

# Overview

Sodium cyanide (CAS No 143-33-9; NaCN) was declared a priority existing chemical on 7 May 2002 in response to environmental concerns. Reasons for declaration included reports of mass bird poisonings as a result of consumption of cyanide-contaminated water at tailings dams, the potential release of toxic and flammable hydrogen cyanide gas when sodium cyanide comes in contact with water, the high acute toxicity to aquatic life, birds and animals, and high chronic toxicity to aquatic life.

The purpose of this assessment is to identify the potential environmental exposure in Australia from the industrial use of sodium cyanide, to characterise the hazards associated with sodium cyanide, and to determine the risk of adverse effects to the environment. It should be noted that the scope of the review pertains to the use of sodium cyanide and not other cyanide salts. This assessment does not address the human health effects of sodium cyanide.

This assessment has drawn upon international assessments, information provided by applicants, and both published and unpublished data obtained from various sources. The current controls by industry have been assessed to identify whether these are adequate to protect the environment. Finally, this assessment has made recommendations for minimising any environmental risks associated with industrial uses of sodium cyanide in Australia. This overview summarises the major findings of the report.

## **Manufacture, transport and use**

Australia is a major global manufacturer and exporter of sodium cyanide, with manufacturing facilities in Western Australia and Queensland. About 100 000 tonnes of sodium cyanide are manufactured each year, of which about 40%-60% is exported. There are several companies that also import sodium cyanide and/or reformulate small quantities. Imports have increased in 2008 as compared to 2004 onwards.

Sodium cyanide is a highly soluble, white deliquescent crystalline powder. For gold mining use in Australia, it is manufactured as solid briquettes, or provided in a liquid form containing approximately 30% NaCN. In water, the cyanide is present as cyanide ion (CN<sup>-</sup>) or the dissolved gas hydrogen cyanide (HCN). The liquid product is made highly alkaline in order to minimise loss of HCN by volatilisation.

In Australia, sodium cyanide is mainly used in the mining industry to recover gold from ore. Approximately 40 000-60 000 tonnes per annum (tpa) is used for this purpose, with the amounts used in each state and territory related to the relative sizes of the gold mining industries. Bulk quantities of sodium cyanide in solid or liquid form (~30% solution) are transported by road and rail from the manufacturing sites to gold mines. Lesser amounts of sodium cyanide are used for ore flotation of base metals (e.g. copper, lead, zinc) and in the electroplating and metal (case) hardening industries. A small quantity of sodium cyanide is used for analytical laboratory testing purposes.

Cyanide (CN) is ubiquitous in the environment at generally low but variable concentrations due to natural (e.g. micro-organisms, plants, animals) and anthropogenic (e.g. industrial) sources. However, free cyanide (cyanide present in water as hydrogen cyanide or cyanide ion, rather than cyanide in inorganic compounds or complexes, or attached to sugars or other organic substances) is very reactive and does not occur commonly in nature. Free cyanide reacts with various metals and their compounds, hence its uses in industry and mining.

Gold cyanide complexes are soluble in water, and consequently cyanide enables low levels of gold to be extracted from ore and the gold is then recovered by further processes. The treatment of the ore with cyanide (known as gold ore beneficiation) may occur in two basic ways after the ore is extracted from the ground, referred to as tank leaching and heap leaching. With tank leaching (the main method used in Australia), the ore is milled and mixed with the cyanide solution in large tanks, and the used cyanide solution and exhausted ore are disposed of to tailings storage facilities. With heap leaching, the cyanide solution is applied to the tops of large heaps of crushed ore, the solution containing dissolved gold is collected at the bottom, and the solution recirculated after the gold is removed, or treated to destroy the cyanide residues before disposal. In both cases, the concentrations of sodium cyanide used to obtain the gold from the ore are typically 100-500 mg CN/L.

### **Environmental fate**

The overall fate of sodium cyanide and its products in the environment is complex and depends on a wide range of site specific and operational factors. In solution, the amount of HCN present increases with decreasing pH and an important form of release at the pH range in the normal environment is volatilisation of gaseous HCN. In addition to volatilisation, reactions that can occur include complexation with various metals, adsorption, reaction with various forms of sulphur, oxidation, hydrolysis, and aerobic and anaerobic degradation reactions. Metallo-cyanide complexes may form insoluble precipitates, and if exposed to light, iron-cyanide complexes may undergo photolysis reactions releasing HCN. Products such as cyanate and thiocyanate may decompose further. Some forms of cyanide, such as weak metallo-cyanide complexes, may also contribute to cyanide toxicity to wildlife. Forms of cyanide available at the low pH in the stomachs of birds and mammals are commonly measured as Weak Acid Dissociable cyanide (WAD CN).

In tailings storage facilities (TSFs) and heap leach piles, cyanide may be lost by volatilisation of HCN, degraded by various abiotic and biotic processes, fixed within the site by precipitation and adsorption of metallo-cyanides, and may potentially migrate in seepage to underlying strata and groundwater. The extent to which seepage occurs varies widely between individual sites. The amount of cyanide going to TSFs or remaining in them may be reduced by recovering the cyanide-containing water for re-use in the process, or by using various chemical processes to convert cyanide to cyanate, or potentially to recover free cyanide from other forms of cyanide. As a result of process and tailings management and other site factors, WAD CN concentrations in surface waters at operational TSFs vary widely; from ~1-10 mg WAD CN/L where cyanide has been largely destroyed to >100 mg WAD CN/L without measures to limit the concentration in tailings effluent.

Most sodium cyanide-derived waste from non-mining uses is expected to be treated to destroy free cyanide before delivery to landfill, where dissipation, degradation and fixation processes are expected to occur. Cyanide-resistant micro-organisms capable of biodegrading cyanide have been identified in aerobic sewerage treatment systems and the small amounts of cyanide arising from industrial discharge into sewers are likely to be destroyed during secondary treatment.

### **Environmental exposure**

Exposure of terrestrial and avian wildlife and aquatic organisms to anthropogenic sodium cyanide, or cyanide forms arising from it, could potentially occur at various stages in the life cycle of sodium cyanide; namely, from manufacture, to transport, use and ultimate release to the environment. Terrestrial and avian wildlife may be exposed to residues in water at TSFs and heap leach facilities, and aquatic organisms may be exposed to cyanide in water released from these facilities into downstream areas. Measures which are used to limit exposure of wildlife to

cyanide residues include restricting or preventing access by birds, bats and terrestrial animals to water containing toxic cyanide levels (e.g. netting, fences), ensuring such areas are not attractive to birds or bats (e.g. avoiding the formation of nesting or roosting sites in the vicinity), and/or using deterrents.

