Cadmium and New Zealand Agriculture and Horticulture: A Strategy for Long Term Risk Management

A report prepared by the Cadmium Working Group for the Chief Executives Environmental Forum

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1. Cadmium is a naturally occurring heavy metal in soils. Cadmium is only acutely toxic at very high levels, but it does accumulate in kidneys and livers which can lead to chronic toxicity problems. Current dietary surveys for New Zealander's indicate that the daily intake of cadmium is lower than the World Health Organisation (WHO) tolerable daily intake guidelines. It is unlikely that at current food cadmium levels there are any adverse health implications for the New Zealand population. However, there is some potential for the intake guidelines to change in future as new science come to hand, and there is a need for continued vigilance.

2. Phosphate fertiliser is the primary source of cadmium accumulation in agricultural soils, and the industry has imposed a voluntary limit on the levels of cadmium in fertilisers. However, low cadmium sources of phosphate rock are limited in supply and uncertain in their availability. Moreover there are no commercially viable processes for removing cadmium from rock phosphate. The accumulation of cadmium in NZ soils is likely therefore to continue in the immediate future.

3. In response to concerns about the likely continued accumulation of cadmium, the Chief Executive Environmental Forum established the Cadmium Working Group (CWG) supported through the Ministry of Agriculture and Forestry. The Working Group was tasked with assessing the potential risks surrounding cadmium in New Zealand's agriculture and food systems, and to develop responses. This report sets out the CWG's strategy for managing cadmium over the long term. It is intended to stand for the next seven years whilst information is collected and research undertaken to fill key knowledge gaps, with the aim of a review at the end of the period to determine progress and future directions.

4. Strategy Objective ***To ensure that cadmium in rural production poses minimal risks to health, trade, land use flexibility and the environment over the next 100 yrs***

5. Strategy Approach:a focus on the key risk areas of:
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   - Maintaining trade access and a vibrant productive sector
   - Maintaining flexibility in land use options
   - Protecting the environment, particularly groundwater and natural ecosystems

6. The Work Programmes cover:
   - Governance
   - Food Monitoring
   - Fertiliser Management
   - Management and Education
   - Environmental Monitoring and Research

Table 1: Summary of Cadmium Management Strategy Work Programmes

Work Programme	Risks addressed	Method	Key features	Responsibility	Implementation milestones
Governance	Human health, trade, land use flexibility, environment	Strategy management	Cadmium Management Group with all key stakeholders	Convened by MAF	Meet annually
		Risk based guideline development	Risk based soil guidelines	CWG. MFE, Industry	Completed in line with 7 year review of strategy.
Food Monitoring	Human health, trade		Total Diet Study, and specific monitoring of risk products. Management practices introduced where ML exceedances occur	NZFSA, with assistance from industry groups	Underway, report in late 2011. 5 yearly thereafter
Soil and fertiliser management	Land use flexibility, environment	Soil Monitoring	Regular soil testing,	Fertiliser industry, regional councils	Immediate implementation, annual reporting.
		Fertiliser Monitoring	Regular testing and 6 monthly fertiliser audits	Fertiliser Quality Council	6 monthly reports. Ongoing, annual report to CMG.
		Interim Guidelines	Independent international expert commissioned by CMG.	Convened by MAF with MFE	Develop interim guidelines for adoption by CMG by 30 September 2010
		Fertiliser management	Tiered fertiliser management system aligned with interim guidelines: 4 trigger values: 'a' trigger value - 0.6 mg Cd/kg 'b' trigger value - 1.0 mg Cd/kg 'c' trigger value - 1.4 mg Cd/kg 'd' trigger value - 1.8 mg Cd/kg	Fertiliser industry	Immediate implementation, annual reporting on management actions. Industry to develop indicators by first reporting period.
Management and Education	Human health, trade, land use flexibility, environment		Management practices to minimise the risk of cadmium to food chain and environment	Industry, with oversight from NZFSA	6 months for implementation. Inclusion in training courses.
Environmental Monitoring and Research	Human health, trade, land use flexibility, environment	Environmental monitoring	Programme to be developed to determine impact on groundwater and environment	Regional Councils	12 months, EW to co-ordinate.
		Research	Research to address immediate requirements as well as longer term needs. Information to be developed for review in 7 years.	Cadmium Working Group – MAF, MfE with MoRST	12 months - review of science and data needs funded by parties.

2 Background

Cadmium is a naturally occurring heavy metal in soils. It is not thought to be essential to life, but can be toxic at high levels. Cadmium largely enters the human food chain by being taken up by grass and crops, then either directly or by accumulating in the kidneys and livers of animals that eat grass and are subsequently eaten by humans. Smoking is also a source of cadmium. Cadmium is only acutely toxic at very high levels, but its accumulation in kidneys and livers can lead to chronic toxicity problems. The total lifetime accumulation of cadmium is important. Current dietary surveys for New Zealander's indicate that the daily intake of cadmium is lower than the World Health Organisation (WHO) tolerable daily intake guidelines. It is unlikely that at current food cadmium levels there are any adverse health implications for the New Zealand population. However, there is some potential for the intake guidelines to change in future as new science comes to hand. There is a need for continued vigilance.

Cadmium concentrations are not high in New Zealand soils, and are at levels comparable with our overseas trading partners. However, in common with those trading partners, soil cadmium levels are increasing at a slow rate. This increase comes primarily from cadmium that is present in phosphate fertilisers applied to our soils to maintain production. The national average baseline or natural background level is 0.16mg/kg of soil (range 0 – 0.77mg/kg), and the national average concentration across all agricultural land classes is 0.35 mg/kg (range of 0 – 2.52 mg/kg). The levels of cadmium in soil are driven largely by fertiliser use history and tillage depth. Regions with intensive agriculture with its associated intensive phosphatic fertiliser use tend to have higher cadmium loadings and soil concentrations. The national average accumulation rate over the last five years is approximately 5 µg/kg soil/year, which is lower than the historical rates because of a reduction in cadmium concentration in fertilisers.

The fertiliser industry has made an initial response to cadmium issues by imposing a voluntary limit on the levels of cadmium in fertilisers. This involved a move away from less expensive and higher quality Nauru sources to other sources, and this is considered likely to have reduced the average increase in soil cadmium to two-thirds of the previous rate. However, low cadmium phosphate rocks are difficult to source, and supply can be erratic. Sources such as the North Carolina rock have been denied to the New Zealand industry as they are classified as 'strategic resources' and only exported in a value added form. A similar situation exists with Chinese rock phosphate, further complicated by export taxes and logistical difficulties. The current main low cadmium source from Morocco is mined in the Western Sahara. This area is subject to a United Nations mediated process, the outcome of which may impact on long term supply. Certainty of supply is important for the fertiliser industry, which must modify processing equipment to cope with different sources of rock phosphate.

