Appendix J: Professor Ross Cullen's Report on the Analysis of Effects on the Market Economy in the Application

A Commentary on Risks, Costs and Benefits, Section 4 in Application for the Reassessment of 1080 under the Hazardous Substances and New Organisms Act 1996

This application for Reassessment of 1080 includes a wide ranging analysis of Risks, Costs and Benefits associated With use of 1080 compared to a situation Without 1080. The effects of use of 1080 have been assessed under the following categories:

- Effects on market economy
- Effects on social and community
- Effects on human health and society
- Effects on environment (soil, water, air) and (animals and plants)

The identification of effects is stated (p.173-174) to have come from a Lifecycle workshop, assessment of submissions received from hui consultation, assessment of submissions received from the public consultation process, literature search and review.

The approach taken in the Application is described p.171 as a qualitative approach, but it might better be described as part quantitative, part qualitative. The Application identifies likely effects (beneficial or harmful) of With 1080 compared to a situation Without use of 1080, then for each effect estimates the magnitude of the effect occurring and the likelihood of the effect occurring. In each case, the product of magnitude and likelihood determine the measure of benefit and disbenefit.

Some comments can be made on the approach taken in the Application. A With versus Without stance is widely advocated and used within Benefit Cost Analysis and seems appropriate to use in this instance. The measurement of effects is completed with reference to a table p.175, which provides five levels of effect for each of: market economy, social and community, human health and safety, Natural Environment - soil water air, Natural Environment - animals and plants. The Table p.175 lists in each cell descriptions of the relevant benefits. These descriptions are specific to this application and other Applications might use different descriptions to describe for example an Extreme beneficial effect on the Market Economy or a Moderate beneficial effect on soil, water, air. Only the Market Economy column quantifies the effects.

The application then introduces a Likelihood table, p.176, that provides qualitative descriptions of events occurring. P.176 uses the Magnitudes labels (Extreme, Major, Moderate, Minor, Minimal) on one axis of a table and the Likelihood labels (highly improbable, improbable, very unlikely etc) on the vertical axis to construct a table of Levels of Effect. Each cell in the table represents a unique product of magnitude of effect and likelihood of effect. Economists often describe these products as Expected Values.

The final step in this part of the Application is to label cells in the Benefits table A, B, C, D, E or F. A or B cells are described (p. 176) as Either insignificant or minor benefit, C or D cells as Benefits are considerable but do not justify high costs or risks, E cells as Great benefit at a regional or local level, or moderate benefits at a national level; may justify cost or risk to realise, F cells as Extreme benefits at a national and local level; warrants cost or risk to realise. These six categories (A, B, C, D, E, F) are clumped into four broad bands A or B, C or D, E, F. The accompanying descriptions in three cases mention both benefits and costs or risks, e.g. E – 'Great benefit at a regional or local level, or moderate benefits at a national level; may justify costs or risk to realise'

This final step introduces an unusual element to the Application, the comparison of individual benefits from an effect, to possible risks or costs. There is no obvious rationale for this approach, and a more commonly used approach in Benefit Cost Analysis is to estimate all of the beneficial effects of a project or programme, and to sum them. The summed beneficial effects can then be compared to the sum of expected costs or total adverse effects of a project or programme.

The report follows some similar steps in explaining how magnitude of Adverse Effects /Risks are assessed, as outlined in the tables p.177-178. Five levels of magnitude are used with labels, Extreme, Major, Moderate, Minor, Minimal. Corresponding to these labels are descriptions of adverse effects under five headings: market economy, social and community, human health and safety, Natural Environment - soil water air, Natural Environment - animals and plants. The descriptions in the cells of table contain three statements in each of the Market Economy cells, two statements in the Social and Community cells, one statement in the Human health and safety cells, up to five statements in the Natural Environment cells.

The next step is to explain the seven Likelihood labels used (p.178) which are identical to those used when assessing benefits. The two components, magnitude and likelihood are used to develop a table titled Levels of Risk Matrix. This table shows magnitude x likelihood and might be better described as expected value of adverse effects. Cells in the table (Level of Risk Matrix) are labelled A, B, C, D, E, or F with the most improbable and smallest cost effects labelled A, and the most likely and costly effects labelled F. Labelling of these cells is non-symmetric – there are more D, E and F labels associated with higher likelihood effects. That action is designed to impart a conservative emphasis to assessment of adverse effects. Finally the six categories (A, B, C, D, E, F) are clumped into four broad bands, A or B, C or D, E, F and brief statements provided describing each broad band, e.g. C or D - 'Risks within the ALARP band (As Low as Reasonably Practicable) and broadly classed as tolerable subject to ongoing monitoring and control.'

