CHECKLISTS FOR SUSTAINABLE MINERALS

INTRODUCTION

These Checklists are developed from the Sustainable Minerals series of booklets published by Environment Australia.

Each Checklist uses a consistent layout to summarize key activities for each topic in the booklet subjects, including succinct cross-references where necessary.

For the technical area being addressed, each Checklist effectively summarizes what should be done for a mine-site to be managed in accordance with best environmental practice principles. An operator can use the Checklists as a guide to:

- Determine whether current operations meet best practice principles and practices;
- Identify areas where management principles, systems and operations may be improved;
- Estimate the relative level of risk that current operations pose in terms of possible environmental harm and non-compliance

There are many important avenues for building the level of knowledge necessary to understand and correctly apply principles and practices consistent with best practice environmental management in mining. These include the repeated use of the Checklists, interaction with staff from environmental and mining regulatory agencies, and information exchange with industry colleagues and industry associations.

The Checklists often refer to standards, case studies and codes in order to help guide the user on how a particular issue could be managed. There is no single universal best practice approach to manage the broad range of environmental risk. Approaches vary just as the type of mine, the commodities being extracted and processed, the type of processing, the climate, topography and surrounding environment will vary.

Operators should choose the most appropriate approaches for environmental management at their particular site - the standards and case studies that we propose simply provide examples of some possible approaches. These examples are not exhaustive, and the operator is encouraged to investigate additional options if the examples given do not directly apply to their situation. The Sustainable Minerals web site contains many links to useful resources.

LAYOUT OF THE CHECKLISTS

A generic, matrix approach is used to set out the Checklists. Each one is set out as six columns stating:

- relevant *issues* as a series of questions (in effect, a simple list of desirable systems and behaviors);
- *outputs* or outcomes to be expected if the question has been addressed by the company (ie evidence that the systems and behaviors are operational at the site under evaluation);
- suggested *performance measures* which can be used to evaluate whether the outputs are adequate to competently address the issue in question (ie whether the systems and behaviors being applied are consistent with best practice principles);
- opportunities for *improvement* to increase the level of assurance of best practice environmental protection on the issue under consideration (ie techniques to further reduce the risk of unacceptable environmental impacts);
- *comments* which help to illustrate the issue under consideration, alternative approaches in addressing it, or useful links to related information; and
- a column for *notes*, which can be used to record aspects of the question, or responses to it etc, for your mining operation.

Each Checklist is broken down into sections which as far as possible reflect a progression from:

- risk identification (ie information gathering);
- systems development (ie management systems from policies to action plans);
- management of the risks (ie operational systems);
- monitoring of performance; and
- review of performance.

The approach taken varies between Checklists to reflect the nature of the topic, and the presentation of information in the Sustainable Minerals booklet on which each Checklist is based.

The Checklists provide a brief, uncomplicated and systematic resource to on-site personnel who wish to evaluate the quality of environmental systems and procedures at their site which can be applied without recourse to external resources. They are designed to be especially helpful for small to medium scale enterprises, which may lack the in-house environmental expertise of larger companies or the resources to engage consultants.

The Checklists can be used by the operator on an ad-hoc day-to-day basis to identify areas for improvement, or can be adapted as a protocol for an environmental audit into the technical area in question. The audit can be undertaken by the operator (an internal audit), or by a third party such as a consultant engaged by the operator or a regulator agency (an external audit).

No set of written material can guarantee an outcome consistent with best practice. Users of these Checklists should be aware that their application can only be effective if they are used seriously, objectively and professionally, and followed up with action to remedy any weaknesses identified by the process. The Checklists are not simply a set of papers to be ticked off and filed – they must set off a train of cyclical evaluations and corrective procedures which in combination and over time move the operation towards better levels of environmental protection and lower risk of non-compliance.

CHECKLIST FOR CLEANER PRODUCTION

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Planning & Leadership - refer section 4.1 in Cleaner Production Sustainable Minerals booklet					
1.1 Have you developed a mission statement embracing Cleaner Production (CP) principles?	Managers, staff, contractors, regulators & stakeholders aware of commitment	Corporate/site mission statement commits to CP principles.	Mission Statement refers to documentation where methods & targets for implementation of CP are described - eg site Environmental Management Plan. Application of CP on the site built in to mine plan.	*Further details on design of environmental systems & mine planning are contained in the Environmental Management Systems & Mine Planning for Environment Protection Sustainable Minerals booklets.*	
1.2 Is the mission statement linked to guidelines at an operational level?	Managers, staff & contractors aware of their roles in the implementation of CP	Cross-referencing between mission statement & key site management documents, including the EMS, monitoring program, operational guidelines &manuals.	CP practices should focus on those areas of significant possible risk to the environment determined during EIA - refer to the Environmental Impact Assessment Sustainable Minerals booklet		
1.3 Have you informed all staff of the commitment to CP?	Managers, staff, contractors, regulators & stakeholders aware of the corporate commitment to CP	Evidence of communication of commitment to CP in staff manuals, newsletters & site policy documents.	CP included as a topic in staff inductions, skills training & refresher courses.		
1.4 Have you formed a CP working team?	Focal point for the development &implementation of CP initiatives	• CP Team formed with official sanction • evidence of its operation.	• CP team featured in organisational structure &provided with specific authority, scope &objectives sanctioned by the executive • CP team reports direct to senior management, eg the site general manager or executive board	*There may be significant barriers to introducing CP initiatives. The best way to resolve this is to involve as many sections or departments of the organisation as possible. A simple way to form the team is to seek volunteers from each operational arm including: production, finance, engineering, environment, human resources, sales &marketing, occupational health &safety, &purchasing.*	

1.5 Is there a leader for CP who can motivate environmental change?	A "champion" of CP with responsibility to encourage discussion, new ideas &to spread enthusiasm.	Formal notification of CP leader	The CP leader should have the full backing of top management.	*The leader must:* • *be a good communicator* • *have the backing of top management* • *have leadership skills &be a respected member of the organization* • *have technical and/or administrative knowledge in a number of aspects of the organization* • *be a lateral thinker &unafraid of change* • *be enthusiastic towards &committed to CP*	
1.6 Have you established quantifiable goals &objectives?	• Clarity &objectivity in setting targets &evaluating progress against them • meaningful outcomes for operational effectiveness in improving environmental &economic performance	General &specific goals &objectives capable of being monitored &measured in quantifiable terms	Targets established for predetermined time periods (eg an overall 10% reduction in wastes generated by a specified date; 25% reduction in chemicals used through better inventory control by specified date).	• *The technical &financial feasibility of set objectives may change over time &so objectives should be reviewed regularly.* • *Goals &objectives should be achievable, flexible, measurable, &agreed on by all those involved in implementing them.*	
1.7 Have you identified potential barriers to implementing CP?	Acceptance by all staff, removal of resistance to CP initiatives, less criticism &more active participation	Assessment of potential barriers.		*Removal of resistance requires involvement of top management &all staff. Staff need to know the benefits for them as well as the benefits to the company &its shareholders.*	

Part 2: Information Gathering - refer section 4.2 in Cleaner Production Sustainable Minerals booklet					
2.1 Have you identified major process equipment, operating practice &processes?	Good understanding of the technology, processes &production methods used	Detailed documentation of process equipment, operational practices, &processes available to CP team		*This information forms the basis for assessing the feasibility for CP improvements. The act of collation often identifies significant gaps in available data, which must be filled in order to undertake a comprehensive CP assessment. All aspects of the operation must be covered, so that opportunities for improvement in non-core activities such as contractual supply arrangements, utility use (power, water), by-product options &inventory control.*	
2.2 Have you evaluated the quantity, quality, &type of raw materials used &out-of-specification product generated?	Good understanding of the amounts &types of raw materials used &produced, &their toxicity &hazardous characteristics	Documented information on quantity, quality, &type of all raw material inputs &non-specification product			
2.3 Do you know the amounts &types of wastes (solid, liquid &gaseous) generated?	Good understanding of the amounts &types of wastes generated (solid, liquid, gaseous)	Documented information on the amounts &types of wastes (solid, liquid &gaseous) generated			
2.4 Have you determined the cost of raw materials &other resources including water &energy?	Good understanding on the cost of all raw material, energy &water inputs	Documented information on the cost of raw materials &other resources including water &energy			
2.5 Are the costs of waste storage, treatment &disposal known?	Good understanding of the costs of wastes (solid, liquid &gaseous) storage, treatment &disposal	Documented information on the costs of waste storage, treatment &disposal.			
2.6 Have you collated available monitoring data?	Good understanding of environmental performance to date	Monitoring data to date collected &collated			

Part 3: Initial Assessments - refer section 4.2 in Cleaner Production Sustainable Minerals booklet					
3.1 Have you calculated the levels &efficiencies of current production?	Comprehensiveness of coverage of levels &efficiencies of production &relevance of indicators used to production efficiency &environmental protection effectiveness - eg in terms of product per raw material input, production per person employed &waste generation patterns	Report assessing levels &efficiencies of production in terms relevant to production efficiency &environmental protection effectiveness	A wide range of indicators should be used to reflect all aspects of the operation, eg: • absolute values (eg tonnes solid waste per year) • eco-efficiency ratios (eg tonnes of solid waste per tonne of product) • environmental impact indicators (eg no. of public complaints per month) • management-focussed indicators (eg % of staff trained in environmental awareness).	*Many Australian mining companies publish information in annual environmental reports which are relevant to CP performance, including performance indicators on waste generation, water &energy use. This allows comparison from year to year &between different operators &is a major factor in improved public perception of the environmental responsibility of the mining sector.*	
3.2 Have you compared performance guarantees for equipment &processes with their current performance?	Areas or poor management/ maintenance/quality control/training exposed &opportunities for improvement indicated	Report comparing equipment &process performance with manufacturer guarantees	Ongoing liaison with suppliers following installation &operation can result in periodic modifications to equipment &operating procedures to continually improve operational efficiencies &product design.		
3.3 Have you analysed the contents &conclusions of previous operational performance reports, audits &related information?	Identifies areas of underperformance or opportunities for improvement, whether recommendations have been implemented, &checks consistency of related information/documentation, possibly indicating opportunities for improvement in operational or reporting procedures	Review report which lists findings &recommendations of previous operational performance reports &issues arising from these &related information		*Reports which should be reviewed to gather information for the initial assessment include:* • *periodic production, financial,&management reports* • *invoices for energy &materials* • *material usage &resource databases* • *waste &energy audits*	

3.4 Have you analysed the findings &recommendations of previous environmental audits?	Identifies areas of underperformance, opportunities for improvement, &provides a basis for investigating reasons why any recommendations were not implemented	Review report which lists findings &recommendations of previous environmental audits, &whether recommendations were implemented	A comprehensive environmental assessment of the operation may already exist. If not, the current status of the operation should be determined in terms of: • environmental regulatory compliance • solid &liquid hazardous waste management • air emissions • non-hazardous waste management • waste-water generation, treatment &discharges • National Pollutant Inventory • raw materials usage • energy usage • greenhouse gas emissions • hazardous chemicals storage • ozone depleting substances • water usage	*If a comprehensive environmental assessment is impractical because of limited resources, an internal review can be undertaken examining:* • *environmental regulatory licences &permits* • *trade waste discharge permits &monitoring results* • *internal reports on incidents &accidents* • *waste disposal dockets.* *If there any compliance issues they must be addressed before CP measures can be undertaken.* *Types of environmental audit are described in the Environmental auditing Sustainable Minerals booklet. Requirements for reporting under the NPI, &handbooks for industry can be found at www.npi.gov.au.*	
3.5 Are you confident that you have expressed the full environmental costs of the operation?	Total costs of environmental management &impact prevention are understood, allowing fully informed decisions to be made in relation to environmental protection procedures, the setting of appropriate performance measures &accurate reporting against them.	Evidence that environmental costs are accounted for separately &not included in overhead or engineering accounts	Environmental accounting software will help to: • simplify hazardous materials identification, use &tracking • store process information for future reassessment of alternative techniques • simulate the effect of waste stream analysis • develop mass balance calculations for the whole project, or components, by total mass, or individual chemical	*Inappropriately allocated costs give managers (and the CP Team) distorted signals about the true costs &benefits of retaining or changing processes, procedures &products.* *Examples of environmental costs incurred in industry are given in Table 3 of the Sustainable Minerals booklet.* *Environmental accounting software is available commercially, or at no charge (eg USEPA "SWAMI"; CRC for Waste Management "CLEAN-PRO").*	

			compounds or elements • perform cost benefit analyses • rank CP options by cost of treatment, disposal &waste volumes • develop flow diagrams of material inputs, process sequencing, &waste output streams • identify pollution prevention strategies &concepts • prepare data for waste reporting, inventories		
4.1 Have you completed a waste audit?	In-depth understanding of waste generation, management, &performance, providing sound basis for identifying weak points &opportunities for improvement	Waste audit report for the site	A waste audit should provide detailed information on: • sources of all wastes, including air, hazardous &non-hazardous liquids &solids • toxicity, hazards, &special handling requirements • waste generation patterns &quantities (in absolute &relative terms for each waste type, eg kg of a waste type per tonne of product) • trends in waste generation over time • cost of waste storage, treatment &disposal • methods &critical assessment of waste storage, treatment &disposal • key performance indicators for waste generation	*The options development phase is commonly the most difficult part of a CP program. It relies on open-minded &lateral thinking to ensure that the maximum number of potential options is put forward &explored. The CP team must be aware that significant &innovative opportunities may derive from unusual or less obvious solutions. Areas to consider include:* • *water usage* • *solid waste generation* • *waste water quality &quantity* • *raw material types &usage* • *energy usage (natural gas, LPG, electricity, oil, coal)* • *hazardous waste generation* • *air emissions* • *types of chemicals &their use.*	

			• liabilities related to wastes, &potential future management problems.		
4.2 Have you completed an energy audit?	In-depth understanding of energy costs, consumption, &efficiency of use, providing sound basis for identifying weak points &opportunities for improvement	Energy audit report for the site	An energy audit should aim to establish: • monthly energy use • comparisons of energy use &production patterns • energy costs &usage in absolute &relative terms (eg kWh &$/tonne product) • trends in usage &costs over time • key performance indicators for energy use &efficiency.	*Reducing or eliminating inefficient energy usage on site, &finding alternative cheaper and/or cleaner fuel sources will minimise overall energy costs. Energy optimisation programs can also reduce wastes &greenhouse emissions.* *Guidelines on energy reviews &examples of mass &energy balances are given in the Cleaner Production Manual: Environment &Business Profiting from Cleaner Production (Environment Australia 1996).*	
4.3 Have you completed a water audit?	In-depth understanding of water consumption, use, management, treatment, disposal, &environmental impacts, providing a sound basis for identifying weak points &opportunities for improvement	Water audit report for the site	The water audit should establish: • monthly water use • comparisons of water use, raw material use &production patterns • water costs &usage in absolute &relative terms (eg kL &$ / tonne product or tonne ore) • potential for re-use, recycling &use minimisation • trends in usage &costs over time • key performance indicators for water use &efficiency.	*A full process water balance calculation is essential for a mine site.* *Examples of reporting in relative terms are given in Case Study 1 in the Sustainable Minerals booklet.*	

4.4 Have you evaluated the audit reports &other information to identify specific options for improvement?	Comprehensive list of options for improvement covering all aspects of the operations on your site	List of possible initiatives which are considered likely to provide improvements in economic and/or environmental effectiveness &efficiency	Selection of options should be based on a methodical review of core processes &activities, from raw materials through to end wastes, &management frameworks &activities. Basic questions should be posed, including questioning of: • product &service design • choice of technology • storage &handling methods • processing &manufacturing methods • waste management methods • choice of energy forms • operational procedures • staff knowledge &training • process monitoring &management • pollution control methods.	*In establishing "opportunity areas", the CP team should ask &get answers to questions such as:* • *why do we do it this way?* • *would a design change use less raw materials/energy?* • *why do we use this chemical?* • *how do our waste generation rates compare with industry standards or other parts of our organisation?* • *are our procedures for staff training adequate?* • *what alternative technologies are there for waste treatment &re-use?* • *why has our water/energy/reagent consumption increased over the years?* • *is there a better fuel for our heating processes?* *Comprehensive records should be made &retained for all options, as their feasibility may be reassessed in a later CP cycle.*	
Part 5: Feasibility Analysis [refer section 4.4 in Cleaner Production Sustainable Minerals booklet]					
5.1 Have you evaluated the technical feasibility of each option?	• Management able to make quality decisions based on sound &comprehensive assessment of current performance • Agreed CP program likely to have successful outcomes owing to thorough feasibility analyses	Assessment report which evaluates the technical feasibility of each proposed option.	Options should not be dismissed because at first glance they appear to be not feasible. Further investigation, research, or on-site development may result in suitable technological solutions.	*If internal knowledge is limited, manufacturers/providers, consultants &industry/government advisers may be able to advise on available technologies &their applicability.*	
5.2 Have you undertaken an economic assessment for each option?		Assessment report which evaluates the economic feasibility of each proposed option.	Where large amounts of expenditure are involved, the assessment should calculate a full rate of return on capital &include a cost-benefit analysis (using indicators of payback time, internal rate of return on investment, &net present value).	*Identify current costs &compare them with anticipated costs of the proposal. Costs include one-off costs (equipment, process alterations, production delays) &ongoing costs (eg higher operating &maintenance costs, human resources, different feedstock/consumables, alternative waste treatment or disposal methods).*	

5.3 Have you undertaken an environmental assessment for each option?		Assessment report which evaluates the environmental feasibility of each proposed option.	Options should not be dismissed because at first glance they appear to be not feasible. Further investigation, research, or on-site development may result in suitable technological solutions.	*If internal knowledge is limited, manufacturers/providers, consultants &industry/government advisers may be able to advise on available technologies &their applicability.*	
5.4 Have you prioritised the options in terms of urgency, feasibility &cost?		Assessment report ranks the options in terms of their urgency, feasibility &costs, &CP team proposes CP action agenda to senior management		*Calculation of probable reduced financial liabilities (eg rehabilitation costs) or decreased risk of non-compliance, may be useful in determining relative priorities between different options.*	
5.5 Have you selected options for implementation?		Senior management determines CP action program based on action agenda proposed by CP team.	Preferred options should be separated into those affordable within available budget, &those requiring special funding. Specific cost-benefit analyses should be presented to senior management with any high-cost option which is considered a high priority.	*Options which centre on operational, procedural or material changes with little capital expenditure are prime candidates for immediate implementation. They can provide speedy results, demonstrate commitment, &give encouragement for further CP initiatives.*	
5.6 Have you put temporary fixes in place if permanent fixes will take some time?	Ongoing areas of outstanding poor performance (eg environmental damage, increasing liabilities, unwarranted expenditures) addressed immediately; ie temporary fix may be to cease an operation pending installation of better equipment)	Short term fixes undertaken for all urgent issues identified by CP team.	The CP team leader should be given the authority to implement temporary fixes without the need for prior endorsement by senior management where the need is considered to be urgent.		

Part 6: Implementation and Monitoring refer section 4.5 in Cleaner Production Sustainable Minerals booklet					
6.1 Have you implemented options according to priorities?	Clarity of process; endorsement of relevance of CP team; confirmation of corporate commitment &effectiveness to workforce &stakeholders	Documentation of initiatives completed reflects priorities in CP program			
6.2 Have you involved staff in the implementation &monitoring of CP initiatives?	Staff belief in CP &in corporate commitment &intent; improved corporate culture in environmental protection; reduced resistance to CP	Documentation demonstrating staff involvement in CP initiatives		*Techniques for improving staff environmental awareness are described in the Planning a Workforce Environmental Awareness Training Program Sustainable Minerals booklet.*	
6.3 Have you explained to staff why the changes are being made?	Improved environmental awareness amongst staff; strengthened support for CP &lowered resistance to change; empowerment of staff &increased levels of participation in CP	Documentation showing staff have been informed of initiatives &the reasons for them		*Techniques for improving staff environmental awareness are described in the Planning a Workforce Environmental Awareness Training Program Sustainable Minerals booklet.*	
6.4 Have you identified any skills requirements related to the changes &implemented appropriate staff training?	• CP initiatives more likely to succeed • Staff directly involved in &feel ownership of the changes. Improved environmental awareness amongst staff	Documentation that initiatives in CP program have been assessed in terms of skills &training needs, &appropriate training has been provided to relevant staff	Staff feedback regularly sought on the effectiveness &efficiency of the CP program &the CP initiatives implemented		

6.5 Have you monitored the environmental performance of the new initiatives &reviewed their environmental &economic performance?	Ability to measure effectiveness of the CP process &demonstrate actual vs anticipated benefits. Provides sound basis for improving CP processes &designing priorities for next CP round.	Documentation of monitoring data for CP initiatives, including evaluation of performance against anticipated improvements	The effectiveness of CP initiatives can be included as a standing item in senior management meetings, &should be reported on in annual environmental reports for the site.	*Design &implementation of environmental monitoring programs are described in the Sustainable Minerals booklet on Environmental Monitoring &Performance. The types of benefits that can be reported from CP initiatives are demonstrated in the Case Studies in the Sustainable Minerals booklet on CP.*	
6.6 Have you reviewed the goals &objectives for CP &set targets for further improvement?	Avoids covering the same ground too often; sets sound framework for continual improvement through successive CP cycles.	Documentation of: • periodic review of CP goals &objectives • CP targets for the future	Review of CP goals &objectives should be undertaken in concert with any review of corporate environmental or production goals, objectives or policies.	*CP should be seen as an ongoing process &way of thinking in which all staff should be constantly engaged. However, a concerted CP exercise should be periodically conducted as outlined in the Sustainable Minerals booklet, for example once every 5 years.*	

CHECKLIST FOR COMMUNITY CONSULTATION

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
Questions 1.1 to 1.10 relate to the conceptual or exploration phase of a mining project - see summary in "phase 1" box on page 20 of Community Consultation & Involvement Sustainable Minerals booklet					
1.1 Have you identified & written to the surrounding indigenous & non-indigenous landowners & occupiers outlining your intentions?	Documented & filed correspondence	Register of all landowners & occupiers sourced from local government records			
1.2 Have you met with the people in the area?	Records of meetings with landowners & occupiers	Meeting records for all landowners & occupiers identified in the register.			
1.4 Have you identified special interest groups & determined their interests & needs?	Register of special interest groups	Register of special interest groups includes listing of concerns, interests, needs & aims for each group			
1.5 Have you advertised your activities or intentions in the media?	Advertisements in local/regional newspapers, community newsletters, & relevant national newspapers; on local radio/TV stations	Advertisements in: • local/regional newspapers, • community newsletters • relevant national newspapers • local radio/TV stations.	Notices in newsletters produced by special interest groups & the local council (or included with rates notices) will ensure that information gets to landowners, occupiers & people with special interest in the proposal.		
1.6 Have you provided additional information about the project to those who have requested it?	Evidence of mechanism for receiving requests & providing appropriate additional information	Register of requests for additional information including date of request, date of despatch of information, & the material provided.	A brochure can be prepared which addresses those issues relevant to the concerns of landowners, occupiers & members of special interest groups.	*The first stages are critical to building trust & mutually beneficial relationships with the community. The box on page 11 of the Community Consultation & Involvement Sustainable Minerals booklet shows how good relationships were established by BHP Minerals for the Beenup titanium project in Western Australia.*	

1.8 Have you appointed a community liaison officer?	Evidence of formal appointment of a community liaison officer	Documented authority & powers of the community liaison officer		
1.9 Does the community liaison officer have authority, to speak, act & make commitments on behalf of the community?	Evidence of formal appointment of a senior staff member as community liaison officer	Documented authority & powers of the community liaison officer, including authority to speak, act & make commitments on behalf of the company	A community liaison officer who is a senior executive with a seat on the company board demonstrates commitment to effective communication with & response to the community	*The effectiveness of appointing a senior executive as community liaison officer is explained in the box on page 10 of the Community Consultation & Involvement Sustainable Minerals booklet*.
1.10 Have you set up a contact number for inquiries about the project?	Documentation showing evidence of nominated contact telephone number	Evidence of nominated telephone number having been advised to all interested parties on the register of landowners, occupiers & special interest groups	Call forwarding or messaging service to facilitate receipt of calls out of office hours (ie 24hours/7 days a week)	
Questions 1.11 to 1.16 relate to the evaluation or feasibility phase of a mining project - see summary in "phase 2" box on page 21 of Community Consultation & Involvement Sustainable Minerals booklet				
1.11 Have you formed a community liaison committee?	Formal documentation of formation of a community liaison group & its membership	Documentation to include: • terms of reference for committee • membership • meeting frequencies & locations • working arrangements, including procedures for nomination of agenda items	• Committee chaired by an independent person likely to engender respect from the community • Meetings held at regular intervals agreed by the committee • Community liaison officer always attends • Standing agenda item on progress against issues arising.	
1.12 Have you prepared detailed information about the scope & scale of the project?	A comprehensive description of the project & its social, economic & environmental impacts which is prepared in plain English	The information should describe: • your company • regional & national importance of project • project location, hours of operation, job opportunities & skill levels • likely environmental issues & plans to manage them • likely social issues & plans to manage them		

		• the economic of the project		
1.13 Have you distributed details of the project to all stakeholders?	Evidence of wide distribution of the information document	Distribution to all special interest groups, individuals likely to be affected by the project & other interested individual, local media, relevant government authorities & council	Distribution includes: • Land owners & occupiers • Local government • State government • Federal government • Townspeople • Indigenous people • Environmentalists • Competing land users • Regulators • Politicians • Media • Shareholders • Suppliers • Potential customers	*Information should be kept up to date, eg if presenting material at local shows etc, don't use the same material for more than one or two occasions.*
1.14 Have you held public meetings?	Evidence of public meetings to discuss the project proposal	• Minutes of meeting or documentation of matters arising • Evidence of prominent & timely advertising of meeting in appropriate media	The independent chair of the community liaison committee should chair the meeting. Part of the formal presentation could be made by a community representative, eg to present the key community concerns about the project to the meeting (this can help reduce the amount of unstructured input from the floor).	*Advertising could include posting of notices in public areas such as council offices, libraries, bus stations, and community halls. Meeting agenda should allow plenty of time for audience discussion. The box on page 12 of the Community Consultation & Involvement Sustainable Minerals booklet lists "Ten Laws of Effective Communication".*
1.15 Have you established timetables for requests, suggestions & submissions?	Timetable set for community input	Timetable for community input clearly indicated in advertisements, information material & at the public meeting	The timetable should also indicate the timeframe for considering community input & reporting back to the community on consequent changes to the project	
1.16 Have you stimulated conciliatory & constructive exchanges?	Evidence of willingness to negotiate & compromise	Evidence that matters arising from public meetings & other interactions with community representatives are resolved harmoniously & within reasonable timeframes	Difficult issues will be best handled where the community liaison officer is able to discuss issues at board level & can make binding commitments face-to-face with community representatives	

