ENVIRONMENTAL RISK MANAGEMENT AUTHORITY
NGĀ KAIWHAKATŪPATO WHAKARARU TAIAO

ERMA New Zealand

FORM HS1

Application for approval to

IMPORT OR MANUFACTURE ANY HAZARDOUS SUBSTANCE FOR RELEASE

under section 28 of the Hazardous Substances and New Organisms Act 1996

Name of Substances:

ESN containing sodium nitrite at 950 g/kg
Bait containing sodium nitrite at 100g/kg

Applicant: **Connovation Ltd**

Office use only

Application Code: ☐☐☐☐☐☐☐☐ Date received:____/____/____

ERMA NZ Contact: _____ Initial Fees Paid: $

Application Version No: _____.

Section One – Applicant Details

1.1 Name and postal address in New Zealand of the organisation making the application:

Name: Connovation Limited
Address: PO Box 58 613,
Botany
Manukau City 2163
Phone: 09 273 4333
Fax: 09 273 4334

1.2 The applicant's location address in New Zealand (if different from above):

Address: 36B Sir Williams Avenue,
East Tamaki,
Auckland

1.3 Name of the contact person for the application:

Name: Jeanette Drysdale
Position: Registration Consultant
Address: PO Box 72 275, Papakura 2244
Phone: 09 299 9435
Fax: 09 299 6434
Email: drysdale_ja@xtra.co.nz

Section Two – Application Type and Related Approvals Required

2.1 Is the information in this application relevant to import, manufacture or both:

- Import only? No
- Manufacture only? No
- Import and manufacture? **Yes**
- If import only, indicate whether or not manufacture is likely in New Zealand N/A

2.2 If the information in the application relates to manufacture in New Zealand, provide information on the proposed manufacturing process and any alternatives.

The active ingredient sodium nitrite will be imported and used to manufacture ESN, a substance containing 950g/kg sodium nitrite. The ESN will then be used to manufacture the bait containing sodium nitrite to a concentration of 100g/kg. The details of the composition of the substances and the manufacturing processes are provided in the *Confidential Appendices 1 & 2*.

2.3 If you have reasons for not providing detailed information in this application, explain what they are and provide some justification.

N/A

2.4 If this substance(s) needs an approval under any other legislation, has an application for this approval been made? (Optional)

Name of Approval	Application made
Agricultural Compounds and Veterinary Medicines Act 1997	Yes
Food Act 1981	N/A
Medicines Act 1981	N/A
Chemical Weapons (Prohibition) Act 1996	N/A
Radiation Protection Act 1965	N/A
Biosecurity Act 1993	N/A
Resource Management Act 1991	N/A
Other (please specify):	

Section Three – Information on the Substance(s)

3.1 State the unequivocal identification of the substance.

Active ingredient

Common name:	Sodium nitrite
Chemical name:	Nitrous acid, sodium salt
CAS No:	7632-00-0
Formula:	H-N-O_2.Na
Molecular weight:	69
Appearance:	White to slightly yellow powder, granules, crystals
Melting point:	271 ^{0}C
Decomposition temperature:	>320 ^{0}C
Density:	2.17
Solubility in water:	84.8 g/100ml @ 25 ^{0}C
pH:	~ 9 (in aqueous solution)

Reference: Hazardous Substances Data Bank (HSDB)

3.2 Provide information on the chemical and physical properties of the substance.

Table 1: Physical and chemical properties of substances

Property	**ESN containing sodium nitrite at 950 g/kg**	**Bait containing sodium nitrite at 100 g/kg**
Form	Powder	Paste
Colour	Slightly yellow	Green
Density	1.17	1.25
Solubility in water	Soluble	Not applicable
pH	7.35	Not applicable

Reference: Confidential Appendix 1

3.3 Provide information on the hazardous properties of the substance.

Sodium nitrite is listed as an approved substance [HSR001286] on the ERMA Register.
The hazardous classifications for sodium nitrite are 5.1.1C (oxidiser), 6.1C (oral), 6.4A, 6.6B, 6.9B (oral), 9.1A (fish), 9.1D (crustacean) and 9.3B.
Reference: ERMA

The hazardous classifications for the ESN and the bait containing sodium nitrite at 100 g/kg have been determined using the mixture classification rules (*Confidential Appendix 3)*. None of the other components in the ESN or Bait containing sodium nitrite at 100g/kg are identified as hazardous and contributing to the overall hazardous classifications of the substances. The hazardous classifications summarised in Table 2, are triggered by the sodium nitrite alone.

Table 2: Summary of the hazardous classifications for the ESN and the Bait containing sodium nitrite

Hazardous class	**ESN containing sodium nitrite at 950 g/kg**	**Bait containing sodium nitrite at 100 g/kg**
Class 1: Explosiveness	Not triggered	Not triggered
Class 3: Flammability	Not triggered	Not triggered
Class 5: Oxidizing properties	5.1.1C	Not triggered
Class 6: Toxicity **Sub class 6.1 Acute toxicity**	6.1C (oral)	6.1D (oral)
Sub class 6.3 Skin irritation	Not triggered	Not triggered

Hazardous class	ESN containing sodium nitrite at 950 g/kg	Bait containing sodium nitrite at 100 g/kg
Sub class 6.4 Eye irritation	6.4A	6.4A
Sub class 6.5 Sensitisation	Not triggered	Not triggered
Sub class 6.6 Mutagenicity	6.6B	6.6B
Sub class 6.7 Carcinogenicity	Not triggered	Not triggered
Sub class 6.8 Reproductive/ Developmental toxicity	Not triggered	Not triggered
Sub class 6.9 Target organs/systems	6.9B	6.9B
Class 8 :Corrosiveness Sub class 8.1 Metals	Not triggered	Not triggered
Sub class 8.2 Skin corrosiveness	Not triggered	Not triggered
Sub class 8.3 Eye corrosiveness	Not triggered	Not triggered
Class 9: Ecotoxicity Sub class 9.1 Aquatic	9.1A	9.1B
Sub class 9.2 Soil environment	Not triggered	Not triggered
Sub class 9.3 Terrestrial vertebrates	9.3B	9.3C

Hazardous class	ESN containing sodium nitrite at 950 g/kg	Bait containing sodium nitrite at 100 g/kg
Sub class 9.4 Terrestrial invertebrates	Not triggered	Not triggered

: Confidential Appendix 3

3.4 Identification of the default Controls on the substances.

The Default Controls triggered by the hazardous classifications for the ESN and the Bait containing sodium nitrite at 100 g/kg have been summarised in Tables 3 and 4 respectively.

The 5.1.1, 6.1C and 9.1A classifications for the ESN trigger the controls for Tracking and for an Approved Handler. However the Bait containing sodium nitrite at 100 g/kg does not trigger these controls.

Table 3: Default Controls triggered the ESN

Class	Hazardous Classification	Default controls
Oxidiser	5.1.1C	O1,O2,O3,O4, 05,O6,O7,O8,09,O10,O11
Class 5		I1,I7,I9,I15,I19,I21,I27,I29
		P1,P3,P11,PG3
		D3,D6,D7,D8
		EM1,EM5,EM8,EMP,EM10,EM11,EM12,EM13
		AH1
Acute Toxicity	6.1C (oral)	T1, T2, T3, T4, T5 T6, T7, T8
Subclass 6.1	6.4A	I1, I8, I9, I16, I17, I18, I19, I20, I21, I28, I29, I30
	6.6B	P1, P3, P13 , PG3
	6.9B	D4, D6, D7, D8
		EM1, EM6, EM8, EM11, EM12, EM13
		TR1
		AH1
Aquatic	9.1A	E1, E2, E5,E6, E7,E8
Ecotoxicity		I1, I3, I9, I11, I19, I21, I23, I29
Subclass 9.1		P1, P3, P15 , PG3
		D5, D6, D7, D8
		EM1, EM7, EM8, EM11, EM12, EM13
		TR1
		AH1
Terrestrial	9.3B	E1, E2, E4, E6, E8
vertebrates		I1, I3, I9, I11, I19, I21, I23, I29
Subclass 9.3		P1, P3, P15, PG3

Class	Hazardous Classification	Default controls
		D5, D6, D7, D8
		EM1, EM7, EM8, EM13

Table 4: Default Controls triggered for the Bait containing sodium nitrite at 100 g/kg

Class	Hazardous Classification	Default controls
Acute Toxicity	6.1D (oral)	T1, T2, T4, T7, T8
Subclass 6.1	6.4A	I1, I8, I9, I16, I17, I18, I19,I20, I21, I28, I29, I30
	6.6B	P1, P3, P13
	6.9B	D4, D6, D7, D8
		EM1, EM6, EM8, EM11, EM12, EM13
Terrestrial	9.1B	E1, E2, E4, E6, E8
vertebrates	9.3C	I1, I3, I9, I11, I19, I21, I23, I29
Subclass 9.3		P1, P3, P15, PG3
		D5, D6, D7, D8
		EM1, EM7, EM8, EM13

3.5 Provide information on what will happen to the substance throughout its whole life from its introduction into New Zealand, its uses, through to disposal.

Importation

The active ingredient sodium nitrite is to be imported into New Zealand packaged as 25 kg quantities in plastic bags within a multi-layer paper bag. The material would arrive as sea freight and then be transported by road to the manufacturing site.

Manufacture

The sodium nitrite will be stored under lock and key in a Dangerous Goods Store separate from incompatible materials. The manufacturing site has procedures and personnel in place to handle substances that require an Approved Handler and Tracking (*Confidential Appendix 2*).

The sodium nitrite is then reprocessed to manufacture the ESN. The manufacture of the ESN is described in *Confidential Appendix 2*. The ESN if not used immediately will be stored in a plastic bag within a HDPE pail fitted with press on lid.

The ESN is then used as a raw material to manufacture the bait containing sodium nitrite at 100 g/kg. The manufacture of the bait product is described in *Confidential Appendix 2* and will be at the applicant's manufacturing facility.

The bait is to be packaged in up to 20 kg quantities in white HDPE pails fitted with press on tamper evident lids. Pails would be labelled (*Confidential Appendix 4*) and stored securely at the manufacturing facility until dispatch and subsequent use. If smaller pails are used, e.g. 2.5, 5 or 10 kg, these could be packed into secondary packaging (cardboard boxes) before dispatch off-site. Packaging for the bait will be compliant with Packing Group III requirements.

Identification

Labels and Safety Data Sheets would be available (*Confidential Appendices 4 & 5).* The labels and SDS's will identify the hazard statements, precaution phrases and provide advice for First Aid response, Storage, Disposal and Use of the substances. Appropriate hazard pictograms will also be used.

Transport

An appropriate shipping description for the ESN is UN NO. 3077, OXIDISING SOLID, TOXIC, N.O.S (SODIUM NITRITE), Class 5.1.1C, Sub class 6.1, Packing Group III.