Groundwater near tailings storage and heap leach facilities may be contaminated by seepage. This varies widely between sites, and some seepage can be assumed despite careful design.

Exposure may arise if NaCN spills occur during transportation. Some spills of NaCN have occurred during road or rail transport in Australia, and in one incident wildlife were reported to have been affected. Environmental damage was minimised at other incidents where significant spills occurred, due to emergency response measures to contain and recover the spilt material and remove contaminated soil or water. However, some overseas incidents where significant release of NaCN occurred to water led to downstream environmental contamination and harm to aquatic organisms.

Unintended releases of material containing cyanide have also occurred overseas and in Australia due to incidents ranging from minor leaks causing no environmental harm to major structural failures leading to significant environmental harm due to physical effects and other toxic components, in addition to cyanide residues. These incidents indicate the need for appropriate monitoring and response measures for operations on an ongoing basis, as well as correct design and operation of TSFs and heap leach facilities.

Emission of hydrogen cyanide to air may occur as a consequence of the manufacture, transport and use of sodium cyanide. The major use of sodium cyanide is in the gold industry.

### **Environmental effects**

In determining the effects of NaCN on the environment, data on sodium cyanide were supplemented with data from other cyanogenic compounds, because the free cyanide formed when sodium cyanide dissolves in water may also be present in aqueous environments from a number of other sources. These sources include dissociation or release from cyanogenic compounds (e.g. certain other metal cyanides and cyanide complexes, depending on their solubility, the pH and other conditions), and catabolism of cyanogenic glycosides in plant tissue.

These data showed that cyanide has very high acute (e.g. single dose) toxicity to aquatic and terrestrial animals and is also toxic to plants and certain micro-organisms. It also can produce chronic toxicity following long-term or repeat-dose exposure, such as adverse impacts on egg production and spawning in fish. Once in the bloodstream, cyanide rapidly forms a stable complex with enzymes involved in cellular respiration, resulting in cytotoxic hypoxia or cellular asphyxiation. The lack of available oxygen causes a shift from aerobic to anaerobic metabolism, leading to the accumulation of lactate in the blood. The combined effect of the hypoxia and lactate acidosis is depression of the central nervous system (CNS) that can result in respiratory arrest and death. A range of other enzymes and biological systems, other than the CNS, are also affected by cyanide.

In general, the effects of small non-lethal doses of cyanide tend to be reversible over time due to metabolic processes leading to cyanide degradation. There is a range of debilitating signs of sublethal cyanide poisoning (cyanosis), and fitness is likely to be impaired during the recovery phase. Greatest attention was paid in this report to the toxicity of cyanide to birds, as prior to this review commencing there had been incidents in Australia where hundreds or thousands of birds have been killed within a relatively short period at a single gold ore processing site through exposure to cyanide residues in a TSF or associated facilities.

There is now a body of evidence from various anecdotal and scientific observations and incident reports at mine sites that where significant mortalities are observed, WAD CN concentrations are > ~50 mg WAD CN/L, and that relatively few or no mortalities are observed at lower WAD CN concentrations. However, some caution is needed because field observations to determine the extent of sublethal effects are lacking.

Laboratory studies have been conducted where birds were exposed to cyanide in drinking water, which is expected to be the most significant exposure route at mines. Drinking water studies based on standard test guidelines indicated avian LC50 values for bobwhite quail and mallard ducks of 374 mg CN/L and 180 mg CN/L, respectively. However, these studies were considered unreliable due to uncertain actual concentrations and exposure. The toxicity of cyanide in mine effluent and tap water with single or repeated exposure of mallard ducks has also been investigated, with LC50 values of 181-212 mg WAD CN/L and 136-158 mg WAD CN/L respectively. The results were interpreted as indicating an overall LC01 (1% mortality) of 50 mg/L for repeat exposure, which appears to be a further basis for selection of 50 mg WAD CN/L as a protective value. However, the original reports have not been seen, very limited information on the studies was available and the results are considered to be unreliable.

Other brief exposure (2-4 h) studies with mallards indicate a short exposure LC50 of ~115 mg WAD CN/L, which is consistent with field observations on acute mortality. An assessment factor of 10 could be applied to these, suggesting a concentration of ~12 mg WAD CN/L would be safe to protect mallards from any lethal effects with short term exposure. However, in extending these results to other species with different drinking behaviours and bodyweights, the relative size of a single dose would need to be considered (e.g. a dose of ~8-10 mL used for the ~1 kg mallards is relative to a total day's consumption of ~60 mL. Mallards would be expected to take six or more drinks per day, whereas a bird weighing ~50 g would consume around 10 mL water per day, and depending on the species, may only arrive to drink once or twice per day).

The most reliable data available for cyanide toxicity in birds were from acute oral toxicity tests with seven bird species. In this assessment, modelling based on these results has estimated a Predicted No Effect Concentration (PNEC) of ~1 mg/L, noting some limitations in the size and quality of the dataset. The use of acute toxicity data for assessment of toxicity from drinking water consumption requires interpolation of the results using estimated daily water consumption. As birds (and animals) may be able to detoxify cyanide if sufficient time elapses between the intake of sublethal doses, assumptions also need to be made regarding the proportion of daily water consumption that birds would ingest in each dose. In a worst case, it is necessary to consider ingestion of the entire day's consumption in a single dose. This is appropriate for species that arrive at water sources only once or twice per day, but is clearly conservative (or perhaps not even appropriate) for species such as waterbirds (e.g. mallards), which take several drinks over the day. Such differences in drinking behaviour between species make it difficult to extrapolate toxicity results from one species to another.

There are also studies of biochemical effects and effects on pigeon flight time from cyanide exposure, which indicate effects at relatively low doses. Expressed as the concentration given in a single dose of 10 mL (compared to an expected approximate daily water consumption of ~50-60 mL), significant biochemical effects occurred at concentrations as low as 20 mg free CN/L, and significant pigeon flight time effects at 50-80 mg free CN/L. The metabolism of the birds may recover from such doses, but while affected, birds may be more likely to succumb to predators or suffer reduced flying capacity. However, there is no conclusive evidence from observations or incident reports that these effects occur in the field, although in any case they would be very difficult to detect because they would occur at diffuse locations distant from the site where exposure occurred.