Part 2: Management and Operation - see summary in "phase 3" box on page 21 of Community Consultation & Involvement Sustainable Minerals booklet				
2.1 Have you developed detailed information about the impacts of the operation?	A comprehensive description of the project & its social, economic & environmental impacts which is prepared in plain English	The information should describe: • your company • regional & national importance of project • project location, hours of operation, job opportunities & skill levels • likely environmental issues & plans to manage them (including dust, noise, traffic volumes, safety, damage to vegetation, wildlife) • likely social issues & plans to manage them (including heritage & cultural values, employment, business opportunities) • the economics of the project	This information should be communicated to the community before completion of any draft Environmental Impact Statement. The community can often provide input which improves the quality of the proposed mine plan & the EIS, & thus significantly reduce difficulties in the consultation phase & approvals process.	*BHP Minerals was impressed with many of the community suggestions made during consultations through the planning period for the EIS into the Beenup titanium project - see the box on page 9 of the Community Consultation & Involvement Sustainable Minerals booklet*.
2.2 Have you identified key stakeholder groups & their issues of concern?	Register of stakeholder groups	Register of stakeholder groups includes listing of concerns, interests, needs & aims for each group.		
2.4 Have you set up a liaison committee?	Formal documentation of formation of a liaison committee & its membership	Documentation to include: • terms of reference for committee • membership • meeting frequencies & locations • working arrangements, including procedures for nomination of agenda items	• Committee chaired by an independent person likely to engender respect from the community • Meetings held at regular intervals agreed by the committee • Community liaison officer always attends • Standing agenda item on progress against issues arising.	*This committee is commonly a continuation of the community liaison committee established in the conceptual or exploration phase. The terms of reference may need rewriting to reflect the change in scope.*

2.5 Have you arranged for interested parties to visit comparable operations?	Arrangements made for visit/s to operating mines similar to the one you propose	Arrangements made for visit/s to operating mines similar to the one you propose	Arrangements must be sensitive to the cultural setting & life experiences of the people involved: the box on page 16 of the Community Consultation & Involvement Sustainable Minerals booklet describes how Aboriginal people with little experience outside their region were taken to a completely different climatic area with very different environmental issues from theirs, resulting in increased confusion instead of improved understanding.	
2.6 Have you established a presence within the community to answer inquiries or distribute literature?	Evidence of a permanent presence which is readily accessible to the community	Evidence of a permanent presence which is readily accessible to the community, & readily available officers & information resources.	The presence should be in an area commonly frequented by the community such as a shopfront in the local retail centre	*Information technology allows information to be provided in different formats, eg computer-based maps & graphs of activities & environmental monitoring data.*
2.7 Have you established 24 hour / 7 day a week contact points & telephone numbers, & widely communicated these?	Documentation showing evidence of nominated contact telephone number	Evidence of nominated telephone number having been advised to all interested parties on the register of landowners, occupiers & special interest groups.	Call forwarding or messaging service to facilitate receipt of calls out of office hours (ie 24hours/7 days a week)	
2.8 Have you developed links which will bring commercial benefits to local businesses?	Evidence of collaborative ventures with local businesses & employment of local people	Performance measures may include: • contracts with local businesses for supply & services • percentage of mine staff who are local employees	Implement remedial training, scholarships & apprenticeships to enhance training & employment opportunities for local aboriginal people, as well as encouraging local aboriginal enterprises to provide contract services to the mine	*Delivery of direct commercial benefits to the local community from your mine project, & giving people better skills for gainful employment, are two of the strongest avenues for building support for your operations amongst local people.*
2.9 Have you developed links with the local schools?	Evidence of collaborative programs with local schools & colleges	Performance measures may include: • company staff assisting in schools/ technical colleges eg talks on science, engineering, environmental restoration		*Exposure of staff skills (eg via technical presentations to technical college & school), & company capabilities (eg via collaborative assistance to community landcare or construction of public facilities etc) can help to build a positive appreciation of the company's capabilities*

		• sponsoring of school events or contributions to P& C fundraising for equipment		
2.10 Have you developed community demonstration projects?	Evidence of participation in community projects	Company provides expertise & general assistance to local community projects, for example: • sponsorship • planning assistance • loan of equipment • collaboration with local Landcare group • sponsorship to service club projects		*Many Australian companies undertake activities to show their commitment to meeting community concerns. These are commonly related to environmental projects but can extend into any other organised community activity.*
Part 3: Mine Closure - see summary in "phase 4" box on page 22 of Community Consultation & Involvement Sustainable Minerals booklet				
3.1 Have you involved the community in site closure & rehabilitation planning?	Evidence of community knowledge of & input to site closure & rehabilitation planning	Evidence that the community is satisfied with its level of input & that the closure plan & rehabilitation program are sensitive to its concerns & desires	Consultation on the closure & rehabilitation plans should commence early in the operational phase. Roundtable discussions with government & council mining, environmental & planning authorities & the community will optimise the prospect for beneficial land use outcomes with minimal potential for post-closure social or environmental impact.	
3.2 Have you examined opportunities for technology transfer or business enterprises for the community?	Evidence of discussion on this topic by the liaison committee	Examples of opportunities identified for transferring skills to the community, which have the potential to provide continuing employment after mine closure	Examples include nursery services for supply of native plants, land rejuvenation techniques, & utilisation of assets left after mining such as use of heavy machinery workshop or aquaculture in flooded pits or ponds.	

3.3 Have you explored options to involve the community & local businesses in environmental restoration?	Evidence of collaborative activities involving environmental restoration	Evidence of continual involvement during the life of the mine	Examples include setting up a community-based rehabilitation network, often involving schools. The company may supply seed or seedlings & undertake heavy machinery works at no cost. The company may contract local business to undertake rehabilitation work, eg provide nursery services, planting of seedlings & weeding.	
Part 4: Monitoring and Assessment				
4.1 Are you holding regular meetings with the community stakeholders?	Evidence of meetings at regular intervals during the life of the project	Meetings at least once every six months	Meetings widely advertised & agenda items publicly available	*Don't be put off if no-one turns up - at least it demonstrates that* • *there are no burning issues concerning the community* • *your communication channels are still open*
4.2 Have you surveyed the attitude of the community?	Evidence of current community attitudes towards the project	Inputs to complaints line & expressions of attitudes at liaison committee & public meetings collated to provide a barometer of opinion	Attitudinal survey conducted at least once every five years, by independent body	*Displays at your shopfront & at local shows etc can be used to gather opinion through short questionnaires. A computer can be set up in your shopfront with a simple interactive display linked to feedback questions.*
4.3 Do you make special arrangements to deal with critical issues when they arise, eg after a major spillage?	Evidence of special arrangements to accommodate public concern when the usual communication systems are insufficient	Special opportunity for exchange of information within one week following a major safety or environmental incident at the mine, eg special public meeting/site visit/briefing by outside specialists	A senior officer should be nominated as the contact point & spokesman in the event of a significant incident - preferably the mine manager. This person should attend all meetings & make all statements regarding the incident.	*Several briefings and/or meetings may be required through to all resultant impacts from the incident being dealt with. Severe incidents may require daily briefings or meetings. In all events, a public site visit should be arranged when there is no threat to public safety. An inspection should also be arranged when restoration works etc are completed.*
4.4 Are you watching for changing needs amongst the community?	Evidence of current community needs which may interact with company policy or operations	Inputs to complaints line & expressions of attitudes at liaison committee & public meetings collated to provide a barometer of community needs		*Community needs & preferences for post-closure land use, employment etc assessed during the mine planning stage are likely to change where mines have a life of ten years or more.*

4.5 Are you monitoring the effectiveness of the consultation program?	Regular reports to senior management & the board on community relationships	Regular reports prepared by the community liaison group to senior management & the board on community relationships	The reports are based on an evaluation of feedback from media reports, liaison committee & public meetings, surveys, shopfront feedback & staff debriefing.		

CHECKLIST FOR CONTAMINATED SITES

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information Gathering - refer section 3.1 in Contaminated Sites Sustainable Minerals booklet					
1.1 Do you know the composition of all materials used, generated or stored on the site & how they could contaminate land?	Improved basis for estimating risks of contamination, including • design of mine layout • infrastructure • processes • operating systems • management plans to minimise likelihood of contamination	Documentation of all materials used, generated or stored, listing any hazardous characteristics & their potential to contaminate land.	Integration into management plans of procedures for prevention & control of contamination of hazardous materials, including: • Waste Management Plan • Chemicals Management Plan • reporting requirements for environmental incidents, events & circumstances	*Refer to Sustainable Minerals booklet on Hazardous Materials Management, Storage & Disposal*	
1.2 Have you identified likely sources of contamination during planning, design & operation phases?	Risks identified at the different stages of mine development, operation & closure can be used as a basis for designing operating systems and manuals to minimise probability of contamination.	Environmental Impact Study (EIS), Mine Plan, & Operating Plan/EMS list likely sources of contamination	As above (1.1).	*Refer to Sustainable Minerals booklet on Hazardous Materials Management, Storage & Disposal*	
1.3 Have you identified receptors - human & environmental - that may be adversely affected?	Consequences of contamination better understood allowing identification of parameters for construction, management & operation, & priorities for implementation.	Environmental Impact Study (EIS), Mine Plan, & Operating Plan/EMS list the environmental receptors that could be adversely impacted from contamination, & assess potential impacts	The sensitivity of identified receptors & the consequences of impacts from contamination can be used to provide design specifications for environmental protection measures. A factor of safety should be applied to provide a level of certainty against accidental or unforeseen contaminant release.		
Part 2: Management					
2.1 Does your Environmental Management System (EMS) identify risks of contamination?	• Risks of contamination understood to managers • ability to devise operational systems, manuals, & staff instructions which can minimise these risks	Risks of contamination listed in Environmental Management System (ie location, relevant operation/ facility, type/s of contaminant, likely severity). Risk evaluation to cover: • exploration & trial operations • minesite construction	EMS updated regularly to incorporate new information & devise modified approaches as required. Such modified approaches may include procedures to reduce likelihood of recurrence of accidental contamination, or new measures to reduce/reverse long-term trends in contaminant transport such as in ground water plumes.	*Refer to Sustainable Minerals booklets on Environmental Management Systems, & Environmental Risk Management.*	

		• mine operations • ore processing or in-situ leaching • tailings storage • handling of waste chemicals, consumables & equipment • management & human behaviour			
2.2 Does your EMS set out operating procedures & management practices to address the identified risks?		Risks of contamination & methods to control them understood by managers, staff & contractors	Environmental Management System should integrate all procedures for prevention & control of contamination, including: • Waste Management Plan • Chemicals Management Plan • reporting requirements for environmental incidents, events & circumstances	*Refer to Sustainable Minerals booklet on [Hazardous Materials Management, Storage & Disposal]*	
2.3 Do you conduct environmental audits which are able to identify current & potential releases that may contaminate land?	Past incidents used as a basis for improving: • assessment of ongoing risks of contamination • the effectiveness of current management systems for minimising the likelihood of contamination.	Documented environmental audit within the last two years which identifies past, current & potential releases that have contaminated/may contaminate land	Contamination prevention audits should be conducted at least once every two years.	*Refer to Sustainable Minerals booklet on [Environmental Auditing].*	
2.4 Are your site policy, operational manuals & procedures, & closure plans up to date?	All site policies, manuals & procedures correctly relate to operations on site, & the effectiveness of management of contaminants to date.	Site policy, operational manuals & procedures, & closure plans are updated regularly or in relation to any significant change in operations	Site policies, manuals & procedures: • reflect the types of hazardous materials in current use & their style of use • provide information on prevention of recurrence of any prior incidents of significant contamination		
2.5 Are staff trained to prevent & deal with contamination?	All staff aware of: • risks of contamination • their responsibilities in reducing that risk • correct reporting	• Training program on the management & prevention of contamination • All staff have received training		*Small operators with limited resources may rely upon government emergency services to respond to emergency situations, in which case it*	

	responsibilities in the event of contamination being observed or suspected	• Regular refresher courses, & induction courses for new staff/contractors		*is important to ensure that they:* • *have access to all entry points to the site (eg lock keys)* • *are advised of hazardous materials used on the site* • *are advised of on-site equipment & systems which can be used to help manage an emergency situation* • *are advised of the OIC of emergency situation & that clear communication channels are determined* • *are involved in regular emergency response liaison meetings & informed of changes in the types of hazardous materials, usage, processes & inventories*	
2.6 Are procedures for management of contamination reviewed regularly?	Procedures for management of contamination are: • well-tailored to the characteristics of the site & mine operations • include improvements designed to avoid recurrence of past accidental releases or perpetuation of any long-term trends in contaminant	Documentation which provides evidence of regular reviews (annual is suitable) & adjustment of procedures for management of contamination.	Reviews can be formally linked to annual environmental audits, where audit recommendations on management procedures for contamination are routinely used as a basis for review & amendment of procedures.		

	transport into the environment				

Part 3: Risk Minimisation - refer sections 3.3 - 3.8 in Contaminated Sites Sustainable Minerals booklet				
3.1 Have you provided, & do you maintain, containment areas for all potential contaminants?	Significant reduction in risk of escape of contaminants	Evidence that all areas of potential contamination are adequately contained	Areas of potential contamination should have been identified in the EIS & Mine Plan & should also be identified through annual environmental audits, monitoring, & regular routine site inspections.	*Containment as bunds and/or concrete aprons should be provided in all areas of potential spillage of hazardous materials such as oil racks, storage for drilling fluids & muds, wash-down areas, processing areas, conveying areas/corridors, & general storage & maintenance facilities.*
3.2 Do you keep your process & storage inventories of hazardous materials on-site to a minimum?	Reduced potential volumes of materials that could be accidentally released	Inventory of hazardous materials, including storage periods prior to use		
3.3 Do you use less toxic materials wherever possible?	• Reduced consequences following any acute or long term escape of hazardous substances. • Less risk to workers. • Less hazards & costs involved in clean-up of any contamination	Evidence of periodic identification and review of alternatives to chemicals & other hazardous substances used on site	Regular assessment of hazardous materials, their toxicity, possible alternatives, inventory, & disposal of hazardous materials, waste & empty containers should be a feature of annual environmental audits	*An example of less toxic materials is the use of biodegradable drilling fluids.*
3.4 Have you designed the mining facilities to take into account ecological aspects, sensitive land use, minesite closure, rehabilitation & subsequent land use?	Any contamination resulting from the mine is less likely to: • impact key environmental sensitive receptors • increase complexity & cost of mine closure & rehabilitation, or • restrict options for post-mining land use	Good mine design minimises the risk of environmental harm, & is sensitive to mine closure & future land use: • stockpiles contained so that wind or water does not disperse them • tanks above ground with inspectable bottoms designed to reduce corrosion • above-ground piping • drainage pipe-work designed to minimise wear, deterioration, cracking • facilities & run-off areas		*Refer to Sustainable Minerals booklet on Mine Planning.*

		sited away from natural drainage channels • bunding of all areas likely to collect or contain hazardous materials during the life of the mine • retention ponds with pump-back facilities between facilities, dumps & disturbed areas, & natural drainage channels		
3.5 Are your operational systems designed to reduce the risk of contamination?		Any contamination resulting from the mine is less likely to: • impact key environmentally sensitive receptors • increase complexity & cost of mine closure & rehabilitation, or • restrict options for post-mining land use Staff understand their responsibilities & their roles in preventing contamination in both routine & emergency situations.	• Any incidence of contamination should be investigated to identify the cause, & remedial action implemented immediately • Any recommendations from annual environmental audits related to significant risk of contamination or identified contamination to be implemented immediately	*Attention should be given to facilities or operations with particular potential to cause significant impacts, because of their nature, size, or the materials used - these include tailings dams, leach pads, cyanide for gold extraction. Closer monitoring, specialist staff training & awareness sessions, & regular refresher courses are warranted.*
3.6 Are waste management facilities included in the design of the mine?	Demonstrated commitment by management to appropriate management of waste	Mine Plan includes a designated waste management facility		*Refer to Sustainable Minerals booklet on Hazardous Materials Management, Storage & Disposal.*
3.7 Have you avoided waste disposal at the site by segregating, trucking out & recycling waste?	• Significant reduction in risk of escape of contaminants. • Less risk to workers. • Less hazards & costs involved in site rehabilitation	• Waste is sorted & opportunity for re-use or recycling is maximised • Hazardous materials disposed of in special facilities which may be off-site • Contractual	• Sorting & recycling depots can be established at the site refuse dump • Explore opportunities for sale of used oils to registered recylers, or re-use in furnaces	

		arrangements for routine & regular removal of more hazardous materials		
3.8 Are waste disposal areas documented?	No misunderstandings about how & where waste is to be managed or placed	All waste management facilities documented in the Mine Plan/EMS, & their appropriate use explained in operational manuals	Waste disposal sites should be clearly signposted with instructions on: • access • wastes allowed/not allowed • management procedures, eg sorting • restrictions on disposal, eg fire restrictions, periodic burial, placement in sealed containers	
3.9 Do you maintain a site register of the location of hazardous materials (on surface, buried, contaminant plumes)?	Known location, type, concentration, mobility & accessibility of contaminants & polluted areas assists in: • ongoing mine planning & operations • identifying risks • rehabilitation planning	Site register of hazardous materials in the environment	Site register updated annually & reviewed in annual environmental audit	
Part 4: Monitoring and Assessing Land - refer sections 5.1 - 5.2 in Contaminated Sites Sustainable Minerals booklet				
4.1 Do you have a monitoring program which examines contamination issues?	Up to date information on: • the areas • concentrations • toxicity • chemical behaviour • direction & rate of movement of contaminants	Documented monitoring program which sets out monitoring & sampling routines for detection/measurement of contamination. Program to include: • groundwater quality • storage tanks • stack & other air emissions • discharges from tailings & ore/rock dumps • discharges from waste disposal facilities	Sampling techniques should conform with *Australian Standard AS 4482.1-1997 Guide to the Sampling & Investigation of Potentially Contaminated Soil, Part 1: Non-volatile & Semi-volatile Compounds*. The annual environmental audit should examine the adequacy of the monitoring program, determine if data are being interpreted appropriately, & recommend any areas of improvement required in the monitoring program	*The ANZECC Guidelines, associated documents & various State environmental agency publications give guidance on detecting or identifying contamination.*

4.2 Is targeted sampling carried out in areas of greater concern?	Assurance that key areas are free of contamination, or that contamination levels are under control. Key areas include sites where spillages are most likely, ie around ground-level tanks or underground tanks; ponds holding toxic chemicals.	Documented evidence in the monitoring program that greater frequency, intensity, or sensitivity of monitoring is undertaken in key areas	Sampling can include closer grid sampling to test for confined plumes, deeper monitoring bores or non-invasive techniques such as ground-penetrating radar, resistivity & conductivity surveys to detect deeper-level contamination	
4.3 Have you compared sampling results with published risk-based guideline values, taking into account the use of the land?	Assurance that monitoring & assessment are consistent with best practice approaches	Application of "Risk-Based Corrective Action" (RBCA) or a similar approach	The principles are to: • manage sites based on the risk to human health & the environment • compare sample results with published risk-based guideline values (eg ANZECC Health & Environmental Investigation Thresholds) • determine if the site poses a risk if these values are exceeded • carry out a more detailed site-specific assessment of the risk if warranted • manage sites to reduce risk, rather than focus on reducing contaminating activities (ie containment & natural attenuation are acceptable factors)	*Further information on the general framework for RBCA is in: ASTM 1995 - "Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites."*
4.4 Have you carried out more detailed assessments of high risk areas?	Information on: • exposure pathways • receptors (such as mine workers) • toxicity of the contaminants • actual levels of exposure	Evidence of detailed investigations where contaminant concentrations are found to exceed threshold values.		*Results of the assessment could indicate that published threshold values are too low & remediation is not required. Figure 1 sets out the general process for assessment of site contamination.*

4.2 Is targeted sampling carried out in areas of greater concern?	Assurance that key areas are free of contamination, or that contamination levels are under control. Key areas include sites where spillages are most likely, ie around ground-level tanks or underground tanks; ponds holding toxic chemicals.	Documented evidence in the monitoring program that greater frequency, intensity, or sensitivity of monitoring is undertaken in key areas	Sampling can include closer grid sampling to test for confined plumes, deeper monitoring bores or non-invasive techniques such as ground-penetrating radar, resistivity & conductivity surveys to detect deeper-level contamination	
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4.4 Have you carried out more detailed assessments of high risk areas?	Information on: • exposure pathways • receptors (such as mine workers) • toxicity of the contaminants • actual levels of exposure	Evidence of detailed investigations where contaminant concentrations are found to exceed threshold values.		*Results of the assessment could indicate that published threshold values are too low & remediation is not required. Figure 1 sets out the general process for assessment of site contamination.*
4.5 Have you reviewed the operation of the minesite to identify potentially contaminating activities?	Understanding of potential future developments in contamination levels/areas/types. These may include: • mine expansion or extension plans	Evidence of periodic review of potentially contaminating activities	One or more of the following can trigger a contamination investigation: • environmental assessment or audit • due diligence investigations	*Cleaner Production principles should be applied to reduce waste when mineral processing facilities or operating procedures are being designed or reviewed.*

	• continued long term seepages • movement of groundwater plumes, & their possible impacts on the environment • mine closure works & costs • post-mine land use		associated with property transfer • report of a significant release to the environment (incident report etc) • excavation or works that encounter contaminants identified by odour or visual impact • routine environmental monitoring • impacts observed by users of adjacent land • routine testing of storage & distribution equipment • losses identified through a review of inventory records	*Case Study 1 describes the role of environmental auditing & management systems in management of contaminated sites. Also refer to the Sustainable Minerals booklet on Environmental Monitoring & Performance.*
Part 5: Remediation of Contaminated Sites refer section 5.3 in Contaminated Sites Sustainable Minerals booklet				
5.1 Do you have management procedures specifically for clean-up of contamination?	• Responsibilities & actions understood • consistency of approach • higher probability of successful clean-up	Standard procedures for clean-up documented in EMS & operations manuals	Procedures to cover both acute (eg accidental spills, breaching of bunds, tank failure), & chronic (eg detection of deep groundwater plume from a long term seepage) Procedures should render a site safe & acceptable for long term continuation of its existing use.	*Key points in procedures should be to:* • *recover as much of the contaminant as possible* • *immediately restrict access to people & animals that may be exposed* • *contain or direct the contamination to minimise environmental effects* • *instruct staff on health & safety aspects* • *not proceed if the process is likely to create more harm than leaving the site undisturbed.*
5.2 Do the procedures reflect the most appropriate methods for clean-up?	• Improved safety for personnel • efficiency of clean-up operations • reduced environmental risk through avoiding inappropriate measures	Reference in procedures to recommendations from manufacturers, Mines Departments, EPAs etc on handling & cleanup		

5.3 Have areas of contamination been adequately investigated?	Levels of contamination kept in check so that no surprises likely later in mine life or in the decommissioning/ rehabilitation stages	Incident reports demonstrating that areas of contamination detected by the monitoring program have been followed up, & the type, extent, behaviour & possible impacts determined	Contamination should be reported to staff & to stakeholders annually, along with a description of remedial measures & the level of clean-up achieved	*Incident reports should be prepared for each incident of contamination identified. The report should provide a standard format for reporting & characterising the contamination, details of clean-up, & description of post clean-up conditions.*
5.4 Have you determined the source of the contamination & taken steps to remove it?	• Continual improvement in site management of hazardous materials • reduced risk of recurrence	• Incident reports identify the source of the contamination & recommendations for remedial action/s • Evidence (documentation, site inspection) of completion of remedial works		*Remedial works may be substantial (excavation, & sourcing & placement of clean fill) for below-ground installations such as underground tanks & piping. Clearly above-ground installation is preferable where practicable.*
5.5 Have you consulted regulatory authorities before constructing a repository for any contaminated material?	Ensures no regulatory breaches incurred	Documentation of involvement by authorities in approval for containment of contaminated material		
5.6 Have you evaluated the most appropriate disposal or remedial technique for the contaminated material?	Ensures maximum efficiency & effectiveness of clean-up in all aspects of environmental, health & safety & financial management	Documentation of assessment of various options for clean-up	A master list of appropriate clean-up options can be constructed from a review of the contaminants on site, & development of the most probable scenarios for contamination to occur (ie contaminant/s involved, location, cause/s of leak, environmental receptors). The appropriate response for an incident which matches one of these scenarios can therefore be determined very quickly will minimal need for analysis of the incident. Consult authorities prior to constructing any on-site containment, as special	*The most direct methods for removal of contaminants are:* • *excavation & disposal in an on-site repository or off-site landfill (check that the material conforms with any restrictions on materials allowed at the site) - Case Study 5 gives an example of waste containment on site, & Case Study 4 describes a risk assessment undertaken to help plan remedial works for a heavily contaminated site* • *soil or groundwater treatment.* *Technologies vary greatly with contaminant,*

			standards & approvals are often required.	*media & site characteristics, & include:* • *bioremediation (land-farming - refer to Case Study 7) which is commonly used for hydrocarbon-contaminated soil* • *stabilisation* • *thermal desorption* • *chemical treatment* • *solvent extraction or soil washing.* *Methods which produce concentrates of contaminants require further treatment or special disposal* • *natural attenuation or degradation - most appropriate for low concentrations* • *pumping & treatment of contaminated surface or ground water* • *air sparging & vacuum extraction of volatiles in water.* *Soil & ground water remediation techniques are summarised in Tables 6-1 & 6-2.*
5.7 In the instance of contamination which cannot be completely removed, are systems in place to prevent contact with people & the environment?	• Less risk of health impacts to workers, or impacts on the public & environment after mine closure • reduced long term liability	Barrier systems constructed over or around area of contamination which are to be left in place	Protective clothing must not be worn as a substitute for clean-up of contamination.	*If a capping is placed over contaminated ground, future activities must be controlled to maintain integrity of the capping system. If the cap is greater than 3m & contamination is not dangerous, site redevelopment is an option. Long term groundwater contamination may require confinement by membranes or clay/bentonite slurry cutoff walls, or pumping to maintain a reverse hydraulic flow or for long term treatment.*
5.8 Does your closure strategy address contamination issues?	• No surprises during rehabilitation & closure, improved budgeting • more affordable/effective decontamination works can be carried out during the	Contaminated areas & their treatment described in the Rehabilitation & Closure Plan		*Case Study 6 gives an example of a closure & remediation strategy.*

	operational phase to reduce costs & complexities in the closure phase			
5.9 Have controls been placed on the future access to or use of the contaminated sites?	Reduced risk of impacts on people & the environment; reduced long term liability	Evidence of institutional controls over any areas of contaminated land remaining after mine closure	Institutional controls should be considered for: • the planned use the land • restrictions on the use of ground water, construction of buildings with basements (eg if volatiles present), & worker activity (eg no sub-surface works without appropriate approval & personal protective equipment)	*Post mine closure contamination will reduce the range of possible future land use options. Planning authority approval is required where a constraints option is proposed. Whilst this approach is legitimate, it does not conform to the principles of best practice environmental management as it leaves a long term legacy of restricted environmental & social amenity, & may carry significant costs well after mine closure. Controls & restrictions may need to be reviewed from time to time if another use for the site is proposed.*

