

Final Report of Expert Group for Silvermines County Tipperary

Lead and Other Relevant Metals



Environmental Protection Agency

Establishment

The Environmental Protection Agency Act, 1992, was enacted on 23 April, 1992, and under this legislation the Agency was formally established on 26 July, 1993.

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The Agency has a wide range of statutory duties and powers under the Act. The main responsibilities of the Agency include the following:

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- the monitoring of environmental quality, including the establishment of databases to which the public will have access, and the publication of periodic reports on the state of the environment;
- advising public authorities in respect of environmental functions and assisting local authorities in the performance of their environmental protection functions;
- the promotion of environmentally sound practices through, for example, the encouragement of the use of environmental audits, the setting of environmental quality objectives and the issuing of codes of practice on matters affecting the environment;
- the promotion and co-ordination of environmental research;
- the licensing and regulation of all significant waste disposal and recovery activities, including landfills and the preparation and periodic updating of a national hazardous waste management plan for implementation by other bodies;
- implementing a system of permitting for the control of VOC emissions resulting from the storage of significant quantities of petrol at terminals;
- implementing and enforcing the GMO Regulations for the contained use and deliberate release of GMOs into the environment;

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The Agency is assisted by an Advisory Committee of twelve members. The members are appointed by the Minister for the Environment and Local Government and are selected mainly from those nominated by organisations with an interest in environmental and developmental matters. The Committee has been given a wide range of advisory functions under the Act, both in relation to the Agency and to the Minister.



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Lead and Other Relevant Metals

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ABBREVIATIONS

DAF	Department of Agriculture and Food
DAFRD	Department of Agriculture, Food and Rural Development
DCMNR	Department of Communications, Marine and Natural Resources
DED	District Electoral Division
DEHLG	Department of Environment, Heritage and Local Government
EPA	Environmental Protection Agency
GSI	Geological Survey of Ireland
IAG	Inter-Agency Group
IGS	Implementation Group for Silvermines
MWHB	Mid-Western Health Board
NTCC	North Tipperary County Council
TEAGASC	Agriculture and Food Development Authority
TMF	Tailings Management Facility

GLOSSARY OF TERMS

Bio-availability in the human body and to farm animals

The process resulting in the difference between oral intake of a contaminant and the uptake of the contaminant into the blood or lymph system.

Bio-availability in soil

The extent to which the form of a chemical substance, e.g., heavy metal, is susceptible to being taken up from the soil by living organisms, such as microbes, plants or animals.

Pedological Processes

Soil forming processes which are mainly responsible for the development of distinct horizons in the soil profile. These processes involve the redistribution of materials within the soil profile and the addition to, and loss of material from, the developing soil.

Water hardness

Hardness is a natural characteristic of water, which can enhance its palatability and consumer acceptability for drinking purposes. Originally taken to be the capacity of a water to destroy the lather of soap, hardness is now determined by measuring the concentration of calcium and magnesium in water. Total hardness is taken to comprise the calcium and magnesium concentrations expressed as mg/l calcium carbonate (CaCO₃).

UNIT OF MEASUREMENT

Plant and foodstuffs: concentration of lead and other relevant metals can be expressed as milligrams per kilogram on either a dry weight or fresh weight basis, i.e., mg/kg_{DW} or mg/kg_{FW}.

Soil samples: total concentration of lead and other relevant metals in soils is expressed as milligrams per kilogram on a dry weight basis, i.e., mg/kg_{DW}.

Stream sediments: concentration of lead and other relevant metals in sediments is expressed as milligrams per kilogram on a dry weight basis, i.e., mg/kg_{DW}.

Surface water: concentration of lead and other relevant metals in surface water can be expressed as milligrams per litre (mg/l) or micrograms per litre (µg/l).

CHEMICAL FORMULAE

As	Arsenic
CaCO ₃	Calcium carbonate
Cd	Cadmium
Cu	Copper
Fe	Iron
Hg	Mercury
Pb	Lead
PbCO ₃	Lead carbonate
PbS	Lead sulphide
PbSO ₄	Lead sulphate
Zn	Zinc

EXECUTIVE SUMMARY

The Expert Group for Silvermines, County Tipperary, was established in June 2001 as a result of a recommendation contained in the Inter-Agency Group *Report of the Investigation into the presence and influence of lead in the Silvermines area of County Tipperary*. The recommendation specified that an Expert Group, to include international experts, be established to formulate guidelines applicable to Ireland on the management of lead in the environment. An interim report was published by the Environmental Protection Agency, which chairs the Expert Group in April 2002 entitled *Expert Group on Lead in Silvermines County Tipperary*. During the course of its work, the Expert Group recognised the need to consider guideline values and guidance in relation to other relevant metals associated with lead in the Silvermines area. The metals, which were considered and discussed during the course of the group's deliberations, were lead, cadmium, arsenic, zinc, copper and mercury. This final report of the Expert Group presents the overall findings and recommendations of the group in relation to these metals. The Expert Group can, however, reconvene at any time in the future should the need arise.

The overall recommendations of the Expert Group are summarised here. The detailed work of the Expert Group is presented in the following chapters of the report.

The main recommendations are:

Approach Adopted

1. The Expert Group considered the various approaches to the development of guideline values and concluded that a *precautionary* approach should be adopted, with due consideration being given to published soil guideline values, based on a risk assessment approach. In arriving at its recommendations in relation to soil guideline values the Expert Group considered relevant international guideline values, such as those used in the United Kingdom and The Netherlands. The Expert Group did not consider it appropriate to recommend a blanket adoption of international soil guideline values due to the unique nature of the Silvermines area. The UK and Dutch soil guideline values were considered in the context of available information on lead exposure and uptake in the Silvermines area and, in particular, the relatively low blood-lead concentrations which were identified during the human health monitoring programme conducted by the MWHB. The Group also stressed that guideline values for soil and sediment specified by it should be used in the overall context of an active management programme. These values should not be used in isolation from such an active management programme.

Active Management

2. The Expert Group considers that a comprehensive "active management" programme, involving the relevant authorities and the local community, is the most effective mechanism for minimising the risk of exposure of children, adults, animals, crops and the wider environment to lead and other relevant metals. It also considers that it is important that the term "active management" be clearly defined.

In relation to the protection of human and animal health in Silvermines, "active management" includes:

- A comprehensive monitoring programme for the area which includes the monitoring of human and animal health, the monitoring of lead and other relevant metals in the

environment and the monitoring of sites where remediation has been carried out. A simple checklist should be developed by NTCC as part of the monitoring programme, which would be completed periodically during a field survey of the area. Aspects which should be included in the visual check are mine site boundaries, significant construction activities, the state of streams and drains in the area, access to stream by livestock etc.;

- Immediate investigation of any incidents that are likely to give rise to increased risk of exposure to lead or other relevant metals by humans and animals;
- Immediate investigation of suspected lead-related animal health problems in the area;
- Availability of emergency procedures and contingency plans in the unlikely event of a major incident occurring, e.g., major dust blow from the Gortmore TMF;
- Reviewing and updating guidance on measures to minimise the uptake of lead and other relevant metals by humans, animals and plants;
- Encouraging the active involvement and assistance of the local community in maintaining awareness of the potential risk from lead in the area and preventative strategies that have been put in place;
- Appropriate dissemination of information to the local community in relation to on-going monitoring and other developments;
- Minimising disturbance of soils in and around residential houses;
- Minimising the disturbance of stream sediments in the area;
- Covering of bare soils where possible to prevent the exposure of humans, particularly children, and animals to contaminated soils;
- Minimising the disturbance of mining wastes; and
- Encouraging the appropriate management of mining sites and sites with elevated lead and heavy metal concentrations.

Guideline values for lead and other relevant metals in garden soil

3. The Expert Group recommends a soil guideline value for lead of 1000 mg/kg_{DW} for garden soils, for the protection of human health. Where this guideline value is exceeded, active management should be initiated.
4. The Expert Group recommends the adoption of the UK Soil Guideline Value for cadmium in garden soil of 1 to 8 mg/kg_{DW}, depending on pH of the soil. Where the guideline value is exceeded active management should be initiated.
5. The Expert Group approves the recommendations and guidance contained in the IAG report in relation to the preparation and consumption of locally grown fruit, including wild berries and vegetables, in the Silvermines area.

Guideline values for lead and other relevant metals in agricultural soils

6. The Expert Group agreed with the IAG report value of 1000 mg/kg_{DW} lead in soils as a guideline value below which toxicity problems in grazing animals are unlikely to occur. On farms where lead concentrations in soils exceed 1000 mg/kg_{DW}, good farming practices to minimise the risk of lead ingestion should be implemented with particular attention paid to young animals, which appear to be more susceptible to lead poisoning.

Guideline values for lead and other relevant metals in sediments

7. The Expert Group considers that the risks to children or adults from in-situ or recently dredged
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sediments are very low, due to the fact that exposure to sediments is very unlikely. In addition, the Expert Group considers that the steps specified by it, in relation to active management for sediments for the protection of animal health, are sufficient to ensure that human health is protected and the risks are minimised.

8. The Expert Group considers it appropriate that a similar guideline value should be used for lead in sediments as in soils, i.e., 1000 mg/kg_{DW}, for the protection of animal health. Above this guideline value, active management should be undertaken in relation to the protection of animal health.
9. The Expert Group considered that the risks posed to animal health by recently dredged sediment containing arsenic, cadmium, copper, mercury and zinc were minimal in comparison to the risk posed by lead. The Group therefore, does not consider it necessary to recommend guideline values in relation to sediments for the other heavy metals.
10. Animals should not be allowed direct access to watercourses where the lead concentration of the sediments is greater than 1000 mg/kg_{DW}.

Ecotoxicological guideline values for the Silvermines area

11. The Expert Group discussed the issue of guideline values in relation to ecosystem protection in the Silvermines area. Due to the presence of mineralised veins in the host rocks and as a result of centuries of mining activity in the area, the Expert Group agreed that it would confine itself to considering guideline values for the protection of human and animal health. It was felt that ecosystems in the area may have adapted to the unusual geochemical conditions, the mining legacy and elevated heavy metal concentrations, and that the imposition of guideline values for the protection of ecosystems in near pristine conditions would be inappropriate. Further research would be needed to investigate the usefulness of, and possibilities for, developing appropriate ecological guideline values for the Silvermines area.

Guideline values for lead and other relevant metals in dust

12. The Expert Group approves the use of the revised German TA Luft Regulations for setting limits for lead, cadmium, arsenic, nickel, mercury and thallium concentrations in deposited dust in the external environment.
13. The Expert Group recommends that the results from the internal dust monitoring, both in houses and the school, should be circulated to the Silvermines community once an evaluation of the findings has been carried out. The need for further dust monitoring and the frequency of such monitoring should be evaluated by the MWHB.

Guideline value for lead in human blood

14. The Expert Group agrees to the use of 10µg/dl as the current acceptable threshold for blood-lead concentration. The MWHB should continue to monitor developments in this area and should take appropriate steps if the threshold is revised in the future.

Guideline value for lead in animal blood

15. In relation to animal health, the Expert Group considers 0 to 1.2 µmol/l (25 µg/dl) lead to be

the normal range for blood-lead concentrations in animals.

Guideline values for lead, cadmium and arsenic in foodstuffs

16. The Expert Group noted the new regulations in relation to the permitted concentration of lead and cadmium in foodstuffs (EC No.466/2001) and the associated Directive on sampling and analysis (2001/22/EC) and Health (Arsenic and Lead in food) Regulations, 1972. DAF has incorporated these limits and the principles of the associated Directive on sampling and analysis into the National Plan to monitor heavy metal residues in animal produce.

Guidance on human health

17. The Expert Group considers that the current guidance in relation to human health in the environment of Silvermines is adequate. The education and awareness campaign in the Silvermines area, which is implemented by the MWHB, should continue to be provided through the on-going work of local health care workers. Guidance documents should be reviewed regularly and should take account of the results of human health monitoring as they become available.

Guidance on animal health

18. The Expert Group reviewed the guidance on animal health, which is available to the farming community in the Silvermines area and considers that the current guidance covers the majority of relevant issues. The Expert Group stressed the importance of preventing animal access to mine wastes, bare soils and stream sediments.
19. Dredged sediments with lead concentration of greater than 1000 mg/kg_{DW} should not be spread on adjacent land or be piled alongside streams and rivers where animals can gain access to the dredgings.
20. The Expert Group agrees with the recommendation, contained in the IAG report, that drinking water for animals should be extracted from streams by using a mechanism which avoids disturbing in-situ stream sediments, e.g., by pump and filtering system. This should be done preferably from a stretch of stream in which the concentration of lead in sediment is less than 1000 mg/kg_{DW} and where sediment disturbance can be avoided. Turbid water (indicating sediment in suspension) should never be used as a water supply for animals.

Guidance on sediment disposal

21. The Expert Group recommends that the mining sites contributing contaminated sediments to the watercourses in the area, in particular those in the Yellow River catchment, should be rehabilitated and managed in accordance with the SRK report *Management and rehabilitation of the Silvermines area*. This will help to provide a long-term solution to the generation of sediments and a safe waste management disposal facility for dredged sediments.
 22. The Expert Group recommends that stream sediments should be sampled and analysed to determine their concentration of lead and other relevant metals before drainage works are undertaken. This is required to determine the most appropriate and method of disposal.
 23. The Expert group recommends that sediments which have a lead concentration greater than
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1000 mg/kg_{DW} should not be disposed of to agricultural land, either along the bank or spread onto adjacent lands. As a temporary measure only, these sediments may be left in-situ until a safe waste management disposal option, which complies with relevant statutory requirements, is found. However, there may be an increased risk of flooding with the consequential spreading of sediments onto adjacent agricultural lands by floodwaters. Further guidance is given in the Teagasc booklet *Lead Animal Health* (Teagasc, 2001).

24. Where stream sediments with a lead concentration of less than 1000 mg/kg_{DW} are dredged and disposed of to adjacent agricultural land, the Expert Group recommends that the ground be rolled after spreading and that the area should not be grazed until grass re-growth is greater than 12 cm in height.