Observations also indicate that birds do not become averse to drinking cyanide-contaminated mine waste water. In fact, they may remain in a pond and take further drinks even after awakening from cyanide stupefaction. A bird that does not fly off may continue to take in further doses, leading to a cumulative toxicity effect. Depending on drinking behaviour (e.g. species differences) a bird may also take in a greater relative dose. However, it is also noted that birds are averse to drinking hypersaline water and field studies show that in hypersaline situations, mortalities due to cyanide are not likely to occur even at WAD CN concentrations exceeding 50 mg/L.

Similarly, the most reliable toxicity data for mammals were acute oral toxicity studies, and modelling based on these results and drinking water consumption tables again estimated a Predicted No Effect Concentration (PNEC) of ~1 mg/L.

For aquatic assessment, a range of acute and chronic toxicity data are available with free cyanide, as considered in the development of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. The cyanide trigger value for protection of 95% of aquatic organisms is 0.007 mg free CN/L at the boundary of freshwater mixing zones, or 0.004 mg free CN/L at the boundary of mixing zones if release is to coastal waters.

### **Risk characterisation and management**

In order to characterise the health risk, the potential exposure level for wildlife is compared to the level of the substance where toxic effects are observed. Factors that affect wildlife exposure include the bioavailability of the substance to an organism. With regard to residues from gold mining operations, measurements of free cyanide are not an adequate indicator of the toxicity of contaminated water to birds and mammals. This is because the amount of free cyanide originally present is increased after ingestion of the water due to release from various cyanide compounds and complexes under low gastric pH conditions. Consequently, in this assessment, the estimated environmental concentration endpoints for risk assessment to birds and mammals have been based on analyses of the WAD CN content of such waste.

Risks to the environment from the manufacture and storage of NaCN were considered to be acceptable if existing Commonwealth and state/territory legislation and voluntary measures are properly implemented and applied. However, it is recommended that the adequacy of existing measures for transport be reconsidered in the light of the road transport incident which occurred in February 2007 in the Northern Territory.

This risk assessment has concentrated on uses in gold mining, where both the amount of sodium cyanide used and the likelihood of environmental exposure are greatest.

Terrestrial and avian wildlife may be exposed to residues of NaCN at gold mines. While wildlife at gold mine tailings storage facilities may be exposed to material containing cyanide residues by various routes, consumption of drinking water is likely to be the major route of exposure. Assessments of risk to wildlife were therefore based on consumption of contaminated water containing a range of possible concentrations of WAD CN, together with the toxicity reference values determined for birds and mammals. On this basis, the risk assessment indicated a highly conservative WAD CN concentration in water of  $\leq 1$  mg/L (based on acute toxicity studies) in order to assure protection of sensitive avian species from acute mortality and from potentially harmful sublethal effects that might lead to delayed mortality. This low level may not be justified based on other evidence and difficulties with extrapolating acute toxicity data, nor may it be practical with present technology. Field data generally indicate that incidents of mortality are very few at WAD CN concentrations  $< \sim 50$  mg/L, and recent studies indicate that higher WAD CN concentrations are likely to be safe in hypersaline situations. Based on this assessment, a framework approach combining strategies to limit the concentration of WAD CN

in waters accessible to wildlife together with strategies to limit exposure is recommended for different scenarios.

Environmental exposure to cyanide residues is expected to be much lower when used in ore flotation, as the processes used are quite different to those used in gold mines. The level of bioavailable cyanide residues in waste streams transferred to TSFs is expected to be much lower in ore flotation, as the pH of the waste stream is low, and the composition of material in the TSFs is different to that in TSFs from gold mines using sodium cyanide. However, risk management for cyanide in TSFs at facilities using sodium cyanide should be consistent with those that at gold mines. Prevention of exposure to cyanide-containing solutions is essential at heap leach facilities, as concentrations cannot be reduced for efficacy reasons.

Risks to the aquatic environment, groundwater and vegetation were also examined and considered acceptable if existing Commonwealth and state/territory legislation and voluntary measures are properly implemented and applied. However, the importance to protect the environment by active monitoring and management of groundwater seepage is stressed.

Industrial uses of cyanide with metals occur at enclosed industrial sites, and under existing legislation and voluntary measures, any unconsumed cyanide is generally destroyed prior to disposal. Hence environmental risks from these uses are expected to be acceptable.

Releases of HCN to the atmosphere are unlikely to cause ecotoxicity, except possibly near the surface of tailings storage facilities (TSFs), where toxicity due to consumption of water containing cyanide is the greater concern. Flammability is also not considered to pose a significant environmental risk. Total releases of HCN from gold industry or other uses of sodium cyanide, while substantial, are considered unlikely to lead to significant increases in air concentration or to result in harmful global effects through action as a greenhouse gas or ozone depletor. Hence risks to the environment from gaseous hydrogen cyanide as a consequence of sodium cyanide use are considered acceptable.

While this review is about industrial uses of sodium cyanide, similar issues would be relevant for potassium cyanide and other simple cyanide salts. Thus, chemical users should take note of the recommendations for sodium cyanide when using these other salts.

# Recommendations

This chapter provides recommendations arising from this Priority Existing Chemical assessment of sodium cyanide. Consideration has been given to where the manufacture, handling, storage, use or disposal of sodium cyanide gives rise, or may give rise, to a risk of adverse environmental effects. Recommendations are directed at regulatory and non-regulatory bodies and industrial users of sodium cyanide.

The recommendations address seven different issues, as follows:

1. Manufacture
2. Storage
3. Transport
4. Release of cyanide during gold ore beneficiation use, including:
  - a. Prevention and management of environmental incidents arising from unplanned releases of material containing cyanide
  - b. Protection of groundwater from contamination by cyanide in seepage from TSFs or heap leach facilities and associated dams
  - c. Protection of aquatic organisms from planned releases of water from disposal facilities following sodium cyanide use for gold ore processing
5. Protection of wildlife during gold ore beneficiation use, including:
  - a. Protection of wildlife at gold tank leach processing facilities
  - b. Protection of wildlife at gold heap leach processing facilities
  - c. Need for suitable monitoring and response programs to support wildlife protection measures
6. Base metal flotation uses
7. Minor industrial uses

Due to the complexity surrounding the assessment of sodium cyanide, each recommendation is accompanied by a separate preamble to briefly provide the rationale supporting the recommendation. For a full understanding of reasons, the main report should be consulted.