CHECKLIST FOR CYANIDE MANAGEMENT

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
1.1 Do you have a cyanide management strategy for your operation?	A documented cyanide strategy and management plan which: • evaluate the behaviour of cyanide at all process stages • map out all potential pathways for complexing and transport • define opportunities for reducing cyanide use • set clear goals and standards for health and environmental protection	The cyanide strategy and management plan addresses all aspects of cyanide handling and use in the context of eliminating risk to workers and the public and minimising potential harm to the environment	The cyanide strategy and management plan should be fully integrated with the mine's Environmental Management System (EMS). Components of an effective EMS are described in the Environmental Management Systems Sustainable Minerals booklet	*An effective cyanide strategy will include methods to reduce both the immediate short term risks to workers and the environment and the long term risks through to post-closure, and set out procedures for stakeholder consultation. Case study 2b describes consultation on discharge standards with community stakeholders.*	
1.2 Have you a sound understanding of the cyanide process as it applies to your operation and the chemical reactions and pathways which are available for cyanide complexes to be formed and accessible to people and the environment?	The cyanide strategy and management plan describe: • cyanide chemistry specific to the site • how these could be available to workers, the general public • the environmental potential impacts.	Evidence in the strategy and management plan of: • chemical modelling specific to the site and processes to be used • analysis of pathways for potential release to humans and the environment.	Cyanide chemistry for the site investigated by a relevant expert (eg chemical engineer), and potential pathways and impacts evaluated by an environmental chemist or toxicologist	*Chapter 2 describes the types and names of cyanide complexes and key chemical reactions.*	
1.3 Are all staff trained in the risks and effects of cyanide	Cyanide management training course for all staff and contractors	All relevant staff and contractors trained, covering:	Regular refresher courses run for all staff, and new staff and contractors trained within 1 month of	*Chapter 3 discusses cyanide poisoning and general safety issues. For more detail refer to: National Occupational Health &Safety Commission 1993 -*	

and techniques for safe handing and risk reduction?		• potential for poisoning • recognising the symptoms • general safety issues • potential impacts on the environment • risk minimisation strategies • emergency procedures	engagement	*Cyanide Poisoning. Australian Government Publishing Service, Canberra.*	
1.4 Are the responsibilities for cyanide management clearly defined, and chains of command defined and widely known?	Cyanide Management Plan includes breakdown of responsibility and command specific to cyanide management and emergency response	Cyanide Management Plan includes breakdown of responsibility and command specific to cyanide management and emergency response	Cyanide Management Plan integrated with Emergency Response Plan. Full integration between the Cyanide Management Plan, Operational Procedures, and Emergency Procedures, including clear definition of staff responsibilities and powers.	*All mine plans, procedures, strategies should be integrated via the overall EMS for the mine - refer to the Environmental Management Systems Sustainable Minerals booklet*	
1.5 Are there unambiguous and effective lines of communication established with specific reference to cyanide management and response?	Cyanide Management Plan sets out communication lines for exchange of information on normal and abnormal operation of the cyanide management system, including communication with external agencies	Communication lines cater for normal operation (eg results of monitoring data), abnormal operation, and emergency situations	Establish formal and frequent consultation with the local community early in the planning process and throughout operations, including during abnormal events	*Meaningful consultation with the local community will commonly reduce concern and agitation about perceived risks from cyanide - refer to the Community Consultation and Involvement Sustainable Minerals booklet*	
1.6 Are you aware of the regulatory requirements that relate to the use, handling, storage and disposal of cyanide?	Initial planning and operational objectives should include knowledge of: • regulatory limits for worker safety • water quality • environmental protection -	Documentation of all relevant legislation; regulation; codes and standards for mining, occupational health and safety; and environmental protection, at the federal, state and local government levels	Establish formal and frequent consultation with the relevant regulatory authorities early in the planning process	*Appendix 1 summarises the statutory requirements for transporting and handling cyanide.*	

	specifically risks to fauna and domesticated animals				
1.7 Are you aware of the draft code of practice for cyanide management and do your operations conform to the code?	Copy of the draft code in the possession of mine management	Evidence of assessment of the adequacy of the mine's cyanide management system against the requirements of the draft code	Requirements of the code included in the regular environmental audit protocol for the site. Company commits to the International Cyanide Management Code developed under the auspices of UNEP &International Council of Mining &Metals (ICMM) http://www.cyanidecode.org/	*The draft code is accessible at http://www.cyanidecode.org/draft_code.pdf*	
Part 2: Management and Operation					
2.1 Does your facility incorporate (or does the design plan provide for) physical measures to minimise environmental and health risks and maximise opportunity for effective cyanide management?	Does the mine plan or built facility adequately provide for: • reliable barriers for safe containment • sufficient volumes for effluent containment • active management of inflows and outflows?	• Bunding or double lining of tanks or ponds containing cyanide, or cyanide solutions or cyanide-contaminated water • evidence of volumes calculated on extreme rainfall events based on local meteorological data • pumping capacity sufficient to cope with emergency situations and avoid uncontrolled release	System design should be based on a zero-release strategy, even in extreme precipitation conditions.	*The Water Management Sustainable Minerals booklet describes factors for calculating the capacity of containment structure, and the Hazardous Materials Management, Disposal and Storage Sustainable Minerals booklet gives examples of bunding systems.*	
2.2 Does the process circuit incorporate measures to minimise	Does the process circuit design take into account:	• Evidence of chemical modelling of	Indications of: • negative impacts on		

environmental and health risks and maximise opportunity for effective cyanide management?	• effluent characteristics (components, concentrations, physico-chemical properties) which may enhance retention, degradation or attenuation of toxicity • expected rates and quality of seepage and its impacts on process chemistry efficiency and potential environmental impacts?	process waters involving all inputs and resultant cyanide reactions • assessment of the effects on cyanide complexation on cyanide availability and effectiveness for gold extraction, on toxicity, and on availability to humans and the environment • evidence of consideration of cyanide loss to surface and ground waters	processing efficiency • increased toxicity or bioavailability • contamination of natural waters should be used to identify improvement targets for process chemistry or physical containment		
2.3 Are there procedures for safe transport of cyanide?	• Procedures available to all staff and contractors/carriers, and prominently displayed at key locations, ie at receiving area • Staff trained, with frequent refresher courses.	• Documented procedures for the safe transport of cyanide; agreed between provider and client • use of the most appropriate form and packaging for the volume requirements of the operation	One approach is for cyanide transport and delivery in sparge containers which reduce the need for handling and the risk of spillage		
2.4 Are there procedures for safe storage of cyanide?	Procedures available to all staff and contractors, and prominently displayed at key locations, ie at storage area/s. Staff trained, with frequent refresher	• Documented procedures for the safe storage of cyanide • use of the most appropriate form and packaging,			

	courses.	considering the volume requirements of the operation • adequate ventilation in storage facilities to avoid build-up of hydrogen cyanide gas • minimise risk of contact of solid sodium cyanide with water, ie sound roofing, raised floor • bunding of storage facility and positioned away from water courses to avoid water contamination • storage separate from corrosive materials, acids and explosives			
2.5 Are there procedures for safe handling of cyanide?	• Procedures available to all staff and contractors, and prominently displayed at key locations, ie where cyanide is unpacked, decanted, mixed, and transferred between containments • Staff trained, with frequent refresher	• Occupational exposure standard/threshold limit value is applied • appropriate protective clothing worn whenever handling occurs • workers should always work in pairs when undertaking hazardous	Refer to Chapter 3 and Case studies 3 &4 describe several approaches to safe handling	*Cyanide handling must take into account the occupational exposure standard or Threshold Limit Value of 5mg/m3 for sodium cyanide powder and 10ppm for hydrogen cyanide gas.* *Hazardous operations include:* • *opening storage containers* • *dissolving sodium cyanide pellets* • *cleaning up spillages.* *Minimum protective clothing is:* • *hard hat* • *long PVC gloves* • *safety boots*	

	courses	operations - one acting as a sentry to initiate emergency action if needed		• *full face canister mask* • *disposable "poly" overalls with hood.*	
2.6 Has a risk of the workplace assessment been undertaken to assess risk of cyanide exposure to staff?	Documented evidence of a comprehensive risk assessment of all stages and sections of cyanide management, including storage, transport, usage, containment and disposal	Risk assessments should be undertaken at the planning stage, and at regular intervals (eg less than 5 years apart) during operations or following adjustments to cyanide management procedures	An appropriate approach is to adopt Hazard Analysis at Critical Control Points (HACCP).		

2.7 Has a cyanide balance been constructed for the minesite?	Documented evidence of a comprehensive cyanide balance calculation for the minesite	The calculation should include: • knowledge of orebody composition and how variations will affect cyanide consumption • local meteorology and implications for cyanide consumption through evaporation and photolytic degradation • interactions with the water balance for the mine resulting in dilution and concentration effects	The cyanide and water management plans for the site should be closely integrated, and cyanide and water balance calculations should be undertaken together.	*Equations 5, 16 &17 in Chapter 2 help to understand how cyanide loss may be increased through meteorological effects.*	
2.8 Does the cyanide circuit contain procedures for minimising cyanide use?	Evidence of a cyanide budget used to monitor cyanide use and identify consumption/loss pathways	The cyanide budget should factor in: • cyanide additions • concentrations at different process circuit stages • consumption • various losses • recovery through re-use and recycling • any discharges and recycling	The cyanide budget should be based on the minimum concentrations of cyanide necessary to achieve effective gold recovery.		
2.9 Are systems used for cyanide treatment and re-use?	Systems in place and operational for the treatment and recycling of cyanide	Monitoring data from treatment and recycling systems used to control and minimise consumption of new cyanide	The cyanide budget should be based on the minimum concentrations of cyanide necessary to achieve effective gold recovery.	*Cyanide removal technologies for recycling are summarised in Table 6 and an example of cyanide treatment is presented in Case Studies 6 &7*.	
2.10 Are measures in place to protect wildlife and livestock?	Evidence of installations to deter or exclude wildlife	• All water bodies accessible to wildlife have WAD (weak acid dissociable) cyanide concentrations of less than 50mg/L^{-1}	In addition to measures to optimise (ie lower) cyanide concentrations, other measures include fencing, floating balls, netting, hazing (eg fireworks, lights, sound), minimising pondage surface area, reducing shallow water areas which attract wading birds, and	*Ponds with WAD cyanide concentrations of less than 50mg/L^{-1} are generally considered safe for*	

		• Simple measures in place for exclusion and deterrence of wildlife	surrounding ponds with clean water troughs or clean water wetlands.	*wildlife.*	

Part 3: Remediation					
3.1 Are there procedures in place for clean-up in the event of accidental spillage?	Documented operational procedures for clean-up, including responsibilities, standards, and reporting requirements	Procedures should take into account: • the physical form and the amount of cyanide lost, eg liquid or solid spill, seepage from tailings pond or heap leach pad, presence of HCN gas • size and area of incident • response time (may depend on how soon the incident is noted after its occurrence) • accessibility, eg at surface or underground seepage plume • environment involved, eg land, water.	• Copy of operational procedures provided to regulatory authority. • A log of incidents and how they were treated should be maintained.	*Section 4.4 describes some spillage scenarios and the actions which should be taken in those situations.*	
3.2 Do clean-up procedures specify standards to be achieved for environmental protection, including environmentally responsible disposal of contaminated materials?	• Clean-up procedures provide guidelines on the level of clean-up required • proper disposal of any contaminated material recovered	• Clean-up procedures provide guidelines on the level of clean-up required • proper disposal of any contaminated material recovered	Guidelines should include provision for rehabilitation where appropriate or achievable.		
3.3 Does the mine closure plan address cyanide disposal including disposal of contaminated materials?	Documented Closure Plan addresses potential cyanide contamination	Closure Plan includes plans for disposing of or treating areas containing or contaminated by cyanide at closure, and takes into account behaviour of different cyanide complexes		*WAD cyanides will generally dissociate as heap leach pads and tailings age, and generally become more acidic and release cyanide at a faster rate. Reactions with precipitation may also*	

				release HCN gas.	
3.4 Does the mine closure plan include specifications of and provisions for long term monitoring of cyanide levels?	Closure Plan includes provisions for long term monitoring of cyanide	Closure Plan includes provisions for long term monitoring of cyanide		*Monitoring cyanide at low levels is commonly unreliable, so that care should be taken in designing monitoring systems and setting realistic standards.*	
Part 4: Monitoring and Assessment					
4.1 Is there a cyanide monitoring regime for the work place?	Occupational health and safety plan includes documented monitoring regime for cyanide	Workplace cyanide monitoring regime based on risk assessment and analysis of hazards, eg using HACCP	Worker safety should also be provided through monitoring and sampling for airborne contaminants. Samples should be: • representative of worker exposure • collected by an approved method • secure from tampering	*Continuous sampling of HCN using electronic detection equipment is fast and allows more response time in emergencies. An alternative and slower method is the semi-batch technique which uses air pumps and sampling tubes.*	
4.2 Is there a monitoring regime in place which addresses all of the possible areas and pathways of environmental impact from cyanide and its various forms?	Mine EMP includes a documented monitoring regime for cyanide	Monitoring regime comprehensive and includes all areas where cyanide is contained and used; all pathways for potential release of into the environment with emphasis on surface water drainage and ground water; and direct monitoring of wildlife and livestock		*The Environmental Monitoring &Performance BPEM booklet discusses design of monitoring programs. Monitoring cyanide at low levels is commonly unreliable, so that care should be taken in designing monitoring systems and setting realistic standards. Ponds with WAD cyanide concentrations of less than 50mg/L-1 are generally considered safe for wildlife.*	
4.3 Are worker	The EMP defines standards	Targets meet regulatory	• Cyanide chemistry for the site investigated by a	*Chapter 2 describes*	

health and environmental protection targets set appropriate to the different forms of cyanide?	for cyanide monitoring which are consistent with the description of cyanide chemistry in the mine cyanide strategy and management plan	requirement.	relevant expert (eg chemical engineer) • potential pathways and impacts evaluated by an environmental chemist or toxicologist • adoption of standards recommended draft international in the draft cyanide code	*the types and names of cyanide complexes and key chemical reactions.*	
4.4 Does the monitoring regime specify sampling protocols appropriate to the different forms of cyanide?	Sampling protocols defined in the EMP	Sampling protocols reflect the cyanide process being used, the chemical reactions and pathways available, and the types of cyanide complexes likely to be formed (as determined in the cyanide management plan)		*Protocols for field sample collection to preserve cyanide are summarised in Appendix 3; cyanide sampling and measurement techniques are summarised in Appendix 4.*	
4.5 Does the monitoring regime specify appropriate layout, techniques, frequency, quality and sensitivity of monitoring and sampling?	Sampling locations, frequency, techniques, and quality of cyanide monitoring defined in EMP	EMP should include: • specification of sample sites, sampling technique, sampling frequency, analytical method, parameters to measure, use of certified reference materials, required action on detection of outliers or non-compliance • baseline information, ie existing surface and ground water quality; • monitoring of water levels and quality of surface and ground water, process ponds, drinking eater and tailings dams • dust generation and deposition • fauna		*Further relevant information is contained in the Environmental Monitoring &Performance and Dust Control Sustainable Minerals booklets.*	
4.6 Are data collected in accordance with	Monthly and annual reports of environmental data	Monthly and annual reports of environmental data include a checklist of requirements			

the requirements of the monitoring regime?					
4.7 Are the data analysed and regularly reported to the regulatory authorities?	Refer to regulatory authorities			*The Environmental Monitoring &Performance Sustainable Minerals booklet discusses how environmental performance should be measured against the objectives of the Environmental Management Plan.*	
4.8 Are non-compliance issues or abnormalities in the data routinely investigated?	Register maintained of non-compliance and unplanned events	Register of non-compliance and unplanned events, indicates time of event, time of action, type of action, result, and interaction with authorities	Regulatory authority advised immediately of all non-compliance and significant unplanned events		
4.9 Are emergency procedures in place with specific measures for managing cyanide spills and other incidents involving cyanide in its several forms?	EMS contains emergency procedures for cyanide accidents, releases and spills	Cyanide emergency procedures for environmental protection integrated with occupational health and safety and other mine emergency procedures			
4.10 Is the cyanide management system for the minesite regularly audited?	Evidence of completed audits which include coverage of the cyanide management system	Audits of cyanide management system undertaken at least once every two years		*The Environmental Auditing Sustainable Minerals booklet contains information on different types of environmental audit and how to conduct them.*	
4.11 Are results and recommendations of audits used to	Evidence of periodic reviews of cyanide management system	Mine environmental audits followed within six months by a systems review to action audit findings and recommendations	A repeating cycle of audit and follow-up action is an effective way of applying the principle of continual improvement to your minesite		

regularly review and revise the cyanide management system?					

CHECKLIST FOR DUST CONTROL

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning - refer chapters 1-4 in Dust Control Sustainable Minerals booklet					
1.1 Have you determined the sources of dust in your operation?	Potential sources of dust identified in Environmental Impact Statement (EIS) or other report	Comprehensive list of individual sources, including land clearing, topsoil removal, blasting & drilling, excavation, processing, crushing & screening equipment, materials transfer, haul trucks, stockpile/dump/tailings surfaces, roads.	Sources considered for each stage of the mine, ie exploration, construction, operation, decommissioning, rehabilitation & closure.	*Almost all forms of mining create dust, from the exploration stage, through bulk sampling, mine development, operation, & closure (decommissioning & rehabilitation). Bare surfaces may also be a dust source after mine closure. Visual inspection by an experienced operator is usually all that is needed to readily identify & rank dust sources.*	
1.2 Have you attempted to characterise the types of dust & quantities that will be produced?	• Estimates of dust types & levels likely to be produced • Dust emission inventory & determination of dust emission factors	Estimates based on typical measured levels for mining plant, eg see Table 2 in booklet. Dust inventory derived by analysing the mine plan to establish potential dust sources & estimating the level of dust-producing activity associated with each source. Emission factors derived by assessing the quantifiable activities or aspects which generate dust, such as vehicle size, speed & distance travelled on haul roads.	Estimates, inventory & emission factors made for all potential sources for each stage of the mine, ie exploration, construction, operation, decommissioning, rehabilitation & closure. An example of the calculation of an emission factor is given in section 2.3 of the booklet. Case Study 10 describes the application of emission factors in modelling of dust emissions for mine planning.	*The information gathering stage is a major component of EIA, which is described in the Environmental Impact Assessment Sustainable Minerals booklet.Information needed to produce a dust inventory includes:* • *length of haul routes, vehicle-km travelled & vehicle types* • *quantities of material to be*	

				mined • *size & number of blasts, no of blast holes drilled* • *area of exposed surfaces (pre-stripping, waste dumps, stockpiles etc)* • *physical properties of materials handled & of bare surfaces, including moisture, silt content, & particle size distribution* • *truck capacities, bucket sizes, drop distances* • *wind speed, no of rain days.*	
1.3 Does your characterisation of the types & quantities of dust include diffuse dust sources?	All types & locations of dust emissions can be ranked & controls planned in a systematic manner.	Quantitative estimates of dust emission rates from different classes of mining activity & land surface types, eg blasting, haul road traffic & waste dump surfaces - ie including point & diffuse sources.	Use of models to produce estimates of dust types & levels across a wide range of operating & climatic conditions	*Models that predict ambient dust concentrations or deposition rates are commonly used in mine planning. The models use source dust emission rates in conjunction with meteorological data to produce contour maps of dust concentrations.*	

1.4 Have you undertaken an impact assessment to identify possible impacts arising?	• Identification of sensitive receptors • assessment of maximum levels to avoid impacts, significant concerns or discomfort	Assessment identifies dust levels likely to be experienced by workers, & at key locations, ie closest residences, paddocks with domestic stock, & assesses possible impacts.	The potential health risk from dust is related to the size of dust particles. Mine dust lies in the range 1-100 microns; <10µ is inhalable (ie PM10); <2.5µ is respirable, ie can lodge in the lung (PM2.5).		
1.5 Based upon the impact assessment, have you developed a draft management strategy?	A draft management strategy which incorporates input from the community & regulatory authorities & addresses the full suite of environmental & social issues likely to arise from dust at the proposed project.	Initial planning should include development of a draft management strategy which: • identifies all of the potential sources & risks • sets out objectives for environmental protection & risk minimisation • provides a framework for evaluating different options & choosing a design which reflects site conditions & environmental sensitivities	Consultation with key stakeholders during preparation of the draft management strategy		
1.6 Have you devised approaches to mitigate impacts to acceptable levels?	Strategy incorporates "built in" design features to minimise generation of dust at source	Strategy includes section addressing mitigation of dust.	The EIS & mine plan for the project set out a framework based on: • mine design to avoid generation of dust • systems design & management to minimise generation of dust during operations • treatment of dust problems through active monitoring & response, & redesign of strategies if required.		
1.7 Have you considered the probable regulatory requirements?	Level to which targets in the strategy conform to standards & regulations, taking into account estimates of inputs from all probable sources of dust.	Dust strategy describes relevant standards & regulations.		*Examples of guidelines used by regulatory bodies are given in Table 3 in the booklet. Dust exposure to workers is covered in Occupational Health & Safety legislation. It normally applies a "duty of care" on the*	

				industry to reduce risk to workers. Standards & codes of practice from relevant State authorities provide information on acceptable levels for respirable dust for dangerous materials	
1.8 Are the target levels developed in consultation with the community?	Documented agreement on maximum permissible levels between company & key community group/s	Maximum dust levels explained to & agreed with community	Establish formal & frequent consultation with the local community early in the planning process	*Meaningful consultation with the local community will commonly smooth the assessment & approvals process for a new development - refer to the Community Consultation & Involvement Sustainable Minerals booklet. Community concerns extend beyond health impacts to amenity & aesthetics, such as dust clouds & deposition rates. Refer to Chapter 3 in the booklet.*	
1.9 Do the provisions of the operational dust management plan also apply to the mine decommissioning, rehabilitation & closure stages?	Smooth transition from operational to decommissioning stages, with low risk of exceedance of dust control targets	Decommissioning, rehabilitation & closure plans all include provisions for control of dust	Plans incorporate provisions which reflect the specific activities involved at the end of mining	*Higher dust levels may be permissible following consultation with regulators & the community for high intensity, short-term activity such as relocation of overburden stockpiles & landforming.*	

Part 2: Management and Operation - chapter 5 in Dust Control Sustainable Minerals booklet					
2.1 Have you prepared an operational dust management plan?	Dust management plan	• Management Plan sets out targets & management strategies for all issues identified in impact assessment & in community consultations • Management Plan integrated with other operational plans into an overall EMS for the project	The Environmental Management Systems Sustainable Minerals booklet describes the components of a fully integrated EMS for all environmental aspects of a minesite. Many companies seek certification to international standards such as ISO 14001 to help demonstrate their environmental commitment to regulators & other stakeholders.	*Operators can use & seek certification to published EMS standards such as ISO 14000. Software obtainable from this site includes complete prewritten procedures, record forms, & an Environment Manual which can be customised. An implementation guide is also included.*	
2.2 Is the Management Plan known & understood by all staff, including plant operators?	Staff aware of the Management Plan & its contents	Relevant documentation readily available to staff, regulators & auditors	Management Plan available to staff; staff instructions on control of dust; regular checks on effectiveness of operational systems; dust included in environmental awareness training sessions	*The Workforce Environmental Awareness Sustainable Minerals booklet describes general approaches to raising awareness & commitment amongst the workforce, including contractors.*	
2.3 Have you selected appropriate options to minimise the generation of dust?	Few significant issues related to dust at the site	• Evidence of good design to reduce dust generation through mine design, choice of equipment, & work practices • Consistent application of good design across all types of dust sources, including road transport outside the mine.	Use computer modelling to investigate the control measures needed to achieve targets	*Primary measures to effectively minimise dust impacts include:* • *plan operations (construction, topsoil stripping, blasting, rehabilitation) to integrate dust control* • *plan work practices to integrate remedial*	• *establish waste dump final surfaces early* • *progressive revegetation*

				measures (eg chemical additives in dust suppression, dust collection)	
2.4 Have you incorporated design features to mitigate the potential impacts from the dust generated at your site?	Few significant issues related to dust at the site	• Evidence of installation of engineering works, equipment modification etc to minimise dust • Any significant dust sources identified via monitoring have been objectively evaluated & remedial action taken	All reasonable measures taken to reduce dust from all fixed & mobile noisy equipment	*Examples of original & retrofit installations include negative pressure dust hoods at transfer point, moisture adjustment of materials, automatic sprinklers, & sealing or application of suppressants to haulage roads & other dusty bare surfaces.*	
2.5 Do you have operational systems to control dust in all areas with dust potential?	Procedures described in the mine plan & EIS implemented correctly, & dust control targets achieved	EMS & related manuals set out procedures for dust management in all relevant areas of the site	Documented procedures to cover: • land clearing & topsoil removal • blasting & drilling • transportation/haulage • processing, crushing & screening • materials handling & stockpiles • dust collection • waste rock dump management • tailings dam management • residues • decommissioning • rehabilitation.	*Useful pointers are given in Case Studies:* *> case studies 1 & 6* *> case study 8* *> case study 7* *> case study 3, & Tables 4, 5, & on page 16* *> case studies 2, 4 & 7* *> case study 6*	
2.6 Is there documentation to demonstrate that the Dust Management Plan is carried out properly?	Assurance to managers that the dust control targets for the operation are being met	Regular reports (monthly) of dust management activities & assessment against control targets & requirements of the management plan	Standard operating procedures for staff working in dusty areas, operating dusty equipment, & involved in drilling & blasting activity, setting out responsibilities, & methods for limiting & reporting dust levels & incidents.		