Guidance on gardening

25. The Expert Group recommends that where the concentration of lead in garden soils is greater than 1000 mg/kg_{DW}, and where vegetables are to be grown, clean soil should be imported and spread to a depth of 30cm in the area in which vegetables are currently grown and in potential future areas of cultivation.
26. In gardens where no vegetables are grown but where soil lead concentration is greater than 1000 mg/kg_{DW}, bare soils should be covered with vegetation or other appropriate media, such as bark mulch.
27. In relation to cadmium in garden soils, the Expert Group recommends the following active management steps:
 - where cadmium concentration is below 8 mg/kg_{DW}, soils should be limed to raise and maintain the soil at or above pH 7;
 - where cadmium concentrations are greater than 8 mg/kg_{DW}, vegetables should be tested to determine the concentration of cadmium in home-grown vegetables. Where the concentration in the vegetables is below the maximum permitted levels as outlined in Commission Regulation No 466/2001 (see table 6.5), soils should be limed to ensure that the pH is at 7 or above;
 - where cadmium concentrations in home-grown vegetables exceed the maximum permitted levels, as outlined in Commission Regulation No 466/2001, clean soil should be imported and spread to a depth of 30 cm in current and future vegetable growing areas of the garden.
28. The Expert Group recommends that where fruit and vegetables are grown in the Silvermines area for home consumption, the MWHB should offer a service to the local community to have these sampled and analysed for lead and cadmium to establish where clean soil may have to be imported into gardens.
29. The Expert Group recommends that where fruit and vegetables are grown locally, the guidance given in the IAG report should be adopted. That is, thoroughly wash all fruit, including wild berries and vegetables in running water of drinking quality; peel potatoes and all root vegetables prior to cooking; and remove the outer leaves of leafy vegetables prior to washing and consumption.
30. The Expert Group recommends that garden soil fertility levels should be maintained or

enhanced where necessary, particularly in relation to the adequacy of lime (i.e., pH 7 or above) and phosphorus.

Guidance on Soil Disturbance in relation to construction activities

31. The Expert Group recommends the following best practice in relation to soil disturbance:
- reference should be made to building codes, current planning regulations and health and safety regulations, which would be relevant, for example, to site workers engaged in site clearance and construction activities where contamination is expected;
 - bare areas of soil should be kept to a minimum during soil disturbance operations, such as, construction works etc.;
 - bare soils on sites should be dampened with water during weather conditions which favour the generation of dust on site; and
 - once works have been completed on sites, bare soils should be covered over to minimise the potential risk to human and animal health, e.g., sown with grass.
32. The Expert Group recommends that appropriate conditions should be attached to any planning permission relating to developments that require disturbance of soils in the area.

Guidance on soil disturbance related to agricultural activities

33. The Expert Group recommends that soil fertility levels be determined prior to reseeded and that these levels should be maintained or improved where necessary. It should be noted that elevated zinc and cadmium concentrations might affect germination and the establishment of grass.
36. The Expert Group recommends the following in relation to ploughing and reseeded where this is to be undertaken:
- reseed in the Autumn with late diploid perennial rye grass;
 - apply fertiliser based on Teagasc current nutrient advice;
 - roll after emergence;
 - in Spring, if growth is uneven, top herbage, apply fertiliser, roll and take an early silage crop; and
 - after a silage cut is taken, roll, apply nitrogen and allow re-growth for 3 to 4 weeks before grazing.
37. The Expert Group recommends that farmers in the area should avoid poaching the land during the winter months and at other times when the soil becomes saturated. This would minimise the risk of exposure of animals to bare soils with elevated lead concentrations.

Guidance on mine waste disturbance

38. The Expert Group recommends that unplanned disturbance of mine waste should not take place due to the risk of releasing pollutants to the environment. In the Silvermines area, mine waste should only be disturbed where it is part of a planned and authorised remediation programme.
39. Where approval for mine waste disturbance is granted as part of a remediation programme for the area, precautions should be taken to minimise the risk of exposure to humans, animals and
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the environment from lead and other relevant metals.

Guidance on children's playgrounds and playing fields

40. The Expert Group recommends that where there is a potential for the exposure of children to bare soils in playgrounds or play areas, soils should be sampled and analysed for lead. Where the concentration is greater than 1000 mg/kg_{DW}, appropriate measures should be taken to ensure that exposure to bare soil is minimised, e.g., grass cover in the area should be established and maintained.
41. In relation to playing fields, the Expert Group recommends that grass cover should be maintained or improved, where necessary, to minimise risk of exposure to bare soil.

Human Health Monitoring

42. The screening programme undertaken by the MWHB in 1999, 2000 and 2001, has shown the blood-lead concentrations in children are declining in the area and are below the threshold value of 10µg/dl. The Expert Group considers that there is little to be gained from continued monitoring of blood-lead levels, particularly due to the invasive nature of such monitoring. The need for monitoring blood-lead levels or the use of hand wipes should, however, be reviewed if an event occurs which indicates an increased risk to the community.

1 CONTEXT

1.1 Introduction

Cattle deaths from lead poisoning in early 1999 on a farm adjacent to the Gortmore Tailings Management Facility (TMF) in Silvermines, Co. Tipperary, resulted in the activation of a Protocol for collaboration between public agencies dealing with issues such as human and animal health and the environment entitled *Protocol for the Investigative Approach to Serious Animal / Human Health Issues* (EPA *et al.*, 1997). This Protocol was agreed between the Department of Agriculture, Food and Rural Development, the Department of Health and Children, the Department of Environment and Local Government, Teagasc and the Environmental Protection Agency.



Tailings Management Facility at Gortmore

An Inter-Agency Group (IAG) was established to conduct an investigation into the presence and influence of lead in the Silvermines area. The IAG made 39 recommendations in relation to human health, animal health, food safety, soils, environment and rehabilitation of mine working in the area. These findings were published in June 2000 by the Department of Agriculture, Food and Rural Development in the *Report of the Investigation into the Presence and Influence of Lead in the Silvermines area of County Tipperary* (DAFRD, 2000).

The IAG investigation, and the subsequent work of the Implementation Group for Silvermines, covers an area of approximately 23 square kilometres. This area was delineated using the results of a geochemical survey undertaken in 1963 with farm boundaries and District Electoral Divisions (DEDs) superimposed onto the map. Work to date has focused primarily inside this area, as indicated in Figure 1.1 (DAFRD, 2000).

Recommendation Number 39 of the report recommended that as a matter of priority, an Expert Group – to include international experts - should be established to formulate guidelines applicable to Ireland on the management of lead in the environment. The conclusions of the Expert Group should be available to, and should inform the work of, the Implementation Group for Silvermines (IGS), which was established in December 2000 to implement the recommendations contained in

the IAG report.

During the course of its work, the Expert Group also considered the need for guideline values and guidance in relation to other relevant metals associated with lead in the Silvermines area. The metals which were considered and discussed during the course of the Expert Group's deliberations were lead, cadmium, arsenic, zinc, copper and mercury.

1.2 Establishment of the Expert Group

The Expert Group for Silvermines met on four occasions. These meetings were held in June 2001, December 2001, June 2002, with the final meeting held on the 28 and 29 July 2003. The Expert Group consists of international experts and national representatives from various government departments, agencies and North Tipperary County Council.

International Experts

- Professor Brian Davies, BSc, PhD, C.Chem., F.R.S.C., Emeritus Professor of Geological Sciences, School of the Environment, Clemson University, South Carolina, USA.
- Dr Frank Swartjes, BSc, PhD, Head of the Expert Group for Risk Analysis in relation to soil quality, National Institute of Public Health and the Environment, The Netherlands.
- Professor Iain Thornton, PhD, DSc, DIC, Emeritus Professor of Environmental Geochemistry, Imperial College of Science, Technology and Medicine, London, UK.

Representatives from Government Departments and Agencies

Ms. Marie Sherwood, EPA (Chair)
Ms. Jane Brogan, EPA
Dr Matt Crowe, EPA
Ms. Carrie Garavan, Doctoral Scholar, EPA/UL
Dr Kevin Kelleher, MWHB
Dr Dave McGrath, Teagasc
Mr Jimmy McLaughlin, DAF
Mr David Moore, DEHLG
Mr Marcus O'Connor, NTCC
Dr Pat O'Connor, GSI (DCMNR)
Mr Frank O'Halloran, NTCC

1.3 Reports of the Expert Group

The EPA published an interim report on 12 April 2002 entitled *Expert Group on Lead in Silvermines County Tipperary* (EPA, 2002). This report dealt with the management of lead in the environment, with particular reference to human and animal health. Guideline values and guidance were discussed and specified in the report in relation to the protection of human and animal health. The group also identified additional tasks that required to be done prior to finalising its deliberations.

These tasks were:

1. Develop guideline values and guidance, where appropriate, for other relevant metals.

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2. Compile sampling protocols for soil, sediment and water.
 3. Review relevant parts of the report commissioned by the Department of Communications, Marine and Natural Resources.

This report, the final report of the Expert Group, presents the overall findings and recommendations of the group in relation to both lead and other relevant metals. The Expert Group also reviewed the relevant parts of the report commissioned by the Department of Communications, Marine and Natural Resources. The Expert Group also considered that the compilation of sampling protocols was unnecessary and that relevant published procedures and standards should be adopted where appropriate. It should be noted that the Expert Group can reconvene at any time in the future, should the need arise.

1.4 Terms of Reference and Objectives

Terms of reference were drawn up for the Expert Group. The main objectives for the Expert Group were set out in the Terms of Reference and are as follows:

1. To recommend appropriate standards for lead and other relevant metals in environmental media, including soils, sediments, surface waters, groundwaters and air. The Expert Group should review best international practice for the management of lead in the environment, with particular reference to the type of conditions that exist in the Silvermines area, i.e., relatively high natural levels of lead and releases into the environment as a result of mining activities.
2. To formulate appropriate guidelines on the use and application of the standards, taking into account the relative risk of the various pathways by which humans and animals become at risk from lead and other relevant metals. These guidelines will advise on appropriate mitigation measures to reduce the risks to children, adults and animals from lead and other heavy metals in the environment.
3. To assess the current monitoring programme being undertaken in the Silvermines area and advise on any alterations, additions etc., that may be required to the monitoring programme. Where gaps in information are identified, the need to undertake research in the Silvermines area should be examined and the type of research required should be specified.

2 METALLIC TRACE ELEMENTS IN SOILS

2.1 Introduction

This section presents some background information on typical heavy metal concentrations in soils, both in Ireland and abroad, together with information on metal content of soils in the Silvermines area. This serves to illustrate the unique nature of mining areas, such as Silvermines, which have high naturally occurring levels of metals.

2.2 Trace elements in soils

Trace elements are elements which generally occur in soils or plants in very small concentrations. Some, such as copper and zinc, are essential for the nutrition of plants and animals, though if present in large concentrations can be toxic. Others, including lead, cadmium and arsenic, are not essential and if present in high concentrations can adversely affect crops and human and animal health. The total content of trace elements in all soils is related primarily to the geochemistry of the parent rock. In young soils, the normal pedological processes have brought about little or no depth differentiation in the total contents of trace elements within the soil profile. As the soil matures and ages, leaching of soluble constituents down through the soil profile occurs and biogeochemical cycling by soil microbes and plants occur. This may lead to either the movement of certain elements between horizons in the soil profile and/or an accumulation in the surface soil. In addition, elements will be added to the soil by anthropogenic pollution and from natural sources, such as deposited dust, volcanic emissions and from drainage water received from higher elevations (Wild, 1988).

An international review of elemental constituents of soils, which was published in 1982, gives range and mean values for trace elements in soils from analysis of soils undertaken throughout the world. This information was compiled and a simple arithmetic mean was calculated from unscreened data for each trace element in soils (Bowen *et al.*, 1982). A summary of the results for cadmium, copper, lead, zinc and arsenic is provided in Table 2.1.

Table 2.1: Range and mean concentration of heavy metals in unpolluted soil

Element	Number of samples	Range (mg/kg _{DW})	Mean (mg/kg _{DW})
Arsenic	1193	0.1 – 194	11.3
Cadmium	1642	< 0.005 – 4.67	0.62
Copper	7819	20 - 100	25.8
Lead	4970	< 1.0 - 888	29.2
Zinc	7402	1.5 - 2,000	59.8

After Bowen *et al.*, 1982

A statistical survey of soil data from England and Wales indicated that the normal lead content of surface soils (0-15cm) lies between 15 and 106 mg/kg_{DW}, with a geometric mean of 42 mg/kg_{DW} (Davies, 1983). This study concluded that uncontaminated soils are unlikely to contain more than 110 mg/kg_{DW} of lead and that the average soil lead concentration in England and Wales is 42 mg/kg_{DW}.

Data on heavy metal concentrations in Irish soils are relatively limited. Sources of trace element concentrations in Irish soils include information from An Foras Talúntais and Teagasc. Teagasc initiated a National Soil Geochemical survey in 1995. A total of 295 soil samples were taken on a grid basis as part of this survey, representing 22 per cent of the land-base of the Republic of Ireland. Soils were analysed for cadmium, chromium, copper, nickel, lead, mercury and zinc. Table 2.2

provides a summary of some of this work for lead and other relevant metals.

Table 2.2: Summary of heavy metal concentrations in Irish soils

Land Use	No. of samples		Heavy metal concentration in mg/kg _{DW} of soil					
			Lead	Cadmium	Copper	Mercury	Arsenic	Zinc
Pasture	231	¹ mean	30.0	0.52	18.0	0.11	15.7	73.1
		median	25.9	0.40	16.4	0.09	12.1	71.1
Tillage	30	mean	30.3	0.76	19.1	0.11	16.4	88.6
		median	26.5	0.53	17.3	0.10	13.9	92.5
Forest	26	mean	38.1	0.29	8.7	0.15	12.8	38.0
		median	30.3	0.22	7.9	0.14	9.2	32.7
Peat bog	8	mean	17.6	0.35	4.9	0.13	3.2	26.2
		median	18.3	0.35	4.2	0.09	3.2	19.4

McGrath, 1998

As can be seen, mean soil lead concentrations in rural areas of southeast of Ireland range from 17.6 mg/kg_{DW} to 38.1 mg/kg_{DW}, which are similar to concentrations measured in soils in other countries. Work on the completion of the National Soil Geochemical Survey is currently underway at Teagasc. Over one thousand soil samples will be taken and analysed for a range of chemical and biological parameters. It is expected that this work will be finalised by the end of 2004.