## **1. Manufacture**

Existing Commonwealth and state/territory legislation and voluntary measures provide adequate controls and guidance for managing the design and operation of sodium cyanide manufacturing facilities to protect the environment from exposure to harmful levels of cyanides.

These measures include legislation relating to Major Hazard Facilities, waste management, and emissions management and monitoring, and the involvement of industry in various voluntary Codes of Practice, including the International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold (ICMC) and those under the international Responsible Care® program.

**Recommendation 1:**

**Industry should continue to comply with existing Commonwealth and state/territory legislation and to implement voluntary measures to ensure an acceptable risk to the environment during the manufacture of sodium cyanide. State/territory governments should continue to monitor compliance.**

**2. Storage**

There is potential for exposure of the environment to cyanide during the filling, transport and unloading of sodium cyanide containers, or through breaching of a storage container in an accident.

Existing Commonwealth and state/territory legislation and voluntary measures provide adequate controls and guidance for managing the storage of sodium cyanide in order to protect the environment from exposure to harmful levels of cyanide.

For storage and handling the existing guidance include the National Standard and Code of Practice for the Storage and Handling of Dangerous Goods, National Standard and Code of Practice for the Control of Major Hazard Facilities, Australian Standards applying to storage and handling, complementary state/territory legislation to these, other related Commonwealth and state/territory legislation, and the involvement of industry in various voluntary Codes of Practice.

**Recommendation 2:**

**Industry should continue to comply with existing Commonwealth and state/territory legislation and to implement voluntary measures to ensure an acceptable risk to the environment during storage of sodium cyanide. State/territory governments should continue to monitor compliance.**

**3. Transport**

Sodium cyanide in either solid or liquid form may be transported by rail or road in bulk quantities, often long distances from the manufacturing sites to remote areas (for example, for use in gold beneficiation and in base metal flotation).

Existing Commonwealth and state/territory legislation and voluntary measures provide controls and guidance for managing transport of sodium cyanide in order to protect the environment from exposure to harmful levels of cyanide. For land transport within Australia, these measures include the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code, 2007).

The International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold, and for manufacturers, the international Responsible Care® program also provide guidance.

Transport of sodium cyanide in solid form occurs in composite intermediate bulk containers (CIBCs) inside freight containers holding 20 CIBCs. Solid sodium cyanide manufactured at Gladstone in Queensland is also transported in larger (e.g. 20-22 tonne) specially designed solid-to-liquid (StoLs) isotainers.

Transport of sodium cyanide in liquid form is restricted to land transport in isotainers and occurs predominantly in Western Australia, but some transport in liquid form also occurs from the Gladstone site in Queensland.

It would be more difficult to contain, treat and recover releases in liquid form, but releases in the solid form would dissolve rapidly if rain or surface water were present, with potential for runoff to surrounding areas.

A truck accident in the Northern Territory in 2007 resulted in spillage of sodium cyanide, and while minimal environmental harm resulted, the incident suggests there may be improvements that could be made to current legislation and guidance in various jurisdictions. Key recommendations from a review of this incident were the adoption of the 7th Edition of the Australian Dangerous Goods Code (ADG7) and improvements to coordination across Government agencies, both for compliance monitoring arrangements and for emergency response procedures.

**Recommendation 3:**

**Transport of sodium cyanide should be conducted according to best practice principles in order to reduce the likelihood of, or lessen the impacts of accidents leading to sodium cyanide release to the environment. Transport precautions and procedures should follow the Australian Dangerous Goods Code 7 (NTC, 2007). These principles include the following:**

- **Compliance with dangerous goods transport regulations for bulk container design, packaging, placarding and safety equipment;**
- **Selection of mode of transport;**
- **Where alternative routes are available, careful route selection to minimise travel through environmentally sensitive areas;**
- **Optimisation of load size to minimise overall risk, and compliance with local transport requirements such as Restricted Area Vehicle permits;**
- **Driver training covering vehicle handling, bulk transfer procedures and emergency response; and**
- **Access by transporters to appropriately trained and equipped emergency responders that can respond in a timely manner.**

**Implementation and adequacy of these measures should be monitored by the relevant state and territory authorities. Industry should continue to comply with Commonwealth and state/territory legislation and to implement voluntary measures to ensure an acceptable risk to the environment during transport of sodium cyanide.**

#### **4. Release of cyanide during gold ore beneficiation use**

Tank and heap leaching operations using the cyanidation process for gold beneficiation form the principal route of environmental exposure to sodium cyanide. This is the case in terms of both the extent of use and the nature of release to the environment, noting much of the cyanide used is not consumed or lost in the process, but is deposited with tailings into tailings storage

facilities in the case of tank leach processes, or remains in the solutions flowing from heap leach piles or in immobile forms within those piles.

Replacement of sodium cyanide with other substances is not yet generally practicable. Recovery of cyanide for re-use on site is possible for some operations and would minimise release to the environment.

**a Prevention and management of environmental incidents arising from unplanned releases of material containing cyanide**

International incidents have demonstrated the potentially serious consequences for the environment from structural failures, overtopping, or spillage or leakage from heap leach piles, TSFs and associated equipment and facilities.

Monitoring programs to check for operational problems are in place at mine sites and have been operating satisfactorily and allow suitable corrective and preventative action to be taken. Currently available regulatory and voluntary measures are considered sufficient to ensure that the design, construction and operation of ore beneficiation sites, TSFs and associated facilities are adequate to protect the environment from structural failures, with additional measures to capture and control overflows, seepage, spillages and leaks at the mill, TSF and other areas of the site where cyanide residues may be present.

**Recommendation 4a**

**Industry should continue to comply with existing Commonwealth and state/territory legislation, and to implement voluntary measures to ensure acceptable risks to the environment from releases of cyanide containing material arising from the failure of structures containing cyanide residues or from dam overtopping, leaks and spills. State/territory governments should continue to monitor compliance.**

**b. Protection of groundwater from contamination by cyanide in seepage from TSFs or heap leach facilities and associated dams**

Under the National Water Quality Management Strategy (ANZECC/ARMCANZ, 1995), operations are required to manage seepage from tailings storage and heap leach facilities to protect the beneficial uses of groundwater and prevent ecological damage from cyanide (and other constituents) in the event that groundwater reaches surface waters.