2.7 Do you have a system in place to incorporate improvement?	Continual improvement, & reduced probability of recurrence of undesirable dust events	Evidence of review & update of systems & equipment where unsatisfactory dust levels have been recorded	Assessment of the adequacy of dust control should be incorporated in annual environmental audits of the project.		
Part 3: Monitoring and Assessment - chapter 6 in Dust Control Sustainable Minerals booklet					
3.1 Is there a monitoring regime in place which addresses all of the possible areas for environmental & social impact from dust identified at the planning stage?	The level of performance of dust control & potential impacts on workers, the public & environment is well known to managers	Comprehensive monitoring regime which includes measurement of levels in worker areas & areas of community sensitivity. Monitoring regime sets out: • parameters to be monitored • monitoring locations • monitoring interval • data & data analysis requirements for monitoring reports • reporting interval	Reporting & record keeping includes: • recording intervals • location of attended & unattended monitoring instruments • comparison of monitoring results with those from modelling	*The Environmental Monitoring & Performance Sustainable Minerals booklet discusses design of monitoring programs.*	
3.2 Are environmental & community protection targets set, & are the layout, techniques, frequency, quality & sensitivity of monitoring & sampling appropriate to these targets?	Low probability of community concern provided dust is controlled to within levels agreed by community	Control targets agreed with the community are set out in the management plan & monitoring regime & are used as key benchmarks to evaluate adequacy of performance in regular monitoring reports	Tools for effective dust monitoring include: • baseline sampling - to allow comparison with the pre-mine environment • control site sampling - to allow comparison with areas unaffected by the mine during operations • dust deposition gauges - provides basic, long term data • high volume samplers - provide quantitative data over 24 hr periods but do not identify the actual dust source • continuous particle monitors - provide continuous data relevant to short term events; can operate on-line • size-selective samplers - sample dust in size fractions of particular interest • personal exposure samplers - worn by workers, especially those at particular risk from dusty operations	*The Environmental Monitoring & Performance Sustainable Minerals booklet discusses how environmental performance should be measured against the objectives of the Environmental Management Plan.*	*The monitoring data can be fed into site dust models to predict dust levels & determines appropriate strategies to avoid significant dust events - refer Case Study 8.*

3.3 Is monitoring undertaken in accordance with appropriate standards?	High level of assurance of reliability of dust monitoring results	Evidence that monitoring techniques accord with appropriate national standards	Standards Australia has developed several standards for dust monitoring: • AS 2724.3 - Determination of Total Suspended Particulates (TSP) • AS 2922 - Ambient Air - Guide for the Siting of Sampling Units • AS 2985 - Workplace Atmospheres - Methods of Sampling Respirable Dust • AS 3542 - Use of Standard Ringelmann & A5 Miniature Smoke Charts • AS 3580.9.6 - PM10 High Volume Sampler with Size Selective Inlet - Gravimetric Method • AS 3580.10.1 - Deposited Matter - Gravimetric Method • AS 3640 - Workplace Atmospheres- Methods of Sampling Inspirable Dust.	*Examples of the application of several dust monitoring techniques are given in Case Studies 3 & 9.*	
3.4 Does monitoring include meteorological data?	Proactive management of site activities can be undertaken to avoid significant dust events in periods of bad weather, eg avoiding topsoil clearing in hot, dry & high wind conditions.	Routine collection of data on predicted rainfall, temperature & wind velocity		*Case Studies 5, 6 & 8 describe how weather forecasts are used to modify activities & avoid major dust production.*	
3.5 Are data collected in accordance with the requirements of the monitoring regime?	Low risk of regulatory non-compliance or of community concerns re dust	Monthly & annual reports of dust data, which cross-refer to monitoring regime requirements.			
3.6 Are the data analysed & regularly reported to the regulatory authorities?	Assurance that all regulatory requirements for dust are being met continuously	Regular reports (eg monthly) provided to regulating authority/ies.	In addition to reporting to regulatory authorities, dust control performance is reported against the community-agreed targets in public reports, including annual environmental report.		
3.7 Are non-compliance issues	• Management aware of any areas of poor	Register of non-compliance & unplanned events, indicates time	Regulatory authority advised immediately of all non-compliance & significant unplanned events.		

or abnormalities in the data routinely recorded?	performance • Management provides an ongoing measure of effectiveness of the current system & past improvements	of event, time of action, type of action, result, & interaction with authorities.			
3.8 Is there a system in place for significant dust events or issues to be addressed to reduce prospects of recurrence?	Reduced risk of recurrence of significant dust events	Evidence that entries in the register of non-compliance & unplanned events are investigated properly & appropriate remedial action is identified & implemented promptly	Standard deadline set for completion of actions to remedy dust events. Number of entries in the register, & speed of actioning improvements, can be used as reporting criteria to staff, management, regulators & community.		
3.9 Is liaison with the community maintained in relation to dust issues?	Good community relationships maintained	Documentation of regular community liaison meetings which address dust	Community meetings held regularly with dust a standing agenda item; special meetings held immediately after a significant event raising community concern.	*The Community Consultation & Involvement Sustainable Minerals booklet gives more information on community consultation issues & techniques.*	
3.10 Is a complaints register maintained & are complaints investigated?	• Areas of poor dust control are addressed quickly so that risk of recurrence is minimised • good community relationships maintained.	Documented complaints register which records details of complaints & any follow-up action	• Register records date, time, & type of event which is the subject of the complaint; follow-up action, risk of recurrence • reporting back to complainant.		

CHECKLIST FOR ENERGY EFFICIENCY

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Planning and Management - refer to Chapter 2 in the Sustainable Minerals booklet					
1.1 Do you have structured management systems which apply to energy & greenhouse management?	Business management system	Energy & Greenhouse management addressed in a specific, documented, business system, or clearly addressed in existing business processes such as environmental, capital planning or quality plans & procedures		*Energy management should apply to all aspects of the operation & be strategic in nature to ensure that new initiatives, one-off activities & activities out of the mainstream are captured & risk of negative outcomes minimised.*	
1.2 Is the corporate vision clearly documented?	Corporate vision statement of energy management	Vision statement documented & incorporated in key management & planning documents			
1.3 Is the corporate vision effectively transferred into operational activities?	Operational policy on energy management	Operational policy accurately reflects corporate vision statement		*The operational policy should address:* • *the level of energy reduction sought in both the short & long term* • *the factors limiting improvements in energy efficiency* • *the human & financial resources to be committed* • *the value placed on greenhouse emissions when selecting energy sources, processes or operational methods* • *public access to relevant information* • *commitment to voluntary industry programs*	
1.4 Are staff aware of the corporate commitment & sufficiently knowledgeable?	Motivated & aware staff share the corporate commitment	• Posters & staff notices describing energy efficiency policy & objectives. • Energy efficiency policy & operational issues covered by meetings (check agenda & minutes) & training materials (check training documentation). • Arrangements for training of all	Description of energy efficiency included in induction materials for new staff. Annual refresher courses	*Staff should be aware:* • *what is the company doing about energy & greenhouse? (company policy)* • *what can you do to contribute to our energy & greenhouse objectives?* • *how will the company support you*	

		staff, including contractors & newly appointed staff in energy efficiency		*in these activities?*	
1.5 Do you have a comprehensive understanding of the use of energy & the opportunities for reduction in consumption?	Report on energy consumption, cost & related issues	Report describes and benchmarks: • how much energy is used • where & when it is used • the cost of the energy • greenhouse emissions associated with energy use & other site emissions			
1.6 Have you thoroughly investigated the information needed to make sound business decisions?	Energy audit report	Energy audit: • breaks down of energy use by fuel, energy users, activity & cost centre • profiles energy load across specific plant items • benchmarks (internally & externally) & develops performance indices • consolidates & analyses current or previous initiatives in energy & greenhouse management • describes management, operational & maintenance procedures covering energy use • presents an inventory of greenhouse gas emissions	An external specialist is normally needed to undertake the energy audit	*Information to be provided to the auditor should include:* • *a compilation of historical billing data* • a *compilation of sub-metering data* • *identification of major energy-using equipment, energy ratings, running time & energy consumption patterns.*	
1.7 Have you established overall performance targets?	Overall energy efficiency performance targets	Targets are consistent with policy objectives & refined through reference to energy reviews or audit studies	• Ensure that the desired achievements are matched to available resources. • match each target with a specific action plan	*Example targets may be:* • *overall site target - 10% energy reduction in energy use over 2 years* • *cost centre target - 15% reduction in energy use per tonne crushed* • *operator target - reduce vehicle idling time by 10%.* *The Greenhouse Challenge Program provides formal planning & reporting mechanisms which can be used by*	

				companies as the basis for their energy & greenhouse management plan.	
1.8 Have you developed a specific plan to match each target?	A set of action plans	Each target has an associated planning document, containing: • a description of each project proposed • the project objectives • the specific series of activities to complete the project • responsibilities • completion milestones			
1.9 Are appropriate responsibilities & accountabilities defined & allocated?	Defined responsibilities & accountabilities	• Individuals nominated with specific responsibilities & accountabilities. • All project team members aware of their individual responsibilities, accountabilities & reporting requirements			
1.10 Is adequate & formal provision made for funding an energy efficiency improvement project?	Costs of energy improvement activity evident in financial accounting.	Evidence of funding allocation for: • projects specifically designed to improve energy & greenhouse performance • other operational improvement projects or plant expansion • new or replacement equipment	To capture the full value of proceeding down a path of energy efficiency & greenhouse mitigation, business cases for capital allocation should include life cycle costing & risk assessment	*Common accounting practices can be applied when evaluating direct energy savings. For greenhouse, the allocation of a cost to emissions (eg $10/tonne of* CO_2*) can make the assessment more objective.* *Clear guidance & procedures for capital allocation will prevent energy inefficient equipment & processes being introduced to the site.*	

1.11 Are optimal conditions established for the supply of energy?	Robust mechanisms for: • selection of energy type • selection of suppliers • negotiation of contract conditions	Robust mechanisms for selection of energy type, selection of suppliers, & negotiation of contract conditions		*Energy costs can be minimised by:* • *a purchasing process that captures the advantages of the deregulated energy market while being cognisant of "green power" options* • *selection of the most appropriate energy source for a particular operation* • *selection of the most appropriate energy source for a particular operation* • *control of demand charges & flexibility to take advantage of curtailment opportunities* • *accurate billing data at the appropriate tariff or rate structure* • *contractual agreements to continuously improve quality & reliability of supply.*	
1.12 Are all facilities or activities relevant to energy consumption subject to operational control?	Documented operational procedures & work instructions	Documented operational procedures & work instructions for all facilities & activities relevant to energy consumption	The rigour of operational control for individual facilities or activities can be determined through estimates of risks & consequences for each	*5-10% savings in energy are commonly possible through basic maintenance & properly commissioned control systems.A comprehensive equipment database can be developed to document all energy-consuming facilities to highlight energy use & allow energy efficiency to be calculated.*	
1.13 Is a system in place to monitor & report on the use of energy, identify variances from target levels & provide feed-back to improve reporting?	Monitoring & Reporting system	Copies available of regular monitoring reports. Evidence that report feed-back is used to periodically amend energy & greenhouse management programs	Annual or more frequent summary reports made available to regulators & key stakeholder groups	*Examples of levels of reporting are:* • *senior management - monthly reports on overall energy, greenhouse emission & costs against targets, plus exception reports (used to develop corporate reports & track against policy objectives)* • *operations management - weekly cost centre/division performance & exception reports (used to develop reports for senior management & to benchmark and drive improvement of operational teams)* • *operators - equipment & process performance reported daily or by shift (consolidated for operations managers).*	
1.14 Do you keep up with	Knowledge of best	Evidence or regular & formalised	Where significant	*In addition to major industry components, the*	

improvements in energy efficiency equipment & techniques?	technologies & techniques applicable to your operation	arrangements for reviewing information in trade journals, at conferences, via subscriptions, technical publications, industry & government publications, & the internet	investment is proposed & expert knowledge is not available internally, a design review by external experts is recommended	*efficiency of all parts of you operation must be considered, eg to include upgrades to lighting, heating & office equipment efficiencies in the administrative buildings.*	
1.15 Do you undertake regular management reviews of energy efficiency programs & reporting systems?	Management review reports on energy efficiency	Management review reports which cover the full range of business activity		*Management review reports address:* • *strategic issues & energy policy amendments* • *new business methods, activities, technologies, economic circumstances that may impact on energy & greenhouse* • *assessment of initiatives completed in the review period* • *evaluation of key performance indicators & refinement of targets* • *approval of projects & initiatives for the next review period.*	

Part 2: Energy Efficiency - refer Chapter 3 in the Sustainable Minerals booklet				
2.1 Have you prioritised areas for efficiency gains based on the proportions of total energy consumed at your site?	Inventory of energy usage for all equipment & processes	Inventory lists of all operational components & processes, in order of the proportion of total energy consumed		*Energy savings of substantial scale are more likely to be achieved in a cost-effective manner & provide much better payback on the systems which use the most energy. It is prudent for pursuit of savings in less energy-intensive systems to be a lower priority.*
2.2 Do you consider the total life-cycle costs when decisions are made about capital expenditure?	Set of standard selection criteria used when making decisions on capital expenditure	Standard selection criteria formalised & accessible to all staff responsible for selecting new equipment & systems for purchase. Criteria include estimation of like-cycle costs.		*Higher initial capital cost is justified if the item provides greater efficiencies in energy consumption & greenhouse performance over its operating life.*
2.3 Have you considered opportunities for energy savings & reductions in greenhouse emissions in the **exploration & drilling stage**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies during the exploration & drilling stage		*Areas to consider include:* • *less greenhouse-intensive vehicle fuels such as LPG, CNG or LNG instead of diesel* • *efficient organisation of equipment & supplies* • *efficient fuel & energy use in camp operations, cooking & storage.*
2.4 Have you considered opportunities for energy savings & reductions in greenhouse emissions in **ore extraction operations for open cut mining**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in open cut mining operations		*Areas to consider include:* • *conveyor vs electric or diesel truck haulage (electrical systems can be more efficient over longer distances)* • *in-pit crushing (increases haulage efficiency by allowing more mass per load)* • *modifying blasting regimes to produce smaller ore lumps & reduce crushing energy requirements (note trade-off between crusher energy savings & increased greenhouse emissions from explosives & blast hole drilling requirements should be accounted)* • *minimising energy use by vehicles (fuel efficiency, CO_2 emissions from different fuels, GPS & other vehicle movement control systems to reduce movements & idling times* • *vehicle maintenance & fuel efficiencies* • *fast-fill methods for refuelling & filling water carts* • *regenerative braking on electric vehicles (ie energy back into grid).*
2.5 Have you considered	Mine management &	Mine management & operational plans		*Areas to consider include:*

opportunities for energy savings & reductions in greenhouse emissions in **ore extraction operations for underground mining**?	operational plans contain requirements for energy & greenhouse efficiencies	contain requirements for energy & greenhouse efficiencies in underground mining operations		• *relative efficiencies & trade-offs between electricity, diesel or compressed air for drilling, bogging & transport, including conversion inefficiencies & distribution losses* • *mine layout, to reduce transport costs & distribution losses* • *increased ventilation costs from diesel-powered equipment* • *blasting & caving techniques to reduce ore block size, transport & bogging costs* • *tailings backfill, avoiding or reducing costs of tailings dam construction, pumping & management costs* • *shaft winder vs decline & truck haul energy costs (beyond around 600m winders are usually more efficient).*

2.6 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **ventilation & dust extraction**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in ventilation & dust extraction operations	Case Study 4 gives an example of improved efficiencies related to mine ventilation.	*Fan loads can account for <40% of energy used in underground mines.* *Areas to consider include:* • *review system to match fan capacity & size to demand* • *monitor performance & use results to optimise system & reduce costs; link to centralised control system to avoid wasteful use* • *maximising colder air to reduce downward pumping energy draw (air can be cooled in warmer months to reduce fan loads)* • *choose efficient fan designs & accessories to reduce inlet/outlet losses* • *review diameter of ventilation drives or raise-bores to reduce pressure drop losses* • *re-rate fans if mining activity levels change significantly.*	
2.7 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **water management**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in water management operations	Case Study 2 provides an example of how reductions in water demand lead to savings in pumping costs, & recycling of process water reduces the quantities of chemicals required & reduces greenhouse impact because of lesser chemical reactions. Case Study 4 includes a description of improved efficiencies in water pumping.	*Fan loads can account for <40% of energy used in underground mines.* *Areas to consider include:* • *review system to match fan capacity & size to demand* • *monitor performance & use results to optimise*	

				system & reduce costs; link to centralised control system to avoid wasteful use • *maximising colder air to reduce downward pumping energy draw (air can be cooled in warmer months to reduce fan loads)* • *choose efficient fan designs & accessories to reduce inlet/outlet losses* • *review diameter of ventilation drives or raise-bores to reduce pressure drop losses* • *re-rate fans if mining activity levels change significantly.*	
2.8 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **tailings management**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in tailings management operations		*Areas to consider include:* • *locate tailings dam as close as possible to facility* • *investigate gravity flow to reduce pumping requirements* • *where there is surplus water, investigate evaporative or other water loss options to reduce pump-back* • *tailings thickeners to increase tailings density & reduce pumping volumes*	

2.9 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **transport**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in transport operations	Case Study 4 gives an example of improved efficiencies from reduced idling time by vehicles.	*Areas to consider include:* • *future probable fuel costs & relativities* • *review fuel efficiency of mobile plant* • *engine management & idle time (reduced idling time during meal breaks & shift changes can save <5% of total diesel consumption)* • *alternative fuels including electric power & biodiesel* • *reduce double-handling* • *fuel additives/conditioners* • *fast-fill systems for refuelling, & optimal location of filling station* • *vehicle movement monitoring, management & control system* • *design gradients of haul roads to maximise fuel economy* • *maintain optimum tyre pressures.*

2.10 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **crushing & milling**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in crushing & milling operations	Case Study 4 gives an example of improved efficiencies related to ore crushing.	*Crushing & milling commonly accounts for 50-80% of total energy use at a mine.Areas to consider include:* • *correct primary crusher type (jaw crusher <500 tonnes per hour(tph); gyrator for throughputs >750 tph)* • *optimal crusher size settings & screen cloth optimisation* • *reduction of circulating loads* • *early rejection & crushing of scats* • *new technology in rubber-lined mills* • *optimal ball size or feed size (eg blending)* • *load cell monitoring to ensure correct charge loads* • *divert excess capacity to other mills* • *high awareness of new technical developments in these areas.*	
2.11 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **separation processes**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in separation processes	Case Study 3 shows how effective waste heat recovery can be used to reduce energy demand.	*New blade & tank designs can produce <50% energy savings. Areas to consider include:* • *review of cell efficiencies to identify potential anergy savings in cell agitation, flotation, impeller & drive technology* • *replace wedge belt drives with tooth belts* • *heat recovery to aid drainage, separation, & control viscosity* • *optimise chemical regimes* • *oxygen enrichment to reduce air pumping* • *use waste heat to dry concentrates, or use solar drying.*	

2.12 Have you considered opportunities for energy savings & reductions in greenhouse emissions relating to **site services**?	Mine management & operational plans contain requirements for energy & greenhouse efficiencies	Mine management & operational plans contain requirements for energy & greenhouse efficiencies in site services	Case Study 4 gives an example of improved efficiencies related to air compressor use.	*Services can account for 20-30% of total energy consumption. Areas to consider include:* • *check for air leaks in compressors & review opportunities for usage of waste compressor heat* • *develop performance standards for compressors & monitor performance regularly* • *install "ring main configuration" for compressed air* • *standardise lighting, reduce lighting loads, & install timers, light sensors or Building Management System automatic control.* • *power station issues include choice of fuel, maintenance, & optimal size & efficiency choices for equipment* • *renewable power can be an option in remote site installations such as lights, smaller pumps* • *higher efficiency electric motors* • *avoid motor rewinding (efficiency declines)* • *choose equipment on star rating for energy efficiency where available* • *solar hot water systems* • *high performance lubricants to reduce friction.*

Part 3: Greenhouse Gas Reduction - refer Chapter 4 in the Sustainable Minerals booklet				
3.1 Do you have an inventory of all greenhouse gas emissions for your site?	Inventory of greenhouse gas emissions	Inventory covers all aspects of operations & all equipment, including both energy & non-energy related emissions: • direct emissions of CO_2, CH_4, & N_2O from the combustion of fuels on site • direct emissions of CO_2 & other greenhouse gases from various process sources • direct emissions of CO_2 & CH_4 from fugitive sources eg coal seams • indirect emissions from the generation & supply of purchased electricity used on site • indirect emissions from the production & supply of other fuels used on site	Reporting of both full fuel cycle & point source emissions as encouraged by the Greenhouse Challenge Program will provide a much clearer picture of the direct & indirect emissions profile & ensure that all emissions are accounted for. This will facilitate determining the exact magnitude on any potential carbon liability should policies, such as emissions trading, be introduced in the future to constrain emissions.	*Many consumables have a high greenhouse gas intensity (ie ratio of emissions per unit (or cost) of a product, including cement, lime, gases (O_2, N_2, NH_4).* *The following products & processes emit greenhouse gases:* • *limestone, soda ash & dolomite used in neutralisation* • *blasting explosives* • *HFCs from some airconditioners & refrigeration systems* • *SF6 from electrical transformers & switchgear* • *land disturbance, ie soil disturbance & vegetation loss* • *agricultural activities, eg irrigation, fertilizer application, animal husbandry* • *waste treatment & disposal.* *An inventory including all sources of greenhouse gas will help identify possible additional costs if a carbon levy is introduced.*
3.2 Have you evaluated the emissions identified in the inventory?	Evaluation data	Evaluation data - normally based on the consumption of the energy source multiplied by the emission factor.For sources such as coal seam emissions & spontaneous coal combustion emissions will need to be determined from site measurements, as site variations make a standard emission factor impractical		*Most direct emissions can be evaluated from the chemical properties of the material, or published methodologies: National Greenhouse Gas Inventory Workbooks;* *CSIRO;* *ACIRL*
3.3 Have you identified priorities for reducing greenhouse gas emissions?	Priorities based on the results of the evaluation exercise of the emissions inventory	Priorities are based on the quantities of emissions from each process, activity or piece of equipment, & an assessment of the practicality, cost & time to achieve meaningful reductions.	Priorities can also be set to focus on areas of improvement described in corporate policy or suited to most effectively achieving improvement targets - refer Questions 1.7 & 1.8	

3.4 Have you considered alternative processes & products with lower greenhouse gas intensities?	Evaluation reports of alternative technologies	• Evaluation reports for each component identified for action in the current improvement plan • Reports include comparative greenhouse performance, assessment of suitability for your site, & consideration of new & emerging technologies	Options for improvement include: • lower greenhouse-intensive fuel sources • lower greenhouse-intensive reagents (eg caustic soda instead of soda ash) • improving on-site efficiency in electricity generation • considering renewable electricity generation technologies • emissions capture & abatement Case Study 3 gives an example of how CO2 emissions were reduced by converting from diesel fuel to gas for concentrate drying.	*Natural gas produces 64kg CO2e/GJ HHV) relative to of diesel (78kg) or coal (96kg).* *Renewable electricity generation may be more readily installed at remote sites eg pumping stations, lighting, loading, using solar, wind, wave, or biomass.* *Methane can be capture from coal seams & used to generate power - refer to Case Study 5 (note methane is 21 times more potent than CO_2 as a greenhouse gas).* *In areas with >400mm annual rainfall, carbon sinks can be created by planting trees - refer to Case Study 6*
3.5 Have you established greenhouse abatement projects?	Progress towards greenhouse gas abatement through targeted projects	Documented greenhouse gas abatement projects which: • are co-ordinated with energy efficiency action plans • have objectives that are consistent with corporate policy & abatement targets • have specified timelines • incorporate alternative & new technologies identified in the evaluation reports (Question 3.4)	Project descriptions include objectives based on industry benchmarking, & industry & government guidelines for best practice technologies. Projects designed to implement approaches & standards in national & international voluntary codes.	