There is no commercially viable process for the removal of cadmium from phosphate rock. Some cadmium is removed as a result of the manufacturing process in the production of high analysis fertilisers. These high analysis products contain varying amounts of cadmium, are expensive and produce a type of fertiliser which creates other problems, not the least of which is the added cost and environmental impact. For example the current single superphosphate contains sulphur as well as phosphate, which suits New Zealand's sulphur deficient soils. Alternate low cadmium sources such as diammonium phosphate (DAP) contain nitrogen, which while suitable in some situations, restricts the timing of nitrogen

fertiliser application and may create other environmental problems. The accumulation of cadmium in New Zealand soils is likely therefore to continue in the immediate future. In response to concerns about the likely continued accumulation of cadmium, the Chief Executive Environmental Forum established the Cadmium Working Group (CWG). The Working Group was tasked with assessing the potential risks surrounding cadmium in New Zealand's agriculture and food systems, and to develop a response.

The first report of the CWG discussed the current status of cadmium in agricultural soils, and identified potential risks to human health, trade and the economy, and flexibility of land use. Their conclusions in respect of each of these risks are as follows:

- Cadmium in foods currently do not pose a risk to human health in New Zealand.
- In respect of trade, there is a small risk of exceeding food standards for cadmium in offal and some vegetables, and there are risks in NZ falling behind the cadmium standards of our trading partners and subsequent damage to our clean green reputation.
- Cadmium accumulation poses risks to the future ability to subdivide land for residential or rural residential purposes, and could affect the ability of landholders to grow certain types of produce.

The report recommended the development of a strategy to manage cadmium in New Zealand including governance arrangements. The purpose of this report is the development of a National Cadmium Management Strategy. The Strategy adopts a risk based approach to managing issues associated with cadmium in agricultural soils. This strategy addresses the concerns raised by the CWG first report, and sets out a strategy for managing cadmium over the long term (100 yrs, upgraded from an initial consideration of 50 years). It is intended to stand for the next seven years whilst information is collected and research undertaken to fill key knowledge gaps, with the aim of a review at the end of this period to determine progress and future directions.

3 Strategy Objectives

The National Cadmium Management Strategy's objective is:

"To ensure that cadmium in rural production poses minimal risks to health, trade, land use flexibility and the environment over the next 100 years"

This will be achieved by:

- New Zealanders will not be consuming more than the internationally-agreed Provisional Tolerable Monthly Intake for cadmium over the period of the strategy as evidenced by the New Zealand Total Diet Study (NZTDS)[1].
- Food exported from New Zealand will comply with the cadmium standards existing in the particular export market.
- New Zealand will provide sufficient information for consumers to maintain confidence in the national system for managing cadmium in food to the required levels.
- Management and mitigation of cadmium does not pose an unnecessary or inequitable cost on New Zealand producers that renders them uncompetitive in world markets.
- Ensure that cadmium does not unduly limit foreseeable land use options.
- Ensure long term protection of the environment and groundwater from any potential risks of cadmium.
- Develop the knowledge base of cadmium risks and their mitigation for the review of the strategy.

[1] Noting that the current PMTI of 25 ug/kg bw was approved by JECFA in June 2010.

4 Approach

This strategy is based on a risk management approach to dealing with cadmium in agriculture. The risk based approach involves a focus on the key risk areas of:

1. Protecting human health.
2. Maintaining trade access and a vibrant productive sector.
3. Maintaining flexibility in land use options.
4. Protecting the environment[2], particularly groundwater and natural ecosystems/farm ecosystems.

The strategy will ensure that there are management strategies in place to reduce these risks to an acceptable level. The strategy recognises, however, that our ability to manage risks is constrained by a lack of information in key areas such as the impact of cadmium on the environment and groundwater.

Because of this lack of knowledge, the strategy is an interim approach that aims to have a review at the end of 7 years. It manages risks to the best of our current knowledge and ability recognising the costs of precipitate action, but also focuses on developing the information base that will allow us to better manage risks in the future. The basis of this approach is therefore to:

- Develop New Zealand risk based guidance for cadmium in agricultural soils.
- Proactively, but cautiously manage risks based on current available information.
- Develop new knowledge to allow the appropriateness and effectiveness of the strategy to be assessed at review.

Because the build up of cadmium is slow, taking this approach allows recognition of the issues and implementation of an approach to manage the most immediate risks, without imposing potentially unnecessary costs on the industry and regulators.

The strategy has two broad and overlapping thrusts for managing the risks:

- A comprehensive food monitoring programme, which is the means of identifying the risks to trade and human health.
- A soil, water and fertiliser monitoring and fertiliser management programme, which is the primary means addressing the land use flexibility and environmental risks.

Where threats in specific situations or food products are identified, either through the food monitoring programme or the soil monitoring, there will be a common management and education programme to mitigate those risks. There will also be consistent governance arrangements, and a common research programme underpinning the strategy. The structure of the strategy is shown in

[2] The environment is defined in the RMA as including ecosystems and their constituent parts, including people and communities; natural and physical resources; amenity values; and the social, economic, aesthetic and cultural conditions which affect the previous or which are affected by those matters.

Figure 1 below. The strategy addresses each of the specific risk objectives through the following pathways:

- The risks to ***domestic human health*** will be managed primarily through food standards and non-regulatory measures based on data gathered via the food monitoring programme, with the initial emphasis on the Total Diet Study. Non-regulatory approaches may include measures such as education of growers about minimising cadmium uptake in products.

