



Water Quality Protection Guidelines No. 1

Water quality
management in
mining and mineral
processing:
An overview

2000

WATER AND RIVERS COMMISSION

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Reference Details

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The recommended reference for this publication is: Water and Rivers Commission 1999, *Water Quality Protection Guidelines (Nos. 1 – 11), Mining and Mineral Processing*, Water and Rivers Commission.

ISSN 1329-0746

*Text printed on recycled stock
May, 2000*



Foreword

These inter-agency guidelines are part of a series of guidelines that have been prepared jointly between government agencies. Inter-agency guidelines aim to combine the requirements of each agency into a single document providing a 'one-stop-shop' for industry and community stakeholders. This document comprises a set of guidelines for protecting the quality of water resources in areas where mining and mineral processing occur. They have been placed in the public forum as a guide to best environmental management practice.

The Water and Rivers Commission has prepared this document in consultation with the Department of Environmental Protection and the Department of Minerals and Energy.

The guidelines will also enable proponents to identify the basic information required when preparing Notices of Intent and will assist the Department of Minerals and Energy to identify water resource issues in the project assessment process.

This document comprises an overview guideline (No. 1) and ten specific guidelines (Nos 2 to 11) which address water quality issues relating to mining and mineral processing proposals.

These guidelines are a refinement of those used by the former Water Authority of Western Australia to license mining activities under delegation from the Department of Environmental Protection (DEP). Following the restructuring of the Water Authority of Western Australia, the responsibility for licensing prescribed premises is now back with DEP. This document aims to support DEP in its regulatory role.

The guidelines will be enhanced or amended based on feedback and experience. You are invited to provide comments on the content and application of these guidelines. Please use the submission sheet included in this document to provide your response. The Water and Rivers Commission will review feedback on the guidelines during the 2000/01 financial year, approximately 12 months after their release.

These guidelines are also available on the Water and Rivers Commission's web page at:

<http://www.wrc.wa.gov.au/protect/policy/>



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Summary

The mining and mineral processing industry is among the most significant contributors to the Western Australian economy. The Water and Rivers Commission recognises the need for this industry to secure access to water of appropriate quality, in sufficient quantity and at a reasonable price. It also recognises that efficient management of water supplies for mining operations is an integral part of maintaining the viability of the industry. As the State's primary water resource manager, the Commission has developed these guidelines in collaboration with the Department of Environmental Protection and the Department of Minerals and Energy. The aim is to provide advice to the mining industry on acceptable environmental practices to ensure the protection and enhancement of the State's water resources.

The mining and mineral processing industry undertakes activities that may impact on water resources. These include chemical storage, stormwater management, mine dewatering and management of tailings. Mining and processing activities need to be managed responsibly so that current and future beneficial use of water resources is not compromised.

These guidelines provide a consistent framework for dealing with water quality issues associated with mining and mineral processing. They should be used by Government Agency staff, mining personnel, environmental consultants, regulatory authorities and others affected by mining activities.

The guidelines should be used in conjunction with existing statutes, regulations and industry guidelines when extensions or new developments are planned.

They are based on management practices already adopted by many mining companies and have evolved over time with input from government agencies through the referral and assessment process.

They reflect industry standards and incorporate best management practices and experience gained by mining companies from both Australian and overseas operations.

The guidelines in this series address the following issues:

- tailings facility management;
- use of liners for chemical, residue and wastewater containment;
- construction of groundwater monitoring bores;
- minesite water quality monitoring;
- minesite stormwater management;
- management of fuel and workshop wastes;
- management of liquid waste discharges from laboratories;
- management of acid mine drainage;
- siting and installation of above-ground bulk fuel and chemical storage facilities;
- planning and management of mine dewatering.

The guidelines are viewed as dynamic documents and will be changed as improved management practices are developed. Others will be developed as the need arises.



1 Introduction

1.1 Background

Geographic distribution

Mining and mineral processing occurs throughout Western Australia. Mining tenements covered over 38.8 million hectares as of 30 June 1998.