The bait containing sodium nitrite at 100 g/kg would be transported as UN NO. 3077, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID (CONTAINS SODIUM NITRITE), Class 9, Packing Group III.

The substances when transported within New Zealand would be required to comply with NZS 5433; 2007, Transport of Dangerous Goods on Land. Within NZ, transportation could be rail or road or via ship (across Cook Strait).

Storage

The ESN will be stored in a Dangerous Goods Store in compliance with the Hazardous Substances (Packing) Regulations 2001, Hazardous Substances (Identification) Regulations 2001, Hazardous Substances (Tracking) Regulations 2001 and Hazardous Substances (Emergency Management) Regulations 2001.

The Bait containing sodium nitrite at 100 g/kg while not requiring to be 'locked up' (no Approved Handler control triggered) would be stored in secure storage at the manufacturing site.
Once this ready-to-use bait is dispatched to the end-user, storage would be as applicable to the substance hazardous classifications (refer Table 2) and as described on the product label (*Confidential Appendix 4*).

Use

The ESN is intended to be used as a raw material and the Bait is in a ready-to-use form as a Vertebrate Toxic Agent (VTA). The bait containing sodium nitrite at 100 g/kg has been demonstrated as being effective for the control of possums and feral pigs (*Confidential Appendices 6 & 7*).

Possums
Standard ground baiting methods would be used for possums. Bait stations for possums, as an example, would be laid in a grid of approximately 80 per 100 hectares and set up at 100 m intervals on lines paced 150 m apart in areas where vegetation is sparse and 100 m apart in areas of thicker scrub. Pre-feeding with non-toxic bait in the bait stations would be used. This would involve the placement of approximately 200 g of non-toxic paste bait in each station. Pre-feed baiting would typically be carried out three times a week for two to three weeks before toxic baiting. Then the toxic bait (sodium nitrite at 100g/kg) , in quantities of 100 -200 g of bait dependent on the density of possums present, would be placed in each bait station and toxic bait "take" checked and replenished if needed.

Feral pigs
All bait placement, toxic and non toxic, would be carried out using bait boxes, with secure lids that feral pigs are strong enough to lift with their snouts. The lids will be strong and heavy enough to restrict non-target access to bait. A hinged lid would be used with a stake behind the hinges that allowed lids to open but ensure it shuts. Bait boxes would be set up in specific areas where pigs need to be controlled. Boxes would initially be baited with non-toxic bait, which has been shown to be palatable to pigs. Non – toxic baits each weighing approximately 250 g, would be placed in the boxes over several nights prior to placement of the toxic bait. Toxic baits, 5-10 x 250 g each would be placed in each bait box.

Pre-feeding with a non-toxic feed is carried out to confirm the presence of target species before the toxic bait is used. This pre-feeding also provides an opportunity to make observations of any non-target species that might be in the area.

All pest control operations will comply with the Hazardous Substances (Class 6) Regulations 2001, Hazardous Substances (Identification) Regulations 2001, Hazardous Substances (Emergency Management) Regulations 2001, Hazardous Substances (Tracking) Regulations 2001 and any applicable Hazardous Substances (Personnel Qualification) Regulations 2001. In addition, any further controls set under the ACVM Act 1997 for VTA's and if applicable within resource consent, issued under the Resource Management Act, will be followed.

The most likely non-HSNO controls (under ACVM Act 1997) for use of sodium nitrite as a VTA are:

2. *The product must be manufactured in accordance with ACVM Standard for Good Manufacturing Practice and to the chemistry and manufacturing specifications provided by the registrant and approved as part of the registration.*
4. *The product must only be sold or imported according to the current registration.*
31. *This product must only be used as specified in the label content.*
37. *Ongoing obligations:*

    The registrant must provide an annual summary of adverse events to the ACVM Group. Adverse events which have serious implications for the continued use of the product must be notified immediately.

    The registrant must also advise the ACVM Group of any new studies or data that contradicts information previously supplied.
51. *Vertebrate Toxic Agents: In addition to any labelling, advertising or promotion requirements specified in the current registration, labelling, advertising or promotion of the product must comply with the current ACVM - New Zealand Labelling and Advertising Guide for Vertebrate Toxic Agents Requiring Registration.*

Disposal

Any waste from the manufacturing process would be disposed of through an approved hazardous waste management company by incineration (in an approved facility) or by burying in a biologically active landfill.

The VTA bait would be recommended to be disposed of by burying or by incineration. If burying bait, recommended best practice is to bury at a 60 cm depth in biologically active soil.

No specific provision for the recovery of dead carcasses of target pests (e.g. possums, feral pigs) is considered necessary as the residual levels of sodium nitrite in animals are expected to be small.

Section Four: Risks, Costs and Benefits

4.1 Identify all of the potential risks, costs and benefits of the substance(s)

4.1.1 Risks

The risk identification assessment has focused on:

- Potential risks that arise from planned use;
- Potential risks that arise when the controls fail; and
- Potential risks that arise from unforeseen and unplanned events.

The risks were identified using the ERMA guidance notes, knowledge from previous applications for VTA's and taking into consideration the applicant's experience in the use of existing VTA's. Potential risk events and exposure at all stages of the lifecycle for the substances was prepared and are summarised in Table 5. The magnitude of the risks identified and the effectiveness of controls to mitigate these risks will be discussed in section 4.1.

Table 5: Identification of possible events, exposure pathways and the lifecycle stage for the substances

M=Manufacture, T=Transport, S=Storage, U=Use, D=Disposal

Event	Risk pathway	Lifecycle stage
Accidental discharge into the air	Packaging damage	M, T, S
	Traffic accident	T
	Fire	M, T, S
	Safety precautions not followed	T, S, U, D
	Worker exposure	M, T, S, U, D
	Public exposure	T,S,U, D
	Spillage	M, T, S, U, D
Deliberate discharge into the air	Vandalism	T,S,U
	Eco-terrorism	T,S,U
Accidental discharge to land (soil)	Packaging damage	M,T,S,U,D
	Traffic accident	T
	Fire	M, T, S
	Safety precautions and use instructions not followed	M, T, S, U, D
	Bait not recovered after VTA operation completed	U
	Incorrect disposal	D
	Toxic bait misplaced	T, S, U, D
Deliberate discharge to land	Vandalism	T,S,U
	Eco-terrorism	T,S,U
Accidental discharge to water	Fire	M, T, S

Event	Risk pathway	Lifecycle stage
	Packaging damage	M, T, S, U, D
	Traffic accident	T
	Safety precautions and use instructions not followed	M, T, S, U, D
	Bait not recovered after VTA operation completed	U
	Incorrect disposal	D
		T, S, U
Deliberate discharge to water	Vandalism	T, S, U
	Eco-terrorism	T, S, U
Risks in relation to use (as VTA) on land	Safety precautions and use directions not followed	U
	Wrong area controlled	U
	Humans eat toxic bait	U
	Domestic animals scavenge carcasses	U
	Non-target species mortality	U
Entry into waterways or human water supply	Traffic accident	T
	Safety precautions and use directions not followed	U
	Poisoned carcasses in waterway	U
	Deliberate - Eco-terrorism	T, S, U
Entry into food chain	Dead carcasses collected/used for food	U
	Dead non-target species collected for food	U
	Spillage into water/cropped or farmed areas	U
	Contamination of food stuffs	U
	Deliberate - Eco-terrorism	U

Additional comment to the possible risk events given in Table 5 have been considered under the headings of:

- Primary exposure
- Secondary exposure
- Manufacturing
- Transport & storage
- Application
- Use as VTA
- Disposal
- Post-application

4.1.1.1 Primary exposure

This section summarises the potential risk to humans, other animals or birds directly ingesting or contacting the substances.

Humans

Sodium nitrite toxicity is attributed to the induction of methaemoglobinaemia. Methaemoglobin (MtHb) is a derivative of haemoglobin, in red blood cells, when the iron present has been oxidised.

The mode of action of nitrite is the oxidization of the haem iron in red blood cells from the ferrous state (Fe^{++}) to the ferric state (Fe^{+++}) to form MtHb. MtHb is incapable of carrying oxygen and cyanosis results, with death occurring if the sodium nitrite dose is high enough. The pattern of methaemoglobinaemic response induced when erythrocytes are exposed to sodium nitrite oxidant challenge will be a balance between MtHb formation and its subsequent reduction back to haemoglobin by the protective enzyme MtHb reductase. As a consequence of the formation of excessive methaemoglobin, when the protective enzyme cannot cope with the rate MtHb formation, oxygenation of the blood and oxygen delivery to tissue is impaired. The oral lethal dose for humans has been estimated to vary from 33 to 250 mg nitrite ion / kg bw, the lower doses applying to children and elderly people (Boink & Speijers, 2001).

The ESN has hazardous classifications of 5.1.1C, 6.1C (oral), 6.4A, 6.6B, 6.9B, 9.1A and 9.3B. These classifications are the same as for sodium nitrite as listed as a single compound on the ERMA Register (HSR0001286). The ESN will be manufactured and used as a raw material, and for preparation of the bait containing sodium nitrite at 100 g/kg. Possible risks for this substance are therefore confined to those persons at the manufacturing site or in the event of a spillage for any material being transported or stored. Potential exposure risks can be managed by using trained persons wearing appropriate personal protection equipment (PPE), secure storage and using suitable packaging for an oxidising substance with toxic properties.

The bait containing sodium nitrite at 100 g/kg has hazardous classifications of 6.1D, 6.4A, 6.6B, 6.9B, 9.1B and 9.3C. As with the ESN, possible risks can be managed at the manufacturing site. Product packing (packing group III), labelling and information of the Safety Data Sheet and product label would identify hazards and how to manage these safely.

The 6.1D acute oral classification identifies a LD_{50} of > 300 and $\leq$ 2000 mg/kg b.w. For a young child, assuming 15 kg weight, this is equivalent to > 4.5 g to $\leq$ 30 g sodium nitrite. As the formulated bait this is equivalent to >45g to $\leq$ 300 g of bait per child. For an adult of typical 70 kg weight, the sodium nitrite LD_{50} would be > 22.5 g to $\leq$ 140 g. This is equivalent to 225 to 1400 g of formulated bait per person. Accidental poisoning with vertebrate pesticides is a very rare event and given the comparatively large amounts of bait the risk to humans of acute toxicity from formulated bait should be low.

Sodium nitrite is classified for chronic toxicity as a 6.6B and 6.9B. Ingestion of sub-lethal doses of sodium nitrite could over time result in genetic defects or adverse effects to organs (blood system). Nevertheless there is a low risk in term of sub-lethal effects in workers. Doses of 1 to 8.3 mg nitrite ion /kg BW give rise to induction of a slight methaemoglobinaemia (Boink & Speijers, 2001).