2.3 Ore body in the Silvermines area

The ore body at Silvermines is mainly composed of massive sulphides in host rock of limestone and dolomite. The ore minerals present are galena (PbS – lead sulphide) and sphalerite ((Zn, Fe)S – zinc iron sulphide). These are found in association with pyrite (FeS₂ – iron sulphide), chalcopyrite (CuFeS₂), tetrahedrite (Cu₁₄Sb₄S₁₃), arsenopyrite (FeAsS – iron arsenide sulphide), marcasite (FeS – iron sulphide) and barite (BaSO₄) (Williams and McArdle, 1978).

The ore minerals in Silvermines therefore contain a range of other associated metals, such as cadmium which is found in sphalerite, mercury and silver which can be found in galena, copper in chalcopyrite, and arsenic which is found in arsenopyrite. Although the main focus in the Silvermines area is lead, the Expert Group considered that guideline values should be developed, where appropriate, for other metals and that the various elements of active management as defined in the Expert Group report on lead, should be examined and added to where necessary.

The metals that are considered in this final report of the Expert Group for Silvermines are:

- Lead (Pb)
- Arsenic (As)
- Cadmium (Cd)
- Copper (Cu)
- Mercury (Hg)
- Zinc (Zn).

2.4 Lead and other relevant metals in soils in the Silvermines area

As part of the IAG investigation which commenced in the Silvermines area in 1999, Teagasc initially undertook an exploratory soil sampling programme, taking 29 soil samples from agricultural areas.

¹Arithmetic mean

The mean soil lead concentration for these samples was 1136 mg/kg_{DW}, with a range of 50 to 3650 mg/kg_{DW}. Following on from that, a more extensive soil sampling programme was subsequently undertaken with 218 samples taken from agricultural areas. The mean soil lead concentration from these samples was 782 mg/kg_{DW}, with a range of 25 to 14842 mg/kg_{DW}. A summary of the results of all relevant metals is presented in Table 2.3

Table 2.3: Concentration of lead and other relevant metals in Silvermines soils

Sampling Programme	Soil type	No of samples		Heavy metal concentration in mg/kg _{DW} soil				
				Lead	Arsenic	Cadmium	Copper	Zinc
Exploratory	Agricultural	29	mean	1136	35	2.6	46.2	836
			median	239.2	20.5	1.0	32.4	235.4
Extensive	Agricultural	213	mean	780	21.9	1.1	27.0	361
			median	149	13.8	0.6	17.8	112
Exploratory	Gortmore TMF	5	mean	8154	543	24.8	150.3	7872
			median	9680	552	24.3	151.1	8590
Extensive	Gortmore TMF	5	mean	9654	463.5	20.2	395.6	7046
			median	11138	192	12.8	194	6583

About 20 per cent of all soil samples taken in the Silvermines area had lead concentrations greater than 1000 mg/kg_{DW}. Soils enriched in lead were also enriched in zinc. High soil zinc concentrations are known to affect plant growth, particularly pasture establishment. A high intake of zinc in the diet interferes with copper metabolism in animals.

The heavy metal distribution in soils in the Silvermines area was mapped using a geographical information system. Map 1 to Map 5 in Appendix B illustrate soil lead, arsenic, cadmium, copper and zinc concentrations in the soil samples taken by Teagasc in the Silvermines area. Both surveys carried out by Teagasc in the Silvermines area indicated that soil mean lead, copper and zinc concentrations in the area were significantly higher than in other areas surveyed throughout Ireland.

This concentration of lead in soils is not unexpected, due to the high natural geological occurrence of lead in the area and the level of historical mining activities that has taken place there. The relatively high concentration of lead in the soils, when compared to typical agricultural land in Ireland, serves to illustrate the unusual nature of the Silvermines area and other similar areas throughout Ireland where mining of metals has occurred.

2.5 Soil standards for heavy metals in soils (Use of Sewage Sludge Regulations)

The Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998 (SI No. 148 of 1998) prescribe standards for the use of sewage sludge in agriculture. The Regulations give effect to Council Directive 86/278/EEC on the protection of the environment, and, in particular, of the soil, when sewage sludge is used in agriculture. Part 1 of the Schedule to the Regulations specifies maximum values for concentrations of heavy metals in soils. Sewage sludge cannot be used on land where the concentration of one or more heavy metals exceeds the values specified in the Schedule.

Table 2.4 gives the maximum values for the concentrations of heavy metals in soil above which sewage sludge cannot be applied to agricultural land.

Table 2.4: Maximum values for concentrations of heavy metals in soil where sewage sludge is applied

Heavy metal	¹ Maximum values mg/kg of dry matter
Cadmium	1.0
Copper	50
Nickel	30
Lead	50
Zinc	150
Mercury	1.0

As can be seen, the maximum value for concentration of lead in soil is 50 mg/kg, which is considerably lower than the mean concentration of 780 mg/kg_{DW} for lead in soils recorded by Teagasc in the Silvermines area. This again, illustrates the unusual nature of areas such as Silvermines, where mining for heavy metals has occurred or where significant geological deposits of heavy metals exist.

¹ Where the pH of the soil is consistently higher than 7, the values set may be exceeded by not more than 50 per cent, provided that there is no resulting hazard to human health, the environment or, in particular, groundwater.

3.0 REVIEW OF THE IAG REPORT

The starting point for the work of the Expert Group was the IAG report on the presence and influence of lead in the Silvermines area of Co. Tipperary (DAFRD, 2000). The general view of the Expert Group and, in particular, the international experts was that the work undertaken by the IAG was comprehensive and covered a broad range of important issues, thereby providing a sound foundation upon which the Expert Group could frame its work. The Expert Group agrees with the conclusion in the IAG report that the Silvermines area is a safe place in which to grow up, live and work, provided that certain precautions are taken by public agencies, other interests, and local people themselves.



Children from the Silvermines National School playing on the rehabilitated school playing area

The Expert Group for Silvermines undertook a review of the following guideline values contained in the IAG report. These guideline values were used by the various agencies and departments involved in the Silvermines area as part of the overall active management programme that exists in the area.

1. Soil lead value of 2000 mg/kg_{DW} as the guideline for "active management" of lead in the environment to protect human health and, in particular, children;
2. Soil lead value of 1000 mg/kg_{DW} as the threshold value below which toxicity problems are unlikely to occur in grazing animals;
3. Lead in drinking water intended for human consumption – current statutory value of 0.05 mg/l (SI No. 81 of 1988);
4. Lead in air – standard recommended is the T.A. Luft standard for lead in deposited dust of 250µg/m²/day;
5. Lead in human foodstuffs – statutory values for lead in Ireland in foodstuffs of 2 mg/kg for vegetables, meat, liver and kidney and 1 mg/kg for milk and milk products (SI No. 44 of 1972);

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6. Lead in human blood - 10 $\mu\text{g}/\text{dl}$ as a safety threshold for the concentration of lead in human blood; and
 7. Lead concentrations in cattle blood – normal range 0 to 1.2 $\mu\text{mol}/\text{l}$ (or 0 – 25 $\mu\text{g}/\text{dl}$).



Ewes and lambs grazing on spring grass

4.0 APPROACH OF THE EXPERT GROUP

4.1 Introduction

The Expert Group considered the various approaches to the development of guideline values and concluded that a precautionary approach should be adopted, with due consideration given to published soil guideline values based on a risk assessment approach. In arriving at its recommendations in relation to soil guideline values the Expert Group considered relevant international guideline values such as those used in the United Kingdom and the Netherlands. The Expert Group did not consider it appropriate to recommend a blanket adoption of international soil guideline values due to the unique nature of the Silvermines area. The UK and Dutch soil guideline values were considered in the context of available information on lead exposure and uptake in the Silvermines area and, in particular, the relatively low blood-lead concentrations which were identified during the human health monitoring programme conducted by the MWHB.



Garryard mine site with tailings lagoon



Open pit at Magcobar mine site

The Expert Group stressed that guideline values specified by it for soil and sediment are specifically related to old mining areas, such as the Silvermines area, where there is a natural geological occurrence of high lead that has been released into the environment by natural processes and by mining activities. The Expert Group also stressed that guideline values for soil and sediment specified by it should be used in the overall context of an "active management" programme. They should not be used in isolation from such an "active management" programme.

4.2 Relevant legislation considered by the Expert Group

The Expert Group considered the impact of both European Community and national legislation on the on-going management of the environment in the Silvermines area. The legislation considered by the Expert Group included:

- Water Framework Directive - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy;
- Dangerous Substances Directive - Council Directive of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (76/464/EEC) and associated regulations, e.g., Water Quality (Dangerous Substances) Regulations, 2001 (SI No. 12 of 2001);
- Drinking Water Directive - Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption and associated regulations, e.g., European Communities (Drinking Water) Regulations, 2000 (SI No. 439 of 2000);

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- Groundwater Directive – Council Directive of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC) and associated Regulations;
 - Commission Regulation (EC) No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs;
 - Waste Directive - Council Directive of 15 July 1975 on Waste (75/442/EEC) and Hazardous Waste Directive – Council Directive of 12 December 1991 on Hazardous Waste (91/689/EEC);
 - Landfill Directive - Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste; and
 - Proposed Directive on the management of wastes from the extractive industries.

Further details on the European and National legislation which was considered by the Expert Group during its deliberations and the potential impact of this legislation in relation to the on-going management of the environment in the Silvermines area is provided in Appendix A.

5.0 ACTIVE MANAGEMENT

The Expert Group noted the existence of the Protocol for the investigative approach to serious animal/human health problem which was drawn up and agreed between the Department of Agriculture and Food, Department of Health and Children, Department of Environment, Heritage and Local Government, Teagasc and the EPA. The protocol provides for the early reporting of serious human or animal health problems to state agencies and an early co-ordinated response to their investigation. This collaboration between the various state agencies and some additional Departments, i.e., Department of Communications, Marine and Natural Resources, Mid-Western Health Board and NTCC still continues. Various components of "active management" continue to be implemented in the Silvermines area through a collaborative approach by the various departments, agencies and the local community.

The IAG Report introduced the term "active management" in relation to the protection of human health and the environment. The Expert Group considers that a comprehensive "active management" programme involving the relevant authorities and the local community is the most effective mechanism for minimising the risk of exposure of children, adults, animals, crops and the wider environment to lead and other relevant metals. It also considered that it was important that the term "active management" be clearly defined. In relation to the protection of human and animal health in Silvermines, "active management" includes:



Wellhead of borehole used to monitor groundwater level and water quality, and Bergerhoff gauge used to monitor dust levels, adjacent to TMF at Gortmore

1. A comprehensive monitoring programme for the area which includes the monitoring of human and animal health; the monitoring of lead and other relevant metal concentrations in the environment; and the monitoring of sites where remediation has been carried out. The Expert Group recommends that a simple checklist should be developed by NTCC as part of the monitoring programme which would be completed periodically during a field survey of the area. Aspects which should be included in the visual check are mine site boundaries, significant construction activities, the state of streams and drains in the area, access to streams by children and livestock etc.;
2. Immediate investigation of any incidents that are likely to give rise to increased risk of exposure to lead or other relevant metals by humans and animals;
3. Immediate investigation of suspected lead - related animal health problems in the area;
4. Availability of emergency procedures and contingency plans in the unlikely event of a major incident occurring, e.g., major dust blow from the Gortmore TMF;

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5. Reviewing and updating guidance on measures to minimise the uptake of lead and other relevant metals by humans, animals and plants;
 6. Encouraging the active involvement and assistance of the local community in maintaining awareness of both the potential risk from lead and other relevant metals in the area and preventative strategies that have been put in place;
 7. Appropriate dissemination of information to the local community in relation to on-going monitoring and other developments;
 8. Minimising disturbance of soils in and around residential houses;
 9. Minimising the disturbance of stream sediments in the area;
 10. Covering of bare soils, where possible, to prevent the exposure of humans, particularly children, and animals to contaminated soils;
 11. Minimising the disturbance of mining wastes; and
 12. Encouraging the appropriate management of mining sites and sites with elevated lead and heavy metal concentrations.

The Expert Group noted that there is an effective community-wide "active management" programme already in place in the Silvermines area, the main objective of which is to minimise the risk to humans and animals of exposure to lead and other relevant metals. By implementing these active management steps, the Expert Group considers that the potential risks posed by lead and other relevant metals will be minimised.



Bare areas on the surface of the TMF at Gortmore

6.0 GUIDELINE VALUES

6.1 Soil guideline values for the protection of human health

6.1.1 Lead in garden soils

The Expert Group reviewed the guideline value of 2000 mg/kg_{DW} lead concentration in soil above which "active management" of the environment was recommended by the IAG. The consensus of the Expert Group was that this value should be reviewed and in the interim report on lead, the Expert Group recommended that the guideline values for lead in soils be reduced to 1000 mg/kg_{DW}. In relation to garden soils the Group also recommends a guideline value for lead of 1000 mg/kg_{DW}. In arriving at this recommendation, the Expert Group noted that the relatively low levels of blood-lead concentrations in adults and children tested during and after the IAG investigation indicate that lead in the environment is not being transferred to any significant degree into human blood and this is the most effective test of bioavailability. Low concentrations of lead in adult's and children's blood should reassure members of the Silvermines community in relation to this important matter.

Where the concentration of lead in garden soils is greater than 1000 mg/kg_{DW} active management steps should be taken to minimise the risk of exposure. The most likely exposure route for lead in garden soils is through hand-mouth activity. The decision of the Expert Group to recommend a garden soil guideline value of 1000 mg/kg_{DW} for lead is based on:

- Collective experience and knowledge of the Expert Group and, in particular, the experience of the international experts;
- Blood-lead concentrations in the human population in the Silvermines area continue to decline and are well below the recommended threshold concentration of 10 µg/dl; and
- The bioavailability of lead in mining areas would appear to be very low, based on the fact that, while the concentration of lead in the environment of Silvermines is elevated, blood-lead concentrations in adults and children tested are low.

Further guidance on lead in garden soils and active management is provided in section 7.4.