More than 30 mineral products are produced, the major ones being iron ore, gold, bauxite, mineral sands, coal and nickel. The Department of Minerals and Energy (WA) Statistics Digest lists over a hundred companies involved in minerals production in WA.

Economic aspects

Western Australia's mining industry is one of the most significant contributors to the State's economy. Downstream processing results in value adding of metals where they are used as constituents of alloys, chemicals, pigments and other products. In 1998 mineral and petroleum production was worth \$17.9 billion, accounting for 29% of Gross State Product (GSP) and 75% of the State's goods exports. Over \$34 billion worth of resources projects are under construction, committed or under investigation.

Water resource considerations

Water is used extensively in mining operations, for example:

- for human consumption;
- as a transport medium (slurries, suspension);
- as a gravity separation medium (centrifuging);
- to physically break up materials (jetting);
- for cooling (in power generation);
- for dust suppression (in machines, conveyors and haulways).

The Commission recognises the need for the mining industry to gain secure access to water of appropriate quality, in sufficient quantity and at a reasonable price to perform these tasks. It also recognises that efficient management of water supplies for mining operations is an integral part of maintaining the viability of the mining industry.

The Commission commends the initiative by the Minerals Council of Australia in developing the Australian Minerals Industry Code for Environmental Management. Similar initiatives will be encouraged and supported by the Commission.

Through the various mining processes, considerable quantities of waste material are generated which, if poorly managed, can lead to a range of environmental problems including pollution of water resources, vegetation loss, soil degradation and site contamination. The beneficial use of the water resource – e.g. industrial uses, conservation of wetlands, pastoral activities – can be compromised unless appropriate management strategies are in place to protect water quality.

Water conservation measures can reduce water use or the need to dispose of excess water. Water audits are an effective means of ensuring that the resource is used conservatively.

1.2 Guideline objective

The objective of these guidelines is to provide information to Commission and other government agency staff, mining personnel, environmental consultants and regulatory agencies on water-related issues that need to be considered during project development and management of mining and mineral processing activities.

The guidelines also refer to the principles that the Commission will adopt in assessing potential impacts on water resource quality. They will also assist the mining sector to determine best environmental practices for protecting water quality.

1.3 Scope of the guidelines

These guidelines apply to all water throughout the State except marine water. They cover the protection of all groundwater and surface water including watercourses with ephemeral flow, streams, rivers, estuaries, lakes and wetlands. They are not intended to apply to artificial ponds and impoundments on private land unless this water has the potential to impact detrimentally on other water resources.



The guidelines should be used in conjunction with existing statutes, regulations and industry guidelines when extensions or new developments are planned.

They endeavour to provide a consistent position, but are not intended to modify or replace specific requirements of other government agencies. Where apparent conflict arises, the site operator or proponent should discuss requirements with the individual agencies to ensure common agreement is reached.

1.4 Development of the guidelines

Development of these guidelines has been assisted by management practices adopted by mining companies, practices that have evolved over time with input from government agencies through the environmental assessment and licensing processes. The guidelines reflect industry standards and incorporate best management practices for mining and mineral processing. They address the following issues:

- tailings storage facility management;
- use of liners for chemical, residue and wastewater containment;
- construction of groundwater monitoring bores;
- minesite water quality monitoring;
- minesite stormwater management;
- management of workshop wastes;
- management of liquid waste discharges from laboratories;
- management of acid mine drainage;
- siting and installation of above-ground bulk fuel and chemical storage facilities;
- planning and management of mine dewatering.

2 Water quality protection legislation

The assessment and approval of mining and mineral processing occur through the *Mining Act 1978*, the *Mines and Safety Inspection Act 1994* and the *Environmental Protection Act 1986*.

The agencies responsible for these Acts and their associated regulations are the Department of Minerals and Energy (DME) and the Department of Environmental Protection (DEP). Under the Environmental Protection Act, the Environmental

Protection Authority (EPA) also assesses proposals that may have a significant impact on the environment.

The DME and EPA have a memorandum of understanding relating to assessment of mining and exploration proposals. Either may refer a proposal to another government agency for advice or approval.