Checklist for Environmental Impact Assessment

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
Questions 1.1 to 1.14 will help determine whether an environmental audit should be conducted.					
1.1 Do you understand the different options for environmental impact assessment (EIA)?	Information gathered on the different options	Information sourced from the three tiers of government on EIA requirements & options			
1.2 Do you understand the basic features required by EIA processes?	Understanding of general requirements of the different EIA options	Understanding of the probable time & resource requirements to undertake an EIA for the proposed project		*EIA processes at most levels require:* • *an outline of objectives & project description* • *analysis of the need for the project* • *indication of consequences of not proceeding* • *enough information & technical data for assessment of impact on the environment* • *examination of alternatives to the proposal or aspects of it*	

				• *description of the environment likely to be affected by the proposal & alternatives* • *evaluation & assessment of potential impacts of the proposal & alternatives* • *outline of reasons for preferred option* • *description of proposed environmental standards* • *evaluation of proposed environmental standards* • *description of how the proposed environmental standards will be implemented & monitored* • *list of information sources & consultations used during preparation of the environmental documentation*	
1.3 Have you collected relevant	Baseline information	Baseline data collection commenced before a	• Variable parameters such as rainfall,	*Understanding of the characteristics of the site is*	

information from early on?	collection commences as early as practicable	formal decision is made to proceed with project evaluation & EIA	stream-flow, groundwater levels & temperature ranges, should be collected over at least 3 years where no local historic data are available. • Fauna & flora surveys need to be done at several different times of the year to adequately record seasonal, migratory & ephemeral species.	*essential to developing effective management strategies.* *Baseline data collection should begin in the exploration stage & continue for as long as an EIA application is likely to eventuate.*	
1.4 Have you designed the scope for you EIA appropriate to the project under consideration?	Documented scope listing all of the issues to be considered by government in relation to the project proposal	Issues to include all environmental & social issues likely to be of concern to government, stakeholders & the community	Broad consultation to develop the scope of the EIA, including informal discussions with: • community groups • government agencies responsible for EIA & project approval (usually EPAs) • government mines or resources departments which approve, oversee or grant tenements • departments	*Early community involvement makes the EIA process more transparent & enables alternatives to be considered before committing substantial time & money to a particular location or type of proposal.*	*Early informal discussion with government agencies will give them an early overview of the proposal, elicit advice on appropriate assessment processes & requirements, & raise early warning signals of possible problems.*

			responsible for infrastructure & utilities • local government which gives local planning approvals & provides services • planning departments • decision-makers such as ministers for mines, environment and planning		
1.5 Do you fully understand your responsibilities in the EIA process & the scale of resource & information requirements for your company?	The company should clearly understand: • approval processes • the nature of the proposal • the developer's constraints in financing, timing & marketing • the likelihood of presently	Evidence of forward planning & allocation of appropriate time & resources to undertake the EIA. Resources to include adequate staff & budget resources; evidence of understanding of probable timeframes through to decision on project approval.		*In many cases, government officers can apply their knowledge & experience to advise on environmental sensitivities & community concerns which the proposed project might face.*	

	unknown environmental impacts occurring at some time in the future • the environmental risk assessment options				
1.6 Have you consulted with the community?	Community groups should clearly understand: • approval processes • the nature of the proposal • the developer's constraints in financing, timing & marketing • the likelihood of presently unknown	Meetings with local community organisations & NGOs & general public meetings	Community consultation should start as early as possible in the planning & preparation stage for EIA. Your representative/s should be at a senior level & able to directly respond to questions & concerns. Concerns & ideas put forward at these meetings should be seriously considered for adoption in the project proposal plan.	*Early, open, committed & responsive consultation with the community will greatly assist in building credibility & confidence in you & your proposal.* *The Community Consultation Sustainable Minerals booklet describes the value of early & ongoing consultation with the community potentially affected by your operation.* *The Beenup Heavy Minerals Mine case study of the Environmental Impact Assessment Sustainable Minerals booklet gives an example of community*	

	- environmental impacts occurring at some time in the future (environmental risk assessment) - the environmental risk assessment options.			*consultation relating to transport & rehabilitation issues associated with a heavy mineral sands mining proposal.*	
1.7 Have you determined the appropriate level of assessment for your project?	Appropriate government authorities should clearly understand: - the nature of the proposal - the developer's constraints in financing, timing & marketing - the likelihood of	Level of assessment matches the scale & probable impacts of the proposal	Early, comprehensive & frank consultations with government will ensure the correct level of assessment is determined. The EIA process is sufficiently incisive to identify the actual level of probable impact, so there is no advantage in trying to nominate a lower level of assessment.	*The Commonwealth & state governments generally offer 4 levels of EIA:* *Notice of Intent or Initial Advice Statement (where the company has adequately addressed environmental concerns & will be using sound management practices; the department with overall regulatory responsibility, advised by the EPA,*	

	presently unknown environmental impacts occurring at some time in the future (environmental risk assessment)			*will make the decision)* • *Public Environmental Review (proposals of only local or regional interest & low probability of environmental impact; public comment period generally 4-6 weeks)* • *EIS (comprehensive review of major projects of wide public interest & dealing with complex, significant environmental issues. Federal government demands EIS where in its opinion "Matters of Environmental Significance" are triggered. Public review period 8-12 weeks.* • *Public Inquiry (high level & exhaustive assessment involving official hearings & allowing submissions from supporters & opponents. Public*	

				Inquiries may take several years). *The Poseidon Bow River Diamond Mines case study in the Environmental Impact Assessment Sustainable Minerals booklet describes a low-level assessment for extension of an alluvial diamond mine; the Ranger Uranium Mine case study describes a comprehensive public inquiry for a uranium mine surrounded by national park.*	
1.8 Are you aware of the appropriate steps required to meet the legislative requirements concerning the EIA process?	Actions for environmental impact assessment by the proponent will conform with legislative requirements & expectations of key government departments	• Company aware of requirements • documentation of actions to be undertaken • progress accords with legislative/regulatory timeframes.	The main steps in the EIA process are: • referral of the project to the government authority • government authority decision on whether assessment is necessary, & the level of assessment • scoping of the issues & community reaction • issue of the EIA guidelines by the assessing authority	*The company itself, another government agency or minister, or any person can refer the project for consideration for environmental assessment.*	

			• preparation by the proponent of the environmental document - the EIS or PER • public review of the environmental document • proponent response to issues identified in the public review • report & recommendations by the assessing authority • consideration of the recommendations by the minister or deciding authority • environmental approval & setting of conditions • monitoring & reporting • continuing liaison with community & government agencies		
1.9 Have you provided information to the assessing authority to allow it to determine whether	Less likelihood of delays or inappropriate decisions	Company should provide basic details including: • location • brief description of the project	The information is presented in a document commonly termed a Notice of Intention (NOI). Many companies use it both to trigger the approvals		

an assessment is necessary, & at what level?		• its duration • the infrastructure needed • perceived environmental issues & their significance • the proposed community consultation program	process & to inform the community.		
1.10 Have you received a copy of the guidelines for the assessment of your project?	EIA planning & execution will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	Company possesses a copy of the EIA guidelines provided by the relevant government authority.	Close liaison with the relevant authorities will produce guidelines which adequately embrace any special features of the project proposal, environmental sensitivities, & community concerns, thus reducing risk of denial of approval, or objections to a decision to proceed.	*Government authorities issue a set of guidelines which are generally standard guidelines for the each different level of assessment; however, additional requirements may be specified if your proposal has special features to be considered in the assessment.*	
Part 2: Content of the Assessment Report - see Chapter 4 in the Environmental Impact Assessment Sustainable Minerals booklet					
2.1 Have you prepared an environmental report which meets the requirements specified in the guidelines issued by the assessing authority? In particular, does	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA	Report meets requirements of the authorities & contains sufficient information for thorough assessment of the probable environmental & social impacts of the proposal. … EIA report includes an	The introduction should: • set out the benefits & implications for the region • implications of not going ahead • describe alternatives to the proposal	*The introduction provides the overall context of the project, with details on the:* • *company or joint venture* • *location, with regional & local maps* • *regional environment*	

your environmental report include: - an introduction to the project?	completion.	introduction to the project		• *project background & objectives*	
2.2 - a description of the environment?	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	… EIA report includes a description of the environment surrounding the proposed development	This section should describe: • regional setting, & adjacent/nearby land uses & tenures • climate, geology, landforms, soils, surface & groundwater quality & hydrology • background dust & noise levels, pollutants & other contaminants in the area • vegetation & animal life, & whether any species are rare or endangered; conservation importance; regional distribution of flora & fauna communities • threats to flora such as plant diseases, weeds, & clearance programs • habitats & mobility	*This section gives a comprehensive description of the environment before project development. It looks at physical, biological & social aspects of the environment which are most likely to be affected*	

			of terrestrial & aquatic fauna, & threats including feral animals • community infrastructure, ethnography & archaeology of the area; regional & local demography		
2.3 - a detailed project description?	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	… EIA report includes a detailed project description	The project description should describe: • the exploration program, delineating the orebody, & discussing reasons for selection of the project site • the stages of mining development & operations including rehabilitation, on-site mineral processing & potential for downstream processing • the requirements for reagents & fuels & how they are to be stored & handled,	*Each phase of the project must be described including site preparation, construction, operations, proposed expansions, decommissioning, rehabilitation & site closure. Detailed maps should be used to show sizes & locations of key elements such as mine pits, tailings dams, processing facilities, transport corridors, overburden placement, & services/infrastructure. Artists' impressions will help illustrate the nature of the project in the different stages*	

			energy needs including transmission corridors, water supply & management, project infrastructure including workforce accommodation • the extent & location of liquid effluent discharges, gas & dust emissions, & disposal of wastes including oils, rubbish & sewage • plans for tailings & materials with acid forming potential • transport of materials into, out of & within the project area, & haul road/ other road construction • disposal of waste rock & overburden, final pit characteristics including stability, & decommissioning options.		

2.4 - identified environmental & social issues?	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	… EIA report identifies the environmental & social issues associated with the proposed development	Early planning will identify most environmental issues so that the EIA describes the optimum option for environmental protection (refer Mine Planning Sustainable Minerals booklet). The EIS should: • evaluate the overall effect on the total ecosystem & surroundings of the area • clearly state the criteria used to assess the impacts • quantify the impacts wherever possible • identify areas where information is incomplete or there is scientific uncertainty • evaluate the risks & hazards of the proposal for short & long term effects at the various locations where significant environmental impact could occur.	*Possible impacts include:* • *Physical - land disturbance, erosion, subsidence, instability; alteration of water courses; effects of quality, quantity, availability of surface & ground waters; salination of water or land; acid drainage; heavy metal contamination; impact on coastal processes* • *Ecological - loss of vegetation, loss of habitat & displacement of fauna; reduction of natural ecological processes; loss of biodiversity; plant diseases & noxious weeds. Contamination from pollutants/hazardous materials; creation of new habitats* • *Land use - changes in land use, incompatibility with neighbouring land uses; preclusion of*	

				other land uses (eg recreation); increased pressure on scarce resources, eg water consumption; creation of new water storage/supplies; opportunities for alternative beneficial land uses • *Social - influx of population (variable over project life); health & social impacts from traffic, noise, odour, dust, dislocation/relocation; change to level or nature of community resources (eg culture, job & income distribution, income levels, community identity); greater employment opportunity, increased revenue to local community* • *Infrastructure - loading on services (eg roads, power, water, housing, hospitals, education*	

				& social services • *Heritage - disturbance to/ reduced amenity of site (Aboriginal, European, natural sites)*	
2.5 - proposals on how the identified issues will be managed?	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	… EIA report includes proposals on how the identified issues will be managed	The EIS should include a proposed Environmental Management Plan (EMP) for the project, which addresses the significant potential impacts identified & how they will be managed & monitored to control the level of impact to acceptable levels. The EMP must be flexible to provide for evolution of new methods & improved understanding of the environment & impacts during project life. The EMP should set out monitoring & research activities to demonstrate the level of protection being achieved & to continually develop improved practices throughout the life of the project.	*"Making sure it works", in the Environmental Impact Assessment Sustainable Minerals booklet explains the importance of Environmental Management Plans & Systems in ensuring that the measures described in the EIS for avoiding significant environmental impact are actually put in place & implemented effectively. The Environmental Management Systems Sustainable Minerals booklet provides detail on the components of a good EMS.*	
2.6 - a description	The completed	… EIA report includes a	Best practice should	*Some effects do not become*	

of long term impacts, their significance, & approaches to mitigate their impacts?	EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	description of long term impacts, their significance, & approaches to mitigate their impacts	include steps to identify possible long term effects & include them in the monitoring program. Possible long term impacts include: • gradual effects of gases on vegetation • generation of acid from pyritic waste dumps • salination of groundwater by evaporation from old mine pits • siltation of water courses & water bodies from unstabilised areas • landform instability after mine closure • vegetation changes from altered water table	*apparent for many years & are often difficult to predict & measure - see "Immediate and long tem impacts" in the Environmental Impact Assessment Sustainable Minerals booklet. Similarly, responses to remedial work may be very slow. Therefore monitoring programs should measure long term impacts & environmental management approaches should be sufficiently flexible to adapt to minimise these effects as early as possible. Refer to the Environmental Monitoring & Performance Sustainable Minerals booklet.*	
2.7 - an evaluation of alternatives to the type of proposal?	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the	… EIA report includes an evaluation of alternatives to the type of proposal	Many elements of a mine development can be located to minimise some impacts on & off the mine - eg positioning facilities so that access roads can be placed to minimise noise impacts. An evaluation of	*Alternatives can be presented so that the most appropriate or preferred option is obvious. A matrix rating the different environmental impacts & economic restraints can*	

	likelihood of delays in EIA completion.		alternatives should be based on an environmental risk assessment & cost benefit analysis - refer Environmental Risk Management Sustainable Minerals booklet.	*help.* *The 'no project' option is important in the evaluation process. This allows the community & government to appreciate the consequences of the project not going ahead.*	
2.8 - a description of environmental monitoring & review methods to be undertaken?	The completed EIA report will reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	… EIA report includes a description of environmental monitoring & review methods to be undertaken	Monitoring must be focussed, produce quantitative data, results must be interpreted & reported, & the changes they indicate must be put into practice. Design of an Environmental Monitoring Program is described in the Environmental Monitoring & Performance Sustainable Minerals booklet.	*Monitoring & performance assessment help show if the EMP is working & if early predictions are correct. The Monitoring Plan should:* • *be specific to the project* • *reflect the potential impacts & environmental sensitivities identified in the EIA* • *include performance criteria (ie maximum permissible levels, & "trigger levels")* • *provide for interpretation of data & reporting to authorities & the public*	
2.9 commitments to avoid or	The completed EIA report will	… EIA report includes a list of commitments to	The EMP in the EIS should list all of the commitments	*An overall commitment to best practice implementation*	

minimise the risk of environmental & social impacts from the proposal?	reflect the scope & detail required by the relevant authorities for decision-making, & will reduce the likelihood of delays in EIA completion.	avoid or minimise the risk of environmental & social impacts from the proposal	for environmental protection. Upon implementation, the EMP should contain the same list, identifying for each commitment: • the name of the person or group responsible • timetable for implementation • standards for assessment • name of person or group who must be satisfied that the commitment is being met.	*of the EIS conditions is for the regular review & environmental auditing of the Monitoring Plan & Program, the EMP, & the level of environmental protection being achieved - including performance against the EIA commitments.*	

Checklist for Environmental Auditing

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
Questions 1.1 to 1.14 will help determine whether an environmental audit should be conducted.					
1.1 Are there aspects of your operations which indicate that you should conduct an environmental audit,	Simple yes or no response	If you answer NO to any of questions 1.1 to 1.14, then an environmental audit is warranted for your site because there appears to be an		*Regular environmental audits are now commonplace in Australia's larger mining operations & contribute to information gathering for*	

ie:Has an environmental audit been carried out previously at this mine?		obvious gap in the minimum standards for environmental management. If there are several NO responses, it means there may be serious deficiencies & an audit is urgent. If all, or almost all the questions result in a NO answer, an environmental audit is imperative to measure the level of environmental risk posed by the operation & to determine a program to minimise risk (which includes directors' & managers' liabilities under environmental legislation).		*annual environmental reporting, demonstration to regulators of compliance, & communication to stakeholders of commitment to environmental protection.* *The Environmental Management Systems Sustainable Minerals booklet describes environmental audit as crucial to a competent & effective environmental management system.*	
1.2 Does this mine operate without the use of chemicals, including fuels?	Simple yes or no response				
1.3 Has a comprehensive environmental management plan been prepared for the mine?	Simple yes or no response				
1.4 Does the organisation have a comprehensive written environmental policy that covers this mine?	Simple yes or no response				
1.5 Has an environmental manager/co-ordinator been appointed in writing for this mine?	Simple yes or no response				
1.6 Is there a specific budget for environmental management & improvement?	Simple yes or no response				
1.7 Are managers at the mine fully	Simple yes or no response				

informed of their obligations & liabilities under environmental legislation?					
1.8 Is environmental training provided for all employees at this facility?	Simple yes or no response				
1.9 Has the mine operated without prosecution under environmental legislation for at least the last two years?	Simple yes or no response				
1.10 Are all underground storage tanks known to be sound, including associated pipework?	Simple yes or no response				
1.11 Is the history of this site known to the present management?	Simple yes or no response				
1.12 Do you know whether you hold all of the required licences & permits to operate this mine, & are they current?	Simple yes or no response	If you answer NO to any of questions 1.1 to 1.14, then an environmental audit is warranted for your site because there appears to be an obvious gap in the minimum standards for environmental management. If there are several NO		*Regular environmental audits are now commonplace in Australia's larger mining operations & contribute to information gathering for annual environmental reporting, demonstration to regulators of compliance, & communication to stakeholders of commitment to environmental protection.*	
1.13 Do you know that this mine has not been contaminated by past or present	Simple yes or no response				

activities on it?		responses, it means there may be serious deficiencies & an audit is urgent. If all, or almost all the questions result in a NO answer, an environmental audit is imperative to measure the level of environmental risk posed by the operation & to determine a program to minimise risk (which includes directors' & managers' liabilities under environmental legislation & relevant sections of corporate law).		*Examples are described in Case studies 1, 2 & 3 in the Environmental Auditing Sustainable Minerals booklet. The Environmental Management Systems Sustainable Minerals booklet describes environmental audit as crucial to a competent & effective environmental management system.*	
1.14 Have you answered all of the above questions?	Simple yes or no response				
Questions 1.15 to 1.16 will help you to choose the right kind of audit for your needs. Refer Chapter 3 in the Environmental Auditing Sustainable Minerals booklet.					
1.15 Have you defined what the objectives are for the audit?	A set of objectives for the audit	The set of objectives should reflect the reason why the audit is required, & include: • the scope of the audit (ie the management systems or technical aspects or environmental themes to be addressed) • the outcomes needed to satisfy the reasons why the audit is to be done		*The following benefits can be derived from an audit, & they can also be used as a guide for determining the appropriate objectives for your audit:* • *identification of environmental risk* • *development of environmental policy* • *development or improvement of the environmental management system* • *avoidance of financial*	

				loss • *avoidance of legal sanctions* • *increase in staff awareness* • *identify potential cost savings* • *improve dealings with employees, environmental groups, the community, regulators, media, shareholders, or insurance & finance institutions;* • *establish a history of environmentally responsible operations, eg through environmental incident reports, environmental monitoring & recording, & reporting to committees*	
1.16 Have you chosen the most appropriate type of audit to meet your objectives?	Audit type	Audit type chosen matches the objectives	Increasingly, customer organisations may audit suppliers in order to measure the total life-cycle environmental efficiency of their products. Third party audits are commonly undertaken by	*Types of audit include:* • *Environmental Management Program Audit - used where a company does not have a formalised EMS; covers entire management procedure for environmental*	

			accredited certifying bodies to enable certification to standards such as ISO 14000. Regulators are increasingly using periodic audit as their key compliance monitoring tool. Environmental audit to assess potential liability is now almost mandatory before financial institutions will accept a security. This form of audit is being sought increasingly by purchasers of primary products, & often entails a cradle-to-grave assessment of the product as well as accordance with legal requirements & community expectations.	*operations* • *Environmental Management System Audit - for companies with formalised EMS in place; can be done by your own staff (ie internal or "first party" audit), by staff of another, allied organisation such as contracted auditor or a supplier (ie "second party audit"), or by an independent organisation (ie "third party audit")* • *Compliance Audits - measure compliance with environmental legislation, regulations, licences, approvals, permits etc, & corporate environmental policies. Statutory Audits are a type of compliance audit devised by regulators to assess performance against a subset of regulatory requirements, such as at a certain stage in a mine's life* • *Technical or Process Audits - used by the operator or regulator to*	

				assess the level & type of environmental impact from a particular operation or process of concern • *Audits for Mergers, Acquisitions & Divestments - to identify financial exposure arising from environmental liabilities, & to satisfy due diligence requirements. Also known as "Phase 1 Audit" in USA* • *Environmental Impairment Liability Audit - prerequisite to obtaining insurance against gradual pollution such as seepage (ordinary policies only cover pollution resulting from 'sudden, unexpected & unintended' events)* • *Environmental Marketing Audit - to assess the environmental standing of a product or range of products, eg for "eco-labelling"*	
			This type of audit is frequently required of	• *Environmental Impact Audit - to assess*	

			subsidiaries of US or UK-owned companies for acquisition or divestment purposes.	*performance against EIS commitments or concerns during the operational life of the mine* • *Environmental Performance Audit - assesses environmental performance of an ongoing activity in terms of environmental outcomes rather than process or compliance* • *Phase 1/2/3 Audit - American term for a tiered system of contamination audit: phase 1 is a non-intrusive audit of environmental liability for acquisition, merger, divestment etc, & may be followed by a phase 2intrusive audit if contamination is indicated, so that an informed investment decision can be made. A phase 3 assessment may be undertaken to gather enough information to develop site remediation program*	
Part 2: Conducting the Audit - see Chapter 4 in the Environmental Auditing Sustainable Minerals booklet					

2.1 Have you engaged appropriate persons to undertake the audit?	Audit team personnel	The audit team includes persons with documented environmental auditing capacities in terms of: • competency • qualifications & experience • accreditation	The audit team leader should be accredited as an environmental audit leader on the Register of Certified Auditors held by the Quality Society of Australia. Where the audit team is to address specific technical issues, it should comprise a multidisciplinary team embracing knowledge of the technical issues to be addressed. Use of an auditor with no previous knowledge of the site protects against over-familiarity, risk of collusion, & subjectivity.	*Environmental auditors can be found by advertising, approaching environmental auditing firms (lists can be obtained from AusIMM, EMIAA & some environmental conferences), seeking advice from organisations such as QSA, ICEA. MICA, EIAA, or by using consultants already known to the company.* *Case study 5 in the Environmental Auditing Sustainable Minerals booklet discusses the benefits of multidisciplinary audit team membership. Audit teams in some petroleum companies are outlined in Case study 6.*	
2.2 Has an audit protocol been developed?	Documented audit protocol	Audit protocol prepared before audit inspection commences, which includes: • a plan for the auditor to follow • allocation of tasks to individual members of the audit team • a format for comparing actual audit activity with the original plan • a format for summarising work in	If the audit is being undertaken in response to stakeholder concerns (eg regulatory agency, community group or finance institution), the protocol should be prepared in consultation with them & agreed before the audit commences.	*Commonly, the first audit of a site will cover all management procedures, operational activities & systems, & environmental issues.*	

		progress & work completed			
2.3 Does the audit protocol provide a comprehensive coverage of the audit objectives?	Audit questions	Questions within the protocol provide comprehensive coverage of the audit objectives & are sufficiently detailed to ensure that answers are informative. Also see Question 2.4.	Agreed audit objectives should be stated at the beginning of the protocol. The protocol format should be set out to mimic the objectives in a logical & progressive fashion. Questions within the protocol provide comprehensive coverage of the audit objectives.	*Avoid questions which invite a simple yes/no answer (eg instead of asking "Do you have a water management plan?", ask "Was a copy of the water management plan provided to the audit team?"*	
2.4 Do the questions in the protocol adequately reflect the range of activities on the site which are relevant to the audit objectives?	Audit questions	Audit questions cover all of the site's activities relevant to the audit objectives.		*A general list of areas to be covered in a mine environmental audit is given at the end of this Checklist.*	
2.5 Does the audit protocol include investigative supplementary questions & prompts?	Prompts or follow-up questions in the audit protocol	Prompts or follow-up questions in the audit protocol designed to elicit more detail on issues on interest to the auditor.	The audit protocol should allow the auditor to pose additional questions to investigate matters of interest more fully than the lead-in question may allow	*Prompts included in the protocol will remind the auditor of key issues to be sought in responses, & will help other members of the audit team to follow the logic & intent of questioning.*	
2.6 Has the audit team done its pre-audit planning?	Well-planned audit protocol reflecting detailed nature of the operation to be audited, its history, regulatory	Protocol includes references (as minimum standards, permit requirements, past impacts, findings of previous audits or reviews) as required performance targets in	Good pre-audit planning will require close contact with regulatory agencies & key stakeholder groups, & extensive reviews of relevant regulatory &	*Careful pre-audit planning will ensure the success of the initial audit & follow-up audits. Effectiveness & efficiency of pre-audit planning will improve over time as the requirements of*	

	requirements, & past performance	questions, or as prompts to the audit team.	other documentation.	*the audit procedure become better known & established. The pre-audit planning may need to cover more than one jurisdiction if the activities to be audited extend across state boundaries.*	
2.7 Were relevant staff interviewed during the audit?	Audit questions posed to those mine staff with direct responsibilities for the issues covered in the questions	Audits usually require the following personnel to be present at the interview: environmental manger, mine or facility manager, operational managers, maintenance managers, transport managers, processing plant managers & process control engineers, & others responsible for production or removal of wastes.	Interviews with key staff pre-arranged. Audit protocol designed to allow personnel with specific responsibilities to attend for discrete sessions (ie no need for all relevant mine personnel to be present at the same time & for the whole duration). Mine staff may be recalled or placed on standby to further investigate issues or detail as they emerge.	*Depending on the scope of the audit, marketing personnel, a legal representative, plant chemists & quality control mangers may also be interviewed.* *Depending on the type of protocol used. Interviews may take several hours for a small mine or several days for a large operation. It may consist of numerous separate discussions with individuals or groups.*	
2.8 Was a site inspection undertaken as part of the audit exercise?	At least one site inspection undertaken as part of the audit exercise	At least one site inspection undertaken as part of the audit exercise. A pre-interview "familiarisation" inspection may be undertaken. A detailed site inspection should follow the interview/s to examine specific issues raised during the interview process.		*Inspection times will vary depending on the size & complexity of the operation & the number of issues to be examined which were highlighted for investigation during the interview process.*	
2.9 Was a comprehensive set of information compiled during the audit?	Comprehensive documentation of audit business	Audit protocol, documentation provided by the site operator, auditor's notes & observations, results of sampling/monitoring if	All documents stamped, numbered sequentially, cross-referred to protocol & placed in a binder to facilitate easy referencing	*Nothing should be committed to memory; all information& observations should be documented in some form, eg photos recording issues on site*	

		undertaken, & photos, maps, plans, diagrams & other illustrative material. All documents verified as genuine, current & valid; a special stamp provided by the lead auditor may be used to demonstrate verification.	(these papers are important as they form the basis for following up disputes regarding audit findings or procedures). Photos are very important elements of an audit record. They can be used to impart facts effectively to executive staff who did not participate in the whole audit process, discuss options for improvement, & compare progress between subsequent audits.	*inspection, with location, date & issue descriptors.*	
Part 3: Audit Results					
3.1 Has a report of the findings of the audit been prepared?	Audit report	Draft audit report prepared on site before departure of the audit team			
3.3 Were recommendations included in the audit report?	Audit report includes recommendations to address issues arising	Recommendations are tangible & pragmatic, aimed at minimising environmental risk, ensuring compliance with environmental legislation, & improving environmental management procedures		*An audit of a major facility may contain 50 or more recommendations.Case studies 2, 4, 7, 8 & 9 in the [Environmental Auditing Sustainable Minerals booklet] describe benefits arising from companies enacting audit recommendations.*	
3.4 Were the audit findings presented to senior site staff prior to departure of the	Exit interview includes presentation of audit findings to senior site staff	Audit report documents the exit interview, persons present, & their positions	The exit interview should be accessible to all staff participating in the exercise so that they can	*Mine staff often want to know "what happens next". The audit leader can explain the audit follow-up process & the benefits*	

audit team from site?			receive results first-hand, & have the opportunity to seek clarification where needed.	*of implementing recommendations before the next audit.*	
3.5 Was agreement reached between the audit team & the site management on the validity of the audit findings?	Documented agreement between audit team leader & senior site representative on validity of audit findings	Signature of the audit team leader on the final report, accompanied by senior site representative validating the audit process & its findings	Ideally the signatures should be given at the exit interview. However, if there is disagreement these can be obtained later. Preferably, the team leader should remain on-site until agreement & signatures are obtained.	*Joint signatures will improve the credibility of the target operation/company in the eyes of stakeholders, & validity of the audit process in the eyes of company staff.*	
3.6 Was a timetable agreed for a follow-up audit?	Indicative date & scope of next audit	Indicative date & scope of next audit agreed to by company	The time to the next audit, & its scope, can be recommended by the audit team leader on the basis of the number & severity of the issues raised by this audit, & the level of environmental risk posed.	*If an operation has sound environmental management systems in place, the indicative period to the next audit will be longer than for another mine with poor EMS - even though the outcomes of the audit in terms of environmental impact may be similar.*	
3.7 Is the audit report publicly available?	Audit report available to third parties	Audit report available to third parties	Audit report available to regulators, key stakeholders, & the community	*Some companies may hold the audit report as "commercial in confidence". However its commitment to best practice, & relationships with stakeholders, will be better served by publication of the report & a commitment to address the audit findings & recommendations.Case study 3 in the Environmental Auditing Sustainable Minerals booklet.*	

				describes a system where audit results are routinely presented for discussion to a broad stakeholder group by mine & regulator officials.	
3.8 Does the protocol for the follow-up audit include an examination of the issues arising from & recommendations in the preceding audit?	Progress against recommendations & issues arising from this audit included as a key objective for the next audit	Commitment by company to include audit recommendations & issues into the objectives of the next audit	Company declares timetable for next audit & its intentions for audit objectives to stakeholders. Stakeholders may be invited to contribute to design of the next audit.	*The Community Consultation Sustainable Minerals booklet describes the value of ongoing consultation with the community potentially affected by your operation.*	

General List of Areas to be Covered by a Complete Environmental Audit for a General Industrial Site

Note: the list reflects a general industrial site and does not cover mining-specific issues such as tailings storage, pad leaching, vibration, subsidence or rehabilitation, nor other issues such as socio-economic impacts or discharge of mine water. These items will be specific to the nature of your site (location, climate, material mined, processes used, environmental sensitivities etc), and should be compiled by the audit team as part of the pre-audit planning process.