In summary, a disaggregated approach to assessment is proposed. The approach to assessment of benefits uses estimated magnitude x estimated likelihood. These are part quantitative part qualitative. The summary statements about benefit p.176, mention benefits and costs or risk. The approach to assessment of adverse effects/risks uses estimated magnitude x estimated likelihood. These are part quantitative part qualitative. The summary statements (p.178, table lower right) are called 'risk' rather than adverse effects.

With versus Without Scenarios

The assumptions made when developing the With 1080 situation versus the Without 1080 situation are listed pp.39-40, 46-47. These assumptions are critical factors influencing the outcomes expected to occur in the With and Without situations and include factors such as the cost per hectare of control operations, efficiencies and effectiveness of control methods, areas treated annually by AHB and DOC given a specific annual budget. The economic case for use of 1080 is largely based upon the assertion that aerial pest control is lower cost and more effective than is ground pest control and can be used to manage large and rugged areas. Surprisingly, given the importance of these items, no references are cited in support of those assertions. Statements in the Application include the following:

> 'A more common range is 2-4 times more expensive than ground control while the value that occurs most frequently (median value) [sic] is x3. This is the multiplier used by DOC when estimating the costs of having to control pests without the user of 1080. The AHB estimates that a multiplier of x2 is appropriate for comparing aerial costs with more expensive ground control on 'easy country' for Tb control and a x4 multiplier applies for ground control on 'difficult country.' (Application, p.12, and see also pp. 39, 46.)

Some of the references pp. 377-378 provide information on the costs imposed by pests in New Zealand. But there are no references cited between pp 1-68 which describe: Pest Control in New Zealand; Context: Pest Control Scenarios; Context: Case Studies. The lack of reference to peer reviewed studies or any type of study of these issues is in very sharp contrast to the numerous references on hazards, environmental effects, health effects, cited pp. 116-125, 205-206, 220, 361-369. This may indicate Applicant's unfamiliarity with the literature as well as imbalance in research funding on pest control costs and benefits. The lack of documented support for statements made about the relative: cost, effectiveness and feasibility of controlling large areas, on rugged terrain, (using aerial 1080, ground control with 1080, with other toxins, with traps), is surprising as research has been completed in New Zealand on pest control costs, and effectiveness of control methods. See for example Cullen, Kerr and Warburton (1996), Cullen and Bicknell (2000), Ross (2004).

Cullen and Bicknell (2000), Table 18.1 provides indicative costs for various possum control situations and methods. Three rows from that table are included below:

Type of operation	**area (ha)**	**% reduction**	**approximate cost 1998 $ /ha**
Knockdown, aerial 1080 cereal baits, 10 sites, 1990-93, overhead costs excluded	6473	76	22.60
Knockdown, ground hunting, 2 sites, 1997, direct costs. Inclusive of monitoring costs	2059	83	22.40 31.30
Knockdown, aerial 1080, 2 sites, 1997, direct costs. Inclusive of monitoring costs	5073	78	23.00 31.00

The data indicate that knockdown (initial) possum control during the 1990s could be completed at similar cost by aerial and ground methods. Cullen and Bicknell (2000, p.201) comment that aerial application ... 'is much less limited by location, total area to be managed, or steepness of terrain.'

Ross (2004) studies the costs of aerial and ground based control over a ten year time period, using a 10 percent discount rate, and including consent costs. Ross (2004) notes that 1080 aerial control is the most cost effective control strategy for achieving a sustained 80% population reduction over a ten year period. The present value of costs for five different control strategies are provided in Ross (2004, Table 6).

Control Strategy	**Strategy**	**Cost/ha**
1080 aerial with consent costs	3-yearly control	$59
1080 aerial with '*worse-case*' costs	3-yearly control	$69
Contractor's choice with consent costs	2-yearly control	$129
1080 bait stations with consent costs	2-yearly control	$155
Feratox® & trapping with consent costs	2-yearly control	$156
Feracol® with consent costs	8 years of control	$209

The greater cost effectiveness of aerial 1080 derives from its lower costs per hectare and its greater efficacy in killing possums. Contractor's choice (Feratox® and trapping) is twice as costly per hectare as aerial 1080 over a ten year period for a sustained pest population reduction.