Water quality protection issues can be directly addressed through the above-mentioned Acts. There are also special requirements in declared areas under the *Water and Rivers Commission Act 1995*. Legally binding environmental conditions may be attached to licences, ministerial statements or tenement approvals. Additionally, the Environmental Protection Act (EP Act) contains offence provisions for persons who cause pollution or discharge waste in circumstances in which it is likely to cause pollution.

Environmental Protection Act 1986

The EP Act confers broad powers on the Environmental Protection Authority (EPA) and the Department of Environmental Protection (DEP) to control water pollution from industry.

Under Part III of the EP Act, the EPA prepares Environmental Protection Policies (EPPs) that establish the basis upon which a portion of the environment is to be protected or pollution is to be controlled or abated.

The EPP may specify environmental quality objectives, set indicators, parameters or criteria to measure environmental quality, create offences and penalty provisions and establish a program to safeguard the environmental values declared to be protected within the policy area.

Development of an EPP involves a process of public interaction and ministerial approval and, once approved, it has the force of law. The EPA has developed EPPs for the management of water quality associated with groundwater, riverine and estuarine systems and for the protection of lakes and wetlands.

Under provisions of Part IV of the EP Act, proposals that are likely to affect the environment significantly must be referred to the EPA. The EPA then sets an appropriate level of environmental assessment for the



proposal. The level of assessment ranges from ‘not assessed’ through a moderate level of formal assessment (Consultative Environmental Review) to detailed environmental impact assessment (Environmental Review and Management Program).

When formal assessment is required, the proponent must prepare and make public a report describing the proposal, the potential effects on the environment and the proposed procedures to manage those effects. The DEP assists the EPA in making an assessment. In relation to water quality issues, the proposal must demonstrate compliance with standards and with the principles of best practice and cleaner production.

Following formal environmental assessment, the Minister for the Environment may apply conditions to the proposal (or, in some cases, determine the proposal should not proceed). The conditions are legally binding and failure to comply with them is an offence.

Part V of the EP Act, enables the DEP to issue works approvals and licences for premises prescribed under the Environmental Protection Regulations 1987 (as amended). Part V also contains provisions for offences for persons who intentionally or with criminal negligence:

- cause pollution or allows pollution to be caused (s 49);
- discharge waste in a manner likely to cause pollution (s 50).

Mining Act 1978

The Mining Act allows the assignment of rights to mine and extract the State’s minerals through the granting of a series of leases or licences under prescribed conditions. All leases and licences granted under the Act are subject to conditions that may be placed on them at any time by the Minister for Mines to ensure sound environmental management as the rights conferred by those leases and licences are exercised.

Water and Rivers Commission Act 1995 (WRC Act)

Under the WRC Act, the Commission has responsibility for the conservation, protection and management of the State’s water resources. The Act assigns the Commission with the responsibility for

administering the following Acts relating to protection of water quality:

- *Country Areas Water Supply Act 1947* (CAWS Act);
- *Metropolitan Water Authority Act 1982* (MWA Act);
- *Metropolitan Water Supply, Sewerage and Drainage Act 1909* (MWSS&D Act);
- *Waterways Conservation Act 1976* (WC Act).

The quality of public drinking water sources in the Perth Metropolitan Area is protected by proclaiming Underground Water Pollution Control Areas (groundwater resources) and catchment areas (surface water resources) under the MWSS&D Act.

Public drinking water sources outside the Perth Metropolitan Area are protected by proclaiming Water Reserves and Catchment Areas under the CAWS Act.

The by-laws under the MWSS&D and the CAWS Acts enable the Water and Rivers Commission to control potentially polluting activities, to regulate land use, to inspect premises and to take steps to prevent or clean up pollution.

In public drinking water source areas, the Commission has defined three levels of priority classification as follows:

Priority 1 (P1) source protection areas are managed in accordance with the principle of *risk avoidance*. The source protection objective for P1 areas is to ensure no degradation of source water quality. Land is generally in public ownership and development is generally precluded from P1 areas

Priority 2 (P2) source protection areas are managed in accordance with the principle of *risk minimisation*. The source protection objective for P2 areas is to maintain existing water quality. Land is generally in private ownership and typically supports low intensity rural and rural lifestyle uses. Urban and industrial land uses are precluded.