However sodium nitrite is also used as a colour fixative and preservative in meats and fish (Binkerd & Kolari, 1975) and workers in the industry are more likely to ingest nitrates/nitrites daily in food and drinking water, than they are from handling baits. Sodium nitrite has also been used experimentally in human and veterinary medicines as a vasodilator, a bronchodilator and an antidote for cyanide poisoning. The current acceptable amount of nitrite ion in a daily diet is up to 0.07 mg of nitrite ion per kg of body weight per day. For a person weighing 70 kg, this would be about 70 mg sodium nitrite per day (NZFSA, 2010) and as the sodium nitrite formulated bait, equivalent to 700 mg bait per day.

In humans, exposure to low doses would be without effects. At higher doses the expected effects of sodium nitrite *in vivo* is the relaxation of smooth muscle, especially of small blood vessels, and increasingly at toxic concentrations, the conversion of haemoglobin to methaemoglobin. Normal levels of methaemoglobin in human blood are 1-3%. Once the proportion of methaemoglobin reaches 10% of normal haemoglobin, clinical symptoms such as a cyanosis occur. Moderate methaemoglobinaemia (< 30 % of total haemoglobin oxidised) causes discomfort (nausea, headache) with severe methaemoglobinaemia (> 50 %) being possibly life threatening. Signs and symptoms of more severe nitrite poisoning include cyanosis, nausea, irregular heart beat and breathing, then, unconsciousness and death. In the event of a poisoning, methylene blue has a protective effect against nitrite-induced MtHb formation and may therefore be used as an antidote in nitrite intoxications (HSDB). Appropriate handling of ESN and baits should prevent this even low level exposure and the risk of induction of even a slight and transient methaemoglobinaemia.

Build up or bio-accumulation of nitrite could be perceived as a risk. However, nitrite is not persistent in the body and will be absorbed and transferred to the blood in the upper part of the gastrointestinal tract. Food, particularly when containing abundant pectin may delay or decrease absorption. Pharmacokinetic analyses reported in the literature have shown that nitrite has a plasma elimination half-life of 42 minutes (Dejam *et al*. 2007). This rapid elimination means that, with infrequent very low level exposure, the risk of bioaccumulation to more toxic concentrations would be very low.

Long term effects of exposure to sodium nitrite could be another perceived risk. A concern in the past has been that long-term exposure to nitrate and nitrite in food might be associated with formation of nitroso compounds, many of which are carcinogenic. To test this mice and rats have been dosed with orally nitrosatable compounds and nitrite at doses which were extremely high in comparison to human exposure, and showed an increase in the number of tumours. However, none of 21 studies in mice and rats concerning the possible carcinogenicity of nitrite indicated any carcinogenic effect. In at least three studies with F344 rats a decrease in tumour incidence was observed. (Boink and Speijers, 2001).

In conclusion to this section there is short term acute and long –term chronic risks associated with abnormally high levels of exposure to nitrite. However, exposure even to workers involved in the pest

control industry is far more likely to occur from naturally occurring nitrite in the environment or nitrite in food than it is from baits provided safety precautions are followed. Accidental poisoning with VTA's in New Zealand is extremely rare and if it did occur an antidote exists for sodium nitrite induced toxicity.

Ecotoxicity

The ESN has hazardous ecotoxicity classifications of 9.1A and 9.3B. Classifications for the bait containing sodium nitrite at 100 g/kg are 9.1B and 9.3C. These classifications are a consequence of the sodium nitrite, and no other components in the substances.

There is information from laboratory studies that sodium nitrite is toxic to some aquatic organisms. The ERMA database references a LC_{50} (96 hr) of 0.11 mg/L for Rainbow trout (*Oncorhychus mykiss*) and that the substance is biodegradable, and not bioaccumulative (log P_{OW} -3.7 at 25 ^{0}C). There is a minimal risk that sodium nitrite baits could contaminate soil, except perhaps in a small localised area adjacent to bait stations, and a negligible risk that sodium nitrite bait could contaminate waterways. Hence, aquatic toxicity should not be relevant if normal ground-based baiting practices are followed when the risk of significant contamination of waterways with sodium nitrite is negligible.

It should also be noted in the risk assessment process that nitrogen is one of the most abundant chemical elements of the earth's atmosphere (almost 80%). Ammonia, nitrite and nitrate are the common ionic forms of inorganic nitrogen in ecosystems. These ions can be present naturally, as part of the nitrogen cycle, as a result of atmospheric deposition, nitrogen fixation by bacteria and biological decay of organic matter. Hence nitrite occurs naturally in soil and water and nitrates and nitrite can be removed from water by macrophytes, algae and bacteria.

The amount of sodium nitrite used in baits discretely placed in bait stations for control of possums and pigs should not impact on background naturally occurring levels in the environment. A large proportion of bait eaten by pest species should be metabolised prior to death or excreted. Sodium nitrite is reported to be photo-oxidised with a half-life of 82.3 days (US EPA, 2007). In the environment, bacteria of the genus *Nitrobacter* oxidise nitrites to nitrates, which are reduced to nitrogen by anaerobic bacteria in soil and sediment (OECD, 2005).

Other animals

For the species that have been studied, similar patterns of toxicological effects and rapid excretion to nitrite are common features. Table 5 shows the lethal doses for sodium nitrite in different mammalian species. Pigs and humans have similar lethal doses. Dog and cattle dose are also similar and appear to be potentially more susceptible. Small dogs (3 to 4 kg) could conceivably ingest a toxic dose of sodium nitrite from 1.8 g of the bait (sodium nitrite at 100 g/kg), 20 – 30 kg weight dogs would need to ingest 18 g of bait. Cattle with a larger body weight, e.g. 300 kg, would need to ingest a greater

quantity, e.g. 200 g bait. The potential risk to these species will need to be managed by where and how the VTA bait is used.

Table 5: Published lethal oral doses for sodium nitrite in mammals

Species	Lethal gavage dose (mg/kg)	Lethal dose reference
Pig	90	Winks *et al*.,1950
Human	94	Boink & Speijers, 2001
Dog	60	Berlin, 1970
Sheep	170	Parton *et al*., 2006
Cattle	67	Bartik & Piskac, 1981

As with humans the receptor site for sodium nitrite poisoning is haemoglobin in the red blood cell and MtHb is incapable of carrying oxygen and cyanosis results, with death occurring if the dose is high enough. The activity of the enzyme MtHb reductase varies in different animals, and is known to determine a species direct sensitivity to a sodium nitrite. The factor most influencing potential risk to livestock, dogs or other pets will be whether or not the animals have direct contact with bait and the opportunity of these species to eat bait. This will be mitigated by label instructions, use of appropriate designed bait stations, the location of bait stations, signage, precautions when dispensing toxic baits and recovery of any untaken bait for disposal.

Veterinarians are familiar with nitrite or nitrate poisoning in grazing ruminants, as it can occur suddenly in grazing cattle. Active growth of plants after rain following dry or drought conditions can lead to nitrate or nitrite poisoning, when high levels of nitrate accumulate in fodder. Symptoms will include cyanosis, ataxia, unconsciousness and death in untreated animals. Baits must be kept clear of livestock, pets and working dogs. This will be achieved by only using the bait containing sodium nitrite at 100g/kg in a bait station that restricts access by grazing animals. Possum bait stations, e.g. Philproof type are already used commercially and successfully. For pigs, a bait box has been designed. Access by small ruminants is unlikely. Where a risk might be identified then grazing stock would be first removed from the pest control area.

Methylene blue is suggested as a possible antidote but which has to be administered with care as high doses can cause toxicity in some species. Acetylcystein has been suggested as a preferable alternative for cats. The use of nitrite containing baits as a VTA should not directly increase the incidence of MtHb in cattle since the amounts used will be small compared to naturally occurring nitrite in the environment and nitrite from other anthropogenic sources.

Birds

The ESN is to be used as a raw material so birds are extremely unlikely to ever be at risk of primary poisoning by this substance. However the bait containing sodium nitrite at 100 g/kg will be used outdoors and would be protected by placements in bait stations of a design appropriate to the target species (possums or feral pigs).

The bait is coloured green as a deterrent to birds and used in a matrix that is already used commercially in other VTA products (*Confidential Appendix 8*). There is no evidence of this bait matrix as used in existing products being 'attractive' to birds. Birds will not be able to gain access to a pig bait station because of the lid system on these stations.

4.1.1.2 Secondary exposure

Secondary exposure specifically addresses any potential risk to non-target species by secondary poisoning (from poisoned carcasses or residues).

Secondary poisoning

Secondary poisoning risk is determined by the potency of the toxin, the extent that residues exist in poisoned carcasses, the rate of degradation of the toxin in the carcass of the target species, and the rate of excretion of sodium nitrite in animals ingesting parts of a carcass, which might contain traces of toxin.

In this regard the following mitigating features of sodium nitrite are important:

i) Sodium nitrite has a comparatively low acute toxicity when compared with other VTA toxins and even in target species a large bolus of the bait needs to be ingested quickly for toxicity to occur.

ii) Sodium nitrite has a plasma elimination half life of < 1 hour so a large proportion of a toxic dose will be excreted in target species prior to death.

iii) Sodium nitrite breaks down in contact with moisture and in particular with acid conditions, for example in the stomach, so any bait and residues of sodium nitrite left in the stomach of a dead animal will continue to be detoxified after it has died

iv) For animals eating carcasses which contains low levels of sodium nitrite, risk of chronic toxic effects is reduced by rapid excretion .

The absorption, metabolism and excretion of sodium nitrite at different doses in rats are described in Table 6. Peak plasma levels of nitrite were achieved in both sexes of rats approximately 30 minutes after oral exposure, and peak methaemoglobin levels were achieved after 100 minutes. This data from an earlier publication by Kohn *et al*. (2002) indicates the plasma elimination t (½) for sodium nitrite in rats ranges from 42.0 to 62.5 minutes after oral dosing. Animal pharmacokinetic data exists in both small and larger animals. The Kohn *et al*. values are similar to those reported in humans (Dejam *et*

al., 2007), who showed a plasma elimination half-life of 42 minutes. They also correlate closely to plasma elimination t (½) values of 29.0, 30.0 and 34.0 minutes in sheep, dog and ponies reported by Schneider and Yeary (1975).

Table 6: Plasma elimination t(1/2) in minutes with lower and upper 95% confidence limits for sodium nitrite in rats (calculated from data in Kohn *et al.*, 2002).