Estimation of benefits and adverse effects.

The Application states p. ES-1 ...

> 'This application brings together 40 years of extensive field and laboratory research in the use and effects of 1080. It has assessed the risks, costs and benefits within the framework of the HSNO Act using the precautionary principle.'

The Application may bring together research on toxicology, environmental effects, health effects of 1080 but it fails to demonstrate evidence of or understanding of economic research on use of 1080, pest control, or Tb. It is reasonable to comment that this section of the Application is unsophisticated, uses crude approaches to estimate even the largest benefits and costs associated with use of 1080, lacks awareness of many pertinent economic research techniques, seems unaware of almost all relevant economic research, and cites a total of three publications focusing on economic aspects of pest control (pp.377-378). Given the importance the HSNO Act s.6 (e) attaches to identifying and considering benefits and costs the Application is amateurish in the way it addresses those issues. Four decades of field and laboratory research on toxicology, health effects, and environmental effects of 1080 need to be complemented by sophisticated, high quality economic research to ensure that informed decisions can be reached on the merits of continued use of 1080. The Application, regrettably, does not provide quality economic analysis and fails to cite existing relevant economic research.

Section 4.1a Effects on the market economy

The Application p.181 lists some key points about the methods used to estimate benefits and costs (adverse effects). The effects are based on a With versus Without comparison. The time period considered is approximately 10 years (2006-2015). It is important to note that the Application does not state whether the dollar values used in this section, for example value of cattle slaughtered, are revenue or revenue minus direct costs (gross margins). The Application makes no mention of possible impacts of inflation on values used in this or other sections or the importance of making all dollar values comparable by inflating e.g. 1990 dollars to make them comparable to 2006 dollars. It does not comment on why there is no attempt to estimate present values for a stream of benefits over a ten year period.

M-B1 Increase in income from meat production animals

The value of cattle, $783.58 per head and $242 per head for deer are overly generous values for the benefit of reduced slaughtering as a result of fewer Tb reactor herds as there is no recognition of costs associated with farming those cattle or deer. A more appropriate figure would be the change in farm surplus on reactor herd farms because of the reduced number of cattle and deer slaughtered.

M-B2 Increase in production from dairy animals

A similar comment is warranted on the dollar value used for an increase in production from dairy animals. The figure of $1090 per cow is likely to overstate the change in profitability of the dairy farms as a result of fewer reactor dairy cows.

M-B4 Removal or relaxation of restrictions on livestock movements.

A reduction in numbers of herds that will face movement controls is argued to be extremely likely. The approach used to estimate the benefit flowing from this is to multiply the reduced number of effected herds (180) by a range of possible financial burden incurred by effected farms ($30,000- $200,000) x 10 years. This produces a range from $54 million - $360 million of benefits attributed to better Tb control because of an ability to use 1080. This range $54 million - $360 million is listed as a Major benefit (falls within the range $100-$500 million).

Given the importance of this benefit more sophisticated modelling to obtain a better estimate of its expected value is warranted. Attention could focus on the likelihood of the reduction in movement control herds occurring, and on the impacts movement control has on farm profitability (likely to be smaller than the impact on farm revenue). The case for the values used in the Application for these two items are not well documented.

M-B5 Reduced competition for grazing from pests

Calculation of this benefit over ten years of $230 million, is partly based on the value of sheep $55 per head, and the number of sheep displaced by rabbits (assumed to be two million). This is a crude approach at benefit estimation and likely to overestimate the benefit. An alternative approach would be to model a representative sheep farm to estimate the change in farm profitability that occurs from pests displacing sheep and use that figure to estimate the benefit at a national level from reduced grazing competition.

The estimate of the benefit from reduced stock displacement by possums of $12 million per annum arrises from a 1990 estimate of numbers of possums at the bush/pasture margin and the pasture they eat. No evidence is provided in the Application that a current estimate of possum numbers, and amount of pasture they graze has been obtained, and their current and projected effects on farm profitability have been estimated.

Greer (2006) provides information on these issues and concludes that in Hawkes Bay at 2005 prices, average production foregone due to the presence of possums at current population density is valued at $2.26 per hectare.

M-B7 Reduced cost to the agricultural sector and government associated with vector control

The Application notes that reductions in vector control costs are expected (Extremely Likely) to occur over the next twenty years in the With 1080 case versus the Without 1080 case. The Application states this will provide a Moderate benefit (dollar benefit between $50 and $100 million). However the data p.375, indicates the cost savings are expected to increase from $0 in 2005 to reach $11.6 million in 2014/2015. The likelihood of this occurring is less that 1.0. The mean cost saving per annum over the decade may be less than $5 million. The total cost saving over the decade may be less than $50 million.