1. SITE	**3. RAW MATERIALS**		**9. PRODUCTS**
1.1 position relative to environmental features & public scrutiny	3.1 Pollution potential	5.3 tanker	9.1 transportation
1.2 location relative to usage of surrounding areas	3.2 toxicity potential	5.3.1 presence of proper contract	9.2 labelling
1.3 site history	3.3 quality testing	5.3.2 contractor licence check	9.3 packaging
1.4 chance of prior contamination	3.4 dangerous goods legislation compliance	5.3.3 pollution/toxicity potential	
1.5 security of site	3.5 containment of spills/leaks	5.3.4 knowledge of quality	**10. EMERGENCY RESPONSE PROCEDURES**

1.6 accessibility in emergency situations	3.6 storage	5.3.5 knowledge of destination	10.1 documentation of procedures
1.7 layout with respect to operations	3.7 documentation	5.3.6 knowledge of quantities, contractor & disposal	10.2 scope & detail of procedures
1.8 housekeeping/landscaping	3.8 transportation on-site & between sites	5.3.7 recycling/resale programs	10.3 liaison with external authorities
1.9 presence of asbestos & asbestos-cement sheeting	3.9 raw material sources		10.4 testing of procedures
Loading bays - containment of spills		**6. SOLID WASTES**	10.5 demographic studies
	4. PROCESSES	6.1 presence of proper contract	10.6 natural disaster planning
2.0 MANAGEMENT	4.1 process monitoring	6.2 pollution potential	10.7 staff training & knowledge
2.1 environmental policy & guidelines	4.2 plant maintenance	6.3 segregation programs	
2.2 environmental personnel	4.3 process transfers	6.4 recycling/resale programs & potentials	**11. PRIOR CONVICTIONS & COMPLAINTS**
2.3 environmental laws & procedures	4.4 quality control & testing	6.5 knowledge of destinations	11.1 prior convictions by statutory authorities
2.4 environmental budget			11.2 actions by community-environmental groups
2.5 environmental training	**5. LIQUID WASTES**	7. AIR EMISSIONS	11.3 customer complaints - environmental issues
2.6 third party environmental involvement	5.1 stormwater	7.1 visual check on air emissions	11.4 recording of complaints & responses
2.7 data collection & storage	5.1.1 stormwater drain protection	7.2 pollution potential	11.5 management structure for dealing with external bodies
2.8 public relations on environmental matters	5.1.2 vehicle plant wash-down	7.3 CFCs, halons & use of alternatives	
2.9 staff suggestion schemes	5.2 sewer	7.4 cooling tower/discharge stack cleaning & testing	**12. TRANSPORT**
	5.2.1 treatment systems prior to discharge	7.5 complaints	12.1 servicing of vehicles
	5.2.2 pollution potential of		12.2 recycling of used oil

	untreated discharge		
	5.2.3 discharge monitoring & recording	8. NOISE	12.3 unleaded fuel use
	5.2.4 permits	8.1 noise level at external boundaries	12.4 air conditioning CFC charging
	5.2.5 visual check of sewer discharge	8.2 noise monitoring, protection & abatement programs	12.5 refrigerant issues
			12.6 disposal of worn tyres
			12.7 cleaning chemicals & waste water
			12.8 catalytic exhaust on vehicles
			12.9 transport labelling on vehicles
			12.10 emergency response procedures

Checklist for Environmental Management Systems

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Development and Implementation of the Environmental Management System					
1.1 Are all levels of management totally committed to an Environmental Management System (EMS)?	Public statements of commitment	• Number & recency of public statements • percentage of senior management on record as having made statements supporting EMS	Commitment reiterated by senior management from time to time		
1.2 Have you drafted a	Corporate		Corporate Environmental		

corporate environmental policy?	Environmental Policy		Policy reviewed at least every 5 years		
1.3 Does the corporate environmental policy: • set out what the company wants to achieve? • define long & short term targets & objectives? • establish best practice community consultation? • set out monitoring requirements? • state the company's practical commitment to the policy? • commit to site rehabilitation?	Corporate Environmental Policy includes specific aims & undertakings	Corporate Environmental Policy includes statements on: • what the company wants to achieve through the EMS • long & short term targets & objectives of the EMS • how best practice community engagement is to be undertaken • monitoring requirements • the company's practical commitment to the policy • commitment to site rehabilitation	Corporate Environmental Policy reviewed at least every 5 years		
1.4 Is the corporate environmental policy endorsed by: • all administrative & operational sections? • The board of	Endorsements of Corporate Environmental Policy by executive & managers	Corporate Environmental Policy posted in board-room, & meeting rooms & offices of managers	Corporate Environmental Policy used as a framework for assessment of environmental commitment & performance at board & management meetings		

directors?					
1.5 Is the corporate policy distributed to all site employees?	All employees have seen & understood the policy	Copies of the policy provided to all employees including induction & environmental awareness/training sessions, & posted in staff meeting areas	The policy should be used as a key reference document for environmental awareness, training & induction of all staff including contractors.		
1.6 Has the chairman or chief executive issued a statement to the workforce & community, declaring that all company personnel shall abide by the policy?	Directive from CEO to all staff that they must abide by the policy	• Copies of the statement provided to all employees • copies distributed to key community representatives • appropriate training provided to staff to assist them to conform with the requirements of the statement	Material in plain English, & addresses issues of community concern as well as on-site issues		
1.7 Have you conducted an environmental impact assessment (EIA) which reveals the potential impacts on the mine on the environment & the community?	Environmental Impact Assessment	EIA canvasses all potential impacts from the operation on the environment & the community		*The Environmental Impact Assessment Sustainable Minerals booklet provides information on designing & conducting an EIA.*	
1.8 Have you undertaken regular & effective community engagement?	Liaison meetings with community representatives	Regular community liaison meetings, open to all interested community groups	Two meetings a year or more, community input to meeting agenda, meetings held before, during & after the mine's operational phase.	*The Community Consultation & Involvement Sustainable Minerals booklet describes approaches for effective*	

				community liaison & consultation.	
1.9 As a result of the EIA, have you developed a series of achievable but challenging targets & objectives?	Clear targets & objectives for environmental protection	Targets & objectives include short & long term improvements required to conform to EIA recommendations & requirements	Targets & objectives should be periodically re-set to provide ongoing challenges for continual environmental improvement. Outcomes of regular environmental audits can be used to develop new objectives & targets.		
1.10 Does your environmental management plan detail: • methods & procedures for achieving the targets & objectives? • environmental performance indicators? • responsibilities for the various requirements?	Environmental Management Plan	Environmental Management Plan contains: • methods & procedures for achieving the targets & objectives • environmental performance indicators • responsibilities for the various requirements	• Environmental Management Plan reviewed & amended whenever the objectives & targets are modified • appropriate staff with responsibilities related to the EMP are informed and understand any amendments		
1.11 Are all environmental strategies, policies, responsibilities, procedures, programs & initiatives clearly documented?	EMS contents	• EMS contains clearly documented strategies, policies, responsibilities & procedures for all environmentally relevant activities • Various programs &	EMS documents should be compiled & stored as an Environmental Manual for the project, as a convenient way of collating, recording & retrieving details of the various components making up the EMS.		

		initiatives carried out as part of the EMS program are documented & retained			
1.12 Have you identified, reviewed & documented procedures that may have an impact on the environment?	Documentation of all environmentally relevant procedures	Evidence that all site operational & emergency activities in the project have been assessed as to their compatibility with the environmental targets & objectives	This type of exercise can be run as part of a worker induction program. It also allows individual worker's experiences to be shared with all site personnel, & is a useful reference source when considering modifications to operational or emergency procedures.		
1.13 Have you assigned formal responsibility for procedures to personnel with necessary knowledge & ability?	Register of responsibilities for each environmentally relevant procedure	• Responsibilities clear & unambiguous, & included in staff job descriptions & duty statements. • Evidence that responsibilities are assigned appropriately to personnel with the relevant knowledge & abilities.	All staff should know who holds responsibility for key environmental procedures & decisions, particularly in relation to emergency response procedures where environmental risk in involved.		
1.14 Have you established clear reporting procedures?	EMS details reporting procedures, frequencies, & responsibilities	EMS contains details of reporting procedures & responsibilities for monitoring results, non-	Details should spell out frequency, level of detail, formats, content requirements of reports, who	*Routine daily activities & observations involving key environmental components should also be included.*	

		compliance reports, accident reports, results of audits, findings of inspections, & progress on implementing audit recommendations.	has overall & operational responsibilities for report preparation, & to whom reports should be submitted.		
1.15 Do all staff undergo an environmental awareness course, & any other specific environmental training they may require to carry out their duties?	Environmental awareness training	• Evidence of environmental awareness training of staff • Documented training materials • Timetable for future training • Environmental induction of new staff & contractors	Empowerment of staff, through education & delegation on environmental matters & recognition of good performance, is a significant factors in improving staff awareness & interest in environmental protection.	*The Planning a Workforce Environmental Awareness Training Program Sustainable Minerals booklet presents issues to be considered in order to raise staff awareness of & commitment to environmental issues.*	
Part 2: Integration of the EMS					
2.1 Are conflicts between EMS & production requirements resolved quickly, meeting both environmental & production demands?	Environmental protection not seen as detrimental to production efficiency or targets	Evidence of production decisions being made with reference to corporate environmental policy	• Site environmental manager reports directly to general manager & not to mine engineer/production manager • Environmental Manager consulted on all significant production decisions/changes.		
2.2 Do environmental procedures work with other procedures, rather	Operational & environmental procedures fully	Environmental controls integrated throughout mine management systems, eg	Operational Manuals cross-refer to EMS, & require consultation with/decision by		

than being a new or separate layer of controls?	integrated	woven in to operational manuals for different parts of the facility	Environmental Manager where environmental impact is possible		
2.3 Does management explain why procedures are changed or new procedures are introduced?	Corporate benefits of new arrangements explained at introduction	New arrangements explained in a corporate context, eg to attain Corporate Environmental Policy target or objective	Procedures introduced to encourage speedy & efficient adoption of the new procedures, eg team performance targets can be changed from tonnes per shift to tonnes per shift divided by quantity of spillages per shift		
2.4 Have you reviewed procedures to eliminate problems within a month of them being changed or introduced?	Systematic review of all new procedures	Documentation of reviews of new procedures, evidence of follow-up actions, & speed, effectiveness in remedying faults	Committee chaired by an independent person likely to engender respect from the community. Meetings held at regular intervals agreed by the committee. Community liaison officer always attends. Standing agenda item on progress against issues arising.	*Systematic reviews are an important component of continual improvement, to ensure new procedures deliver the expected benefits, & alert management to the need for further changes if the expected improvements are not delivered, or cause unexpected side effects (such as increased environmental risk).*	
2.5 Are EMS reporting systems integrated with other reporting structures rather than being separate?	Integrated operational & environmental reports	Evidence of integrated reporting, such as: • environmental performance indicators appended to existing regular reports • environmental	It is critical for environmental monitoring data to be professionally evaluated & for the outcomes of the evaluation to be presented clearly & simply. Trends of concern should not be buried in masses on data. The data can be called up to	*Speed & accuracy of preparation of environmental data are critical to reduce the possibility of an impact continuing longer than needed, & to initiate remedial action as soon as practicable.*	

		information dealt with at regular, rather than special, management meetings • reports need not be overly detailed	support the evaluation if further analysis is required.		
2.6 Are EMS requirements kept simple & brief?	EMS easily accessible & understood by staff	EMS is in plain English, avoids jargon, is well indexed, cross-referenced to operational & emergency management areas & manuals & is not overly long		*The more accessible the documentation is, the greater the likelihood that staff will be able & willing to use it, understand it, & come to regard it as an important workplace resource.*	
2.7 Are people responsible for environmental management & community liaison in the mine planning group?	Integration of environmental considerations into strategic plans.	Mine planning group includes personnel with environmental management & community consultation responsibilities.		*If development of mine proposals includes consideration of issues from community & environmental perspectives, there will be reduced risk of significant environmental impact or adverse community reaction.*	
Part 3: Maintenance of the EMS					
3.1 Are periodic internal reviews of the EMS undertaken?	Internal reviews of EMS	Documented internal reviews of introduction of new systems, components or procedures, & annual reviews thereafter. As well as specific technical issues the regular reviews should	The review group should comprise people with responsibility for environmental management, community liaison, & operations. Experience in environmental auditing is	*The review may reveal specific problems which will need to be addressed to maintain an effective EMS, such as:* • d*ifficulty applying*	

		include: • applicability of the EMS procedures • appropriateness of delegated responsibilities • adequacy of the reporting system.	required if ISO 14011 compliance is required.	*procedures to unforeseen situations* • *a gap in procedures for new or changed processes* • *staff lacking authority, resources, knowledge or time to carry out duties properly* • *reports with too much or too little information* • *unnecessary reports, or reports duplicating information available elsewhere* • *reports requiring too much time to produce.* *The review report should contain proposals to remedy problems.*	
3.2 Does the annual review also assess the company's performance against regulatory requirements, internal objectives & targets, EIA requirements & previous audit recommendations?	Internal reviews of environmental performance	Documented internal reviews of environmental outcomes in terms of: • regulatory compliance • performance against objectives & Targets		*Repeated assessment against regulatory & other targets, & of levels of improved performance, allows issues to be identified & pursued, consistent with the concept of continual improvement.*	

		in Corporate Environmental Policy • requirements established by the EIA for the project • previous audit recommendations			
3.3 Have you conducted environmental audits which: • identify actual & potential problems? • assess the impacts of waste discharges on the environment & community? • assess compliance with regulatory requirements & company targets? • prioritise areas of concern? • formulate solutions?	Regular environmental audits undertaken by external experts	• Reports of past external audits • timetable for future audits	Audits should be conducted at least once every 2 years, & focus on the effectiveness of the EMS. The audits should: • identify actual & potential problems • assess the impacts of waste discharges on the environment & community • assess compliance with regulatory requirements & company targets • prioritise areas of concern • formulate solutions	*The Environmental Auditing Sustainable Minerals booklet describes different types of environmental audits & how they should be conducted.* *External expertise can bring new & more effective solutions, & can identify problems overlooked by the internal review because of over-familiarity or lack of objectivity.*	
3.4 Are the results of the reviews & audits presented to & endorsed by senior management?	Presentations to senior management by review & audit teams at the	• Documented reporting of review/audit outcomes to senior	Senior management should endorse review/audit recommendations, & set priorities & deadlines for	*Displays at your shopfront & at local shows can be used to gather opinion through short*	

	completion of each review/audit exercise	management • evidence of commitment by senior management implement recommendations.	their implementation. Effectiveness of implementation to be evaluated at the subsequent review/audit.	*questionnaires. A computer can be set up in your shopfront with a simple interactive display linked to feedback questions.*	
3.5. Are key management documents amended in the light of review & audit findings?	Periodic review/amendment of Corporate Environmental Policy, EMS, & operational manuals	Routine assessment of review/audit outcomes against policy & management documents, supported by senior management	A senior officer should be nominated as the contact point & spokesman in the event of a significant incident - preferably the mine manager. This person should attend all meetings & make all statements regarding the incident.	*Cyclical review & amendment of key environmental management documents will provide a firm basis for continual improvement in the level of environmental protection achieved at the site over time.*	

Checklist for Environmental Monitoring and Performance

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
1.1 Have you set the goal for environmental monitoring & performance at your operation?	Goal for environmental monitoring & performance	Documented goal for environmental monitoring & performance		*The goal should demonstrate to governments & the community that the operation complies with environmental quality objectives determined through the Environmental Impact Assessment (EIA) process & achieves good environmental performance.*	
1.2 Have you	Application of widely	Selection & endorsement by		*A widely accepted standards set is*	

determined the standards to be used for environmental monitoring & performance at your operation?	recognised & accepted standards for environmental management at your operation	corporate and/or site management of a published set of standards for the environmental management system (EMS) to be used at the site		*the AS/NZS ISO 14000 series:* • *ISO 14001:1996 - Environmental Management Systems - specifications with guidance for use* • *ISO 14004:1996 - Environmental Management Systems - general guidelines on principles, systems, & supporting techniques. http://www.standards.com.au/*	
1.3 Have you defined specific objectives for environmental monitoring & performance at your operation?	Statement of purpose for the monitoring & performance system available to management, staff, government & stakeholders	Documented specific objectives for monitoring & performance at this site, including: • to detect short & long term trends • to recognise environmental changes & analyse causes • to measure impacts & compare with predicted impacts, targets & regulatory requirements • to improve the monitoring system throughout the life of		*State mines & environment departments produce guidelines on appropriate environmental performance objectives. The National Water Quality Guidelines present comprehensive information on standards & objectives for Water Quality & for Water Monitoring.*	

		the mine • to improve practices & procedures for environmental protection			
1.4 Have you applied the precautionary principle & ecologically sustainable development (ESD) as guiding concepts in developing for environmental monitoring & performance?	Statements embracing ESD & the precautionary principle	Commitments to ESD & the precautionary principle made in corporate environmental policy, & in planning & design guidelines for, or introducing, the monitoring & performance program			
1.5 Have you gathered baseline data on the pre-mining environmental condition of the site?	Prime dataset: • to gauge the level of environmental impact from the project • to identify site sensitivity	General dataset on environmental condition & special features requiring protection such as: • endangered species • rare habitats • valuable land uses • heritage sites	Data collection should be undertaken at all phases of activity, including early exploration, prior to any significant disturbance	*Existing information may be available for collation from other sources, eg previous mining company records, Landcare groups.*	
1.6 Have you identified the environmental issues specific to the site?	List of environmental issues for the area of activity/ proposed activity	List of environmental issues for the area of activity/ proposed activity including: • special sensitivities • environmental values	• Community consultation will assist in ensuring that all of the significant environmental		

		possible hazards to the environment given its sensitivities & the nature of the operation.	issues for the area are identified Special consultation may be necessary with aboriginal persons to properly identify all significant cultural sites.		
1.7 Have you determined a set of environmental protection objectives based on the specific environmental character of the area?	List of environmental protection objectives	List of environmental protection objectives is designed to avoid damage to or degradation of the environmental values of the site, in particular any highly sensitive, rare or endangered features	Community consultation will assist in ensuring that the environmental protection objectives you set are adequate to meet stakeholder expectations.	*Many EIA guidelines, government approvals & regulatory documents require definition of environmental values & environmental protection objectives, which are used to determine appropriate monitoring requirements & performance measures; see for example the Queensland government's Guideline 8 - Environmental Management Overview Strategy.*	
1.8 Have you determined monitoring requirements which are specific to the identified environmental issues?	List of monitoring requirements	List of monitoring requirements endorsed by management, indicating: - what to measure - where to measure - when to measure - how to measure - evaluation methods to be used - additional information required		*Special monitoring requirements are normally developed in the process of preparing the Environmental Management Plan for the operation.*	

1.9 Have you documented the monitoring requirements into a monitoring program for the operation?	Monitoring program specific to the site	Fully documented monitoring program specific to the site which provides the methodology & standards to be used to deliver on the complete list of monitoring requirements.	The monitoring program must be an integral part of the operation's Environmental Management Plan, & integrated with all relevant operational & management systems, procedures & requirements	*Typical issues addressed in an Environmental Management Plan, & requiring monitoring arrangements, are:* • *land clearing & topsoil* • *water supply & process water* • *ore & product* • *waste rock* • *tailings* • *hazardous substances* • *general wastes* • *biology - endangered species, feral animals, health risk vectors, weeds, habitat maintenance, biodiversity* • *fire* • *dust* • *noise* • *rehabilitation* • *air* • *groundwater* • *surface water* • *transport* • *heritage areas*	
1.10 Is the monitoring program accessible to staff, stakeholders & regulators?	• All staff aware of monitoring program • authorities aware of detail of	Level of staff knowledge of monitoring program, access to program by relevant staff, copy held by key regulatory authorities			

	monitoring program				
1.11 Are staff trained in environmental objectives & the importance of monitoring?	Staff aware of importance of the monitoring program & its proper conduct & maintenance	• All staff & contractors trained in the objectives, processes & procedures of environmental monitoring • Induction program for new staff & consultants includes training into monitoring program	Periodic refresher courses	*Human error is a significant cause of system failure at mine sites, & can be reduced substantially by regular & quality training. The Planning an Environmental Awareness Training Course Sustainable Minerals booklet contains relevant information.*	
Part 2: Design Framework					
2.1 Have you: • identified the scope of the monitoring • defined monitoring sub-programs for each environmental issue identified in the EMP?	Certainty of design apparent through: • clearly specified sampling frequency & systems • extent of program, & analytical procedures	Documented description of monitoring program, including: • sampling locations • sampling frequency • sampling methods, eg quantity, depth, length of sample time, special container requirements, sample preparation, storage & transport requirements • analytical procedures	National Association of Testing Authorities, Australia (NATA) - registered analytical laboratories can be used to deliver high confidence in results. Duplicates should be submitted for a few % of samples to allow checking for repeatability of results Duplicate samples should be retained for critical situations (eg unplanned releases) in the event that	*Sub-programs for which individual objectives should be set may include:* • *land clearing & topsoil* • *water supply & process water* • *ore & product* • *waste rock* • *tailings* • *hazardous substances* • *general wastes* • *biology - endangered species, feral animals, health risk vectors, weeds, habitat maintenance, biodiversity*	

		& precision required	more detailed analysis is required to establish exposure levels of contaminants	• *fire* • *dust* • *noise* • *rehabilitation* • *air* • *groundwater* • *surface water* • *transport* • *heritage areas*	
2.2 Have you specified how information collected will be used in the decision-making process?	Use of monitoring data in decision-making described in Environmental Management Plan	Environmental Management Plan includes examples of how monitoring data will be used to determine operational procedures relevant to environmental protection.	Action levels (such as contaminant loads/concentrations in water containments) defined & linked to specific contingency actions or decision-points.		
2.3 Is the layout defined for sampling & measurement?	Clarity on aerial boundaries, locations, frequencies, & sampling methods, & on measurement techniques	Documentation on aerial boundaries, locations, frequencies, & sampling methods, & on measurement techniques, including: • detailed locations of sampling sites • specific sampling instructions, eg frequency, depth, size, instant or longitudinal sample • special requirements for sampling instruments & containers	Sampling which compares mine impacts with natural or non-mine conditions is a powerful monitoring tool, eg "upstream/ downstream" water or air sampling, or comparisons with comparable "control" sites	*Frequency of some samplings maybe irregular, ie may take place only under special conditions such as high flow or after a water release. Some samplings may have to take place more or less instantaneously, eg for "upstream/ downstream" comparisons of water quality to be valid.*	

		• transport & storage instructions • any requirements for links in space & time between different samplings			
2.4 Are key indicators selected for monitoring based on appropriate characterisation studies?	Selection & listing of key indicators for monitoring.	Key indicators reflect: • the particular environmental values, issues & environmental protection objectives for the site, as identified in the planning stage • the particular sensitivities inherent in those values, issues & objectives	A major concern for environmental protection at most mine sites is downstream aquatic ecosystem health. Suitable key indicators can be individual sensitive species (high sensitivity species can provide early warning of impacts), or population or ecosystem diversity data. The National Freshwater Quality Guidelines set out methods for biological monitoring using such approaches.	*The indicators must, individually or when considered in groups or collectively, be direct indicators of environmental condition (ie "environmental health"), or of the stressors which potentially impact on environmental condition (eg contaminants).*	
2.5 Have you defined how the data will be analysed & interpreted, & how it must be presented in the monitoring reports?	Certainty & consistency of: • analytical & interpretive procedures • resultant data & information	• Documented methods, procedures & standards for sample analysis & interpretation of analytical data. • documented requirements for presentation of interpreted results	• The same message should be presented to all stakeholders, ie external stakeholders should have access to the same set of interpreted results as presented to		