Dose (mg/kg)	Route	t(1/2) male (min)	t(1/2) female (min)
20	i.v	19.8 (16.9-23.8)	28.3 (24.4-33.8)
40	Oral	42.1 (37.6-47.7)	55.5 (47.9-65.8)
80	Oral	42.0 (33.9-55.0)	62.5 (58.8-66.7)

The pharmacokinetic data on sodium nitrite in such diverse species as mice, rats, sheep, dog, ponies and humans, coupled with information on the toxicodynamics of sodium nitrite, suggests similar C_{max}, t(½), and rapid depletion would occur in other game animal species and we could expect elimination of sodium nitrite following sub-lethal exposure within 12 hours. Hence the risk of residues in game meat is also low. Sodium nitrite is rapidly eliminated in the body by animals and humans. A striking feature of the published information on the pharmacokinetics of sodium nitrite is the similarity in peak plasma concentrations and elimination half-life between different species, regardless of whether they are laboratory animals, pets (e.g. dogs) or larger animals such as horses. To help distinguish between different vertebrate toxins these have been classified into four groups based on their persistence in sub-lethally exposed animals. The criteria for the four groups and the allocation of different compounds to these groupings are summarised in Table 7.

Table 7: Classification of vertebrate toxins based on comparative pharmacokinetics and likely persistence of residues in sub-lethally exposed species (adapted from Eason *et al*, 2008)

Group	Compound	Half-life values in papers summarised above	Likely persistence of residues in edible tissues
1	cyanide	+	12 to 24 hours
	zinc phosphide	+	12 to 24 hours
	para-aminopropiophenone	+	4 days
	Sodium nitrite	< 1 hour	< 12 hours
	1080	< 11 hours	7 days
2	pindone	2.1 days	4 weeks
	diphacinone	3 days	6 weeks
3	cholecalciferol	10–68 days	3 months
	coumatetralyl	50–70days	4 months
4	brodifacoum	130 days	24 months or longer
	bromodiolone	170 days	24 months or longer
	flocoumafen	220 days	24 months or longer

+ no published value but likely to be < 12 hours based on information in sodium nitrite

In conclusion, sodium nitrite when used as a VTA for possums or pigs is very unlikely to lead to secondary poisoning or residues in livestock or game. There would be no risk or negligible risk of wild animal edible tissue being above existing acceptable limits for nitrite in food. Secondary poisoning is most unlikely because of the comparatively low toxicity of sodium nitrite and given target species have to eat a bolus of sodium nitrite to get a lethal dose. The need for sodium nitrite to be ingested in a single large dose is illustrated by the difference in toxicity of sodium nitrite when ingested in a single dose in rats versus the NOEL in chronic studies. The LD_{50} for a single bolus dose is < 100mg/kg in rats but a NOEL for rats of 100-200 mg/kg/day is reported when sodium nitrite is ingested slowly (NTP, 2001). Potential risks from sub-lethal poisoning of target and no-target species would be managed by label statements for best practice for use as a bait, recovery of untaken bait and disposal of bait.

Risk to birds such as hawks and weka scavenging carcasses should be low given the rapid elimination of sodium nitrite by excretion in the target species and further breakdown in carcasses following death, and also because a large bolus dose is needed to induce toxicity. For VTA's such as brodifacoum, residues bio-accumulate and can continue to accumulate until with repeat exposures toxic thresholds are passed. By contrast any repeat exposures to sub-lethal doses of sodium nitrite will be rapidly eliminated between exposures and bioaccumulation to toxic thresholds will not occur.

Potential for residues entering the food-chain or in environment

There is a hypothetical risk of nitrite from possum or pig bait contaminating water including for human consumption. However the total amounts of nitrite used in a bait station will be small compared to normal background levels of nitrite that occur in the environment from nitrogen fixation or from other anthropogenic sources. Nitrite from bait delivered in a bait station should not be a risk to drinking water for human consumption if label instructions are followed and including best practice of bait stations being 20 metre or more from waterways. Neither the ESN nor the bait containing sodium nitrite at 100 g/kg is intended for application directly to plants or animals for human or animal consumption. However if consumed the toxicity of sodium nitrite, its effects and rates of excretion are well known and understood. The intention to use ESN as a raw material, and for the bait as a VTA, and then only for application by hand-laid ground placement in bait stations, further mitigates potential risk of primary or secondary adverse exposure. Nitrates/nitrogen compounds are common in the environment, both as naturally occurring components of the "nitrogen cycle" and also from a variety of anthropogenic sources e.g. fertilisers, sewerage, animal effluent. The use of VTA bait containing sodium nitrite does not introduce a new risk provided the intended use is as described. Furthermore bait placement will be more discrete than fertilizer application.

4.1.1.3 Manufacture

The manufacturing site for the ESN and Bait containing sodium nitrite at 100 g/kg is already used for the storage and manufacture of VTA products including highly toxic active ingredients. Site approvals and operating procedures are in place. Existing controls and procedures will effectively manage the storage of the active and manufacture of the bait. Sodium nitrite is an oxidising substance and additional precautions are required for storage and handling to avoid contact with or storage with incompatible and combustible materials.

4.1.1.4 Application

The ESN and bait containing sodium nitrite at 100 g/kg have not been identified as toxic by dermal contact or as skin irritants or sensitizers. The product labels will recommend gloves be worn when handling the substances.

4.1.1.5 End-use

The choice of bait station and the location/placement of the bait station is important. This prevents or minimises risks to non-target species (animals, birds) and to the environment (water, soil). This also assists in protecting children by restricting access to the bait. It is also normal (and best) practice to not place a bait stations within 20-metres of any waterway. Commercially available bait stations, e.g. Philproof type bait stations for possum bait, protect the bait from weathering (*Confidential Appendix 6*) and limit access by non-target species. For pigs, a bait box with a hinged lid was designed and used on efficacy trials with success (*Confidential Appendix 7*).

It will also be recommended practice to use non-toxic pre-feed in the bait stations prior to placement of the toxic VTA bait. This assists in identifying the presence of the target species and also potential non-target species.

4.1.1.6 Disposal

The ESN is to be used as a raw material and if unable to be used for that purpose would be disposed of to an approved landfill or by incineration in a commercial facility. Any untaken VTA bait is recommended to be collected and disposed of by burying. The bait can also be disposed of by incineration.

Carcasses may be near to the bait stations but this may not always be so as the toxin is not as fast-

acting as toxins such as cyanide. Rapid metabolism and excretion will limit the amount of residues present in a carcass and residues present in meat or the stomach will break down in target species after they have died.

Birds (weka, hawks) may scavenge a dead carcass. However any risk to birds such as hawks and weka scavenging carcasses should be low given the rapid elimination of sodium nitrite by excretion in the target species and further breakdown in carcasses following death, and also because it has comparatively low toxicity and needs to be ingested rapidly to cause toxicity. The risk of rapid ingestion of a high bolus from a carcass will be minimal.

4.1.1.7 Post-application

If recommended practices are followed in pest control operations, sodium nitrite is highly unlikely to be present in meat for human consumption as a result of use as a VTA. A label statement will require any untaken or unused bait to be collected and disposed of safely by burying or incineration. In the event of best practice not being followed, potential risks have been considered. The literature on the health effects of nitrates and nitrites has been reviewed (Boink & Speijers, 2001). Nitrates and nitrites are recognized as an accepted preservative additive for some meat products. The ADI quoted for nitrite is for up to 0.07 mg/kg bw/day expressed as nitrite ion. The sodium nitrite food standard limit for processed meat is $\leq$ 500 mg/kg. Sodium nitrite is also known to be rapidly eliminated by different animals and humans. Should there be exposure (by ingestion) to the bait, then elimination of sodium nitrite residue would probably occur within 12 hours at worst, and most likely within 1-6 hours of any game species or livestock ingesting a sub-lethal amount of bait. There would be no risk or negligible risk of wild animal procurement of edible tissue above acceptable limits.

4.1.2 Costs

Sodium nitrite is a well-known and readily available compound. The manufacture of the ESN can be carried out at the applicants existing manufacturing facility using existing equipment. Similarly the bait containing sodium nitrite can be manufactured using existing equipment and materials.
In the event of a spillage or requirements to disposal of waste or residual bait, the substances can be disposes of by incineration or burial.

The greatest cost with these substances has been the already significant investment in research and development resources in developing the ESN and bait.

4.1.3 Benefits

Sodium nitrite has been identified as a potential cost-effective alternative to 1080 for possum control. In New Zealand, the use of sodium nitrite offers an alternative to 1080 for control of possums; a form of pest control that is necessary to protect conservation biodiversity and prevent TB being transmitted from wildlife to livestock. It is widely accepted that a TB-free status (i.e., <0.2% infected herds) will have positive implications for trade into overseas markets that import New Zealand's primary produce.

There is a need for effective Vertebrate Toxic Agents (VTA's) for mammalian pests. Both ERMA in the re –assessment of 1080, and MAF in recent Biosecurity Strategies have indicated that more tools are needed, and specifically alternatives to 1080. Primarily the need is for more cost effective VTA's without the side effects (e.g. persistence in environment and bioaccumulation) characteristic of some of current approved toxins. Sodium nitrite compared with other VTA toxins will be a cost effective alternative.

Sodium nitrite has a bitter, salty taste. A critical benefit of the ESN is in masking the sodium nitrite taste to improve palatability (& effectiveness) for the VTA bait. The encapsulation of the sodium nitrite before mixing into the VTA bait has been shown to improve the palatability of the bait thus avoiding potential for bait shyness and consequently also improves the effectiveness and mortality of the bait to possums and pigs. It is important that the target species readily eats sufficient quantities of the sodium nitrite bait to facilitate a rapid death. If the possums or pigs eat slowly then methaemoglobinaemia in the blood is induced slowly and does not reach a sufficiently high critical level to induce death. Now that these technical challenges have been overcome ESN containing baits have the potential to offer distinct advantages over current alternatives toxins for possum control.

The consequence of not approving these new substances would mean users would have to use conventional toxins or other means, e.g. trapping or shooting. Approval of sodium nitrite, a humane non-persistent toxin would mean NZ could be leading in providing alternatives which are humane, have low secondary poisoning risk and are more acceptable.

If not approved, an opportunity for a new but well understood and available compound which could be more readily accepted by community groups than some unpopular vertebrate pesticides will have been lost. Progress in TB eradication and conservation will be slowed.

The 6.1D acute classification for the bait containing the sodium nitrite at 100 g/kg, would also offer an opportunity for community pest control groups or Trusts to have access to a VTA that would not require the pest controller to hold a Controlled Substances License (CSL). This would mean effective

safer VTA's could be used that are less toxic to the handlers and with a more acceptable ecotoxicity profile.

Alternative toxin for possums control

The alternative toxins are cholecalciferol which is too expensive for most users at a 0.8% concentration in baits, cyanide which is humane and effective but has no antidote, 1080 which is unpopular in some sections of the community but has a secondary poisoning risk, and brodifacoum which is inhumane and persistent. Zinc phosphide has advantages over several of these toxins but is not as humane as sodium nitrite and does not have an antidote. Sodium nitrite however has been shown to be a humane VTA toxin for the target species, has an antidote, and does not have adverse persistence properties .