Monitoring of the groundwater enables seepage to be detected and appropriate action taken. Protection of groundwater is currently addressed through environmental impact assessment, the site design and work plan approval and monitoring process, and through inspection and reporting processes by state/territory agencies and is also addressed in the ICMC.

It is considered that existing regulatory processes are appropriate for groundwater protection to be planned and managed, based on site assessments and regular review and with regard to the existing quality of the groundwater.

**Recommendation 4b**

**Industry should continue to comply with existing Commonwealth and state/territory legislation, and to implement voluntary measures to ensure acceptable risks to the environment from releases of cyanide due to seepage from TSFs and other structures holding water containing cyanide. State/territory governments should continue to monitor compliance.**

**c. Protection of aquatic organisms from planned releases of water from disposal facilities following sodium cyanide use for gold ore processing**

Exposure to aquatic organisms is not a concern in the TSF or associated dams and ponds used for storage of decant, process or drainage water on the site, but may be a concern if downstream areas were to be contaminated, for example, where intended discharges of TSF or heap leach waters to surface waters need to occur in high rainfall areas.

Most states and territories review plans for facilities which may release cyanide to surface waters in the context of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000a) cyanide trigger value for protection of 95% of aquatic organisms, specifying appropriate compliance limits in water discharged from TSFs at suitable measuring points.

Existing Commonwealth and state/territory legislation and voluntary measures provide adequate controls and guidance for managing risks to the Australian environment arising from planned releases of water from disposal facilities following sodium cyanide use for gold ore processing.

**Recommendation 4c**

**Industry should continue to comply with existing Commonwealth and state/territory legislation, and to implement voluntary measures to ensure acceptable risks to the environment from planned releases of water from disposal facilities following sodium cyanide use for gold ore processing. State/territory governments should continue to monitor compliance.**

**5. Protection of wildlife during gold ore beneficiation use**

**a. Protection of wildlife at gold tank leach processing facilities**

At gold tank leach processing facilities, gold is removed from the ore using sodium cyanide in water, and the remaining material in solution is placed in tailings dams, which are often substantial structures.

Birds and other wildlife may drink the contaminated water in the tailings dams, particularly when alternative water sources are limited, and may also use the area for refuge.

Available information indicates birds do not avoid drinking cyanide-contaminated mine waste water. However, as birds are averse to drinking hypersaline water, cyanide intake may be reduced where the water is hypersaline.

The assessment has determined that risks to wildlife from operations using sodium cyanide in tank leach operations for extracting gold from ore are such that improved management to reduce risks from exposure is needed.

Detailed consideration of risk mitigation strategies to protect wildlife, particularly birds, from the harmful effects of cyanide at these facilities is essential. Two risk mitigation pathways have been considered in this assessment, one controlling concentrations of cyanide levels available in TSFs and the other controlling exposure, by reducing access to wildlife. These two risk mitigation pathways can also be used together to protect wildlife.

#### **Concentration controls:**

In the Australian mining industry the majority of cyanide residue is released to TSFs, which is the main source of release to the environment. There are a large number of TSFs of various designs and with differing processing procedures and tailings stream management strategies operating in Australia. These vary according to climate, topography, geographic location, operational requirements of the mine, processing water quality, ore composition and various other factors. Ore composition also varies at different minesites, and this affects the concentration of cyanide required by the process and the concentration of free CN or WAD CN resulting in the tailings stream. The amount of free CN or WAD CN in the tailings stream cyanide cannot be predicted reliably. Thus it would not be appropriate to establish a single benchmark for all mines, and active monitoring of CN levels is necessary for optimising the beneficiation process and to enable cyanide levels in the tailings stream to be managed.

There is now a body of evidence from various scientific observations, incident reports at mine sites and anecdotal information that significant mortalities are observed at concentrations > ~50 mg WAD CN/L, and that relatively few or no mortalities at lower WAD CN concentrations. However, some caution is needed with the latter because field observations to determine the extent of sublethal effects are lacking.

While the above is generally the case, studies in hypersaline areas have demonstrated that wildlife mortalities due to cyanide do not occur, even where WAD CN concentrations significantly exceed 50 mg/L. Investigations have shown that this is because exposure of wildlife is minimised, as even species adapted to saline water (14 000 – 50 000 mg/L TDS) do not drink hypersaline water (> 50 000 mg/L TDS) and receive minimal exposure through diet or other sources. The chemistry of the tailings discharge in hypersaline situation was also shown to favour degradation of the WAD CN, provided pH and salinity were at appropriate levels and the Cu content within appropriate limits for the WAD CN content.

Concentration levels protective of birds are also considered protective of bats and terrestrial vertebrates such as macropods and reptiles. Where concentration controls are used, appropriate programs should be in place to monitor WAD CN concentrations at appropriate locations and intervals, and specification of control concentrations should address statistical considerations.

#### **Exposure controls:**

An alternative approach to mitigating the risk to wildlife is to minimise exposure by restricting or preventing access by birds and bats to water containing toxic cyanide levels, ensuring such areas are not attractive to birds or bats, and/or using deterrents. The measures need to be considered on a site specific basis with knowledge of the species (Section 11.13).

Protective action needs to be balanced against the possibility that it may itself cause harm to wildlife, and needs to be practicable in the local situation, as separate issues to the costs involved.

In all cases, appropriate monitoring programs should be in place so the operator can react promptly to exposure events with active deterrent and corrective measures as necessary, and preferably, anticipate and prevent exposure events by avoiding the development of habitat

attractive to wildlife in areas where waters containing potentially harmful concentrations of cyanide are released (see Recommendation 5c).