		• interpretation methods & presentation techniques agreed with regulatory agencies • consistency of presentation techniques used in reports over time, & to different audiences	management • Continual investigations into improved techniques for key indicators, analysis, interpretation & reporting is encouraged, particularly when new or emerging sensitivities or environmental impacts are found		
2.6 Have you defined the precision & accuracy required in the data?	List of standards for sampling, analysis & interpretation, to provide certainty & consistency in the quality & reliability of data	Documented list of standards for sampling, analysis & interpretative techniques	Advice can be obtained from regulatory authorities, analytical laboratories, & NATA.	*Relevant information for water sampling is provided in the National Freshwater Quality Guidelines, & some of the Sustainable Minerals booklets provide guidance for necessary precision for dust, AMD, noise, & cyanide.*	
2.7 Have you considered the compatibility of the data to be collected with historical data & with contemporary related data?	Compatibility with historical data allows back-projection of environmental data to provide a sound pre-mine baseline & delineation of mine-related impacts	Evidence of: • collation & review of historical data • selection of suitable key indicators from historical data • matching of monitoring parameters to present an exact or			

		approximate continuum with selected historical data			
2.8 Have you set minimum requirements for monitoring air, water, discharges & biological systems?	Assurance that the monitoring data are sufficiently robust to detect & adequately describe impacts	• Documented minimum requirements for collection & reporting of monitoring data • evidence that these requirements demand that as a minimum: • o all significant environmental values, issues & sensitivity indicators are being monitored o monitoring data for each value/issue/ indicator are sufficient to detect impacts from all significant potential stressors o all potential pathways for			

		stressors to interact with the values/ issues/ indicators are included in the monitoring program			
Part 3: Monitoring Requirements					
3.1 Have you determined appropriate requirements for water monitoring?	Specified requirements for the monitoring of water	Evidence that: • requirements are set for the monitoring of key water quality indicators • catchments are identified & water quality sampling sites defined • temporal sampling frequency is defined • standard sample collection & preservation techniques are used (ie AS 2031) • appropriate chemical analytical methods are chosen to achieve maximum sensitivity & reliability • appropriate quality	Best practice sampling is for continuous monitoring of water quality to ensure critical peak values for variables are measured	*Appendix 1 gives examples of key environmental indicators for water quality, eg pH, EC & SO4 for mines with AMD problems, & also provides information on analytical methods to achieve maximum sensitivity & reliability.* *Temporal frequency should reflect hydrological variability, eg (monthly, seasonal, daily).* *Standard sample collection & preservation procedures are given in AS 2031AS 2031* *Appropriate quality control procedures include calibration, duplicate sampling, external analysis, standard reference materials & maintenance of equipment.*	

		control measures are in place for checking reliability of test results • test results are reviewed & evaluated, & adjustments made to the monitoring program &/or practices as required		*Case Studies 1& 6 provide examples of surface & groundwater monitoring programs.*	
3.2 Have you determined appropriate requirements for land monitoring?	Specified requirements for the monitoring of land.	Evidence that: • requirements are set for the monitoring of key land indicators • areas are identified for monitoring which properly represent each of the land-related key environmental issues • appropriate monitoring methods & frequencies are specified for each aspect • results are regularly reviewed & evaluated, & monitoring program & practices adjusted accordingly		*Issues to be covered include:* • *minimisation of disturbance* • *weed control* • *optimisation of topsoil & subsoil use* • *fire management* • *erosion control (earthworks & revegetation)* • *protection of specific landscape features & aesthetic landform features.* *Techniques may involve mapping, taking photographic records, measuring size, depth & microbiological condition of soil stockpiles.* *Appendix 1 & the Rehabilitation & Revegetation Sustainable Minerals booklet provide more information. Case Study 2 includes an example*	

				of flora & fauna monitoring for rehabilitation.	
3.3 Have you determined appropriate requirements for biological monitoring?	Specified requirements for the monitoring of biological systems.	Evidence that: • requirements are set for the monitoring of key indicators of biological health • community & species dynamics are defined • appropriate indicators are selected for direct toxicity or bioaccumulation measurements • variations in space & time, & related variations in cost, timing & uncertainty, are reflected in sampling location, type & frequency • direct impacts on biological communities are measured/monitored • data are sufficient for statistical analysis in respect of short & long term effects, local & regional effects, individual species, & broad		*Biological aspects of a monitoring program usually include endangered flora & fauna species, feral animals, mosquito infestation and other health risk vectors, aquatic & marine ecosystems & soil/plant pathogens.* *Appendix 1 provides further information. Case Study 1 includes an example of monitoring plant pathogens causing Jarrah dieback.*	

		community impacts • results are regularly reviewed & evaluated, & monitoring program & practices adjusted accordingly			
3.4 Have you determined appropriate requirements for atmospheric & noise monitoring?	Specified requirements for the monitoring of the atmosphere.	Evidence that: • requirements are set for the monitoring of key atmospheric indicators • locations of monitoring sites are defined • temporal sampling frequencies are defined • the most suitable monitoring equipment is selected • quality control procedures are in place • an equipment maintenance program is in place • information output is user-friendly & timely • results are regularly reviewed & evaluated, &	Dust & vibration are commonly major causes of community concern at mines close to settlement. Close consultation & involvement by the community, & cooperation by the company, can substantially reduce community concern & outrage - refer to the Sustainable Minerals booklet on Community Consultation & Involvement.	*Key issues to be addressed by the monitoring program are dust, gases, blasting & vibration, & noise.* *Case Studies 4 & 5 provide examples of dust, noise, vibration, & blast over-pressure monitoring requirements.* *More detailed information is given in the Sustainable Minerals booklets for Noise & Vibration, Dust Management & Atmospheric Emissions.*	

		monitoring program & practices adjusted accordingly			
3.5 Have you determined appropriate requirements for monitoring of process & wastes?	Specified requirements for the monitoring of mining processes & the wastes & other products.	Evidence that: • requirements are set for the monitoring of indicators relating to processing & waste & other products • all processes, consumables, products & wastes are included in the monitoring program • the placement & management of different waste, ore & process chemicals are captured in the monitoring program • containment structures & covers for product, waste & tailings are checked for engineering quality & stability • hazardous materials storage facilities, work practices, operational conditions & maintenance procedures are	Monitoring should extend to on & off site transportation & storage of product concentrates & Wastes.	*Waste materials, waste rock, tailings, process chemicals, ore & mill products are all potential sources of chemical contamination of water, soil & air.* *A particularly serious issue is heavy metal leaching associated with acid drainage (AMD). Sulphide-bearing waste rock requires special management to limit oxidation & acid generation - refer Appendix 1 & the Sustainable Minerals booklet on Managing Sulphidic Mine Wastes & Acid Drainage.*	

		checked • results are regularly reviewed & evaluated, & monitoring program & practices adjusted accordingly			
3.6 Have you determined appropriate requirements for monitoring relating to people & the community?	Specified requirements for the monitoring of the health of the nearby community & their and wider stakeholder concerns..	Evidence that: • requirements are set for the monitoring of matters of concern to people & the community • critical groups of people, & areas likely to be affected by the mining operation, are identified • location of monitoring sites for water & air monitoring are defined • access to cultural & heritage sites is controlled, & employee/contractor knowledge of restrictions is checked regularly • dietary items potentially	Close consultation should be undertaken with local communities early on, & continue through all phases of mining. Concepts are described in the Sustainable Minerals booklet on Community Consultation & Involvement.	*Issues relevant to people, society, culture & heritage close to a mining operation require very specialised monitoring. This may include foodstuffs including bush foods used by indigenous communities, & downstream fisheries; historical features, sacred sites, & air/water quality as they impact directly on human health & quality of life.* *Case Study 6 includes monitoring of possible blasting effects on an aboriginal sacred site.*	

		contaminated by mining operations are identified by contaminant uptake studies • analytical methods are appropriate to maximum sensitivity & reliability of results • photography & mapping used to monitor & protection/damage to special areas • appropriate liaison techniques in place for consultation, & relevant stakeholder groups identified • results are regularly reviewed & evaluated, & monitoring program & practices adjusted accordingly			
Part 4: Data Collection, Evaluation and Presentation					
4.1 Is the monitoring program realistic from a temporal & spatial perspective?	Monitoring workload matches available resources including budget, timeliness & operational practicalities.	All sample collections completed to timing & frequency requirements stipulated in the EMS monitoring program & according to sampling,			

		analytical & interpretation protocols			
4.2 Are sampling methods relevant to the source type?	Data collected are suited to representing the variables being tested & detecting any impacts on the environmental values at risk.	Data collected are suited to representing the variables being tested & detecting any impacts on the environmental values at risk	Some aspects of the broader environment surrounding the operation may be potentially affected by operations other than yours. In order to obtain best environmental outcomes, collaborative monitoring & management is warranted to ensure additive effects do not collectively result in undue impacts.	*Sampling methods can be point source, aerial, 3D, large volume, instantaneous, continuous, short interval or long interval as necessary to appropriately match the variable, concentrations & media being measured. Appropriate mapping scales, intervals between samples will similarly differ.*	
4.3 Are the data of high quality?	High quality data.	Procedures for sampling, preservation, transport & analysis consistent with relevant standards	Analyses conducted by NATA - registered laboratories. Sampling procedures conform to AS 2031.		
4.4 Are new data compatible with other relevant data?	Data consistent, comparable, & aerial & historical extent & context maximised	Evidence that definition of sampling locations, methods, analytical variables & techniques took into account meaningful historical data & current data from other sources.	Sampling data should be standardised between operations within a single extensive environmental entity such as a catchment or airshed to facilitate comparison & aggregation of data.	*Regulatory authorities will assist in developing preferred standards for data collection, collation, interpretation & reporting over extensive environmental entities.*	
4.5 Is data collection cost-effective?	Cost effective monitoring program	Evidence of comparison of costs of alternative collection techniques, & estimates of costs per sampling unit	Automatic samplers can very substantially reduce time & cost in collecting data. These data can be telemetered & accessed in real time from multiple		

			sample points, which can be critical inputs to sound decision-making in emergency situations (eg extreme rainfall & near-capacity containments).		
4.6 Is there a quality control system for measurement & analysis?	Quality control system for measurement & analysis	Documented procedures for quality control, & evidence of their implementation		*NATA - registered laboratories are required to operate stringent quality control. Regular comparison should be made between company & regulator check monitoring to identify areas where quality control may be weak.*	
4.7 Do you seek to incorporate innovative technologies & methods in your monitoring program?	Improved efficiency, reliability, precision, sensitivity from state-of-the art systems	• Evidence of system review & periodic upgrades • Review of data reliability, efficiency & cost-effectiveness of monitoring plan linked to improvement cycle	Comparisons can be made with industry benchmarks & documented best practice techniques to assess suitable application to your operation.	*Regular comparison should be made between company & regulator check monitoring to identify areas where systems improvement may be required.*	
4.8 Have you constructed appropriate database systems to hold & access the data?	Ease of storage, access, speedy retrieval & processing of data in computer database systems	Test retrievals of raw data, processed data & interpreted data for single sample & aggregated information	Data can be incorporated into spatially-related systems to allow: • 2D & 3D displays & interpretation • improved definition of relationships with environmental & other parameters	*Raw data should be retained to enable reprocessing, eg if improved statistical methods are developed to process "noisy" datasets or to better define weak trends.*	

			• higher quality informative presentations to managers, regulators & stakeholders.		
4.9 Do you apply a multidisciplinary approach to data interpretation to provide useful information?	Reduced likelihood of significant or potentially significant tends being overlooked. Improved identification of: • longitudinal trends in monitored variables • causes for variation • types & levels of impacts	Evidence of routine involvement in data interpretation of a relevant range of expertise, eg geology, biology, chemistry, engineer, hydrologist	• Trends which may indicate increasing risk of significant impacts in the future should be extrapolated to determine if any intervention is warranted to reduce that risk • Modifications to the monitoring program may be necessary to improve the level of information, detail & definition to clarify the level of risk.		
4.10 Do you provide regular reports of monitoring data & interpretative results?	Regular reports to management, regulators & stakeholders	Copies of regular reports to management, community & stakeholders	• Whilst the level of detail & style of presentation in the reports may be varied to suit the different audiences, the basic messages	*In relatively stable climatic & operational environments an annual reporting framework may be sufficient. Where there are marked seasonal changes reporting should be at similar intervals to report on performance when the*	

			about the level of environmental protection and principal contaminant levels must be the same • Regular monthly reporting of raw data to the regulator is good practice to ensure currency of information exchange on environmental performance - interpreted data can be presented less frequently, eg quarterly	*system is under greatest stress. Monthly reporting is warranted during high rainfall periods.*	
4.11 Do you regularly assess performance in environmental protection against regulatory requirements & environmental protection objectives?	Monitoring data used as an integral management tool to indicate compliance & measure performance against corporate objectives & goals	Regular reports always contain an evaluation of performance as indicated by the monitoring data against: • regulatory requirements • corporate goals & objectives • environmental protection objectives	• Include check monitoring data in your analysis. • Include indications of long term trends in significant/potential impact vectors, & the level of performance achieved over time (eg number of infringements per year; maximum	*Careful comparison with check monitoring results by regulatory authorities or environmental data from other sources is warranted to ensure consistency & to initiate investigation if disparities are evident (eg to reduce the prospect of dispute over adequacy of environmental protection).*	

			contaminant loads; volume of seepage to groundwater, volume of mine water discharged).		
4.12 Do you regularly present reports of results to the public & invite external comment & assessment?	• Regular reporting keeps public informed • opportunity for involvement increases credibility of company & confidence in level of environmental protection	• Reports published & widely distributed to community & broader stakeholders at least annually • Annual public meetings to discuss report contents & other matters of concern to attendees		*Distribution of both hard copy & electronic formats will ensure good distribution & availability.*	
4.13 Do you have a formal system of review of the monitoring program & related systems & plans?	System for continual improvement in environmental monitoring & performance	Formal, documented system of review.Reviews at regular periods eg 2 years, or when indicated by system failure	System review linked with regular environmental auditing to constitute a cycle of continuous improvement		

Checklist for Environmental Risk Management

Issue	Outputs	Performance Measure	Improvement	Comments	Notes

Part 1: Planning for Environmental Risk Management					
1.1 Are all levels of management totally committed to (Environmental Risk Management) ERM?	Corporate Environmental Policy, site management plans & manuals referring to ERM	Number & recency of public statements, percentage of senior management on record as having made statements supporting ERM			
1.2 Does risk management follow a formally adopted policy where ERM procedures, objectives & management responsibilities are clearly stated?	Corporate Environmental Policy, site management plans & manuals include specific aims & undertakings to apply ERM	Corporate Environmental Policy & site operational plans & manuals include consistent statements on the purpose & benefits of ERM & provide a framework for its implementation			
1.3 Are ERM arrangements integrated with other management systems?	ERM arrangements incorporated into a structured environmental management system for the site	• Risk management program clearly identifies the: - roles & responsibilities for risk management - method & timing of ERM work • Environmental management system for the site integrates safety, environmental, risk, & general mine management	• Additional hazards & changes to risk levels commonly occur at times of change to management practices, infrastructure expansions, & installation of new equipment & operational systems • Extra care & attention should be		

			paid to environmental risk at these times, including conducting a targeted ERM program.		
1.4 Have you consulted with stakeholders throughout the ERM process?	Community & stakeholders understand risk levels & methods used to manage & control them within acceptable levels	• Evidence of consultation with a wide range of stakeholders throughout the ERM process, from beginning to end • Degree to which stakeholder representatives are satisfied with consultative procedures	Communication should be seen as an integral part of effective ERM.	*Effective communication is a two-way process, based on clear & accessible information for stakeholders presented in ways they can understand, & on listening to their concerns & taking those concerns into proper account. More information on effective communication is in the Sustainable Minerals booklet on Community Consultation & Involvement*	
1.5 Have you conducted an ERM assessment as part of: • exploration programs? • mine planning & concept development? • the environmental	Understanding & appropriate management of risks at all phases of the operation	Reports on ERM activity at all phases of the operation	As stressed in the Mine Planning for Environment Protection Sustainable Minerals booklet, consideration of ERM issues early on can steer planning & concept development down paths that	*Some significant risks at different phases:* • *exploration - introduction of weeds, feral pests & plant pathogens, increased public access & fire risk (refer Onshore Exploration Sustainable Minerals booklet)* • *development & construction - heavy vehicle impacts, spillages & dumping of construction materials & waste, large temporary camps with sewage*	

impact assessment? • the construction phase? • the continuing operation of the mine? • decommissioning & rehabilitation?			avoid significant & costly problems & delays. ERM, particularly in the early stages of a project, constitutes a 'sensitivity analysis'; there is a need to accept that in principle *some areas may be too sensitive for mining to be acceptable.* ERM should form a key component of the EIA process - refer to the Environmental Impact Assessment Sustainable Minerals booklet. Case Study 4 gives an example of the role that a risk study played in an EIS & achieving development approval.	*& kitchen wastes* • *mining operation - vegetation clearing, soil erosion, blasting, rock dump instability/ erosion/ leachate & dust, subsidence, acidic/metal-rich/reagent-contaminated water, fuel & process chemical spills, transport accidents, containment failures eg tailings dams/pipelines/conveyors* • *decommissioning & rehabilitation - contamination from dismantling of processing plant, erosion of bare surfaces, pollution of waterways, leachate, failed revegetation, subsidence (the* Rehabilitation & Revegetation Sustainable Minerals booklet *addresses some of these issues).*	
1.6 Have you clearly defined the scope of the ERM exercise?	The entity to be covered by the ERM is clearly defined & documented so that boundaries of the exercise are known & focus maintained	Documentation contains a clear description of the entity to be covered, including definition of the boundaries of the exercise		The entity might be: • an area of the site (eg all areas west of haulage road & contained activities excluding haulage road pavement & associated activities)	

				- a particular activity (eg haulage of ore & waste rock from pit loading point to dump points on waste piles & ore crushing plant) - a particular subset of infrastructure (eg process water circuit including all process plant components handling process water & wet process/product streams, tailings slurry, tailings dam, decant pond, tailings & decant water pipelines, associated bunding, & water gain [precipitation, make-up water] & water loss [evaporation, consumption, water-in product, seepage] - management or operational systems (eg operational manuals, environmental management system, performance indicators for environmental protection).	
1.7 Have you defined the scope & methods of risk analysis to be used?	Documented description of the depth & breadth of the analysis & the techniques to be used	- Documentation describes the number & nature of studies to be undertaken as part of the ERM exercise - Time frame & resources for the exercise are clearly defined	Resource, time, method & scope limitations will all potentially reduce the quality & value of outputs. Therefore some flexibility should be allowed - & programmed for - in the event that significant issues are identified which require more detailed work to investigate	*Boundaries for the exercise should be set to take account of the interactions with & inter-dependencies on other parts of the operation outside the precise scope of the exercise, so that the influence of significant ' external' factors can be included in the analysis.* *Personnel for the exercise should be selected at this stage. Those selected should be able to input into the scope before it is finalised. As scope, resources & methods are inter-related, a number of iterations may be needed to get the design right.Computer models can be used to help collate, process*	

			thoroughly.	*& analyse information - see Case Study 3.* *Published guidelines for ERM system design include:* • *Risk analysis of technological systems - application guide AS/NZS 3931:1998, http://www.standards.com.au/* • *Risk Management - AS/NZS 4360:1999, http://www.standards.com.au/* • *Draft national framework for ecological risk assessment of contaminated sites 1997, www.deh.gov.au/epg/contam/documents.html* • *ISO 14000, http://www.iso.ch/9000e/iso14000.pdf* • *National standard for the control of major hazard facilities - NOHSC: 1014 (1996), http://www.worksafe.gov.au/*	
Part 2: Undertaking the Risk Analysis					
2.1 Have you carefully & clearly defined the organisational & operational context of the entity to be subjected to the risk analysis?	Formal detailed written description of the entity to be examined, clearly defining the scope of the exercise	Clarity, thoroughness & comprehensiveness of description, lack of ambiguity in defining the nature & boundaries of the entity to be examined. Description embraces all	Features to be considered should include: • physical features (layout, equipment)	• *Description by personnel very familiar with the entity will assist, but may also overlook certain aspects because of over-familiarity.* • *Break down the description into services, equipment, communications, procedures etc. Do not overlook the:"odds & sods"*	

		aspects of the entity, with respect to: • all features of the overall mining operation • the relevant environmental context	• operational practices & features • organisational structures & responsibilities • on-site environmental setting • off-site/downstream environmental setting. Doing an environmental audit at this point is a good way of ensuring that all environmental aspects are objectively identified - refer to the Environmental Auditing Sustainable Minerals booklet.	*which do not neatly fit into your groupings (eg cleaning & maintenance).* • *The familiarisation process is typically based on a review of drawings, maps, procedures, reports on previous studies, EIA documentation & associated investigations, & previous audit reports.*	
2.2 Have you worked through the individual elements of the entity to identify all aspects which represent a potential hazard?	Complete list of all possible aspects or events related to the entity being examined which could lead to adverse outcomes	Evidence of a logical, progressive & thorough approach to defining all possible events or aspects which could lead to adverse impacts. Careful consideration should be given to:	For this part of the exercise to be successful, it is important to assume that what can go wrong, will.	*Appendix 1 of the Sustainable Minerals booklet gives an example defining all possible events that could lead to significant adverse outcomes for a tailings dam.*	

		- possible initiating circumstances or events - consequences of those circumstances or events - available technical, operational or organisational safeguards or controls - likelihood of the initiating event or circumstance arising - likelihood of its translation into significant adverse outcomes if safeguards & controls are used			
2.3 To help you identify the potential hazards, have you used an appropriate array of techniques?	Thorough list of potential hazards, reflecting concerns & issues of importance to the mining company & key stakeholders	Documented evidence of a variety of techniques used to identify the potential hazards		*The types of techniques to be used in a thorough hazard identification exercise include:* *audit-type inspections* *brainstorming sessions with relevant parties* *review of community concerns* *review of compliance requirements & licence conditions, & any breaches* *review of any incidents that have occurred (eg "unplanned events")* *review of operating, maintenance &*	

				emergency procedures • *review of previous audits & studies.*	
2.4 Does the hazard identification exercise identify all potentially affected aspects of the environment?	Comprehensive listing of all potential adverse effects on the environment	Hazards identified include but are not limited to: • surface & ground water including diversion of flows • air (dust, smoke, fumes) • atmosphere (greenhouse & ozone impacts • natural areas, flora & fauna including vulnerable species & ecosystems • heritage, including aboriginal heritage items • soil contamination, erosion, degradation • geological structures, surface & subsurface • aquatic systems & fisheries • man-made structures • human health & safety • aesthetic & cultural values		*Case Study 1 describes a system of hazard identification for contaminated water devised by the NSW Government, & includes a flowchart methodology for identification & reduction of risk.*	

2.5 Does the hazard identification exercise identify all types of potential hazards?	Comprehensive listing of all potential hazards which may occur in the entity being investigated	Potential hazards compiled include: • fires • explosions • release of toxic or polluting materials • changes to runoff & water flows • introduction of exotic plant & animal species or pathogens, eg through ballast water at marine loading facilities, rehabilitation plantings, truck & other vehicle movement • subsidence • dam failures	Careful consideration should be given to other potential hazards specific to the entity being considered, in addition to those listed here.	*Interactions between events & various components may mean that one event can lead to several different hazards, eg subsidence causing dam failure may lead to tailings release & downstream aquatic impacts not directly related to the subsidence. All such possible linkages & consequences should be investigated. Case Study 2 describes a system for managing a plant pathogen outbreak, including hazard identification, analysing & assessing risks, risk reduction, & monitoring & review.*	
2.6 Have you considered the broader setting of the entity being investigated, in the hazard identification exercise?	Listing of hazards includes hazards related to broader considerations than those associated with direct operation of the entity under examination	Evidence that the hazards listed address issues such as: • whole of mine life cycle • whole of the area or systems potentially affected • whole of the operations as defined in the		*"Word diagrams" can be used to assist in identifying & evaluating hazards. Appendix 1 gives an example of a word diagram, defining all possible events that could lead to significant adverse outcomes for a tailings dam. The word diagram allows the ERM team to collectively compile possible initiating events, possible consequences of those events, for each activity or operational component of the entity under investigation.* *Logic trees (fault & event trees) can be used*	

		scoping exercise • long term & continuous low-order emissions/impacts • all types of causative factors including natural events such as storms & earthquakes • perceived hazards & controversial issues • wastes & by-products, the mine product & consumables.		*to identify relationships & outcomes in complex systems - see Appendices 2 & 3. Other approaches include "failure, mode, effect analysis" (FMEA) & consequence analysis & human error analysis.* *Surveys or special investigations may be needed to fill in data gaps (eg identifying each step in a consequence chain).*	
2.7 Have you assessed the consequences of each of the possible events?	Listing of consequences of each possible worst-case scenario event	Individual steps identified for each initiating event & the consequences considered for each step & the end outcome.			
2.8 Have you estimated the likelihood of each step in the consequence chain of occurring?	Probability estimate of each event in the consequence chain occurring. These can be aggregated to form a more accurate picture of failure probability of the complete entity, than would result from estimates that consider only the entity in its	The likelihood analysis includes assessment of: • frequency of the initiating event • probability of specific safeguards failing on demand • the likelihood of an event causing a primary failure also	Detailed quantitative analysis deconstructs the system into its component parts, thus allowing deeper analysis & the sensitivity testing of inputs & assumptions.	*Logic trees, as illustrated in Appendices 2 & 3, can be very powerful in getting the sequence of events right & establishing the role & relationships of the variables affecting the outcomes. They are also amenable to allocating probability estimates to each step, & subsequently testing the sensitivity to individual steps or events & isolating significant risk contributors (see examples in Appendix 3).The quality of probability estimates will vary significantly.*	

	entirety.	causing a safeguard failure • coincident events causing a different outcome to one event alone • the likelihood of human errors & appropriate & inappropriate responses • probability of certain weather conditions (wind speed, direction, rainfall intensity/frequency/ duration • fatality/injury probabilities for people & other species		*There are well established databases for items such as equipment (eg pumps & valves). Where well-founded data are absent, extrapolation of experiences from similar system components may be done, provided conservative assumptions & a precautionary approach are taken.*	
2.9 Have you estimated the risk associated with each event & outcome?	Combination of the results of the consequence & likelihood analyses to provide an estimate or indication of the probability of a defined adverse outcome occurring	• Risk estimates for each defined adverse event, expressed as a frequency of occurrence. • Quantitative estimates are preferred where possible, but lack of data or the type of event being		*Quantitative frequency of occurrence can be expressed in different ways to suit the circumstance, eg: probability of occurrence during mine life; per year/thousand years etc; per operating month; per tonne of product; per export dollar or per person employed etc.* *Qualitative outputs may be described as rankings (eg very low to extreme), based on combinations of high or low severity, & high or low likelihood of occurrence. The product*	

		examined may require qualitative estimates to be made. These should be conservative, & employ a precautionary approach to evaluating levels of severity, likelihood, & the subsequent estimation of risk.		*can be expressed as a paired descriptor, or translated into a numerical rating of risk such as 1-5 (very low-extreme).*	
2.10 During the risk analysis process, have you looked for opportunities to reduce risk?	Recommendations made during the ERM for ways of reducing risk	Recommendations made during the ERM for ways of reducing risk	The ERM analysis presents in-depth insights into how the components of the overall system interact. These insights may allow several alternative approaches to risk reduction to be identified, & the most cost-effective combinations of measures to be selected. These most cost-effective approaches should be recommended to management for implementation.	*The ERM analysis will commonly identify areas where risk can be reduced readily & inexpensively. Appropriate recommendations should be made to management immediately so that improvements can be implemented, & risk profiles improved, as early as possible.*	
2.11 Have you sought	Access to broader	Employment of external	Good	*If access to people expert in ERM is difficult,*	

relevant external expertise on special technical matters?	experience, knowledge, & greater objectivity	experts in the ERM process who are experienced in the broad range of technical, process, environmental & other issues to be considered. Persons with previous experience in ERM exercises at similar mine sites.	communication & support to the ERM team is essential, eg in responding to requests for detailed technical information.	*many environmental & mine systems auditors will have relevant technical & broad knowledge appropriate to ERM.*	
Part 3: Risk Assessment					
3.1 Do you have a set of objectives & criteria against which to assess the risks?	Documented set of objectives which describe the levels of risk which are acceptable	Documented set of objectives which describe the levels of risk which are acceptable.	For the biophysical environment, the concept of ecological sustainability & the precautionary principle should be considered in setting criteria & objectives.	*The levels of risk identified by the ERM exercise should be assessed as unacceptable or acceptable, by comparing them against environmental protection objectives & minimum levels of protection required for the site. These must at least match regulatory requirements, & should be high enough to meet corporate & stakeholder expectations. Such criteria are commonly stated in EIS documents & government approvals & regulatory document; refer to the Queensland government's Guideline 8 - Environmental Management Overview Strategy for examples of "environmental protection objectives".*	
3.2 Do you have an agreed range of responses through which risk can be managed?	A range of possible responses for managing risk, documented & approved by management	A range of possible responses for managing risk - these should be documented & approved by management		*Possible responses include:* • *accepting the risk* • *eliminating the hazard or avoiding the risk* • *reducing the consequences* • *reducing the likelihood* • *transferring the risk (eg through*	

				insurance).	
3.3 Have you assessed the risks against the criteria & objectives?	Risk assessment report - detailed risk assessment	Risk assessment report evaluates every significant risk identified by the ERM exercise against the criteria & objectives			
3.4 Have you collated recommendations drawn from all stages of the ERM process & assessed them against the compliance criteria?	Risk assessment report - recommendations for risk management	Risk assessment report lists items of significant risk, prioritised as to: • severity of consequences • probability of recurrence (likelihood) • cost & complexity or downtime to remedy.			
Part 4: Risk Treatment					
4.1 Has management determined how each of the risks identified in the ERM report are to be managed?	Risk management report	A method of management is indicated for every item of significant risk identified in the ERM report		*Possible responses include:* • *accepting the risk - risk is considered acceptable, although appropriate monitoring & contingency planning may be warranted* • *eliminating the hazard or avoiding the risk - eg eliminating the step; changing the technology, location, management practices or materials used; outsourcing the activity* • *reducing the consequences - eg smaller dam, secondary containment,*	

				use less hazardous reagents, better emergency response facilities • *reducing the likelihood - upgrade equipment, better staff training, maintenance & monitoring, etc* • *transferring the risk (eg by outsourcing the activity, or transferring financial liability through insurance).*	
4.2 Have you developed emergency plans for all environmental hazards?	Emergency/contingency plans cover all environmental hazards	Documented emergency & contingency plans for all aspects of the EMS			
4.3 Have you developed a suitable monitoring program?	Environmental monitoring program for the site	Environmental monitoring program refers to ERM results to determine locations & variables to be monitored, & appropriate sampling frequencies		*A good monitoring program can detect emerging problems or impacts & provide opportunity to intervene, particularly if impacts are progressive & long-term. When logic trees have been used in ERM, indicator events a step or two back from an incident can be used to identify appropriate early warning monitoring sites & parameters. The Environmental Monitoring & Performance Sustainable Minerals booklet describes general requirements for a monitoring program.*	
4.4 Is hazard auditing part of your auditing process?	Audit protocols include examination of mine site hazards	Past audit reports contain assessment of mine site hazards	Environmental audits can be used to measure the overall effectiveness of ERM, including the effectiveness of implementation of ERM recommendations for	*The Environmental Auditing Sustainable Minerals booklet outlines environmental audit approaches & designs.*	

			risk reduction by management.		