While the guideline value of 1000 mg/kg_{DW} is recommended for the particular conditions present in the Silvermines area, and other similar areas, it should be noted that the Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998 (SI No. 148 of 1998) sets 50 mg/kg_{DW} as the maximum value for the concentration of lead in soils in Ireland where sewage sludge is to be applied. The guideline value of 1000 mg/kg_{DW} recommended for the Silvermines area is a reflection of the unusual geological and mining conditions prevalent in the area.

6.1.2 Cadmium in garden soils

The Expert Group considered it important that a guideline value for cadmium in garden soils, above which active management should be initiated, should be recommended. The most likely exposure route to people living in the Silvermines area is through the consumption of home-grown vegetables from garden soils. Cadmium uptake by plants is a function of the cadmium concentration in the soil solution, although plant species and cultivars differ widely in their ability to adsorb and accumulate cadmium. The uptake of cadmium by plants is very pH dependent.

After careful deliberation, the Expert Group agreed to adopt the UK soil guideline values for cadmium in garden soils (Environment Agency, 2002a; Environment Agency, 2002b).

Table 6.1 provides a summary of soil guideline values for cadmium as a function of land-use and soil pH.

Table 6.1: Soil guideline values for cadmium as a function of land-use

Standard land-use	¹ Soil Guideline Value (mgCd/kg _{DW} soil)		
	pH 6	pH 7	pH 8
Residential with home-grown vegetables Allotments	1	2	8
Residential without home-grown vegetables	30		
Commercial/industrial	1400		

6.1.3 Arsenic, zinc, copper and mercury in garden soils

In relation to arsenic, the primary exposure route to humans is from soil ingestion, with the consumption of home-grown vegetables representing a minor secondary route of exposure. The Expert Group considers that zinc and copper do not pose a significant risk to human health in the area due to their relatively low toxicity, and low exposure. The primary route of exposure to mercury is through the consumption of fish where bioaccumulation of mercury through the food chain can occur. Therefore, the Expert Group does not consider this as a risk to human health in the Silvermines area.

Having examined the available information on concentrations of heavy metals in garden soils, the Expert Group considered that it was not necessary to recommend specific soil guideline values for arsenic, zinc, copper or mercury. The Expert Group considers that the guideline values specified by it for lead and cadmium will be sufficient to act as a trigger to initiate active management to ensure that human health is protected in relation to arsenic, zinc, copper and mercury also.

6.2 Soil guideline values for the protection of animal health in agricultural soils

6.2.1 Lead in agricultural soils

In relation to animal health, the Expert Group agreed with the IAG recommended guideline value of 1000 mg/kg_{DW} lead in soils as a concentration below which toxicity problems are unlikely to occur in grazing animals. On farms where lead concentrations in soils exceed 1000 mg/kg_{DW}, good farming practices to minimise the risk of lead ingestion should be implemented, with particular attention being paid to young animals which appear to be more susceptible to lead poisoning.

¹ Based on water extraction



Badly poached soil beside ringfeeder used for outwintering cattle; bare soil increases the risk of exposure to lead

6.2.2 Arsenic, cadmium, copper, mercury and zinc in agricultural soils

In relation to arsenic and animal health, approximately 75 per cent of the agricultural soils in the Silvermines area have an arsenic concentration of less than 30 mg/kg_{DW}. Animals ingest soil as they graze and sheep tend to ingest higher quantities of soil per kilogram body weight than cattle. Assuming a high rate of soil ingestion by sheep (20% of their dry matter intake which is about 1 to 1.5kg per day for an adult) and using a figure of 100 mg/kg_{DW} concentration of arsenic in soils, this would contribute less than 1 per cent of a toxic dose for animals of the most commonly found form of inorganic arsenic (trioxide). A similar estimate, using the most contaminated mine waste sites concentrations, would contribute about 2 per cent of a toxic arsenic dose. Given that the main mining sites in the area are fenced off and animals develop a tolerance to arsenic over time, the Expert Group concluded that adverse health effects to animals from arsenic are unlikely.

In relation to cadmium and animal health, literature suggests that ruminant animals only retain about 1 per cent of any cadmium consumed. In sheep, even allowing that they might consume 20 per cent of soil in the diet and based on Teagasc soil cadmium results for the area, no adverse health effects would be envisaged. Cattle consume less soil during grazing than sheep, therefore, the risk from cadmium to cattle would be even less.

In relation to animal health and copper, ruminants are unusual in that they store excess dietary copper in the liver and concentrations vary with the seasons. Copper concentrations in liver tissue from ruminants slaughtered from the Silvermines area have been found to have a similar range to those in other areas of the country, i.e., from concentrations indicating a deficiency of copper to high normal range. It is therefore concluded that ruminants in the Silvermines area are unlikely to suffer any additional adverse health effects from copper.

The Expert Group considered that any risk from mercury would be as a result of bioaccumulation of methylmercury, i.e., consumption of fish or fish products contaminated with mercury. The majority of animals in the Silvermines area are at pasture with little supplementary feeding being undertaken.

Fishmeal is no longer permitted in ruminant rations therefore the adverse effects from mercury in livestock are considered to be nil.

Animals can tolerate relatively high concentrations of zinc in their diet. Due to antagonistic interactions between aluminium, cadmium, calcium, copper, iron and zinc, it is not envisaged that any adverse effects on livestock due to zinc concentrations will arise in the Silvermines area.

Having considered the above information, the Expert Group decided that it was not necessary to recommend soil guideline values for arsenic, cadmium, copper, mercury or zinc for the protection of animal health in the area.

6.3 Sediment guideline values for lead, arsenic and cadmium for the protection of human health

The Expert Group considers that the risks to children or adults from in-situ or recently dredged sediments are very low, due to the fact that exposure to sediments is very unlikely. In addition, the Expert Group considers that the steps specified by it in relation to active management for sediments for the protection of animal health are sufficient to ensure that human health is protected and the risks are minimised.

6.4 Sediment guideline values for lead, arsenic and cadmium for the protection of animal health

The Expert Group considers it appropriate that a similar guideline value should be used for lead in sediments as in soils, i.e., 1000 mg/kg_{DW}. Above this guideline value, active management should be undertaken in relation to the protection of animal health. Animals should not be allowed direct access to watercourses where the lead concentration of the sediments is greater than 1000 mg/kg_{DW}.

The group considered that the risks posed to animal health by recently dredged sediment containing arsenic, cadmium, copper, mercury and zinc were minimal in comparison to the risk posed by lead and, therefore, does not consider it necessary to recommend guideline values in relation to sediments for the other heavy metals. However, the Expert Group recommends that sediments should continue to be analysed prior to disposal to determine the heavy metal concentrations in the sediments. Further guidance on stream sediment disposal is given in section 7.3.

6.5 Ecotoxicological guideline values for the Silvermines area

The Expert Group discussed the issue of guideline values in relation to ecosystem protection. It agreed that due to the presence of mineralised veins in the rocks and as a result of centuries of mining activity in the area, the Expert Group would confine itself to considering guideline values for the protection of human and animal health. It was felt that ecosystems in the Silvermines area may have adapted to the unusual geochemical conditions, the mining legacy and elevated heavy metals concentrations, and the imposition of guideline values for the protection of ecosystems in near pristine conditions would be inappropriate. Such an ecosystem may be unique, with specific flora and fauna evolving over time by adapting to the harsh geological conditions in the area. However, the Expert Group acknowledges that biological diversity might be lower, and ecological and microbiological processes such as nitrification and degradation of organic matter in soils, might be hampered.

Further research would be needed to investigate the usefulness of, and the possibility for developing appropriate guidelines for the protection of the ecosystem of the Silvermines area having regard to the naturally elevated concentrations of heavy metals and the likely adaptation of its ecology to these conditions. The Expert Group recommends that existing baseline ecological information on the area should be compiled and additional ecological studies in selected parts of the area should be undertaken if required.

6.6 Guideline values for water

6.6.1 Introduction

The Expert Group considered the impact of both National and European legislation in relation to water on the on-going management of the environment in the Silvermines area. The main pieces of legislation examined include:

- Water Framework Directive - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy;
- Dangerous Substances Directive - Council Directive of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (76/464/EEC) and associated regulations, e.g., Water Quality (Dangerous Substances) Regulations, 2001 (SI No. 12 of 2001);
- Drinking Water Directive - Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption and associated regulations, e.g., European Communities (Drinking Water) Regulations, 2000 (SI No. 439 of 2000); and
- Groundwater Directive – Council Directive of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC) and associated Regulations.

The Water Framework Directive (2000/60/EEC) came into force on 22 December 2000 and establishes a strategic framework for managing the water environment of the European Community. Member states have three years to transpose the Directive into national legislation. The Water Framework Directive establishes a common approach to protecting and setting environmental objectives for all waters, including groundwaters, rivers, lakes, canals, reservoirs, estuaries and coastal waters. The Directive aims at maintaining and improving water quality within the European Community by setting objectives for all waterbodies, requiring at least 'good status', 'no deterioration' and 'restoration' where necessary. For surface waters 'good status' includes good chemical and ecological status and for groundwater includes good chemical and good quantitative status.

The River Basin District (RBD) will be the main unit managing the water environment and a single River Basin Management Plan (RBMP) must be produced for each RBD. The waters in the Silvermines area will ultimately be managed by the relevant competent authority under a river basin management plan with the objective of achieving good water status. However, waters in the area have been influenced by both the natural geological conditions of the area and past mining activities. The Water Framework Directive provides for this by stating *in cases where a body of water is so affected by human activity or its natural condition is such that it may be unfeasible or*

unreasonably expensive to achieve good status, less stringent environmental objectives may be set on the basis of appropriate, evident and transparent criteria, and all practicable steps should be taken to prevent any further deterioration of the status of waters. Similarly, exemptions are also provided for under the Dangerous Substances Directive and the Groundwater Directive in cases where a water body is permanently affected by naturally occurring conditions or by past human activities. In relation to drinking water, the chemical parameter values specified in the relevant legislation apply. In certain circumstances the Minister for Environment, Heritage and Local Government can grant a departure from the standard (up to 31 December 2003) or the Environmental Protection Agency (from 1 January 2004) in relation to a water supply provided that any such departure does not constitute a potential danger to public health.

The Expert Group noted that the Silvermines Public Water Supply Scheme and the Shallee Group Water Scheme comply with the current national drinking water standards for lead, arsenic, cadmium, copper and mercury.

There is evidence of adverse impacts on the macro-invertebrate community in watercourses close to mining sites in the Silvermines area. Toxic effects were reported from biological monitoring undertaken as part of the IAG investigation in the Yellow River catchment (DAFRD, 2000). Biological monitoring of the Kilmastulla and Yellow Rivers was undertaken in 2002. Results indicate that the Kilmastulla was polluted to some degree over its length (i.e. station 0150 to 1000) with water quality classified as unsatisfactory. The Yellow river was significantly impacted upon by suspected toxic pollution in 2002 (Clabby *et al.*, 2003)

For the purpose of recommending guideline values in relation to water in the Silvermines area, water was considered under two different categories, i.e., drinking water and surface water. A summary of the relevant standards for drinking water and surface water for the various metals is provided in Table 6.2. The water quality standards for lead and other heavy metals are more stringent under the Water Quality (Dangerous Substances) Regulation than under the Drinking Water or Abstraction Regulations. This reflects the sensitivity of certain aquatic species to lead, copper and zinc in the environment. Copper is an element the toxicity of which varies widely, depending on the hardness of water (EPA, 2001).



Kilmastulla river which flows along the east boundary of TMF at Gortmore

Table 6.2: Summary of standards for waters in Ireland

Element		Surface water abstraction SI 294, 1989			Irish Salmonid standards SI 293, 1988	¹ Drinking Water SI 439 of 2000	² Water Quality Dangerous Substances SI 12 of 2001	
		A1	mg/l A2	A3			mg/l	mg/l
Arsenic	As	0.05	0.05	0.1	-	0.01	0.025	0.025
Aluminium	Al	-	-	-	-	0.2		
Barium	Ba	0.1	1.0	1.0	-	-		
Cadmium	Cd	0.005	0.005	0.005	-	0.005		
Copper	Cu	³ 0.05	³ 0.10	³ 1.00	⁴ 0.04	⁵ 2.0	0.005	0.03
Iron	Fe	0.2	2.0	2.0	-	0.2		
Lead	Pb	0.05	0.05	0.05	-	^{5,6} 0.01	0.005	0.01
Manganese	Mn	⁷ 0.05	⁷ 0.3	⁷ 1.0	-	0.05		
Mercury	Hg	0.001	0.001	0.001	-	0.001		
Nickel	Ni				-	⁵ 0.02	0.008	0.05
Zinc	Zn	3.0	5.0	5.0	⁴ 0.3		⁸ 0.008	0.1
pH		5.5 - 8.5	5.5 - 9.0	5.5 - 9.0	6 - 9	≥ 6.5 ≤ 9.5		
⁹ Conductivity		1000	1000	1000		2500		

6.7 Guideline values for dust deposition

The Expert Group approves the current dust deposition monitoring programme, which was established in 1999 around the perimeter of the TMF at Gortmore. The primary objective of the monitoring programme was to quantify the concentration of heavy metals in deposited dust. Eighteen Bergerhoff gauges are located around the perimeter of the TMF, one is located adjacent to the Silvermines National School and a control gauge is located eight kilometres north of the TMF. The gauges collect the dust fall in accordance with the German VDI method 2119 part 2:1972, i.e., Bergerhoff gauges. The Bergerhoff method is a well established international methodology used extensively to assess the potential toxic effects on soil and herbage from dust deposition. The Expert Group felt it was important to reiterate that the current dust deposition programme does not measure lead concentrations in ambient air in relation to human health. However, the results from the human blood-lead screening programme undertaken by the MWHB show that blood-lead concentrations continue to be low and well below the current acceptable blood-lead concentration of 10 µg/dl.

¹ European Communities (Drinking Water) Regulations (SI No. 439 of 2000) came into operation on January 2004 and revoked SI No. 81 of 1988.

² The standards specified for metals SI No. 12 of 2001 which came into operation on 1 July 2001 are for total metal concentration (dissolved and colloidal /s.s.)