#### **Recommendation 5a**

**Management of risks to avian and mammalian wildlife at tailings storage facilities requires improvement. Regulators and operators should adopt a framework strategy (see Table - Recommendation 5a) combining benchmark limits with other measures appropriate to the environmental risks at the individual site.**

A framework for the management of risks to wildlife from sodium cyanide use in gold mining is presented in the Table below. Differences in geology, topography, water quality, climate, geographical location, local standards etc make it difficult to have a single benchmark across Australia. Accordingly, a flexible, framework approach is proposed incorporating the use of alternative measures to limit exposure together with a range of benchmark concentrations according to site factors. The following points form the basis of the proposed framework:

- i. At concentrations  $\geq 50$ mg WAD CN/L, deaths of a significant proportion of birds exposed may occur. At tank leach facilities where it is very difficult or impracticable to lower WAD CN below 50 mg WAD CN/L and the waters are not hypersaline, concentration control measures cannot be relied upon. In these exceptional situations, comprehensive measures must be taken to prevent exposure of wildlife to waters containing  $> 50$  mg WAD CN/L, together with measures to minimise the attractiveness to wildlife of the habitat in and around the tailings storage facility.
- ii. At tank leach facilities where WAD CN concentrations in waters accessible to wildlife and the waters are hypersaline, a 50 mg/L WAD CN limit is not required, as studies in hypersaline areas have demonstrated that hypersalinity is protective of wildlife. However, appropriate target levels for WAD CN, salinity, pH and Cu must be agreed for the specific site, and measures must also be taken to minimise the attractiveness to wildlife of the habitat in and around the tailings storage facility, with exclusion of access to specified areas.
- iii. In general, except at hypersaline sites and exceptional other sites, process controls and cyanide destruction facilities should be in place to enable WAD CN to be maintained at an agreed level below 50 mg/L. Adoption of a level of 50 mg WAD CN/L as a general maximum target at non-hypersaline sites is consistent with that used by the ICMC, as field observations indicate that few wildlife mortalities are likely to occur at WAD CN concentrations below this level. Measures must also be taken to minimise the attractiveness to wildlife of the habitat in and around the tailings storage facility, and may be required to exclude access to specified areas. A range of 10-50 mg WAD CN/L was selected because of the uncertainty as to which point and which species are susceptible to lethal and sub-lethal effects, and secondly to enable a statistical description of the concentration to be specified by regulatory authorities.
- iv. There are also sites where WAD CN is reduced to around 10 mg/L or less for other reasons, e.g. where downstream release may occur. A high level of protection to avifauna and terrestrial wildlife exposed to waters at WAD CN concentrations  $< 10$  mg/L is therefore likely from the concentration control achieved.

This framework could be enhanced in the light of further laboratory data, field evidence and experience. It is envisaged that the framework will operate through state/territory agencies working together with mines in planning wildlife protection measures through the initial Environmental Impact Statement, and site design and work plan approval processes, followed by ongoing interaction through monitoring, inspection and reporting processes with state/territory agencies. Facilities should aim to achieve maximum WAD CN concentrations below 50 mg/L in waters accessible to wildlife by the end of 2012 unless they can demonstrate to the satisfaction of state/territory agencies that local conditions warrant a higher target and that other factors or measures taken adequately prevent exposure of birds and animals to water containing higher concentrations of cyanide.

While 50 mg WAD CN/L is proposed as the general overall maximum concentration target to minimise the risk of significant bird death incidents occurring, as concentrations may fluctuate widely, it is necessary to set appropriate statistical limits below this so that the maximum level is not exceeded. An example would be 30 mg WAD CN/L (90th percentile of time) and 50 mg WAD CN/L (not to be exceeded), cf. NSW DECC, but other standards may be selected. Situations such as areas where rare or threatened species are present may warrant a further level of protection. An example would be 20 mg WAD CN/L (90th percentile) and 30 mg WAD CN/L (maximum), cf. NSW DECC for a more sensitive site. Such levels may be established by an EIS. Lowering the concentration levels may also be required if monitoring shows that harmful impacts to birds are occurring despite the relevant target levels being met and other management steps having been taken, particularly if threatened species are present.

Data show that factors such as time of day affect concentrations at points distant from the outlet to the TSF, for example, because degradation caused by sunlight is reversible at night. For this reason, benchmark targets should apply to tailings effluent at the point of discharge to the TSF, supported as necessary for local requirements by testing at other points, such as supernatant water and decant ponds.

Research has shown the importance of copper in stabilising WAD CN, and copper soluble cyanide complexes in the WAD cyanide concentrations have caused some mine sites to discharge tailings solutions in excess of 50 mg/L. In some circumstances it may be appropriate to measure other components of tailings solutions such as copper, as recommended for hypersaline sites by Adams et al. (2008b).

An important aspect of a benchmark concentration-based system is the ability to adequately monitor the WAD CN concentration. The reliability, accuracy and consistency of analytical results need to be assured. Capabilities differ between large and small sites. For example, small facilities may not currently have any capacity to measure WAD CN on site. If WAD CN concentration is relied upon as the main prevention measure, the frequency of measuring, timeliness of obtaining results, and the accuracy of the results are important to avoid undetected problems arising. Such difficulties with monitoring concentration heighten the importance of monitoring for wildlife incidents as well.

**Recommendation 5a: Framework for management of risks to wildlife from sodium cyanide use in gold mining**

Proposed target WAD CN concentration at the discharge point to the tailings storage facilities (TSF)	Strategy	Comments	Notional implications for wildlife protection
<p><b>Category 4</b>                      ≥50 mg WAD CN/L and the tailings stream is not hypersaline</p>	<p><b>Reliance on prevention or avoidance of wildlife exposure as the sole protection mechanism</b></p> <ul style="list-style-type: none"> <li>This category may be preferred where there are clear reasons why reducing WAD CN to &lt;50 mg/L is not feasible, for example the nature of the ore or water source requires high CN input concentrations and it is difficult to lower CN to acceptable levels by destroying or recovering the cyanide, or this is a heap leaching operation.</li> </ul>	<ul style="list-style-type: none"> <li>Where it is not feasible to lower WAD CN concentrations to acceptable levels, exclusion of wildlife by comprehensive measures is essential</li> <li>Process controls/monitoring to site specific targets for CN (potentially also other components, as in Category 3)</li> <li>Access must be excluded to all waters containing WAD CN &gt; 50 mg/L, monitor nets etc to ensure they remain secure</li> <li>Habitat control/monitoring is essential to minimise attractiveness (high standard)</li> <li>Wildlife monitoring for visitation &amp; mortalities – daily while &gt;50 mg/L, 2-3 times/week if below</li> <li>Response program available if impacts occur</li> </ul>	<p>At concentrations ≥50 mg WAD CN/L, deaths of a significant proportion of birds exposed may occur. Hence, at such concentrations strong measures to minimise exposure are required.</p>
<p><b>Category 3</b>                      ≥50 mg WAD CN/L and the tailings stream is hypersaline</p>	<p><b>Reliance on the hypersalinity of the water minimising ingestion of cyanide by wildlife, in combination with other wildlife exposure</b></p>	<p>The following measures are recommended:</p> <ul style="list-style-type: none"> <li>Process controls/monitoring to site specific targets for CN,</li> </ul>	<p>Provided birds do not drink from contaminated water because hypersalinity makes it highly unpalatable, and do not become exposed by diet or other means,</p>