Priority 3 (P3) source protection areas are managed in accordance with the principle of *risk management*. The source protection objective for P3 areas is to maintain water quality within health guidelines. Land generally in private ownership and may include urban, light industrial and rural uses. Heavy industry and processing/treatment of animal wastes are precluded.

In addition to priority classification, wellhead protection zones and reservoir protection zones are defined to protect the water source from contamination in the immediate vicinity of production wells and reservoirs. Wellhead protection zones are usually circular, with a radius of 500 metres in P1 areas and 300 metres in P2 and P3 areas. Reservoir protection zones usually consist of a 2-kilometre buffer beyond the top water level of a reservoir and include the reservoir itself. Additional restrictions apply within these zones.

The allocation of water (i.e. quantity regulation) is dealt with under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

Under the provisions of the WC Act, the Commission has a conservation function and associated powers in respect of designated waterways (Swan River, Avon River, Peel Inlet, Leschenault Inlet, Albany Waterways, Wilson Inlet) and adjoining land in management areas declared under the Act.

Through administering these Acts, the Commission's expectation is that all mining and mineral processing will be operated so that the existing quality of water resources at each site is maintained or enhanced and environmental values are not compromised.

State Agreements

State Agreements have provided numerous resource projects with security of access to water. These special agreements have been negotiated between Government and proponents of major mining projects and have been ratified by Acts of State Parliament. State Agreements are not, however, exempt from the provisions of the EP Act and other regulatory requirements, except those ratified before 1 January 1972.

3 Water quality protection

3.1 Principles of water quality management

A National Water Quality Management Strategy (NWQMS) has been jointly developed by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC) with input from the National Health and Medical Research Council (NHMRC).

Western Australia has been an active participant in the NWQMS and is now developing state principles and strategies consistent with the national framework.

The proposed state strategy aims to balance social and economic factors and conservation of the natural environment. The following principles form its basis:

- promote an integrated framework to solve water quality problems that recognises interdependence of water quality and land management and ownership of process outcomes by the community and key stakeholders;
- involve stakeholders and the community in processes to promote community stewardship of water quality management programs;
- consider global impacts or impacts beyond State boundaries;
- enhance environmental protection through economic growth, recognising that a strong and diversified economy enhances the capacity for environmental protection;
- maintain or enhance international competitiveness on an environmentally sound basis;
- be cautious to avoid serious or irreversible change to the environment and continually improving environmental performance to reduce risks to water resource values and uses;
- apply a mix of market and regulatory instruments to address water quality management issues in a cost-effective manner;

- determine environmental values or beneficial uses of water resources is the starting-point in any water quality management process;
- where appropriate, apply the ‘polluter pays’ concept that implies that the parties primarily responsible for existing or potential deterioration of water quality are financial liable for the cost of remediation or rendering an activity harmless to the environment.

3.2 Water quality protection in the mining and mineral processing industries

The environmental values and beneficial uses of water resources may be compromised by activities associated with mining and mineral processing. It is important that water resources are used sustainably for current and future generations of West Australians.

It is recognised that water quality varies greatly in the mining areas of Western Australia. The majority of mines on the Eastern Goldfields rely on hypersaline groundwater for process water, whereas in other areas water of higher quality is available. To ensure the appropriate level of protection for all water resources, the Commission will determine the environmental values of water resources in a region or area.

Environmental values may support a beneficial use at some time in the future. The setting of these values requires extensive consultation, as they often represent long-term goals beyond the life of the current land use.

Interim goals will also need to be set to ensure there is no conflict with established beneficial uses.

Where there are no established beneficial uses, the Commission will negotiate with a proponent/operator to resolve any issues that are not adequately addressed by these guidelines. In such cases the proponent/operator will need to demonstrate the project will not significantly alter background water quality in the area.

Gaining appropriate approvals will not, however, alleviate the need for the proponent/operator to incorporate responsible environmental management practices into the overall site management. Prime responsibility for the environment of each mine site or processing plant must be taken by the operator.