Alternative toxin for pig control

There are no toxins registered for feral pig control in New Zealand. In Australia, warfarin and phosphorus have been used in the past and these have recently been discontinued on the grounds of humaneness. 1080 has been used for pig control in Australia but it is not humane in this species. Sodium nitrite containing baits are being developed in Australia as well as NZ.

For feral pig control there are some other specific benefits:

* Preventing spread of fungi associated with kauri dieback; pigs are suspected as a vector (Waipara et al. 2009)
* Prevention of spread of tuberculosis (Tb)
* Conservation-protection of giant native snails (e.g *Powelliphanta*)
* VTA available in case of emergency, e.g. foot and mouth disease outbreak.

At $14 billion, the dairy and meat industries account for over half of New Zealand's agricultural exports. Our continued access to global markets critically depends on our ability to meet international quality standards and regulatory requirements, and the infection of our cattle and deer with bovine tuberculosis (Tb) represents a major threat to these key exports. Possums are the principal wildlife Tb vectors and feral pigs are also implicated

The most effective method of controlling possum populations has been the use of 1080**.** Sixty years of research and development have led to little change in bait types but has seen refinements in its use, notably in the last four decades. Although 1080 is highly effective, its use is constrained by environmental, welfare and social pressures. Despite decades of research, 1080 use remains embroiled in controversy and aerial application has led to deep seated concerns and public demonstrations. Unless alternative options are made available, New Zealand's primary production and, thus, its economic well-being will remain under threat.

To achieve stakeholders' demands for TB eradication and biodiversity protection, pest populations must either be locally eradicated or reduced to a very low level. The ecological cost of achieving this with continued use of 1080 (or persistent second-generation anticoagulants) would be unacceptable to most New Zealanders. We urgently need new tools but these must also be socially acceptable. The applicant and research partners have consulted with communities and iwi (see section 4.3), and have some support for the development and application of "red blood cell " toxins such as para-aminopropiophenone (PAPP) and sodium nitrite.

The benefits of having a sodium nitrite bait available as a VTA have been summarised in Table 8.

Table 8: A summary of potential benefits for a sodium nitrite bait

BENEFITS	DIMENSION	TYPE OF IMPACT and CONTRIBUTION
ENVIRONMENTAL	Native species	• Reverse the decline in indigenous biota (specifically protected bird species, breeding) • Pigs suspected of spreading fungi associated with kauri dieback • Protection of native snails from feral pig activity
	Invasive Species	• Humane toxin for target pests • Impacts minimal (i.e. secondary poisoning/persistence when compared with 1080) • Eradication /control of target pest (possums., feral pigs) • VTA that could be used on pigs in event of disease outbreak (e.g. foot and mouth) • Intervention tool (VTA) which is environmentally and economically sustainable
	Water/Soil/Non-Targets	• Reduced non-target effects with land-based applications only and use inappropriately designed bait stations • Secondary poisoning risk reduced versus 1080 • Concentration/persistence risks reduced versus 1080 and brodifacoum
ECONOMIC	Viability	• Cost effective and readily available compound (sodium nitrite) that can be used for of target pests • Use of a well known compound with a well understood mode of action (absorption, metabolism, excretion) • Formulated as palatable bait
	Growth	• Stimulate innovation in NZ Pest Control industry • Application of more effective VTA tools/methods with lower hazard profile to humans and non-target species • Development of toxin for pest control that can be available for use by community groups
	Employment	• Create new employment opportunities as will be less hazardous for professionals to handle than 1080 or cyanide products as example • Maximise opportunities for local employment in use of ground control VTA products
SOCIAL	Awareness and support	• Create opportunities for involvement with a less toxic alternative • Effective toxin (VTA) on target species • Antidote for toxin

BENEFITS	DIMENSION	TYPE OF IMPACT and CONTRIBUTION
	Enhancing sustainability of livelihoods	• Promote a healthy and safe living environment with minimal risks of secondary poisoning form pest control operations • Tool for controlling pests associated with harbouring/spread of Tb
	Humaneness	• Sodium nitrite is relatively humane toxin when compared with other approved VTA toxins • Formulated to enhance palatability (and therefore effectiveness) for target species
CULTURAL	Sense of place "Turangawaewae	• Helping recreate/protect a distinctive (unique) habitat
CONSENTS / REGULATORY	Consents for control	• The bait containing sodium nitrite at 100g/kg does not need to be registered as a restricted poison therefore there should not be a need to add as toxin to 'Controlled Substances Licences' • As an unrestricted poison there will not be the protracted consent process that causes long delays to using/control with restricted poisons • This would not pre-empt need to obtain other consents, e.g. DoC or consultation where needed, e.g. iwi

Animal welfare

Sodium nitrite, when formulated appropriately to prevent the natural salty taste from adversely affecting palatability, and when given at as a large bolus dose to increase effectiveness, has been demonstrated to be a humane toxin (*Confidential Appendices 6 & 7*). Sodium nitrite was found to be an effective and humane poison for killing pigs and possums in cage trials. Most pigs and possums fed readily on baits containing sodium nitrite and times to death were rapid. From the behavioural observations made after the pigs and possums had consumed the toxic bait the humaneness of sodium nitrite relative to other toxins has been confirmed and it appears to have a welfare profile similar to that of another new toxin (PAPP) in stoats.

Table 9 summarises data from studies on target species that monitored the inset of symptoms and time to death. The key parameters of note in welfare assessment of a VTA are the time to onset of symptoms, the duration of symptoms and the severity of symptoms induced by toxic doses in target species.

Table 9: Effects and time to mortality for target species (i.e. possums, pigs)

Reference	Species	Onset of symptoms (minutes)	Duration of symptoms prior to unconsciousness (minutes)	Time to death (minutes)	Signs prior to unconsciousness
Confidential Appendix 6	Possum	15	45	72 -130	Pale nose extremities, minor vomiting , blue tongues, lethargy, ataxia, slight tremors collapse and death
Confidential Appendix 7	Pig	10 -25	25 - 76	39 - 101	Unsteadiness, loss of colour, lethargy

When these symptoms and times are compared to other VTA toxins (Table 10) it can be seen that sodium nitrite compares favourably and appears to be a more humane toxin than most other toxins.

Table 10: Comparison of Sodium nitrite with other toxins

	Cyanide	Sodium nitrite	1080	Phosphorus	Cholecalciferol	Brodifacoum
Symptoms	Un-coordination Mild or moderate hyperpnoea Loss of response to handling (indicator of unconsciousness) Convulsions	Pale nose extremities, vomiting, blue tongues, lethargy, ataxia, slight tremors collapse and death.	Changed appearance Retching, Vomiting Unsteady head movements & walking Minor tremors or spasms Prolonged lying, prostrate (>2 hours)	Stopped grooming Crouching, prostration Retching, vomiting Stomach congestion Failure of righting response & loss of corneal reflex	Reduced activity Rapid breathing Reduced feeding, weight loss Prostration Mineralisation in organs Lung pathology Unconsciousness (just prior to death)	Changed appearance Reduced feeding Diarrhoea, minor; abnormal breathing, shivering, tremors spasms, un coordination Haemorrhages Prolonged lying Loss of response to handling & palpebral reflex
Time to death	17 (min) 55 (sec)	1.5 hours	11 (h) 26 (min)	25 (h) 12 (min)	9 days	21 days
Duration of effects	3 (min) 18 (sec)	Approx I hour	9 (h) 34 (min)	23 (h)	7 days	6 days
Relative degree of suffering	Low	Low	Intermediate	High	High	High

This table contains information extracted from Gregory *et al* (1998), O'Connor *et al*. (2003 and2007), and Littin *et al* (2000, 2002, 2009).

The symptoms of poisoning were similar in both pigs and possums. In summary, the onset of symptoms of poisoning and time to death are swift in comparison to the anticoagulant toxins or 1080. The sequence of behavioural changes in animals is consistent with our understanding of the toxicology of sodium nitrite, namely that the compound is rapidly absorbed and quickly induces methaemoglobinaemia. In sub-lethally dosed animals there was prompt recovery from sub-lethal poisoning which is consistent with a compound that has a plasma elimination half –life of less than one hour in most animals.

4.2 Provide an assessment of those risks, costs, and benefits identified in Section 4.1 which might be significant.

Significant Risks

Oxidising properties

Sodium nitrite is an oxidising solid and the ESN being 95% sodium nitrite is expected to have the same 5.1.1C classification. Oxidisers have the potential to intensify a fire. Storage and transport precautions are required to ensure there is no contact with combustible materials. The warning and precautions to safely manage this risk can be provided on the product label in the Safety Data Sheet (*Confidential Appendices 4 & 5*) . The bait containing sodium nitrite at 100 g/kg is not expected to be an oxidiser.

Health Risks

The ESN has hazardous toxicity classifications of 6.1C (oral toxicant), 6.4A (eye irritant) , 6.6B (suspected of causing genetic effects) and 6.9B (suspected of causing damage to organs (blood system) through prolonged or repeated contact). These classifications are the same as for sodium nitrite as listed as a single compound on the ERMA Register (HSR0001286). The bait containing sodium nitrite at 100 g/kg has hazardous classifications of 6.1D (harmful warning as oral toxicant), 6.4A, 6.6B and 6.9B.

The encapsulation of the sodium nitrite masks the salty bitter taste of the compound. This has the effect of improving the palatability of the VTA bait to the target species (and therefore effectiveness), but could also potentially increase the potential risk of ingestion by children and non-target species such as cats, dogs, livestock. The possum bait station is expected to contain about 130g of bait (equivalent to 13 g sodium nitrite) and more than a lethal dose for a 15 kg child. This potential exposure risk is to be managed by only using the bait as a ground-based hand-laid bait in appropriately designed bait stations and located with limited access (i.e. up off ground) thereby limiting access to young children and small animals. The pig bait stations have been designed as a box with a lid that needs to be lifted before the bait is accessible. A feral pig is able to do this; a small child is unlikely to be able to achieve this. Also any potential feral pig control operation is unlikely to be in a location where young children would normally be present. However as with all other toxic baiting practice bait should be placed in such a way and with appropriate signage to prevent access.

