters note that they support the continued use of aerially applied 1080 as it is an effective tool for possum control. Deer Industry New Zealand advises that the use of 1080 under the bovine Tb National Pest Management Strategy has contributed to the decline in Tb-infected deer herds from 167 in 1996 to 31 in 2006 and consider that if vector control is prematurely slowed or stopped, vectors will repopulate quickly.

On the basis of the submissions received, the Agency considers that there is much division among the New Zealand public as to whether 1080 is a necessary tool in the management of Tb infection in cattle and deer herds. However, it is strongly supported by a number of cattle and deer industry groups.

## **G6 Agency's evaluation of aerial application on possum density as it relates to bovine tuberculosis control**

The Agency considers that the transmission of Tb from wildlife to domestic livestock and the presence of a wildlife reservoir of the infection are well documented in literature. From the review of the literature detailed above and the submissions received on this application, the Agency considers that the relative contributions of possums and other wildlife (particularly ferrets) to Tb infection of cattle and deer herds are not clearly defined at this time. The Agency acknowledges that the spread of Tb between herd animals is also a possibility but considers that adherence to movement restrictions on infected stock should go some way to minimising this risk.

The Agency acknowledges the four objectives of aerial application as detailed in section G.2.2. Based on the available information, as detailed above, the Agency considers that the relevance of these objectives to the control and/or the eradication of Tb in wild animals are generally supported in literature.

With regard to only aerial application being able to achieve these four objectives simultaneously, the Agency has identified very little specific supporting information. The applicants advise that ground control often fails due to the nature of the terrain to be treated and the cost and duration of the operation. The Agency notes that the findings of Speedy (2003) go some way to supporting the importance of aerial application through demonstrating that this control method is more efficacious, in terms of operation duration, cost and the determination via monitoring that the site did not require additional work following the initial control to achieve the target RTCI.

While the findings of Speedy (2003) do support the use of aerial application as the more efficacious control option, the Agency notes that the study was only carried out at one operational site. The Agency has not identified any similar studies carried out elsewhere in New Zealand to which Speedy's (2003) result can be compared. The Agency is therefore unable to comment as to whether the results obtained are representative of findings on a national basis.

Using bait station application of 1080, the target RTCI was achieved in Speedy's study. However, the Agency notes that this target was attained after an operation duration that was 107 days longer than for the aerial application. This indicates to the Agency that ground control would be unable to simultaneously achieve the four objects for aerial operations, on

land where aerial operations would normally be carried out. The Agency specifically notes that possum density reduction did not occur over a short duration and monitoring indicated that a couple of parts of the operational area required further work to meet the RTCI target, this suggests to the Agency that the initial control did not provide uniform reduction.

The applicants forecast a future without 1080 noting that the quality of ground control operations able to be undertaken in large areas of bush and forest will be insufficient to maintain RTCI values below 2% (the level required for Tb eradication). Additionally, the cost of ground control in some larger areas is stated by the applicant as being too expensive given current budgets. Consequently, the applicants predict that in the absence of 1080 (ie, the absence of aerial control methods) possum numbers will increase and Tb infection will persist. The Agency notes that Caley et al (2001) identified a link between Tb prevalence among possums and the carrying capacity of the habitat suggesting to the Agency that if possum numbers increase so will the prevalence of Tb among possum populations.

While Speedy (2003) do provide some support for the importance of aerial application the Agency notes that this study did only cover one site. Similar studies at further sites around New Zealand would be beneficial. On the basis of the information available the Agency has been unable conclusively determine that aerial application is the only method that will simultaneously achieve the four conditions stated to be required for Tb eradication from wildlife. However, given the nature of some of the terrain in New Zealand the Agency considers it is highly plausible that there are some areas that cannot be accessed for ground control operations.

Given the low proportion of human Tb cases that are considered to be due to bovine Tb, and noting that these low rates are attributed by the Ministry of Health (2002) to herd testing and pasteurisation the Agency does not consider that the use of 1080 has a significant impact on human health in terms of maintaining a lower prevalence of herd Tb infection.

The Agency notes that there is extensive literature relating to bovine Tb in New Zealand.