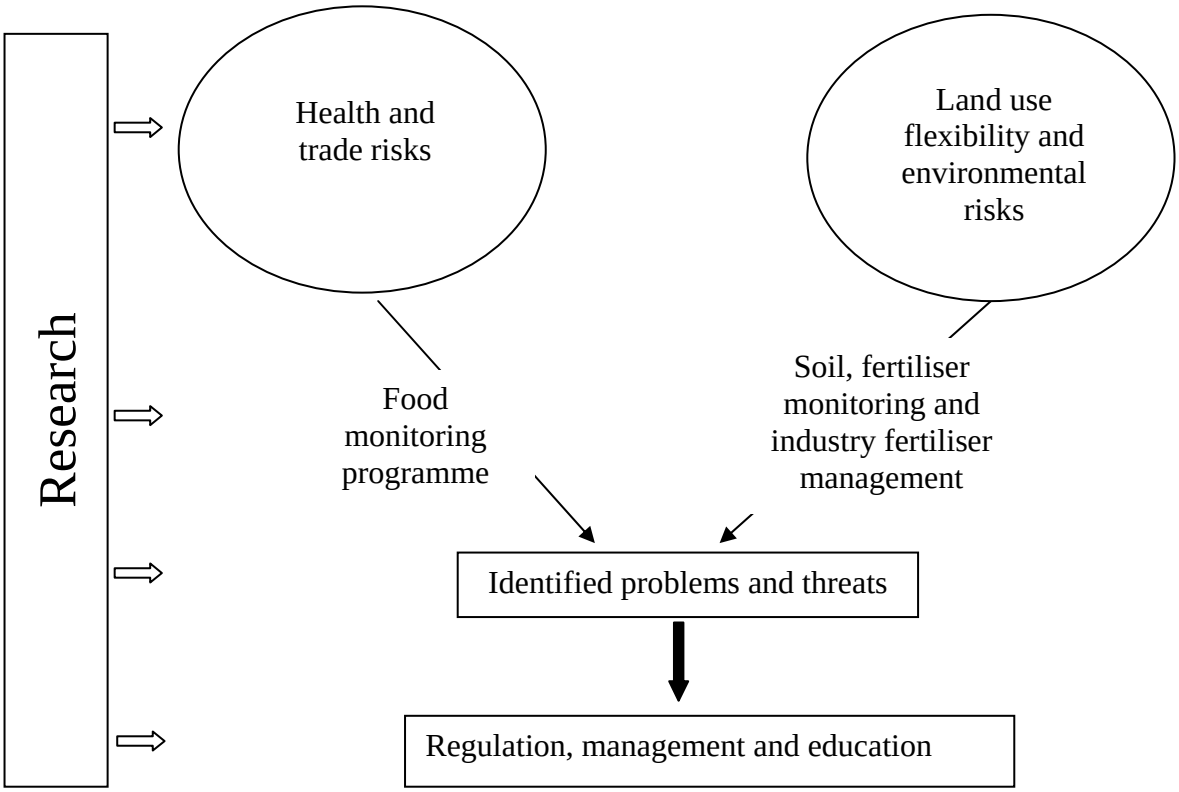
- Risks to ***trade*** will be primarily achieved taking cognisance of international approaches through management and mitigation where specific problems are identified through the food monitoring programme. However governance, particularly communicating with trading partners and customers about New Zealand's approach to management of cadmium, will also be of key importance in providing confidence about our approach.

- Risks to ***costs of production*** will be managed throughout the programme, but in the long term research is required to determine how we can best limit the build up of cadmium in a cost effective manner.

- Maintaining ***land use flexibility*** will be ensured through monitoring of soils and fertilisers, and through a tiered fertiliser management programme that will limit the build up of cadmium. Research will be required to address long term issues surrounding the build up of cadmium and how it should most cost effectively be minimised.

- The impacts of cadmium on the ***environment and groundwater*** are not currently well understood in the New Zealand context. These risks will be managed through a monitoring and research programme. The monitoring will focus on soils, groundwater and ecological sites, and the research will work to understand cadmium pathways and how it can impact on farmland ecosystems (particularly in the soil) and on off-site ecosystems.

Figure 1: Structure of the National Cadmium Management Strategy



5 Work Programmes

5.1 GOVERNANCE

The governance part of the programme aims to oversee the strategy and ensure that the component work streams, organisations and agencies are co-ordinated and resourced. The Governance work stream will ensure that priorities, actions and resources are in place to meet the objectives of the strategy. Its major elements are discussed below.

A Cadmium Management Group (CMG) will be established comprising all key stakeholders in rural production and environmental management. This group will include representatives from:

- Meat and Wool NZ
- Dairy Industry
- Arable Food Industry Council
- Horticulture NZ
- Fertiliser Industry
- Regional Councils
- New Zealand Food Safety Authority
- Ministry of Agriculture and Forestry
- Ministry for the Environment

Members represent sectors rather than organisations, and the group will be convened by MAF who will appoint an independent chair. The CMG will meet at least annually and more frequently if necessary, and will report annually to the Director General of MAF and relevant stakeholders. Sub groups will meet as necessary.

The CMG will ensure that all agencies are acting in a co-ordinated manner to deliver on the aims of the strategy. It will define requirements and set priorities on:

- Research
- Monitoring (food, soil and fertiliser)
- Implementation of strategy
- Communications, information and education

The CMG will co-ordinate communications that:

- Explains the issues and risks associated with cadmium.
- Describes how the cadmium management strategy addresses those issues and how it fits with the programmes of its members.
- Describes the roles of the Cadmium Management Group.
- Provides updates on information derived from the monitoring and research programmes
- Provides information for landholders on cadmium.

The CMG will develop and implement a strategy to ensure the risk based guidelines for management of cadmium are in place by 2017.

The CMG will liaise between industry groups, research funding agencies and research organisations to ensure that the research priorities of the Cadmium Management Strategy are implemented.

The CMG will liaise with agencies over the regulatory framework for cadmium. The CMG will work with MFE, MAF, NZFSA, industry groups and regional councils to develop and refine regulatory approaches towards national consistency to managing cadmium to ensure the protection and sustainability of our agricultural systems as well as the wider ecosystems in which they operate[3]. The CMG will advocate for consistency of regulatory approach among agencies managing cadmium.

The CMG will periodically review the relevance and appropriateness of the Cadmium Management Strategy

The CMG will lead a major review of the Cadmium Management Strategy in 2017 that includes a wider group of stakeholders. This review will assess the:

- Performance of the strategy in managing risks related to cadmium.
- New information which has arisen on cadmium impacts and management to determine whether the objectives or work programmes should be altered.
- The effectiveness of the governance arrangements.

5.2 FOOD MONITORING

Food monitoring is the primary tool for ensuring that risks from cadmium to human health and trade that derive from food for sale are adequately managed. Since these risks could be significant, both to the community and the economy, it is essential that the food monitoring programme is well formulated and able to address all foreseeable risks, but it needs to do so in a cost effective manner. The Cadmium Management Strategy will implement a three level approach to monitoring, based on identifying and managing cadmium risks as shown in Table 2 below.