³ A departure from the quality standard may be granted by the Minister to a sanitary authority in the case where exceptional meteorological or geographical conditions have arisen.

⁴ Standards for copper and zinc vary with hardness; standards quoted are for 100 mg/l CaCO₃.

⁵ The value applies to a sample of water intended for human consumption obtained by an adequate sampling method at the tap and taken so as to be representative of a weekly average value ingested by consumers and that takes account of the occurrence of the peak levels that may cause adverse effects on human health.

⁶ The parametric value to be met by 1 January 2004 is 25µg/l. A value of 10µg/l must be met by 25 December 2013.

⁷ A departure from the quality standard may be granted by the Minister to a sanitary authority in the case of surface water in shallow lakes or virtually stagnant surface water.

⁸ 8µg/l for water hardness less than or equal to 10mg/l CaCO₃; 50 µg/l for water hardness greater than 10 mg/l CaCO₃ and less than or equal to 100mg/l CaCO₃.

⁹ This is conductivity measured as µS/cm and is an expression of water's ability to conduct an electrical current. There is an interrelationship between conductivity and temperature, the former increasing at a rate of some 2% per degree C rise. SI 81 OF 1988 and SI 439 of 2000 specify µS/cm at 20°C.



Bergerhoff gauge used to measure the concentration of lead in deposited dust

The monthly monitoring results were compared to the German TA Luft limits for metals in deposited dust. These are detailed in the German TA Luft Regulations of 1986 which set limit deposition concentrations for lead (250 $\mu\text{g}/\text{m}^2/\text{day}$), cadmium (5 $\mu\text{g}/\text{m}^2/\text{day}$) and thallium (10 $\mu\text{g}/\text{m}^2/\text{day}$) in deposited dust. The Department of the Environment in 1989 recommended that local authorities adopt as a source of reference the German TA Luft Regulations (DoE, 1989).

The German TA Luft Regulations were revised in October 2002 and new limits were set for lead, cadmium and thallium. In addition, the new TA Luft regulations specify limit values for arsenic, nickel and mercury. The averaging period is one year. However the Expert Group considers the current approach used by NTCC, which compares the daily average for each monthly monitoring period against the TA Luft limits, is appropriate. The revised dust depositional limits for these metals are given in Table 6.3

Table 6.3: Revised TA Luft limits for heavy metals in deposited dust

Substance/Group of substances	TA Luft Limit in deposited dust $\mu\text{g}/\text{m}^2/\text{day}$
Arsenic and its inorganic compounds	4
Lead and its inorganic compounds	100
Cadmium and its inorganic compounds	2
Nickel and its inorganic compounds	15
Mercury and its inorganic compounds	1
Thallium and its inorganic compounds	2

The Expert Group approved the use of the German T.A. Luft Regulations for setting limits for lead concentrations and other relevant metals in deposited dust in the external environment..

The Expert Group noted that internal dust monitoring, both in houses and the school, was undertaken by the MWHB in 2002. This is important, as internal dust is likely to be the main source of childhood lead exposure. Both concentration and loading should be measured as the latter has in previous investigations been found to be a useful measure of potential exposure.

The Mid-Western Health Board is currently evaluating the results from the internal dust sampling carried out in houses in Silvermines village, Shallee and in houses located adjacent to the perimeter of the TMF at Gortmore. Following completion of this work, the Expert Group recommends that the need for further monitoring, and the frequency of such monitoring, should be evaluated by the Mid-Western Health Board.

6.8 Guideline values for lead in blood

6.8.1 Lead in human blood

The Expert Group agrees to the use of 10µg/dl as the current acceptable threshold for blood-lead concentration, as recommended by the World Health Organisation (WHO) and the US Centres for Disease Control and Prevention (CDC). The Expert Group noted that this threshold may be revised in the future and recommends that the MWHB continue to monitor developments in research in this area and to take appropriate steps if the threshold is revised in the future.

6.8.2 Lead in animal blood

In relation to animal health, the Expert Group considers 0 to 1.2 µmol/l (25 µg/dl) lead to be the normal range for blood-lead concentrations in animals. Table 6.4 provides an interpretation of blood-lead concentrations in relation to animal health, as presented in the IAG report.

Table 6.4: Interpretation of blood-lead concentrations in cattle

Concentration (µmol/l)	Interpretation
0 – 1.2	Normal range
1.2 – 1.7	Elevated but not of clinical significance
1.7 – 2.4	May be associated with signs of toxicity

DAFRD, 2000

6.9 Guideline values for lead, cadmium and arsenic in foodstuffs

The main pieces of legislation which govern the maximum permitted concentration of the above contaminants in foodstuffs and also the appropriate sampling procedures include:

- Commission Regulation (EC) No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs;
- Commission Directive 2001/22/EC of 8 March 2001 laying down the sampling methods and the methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs; and
- Health (Arsenic and Lead in Food) Regulations, 1972 (SI No. 44 of 1972).

Commission Regulation (EC) No 466/2001 sets maximum levels for certain contaminants in foodstuffs. The maximum levels for lead and cadmium in foodstuffs and for mercury in fish and fish products are given in Table 6.5. There are no limits currently set for zinc.

Table 6.5: Summary of heavy metal concentrations in Irish soils

Product	Lead	Cadmium	Mercury
	maximum level (mg/kg _{WET WEIGHT})		
Cows milk	0.02	-	
Meat of bovine animals, sheep, pigs and poultry	0.1	0.05	
Edible offal of cattle, sheep, pigs and poultry	0.5		
Liver of cattle, sheep, pigs and poultry	-	0.5	
Kidney of cattle, sheep, pigs and poultry	-	1.0	
Muscle meat of various fish	0.2-0.4	0.05-0.1	
Cereals (including buckwheat), legumes and pulses	0.2	-	
Cereals, excluding bran, germ, wheat grain and rice	-	0.1	
Bran germ, wheat grain and rice	-	0.2	
Vegetables, excluding brassica, leafy vegetables, fresh herbs and all fungi (for potatoes the maximum level applies to peeled potatoes)	0.1		
Vegetables and fruits, excluding leafy vegetables, fresh herbs, all fungi, stem vegetables, root vegetables and potatoes		0.05	
Brassica, leafy vegetables and all cultivated fungi	0.3		
Leafy vegetables, fresh herbs, celeriac and all cultivated fungi		0.2	
Stem vegetables, root vegetables and potatoes, excluding celeriac. For potatoes the maximum level applies to peeled potatoes		0.1	
Fruit, excluding berries and small fruits	0.1		
Berries and small fruits	0.2		
Fishery products			0.5

For the past number of years, as per the recommendation contained in the Inter-Agency report (DAFRD, 2000), the Department of Agriculture and Food (DAF) has been sampling bovine muscle and edible offal at slaughter from identified herds from the Silvermines area. Additionally, offal from all animals identified as coming from these herds is excluded from the food chain.

As a result of Commission (EC) No 466/2001, which significantly decreases the acceptable maximum levels of certain contaminants (including lead and cadmium) in foodstuffs, and Commission Directive 2001/22/EC, which lays down sampling methods and methods of analysis for official control of these contaminants, DAF has reviewed and updated the National Monitoring Programme for residues of heavy metals. DAF continues to monitor heavy metal concentrations in animal tissues from farms in the Silvermines area.

Health (Arsenic and Lead in Food) Regulations (SI No. 44 of 1972) set limits in relation to arsenic in foodstuffs. In general, the regulations specify that food which contains arsenic in excess of one part per million (1 mg/kg) cannot be imported, distributed or sold. The limit applies to the food as sold, distributed, imported or exposed for sale, irrespective of its state (fresh or dried). Part I of the Schedule of SI No. 44 of 1972 lists the maximum quantity of arsenic permitted in various foodstuffs and added ingredients.

7.0 GUIDANCE AND BEST PRACTICE

7.1 Guidance on human health

The Expert Group discussed the current guidance in relation to human health available to the community of Silvermines. The following publications are available:

1. Inter Agency Group *Report of the investigation into the presence and influence of lead in the Silvermines area of County Tipperary* published and distributed in June 2000.
2. *What every parent should know about lead levels in children: A Parent's Reference Guide* published by the Mid-Western Health Board and distributed in February 2000. The Mid-Western Health Board also circulated leaflets in 2001 and 2002 on the same topic.
3. *Public health contingency plan in the unlikely event of a major dust blow from Gortmore TMF* published by the Mid-Western Health Board and distributed in November 2002.

The Expert Group considers that the current guidance in relation to human health in the environment of Silvermines is adequate. The education and awareness campaign in the Silvermines area, which is implemented by the Mid-Western Health Board, is being integrated into the on-going work of local health care workers. Guidance documents are available from the MWHB for community members living in the Silvermines area.

The Expert Group particularly agrees with recommendation numbers 2 and 27 in the IAG report:

- Recommendation No. 2 - *Children should be discouraged from accessing areas of high lead content; and*
- Recommendation No. 27 - *To avoid the disturbance of sediments, the rivers and streams in the Yellow river catchment area should not be used for recreational purposes.*



Tailings pond at Garryard site



Open pit and vegetated tailings at Ballygowan

In addition, the Expert Group noted that North Tipperary County Council has erected a warning notice adjacent to the Silvermines village stream, as it crosses the Dolla road and where it is known that children play, to discourage recreational use of this stream. Where necessary, fencing off of other contaminated streams, ponds and mine wastes should also be considered for the protection of human health and, in particular, that of children.

7.2 Guidance on animal health

Teagasc published a guidance booklet *Lead and Animal Health* in March 2001. This was circulated to the farming community in conjunction with individual farm maps, which indicate the concentration of lead in farm soils.

The Expert Group reviewed the guidance, which is available to the farming community in Silvermines in relation to animal health in the area, and considers that the current guidance in relation to animal health covers the majority of issues in the area. The Expert Group stressed the importance of preventing animal access to mine wastes, bare soils and stream sediments. Cattle are inquisitive by nature and frequently consume exposed soil and other unusual materials.



Cattle exposed to bare soils

Dredged sediments with lead concentration of greater than 1000 mg/kg_{DW} should not be spread on adjacent land or be piled alongside streams and rivers where animals can gain access to the dredgings. An alternative, safe waste management disposal option, which complies with relevant statutory requirements, will have to be found for sediments where the concentration of lead is greater than 1000 mg/kg_{DW}. Dredged sediments provide a potential source of exposure, irrespective of the chemical and mineral form of the lead.

The Expert Group agrees with the recommendation contained in the IAG report that animals should not be allowed direct access to watercourses and that drinking water for animals should be extracted from streams by using a mechanism which avoids causing disturbance of in-situ stream sediments, e.g., by pump and filtering system. Turbid water (indicating sediment in suspension) should never be used as a water supply for animals.

7.3 Guidance on sediment disposal

Mining sites in the Silvermines area have been identified as being a major source of contaminated sediments, which are ultimately deposited in local streams and rivers in the area, e.g., Garryard and Garryard Old Stockpile. Full and definitive rehabilitation and management of the mining sites in the area will reduce the quantity of contaminated sediments entering these watercourses and will help provide a long - term solution to the problem of contaminated sediments, particularly in the Yellow river catchment. Ideally, dredged sediments from the area should be disposed of to an appropriate waste management facility in accordance with all relevant legislation. The Expert Group therefore recommends that the remediation and management plans for the mining sites, as detailed in the SRK report commissioned by Department of Communications, Marine and Natural Resources in 2002, i.e., *Management and Rehabilitation of the Silvermines area* be implemented as soon as feasible. In relation to contaminated sediments identified in the Yellow river catchment, the SRK report indicated that the sediments be removed and placed in an engineered waste facility located on the surface of the TMF at Gortmore (SRK, 2002).

In the interim, however, the Expert Group recommends that stream sediments should be sampled and analysed to determine their concentration of lead and other relevant metals before drainage works are undertaken. This is required to determine the most appropriate and safe method of disposal. The safe disposal of contaminated sediments also contributes to the long-term remediation of the Silvermines area. This is particularly important for sediments located in the Yellow River catchment area. This recommendation should be reviewed when definitive rehabilitation of the mining sites in the area has taken place.

The Expert Group recommends that sediments which have a lead concentration greater than 1000 mg/kg_{DW} should not be disposed of to agricultural land, either along the bank or spread onto adjacent lands. As a temporary measure only, these sediments may be left in-situ until an alternative safe waste management disposal option is found. However, there may be an increased risk of flooding with the consequential spreading of sediments onto adjacent agricultural lands by floodwaters. Further guidance is given in the Teagasc booklet *Lead and Animal Health* (Teagasc, 2001).

Where stream sediment of less than 1000 mg/kg_{DW} is dredged and disposed of to adjacent agricultural land, the Expert Group recommends that the ground is rolled after spreading and that the area is not grazed until grass re-growth is greater than 12 cm in height.



Recently dredged stream with sediment spread on adjacent land. The concentration of lead in the sediment was less than 1,000 mg/kg

The Expert Group also pointed out that heavy metal contaminated sediments, when protected against oxidation, are significantly less toxic than when exposed to air and that this should be considered when determining safe disposal options for sediments in the area. Lead also becomes more mobile when exposed to air. The Silvermines ore body consists of pyrite, chalcopyrite, galena and sphalerite, i.e., polymetallic sulphides. The predominant form in the waste is likely to be sulphides together with limestone, dolomite and baryte. On exposure to air, the galena (lead sulphide) weathers to the sulphate and reaction with the carbonate rocks may cause several lead carbonates to form. Each chemical form differs significantly in its solubility in water, as indicated in Table 7.1.

Table 7.1: Solubility of various lead compounds

Compound	Solubility Product (K_s)	Saturated solution	
		moles	mg/l
Lead sulphide (PbS)	27.5	1.78×10^{-14}	3.68×10^{-9}
Lead sulphate (PbSO ₄)	7.8	1.26×10^{-4}	26.1
Lead carbonate (PbCO ₃)	13.1	2.82×10^{-7}	56.7×10^{-3}

The solubility of lead sulphide is negligible. Analysis of soils containing lead mine wastes derived from galena (PbS) in England, based on scanning electron microscopy and x-ray analysis, showed the mineral pyromorphite (Pb₅(PO₄)₃Cl) to be the principal lead-bearing constituent (Cotter-Howells and Thornton, 1991). This Pb-phosphate mineral is a weathering product of galena and lead carbonate, and has a very low solubility and bioavailability. The data on solubility explain why metal polluted stream water can be remediated by passing it into artificial wetlands (to force the formation of sulphides) or through a limestone chippings passive treatment plant to precipitate metal carbonates.