Proposed target WAD CN concentration at the discharge point to the tailings storage facilities (TSF)	Strategy	Comments	Notional implications for wildlife protection
	<p><b>minimisation measures</b></p> <ul style="list-style-type: none"> <li>This category may be preferred where hypersalinity in water containing residues of cyanide makes it sufficiently unpalatable that birds do not drink sufficiently from it to obtain a toxic dose.</li> </ul>	<p>salinity, pH &amp; Cu</p> <ul style="list-style-type: none"> <li>Habitat control/monitoring &amp; covering open seepage trenches with gravel (specific recommendations for such sites)</li> <li>Wildlife monitoring for visitation &amp; mortalities – daily while &gt;50 mg/L, 2-3 times/week if below</li> <li>Rainfall observations, as rain water has possible implications for salinity levels</li> <li>A response program available if impacts occur</li> </ul>	<p>avoidance of exposure minimises the risk of mortality from cyanide consumption.</p>
<p><b>Category 2</b> 10-&lt;50 mg WAD CN/L, according to the performance of other measures and other site specific factors</p>	<p><b>Reliance on a combination of concentration control and wildlife exposure minimisation strategies to protect wildlife.</b></p> <ul style="list-style-type: none"> <li>This category may be preferred where WAD CN concentrations in water accessible to wildlife can be maintained satisfactorily below 50 mg/L</li> </ul>	<ul style="list-style-type: none"> <li>Process controls/monitoring to site specific targets for CN (potentially also other components, as in Category 3)</li> <li>Actual level of CN &amp; statistical description, &amp; where to sample, must be agreed on a site specific basis.</li> <li>Limitation/prevention of access to waters in specified areas</li> <li>Habitat control/monitoring to</li> </ul>	<p>At concentrations of &lt;50 mg WAD CN/L, available field data indicate that few acute mortalities are likely to occur.</p> <p>Insufficient field evidence is available regarding the likelihood of sublethal effects arising such as greater predator susceptibility and reduced flying ability (important for migratory birds). Mortality or sublethal effects could vary between species (e.g. with drinking and swimming</p>

Proposed target WAD CN concentration at the discharge point to the tailings storage facilities (TSF)	Strategy	Comments	Notional implications for wildlife protection
		minimise attractiveness <ul style="list-style-type: none"> <li>• Wildlife monitoring for visitation &amp; mortalities – 2-3 times/week while <math>\leq 50</math> mg/L, increased frequency if issues arise</li> <li>• Response program available if impacts occur</li> </ul>	behaviour as well as species sensitivity), and with behaviour affected by local conditions (e.g. whether or not alternative water sources are available). Greater risks of mortality would be expected as the concentration in this range increased and with decreasing effectiveness of alternative measures.
<i>Category 1</i> <10 mg WAD CN/L	<b>Stronger concentration controls are in place for other reasons.</b> <ul style="list-style-type: none"> <li>• e.g. because the effluent is already treated to protect downstream aquatic areas (i.e. where water is released).</li> </ul>	<ul style="list-style-type: none"> <li>• Process controls/monitoring to site specific targets for CN</li> </ul>	At concentrations <10 mg WAD CN/L, no acute mortalities and minimal sublethal effects are expected.

**Further comments:**

1. At each level, particularly Categories 2 to 4, appropriate ongoing monitoring and response programs for both wildlife impacts and cyanide concentrations present are necessary, together with auditing/reporting mechanisms (see Recommendation 5c). This is to ensure that the stated concentration level is being achieved and that harmful impacts on wildlife are not occurring, and so that if wildlife are present they can be discouraged by active response measures. Where relevant, monitoring should also ensure that habitat attractive to wildlife does not develop and that exclusion structures such as netting and fences remain in good condition.
2. There is significant uncertainty as to the concentrations at which lethal and sublethal effects would occur for different bird species in the field.

3. The categories are not intended to indicate a progression in environmental safety: a similar level of environmental safety should be possible by an appropriate combination of exposure minimisation measures for the WAD CN concentration range, but within each category an increasing level of protection could be achieved by the combination of measures selected.
4. The concentration categories have been based on WAD CN concentrations at the point of discharge to the TSF, where they are likely to be maximal. This gives further protection to areas beyond that point (e.g. the decant pond), as WAD CN concentrations would be expected to fall over time and distance, as further reactions and loss of HCN occur. WAD CN concentrations in tailings dams are also more likely to fluctuate diurnally due to photolysis effects.
5. Attention needs to be given to the capacity of a facility to adequately monitor concentrations of cyanide, including the frequency of sampling, timeliness of analysis and reliability of the analysis. More demanding additional measures may then be appropriate to minimise potential exposure of wildlife at these sites.

DRAFT

## **b. Protection of wildlife at gold heap leach facilities**

In gold heap leach facilities, free CN (rather than WAD CN) concentrations in solutions applied to heap leach piles may exceed 100 mg/L, and concentrations may remain high in pregnant (containing the gold complex) solution that has leached through the pile and subsequent process water ponds at heap leach facilities.

Birds (and possibly bats) may consume this solution as a consequence of ponding on the surface of the heap leach pile. There are also risks that birds may also drink from the pregnant solution and other ponds containing cyanide residues.

For efficacy reasons, steps to reduce WAD CN concentrations to safe levels are not appropriate for waters containing elevated concentrations of cyanide at heap leach facilities. Under these circumstances, steps must therefore be taken to prevent access by birds to toxic cyanide solutions.

Ponding on the surface of heap leach piles must be minimised in both area and duration by steps such as treatment of the ore to ensure satisfactory water infiltration (e.g. agglomeration) and by ensuring that the irrigation rate of process water to the heap does not exceed the infiltration rate. Access of birds and terrestrial animals to any such waters should be prevented by steps such as enclosing, netting or covering them with gravel, by filling drains with rubble or by using pipes instead of open drains.