Table 2: Monitoring Risk Management Framework

Level		Type	Source	Aim	Responsibility
1	Identify	Total Diet Study (TDS)	Dietary exposure via synthesised model diets	Primary screening for risk to consumers. Understanding of trends in Cd in NZ diets at a mean and sub-population basis	NZFSA
2	Assess	Specific risk product surveys (SPRPS)	Risk products identified by TDS and by other information	Assess level of risk to trade and human health	NZFSA and industry, depending on product and survey requirements
3	Manage	Apply interventions and reduce risks	Confirmed risks from SPRPS	Ensure trade and human health risks are below acceptable threshold	Industry, with NZFSA input in high risk situations

Identification – Total Diet Study (TDS)

The TDS is the best indicator available for the status of cadmium in New Zealand diets. The TDS is undertaken on a 5 yearly basis, and involves sampling from supermarkets and other retail outlets of representative foods in the New Zealand diet. The data is collated on an individual product and calculated on a whole diet basis.

[3] There is potential for this approach to be applied to other diffuse contaminants of agricultural land.

The TDS represents an excellent first screening basis, but there are some problems with the data collection and storage which limit the ability to collate and compare data across years. As testing has become more sensitive, data which was previously below the limits of detection now has a recorded value. Because of the way in which a result reported as below the limit of detection was previously assigned, this can show up as an apparent decreasing trend in cadmium in that product. Thus it may be that the apparent decrease in cadmium levels is merely an artefact of the testing and recording system.

The CWG intends that the TDS continues as the first line risk management approach for cadmium in food. However, it is of key importance that we are able to discern trends in the data from this survey, because good trend information will give us long lead times to understand what action is required. This trend information is needed both at a dietary level and for individual products.

The objectives for the TDS are to:

- Continue with the five yearly survey, with periodic reviews to ensure that the timing and sensitivity of the programme are appropriate.
- Ensure that the testing, data collection and storage, and analysis are able to provide trend information on changes in cadmium status.
- Ensure that information is available at the total diet and product group level, and for specific risk groups in the population.
- Monitor the status of cadmium in overseas trading partners to enable comparison with New Zealand product and health status.

Level 2 programmes – Assess

The TDS is useful as a primary screening process, but it would be expensive and unnecessary to upgrade it to the point where it was able to fully assess the risks for each product group. For this reason the CWG proposes a second tier monitoring programme targeted at specific products. These target products would be selected on the basis of:

- Information from the TDS.
- Known risk products that are important from a trade perspective, including ones that are not currently addressed by NZFSA.
- Monitoring information from overseas that indicates risk products.
- Other information such as soil monitoring data, varietal information or management practices that may raise risks, particularly in sensitive trade areas.

Once target products have been identified, NZFSA and the relevant industry body will enter into negotiations to determine the:

- Monitoring requirements
- Responsibilities
- Funding

NZFSA will provide assistance and advice but will not necessarily undertake the monitoring. However, they will provide oversight to ensure that risks to human health, and collective risks to trade for New Zealand's image are well managed.

Traceback of products to individual producers may well be incorporated at this stage, although this will be dependent on survey design and testing. It is intended, however that the

monitoring programme assist with understanding of why particular products exceed Minimum Levels and correcting this where necessary.

The objectives for the Level 2 monitoring are:
- Assess level of risk from specific products.
- Ensure that trade in those products is protected.
- Ensure that NZ's collective trade risk from damage to its image is managed appropriately.

Level 3 – Manage

Once specific risks have been established, a programme will be established to ensure that the risks are managed to acceptable levels. This level of monitoring will link closely with management and mitigation programmes on farm. The objective of this level of monitoring is to:
- Provide information to support management and mitigation interventions, including traceback where required to the farm level.

Programmes at this level will be very specific to the product type and risk level. These programmes will be developed by NZFSA and industry, with responsibility determined according to the nature of the product and the level of risk. Where industry undertakes responsibility, NZFSA will continue to provide expertise and oversight.

5.3 SOIL AND FERTILISER MONITORING AND FERTILISER MANAGEMENT

Soil Monitoring

Soil monitoring is the primary tool for determining the ongoing status of cadmium in New Zealand, and the way it is accumulating over time. Monitoring of soils will be undertaken by a number of organisations:
- Fertiliser industry as part of the industry self management
- Regional councils as part of their State of the Environment monitoring
- Research organisations.

The industry self management programme will involve regular soil testing for cadmium as part of the management system. The sampling depths from the industry programme and the monitoring undertaken for State of the Environment reporting are not fully aligned, and the appropriateness of the monitoring depth should be addressed by the review for the interim guidelines and at the 7 year review for the risk based guidelines.

Responsibility
- FertResearch – co-ordination
- Fertiliser companies – soil testing
- Regional councils – SoE reporting

Fertiliser Monitoring

Fertiliser monitoring is an important part of managing cadmium build up and base information for a mass balance approach to understanding cadmium behaviour in the soils and environment. A fertiliser monitoring programme is currently undertaken by the NZ Fertiliser Quality Council. The role of the Fertiliser Quality Council is to provide the independent Fertmark auditor who as well as monitoring nutrient levels, also monitors cadmium levels in all phosphate fertilisers. This is done through a combination of fertiliser company reporting

from their own laboratories and Fertmark random testing at dispatch points throughout New Zealand, using the Fertmark laboratory testing methods. All results are reported to Fertiliser Quality Council.

Responsibility
Fertiliser companies will continue to test cadmium levels in product using Fertmark testing methods, and this will be reported to and audited by the Fertiliser Quality Council. This represents a continuation of the current management arrangements for fertiliser. The Fertiliser Quality Council will provide the fertiliser monitoring information to the Cadmium Management Group on an annual basis.

Fertiliser Management

Given that phosphate fertilisers are a primary source of cadmium to agricultural soils, it is appropriate to develop programmes that manage cadmium accumulation. The proposed programme is industry based and aims to ensure that cadmium is maintained at levels in the soil where it poses acceptable risk to the health of the soil and its suitability for use for agricultural purposes.

The fertiliser programme is based on a tiered system. The *Tiered Fertiliser Management System* (TFMS) is a system for linking soil cadmium levels to management action. The management tiers are based on increasing soil cadmium levels, with specific fertiliser recommendations to address loading rates at each tiers. It aims to ensure that soil cadmium levels remain within a recommended range of values over a given time period
The TFMS has four tiers.