7.4 Guidance on gardening

The Expert Group recommends that where the soil guideline value for lead in garden soils is greater than 1000 mg/kg_{DW} and where vegetables are to be grown, clean soils should be imported and spread to a depth of 30 cm in the area in which the vegetables are currently grown and in potential future areas of cultivation. In gardens where no vegetables are to be grown but where soil lead concentrations are greater than 1000 mg/kg_{DW}, bare soils should be covered with vegetation or other appropriate media such as bark mulch etc. As soil ingestion via hand to mouth activity is the primary route of exposure for young children, it is important that steps are taken to reduce the likelihood of soil ingestion.

In relation to cadmium, the Expert Group stated that the primary route of exposure is through the consumption of home-grown vegetables and that uptake of cadmium by the plants is very much dependant on the pH of the garden soil and type of vegetables grown. Lettuce and spinach, in particular, are susceptible to cadmium uptake.

In relation to cadmium in garden soils, the Expert Group recommends the following active management steps:

- where cadmium concentration is below 8 mg/kg_{DW}, lime soils to raise and maintain the soil at or above pH 7;

- where cadmium concentrations are greater than 8 mg/kg_{DW}, vegetables should be tested to determine the concentration of cadmium in home-grown vegetables. Where the concentration in the vegetables is below the maximum permitted levels as outlined in Commission Regulation No 466/2001 (see table 6.5), lime soils to ensure the soil pH is at 7 or above; and
- where cadmium concentrations in home-grown vegetables exceed the maximum permitted levels as outlined in Commission Regulation No 466/2001, clean soil should be imported and spread to a depth of 30 cm in current and future vegetable growing areas of the garden.

The Expert Group also recommends that where fruit, including wild berries and vegetables, is locally grown for home consumption the guidance given in the IAG report to reduce dietary exposure to lead should be adopted i.e.:

- thoroughly wash all fruit and vegetables in running water of drinking quality;
- peel potatoes and all root vegetables prior to cooking; and
- remove the outer leaves of leafy vegetables prior to washing and consumption.

In addition, garden soil fertility levels should be maintained or enhanced where necessary, particularly in relation to adequate lime (i.e. pH 7 or above), potash and phosphorus levels. Phosphate is known to assist in the formation of more inactive forms of lead in the soils and therefore reduces uptake of lead. In addition, increased concentrations of calcium and phosphate in foodstuffs are known to reduce the availability of lead in both humans and animals.

A summary of the results from the garden soil sampling programme undertaken by Teagasc and the MWHB is given in Table 7.2.

Table 7.2: Summary of heavy metal concentrations in garden soils

Metal	Number of samples	Mean value	Median value	Minimum	Maximum
		Concentration mg/kg _{DW}			
Lead	162	449	75.8	12.3	7500
Cadmium	162	1.66	1.27	0.25	8.15
Arsenic	52	27.4	-	8.8	110
Zinc	162	350	-	12.7	5301
Copper	128	34.2	-	8.8	34.2

The results of the soil sampling and analysis programme indicated that in certain gardens the lead and cadmium guideline values are exceeded. The MWHB and Teagasc will provide individual garden soil sample results and appropriate guidance to residents in the area. Where further information is required on pH and/or garden lime requirements, arrangements can be made for additional sampling to be undertaken.

7.5 Guidance on soil disturbance

The Expert Group has considered the requirement for guidance on soil disturbance in the Silvermines area wherever significant soil disturbance takes place. Such guidance is considered under two categories, i.e., guidance related to construction activities and guidance related to agricultural activities.

7.5.1 Guidance on soil disturbance related to construction activities

In relation to soil disturbance arising from construction activities, the Expert Group believes it is important to distinguish clearly between short-term exposure to a contaminated soil by an adult workforce and long-term exposure by the young child.

Significant short-term soil disturbance would include:

- digging foundations;
- site excavations;
- top-soil or subsoil removal;
- construction of bridges and culverts;
- field drainage operations; and
- site clearance.

The Expert Group recommends the following best practice in relation to soil disturbance:

1. reference should be made to building codes, current planning regulations and health and safety regulations, which would be relevant, for example, to site workers engaged in site clearance and construction activities where contamination is expected;
2. bare areas of soil should be kept to a minimum during soil disturbance operations, such as, construction works etc.;
3. bare soils on sites should be dampened with water during weather conditions which favour the generation of dust on site; and
4. once works have been completed on sites, bare soils should be covered over to minimise the potential risk to human and animal health, e.g., sown with grass.

The Expert Group also recommends that appropriate conditions should be attached to any planning permission relating to developments that require significant disturbance of soils in the area.

7.5.2 Guidance on soil disturbance related to agricultural activities

The Expert Group recommends that soil fertility levels be determined prior to reseeded and that soil fertility levels are maintained or improved where necessary. It should be noted that elevated zinc and cadmium concentrations might affect germination and establishment of grass. The Expert Group noted that the IAG investigation found that both soil acidity, which is corrected by the application of calcium carbonate or lime, and phosphorus deficiency were prevalent in the Silvermines area.

The Expert Group recommends the following in relation to ploughing and reseeded where these are to be undertaken:

1. reseed in the Autumn with late diploid perennial rye grass;
2. apply fertiliser based on Teagasc current nutrient advice;
3. roll after emergence;
4. in Spring, if growth is uneven, top herbage, apply fertiliser, roll and take an early silage crop; and
5. after a silage cut is taken, roll, apply nitrogen and allow regrowth for 3 to 4 weeks before grazing.

The Expert Group also recommends that farmers in the area should avoid poaching the land during the winter months and at other times when the soil becomes saturated, thereby minimising exposure to bare soils with elevated lead concentrations. This will help reduce the risk of lead poisoning in animals.

7.6 Guidance on mine waste disturbance

Wastes arising from mining activities are heterogeneous in nature, which makes an assessment of their properties and a classification of waste types extremely difficult. The types of waste and their properties (e.g. mineralogical or leachability) within any specific waste deposit vary both horizontally and vertically within a very small volume of the material, making it very difficult to predict what reactions will occur where this waste is disturbed. The Expert Group therefore recommends that unplanned disturbance of mine waste should not take place, due to the risk of releasing pollutants into the environment. In the Silvermines area, mine waste should be disturbed only where it is part of a planned and authorised remediation programme for the area.



Mine waste located at Garryard Old Stockpile

Where approval for mine waste disturbance as part of a remediation programme for the area is granted, precautions should be taken to minimise the risk of exposure to humans, animals and the environment from lead and other relevant metals.

7.7 Guidance on children's playgrounds and playing fields

The Expert Group recommends that where there is the possibility of children getting access to bare soils in playgrounds or play areas that soils in these areas should be sampled and analysed for lead. Where the concentration of lead is greater than 1000mg/kg_{DW}, appropriate measures should be taken, such as, ensuring grass cover is established and maintained so as to minimise the risk of exposure to lead. Any relevant regulations in relation to these areas should be complied with.

In relation to playing fields, e.g., soccer pitches, Gaelic football pitches etc., grass cover should be maintained or improved and exposure to bare soil should be minimised.

8.0 CURRENT MONITORING PROGRAMME

The Expert Group reviewed the current monitoring programme in Silvermines, which forms part of an on-going active approach to the management of lead in the environment.

8.1 Human health monitoring

The human health monitoring programme in Silvermines monitored lead concentrations in human blood from 1999 to 2001. In addition, lead concentrations in drinking water, fruit and vegetables have been monitored and further sampling was undertaken in 2001. The MWHB and Teagasc also carried out a sampling programme in 2001 and 2002 to determine the concentration of lead in household dust, on hands using hand-wipes and in garden soils. The results of this sampling programme are currently being evaluated by the MWHB. A report is being prepared and the results will be made available to residents in the area by the MWHB.

In relation to the human blood-lead level screening programme undertaken by the MWHB, blood samples were taken from pre-school children, primary school children and adults in 1999, 2000 and 2001. Blood-lead level screening was offered to all pre-school children in the study area and all school children in the five schools in the area. The level of participation in the blood screening programme was generally very good. Table 8.1 gives the percentage of participation by children in the five schools in the area over the three-year period.

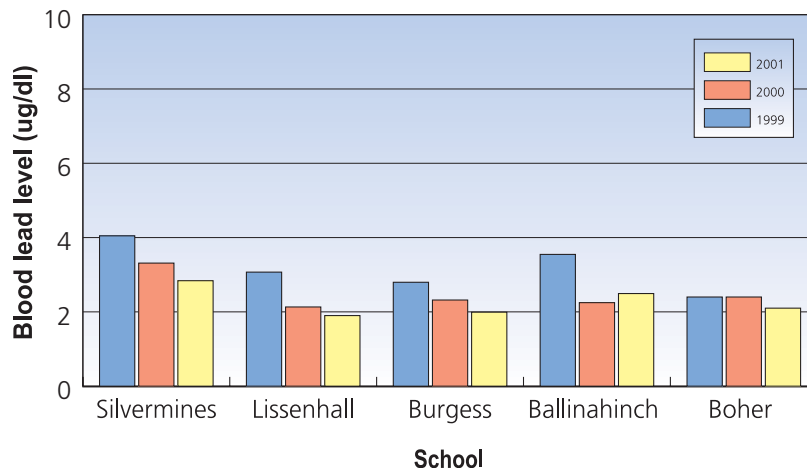
Table 8.1: Percentage of participation of primary school children in blood-lead screening programme

School	1999	2000	2001
Silvermines	86%	73%	75%
Ballywilliam	97%	76%	73%
Ballinahinch	65%	44%	43%
Lissenhall	90%	76%	71%
Boher	82%	63%	15%
Preschoolers	62%	17%	8%

Source: MWHB, 2003

Figure 8.1 illustrates the concentration of lead in blood from primary school children who participated in the blood screening programme. Since the commencement of the IAG investigation and the on-going awareness campaign, blood-lead levels in school children continue to decline and remain well below the threshold value of 10 µg/dl.

Figure 8.1: Primary school children's mean blood-lead level for 1999 to 2001



The Expert Group considers there is little to be gained from continuing monitoring of blood-lead levels, particularly due to the invasive nature of monitoring. The need for monitoring blood-lead levels or the use of hand wipes should, however, be reviewed should an event occur which indicates an increased risk to the community. Results from internal (i.e., vacuum cleaner bags) and external (i.e., Bergerhoff gauges) dust monitoring should identify the need for additional blood monitoring or hand wipe monitoring. Awareness of the potential risk from lead in the environment should be maintained through education and awareness programmes. This is being integrated into the routine work of local health care workers in the Silvermines area.

8.2 Animal health monitoring

Animal health monitoring has been sub-divided into animal health and food safety. In relation to animal health, the Expert Group considers that investigation of animal health incidents by the DAF, as they arise, is an appropriate approach.

The Expert Group recommends that the on-going monitoring of meat and offal samples from farms in the Silvermines area should continue, particularly in light of the European Commission Regulation (EC) No 466/2001 of March 2001 setting maximum levels for certain contaminants in foodstuffs (refer to Table 6.5). The maximum levels for certain contaminants including lead are more stringent than in previous regulations, particularly for meat, offal and milk.

8.3 Environmental monitoring

Environmental monitoring, which is currently undertaken in Silvermines, includes:

- analysis of soils and herbage samples taken by Teagasc on farms where outbreaks of lead poisoning have been identified;
- sampling and analysis of surface water and stream sediment from farms and other areas of concern by the EPA and NTCC, as required;
- on-going physico-chemical and biological monitoring of the Kilmastulla and Yellow rivers, as part of the national water quality monitoring programme, by the EPA and NTCC; and

- external dust deposition monitoring adjacent to the TMF at Gortmore, in Silvermines village and control site, by NTCC.

The Expert Group approves of the current environmental monitoring programme for the Silvermines area. In addition, the Expert Group recommends that where a sample is taken, a full suite of analyses should be conducted, including lead, cadmium, arsenic, zinc and copper, as the ore body at Silvermines is dominated by sphalerite and galena.

9.0 ADDITIONAL WORK AND RESEARCH NEEDS

The Expert Group was asked to identify any further research needs during its work. However, it is important that where research needs are identified the results from this research must be of practical benefit to the community of Silvermines.

The Expert Group recommends that the following work should be considered:

1. A further stream sediment sampling and analysis programme should be undertaken to provide a more comprehensive picture of lead concentrations in stream sediments in the area. The Expert Group recommends that a river bank sample, a stream sediment sample and a water sample be taken at each sample location. In relation to the on-going management of dredging spoil from streams and drains, the Expert Group considers that it is preferable that sediment sampling and analysis be conducted on a site-specific basis when dredging is planned for a particular stretch of watercourse.
2. A GIS system should be developed for the area, which will be used to manage on-going monitoring information obtained from the area.
3. Existing baseline ecological information on the area should be compiled and additional ecological studies in selected parts of the area should be undertaken if required.
4. Research to investigate the usefulness of and the possibility of developing appropriate guidelines for the protection of the ecology of the Silvermines area having regard to the naturally elevated concentrations of heavy metals and the likely adaptation of its ecology to these conditions.
5. Studies into lead and cadmium uptake by edible plants in the Silvermines area, coupled with the application of chemical extraction procedures, to determine the bioavailability of these metals and the potential risks.
6. Determination of the speciation of lead in in-situ sediments and post-dredging to evaluate the risk posed to animal health and the environment. This work should assess disposal options for dredged sediments with elevated lead and heavy metal concentrations.
7. Detailed study of the TMF at Gortmore to determine the physical and chemical properties of the tailings, including the acid rock drainage (ARD) generating potential of the tailings, leachability, cause of grass die-back etc. Long-term sustainable management options for the TMF should be assessed as part of this work.
8. Use of scanning electron microscopy to identify the present mineral species of lead and other metals in the environment, particularly in mine waste materials. The mineral species of lead in the Silvermines environment may change over time due to ageing, and the outer weathered surfaces will influence the rate of solubility, mobility and bioavailability.
9. Evaluate the suitability and effectiveness of phyto-remediation technology for the main mine sites in the Silvermines area.