M-B8 Reduced likelihood of formal restrictions on access to export markets for beef, venison, and dairy products.

The Application states the magnitude of the effect (due to lower levels of Tb) is assessed as Major ($100 -$500 million), but provides no supporting calculations for this assessment and cites no research on the effects of market access restrictions on beef, venison or dairy prices. The possible impacts of trade restrictions on New Zealand exports have been considered by other authors including Clough and Nixon (2000, p12), who conclude … 'the chance of New Zealand facing a ban simultaneously in our major markets is very small. So small in fact that it is almost non existent.'

Economic research on the impact of trade restrictions on New Zealand, and their links to environmental policies and their effects, have been examined in several New Zealand studies including Rae and Strutt (2001), Saunders, Cagatay and Wreford (2003), Saunders, Wreford and Cagatay (2006). The Application seems completely unaware of the range of economic techniques available to provide sophisticated, defensible estimates of the likely effects of trade restrictions.

M-B10 Decreased likelihood of loss of markets due to market perceptions of New Zealand's Tb status.

Dairy and beef exports are about $8 billion per annum. Exports go to over 90 countries. Loss of export markets due to New Zealand's Tb status is a possibility, but the likelihood of that occurring is uncertain. The Application states that it is Extremely Likely there will be decrease in likelihood of loss of markets With 1080 versus Without 1080. That is plausible, but it may be reduction in annual likelihood of loss of market from e.g. 2% annual probability to 1% annual probability.

If there is a loss of a market, how large will the dollar loss be? The Application states, p.377 … 'some or all export dollars from this source could be lost.' The Application concludes this represents a Major effect ($100-$500 million). There is not enough information provided in the Application to draw such a strong conclusion. It is highly improbable that all New Zealand dairy and beef export dollars would be lost because of loss of one or more markets. No research is cited in the Application that studies the dollar losses occurring from loss of one or more export markets. Clough and Nixon (2000) have commented on this issue and note that AHB (undated) argued the potential trade loss from sanctions against New Zealand exports due to Tb amount to $1.29 billion per trade ban incident, with a 2% risk of occurrence per year. The Application does not cite

Clough and Nixon (2000) who conclude p.iii, a trade ban would be difficult to sustain under current international trade rules, the risk is very small and the expected value of an avoided trade ban is modest.

M-B13 Benefits for Tourism as a result of maintenance of healthy forest habitat and native biodiversity

It seems plausible that many tourists will become aware of damage to forest habitat and biodiversity during visits to New Zealand. Dieback of forest canopy is readily visible in some areas and the comparative absence of New Zealand fauna is striking in many regions. The potential dollar benefit to New Zealand from tourism are not indicated accurately in the Application. The statement, p.191 ... 'some examples of where this money may be earned for tourism by New Zealand natural values' is simplistic. The dollar values reported in the examples are estimates of consumer surplus to tourists, not net benefits of tourism to New Zealand.

The paragraph immediately following those examples p.191, illustrates a reasonable approach to estimate this effect, but which needs some research. This effect could become large if New Zealand fails to maintain healthy forests and native biodiversity.

M-B14 Benefits to aspects of New Zealand economy which benefit from ecosystem services in general.

The total value of ecosystem services may be large, but the concern is with *changes* in values of ecosystem services. Pest control With 1080 is likely to protect more ecosystem services than will Without 1080. There is uncertainty over the magnitude of the biophysical effect, and lack of information on the value of effect. A conservative stance has been taken in the Application in this case.

M-B15 Reduced costs from erosion and flood damage

Our lack of knowledge over these effects makes assessment of them fraught. A conservative approach is reasonable.

M-A5 Negative impact on domestic and international markets due to market perceptions of the use of toxins.

The key item in this effect is perception of the use of toxins in the With 1080 scenario versus the Without 1080 scenario. The Application states it is improbable there will be a negative perception impacting on domestic and international market values of New Zealand produce. Improbable is defined p.178, as ... 'only occurring in very exceptional circumstances.' The Application p.200 states that ... 'Currently the New Zealand Food Safety Authority reports that none of our trading partners are concerned about the use of 1080 in New Zealand (Jolly 2005).' Use of the word 'currently' suggests that at another time one of our trading partners, or domestic consumers might be concerned about the use of 1080. The likelihood of concern arising may be considerably greater than indicated by 'Improbable.'