At

- Tier 1, there are no limits on the application of phosphate fertiliser other than a five yearly screening soil test for cadmium status.
- Tier 2, application rates are restricted to a set of products and application rates to minimise accumulation, and landholders are required to test for cadmium every five years using approved programmes.
- Tier 3 application rates are further managed by use of a cadmium balance programme to ensure that cadmium does not exceed an acceptable threshold within the next 50 years.
- Tier 4 no further accumulation above the “Trigger” value (1.8 mg Cd/kg soil).

At Tiers 2, 3 and 4 landholders will be required to use a set of management practices to limit the risks posed by cadmium to the food chain and environment, and these management practices will link with the management and education work programme and the food monitoring programme.

The Cadmium Working Group recognises the value of the tiered system in raising the issues of cadmium for landholders, in reducing the rate of diffuse accumulation in agricultural soils, and in managing bioavailability of cadmium when soil concentrations are elevated. The thresholds at which tiers are implemented will correspond to the guideline values for cadmium management in New Zealand. The process for identifying these guideline values and associated sampling protocols is described in Appendix 1. Once the guideline values have been set, industry will incorporate them into the tiered management system, and that system will be adopted by the CWG as an integral part of the Cadmium Management Strategy. The CWG approved tier trigger levels and other decisions are presented in Appendix 4.

Responsibility:

- ***MFE and MAF have overseen the commissioning and management of the independent review of interim guidelines with the agreement of the industry and CWG as per Appendix 1.***

- ***Industry will continue to implement the tiered management strategy and will report to the CMG on key elements of the strategy, and particularly on progress in ensuring that cadmium accumulation is as low as is reasonably achievable[4].***

5.4 MANAGEMENT AND EDUCATION

In order to address risk areas once they have been identified, a management and education programme will be developed. Where problems are identified in particular soils or produce, there is a need to ensure that growers are equipped to respond with appropriate strategies. There is no intention at this stage to undertake a broad scale education programme, but rather to target information to specific problem properties and products. A requirement for specific mitigation strategies will be triggered in one of two ways:

- Risk product groups where exceedances have been identified through the food monitoring programme.
- High soil cadmium levels identified in the soil monitoring programme.

Where this occurs, the CWG intends that there will be a specific process developed to ensure that risks to the food chain are appropriately managed. The development of the mitigation strategies is seen largely as an industry responsibility, with input from research agencies and the NZFSA. The mitigations may be:

On farm

- Husbandry practices;
- Soil conditions (pH, zinc, organic matter);
- Fertiliser application strategies; and
- Plant variety selection.

Off farm

- Product testing;
- Product exclusion;
- Product mixing.

It is anticipated that the research programme will refine and develop the range of practices available for managing cadmium uptake.

Education of farmers/growers will be undertaken on an individual basis using existing one on one advisors. The key routes will be:

- Fertiliser representatives.
- Industry extension personnel
- Regional council land managers.

Each industry sector will develop access to the necessary resources (fact sheets, management guidelines) to assist advisors and farmers/growers.

[4] As per the ALARA ("as low as is reasonably achievable") principle used in food safety.

Responsibility:

- Primarily the responsibility of industry organisations in conjunction with fertiliser representatives.
- NZFSA to have a support and oversight role.
- MfE, MAF, regional councils and other agencies to provide support and assistance in their statutory roles.

5.5 ENVIRONMENTAL MONITORING AND RESEARCH

Environmental Monitoring

There is a need for more information on the status and impacts of cadmium in the wider New Zealand environment at present. The key needs are for a groundwater monitoring programme and research monitoring of cadmium status (and impacts) in other parts of the environment.

Several regional councils are intending to begin monitoring for groundwater, but it would be useful if there were a standardised system in place for periodic inclusion of cadmium in the list of items tested in groundwater monitoring programmes. It would also be useful if this information were collated centrally for use by agencies and the CMG.

Monitoring of cadmium in the environment will initially form part of the research programme on cadmium environmental impacts. The results of that research will determine the nature and extent of any further monitoring programmes in this area.

Responsibility:
Regional councils – groundwater monitoring
Research agencies – environmental monitoring
MfE – facilitate the standardisation of testing and collation of data

Research

The research work stream underpins all the other work programmes. The research priorities break down into three key areas that approximately correlate with immediate, medium and long term priorities. The research will be prioritised to fit into the risk based guidelines development.

Immediate – Knowledge required to improve management of cadmium

This knowledge will support the monitoring, management and mitigation work streams, and will be closely related to the information that comes out of the monitoring and traceback programmes. Key research priorities include:

- Information about soil cadmium concentrations.
- Pathways and transport mechanisms within soil and the soil-plant-animal systems in a New Zealand context, particularly in the context of identified exceedances.
- Soil management techniques to minimise cadmium uptake.
- Varietal variation in cadmium uptake with a view to exploiting genetic variation in uptake[5].

[5] Plant breeding will be a key tool for growers of high risk crops, because it is well understood that particular varieties of plant appear to have high cadmium uptake rates, even in relatively low soil cadmium levels. Where specific product lines are identified as at risk in the NZ situation, it is important that industry work with plant breeders to assess current varieties to see if they are accumulators and to include cadmium as a selection trait. Although breeding is a long term solution, because of the long lead times, the linkages between industry and plant breeders needs to be established at an early stage. Low cadmium varieties represent a simple, effective and easily adopted technology for the management of cadmium risks.

- Cost-benefit analysis of risk-based approaches to managing cadmium.

Medium term – Information needed to review the strategy.
The strategy will be reviewed in 7 years, and it is important that the group is at that stage able to assess the success of the strategy, and to understand whether it adequately addresses the risks faced. The major issues in this medium term priority relate to those areas not addressed currently in the strategy, particularly the environmental and groundwater impacts of cadmium. However, information is also required for the CMG to understand whether the current focus on food monitoring as the primary risk management tool is appropriate, and whether a soil based approach is potentially effective and desirable.

Key medium term research priorities are:
- Understanding of cadmium levels suitable for different land uses and animal classes.
- Environmental and ecological impacts of cadmium both *in situ* (soil organisms) and in the wider ecosystem.
- Risks from cadmium in groundwater in relation to drinking water standards.
- Cost-benefit analysis of the cadmium management strategies and alternative actions.
- Soil cadmium balances and appropriate tools.