10. Pilot project on feasibility of establishing a mining heritage site in the Silvermines area.



Miner statue in Silvermines village

11. Assess and, if required, develop the necessary technology/equipment to enable extraction of water from streams for animal drinking water, which avoids sediment disturbance.

REFERENCES

An Foras Talúntais, 1980. *Soil Association of Ireland and their land use potential - Explanatory bulletin to soil map of Ireland*. An Foras Talúntais, Dublin.

Bowen, H., Berrow, M., Burton, J., Cawse, P., Patterson, D., Statham, P. and Ure, A. 1982. *Environmental Chemistry: The elemental constituents of Soils, Vol. 2. A review of literature published up to mid-1980*. The Royal Society of Chemistry, London. UK.

Clabby, K.J., Lucey, J. and McGarrigle, M.L. 2003. *Interim report on the Biological Survey of River Quality – Results of 2002 Investigations*. Environmental Protection Agency, Johnstown Castle, Wexford.

Commission Directive 2001/22/EC of 8 March 2001 laying down the sampling methods and the methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs.

Commission Regulation (EC) No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs.

Cotter-Howells, J. and Thornton, I. 1991. 'Sources and pathways of environmental lead in children in a Derbyshire mining village'. *Environmental Geochemistry and Health*, 13, pp 127-135.

Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community

Council Directive 98/83/EC of 3 November 1998 on the Quality of Water Intended for Human Consumption.

Council Directive 80/68/EEC of 17 December 1979 on the Protection of Groundwater against pollution caused by certain dangerous substances.

Davies, B. E. 1983. 'A graphical estimation of normal lead content of some British soils'. *GEODERMA* 29, pp. 67-75.

Department of Agriculture, Food and Rural Development. 2000. *Report of the Investigation into the presence and influence of lead in the Silvermines area of County Tipperary*. DAFRD, Dublin.

Department of Environment. 1989. Air Pollution Act, 1987- Licensing of Industrial Plant: Circular letter AP 1/89. Department of Environment. Dublin.

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Environment Agency. 2002a. *SGV 3 – Soil guideline values for cadmium contamination*. Environment Agency, Bristol, UK.

Environment Agency. 2002b. *Contaminants in soil: Collation of toxicological data and intake values for humans – cadmium*. Environment Agency, Bristol, UK.

Environmental Protection Agency, Department of Agriculture and Food, Department of Health/Health Boards and Teagasc. 1997. *Protocol for the Investigative Approach to Serious Animal Health/Human Health Problems*. EPA, Wexford.

Environmental Protection Agency. 2001. *Parameters of Water Quality: Interpretation and Standards*. EPA, Johnstown Castle Estate, Wexford.

Environmental Protection Agency. 2002. *Expert Group on Lead in Silvermines County Tipperary – Interim Report*. EPA, Johnstown Castle Estate, Wexford.

European Communities (Drinking Water) Regulations, 2000 (SI No. 439 of 2000).

Health (Arsenic and Lead in Food) Regulations, 1972 (SI No. 44 of 1972).

McGrath, D. 1998. 'Use of microwave digestion for estimation of heavy metal content of soils in a geochemical survey'. *Talanta* 46 (1998) pp. 439-448. Elsevier Science, Oxford, UK.

SRK Consulting. 2002. *Management and Rehabilitation of the Silvermines Area*. Prepared for the Department of Marine and Natural Resources. SRK Consulting, Cardiff, Wales.

Teagasc. 2001. *Lead and animal health*. Teagasc, Johnstown Castle, Co Wexford.

Waste Management (Use of Sewage Sludge in Agriculture) Regulations, 1998 (SI No. 148 of 1998).

Williams, C.E. and McArdle, P. 1978. 'Ireland'. In: Bowie, S.H.U., Kvatheim, A. and Haslam, H.W. (eds) *Mineral deposits of Europe – Volume 1: Northwest Europe*. Mineralogical Society, London, UK.

Wild, A. (ed.) 1988. *Russell's Soil Conditions and Plant Growth*. Longman Scientific & Technical, Essex, England.

APPENDIX A – LEGISLATION CONSIDERED BY THE EXPERT GROUP

Water Framework Directive

The Water Framework Directive (2000/60/EEC) came into force on 22 December 2000 and establishes a strategic framework for managing the water environment of the European Community. Member states have three years to transpose the Directive into national legislation. The Water Framework Directive establishes a common approach to protecting and setting environmental objectives for all waters, including groundwaters, rivers, lakes, canals, reservoirs, estuaries and coastal waters. The Directive aims at maintaining and improving water quality within the European Community by setting objectives for all waterbodies requiring at least 'good status', 'no deterioration' and 'restoration' where necessary.

The River Basin District (RBD) will be the main unit for managing the water environment and a single River Basin Management Plan (RBMP) must be produced for each RBD. Identification and analysis of the pressures and impacts on the water environment is required in the preparation of a RBMP which will determine what measures need to be taken in order to achieve 'good status'. For surface waters 'good status' includes good chemical and ecological status and for groundwater includes good chemical and good quantitative status.

The waters in the Silvermines area will ultimately be managed by the relevant competent authority under a river basin management plan with the objective of achieving good water status. However, waters in the area have been influenced by both the natural geological conditions of the area and past mining activities. The Water Framework Directive provides for this by stating *in cases where a body of water is so affected by human activity or its natural condition is such that it may be unfeasible or unreasonably expensive to achieve good status, less stringent environmental objectives may be set on the basis of appropriate, evident and transparent criteria, and all practicable steps should be taken to prevent any further deterioration of the status of waters.*

Dangerous Substances Directive

Under the Dangerous Substances Directive, Member States are required to take appropriate steps to eliminate pollution of waters by List I substances listed in the Annex and to reduce pollution of waters by List II substances also listed in the Annex. List I includes cadmium and its compounds. List II includes metalloids and metals, such as, lead, zinc, arsenic and copper. The Dangerous Substances Directive will remain in force until 22 December 2013, when it will be repealed by the Water Framework Directive.

The Water Quality (Dangerous Substances) Regulations, 2001 (SI No. 12 of 2001) were enacted on 1 July 2001. The Regulations transpose certain requirements of the Dangerous Substances Directive into national legislation. They prescribe water quality standards in relation to specified List II substances, including lead, zinc and arsenic, in surface water, e.g., rivers, streams etc. The Regulations require that the annual mean concentration of certain substances are not exceeded and the standard specified for fresh waters depend upon hardness of water measured in mg/l CaCO₃. Where the existing condition of a water body does not meet a specified standard in relation to a substance there should be no disimprovement and compliance with the specified standard should occur no later than 31 December 2010 or by 31 December 2015 for specific cases.

However, in common with the Water Framework Directive, exemptions are provided for in the Regulations. Article (9) (2) states that *a specified standard shall not apply in relation to a water body where the Agency [Environmental Protection Agency] is satisfied that the water body is so*

permanently affected by naturally occurring conditions or by past human activity that compliance with that standard is not feasible or would be disproportionately expensive.

Drinking Water Directive

The objective of this Directive is to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that the water is wholesome and clean. The Directive came into effect on 25 December 1998 and specifies quality standards in relation to drinking water. This Directive replaced Council Directive of 15 July 1980 relating to quality of water intended for human consumption (80/778/EEC). The European Communities (Drinking Water) Regulations 2001 (SI No. 439 of 2000) transposed the Directive into national legislation and came into operation on 1 January 2004.

The Silvermines Public Water Supply Scheme and the Shallee Group Water Supply Scheme comply with the current national drinking water standard for lead, i.e., 25 µg/l under the European Communities (Drinking Water) Regulations, 2000, SI No. 439 2000. The standard for lead in drinking water to be achieved by 25 December 2013 is 10µg/l.

Groundwater Directive

The purpose of the Groundwater Directive is to prevent the pollution of groundwater by substances belonging to the families and groups of substances in list I or list II in the Annex to the Directive and, where possible, check or eliminate the consequences of pollution which has already occurred. List I substances include cadmium and mercury, while lead, zinc and arsenic are included as List II substances. The Directive requires that Member States prevent the introduction of List I substances into groundwaters and to limit the introduction of List II substances.

However, in common with the Water Framework Directive, exemptions are provided for in the Directive. Article 4 (2) states that *should prior investigation reveal that the groundwater into which the discharge of substances in List I is envisaged is permanently unsuitable for other uses, especially domestic or agricultural, the Member States may authorise the discharge of these substances provided their presence does not impede exploitation of ground resource. These authorisations may be granted only if all technical precautions have been taken to ensure that these substances cannot reach other aquatic systems or harm other ecosystems.*

It is likely that groundwaters in the Silvermines area have been influenced by both the natural geological conditions of the area and past mining activities. Part of the on-going work of the Department of the Communications, Marine and Natural Resources is to carry out a characterisation study of groundwaters in the Silvermines area, which will help evaluate groundwater quality. The study, once completed, may identify the remedial measures necessary to limit the impact of mining sites on groundwaters in the area.

Commission Regulation setting maximum levels for certain contaminants in foodstuffs

The Commission Regulation (EC) No 466/2001 of 8 March 2001 sets maximum levels for certain contaminants, including lead, cadmium and mercury, in foodstuffs and shall apply from 5 April 2002. The Regulation is binding in its entirety and directly applicable in all Member States.

Regulation 466/2001 sets more stringent levels in relation to lead in foodstuffs than previous national regulations, i.e., Health (Arsenic and Lead in Food) Regulations 1972 (SI No. 44 of 1972). This may have implications in relation to milk, meat, edible offal and vegetables produced in the Silvermines area and may also have implications on a national scale. The methodology for sampling

and analysis of foodstuffs is set down in Commission Directive 2001/22/EC which specifies the sampling methods and methods of analysis for the official control of the levels of lead, cadmium, mercury and 3-MCPD in foodstuffs. Member States shall bring into force the laws, regulations or administrative provisions necessary to comply with Directive 2001/22 EC by 5 April 2003. The Directive requires that aggregate samples should be taken and then analysed.

Waste and Hazardous Waste Directives

The Waste Management Act, 1996 provides for the transposition of European legislation on waste into Irish law. Council Directive 75/442/EEC on waste, among other things, required the Commission to draw up a list of wastes. This list, which is known as the European Waste Catalogue (EWC), was published as Commission Decision 94/3/EEC. The control and management of hazardous waste is specified in Council Directive 91/689/EEC on Hazardous Waste. In accordance with the Hazardous Waste Directive, a Hazardous Waste List (HWL) was drawn up and published as Council Decision 94/904/EC. The wastes listed in the HWL are those wastes that appear in the EWC which have been deemed to be hazardous.

The EWC/HWL is a harmonised, non-exhaustive list of waste types which has recently been revised and the new EWC/HWL came into force with effect from 1st January 2002.

Wastes arising in the Silvermines area from activities, such as drainage works on drains, streams and rivers, are now classified under chapter 17 of the EWC/HWL: Construction and Demolition Waste (including excavated soil from contaminated sites). The waste descriptions most relevant are dredging spoil containing dangerous substances (EWC code 17 05 05*¹) and/or dredging spoil other than those mentioned in 17 05 05* (EWC code 17 05 06). In order to be classified as hazardous waste, the dangerous substance must exceed the relevant thresholds as defined in the EWC/HWL and also Directive 67/548/EEC as amended (i.e., Council Directive on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances). Decisions on whether or not a specific waste type is hazardous or non-hazardous will be determined by analysis of waste types on a case by case basis.



Mine waste and drums dumped at Shallee mine site

¹ Any waste marked with an asterisk (*) is considered a hazardous waste pursuant to Directive 91/689/EEC on hazardous waste

Council Directive on the Landfill of Waste

The primary objective of the Landfill Directive (1999/31/EC) is to prevent or reduce as far as possible the negative effects of landfilling wastes on the environment and human health by way of imposing stringent operational and technical requirements on landfills and waste. The Landfill Directive came into force on 16 July 1999 and Member States were required to bring into force laws, regulations and administrative provisions necessary to comply with the Directive by July 2001. The European Communities (Amendment of Waste (Licensing) Regulations, 2000) Regulations (SI No. 337 of 2002) and Waste Management (Licensing)(Amendment) Regulations (SI. No. 336 of 2002) give legal effect to certain requirements of the Council Directive on Landfill of Waste.

The Landfill Directive has implications in relation to the disposal of waste in the Silvermines area. Article 5 (3) (a), which prohibits the disposal of liquid wastes into landfill, has implications in relation to decisions as to the most appropriate disposal option for some mine wastes and contaminated sediments. However, under Article 3 (2), certain activities and wastes are exempted from the scope of the Landfill Directive. These include the spreading of sludges resulting from dredging operations and similar matter on soils for the purposes of fertilisation or improvement; the deposit of non-hazardous dredging sludges alongside small waterways from where they have been dredged out; and the deposit of unpolluted soil or non-hazardous inert waste resulting from prospecting and extraction, treatment, and storage of mineral resources.

Of most significance, in relation to the on-going management of wastes arising in the Silvermines area, is the exemption of the deposit of non-hazardous dredging sludges alongside small waterways, from where they have been dredged out.

Proposal for a Directive on the management of waste from the extractive industry

In 1998, two major pollution incidents which occurred as a result of failures of tailing dams in Romania and Spain, lead to an examination of the extractive industry by the EU Commission. Key environmental issues that were identified were the potential for environmental pollution arising from operational and waste disposal activities and the safety of waste facilities. In response to these concerns two EC Communications were drafted and adopted entitled *Promoting sustainable development in the EU non-energy extractive industry* [COM (2000) 265 final 3.5.2000] and *Safe operation of mining activities: a follow-up to recent developments in the EU non-energy extractive industry* [COM (2000) 664 final of 23.10.2000].