M-A9 Negative perceptions of large scale aerial application of pesticide and impact on tourist spending.

Perception is a key factor in this case, but here the Application p.201, states it is Likely that there will be negative perceptions influencing consumer spending on tourism. The magnitude of the effect is assessed as Minimal. It does seem likely that views of tourists (domestic and international) will be polarised on use of toxins in New Zealand and research is warranted on this topic.

M-A11 Negative impact on recreational hunting activity from by-kill and associated loss of business activity and commercial opportunities.

The likelihood of this occurring is assessed as Very Unlikely (only occurring in very unusual circumstances). However the Application p.3 indicates that deer numbers can be impacted by use of 1080. There are some well known instances where deer in popular recreational hunting areas have been killed by 1080 (see Nugent and Yockney, 2004, and references in that paper). Hence Very unlikely seems too sanguine an assessment of likelihood.

The magnitude of this effect is understated by the statement p.203, that ... 'the recreational hunting industry has been valued at $14 per day or $180-240 per animal shot (Nugent and Henderson 1990).' More recent research could have been sought to determine the magnitude of this effect in 2006 dollars.

Effects on Social and Community.

Several of the effects considered in this part of the Application including S-B1, S-B2, S-B 4, lack evidence about the magnitude of the effects. No evidence is provided in the Application to show there has been a search for literature to remedy that defect.
The references pp. 383-384 include at most one social science reference. A New Zealand social science reference is found p.377, but is not referred to in Effects on Social and Community.

The statement p.380 ... 'there is no research that specifically links the enjoyment of recreational activities with the maintenance of healthy forest habitat and biodiversity' indicates the Applicant's unfamiliarity with social science research. Kerr and Cullen (1995) study public preferences for allocation of a possum control budget and report that willingness to pay for possum control at a site (Paparoa National Park) is a function of site characteristics including rarity and vulnerability of species, recreation opportunities. Mortimer, Sharp and Craig (1996) report that preservation of endangered species was considered the most important reason for conserving offshore islands and recreation was the fourth most important reason for preservation.

References

Animal Health Board, (undated). Towards a Tb free New Zealand. Animal Health Board, Wellington.

Clough, P. and Nixon, C. (2000). Coughing up for bovine Tb control. Treasury Working Paper 00/24. The Treasury, Wellington.

Cullen, R, Kerr, G.N. and Warburton, B. (1996). Costs and benefits of control programmes for an introduced herbivore. In, Mountains of East Asia and the Pacific. In (ed) M.M. Ralston, K.F.D. Hughey, K.F. O'Connor, Lincoln University. 189-198.

Cullen, R. and Bicknell, K.B., (2000). Possum management, an economic analysis. In (ed) T. Montague, Possums in New Zealand: The biology, impact and management of an introduced marsupial. Manaaki Whenua Press, Lincoln. 198-207.

Greer, G. (20006). The economic benefits of the possum control area programme. AERU Research Report No. 282. Lincoln University.

Kerr, G.N. and Cullen, R. (1995). Public preferences and efficient allocation of a possum control budget. Journal of Environmental Management, 43; 1-5.

Mortimer, R.J., Sharp, B.M.H. and Craig, J. (1996) Assessing the conservation value of New Zealand's offshore islands. Conservation Biology 10(1): 25-29.

Nugent, G. and Yockney, I. (2004). Fallow deer deaths during aerial-1080 poisoning of possums in the Blue Mountains, Otago, New Zealand Journal of Zoology, 31, 185-192.

Rae, A.N. and Strutt, A. (2001). Livestock production and the environment: some impacts of growth and trade liberalisation. New Zealand Economic Papers, 35, 176-194.

Ross, J. (2004). A modelling comparison of the cost effectiveness of aerial and ground- based control operations for initial and maintenance control of possums (*Trichosurus vulpecula*), Landsdown Ventures Ltd, Christchurch.

Saunders, C., Wreford, A, and Cagatay. S. (2003). Lincoln Trade and Environment Model (LTEM): Linking trade and environment. AERU Research Report no. 263, Lincoln University.

Saunders, C., Cagatay, S. and Wreford, A. (2006). Trade liberalisation and greenhouse gas emissions: the case of dairying in the European Union and New Zealand. Australian Journal of Agricultural and Resource Economics, 50(4), 538-555.