Operators of any mining or mineral processing activity should not compromise the potential future uses of water resources at that site. The Commission recognises that on some occasions detrimental impacts to local water resources may occur. However, these cases must be the exception rather than the rule, and they will be subject to rigorous environmental evaluation.

3.2.1 Environmental Management System (EMS) and ISO 14000 series

The recent trend by mining companies towards development and implementation of environmental management systems such as the ISO 14001 standard is a positive step in providing a structured and systematic process for pollution prevention and environmental performance. Organisations who have an Environmental Management System (EMS) in place can provide confidence to all interested parties that:

- there exists a management system to meet the provisions of its policy, objectives and targets;
- emphasis is placed on prevention rather than corrective action;
- evidence of reasonable care and regulatory compliance can be provided;
- the systems incorporate the concept of continual improvement and adaptive management.

Importantly, from a water resource management viewpoint, this approach provides flexibility for the operator to achieve desired environmental outcomes.

3.3 Key water quality protection issues in the mining and mineral processing industries

3.3.1 Tailings facilities

Tailings storage facilities are constructed to store waste products generated from mineral processing. These areas have typically been engineered and managed to optimise the amount of tailings stored while minimising the potential environmental impacts. A tailings storage facility should not be used for anything other than its intended purpose.



The storage of tailings can cause a number of short-term and long-term environmental problems if the facility is poorly located, designed or managed. Seepage of some process water from storage facilities is inevitable; problems arise where excess seepage impacts on groundwater, surface water and vegetation or where seepage causes failure in the structural integrity of the tailings dam.

Surface water and groundwater can also be affected by leakage caused by pipeline ruptures, seepage through the embankments of tailings storage facilities and overflows due from undersized storage facilities.

The Commission recognises tailings storage facilities need to be designed and operated to accommodate site-specific constraints. Leakage or seepage of water from tailings storage facilities needs to be minimised or mitigated to reduce the risk of both short-term and long-term environmental problems. This applies particularly where other beneficial uses of a water resource may include potable water supply, conservation or agricultural pursuits.

In consideration of this, the Commission has developed *Water Quality Protection Guidelines No. 2 – Tailings facilities*, which outlines the principles for reducing the risk of short-term and long-term environmental problems associated with storing tailings.

3.3.2 Liners for waste containment

Liner systems are used to contain leachate through heap leach operations or for storage of metal-sulphide waste. The use of these liners should prevent short-term and long-term environmental problems that can arise if stored material is not securely contained. Any premature failure of liner systems may result in severe effects on the environment and, in some cases, the loss of valuable mineral-enriched solution. For both these reasons it is important the integrity of the liner system is maintained throughout the life of a project and beyond, if long-term isolation of polluting material from the environment is envisaged.

The Commission provides guidance on this subject in *Water Quality Protection Guidelines No. 3 – Liners for waste containment*.

3.3.3 Minesite water quality monitoring

Monitoring enables the impact of mining activities on water quality, and the performance of chemical containment, to be assessed. This information will prompt changes to environmental management practices where necessary. Monitoring can also be used during the Environmental Impact Assessment (EIA) process to establish baseline data against which an operator can monitor its environmental performance. In doing so, undesirable environmental impacts will be detected and remedied effectively at an early stage.

The Commission provides guidance on construction and monitoring of water resources in *Water Quality Protection Guidelines No. 4 – Installation of minesite groundwater monitoring bores* and *Water Quality Protection Guidelines No. 5 – Minesite water quality monitoring*.

3.3.4 Minesite stormwater

Stormwater management is essential to minimise the potential for dams containing toxic chemicals from overflowing or for runoff carrying suspended solids to watercourses. Appropriate stormwater management practices need to be in place as part of overall site management.

In Western Australia a great deal of mining activity takes place in arid regions. Stormwater should be treated as a valuable resource that can be used in site operations.

The Commission provides guidance on this issue in *Water Quality Protection Guidelines No. 6 – Minesite stormwater*.