The Commission Communication on Safe Operation of Mining Activities sets out three priority actions envisaged to improve the safety of mines, relating to industrial risk management, management of mining waste, and integrated pollution prevention and control. The three main recommendations are:

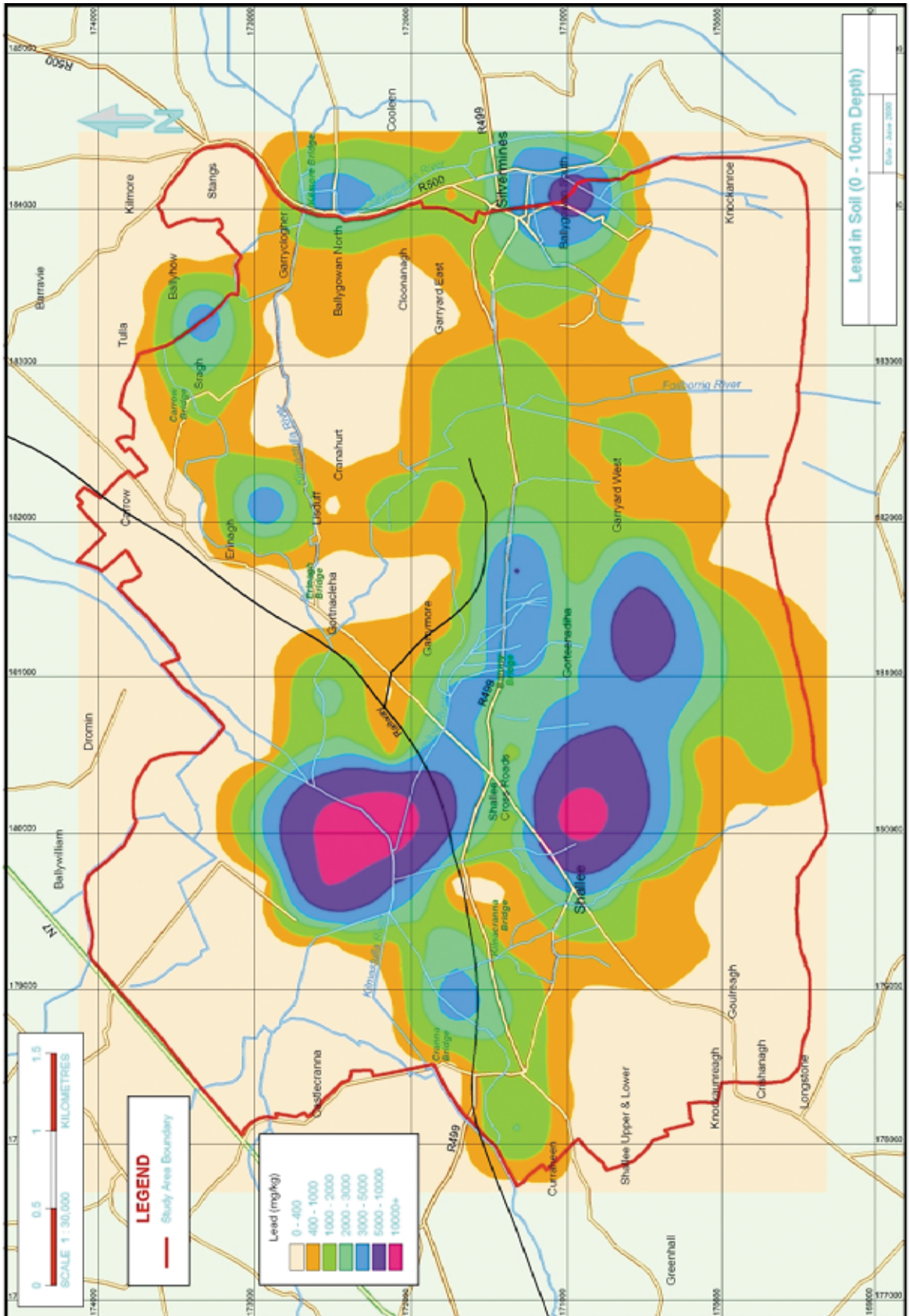
- An amendment to the Seveso II Directive to include mineral processing of ores and associated tailings dams;
- An initiative (i.e., Directive) on the management of mining waste and best practice in relation to the prevention of environmental damage during the waste management phase; and
- A Best Available Techniques reference document (BREF) describing the best available techniques for waste management to reduce pollution and to prevent or mitigate accidents in the mining sector.

The European Commission draft Directive on *The Management of Waste from the Extractive*

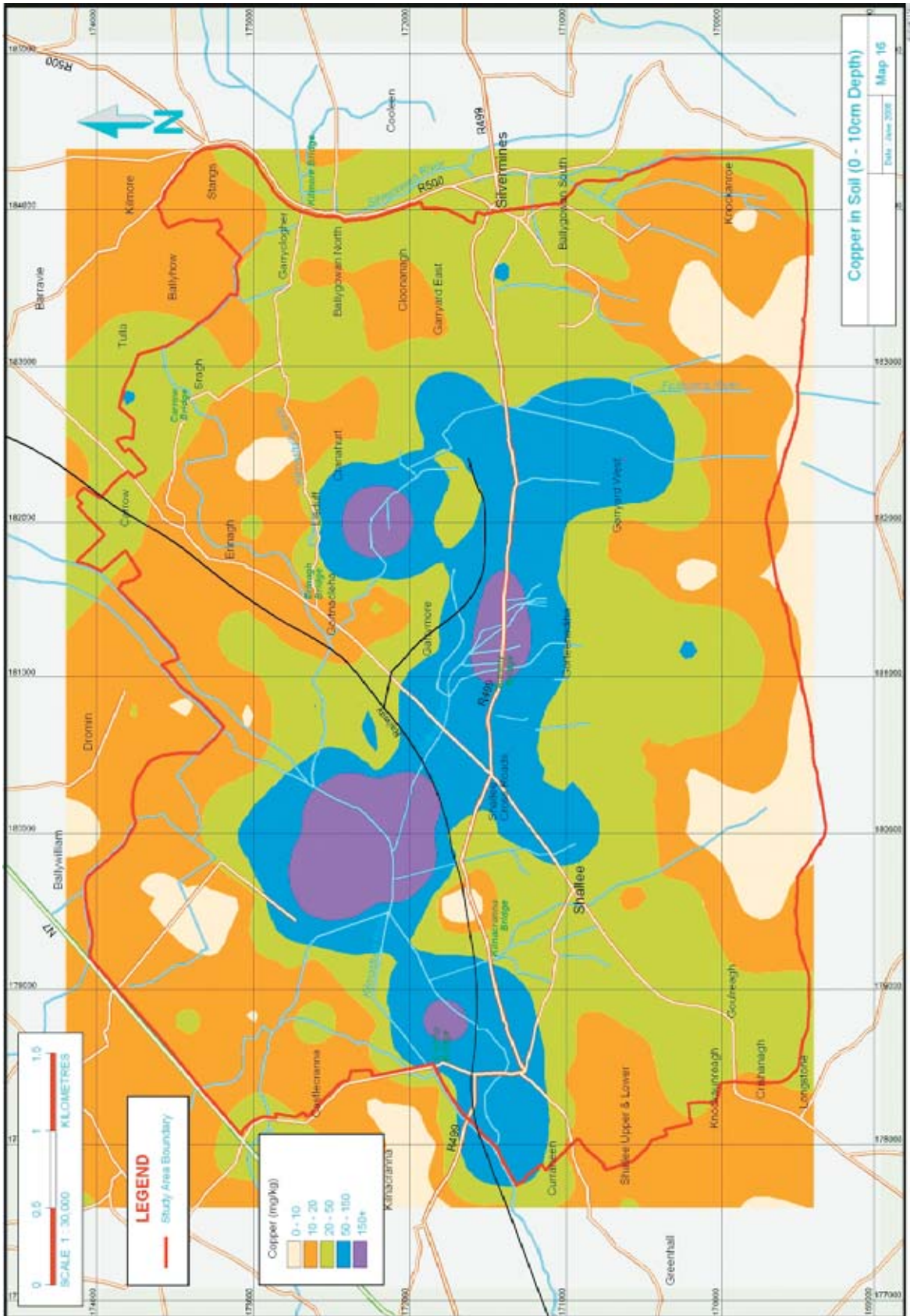
Industry (COM (2003) 319 final) has been circulated to the various stakeholders and member countries as part of a consultation process. The aim of the proposed Directive is to provide for measures, procedures and guidance to prevent or reduce negative effects on the environment and human health from the management of waste from the extractive industry.

Article 19 of the current draft provides for the exchange of technical and scientific information with a view to developing methodologies relating to the drawing up of inventories of closed waste facilities. These waste facilities should be classified according to the degree of impact on human health and the environment. Article 19 also proposes the development of methodologies relating to the rehabilitation of closed waste facilities of the extractive industry, classified as causing serious negative environmental impacts or having the potential to become a serious threat in the near future to human health, the environment and/or property. The implications, if any, from this Directive for the Silvermines area or similar areas, where mining was undertaken in the past, will have to be assessed once the Directive is finalised.

**APPENDIX B - MAPS ILLUSTRATING CONCENTRATION OF HEAVY METALS IN SOILS
IN THE SILVERMINES AREA**



Map 1: Lead in Soils in the Silvermines Area (including TMF at Gortmore)



Map 4: Copper in soils in the Silvermines area

An Gníomhaireacht um Chaomhnú Comhshaoil

Bunú

Achtaíodh an tAcht fán nGníomhaireacht um Chaomhnú Comhshaoil ar an 23ú lá d'Aibreán, 1992 agus faoin reachtaíocht seo bunaíodh an Gníomhaireacht go hoifigiúil ar an 26ú lá d'Iúil, 1993.

Cúraimí

Tá réimse leathan de dhualgais reachtúla ar an nGníomhaireacht agus de chumhachtaí reachtúla aici faoin Acht. Tá na nithe seo a leanas san áireamh i bpríomhfhreagrachtaí na Gníomhaireachta:

- ceadúnú agus rialáil próiseas mór/ilchasta tionsclaíoch agus próiseas eile a d'fhéadfadh a bheith an-truaillitheach, ar bhonn rialú comhtháite ar thruailliú (Integrated Pollution Control-IPC) agus cur chun feidhme na dteicneolaíochtaí is fearr atá ar fáil chun na críche sin;
- faireachán a dhéanamh ar cháilíocht comhshaoil, lena n-áirítear bunachair sonraí a chur ar bun a mbeidh rochtain ag an bpobal orthu, agus foilsiú tuarascálacha treimhsiúla ar staid an chomhshaoil;
- comhairle a chur ar údarais phoiblí maidir le feidhmeanna comhshaoil agus cuidiú le húdarais áitiúla a bhfeidhmeannas caomhnaithe a chomhlíonadh;
- cleachtais atá fóna ó thaobh an chomhshaoil de a chur chun cinn, mar shampla, trí úsáid iniúchtaí comhshaoil a spreagadh, cuspóirí cáilíochta comhshaoil a leagan síos agus cóid chleachtais a eisiúint maidir le nithe a théann i bhfeidhm ar an gcomhshaoil;
- taighde comhshaoil a chur chun cinn agus a chomhordú;
- gach gníomhaíocht thábhachtach diúscartha agus aisghabhála dramhaíola, lena n-áirítear líontaí talún, a cheadúnú agus a rialáil agus plean náisiúnta bainistíochta um dhramháil ghuaiseach, a bheidh le cur i ngníomh ag comhlachtaí eile, a ullmhú agus a thabhairt cothrom le dáta go tréimhsiúil;
- córas a fheidhmiú a chuirfidh ar ár gcumas astúcháin COS (Comhdhúiligh Orgánacha Sho-ghalaithe) a rialú de bharr cáinníochtaí suntasacha peitрил a bheith á stóráil i dteirminéil;
- na rialúcháin OMG (Orgánaigh a Mionathraíodh go Géiniteach) a fheidhmiú agus a ghníomhú maidir le húseaid shrianta a leithéad seo d'orgánaigh agus iad a scaoileadh d'aon turas isteach sa timpeallacht;

- clár hidriméadach náisiúnta a ullmhú agus a chur i ngníomh chun faisnéis maidir le leibhéil, toirteanna agus sruthanna uisce in aibhneacha, i lochanna agus i screamhuiscí a bhailiú, a anailisiú agus a fhoilsiú; agus
- maoirseacht i gcoitinne a dhéanamh ar chomhlíonadh a bhfeidhmeanna reachtúla caomhnaithe comhshaoil ag údarás áitiúla.

Stádas

Is eagrais poiblí neamhspleách í an Gníomhaireacht. Is í an Roinn Comhshaoil agus Rialtais Áitiúil an coimirceoir rialtais atá aici. Cinntítear a neamhspleáchas trí na modhanna a úsáidtear chun an tArd-Stiúrthóir agus na Stiúrthóirí a roghnú, agus trí an tsaoirse a dhearbhaíonn an reachtaíocht di gníomhú ar a conlán féin. Tá freagracht dhíreach faoin reachtaíocht aici as réimse leathan feidhmeannas agus cuireann sé seo taca breise lena neamhspleáchas. Faoin reachtaíocht, is coir é iarracht a dhéanamh dul i gcion go míchuí ar an nGníomhaireacht nó ar aon duine atá ag gníomhú thar a ceann.

Eagrú

Tá ceanncheathrú na Gníomhaireachta lonnaithe i Loch Garman agus tá cúig fhoireann chigireachta aici, atá lonnaithe i mBaile Átha Cliath, Corcaigh, Cill Chainnigh, Caisleán an Bharraigh agus Muineachán.

Bainistíocht

Riarann Bord Feidhmiúcháin lánaimseartha an Gníomhaireacht. Tá Ard-Stiúrthóir agus ceathrar Stiúrthóirí ar an mBord. Ceapann an Rialtas an Bord Feidhmiúcháin de réir mionrialacha atá leagtha síos san Acht.

Coiste Comhairleach

Tugann Coiste Comhairleach ar a bhfuil dáréag ball cunamh don Gníomhaireacht. Ceapann an tAire Comhshaoil agus Rialtais Áitiúil na baill agus roghnaítear iad, den chuid is mó, ó dhaoine a ainmníonn eagraíochtaí a bhfuil suim acu i gcúrsaí comhshaoil nó forbartha. Tá réimse fairsing feidhmeannas comhairleach ag an gCoiste faoin Acht, i leith na Gníomhaireachta agus i leith an Aire araon.



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