### **Recommendation 5b**

**To manage risks to avian and mammalian wildlife at heap leach facilities using sodium cyanide for extracting gold from ore, the requirements pertaining to Category 4 in the above framework (Table - Recommendation 5a) should apply. In particular, operators should minimise ponding on heap leach piles and prevent access of birds and other wildlife to waters containing WAD CN concentrations >50 mg/L. Industry should also continue to comply with existing Commonwealth and state/territory legislation and to implement voluntary measures. State/territory governments should continue to monitor compliance.**

## **c. Monitoring and response programs to support wildlife protection measures**

Response programs, which involve monitoring, are needed to support the wildlife protection measures, in order to ensure that the measures are successful, and determine if modifications are needed. Three monitoring programs are required: monitoring of birds, monitoring of cyanide levels in TSFs and monitoring of habitats near TSFs, so they are not an attraction to birds.

An important outcome of the ACMER research project Impacts of Cyanide on Wildlife and previous Northern Territory research has been the recognition of the importance of the habitat in and near TSFs for attracting birds, as well as influencing how long they remain in the area. Hence monitoring of habitat based on guidance that has emerged from this research is essential.

Wildlife monitoring techniques and timing need to be adequate to detect incidents promptly, to spot affected animals before they are scavenged or buried, and to ensure an extra level of protection is maintained for threatened species. Routine observations therefore need to be conducted and recorded in a consistent fashion so that increases or decreases in the presence of wildlife and in impacts are evident. Observers need to be trained in appropriate observation techniques to record the birds or type of animals affected on a routine basis.

This assessment has found that most regular observers at mine sites are not bird experts and therefore could not be relied upon to correctly identify to species level the multitude of birds that may arrive at a site over time. Consequently, to ensure that impacts occurring to threatened species are not overlooked, other mechanisms need to be in place, such as less frequent monitoring by skilled personnel to identify species present at the site and further evaluation to species level when mortalities occur, particularly if threatened species have been observed or may be anticipated at a site.

Suitable programs should be in place to monitor WAD CN concentrations in tailings discharge, with sampling conducted sufficiently frequently so that increases above target levels are avoided or detected promptly. This will enable corrective action to be taken and minimise the likelihood of harmful effects developing. Occasional monitoring at other points, such as in TSF supernatant, decant and return water ponds, seepage trenches etc, may also be needed, particularly where water in them is accessible to wildlife. Sample collection and storage and analysis techniques should be scrutinized to ensure they provide adequate consistency and accuracy. There are strong reasons for favouring the point of tailings discharge as the prime point where concentration limits should be applied, as this is where concentrations in tailings would be expected to be highest.

With monitoring of WAD CN levels in water, of impacts on wildlife and of changes in the habitat present, plans must be in place for appropriate responses to concentration exceedances or wildlife incidents that do occur, or for habitat correction to the extent possible. These should include short-term contingency plans to respond appropriately to exceedance problems, e.g. taking active measures to disrupt bird activity ('bird frite') while toxic concentrations are present, taking steps to reduce concentrations in the water, and temporary plant shutdown to prevent further build up of cyanide levels. Action to avoid an ongoing or recurring event should be pursued as necessary.

Monitoring for various purposes is included in the ICMC and monitoring is already addressed in existing procedures by mines and requirements by regulators. However, it is considered that at many sites improvements in the standards of monitoring conducted and in the associated response and reporting plans may be necessary.

Monitoring and reporting programs should be agreed between the state/territory regulator and the mine operator. An agreed reporting schedule is necessary to enable regular evaluation by the regulator of the adequacy of ongoing cyanide management procedures at the site, as well as early awareness of events which are considered significant due to their scale and/or the species affected. There should be a clear and unambiguous agreement as to what sort of information is required, how often it should be provided, and when an event ranks as 'significant'.

There are various voluntary industry strategies and programs in place to manage the risks to the environment from sodium cyanide. These strategies/programs should be managed with a view to continuous improvement.

### **Recommendation 5c**

**To ensure that risk mitigation measures are effective, industry, in agreement with the relevant state/territory government agencies, must ensure that suitable habitat, wildlife and cyanide concentration monitoring and response programs are in place and operating satisfactorily at sites using sodium cyanide for extracting gold from ore.**

**Industry should use the monitoring data obtained to report to the relevant government agencies, according to an agreed process to allow significant incidents to be brought to the attention of the agencies promptly so that government agencies can confirm the adequacy of ongoing cyanide management procedures at each site.**

## **6. Base metal flotation uses**

Sodium cyanide is used as a depressor in the flotation of base metals, and cyanide residues may therefore be deposited with the tailings stream into tailings storage facilities. The quantities of sodium cyanide used for this purpose at any given site are typically much less than those used for extracting gold from ore.

Cyanide concentrations arising in tailings storage facilities are supposedly very low, and the free cyanide is largely destroyed in the process, but there were no measured data available to confirm this for Australian ore processing facilities.

Delivery to a TSF of cyanide as free cyanide or various other forms of WAD CN would present similar risks to the environment to those from use in the gold industry. For this reason it is appropriate that similar action to that recommended for the gold industry be taken to protect the environment.

### **Recommendation 6**

**Current risk management procedures for the use and disposal of sodium cyanide when used as a depressor in base metal flotation are acceptable. Industry together with state/territory governments should ensure that cyanide management of tailings storage facilities at these sites provide a consistent level of protection to those applying to gold operations. Where WAD CN concentrations in tailings discharge exceed 10 mg/L, the same framework approach (Table – Recommendation 5a) and monitoring requirements applying to gold mines should be used.**

## **7. Minor industrial uses**

There is little potential for environmental exposure to arise from non-mining uses of sodium cyanide, including electroplating, surface treatment of iron and steel (metal hardening), metal cleaning and laboratories. In these relatively minor use situations, used cyanide solutions or solids are generally contained and treated on or off site prior to disposal to the sewer or controlled landfill, and/or only small quantities are used on each occasion. Furthermore, the use of sodium cyanide in these industries has already declined due to the availability of viable alternatives, particularly in the electroplating industry.

Existing Commonwealth and state/territory legislation and voluntary measures provide adequate controls and guidance for managing risks to the Australian environment arising from the use of sodium cyanide in the electroplating and metal hardening industries, for metal cleaning, and in laboratories.

These measures include the National Standard for the Storage and Handling of Workplace Dangerous Goods, provision of information in MSDSs, and state/territory environment protection and waste management legislation.

**Recommendation 7**

**Industry should continue to comply with existing Commonwealth and state/territory legislation and implement voluntary measures to ensure that risks to the environment during the use and disposal of sodium cyanide when used in non-mining situations are acceptable. State/territory governments should continue to monitor compliance.**

**DRAFT**