Long term research
The working group recognises that the continued build up of cadmium in New Zealand soils is not an ideal situation, even if it is unavoidable at present. The drivers in the most sensitive jurisdictions tend toward less and less acceptability of environmental harm and the presence of potentially harmful substances in food products. Furthermore there are important drivers in the fertiliser industry that may reduce the attractiveness of single superphosphate as a P sources. These include the presence of other undesirable trace elements, potential for more restricted access to low phosphate rock suitable for single superphosphate, and increased transport and application costs that reduce its cost advantage.

The group considers it important that longer term research is implemented focused in areas that may lead to no net accumulation of cadmium in soils. There are a number of New Zealand specific areas of research that may be profitable to pursue, particularly if implemented in conjunction with other industry priorities. Potential areas of research include:
- Alternative sources of low cadmium phosphate.
- Remediation approaches where this may be necessary.
- Understanding of the costs and benefits of a strategy of no net accumulation.
- Increasing the efficiency of phosphate use.

Responsibility:
Different parts of the research programme will be implemented according to the priorities of the member bodies. The CMG will be responsible for ensuring that the full portfolio of research is implemented in the near term. MAF and MfE will take an active role in persuading government funded research agencies to put more research emphasis into cadmium. This will involve co-ordination among the bodies represented on the CMG, and communication with key research funding and provision organisations. It will be important to identify this as a priority in organisation's research strategies as well.

Appendix 1: Industry cadmium management strategy for agricultural land

The CWG has determined that the most suitable way forward for the Cadmium strategy is to develop guidelines under the framework in Appendix 2.

Appendix 2 basically refers to a range of guidance that expresses a management structure or hierarchy to deal with contaminants in general. The highest status is given to NZ produced "Risk based" guidelines in the hierarchy.

Risk based guidelines are currently being developed by MfE for treatment of cadmium contaminants for urban land use in a National Environment Standard on soil contaminants. However, no risk based guidance has been produced for agricultural land use. This paper proposes as a goal of the CMG, to establish New Zealand risk based guidance for cadmium in agricultural land in the period leading up to the seven year review date of the National Cadmium Management Strategy.

In the Appendix 2 hierarchy, in the absence of New Zealand risk based guidance, international risk based guidance is given the next highest status. The status given to international guidance is dependent on a review of how suitable the guidance is in the New Zealand environment. International risk based guidance could provide an intermediate solution to the existing issue of finding agreed values for use in agricultural soils.

To confirm what international guidance is most suitable for the interim in New Zealand, the CWG has commissioned an independent international expert to review potential guidelines and recommend the appropriate international guidance including sampling protocol. The review has covered the full range of available international risk based guidance. The review has then been independently peer reviewed by a local expert nominated by the CWG. The steps followed were:

1. CWG worked with MAF & MfE to advise on the commissioning of an independent international expert (under management of MFE and MAF) to recommend appropriate international risk based guidance under the framework of Appendix 2 including the soil sampling protocol. The expert assessed the tiered fertiliser management strategy and any other values submitted by CWG members.
2. CWG commissioned an independent local expert to peer review the international expert's work.
3. CWG ratified on 1st September 2010, the independent expert's recommendation, and guidelines to be incorporated in the industry fertiliser management strategy. Industry fertiliser management strategy is endorsed by the CWG and incorporated in the National Cadmium Management strategy.
4. The CWG has provided the ratified National Cadmium Management Strategy to MAF and seeks to get it endorsed by the CEEF with Murray Sherwin as sponsor.
5. CWG members agreed to work together to enable research funding, and collectively provide guidance and assistance to MAF, MfE and NZFSA on development of full New Zealand risk based guidelines.
6. The CWG supports MFE and MAF in a process of reviewing and clarifying the CLMG No 2 guidelines to change the emphasis to managing contaminants.

Appendix 2: Framework for development of interim guidelines for cadmium in agricultural soils

THE HIERARCHY OF GUIDELINE VALUES

There is no consistent central or local government policy on the use of national or international documents containing environmental guideline values. Determining the order in which available guideline values should be used when assessing a site is not a simple matter, resulting in confusion as to which criteria to use in which circumstances.

To alleviate this uncertainty, and to assist practitioners in preparing and reviewing site assessments, a hierarchy of guideline values contained in the reference documents has been established. The hierarchy is intended to provide guidance to preferred guideline values that should be used when assessing a site, and is provided in the form of a hierarchy of documents containing the guideline values.

The hierarchy has been developed according to the following principles.

- The New Zealand guideline values should be used in preference to guideline values from other nations or jurisdictions.
- Guideline values using a risk assessment methodology to establish guideline values (risk-based guideline values) should be used in preference to those that present threshold values.

Following these principles an overall hierarchy of reference documents has been established. This hierarchy, in order from most to least preferred, is:

1. New Zealand derived risk-based guideline values
2. Rest of the world derived risk-based guideline values, with preference given to those that employ risk assessment methodologies and exposure parameters consistent with that already used in New Zealand
3. New Zealand derived threshold values
4. Rest of the world derived threshold values.

This hierarchy has been developed for the following reasons.

- New Zealand documents have been developed using international best practice. They have been through substantial national and international peer review, and are accepted by national and local government and industry. In some cases they also reflect exposure pathways common in New Zealand (e.g. consumption of home-grown produce) that are often omitted from international documents.
- On the one hand, some countries have been addressing contamination issues for much longer than New Zealand and have invested heavily in the development of methodologies for deriving guideline values. Indeed, some of these methodologies have been used in the derivation of some New Zealand guideline values. On the other hand, internationally derived guideline values are likely to contain regulatory and social assumptions that are not necessarily applicable in the New Zealand context, and therefore these values should be used only in the absence of New Zealand values.

The hierarchy of documents

To assist in the selection of the appropriate guideline values for a given environmental media and/or purpose, a hierarchy of reference documents containing guideline values is established

separately for those documents that contain guideline values for soil and water. Further differentiation of documents within those groupings is made on the basis of protection (eg, human health, ecological receptors). However, users should note that different parameters and, in some cases, pathways of exposure, are used to derive the guideline values from different jurisdictions and users should refer to the original documents to ascertain the applicability of a selected guideline value.