Methylene blue is available as an antidote in cases of poisoning. The following information on treatment of sodium nitrite appears in the HSDB reference:

In cases of mild nitrate toxicity (blood methaemoglobin levels < 20%), asymptomatic patients do not require treatment other than avoiding ingestion or inhalation of substances that cause methaemoglobinemia. In symptomatic patients with moderate or severe toxicity and hypoxia or dyspnoea, 100% oxygen should be administered immediately to saturate fully all remaining normal haemoglobin. Specific therapy for methaemoglobinemia consists of intravenous administration of methylene blue at a dose of 1 to 2 milligrams/kilograms (mg/kg) body weight (0.1 to 0.2 milliliters [mL]/kg body weight of a 1% solution in saline) over a 5- to 10-minute period. Within 15 minutes of methylene blue administration, cyanosis will usually begin obviously to improve. If no response to the initial injection occurs within 15 minutes in seriously ill patients, or within 30 to 60 minutes in moderately ill patients, a second methylene blue dose of 0.1 mL/kg body weight can be given. Caution is advised because methylene blue can slightly worsen methemoglobinemia when given in excessive amounts. In general, the total dose administered during the first 2 to 3 hours should not be > 0.5 to 0.7 mL/kg of body weight. Methylene blue should not be administered to a patient with known G-6-PD deficiency because severe haemolytic anaemia can develop. For severe, life-threatening methemoglobinemia, especially when the patient responds poorly to methylene blue therapy or when the patient has G-6-PD deficiency, treatment options include exchange transfusion and hyperbaric oxygen therapy. During treatment in the hyperbaric chamber, sufficient oxygen can be dissolved directly in the blood to support life; reversible binding to haemoglobin is not required.
Acetylcystein as been suggested as the alternative preferential treatment for cats.

The 6.6B (suspected of causing genetic effects) and 6.9B (may cause damage to organs [blood] through prolonged or repeated exposure) are potential adverse health effects that might be an exposure risk to those manufacturing the substances or in using the VTA bait. The product labels and Safety Data Sheets will warn of the potential hazard and include precautionary advice to wear gloves and to wash thoroughly after handling.

Environmental risks

The ESN has hazardous ecotoxicity classifications of 9.1A and 9.3B. Classifications for the bait containing sodium nitrite at 100 g/kg are 9.1B and 9.3C. These classifications are a consequence of the sodium nitrite. Potential exposure and therefore risk can be limited by implementing the HSNO life cycle controls, using the bait for ground-based pest control operations only, and in appropriately designed bait stations and locations.

A summary of potential significant risks are summarised in Table 11.

Table 11: Summary of potential significant risks for ESN and Bait containing sodium nitrite at 100 g/kg assuming the HSNO default controls are applied

Potential significant risk	Lifecycle step	Hazardous Property	Potential adverse effect/impact
Fire; combustion	Manufacture Storage	ESN is oxidising solid (5.1.1C)	Material damage unless packaged and stored appropriately
Accident or packaging failure causing spillage (land, water)	Manufacture Storage Transport Use Disposal	*Toxic* ESN – 6.1C(oral), 6.4A, 6.6B, 6.9B Bait containing sodium nitrite at 100 g/kg – 6.1D, 6.4A, 6.6B, 6.9B *Ecotoxic* ESN – 9.1A, 9.3B Bait containing sodium nitrite at 100 g/kg – 9.1B, 9.3C	Human health (operators, bystanders) Aquatic environment Terrestrial vertebrates
Occupational exposure	Manufacture Use Disposal	*Toxic* ESN – 6.1C(oral), 6.4A, 6.6B, 6.9B Bait containing sodium nitrite at 100 g/kg – 6.1D, 6.4A, 6.6B, 6.9B	Human health (operators) - Acute (ingestion risk) - Eye irritant - Chronic (6.6B, 6.9B)
Contamination during use of bait (spillage, off-label use)	Use	*Toxic* ESN – 6.1C(oral), 6.4A, 6.6B, 6.9B Bait containing sodium nitrite at 100 g/kg – 6.1D, 6.4A, 6.6B, 6.9B *Ecotoxic* ESN – 9.1A, 9.3B Bait containing sodium nitrite at 100 g/kg – 9.1B, 9.3C	Human health (public) Aquatic environment Terrestrial vertebrates (non-target)
Accidental poisoning of children, and non target species (dogs, domestic cats, some bird species)	Use Disposal	*Toxic* ESN – 6.1C(oral), 6.4A, 6.6B, 6.9B Bait containing sodium nitrite at 100 g/kg – 6.1D, 6.4A, 6.6B, 6.9B *Ecotoxic* ESN – 9.1A, 9.3B Bait containing sodium nitrite at 100 g/kg – 9.1B, 9.3C	Human health (public) Terrestrial vertebrates
Incorrect or no action re disposal	Use Disposal	*Toxic* ESN – 6.1C(oral), 6.4A, 6.6B, 6.9B	Human health

Potential significant risk	Lifecycle step	Hazardous Property	Potential adverse effect/impact
		Bait containing sodium nitrite at 100 g/kg – 6.1D, 6.4A, 6.6B, 6.9B *Ecotoxic* ESN – 9.1A, 9.3B Bait containing sodium nitrite at 100 g/kg – 9.1B, 9.3C	 Aquatic environment Terrestrial vertebrates

The magnitude of risk should a potential risk event occur was then considered and summarised in Table 12.

Table 12: The magnitude of risk for each potential event

Event that leads to exposure	Distribution of effects (geographic)	Distribution of effects (demographic)	Distribution of effects (temporal)	Reversible/ Irreversible	Voluntary/ Involuntary	Magnitude (Consequence)
Fire (oxidising compound)	Localised	Manufacturing Storage Use	Short term	Irreversible	Involuntary	Major
Accidental discharge into water, or onto land from spillage	Localised	Manufacturing Storage Transport Use Disposal	Short term	Reversible	Involuntary	Minimal
Occupational exposure	Localised	Manufacturing Use	Short term	Reversible	Voluntary	Minimal
Contamination (equipment, surrounding materials) during use	Localised	User	Short term	Reversible	Involuntary	Minimal
Access to bait by non target species	Localised	Use	Short term	Reversible/	Voluntary - Involuntary	Minimal - minor
Incorrect disposal	Localised	Manufacture Use	Short term	Reversible	Involuntary	Minimal

Definition of the Magnitude descriptions used to assess the qualitative magnitude of risk

Description	Definition
Minimal	Mild, reversible effect on human health (1-2 people) Environmental effects highly localised/contained- minimal environmental impact
Minor	Mild, reversible effect on human health (up to 10 people) Environmental effects localised and minor - reversible environmental impact
Moderate	Reversible, adverse effect on human health (> 10 people) Environmental effects localised and moderate - reversible environmental impact
Major	Serious, reversible, adverse effect on human health (>10 people) Significant, irreversible, adverse effect on human health (up to 10 people) Environmental effects localised and irreversible - no species loss
Massive	Serious, irreversible, adverse effect on human health (> 10 people) Environmental effects widespread and irreversible - species loss

Significant Costs

No significant potential costs have been identified from the future use of sodium nitrite as a VTA. There have however been significant costs in the research and development of alternative VTA products for use in New Zealand.

Significant Benefits

The hazardous classifications for ESN and the Bait containing sodium nitrite at 100 g/kg are directly attributable to the sodium nitrite and no other components in the substances. The ESN has hazardous toxicity classifications of 6.1C (oral toxicant), 6.4A (eye irritant), 6.6B (suspected of causing genetic effects) and 6.9B (suspected of causing damage to organs [blood system] through prolonged or repeated contact), 9.1A and 9.3B. These classifications are the same as for sodium nitrite as listed as a single compound on the ERMA Register (HSR0001286). The bait containing sodium nitrite at 100 g/kg has hazardous classifications of 6.1D (harmful warning as oral toxicant), 6.4A, 6.6B, 6.9B, 9.1B and 9.3C.

Sodium nitrite is a substance with a known and well-understood mode of action in the blood system. At toxic concentrations, the sodium nitrite converts haemoglobin to methaemoglobin resulting in symptoms that can include paleness, lethargy, dizziness, vomiting and unconsciousness before death.. Methylene blue is available as an antidote in cases of poisoning. Humans or other animals treated promptly with the antidote can fully recover for toxic effects. Acetylcystein is an alternative preferential antidote for cats.

The use of sodium nitrite as a toxin for killing possums and pigs is a very recent development. It is seen as a "red blood cell toxicant", a phrase being used to embrace two new candidate vertebrate pesticides (para-aminopropiophenone [PAPP)] and sodium nitrite) both of which induce methaemoglobinaemia, MtHb (Eason *et al*., 2010a; Lapidge *et al*., 2010). The sodium nitrite has the bitter salty taste and the encapsulation of the compound prior to incorporating into a VTA bait has improved the palatability of the bait to the target species and therefore also the effectiveness and reliability as a VTA.

Sodium nitrite was found to be an effective and humane poison for killing pigs and possums.
Neither the ESN nor the bait containing sodium nitrite at 100 g/kg is intended for application directly to plants or animals for human or animal consumption. However if consumed the toxicity of sodium nitrite, its effects and rates of excretion are well known and understood.

4.3 Provide an assessment of any particular risks, costs and benefits which arise from the relationship of Māori and their culture and traditions with their taonga, or which are, for other reasons, of particular relevance to Māori.

The development of sodium nitrite and related new "red blood cell" toxins, such as para-aminopropiophenone, is linked to a Lincoln University FRST programme entitled "Pest Control for the 21st Century" (*Confidential Appendix 9*). As part of the implementation strategy for this research programme and the pest control tools, a national Māori advisory and advocacy group known as Nga Matapopore "The Watchful Ones" was established and oversees the research conducted within the programme.

The development of new "red blood cell" toxins in the context of the whole programme has been discussed with this group. Initially the focus has been on para-aminopropiophenone (PAPP). In addition, the active ingredient sodium nitrite has been introduced to the discussions as another example of a red blood cell toxin being researched by Lincoln University in collaboration with the applicant.

The applicant understands from hui with Nga Matapopore and hui with Tuhoe representatives that many Māori hold strong views on poison use and are reluctant to use any toxin. This view was confirmed by analysis of the issues associated with the aerial application of 1080, during the 1080 re-assessment process. Out of 28 written submissions from Māori, 32% had a general opposition to toxins in the environment (Ogilvie *et al*., 2010). However, there is cautious support for toxins that are humane and do not persist in the environment. At one hui of Nga Matapopore, the treatment of unwanted animals that have been introduced to New Zealand, at no fault of their own, was discussed. It was agreed that culling methods should still accord these species respect and this principle was one of importance to Māori. Accordingly control tools that were demonstratively humane were considered most important. In this regard the welfare profile of the new "red blood cell" toxins was considered to have some merit, though considerable care in their use to restrict non-target exposure would also be considered of paramount importance.

It is hoped therefore that products that are alternatives to traditional vertebrate pest control tools (such as 1080 bait) will be supported by many Māori who are keen to protect native flora and fauna. Use of encapsulated sodium nitrite has the potential to offer a new option for the control of possums and would have conservation, protection of taonga and disease control benefits. The use of sodium nitrite bait will benefit native species by reducing possum browse, and predation of indigenous fauna by possums without many of the undesirable effects associated with 1080 or brodifacoum. Not only has

over-use of 1080 been a concern to Māori but so has the potential for contamination of wildlife including game species such as feral pigs and deer.