3.3.5 Mechanical servicing and workshop facilities

Mining sites usually store considerable quantities of fuel, particularly diesel. Servicing of mechanical components in mining and mineral processing involves the use of coolants, hydraulic oils, brake fluids and lubricants. Wastewater can be generated from vehicles



being washed down or degreaser being washed off mechanical components. These waste products have the potential to degrade water resources unless proper management practices are in place.

The Commission provides guidance on this issue in *Water Quality Protection Guidelines No. 7 – Mechanical servicing and workshop facilities*.

3.3.6 Laboratory waste discharge

Laboratories need to dispose of a range of chemicals, such as strong acids and alkalis, salt, nutrients and organic solvents. If not disposed of properly, these wastes may adversely affect water resources, disrupt biological waste stabilisation processes and threaten wastewater drain systems.

The Commission provides guidance on this issue in *Water Quality Protection Guidelines No. 8 – Laboratory waste discharge*.

3.3.7 Acid mine drainage

Acid mine water is generally formed from the oxidation of sulphide ores on their exposure to atmospheric oxygen and water through the mining process. Sulphide-rich rocks are commonly associated with gold, nickel, copper, iron ore, lead and coal deposits.

Acid mine water can be produced from mine dewatering or leaching of sulphide waste. Mineral sands mining in coastal locations can also produce acid drainage from exposure of peat beds.

Drainage of acid water has the potential to impact on the quality of water resources. Acid water can affect watercourse biota and contaminate water supplies with heavy metals, rendering it useless for livestock, irrigation and domestic purposes.

In Western Australia, many mine sites are located in arid to semi-arid climates. The low annual rainfall and extended drought periods are likely to minimise the risk of acid mine drainage. Even so there is still potential to affect nearby rehabilitation sites, native vegetation, local groundwater and ephemeral streams. Operators

should conduct waste characterisation studies to assess the risk of environmental harm from AMD.

The Commission provides guidance on managing this issue in *Water Quality Protection Guidelines No. 9 – Acid mine drainage*.

3.3.8 Above-ground fuel and chemical storage

The storage of bulk quantities of chemicals such as fuel, acids, alkali and cyanide has the potential to degrade surface water and groundwater. This may occur due to inadequately constructed storage facilities, poor management practices and deterioration of the storage facility. Once released, the chemical may adversely impact other beneficial uses, e.g. stock watering and public water supplies.

The Commission provides guidance on this subject in *Water Quality Protection Guidelines No. 10 – Above-ground fuel and chemical storage*.

3.3.9 Dewatering

Dewatering is commonly used as a method of coping with groundwater seepage, mine excavations that intersect aquifers or heavy rainfall.

Discharge water containing high solids load or high concentration of contaminants, or differing substantially from the receiving waterbody, can affect the total water quality.

The discharge volume and discharge period can also alter the normal ecosystem function of the receiving environment.

This can lead to a number of detrimental environmental effects, including deoxygenation of water, toxicity of biota and reduced light penetration. It may also impact on downstream uses such as agricultural pursuits and farmstead and industrial water supplies.

The Commission provides guidance on this subject in *Water Quality Protection Guidelines No. 11 – Mine dewatering*.



4. Useful references

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Glossary and Abbreviations

1. Beneficial use Existing or proposed use of any portion of the environment which is:
 - (a) conducive to the benefit, convenience, welfare, amenity, safety, health or aesthetic enjoyment of the public and which requires protection;
 - (b) so declared under an approved policy.

2. Environmental value A quality, characteristic or attribute of any portion of the environment, the protection of which is required:
 - (a) to maintain ecological function;
 - (b) to support a beneficial use; or
 - (c) under an approved policy.



Further enquiries

Any project where the proponent/operator is unable to comply with these guidelines, or where site conditions prevent their application, should be submitted to the Commission as early as possible in the development of the proposal so that the matter may be resolved.

Any queries relating to the **content of these guidelines** should be directed to:

Program Manager Assessment and Advice
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These guidelines are also available from the Water and Rivers Commission's web page at:
<http://www.wrc.wa.gov.au/protect/policy/>



Other related guidelines in this series include:

WATER QUALITY PROTECTION GUIDELINES NO. 2
Tailings facilities

WATER QUALITY PROTECTION GUIDELINES NO. 3
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