Table 5: Hierarchy of documents containing guideline values for soil[a]

Basis of protection	Reference document	Grouping
Human health only[b]	*Health and Environmental Guidelines for Selected Timber Treatment Chemicals* (MfE and MoH, 1997) *Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand* (MfE, 1997) *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999)	NZRB
	Guideline on the Investigation Levels for Soil and Groundwater (NEPC 1999) (health investigation levels, residential land use only). *Assessment of Risks to Human Health from Land Contamination* (DEFRA and EA, 2002) *Soil Screening Guidance: Technical background document* (US EPA, 1996a) and *User's guide* (US EPA, 1996b); *Supplemental Guidance for Developing Soil Screening Levels at Superfund Sites* (US EPA, 2001) Region 6 *Human Health Medium- Specific Screening Levels* (US EPA, 2002a) Region 9 *Preliminary Remediation Goals* (US EPA, 2002b) *Soil Guideline Values for cadmium in soil, Science Report SC050021 / Cadmium SGV (UK EPA, June 2009)* *Supplementary information for the derivation of SGV for cadmium Better Regulation Science Programme Science report: SC050021/Technical review cadmium (UK EPA, June 2009)*	IRB[c]
	Guideline on the Investigation Levels for Soil and Groundwater (NEPC, 1999) (all land uses except residential)	ITB
Human health and ecological receptors	*Canadian Environmental Quality Guidelines* (CCME, 2002) *Circular on Target Values and Intervention Values for Soil Remediation* (Ministry of Housing, Spatial Planning and the Environment, 2000)[d]	IRB
Ecological receptors only	*Ecological Soil Screening Level Guidance* (US EPA, 2000)	IRB
	Guideline on the Investigation Levels for Soil and Groundwater (NEPC 1999) (ecological investigation levels)	ITB
Groundwater	*Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999)	NZRB
	Soil Screening Guidance[e] (US EPA, 1996a and b)	IRB

NZRB = New Zealand risk-based; IRB = international risk-based; NZTB = New Zealand threshold based; ITB = international threshold based.

a No hierarchy is established for the documents within each category.

b The underlying premise in existing New Zealand industry-based guidelines is that protection of on-site ecosystems is only required to the extent necessary to facilitate the use of the land (ie, plant growth and livestock). These guidelines have been classed as protecting human health only, as they do not consider the full extent of the protection of ecosystems as do the Canadian and Dutch documents.

c UK, Canadian and Dutch criteria are the only criteria (other than New Zealand) that include produce consumption.

d While Dutch criteria for human health protection are based on a residential land-use scenario, the majority of intervention values are based on protection of the ecosystem as these were lower than values derived for protection of human health. Hence, these values have a wider applicability than just to a residential land-use scenario.

e US EPA Region 6 and Region 9 guidance documents also provide groundwater values. However, these values originate from US EPA, 1996a.

Table 6: Hierarchy of documents containing guideline values for surface water, groundwater and sediment

Basis of protection	Reference document	Grouping
Human health	*Drinking-water Standards for New Zealand* (MoH, 2000)	NZRB
	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000)[1] *Canadian Environmental Quality Guidelines* (CCME, 2002) *Circular on Target Values and Intervention Values for Soil Remediation* (Ministry of Housing, Spatial Planning and the Environment, 2000)	IRB
Ecosystems	*Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000)[1]	NZRB
	Canadian Environmental Quality Guidelines (CCME, 2002)	IRB
Agriculture, recreational use[2]	*Health and Environmental Guidelines for Selected Timber Treatment Chemicals* (MfE and MoH, 1997) *Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand* (MfE, 1997) *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999)	NZTB
	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000)[1]	ITB
Sediment	*Circular on Target Values and Intervention Values for Soil Remediation* (Ministry of Housing, Spatial Planning and the Environment, 2000) Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments (Long et al, 1995)	IRB

NZRB = New Zealand risk-based; IRB = international risk-based.

1 The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* is grouped as an international risk-based document for human health, agriculture and recreational use as these sections use Australian-specific data. In contrast, New Zealand ecotoxicity data have been used in the derivation of values for protection of ecosystems. Hence these values are termed New Zealand risk-based.

2 These values are not included in the EGV database. However, they are mentioned in this table to indicate that these values do exist. Readers should refer to the original documents to ascertain the basis of their derivation.

It is important to note that a hierarchy is *not* established for the guidance documents within each category – the documents are listed alphabetically. Final selection of the appropriate criteria should be conducted according to the principles outlined in section 2. Particular attention should be given to the selection of guideline values for residential land use, as New Zealand, UK, Canadian and Dutch criteria are the only ones that include produce consumption as a pathway of exposure in this scenario.

If a reference document and its guideline values are not found in the database, this does not necessarily mean these criteria cannot be used in assessing a site. Guideline values from overseas jurisdictions can be used as long as:

1. the hierarchy established in this guideline document is followed
2. the user can demonstrate that the methodology used to derive the guideline values is consistent with New Zealand risk-based methods, or justify the appropriateness of using values based on different derivation methodologies for the particular site under consideration
3. the exposure pathways on which the criteria are based are those that operate at the site being assessed.

Users should apply this hierarchy in selecting appropriate guidelines. If, for any reason, users deviate from the hierarchy established above, the reasons for the deviation should be given and fully documented within the site assessment report. The minimum information requirements of site assessment reports have previously been outlined (Ministry for the Environment, 2001).

While this document has been developed as a tool for practitioners, users should ensure they are conversant with the derivation of any guideline value referenced in a site assessment.

APPLYING ENVIRONMENTAL GUIDELINE VALUES

In the previous section we established a hierarchy for applying the guideline values for sites that are given in various New Zealand and international documents. Before applying the hierarchy, however, it is important to understand the principles that govern the application of these environmental guideline values, and to understand the factors that can influence their applicability. Doing so should ensure that the guideline values used in assessment and management are chosen appropriately.

The following discussion establishes some principles for applying the hierarchy.

Principles of application

The hierarchy should be applied in keeping with the following principles.

Principle 1

In the Resource Management Act 1991, "sustainable management" means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety (RMA 1991, section 2). Therefore, guideline values should be applied that are appropriate for the site itself and the likely use of the site. For example, an industrial site that is to be rezoned as parkland should be remediated or managed to ensure that parkland criteria are met – not industrial criteria. Similarly, it is important to consider *all* receptors (human and ecological) on and near a site.

Principle 2

There are a large number of environmental guideline values available internationally for the assessment of contaminants in agricultural soils. The guideline values and documents referenced in this document and provided in the EGV database are those identified by practitioners in New Zealand at the time of writing as being the most commonly used, or are significant documents to which attention should be drawn.

If no New Zealand guideline value is available, there are three approaches that can be used to select a value from an international source.