The more common proposed use of the new sodium nitrite bait is for possum control, delivered from bait stations. A more discrete use will be the targeting of unwanted feral pigs that for whatever reason are difficult to hunt and shoot or kill by "dogging". It is not anticipated that the concept of poisoning feral pigs, which are represent a resource and food source will be welcomed by Māori. However this toxin bait is only likely to be used for pig control where shooting and dogging is not easily undertaken, where TB is rife, where farmers are having problems controlling pigs on their farms, or where it is agreed that feral pigs are causing conservation problems, such spreading the pathogens for kauri dieback. There is increasing evidence that kauri dieback is caused by Phytophthora Taxon *Agathis* and unfortunately pigs are implicated in the spread of pathogen (pers comm. Nick Waipara at Auckland Regional Counicil; Waipara *et al*., 2009).

A humane death has been identified as a very important aspect and is a key to the effectiveness of a sodium nitrite bait for both possum and pig control. When deciding on a potential bait for pig control, the applicant rejected conventional toxins such as 1080 or brodifacoum on the grounds of welfare or persistence. Sodium nitrite was chosen because of its humaneness, when delivered at a lethal dose, but also because if any game animal did ingest a sub-lethal dose it would be very quickly eliminated and nitrite residues derived form the bait would not contaminate game meat which might be harvested at a later date.

4.4 Provide an assessment of any risks, costs or benefits to New Zealand's international obligations.

NZ has international obligations regarding animal welfare and also residues in meat. A VTA product containing sodium nitrite has benefits for both, and assists in our obligations with regard to international biodiversity.

With regard to residues, buffer zone specifications for wild animal procurement are cited here as an example of a risk and benefit for sodium nitrite use. Buffer zone specifications are intended to protect against concentrations of vertebrate toxic agents (VTAs) being above acceptable national and international limits in edible tissue (muscle/meat). Currently the NZFSA has set the buffer zones at 200 m for rabbits, 1 km for hares and wallabies, 2 km for pigs (except where second-generation anticoagulants are used where it is 5 km) and 2 km for all other wild animals.

There would be no risk, or a negligible risk, of wild animal procurement of edible tissue, for human consumption above acceptable limits if only "low residue" vertebrate pesticides with very rapid depletion times after sub-lethal exposure, such as encapsulated sodium nitrite were employed for pest control. And, if this was the case there would be no or minimal need for buffer zones and caution periods. However, at this time there is still a need for the use of vertebrate pesticides with long retention times, such as brodifacoum, until alternatives tools such as an encapsulated sodium nitrite bait are available.

New Zealand is party to two relevant conventions that have relevance to this application and the sodium nitrite bait would assist in meeting the obligations of these conventions.

Convention on Biological Diversity (www.biodiv.org)

This international convention was signed in 1992 and has three main goals:

1. The conservation of biological diversity;
2. The sustainable use of components of biological diversity; and
3. The fair and equitable sharing of the benefits from the use of genetic resources.

Article 8(h) of this convention states that signatories need to: 'Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species'.

World Trade Agreement (WTO) on Sanitary and Phytosanitary Measures (www.wto.org)

This agreement entered into force with the establishment of the World Trade Organisation in 1995 and has four main goals:

1. To protect human or animal life from risks arising from additives, containments, toxins or disease-causing organisms in their food;
2. To protect human life from plant- or animal-carried diseases;
3. To protect animal or plant life from pests, diseases, or disease-carrying organisms; and
4. To prevent or limit other damage to a country from the entry, establishment or spread of pests.

Of most significance to our national economy is the New Zealand's international Tb status. International standards of disease freedom are set by the Office Internationale des Epizootoes. Currently, a country is considered to be free of Bovine TB when 99.8% of all herds have been officially tested free of the disease for a minimum of three years. A new "low residue" toxic bait will be an additional tool to help NZ achieve TB eradication.

4.5 Provide information on the proposed management of the substance.

The encapsulated sodium nitrite (ESN) has hazardous classifications of 5.1.1C, 6.1C, 6.4A, 6.6B, 6.9B, 9.1A and 9.3B. This substance will be manufactured from imported sodium nitrite at a facility that already stores and manufactures toxic VTA's. The applicant has ISO 9001 accreditation and is approved as a manufacturer by the ACVM Group. The Bait containing sodium nitrite at 100 g/kg has hazardous classifications of 6.1D, 6.4A, 6.6B, 6.9B, 9.1B and 9.3C and would be manufactured at the same facility.

Both substances could be transported off-site in approved labelled packaging for analysis and testing. The ESN would be subject to Approved Handler and Tracking Controls. The Bait containing sodium nitrite at 100 g/kg is proposed as a VTA for possums and feral pigs. The substance would be packaged in HDPE pails of up to 20 kg, with press on lids that can be fitted with tamper evident seals before dispatch. Product labels and Safety Data Sheets would be available for both products.

Both ESN and the bait would be transported as Dangerous Goods for land transport. The ESN would be identified as an Oxidising Solid, Toxic (Class 5.1.1C, Sub-class 6.1) and the Bait product as an Environmentally Hazardous Substance, Solid (Class 9).

The HSNO Default Controls would be expected to safely and effectively manage the potential adverse effects, as identified in Sections 4.1 – 4.4 of this application. In addition to the default codes that are triggered by the HSNO classifications for the substances the applicant and users would be required to comply with additional statutory requirements that relate to the use of VTA's in NZ that are applicable under the following legislation/regulations:

Wildlife Act 1953;
Wild Animal Control Act 1977;
Reserves Act 1977;
National Parks Act 1980;
Land Act 1948;
Ministry of Agriculture and Fisheries Act 1953;
Animal Pests Destruction Act 1967;
Local Government Act 1974;
Agricultural Pests Destruction Act 1967;
Animals Act 1967,
Biosecurity Act 1993;
Health Act 1956;
Health and Safety in Employment Act 1992;
Dairy Industry Act 1952;
Food Regulations 1983;
Meat Act 1981;
Agricultural Compounds and Veterinary Medicines Act 1997

The Bait containing sodium nitrite at 100 g/kg will be required to be approved as a Vertebrate Toxic Agent (VTA) under the ACVM Act 1997 before being offered for sale for the control of any target species. An application is in the process of being submitted.

The product label will provide information about the product, what to use for and how, and advice on other life cycle stages (storage, handling, and disposal) and first aid information.

Users of VTA's on some lands will require an approval (AEE), where appropriate, under section ss.5, 6, 30 and 31 of the Resource Management Act 1991. Consultation with iwi may be required as part of this process. Accordingly, it is possible that at some sites it may be unacceptable to iwi for a specific bait type to be used.

Users of any of the VTA baits on the conservation estate will have to comply with s26ZR of the Conservation Act 1987 which permits only warranted officers, or any person authorised by the Director General of Conservation, to control pests using a hazardous substance. If the Department of Conservation considers using any PAPP bait, it may be expected to consult with iwi as part of its obligations under section 4 of the Conservation Act 1987.

4.6 Provide an overall evaluation of the combined impact of all of the risks, costs and benefits set out in sections 4.2, 4.3 and 4.4.

The next table summarises the assessment of residual risk assuming the HSNO Default Controls are followed. The level of risk at each life cycle stage for both substances are summarised (Table 13).

The possum has been described as New Zealand's number one vertebrate pest, in both economic and ecological terms. From an ecological perspective, possums damage indigenous forests; however, the type of damage varies widely. Where preferred foods are dominant, canopy damage can be extensive and this can lead to complete canopy collapse. Dietary overlap with many key bird species suggests that possums compete with native species for food in the indigenous forest habitat. Where possum control has been conducted researchers have noted a significant increase in endangered vegetation and bird numbers. ESN containing bait can play a role in controlling possums alongside other tools for conservation and TB vector management. The availability of this new bait will reduce over-reliance on traditional VTA's like 1080 and brodifacoum.

Table 13: Level of risk at each life cycle stage for ESN and the Bait containing sodium nitrite at 100 g/kg

Lifecycle Stage	Potential Adverse Effect	Magnitude of Adverse Effect	Likelihood of Adverse Effect Occurring	Level of Risk
Manufacture, storage, transport	Fire risk ; ESN classified as oxidising substance (5.1.1C)	Minimal to Moderate	Improbable	Minimal to moderate
	Spillage /exposure resulting in adverse human health effects or ecotoxic effects ESN classified as 6.1C, 6.4A, 6.6B, 6.9B, 9.1A 9.3B Bait classified as 6.1D, 6.4A, 6.6B, 6.9B, 9.1B, 9.3C	Minimal	Improbable	Negligible to Minimal
Use as VTA	Spillage resulting in adverse human health effects or adverse effects to organisms in the environment.	Minimal	Improbable	Negligible to Minimal
	Poisoning of non target species, specifically cats, dogs, birds	Moderate	Possible	Minimal to moderate
Disposal	Disposal resulting in death or adverse effects to organisms in the environment.	Minimal to Moderate	Improbable	Negligible

From an economic perspective, the possum is considered the primary wildlife reservoir of TB for farmed cattle and deer in NZ. Accordingly, the protection of the conservation estate and the eradication of bovine Tb from possum populations will require a plan of on-going possum control. The use of ESN near farms will mean less concern with regards to secondary poisoning of dogs. The use of sodium nitrite as an alternative to 1080 for ground laid applications for possum control would provide a potential cost-effective control or eradication measure.

In many areas of the country pigs are an important resource for hunting, and where they are a nuisance they can often be controlled by skilled shooting and dogging. Feral pigs are found in abundance in certain areas of New Zealand and come into close contact with domestic stock. Because of their susceptibility to tuberculosis, feral pigs retain a high potential to act as vectors of diseases. Feral pigs also cause considerable damage to New Zealand's native species and are a likely vector for kauri root collar rot.

In some instances, where Tb is rife, where farmers are having problems controlling pigs or where pigs are causing conservation problems, such spreading the pathogens for kauri dieback discrete toxic baiting in bait station will provide a new and important tool. In this regard communities and hunters will often prefer alternatives to poisoning: hunting, shooting, fencing and trapping should be used as first choice option. Sometimes these techniques may not be enough as the primary means of control of feral pigs in remote areas, and toxic baits are needed

as back-up. ESN formulated into bait would be a very important tool in the event of an outbreak of a new exotic disease such as foot and mouth.