1. the lowest (most conservative) appropriate guideline value is used, or
2. the user presents all the international guideline values identified, but selects one for use and justifies why that particular value has been chosen, or
3. none of the available criteria are used and a site-specific risk assessment is undertaken.

While there are an increasing number of reference documents available, occasionally a guideline value may not be available for a particular contaminant. In this situation it is also appropriate to undertake a site-specific risk assessment.

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Appendix 3: Cadmium Working Group Membership

Name	Organisation
Sean Newland	Fonterra
Chris Keenan	HortNZ
Jessie Chan	Meat and Wool NZ
Gerald Rys	MAF
James Court	MfE
Hilton Furness	FertResearch
Greg Sneath	FertResearch
Nick Kim	Environment Waikato
Dominique Noiton	Environment Waikato
Ted Taylor	Greater Wellington Regional Council
Eddie Grogan	Environment BOP
Mike Manning	Ravensdown
Ants Roberts	Ravensdown
Warwick Catto	Ballance
Mike Clear	NZFSA
Paul Dansted	NZFSA
Brodie Young	Environment Canterbury
Gary Bedford	Taranaki Regional Council
John Hellstrom	Chair
Matthew Taylor	Environment Waikato
Kevin Geddes	Federated Farmers
Alun Faulkner	Arable Food Industry Council

Appendix 4: Cadmium Working Group Agreement on Tiered Fertiliser Management System and Future Implementation

At a meeting of the CWG on 1 September 2010 and after consideration of the independent expert report entitled "*Review of, and recommendations for, the proposed New Zealand Cadmium Management Strategy and Tiered Fertiliser Management System,"* by Dr Michael Warne, CSIRO, the CWG agreed to the following:

1. A four tier system of trigger values for cadmium in agricultural soils:

- The Four tier trigger values are**:**

'a' trigger value - 0.6 mg Cd/kg
'b' trigger value - 1.0 mg Cd/kg
'c' trigger value - 1.4 mg Cd/kg
'd' trigger value - 1.8 mg Cd/kg

- The **'**d' trigger value needs to have further work to address what needs to be done when it is exceeded.
- Parties agreed that the language in the strategy should use the words "trigger values".

It was agreed that:

- Industry 'best practice" approaches are to be followed over next 5 to 7 years.
- The trigger values above will be reviewed using New Zealand specific values.
- The 4 tiered threshold may become a regulatory requirement, most likely by way of the Tiered Fertiliser Management System being drawn into the code of practice for fertiliser use, and compliance with the code of practice remaining as a condition of revised regional council Permitted Activity rules for fertiliser use.

2. The soil sampling depths should be:

- 0 - 7.5 cm – screening depth on uncultivated land
- 0 - 15 cm – screening depth on cultivated land
- 0 - 15cm – depth for definitive assessment on both cultivated and uncultivated land

It was agreed that standard terminology is needed. For purposes of reporting against thresholds in the national strategy, Regional Councils should adjust results of regional soil sampling to allow for any differences in sampling depth. (Most regional council sampling is carried out at a standardised 0-10 cm depth). Regional councils may also choose to include a specific soil sample of 0-7.5 cm or 0-15 cm for cadmium, and this will help determine conversion factors that might apply. Conversion factors can be used to convert to previous sampling approaches.

3. Detailed sampling guidelines need to be developed on determining if a trigger value has been exceeded

A protocol for soil sampling is to be developed addressing the appropriate sampling density. A statistical process for soil sampling is to investigated, to be contracted out and supported by the fertiliser industry.

It was agreed that a science provider would be commissioned to develop and recommend a statistically robust approach that would cover both sampling and the procedure for comparing the sample results with the relevant trigger value.

This is to be further discussed and addressed by the new implementation group.

4. The minimum farm management unit when using the tiered approach

The land management unit was considered the default position as the sampling unit. As a precautionary approach, defaulting to the highest 'farm block' cadmium soil test result should be used.

Where the sampling is conducted on land management units, the highest soil cadmium result should be adopted or further investigation carried out.

5. Archiving of soil samples

It was proposed that regional councils keep their own (State of the Environment) samples indefinitely, if appropriate. The fertiliser industry recommended standard archiving protocols as currently used by the laboratories be adopted (currently held for 3 months by commercial labs).

6. Data archiving

All agreed that unless parties are in a regulatory environment there was no need for a central database. The fertiliser industry will archive data and provide NZFMRA with non-identifiable farm data. There was a recommendation for the new CMG to explore more rigorous data archiving and reporting of soil samples.

7. Cadmium training

The fertiliser industry already provides training on contaminants and the topic is covered in Massey's Intermediate Sustainable Nutrient Management in New Zealand Agriculture course. The Tiered Fertiliser Management Strategy also needs to be introduced to the course. The fertiliser industry is to follow up.

8. Use of more complex and realistic models

There is potential for OVERSEER to also include cadmium, which is not the case to date. It was suggested as a priority for the OVERSEER owners to discuss adding cadmium to the next financial year project plan. The issue of using more complex and/or realistic cadmium models should be considered, but currently the preferred approach is for improving the current fertiliser industry model as new science becomes available.

9. NZ research to investigate derivation of soil specific limits

A number of questions were raised over the research needed, who would fund it, who would do it, and how that need will be addressed by any future cadmium group. In relation to

toxicology data, there is a need to identify where there are gaps in current data, including determining characteristics to be protected. The research also includes the need for a methodology for establishing soil guideline values and the need for NZ specific values derived from NZ data. This work was considered not urgent at present, but needs to be done in next 7 years.

All parties agreed to commission a scoping study to identify gaps in data and to see where we are at. Parties of the CWG agreed to fund the study. MAF and MfE are to agree who will draft the ToR and lead the project.

10. Communication strategy

A communication plan is required to engage the rural community to be co-ordinated by FMRA, MAF and MfE communications teams. The strategy is to be put on the MAF and FMRA web sites, once approved by CEEFs.

11. Future Implementation

Members of the CWG agreed the strategy would be tabled at the next meeting of the Chief Executive Environment Forum (CEEFs) on 21 October 2010 in Wellington. MfE and MAF are to provide the memo for the CEEF meeting. The strategy would be presented by a joint session between MAF, MfE and fertiliser industry representatives at the CEEF.

The CWG recommended that once the strategy is approved by CEEFs, the CWG is disestablished. A new 'implementation' group termed the Cadmium Management Group should then be established to take the program forward.