There are no toxins currently registered for feral pig control. Pigs are known to be difficult to poison, partly because of their large size, which means larger amounts of poison are needed than for smaller vertebrate pests. When considering a new toxin that can target possums and larger animals such as pigs, a humane death has been identified as a very important factor. Furthermore should any animals be exposed to a sub-lethal concentration, these exposed animals must not retain nitrite residues derived from bait. The information available on sodium nitrite indicates residues will be very quickly eliminated and also not be persistent in the environment at unacceptable concentrations.

Sodium nitrite was found to be an effective and humane poison for killing pigs and possums. Neither the ESN nor the bait containing sodium nitrite at 100 g/kg is intended for application directly to plants or animals for human or animal consumption. However if consumed the toxicity of sodium nitrite, its effects and rates of excretion are well known and understood.

The encapsulation of the sodium nitrite disguises the salty/bitter taste and has been shown to improve the palatability of the paste bait to avoid bait shyness and consequently increase the effectiveness and mortality to possums and pigs. Increased palatability is important for effectiveness as it enables the target species to readily eat sufficient bait and thus consume enough toxicant to facilitate a rapid death. If the possums or pigs eat slowly, then methaemoglobinaemia in the blood is induced slowly and does not reach a sufficiently high critical level to induce death.

Potential exposure and risk to people and non-target species to the bait can be managed by implementing the HSNO life cycle controls, using the bait for only ground-based pest control operations, and then only in appropriately designed bait stations and locations.

Section Five – International Considerations

5.1 ERMA New Zealand is interested in whether this substance (or any of its components) has been considered by any other regulatory authority in New Zealand or by any other country. If you are aware of this, please provide details of the results of such consideration. (Optional)

As sodium nitrite is a commonly used as a meat preservative additive, this compound has been extensively reviewed by regulatory agencies around the world. The current acceptable amount of nitrite in a daily diet is up to 0.06 mg of nitrite per kg of body weight per day (NZFSA 2010) and is comparable to levels set by other overseas regulatory agencies.

Sodium nitrite has not been considered as a VTA before by a regulatory authority, but in US the closely related compound sodium nitrate is registered as a component of a VTA. The USDA/Animal and Health Protection Service (APHIS) currently has registered a Large Gas Cartridge with the EPA. The gas cartridge is a fumigant for control of coyotes, red foxes, and striped skunks in dens. It is not classified as a restricted use pesticide, so no special training is required for its use. The APHIS gas cartridge contains two active ingredients, sodium nitrate and charcoal. The gas cartridge is placed in a den, ignited, and the entrance to the den is sealed. The main combustion product is carbon monoxide, which kills the animals quickly and humanely. Because the cartridge contains only sodium nitrate and charcoal, the EPA has no concerns regarding the environmental fate of the cartridge ingredients. The nitrate is very mobile, and in soil and water serves as a plant nutrient source. The charcoal is immobile and is slowly degraded by microorganisms in soil, whereas in water it floats and disperses. Bioaccumulation in animal tissues does not occur.

Sodium nitrite has been co-developed with the collaboration of researchers and manufacturers in the Invasive-Animal Co-operative Research Centre (IA-CRC) (Eason *et al,* 2010b). The development of sodium nitrite has been developed on the platform of para-aminopropiophenone (PAPP) which has the same mode of action and the same antidote as sodium nitrite. PAPP is selective for stoats and other predators and not toxic to other species, such as possums hence the complementary development of a bait containing sodium nitrite.

Section Six – Miscellaneous

6.1 Provide a glossary of scientific and technical terms used in the application.

ACVM	Agricultural Compounds and Veterinary Medicines
Antidote	Remedy that stops or controls effects of poison
Anthrogenic	Caused by humans relating to or resulting from the influence of humans on the environment
Ataxia	Lack of co-ordination, unsteadiness
Biodiversity	Diversity of plant and animal life in a particular habitat
Bolus	Small round soft mass (as of chewed food)
Bronchodilator	Compound that relaxes and dilates bronchial passageways and improves passage of air to lungs
Chronic	Long-lasting or recurrent condition
Cyanosis	Showing bluish colour in skin or mucous membranes due to not enough oxygen in blood
EC_{50}	The molar concentration of a chemical, which produces 50% of the maximum possible response for that chemical
ERMA	Environmental Risk Management Authority
Erythrocytes	Red blood cells
ESN	Encapsulated sodium nitrite
Haemoglobin	Protein molecule in red blood cells that carries oxygen from lungs to body tissues and returns CO_2 from tissues to lungs
HSNO	Hazardous Substances and New Organisms Act 1996
LD_{50}	Median lethal dose
LC_{50}	Median lethal concentration
Macrophytes	Aquatic plants that grow in or new water
Mammal	Animals, e.g. humans, cats, dogs, where females have mammary glands and both males and females have features such as sweat glands, hair as examples

Metabolism	A range of biochemical process that occur within living organisms; term commonly used for breakdown of food and its transformation into energy
Methaemoglobin	Brownish compound of oxygen and haemoglobin formed in blood
MtHb	Methaemoglobin
Oral	By mouth
Palpebral	Opening for eye; between eyelids
Pectin	Various water-soluble carbohydrates that occur in ripe fruit and vegetables
Plasma	Colourless watery fluid of blood and lymph that contains no cells
Pharmacokinetic	Process by which compound is absorbed, metabolised and eliminated from body
Tb	Tuberculosis
Tuberculosis	Infection resulting from tubercule bacilli transmitted by inhalation or ingestion
UN	United Nations
Vector	Carrier that transmits disease from one party to another
VTA	Vertebrate Toxic Agent

6.2 Provide here any other information you consider relevant to this application not already included.

The applicant anticipates that the use of the bait for pig control, as well as possum control, will cause concern amongst some pig hunters. The applicant is aware of these concerns. In this regard it is anticipated that this bait will be used primarily for possum control, and feral pig control will be a secondary and minor use of the bait. The applicant recognises the importance of pig hunting for food, and also that hunting and dogging can be used for controlling pigs.

The applicant will recommend that pig baiting should only be undertaken, where:

i) shooting and dogging is not easily undertaken
ii) where Tb is rife,
iii) where farmers are having problems controlling feral pigs
iv) or where pigs are causing conservation problems, such as spreading the pathogens for kauri dieback.

Section Seven – Summary of Public Information

7.1 Name of the substance(s) for the public register:

ESN containing sodium nitrite at 950 g/kg

Bait containing sodium nitrite at 100 g/kg

7.2 Purpose of the application for the public register:

To manufacture ESN containing sodium nitrite at 950 g/kg and a Bait containing sodium nitrite at 100 g/kg to be used as Vertebrate Toxic Agents (Category B)

7.3 Use Categories of the substance(s):

Main category

3. Non-dispersive use

Industry category

0. Other

Function/Use category

39. Pesticides non-agricultural

Subcategory: Pest control products

7.4 Executive Summary:

The ESN is encapsulated sodium nitrite and to be used as a raw material in the manufacture of a VTA baits. ESN has hazardous classifications of 5.1.1C, 6.1C, 6.4A, 6.6B, 6.9B, 9.1A and 9.3B. The hazard classifications for ESN trigger the HSNO Default Controls for an Approved Handler or Tracking. The encapsulation of the sodium nitrite masks the bitter salty taste. The ESN is to be used to manufacture a bait containing sodium nitrite at 100 g/kg for use as a VTA for possum and feral pig control. The bait has hazardous classifications of 6.1D, 6.4A, 6.6B, 6.9B, 9.1B and 9.3C. The encapsulation of the sodium nitrite has been shown to give improved palatability of the sodium nitrite in bait to the target species and the observations on test animals have shown the bait to be humane and effective as a VTA. The ESN and Bait containing sodium nitrite at 100 g/kg can be disposed of by burying or by incineration.

Sodium nitrite is used as a preservative additive in some meat products. People ingest nitrates and nitrite daily in food and drinking water. Excessive levels of nitrites from diet or if in case accidental poisoning will result in the conversion of haemoglobin to methaemoglobin in the blood resulting in symptoms that can include paleness, lethargy, dizziness, vomiting and unconsciousness before death. Methylene blue is available as an antidote. Human exposure to nitrite should not occur following the proposed use as a VTA as a hand-laid bait in bait stations . In the event of an accident, humans or non-target animals treated promptly with the antidote, can fully recover. Nitrite is a naturally occurring ion which is part of the nitrogen cycle. Sodium nitrite will biodegrade and is not bio accumulative or persistent in the environment. The bait is also coloured green as a deterrent to birds.

Sodium nitrite has benefits when compared to existing approved toxins as it does not bioaccumulate in animal tissue which may lead to a risk of secondary poisoning of non-target animals, e.g. dogs, and nor is it persistent in the environment. Targeting of the red blood cell with a toxin at a dose that induces a rapid lethal methaemoglobinaemia has been identified as a humane method of culling unwanted pest mammals. Sodium nitrite as ESN, is also identified as being significantly more humane in its effects on target species than some other toxins used in existing VTA products. With regards to welfare it is on a par with the most humane toxin used for possum control, namely cyanide, but is slower acting, which will allow for administration of the antidote in cases of accidental poisoning. The encapsulation of the sodium nitrite has been a significant development with the benefit of disguising the adverse taste associated with the sodium nitrite active that can be a deterrent to the target pests In addition there has been research to minimise the risk to non-target species from paste bait by use of bait stations and prefeeding. Purpose designed bait stations have been designed for pig baiting that will reduce non-target interference and contact with bait. It is also proposed that the paste

bait would be restricted to ground-based control operations and use in bait stations as this would also reduce the risk to non-target species.

Possums are trapped and poisoned for fur recovery, but this is not enough to meet Tb eradication and conservation goals. The possum remains the major economic and conservation pest species in New Zealand and there are many benefits derived from reducing the possum population, particularly in areas where fur harvesting is not being undertaken. Extensive possum control over the past years has been the main driver for a substantial reduction in bovine Tb levels in New Zealand's cattle and deer herds. However this has been heavily dependent on 1080 use so an alternative less hazardous toxicant for ground control pest operations would be beneficial particularly if the ecotoxicity hazard was lower and the concern about secondary poisoning risks, particularly to dogs, could be alleviated.

There are no toxins currently registered for feral pig control. In many areas of the country, pigs are an important resource for hunting, and where they are a nuisance they can be controlled by skilled shooting and dogging. In some instances, where Tb is rife, where farmers are having problems controlling feral pigs or where pigs are causing conservation problems such spreading the pathogens for kauri dieback, discrete toxic baiting in a purpose designed bait station will provide a new and important tool. When considering a new toxin that can target animals like possums and pigs, a humane death has been identified as a very important feature and benefit. Furthermore any sub-lethally exposed animals will very quickly eliminate sodium nitrite residues.

CHECKLIST

Mandatory sections filled out	Yes
Appendices enclosed	Yes
Fees enclosed	No
Application signed and dated	Yes

Signed Date

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Confidential Appendices

Commercially Sensitive Information