Checklist for Hazardous Materials Management, Storage and Disposal

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information Gathering - refer chapters 1 & 3 in Hazardous Materials Sustainable Minerals booklet					
1.1 Do you know the composition of all materials used, generated or stored on the site & how they may be hazardous?	• Improved basis for estimating risks to people & the environment • improved design of mine layout, infrastructure, processes, operating systems • management plans to minimise those risks	Documentation of all materials used, generated or stored, listing any hazardous characteristics & their potential impacts to people & the environment	Integration of procedures for management, storage & handling of all types of hazardous materials on site across all relevant operational plans, systems & manuals, including: • Waste Management Plan • Chemicals Management Plan • reporting requirements for environmental incidents, events & circumstances	*A hazardous substance can be defined as:"a substance that because of its quantity, concentration, acute or chronic toxic effects, carcinogenicity, teratogenicity, mutagenicity, corrosiveness, flammability, explosiveness, radioactivity or physical, chemical or infectious characteristics, may pose a hazard to human health or the environment when improperly treated, stored, disposed of or otherwise managed" Queensland Dept of Mines & Energy).*	
1.2 Have you identified the risks associated with the hazardous materials identified?	• Bases for planning of mine facilities, systems & procedures to reduce the potential for	Environmental Impact Study (EIS), Mine Plan, & Operating Plan/ Environmental Management System (EMS) include a list of:	The sensitivity of identified receptors to, & the consequences of impacts on them from, hazardous materials used to provide design specifications for environmental protection	*It may be useful when identifying the hazardous materials, the way they are used, & the associated risks, to consider them in groups, such as (see Chapter 2):* • *exploration activity*	

	impacts on sensitive receptors • planning of back-up systems & monitoring points to protect sensitive environmental receptors.	• the environmental receptors that could be adversely impacted from the hazardous materials • an assessment of the potential impacts	measures. A factor of safety should be applied to provide a level of certainty against accidental or unforeseen release of hazardous materials.	*materials (mainly fuel oils, lubricants & drilling muds)* • *process chemicals & service materials (including fuels, lubricants, reagents, solvents etc from the processing plant, vehicle servicing area, storage sheds, tanks)* • *process wastes, eg acid-producing or cyanide -rich tailings* • *radioactive materials & wastes ie from some gauges, tracers, scale in oil pipes, furnace dust, slimes in electrorefining, heavy mineral mine reject, radon gas in underground mines* • *other waste streams eg obsolete/excess laboratory chemicals, PCBs in transformers* *Two major types of hazardous material are dealt with in the Cyanide Management & Managing Sulphidic Mine Wastes Sustainable Minerals booklets.*	
1.3 Have you gathered information on how these materials must be managed to	Sound basis for developing systems & procedures for hazardous materials in the Environmental Management System	Documentation of management techniques to minimise risk	Documentation reviewed annually to ensure inclusion of new information	*Resources include the World Health Organisation Environmental Health Criteria Series.* *Australian resources are accessible at Business Entry Point - search*	

reduce these risks?	for the site			*under topic "environmental/hazardous materials".*	
1.4 Does the information you have gathered cover all aspects of use of these materials during all stages of your project?	Allows integrated planning & assurance of appropriate handling of hazardous substances between the different stages of the project, including transitional stages	Information collated for all hazardous substances used, generated or disposed of during exploration, mine construction, commissioning, operation, decommissioning & closure			
Part 2: Planning - refer chapter 3 in Hazardous Materials Sustainable Minerals booklet					
2.1 Are issues related to the use, storage, handling & disposal of hazardous materials considered thoroughly in the Environmental Impact Statement or other planning documents?	Lower risk of impacts during development, operation & closure	Hazardous materials addressed in planning documents			
2.2 Does the proposal for the project (eg in the EIS) incorporate Cleaner Production principles?	Framework for fully integrated approach to reducing risks from hazardous substances	Cleaner Production principles set out in planning document	Planning document sets out priorities for waste minimisation as established in the *National Waste Minimisation & Recycling Strategy 1992*, ie: • waste avoidance	*Several of the Case Studies in the Sustainable Minerals booklet show application of Cleaner Production techniques at Australian mines:* *Case Studies 1 & 4: waste avoidance*	

			• waste reduction • waste re-use • waste recycling & reclamation • waste treatment • waste disposal.	*Case Study 2: recycling, reclamation & reuse* *Case Study 3: waste treatment* *Case Study 9: control of hazardous materials at source.* *Also refer to the Cleaner Production Sustainable Minerals booklet.*	
2.3 Does the proposal for the project consider the benefits of best practice management of hazardous materials & seek to maximise them?	Long-term risks & costs related to poor management of hazardous materials are minimised	Project design takes into account the full range of potential benefits accruing from best practice management of hazardous materials	Decisions on project & systems design should consider both the tangible & intangible, long & short term, benefits that accrue from Cleaner Production.	*Section 1.4 of the Sustainable Minerals booklet gives examples of benefits as:* • *cost savings (eg reduced use or raw materials, lower cleanup costs)* • *risk reduction (worker health, environmental impacts)* • *process control (assists in Total Quality Management - TQM)* • *community relations* • *corporate image*	
2.4 Have you planned the project to minimise the use of hazardous materials?	Assurance that the approach used represents best practice for the site & type of operation	Planning documents assess alternatives for the type & quantity of hazardous materials to be used	Systems & elements of mine layout & design can be reviewed from scratch at the time of major equipment upgrades or mine expansion.	*A site-specific approach should be taken to ensure that the design & systems chosen are the most suitable for the type of mine, its setting, the climate, & the ore characteristics, & that the hazardous materials to be used are*	

				chosen on the basis of technical requirements & environmental safety. Refer to Sustainable Minerals booklet on Mine Planning.	
2.5 Have you planned the project site so that there is reduced risk of spillage or other release of hazardous materials?	Low probability of systems failure & non-compliance	Evidence that mine infrastructure & layout are based on specifications which are designed to avoid the risk of spillages, in both normal & abnormal situations.	Site specific modelling undertaken to identify low-probability/high risk events, such as extreme rainfall events. All designs include a safety factor, eg in bund capacities. "Failsafe" systems such as secondary sediment traps. Double-bunding /double-skin piping in key areas or for highly hazardous materials.	*Layout should avoid placement of possible spillage areas near natural water channels. Separation of clean from contaminated water flows is a fundamental requirement.* Refer to the Environmental Risk Management Sustainable Minerals Booklet for information on assessing & reducing risk.	
2.6 Are engineering controls in place to ensure that aspects of the project related to hazardous materials management are constructed as described in approved planning proposal documents?	Low probability of systems failure & non-compliance	Report by technical expert demonstrating that the mine infrastructure systems are constructed as approved, or better	The duration of time for some EIA processes to be completed may allow time for the company to identify better arrangements for management of hazardous materials which, subject to agreement with the authorities, can be incorporated in the construction phase.		
2.7 Have the engineering controls been tested at the	Low probability of systems failure & non-compliance	Report by technical experts that systems are testing & operating as designed, prior to			

commissioning stage prior to commencement of operations?		commissioning			
Part 3: Operation and Management - refer chapter 4 in Hazardous Materials Sustainable Minerals booklet					
3.1 Do you have a Hazardous Materials Management Plan?	• Management Plan sets out targets & management strategies for all issues identified in impact assessment & in community consultations • Management Plan integrated with other operational plans into an overall EMS for the project	Documented Hazardous Materials Management Plan	The Environmental Management Systems Sustainable Minerals booklet describes the components of a fully integrated EMS for all environmental aspects of a minesite. Many companies seek certification to international standards such as ISO 14001 to help demonstrate their environmental commitment to regulators & other stakeholders.	*Operators can use & seek certification to published EMS standards such as ISO 14000. Software obtainable from this site includes complete prewritten procedures, record forms, & an Environment Manual which can be customised. An implementation guide is also included.* Case Study 6 gives an example of a mine which has set its target at zero discharge of hazardous materials.	
3.2 Does the plan identify all of the hazardous materials used on the site?	Management aware of full range of materials requiring special care & attention, monitoring, development of instructional manuals and signage	Plan includes inventory of all hazardous materials used, generated & disposed of on the site		*The inventory should include hazardous materials of all types, at all parts of the operation, in all of their forms, & at all stages of mining, processing, treatment & disposal.*	
3.3 Have you characterised the environmental impacts possible		Hazardous Materials Management Plan lists possible impacts from each type of hazardous		*Table 1 lists examples of hazardous materials in mining operations & their environmental impacts. More detailed & extensive information*	

from these materials?		material		*can be found in the World Health Organisation Environmental Health Criteria Series & Australian resources are accessible via [Business Entry Point](#) - search under topic/environmental/hazardous materials.*	
3.4 Have you documented the methods for transport, handling, use & disposal for all hazardous materials & requirements for their safe management in each case?		Hazardous Materials Management Plan sets out the methods for transport, handling & use of each hazardous material & describes the risks associated with each		*Refer to [Sustainable Minerals booklet on Mine Planning](#).*	
3.5 Are areas where hazardous materials are handled, stored or otherwise in use, labelled to advise of possible hazards & appropriate procedures to be used to reduce risks?	• Reduced probability of human error and improved worker safety • Staff aware of risks & able to report incidents which do not comply • Staff understand their responsibilities	Site inspection to check for signage and labelling	Infrastructure can be colour-coded or otherwise marked to identify hazardous materials (eg colour-coded piping), & the need for special precautions (eg protective clothing, sentry worker to observe safety of colleagues).	*Special attention should be given to facilities or operations with particular potential to cause significant environmental or worker health impacts, because of their nature, size, or the materials used - eg tailings dams, leach pads, cyanide for gold extraction.*	

	& their roles in preventing contamination in both routine & emergency situations				
3.6 Does the Hazardous Materials Management Plan incorporate up-to-date measures, systems & standards from current codes & guidelines?	Lower risk of systems failure & of non-compliance	Evidence of periodic review & updating of the management plan	• Annual review of management plan. • Inclusion of measures promoted in Australian & international guidelines & codes of practice.	*Links to codes & guidelines are provided by State & national mining councils, & State departments of mining & of environment*	
3.7 Is the Hazardous Materials Management Plan integrated with other operational & environmental management systems for the site?	• No gaps or overlaps in measures or responsibilities in all matters directly or indirectly related to the management of hazardous materials • No inconsistencies in instructions or objectives	Hazardous Materials Management Plan extensively cross-refers to other management plans for the site, notably for Emergency Response, Waste Management & Environmental Management Plans.	The Hazardous Materials Management Plan & other relevant plans, notably for Emergency Response &, Waste Management, should be integrated as sections within one overarching Environmental Management Plan		
3.8 Are specific	• Evidence of	Management plan sets	Nominated persons must have		

responsibilities for management of hazardous materials allocated to appropriate staff?	Management commitment to management of hazardous materials • Clear lines of responsibility & decision-making, especially under emergency situations	out staff with specific responsibilities for management of hazardous materials	appropriate levels of authority to decide & undertake actions in emergency situations.		
3.9 Do you have a Contingency & Emergency Response Plan which covers all hazardous materials identified in the Hazardous Materials Management Plan?	Correct procedures followed in contingency & emergency situations	Documented Contingency & Emergency Response Plans	The plan must nominate responsible persons with authority to implement the measures in the plan. These persons must have appropriate levels of authority to decide & instigate actions themselves in contingency & emergency situations.		
3.10 Are appropriate equipment & instructions readily accessible in the event of a contingency or emergency	Correct procedures followed in contingency & emergency situations	• Correct equipment (including protective clothing) used. • Reduced risk of major impacts from non-	Avoid locking safety gear to ensure it is always readily available. Regularly check that the gear & information notices are present & in good condition.		

situation?		standard incidents			
3.11 Is the disposal of hazardous materials including wastes undertaken in ways which eliminate or reduce environmental impacts?	• Disposal practices for hazardous materials conform with Cleaner Production principles & the objectives of the Hazardous Materials Management Plan • High level of assurance of environmental protection	• No evidence of environmental impacts or non-compliance • Environmental audit reports no impacts, or significant risk of impact, on sensitive environmental receptors			
3.12 Is there a corporate commitment to training in hazardous materials management?	Evidence of Corporate commitment to appropriate levels of staff awareness & understanding	Commitment to training in hazardous materials management documented in corporate policy material & in Hazardous Materials Management Plan			
3.13 Are your staff trained in hazardous materials management?	All staff aware of the hazards of hazardous materials & appropriate measures for their management	Documented training plan in hazardous materials & their management, which has been delivered to all	• Training should include management staff, including those in administrative areas • Regular refresher	*The Sustainable Minerals Booklet on Planning a Workforce Environmental Awareness Training Program will assist in designing a training course for staff.*	

		permanent staff	courses.		
3.14 Are contractors trained in hazardous materials management?		Documented training plan in hazardous materials & their management, which has been delivered to all contractors & short-term employees	Shorter courses can be designed which focus on the specific work performed by contractors & short term staff	*Short course may need to be run several times a year to ensure all contractors & short-term employees understand the risks & hazards involved, & their responsibilities.*	
Part 4: Monitoring and Review - refer chapter 5 in Hazardous Materials Sustainable Minerals booklet					
4.1 Do you have a monitoring program which examines the transport, storage, handling & use of hazardous materials?	Up to date information on: • the level of management of hazardous materials • likely risks • the level of application & observance of staff instructions • standard operating procedures areas, concentrations • toxicity • chemical behaviour • direction & rate of movement of	Documented monitoring program which sets out monitoring & sampling routines for satisfactory containment of hazardous materials. Program to include: • groundwater quality • storage tanks & bunds • stack & other air emissions • discharges from tailings & ore/rock dumps • discharges from waste disposal facilities • regular site inspections to check integrity of systems	The monitoring program should be examined by an annual environmental audit to determine its adequacy & recommend any areas of improvement required.		

	contaminants	including signage • regular review of operating systems & staff practices			
4.2 Do you keep records of your hazardous management systems, procedures & incidents, & copies of relevant manufacturers' instructions, codes, standards & regulatory requirements?	Rapid access to documents for reference, eg in emergency situations, auditing, comparison with new guidelines & updating	Records available on site & readily referred by type of material & procedure		*Proper record-keeping will assist in demonstrating duty of care, meeting of legal requirements & addressing public liability issues.*	
4.3 Do you undertake regular audits of the transport, storage, handling & use of hazardous materials?	Assurance that hazard materials management is consistent with best practice approaches	Evidence that transport, storage, handling & use of hazardous materials in addressed regularly through a formal auditing process	Annual audit	*The protocol for the annual environmental audit should include a section devoted to hazardous materials management. Audits can focus on specific problem areas; Case Study 8 in the Sustainable Minerals booklet describes how auditing was used to develop an integrated system for hazardous waste management at a site. Refer to the Environmental Auditing Sustainable Minerals booklet.*	
4.4 Do you have a system in place which encourages	Reduced risk of impacts from hazardous materials	Evidence that recommendations for improvement in	• Routine analysis & reporting of recommendations for	*Case Study 5 gives an example of the installation of a new cyanide recovery process for improving the*	

continuous improvement in hazardous materials management & waste disposal?	over time	hazardous materials management are implemented	all non-routine incidents involving hazardous materials • Recommendations from audits, investigation of incidents, inspections from the regulatory authority etc implemented within a set period, eg 3 months	*level of environmental protection & reduced consumption of cyanide.* *Case Study 7 gives an example of a mine which is storing iron oxide waste as it undertakes research to develop a market, so that it can dispose of the material as mineral processing feedstock.*	

Checklist for Landform Design for Rehabilitation

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
1.1 Have you collected a comprehensive suite of information on the pre-mining landform?	Baseline data presented in EIS & mine planning documents	Baseline dataset includes information on: • legal requirements for post-mining landform design • land ownership & boundaries • climate • topography, including drainage form & density • soils • vegetation	Record information on location & extent of severe land degradation (soil erosion, salinisation, weed invasion etc); valuable attributes eg undisturbed native vegetation, wildlife habitats & corridors, areas of prime agricultural land & its productivity; details of water courses; slope angles; land capability; soil type using the Northcote (1994) coding system; vegetation &	*Figure 1 in the booklet shows an example of land capability mapping, Table 1 shows land capability classes (after Hannan 1995).* *Figure 2 demonstrates how pre-mining map data can be used in mine planning such as planning for topsoil stripping.*	

		• community attitudes & expectations • present land use	its associations with soil type, soil moisture & topographic position.		
1.2 Is the pre-mine information presented in map form to facilitate its use in mine planning & in post-mine landform design?	Maps of the pre-mine land condition	Maps of: • land ownership information • topography • land capability • soils • vegetation			
1.3 Have you determined the post-mine objectives for landform design?	Statement of post-mine landform design objectives	Overall design objectives described in terms of appearance, land use, & stability; different areas within the site are specified for different landform topography, surface cover type, drainage density & potential land use/capability	Best Practice objectives aim to maintain or improve upon pre-mining land condition, eg by repairing severely degraded land, optimising the potential for beneficial use, & producing a landform & capability which are compatible with the immediate surrounding area & the regional landscape.	*Visual & land use compatibility of rehabilitated mined land is the most important consideration in landform design. Therefore acceptable best practice outcomes will differ from mine to mine depending on topography, climate, land use, land value, & proximity to urban development.*	
1.4 Have you consulted the community?	Records of consultative meetings with local representative groups & relevant local & State authorities, &	Evidence that the landform design is known to & accepted by local community & relevant authorities		*The benefits of early & frequent community consultation are described in the Sustainable Minerals booklet Community Consultation & Involvement.*	

	public meetings where landform design is described & discussed				
Part 2: General Design					
2.1 Have you adopted a whole-of-mine approach in the landform design?	Landform plan	Landform plan covers the entire mine project area & all aspects of mine development through to anticipated situation at cessation/completion of mining.	The landform in the landform plan is based on the amount of material expected to be excavated, processed & dumped through to the end of mine life. Best practice plans incorporate contingency landform plans & work programs which would be implemented if the mine were to close prematurely.		
2.2 Does the general design address key objectives for land compatibility, visual amenity, minimising damage, land restoration & optimal land use?	Landform plan which includes objectives to be achieved	Objectives address compatibility with surrounding landforms & drainage systems, visual appearance, minimising of damage to pre-existing natural or desirable landforms & associated attributes such as ecosystems & public amenity.	The landform plan can incorporate measure to rehabilitate land which was in a degraded state prior to mining, eg from earlier mining operations of from poor agricultural practice.		
2.3 Is the landform design compatible in terms of hydrological characteristics?	Landform plan which addresses hydrological compatibility	Landform plan incorporates measures to ensure resultant flows will not induce erosion. Suitable measures include catchment areas, watercourse gradients & calculated	Discharge points carefully selected to minimise downstream erosion	*Final discharge points are dictated by the location of suitable watercourses on surrounding land. Reshaping should be done*	

		maximum flow rates on the design landform which are no greater than for the pre-existing landform.		*to ensure runoff volumes & velocities at these points will not initiate erosion. State laws governing water diversion through property boundaries & the wishes of neighbouring landholders should also be taken into account when selecting final discharge points.*	
2.4 Is the landform design compatible in terms of drainage system characteristics, including drainage density?	Landform plan which addresses drainage system compatibility	Landform plan incorporates design features for constructed catchments which: • simulate the pre-existing catchment character in terms of size, slopes & densities • validate those design features through estimation of maximum flow rates	The pre-mine drainage system should be used as the benchmark design as they indicate equilibrium between slope lengths & drainage density.	*Slope length & drainage density are closely related. Drainage density on reshaped land should NEVER be lower than the pre-mining density. Since backfilled areas are usually elevated, it is safer to adopt a higher drainage density to reduce the amount of runoff each watercourse must handle.*	
2.5 Is the landform design compatible in terms of landform slope characteristics?	Landform plan which specifies slope angles & profiles to be used to enhance stability	Slope angles & profiles chosen based on pre-mine slope characteristics and/or the calculated characteristics of the constructed land surface	Best practice is to shape slopes to mimic natural slopes which are commonly convex in the upper parts & concave lower down, which has the effect of moderating energy as runoff moves downstream & reducing erosion potential. Note this	*Slope angle, profiles, & length are interconnected & must not be considered in isolation. Final slope form will affect earthmoving costs. Installation of erosion control (such as drop features, armoured ponds,*	

			usually increases the surface area of the new landform & increases earthmoving.	*riffles etc) should be used as a last resort & as "failsafe" measures, & not used as key elements in landform design.*	
2.6 Is the landform design compatible in terms of surrounding & pre-existing land use?	Landform plan addresses post-mine land use in the context of surrounding land & land uses	• Landform plan specifies the anticipated land use of the post-mine landform & describes how this land use is similar or complimentary to surrounding land use • Evidence that the local community & relevant authorities & community expectations endorse the land use objectives	Long term stability & low erosion potential are key considerations in choosing appropriate land use. Close community consultation is required to ensure there are no false expectations. Best outcomes will be influenced by climate, proximity to communities/ urban areas, land value & diversity of land use in the district.	*Land use is unlikely to be exactly the same as before mining. Options may include industrial, recreational, residential, habitat reconstruction, agriculture, grazing. Ongoing consultation throughout mine life is critical. Different land uses may require different types of decommissioning & revegetation - refer to the Sustainable Minerals booklets on Rehabilitation & Revegetation, and Mine Decommissioning. Slope angle can place major limitations on land use options.*	
2.7 Have you considered ways in which operational elements of the mine can be used to form key elements of the landform & drainage design?	Construction of the landform design utilises key operational elements of the mine layout, facilitating smooth transition from operational	Incorporation of key operational elements into the landform design does not compromise the landform design in terms of erosional stability, land capability, land use, & visual aesthetics.	In the mine planning phase, design & location of key operational elements of the mine are determined by considering landform design & rehabilitation requirements. Refer to the Sustainable Minerals booklet on Mine Planning	*Forethought in mine design through integration of location & design details of operational & rehabilitation can reduce earthmoving costs relating to mine closure very considerably. For*	

	to rehabilitation phase & minimising earthmoving costs			*example, ramps into voids can be reshaped into major watercourses.*	
2.8 Have you used specialised tools to assist in improving the quality of landform design?	Detailed models of final landform options allowing testing of optimum design	• Design based on quantitative data. • Design objectives based on criteria collected from pre-mine natural landform. • Design outputs allow quantitative estimates of stability (erodability), land capability, land use options, & aesthetics.	3D models are effective ways of conveying features of the landform design to stakeholders. Computer-based systems are amenable to frequent adjustment to the model to take into account changes in mine size & shape, overburden ratios, length of mine life, & changing regulatory or community requirements.	*Useful tools include DTMs, & landform design packages such as ARGUS (developed by ACIRL). Examples of the application of computerised systems for landform design are given in Case Studies 6 & 7.*	
Part 3: Placement of Spoil					
3.1 If spoil is not going to be returned to the voids, have you carefully considered where the spoil heaps should be located?	Results of surveys	Survey data include information on distribution of: • rare & endangered species • heritage sites • valuable ecosystems • natural drainage pattern characteristics • pre-mining landform.	Consider pre-existing characteristics, especially drainage, to determine whether the new landform & drainage courses can be constructed without risking the landform & hydrological stability of the surrounding area.	*The cost of double-handling spoil will reduce profit margins & can influence the economic feasibility of working lower grade, deeper or more difficult ore zones.*	
3.2 Before placing any spoil in its temporary or permanent location, have you:	Exploration data indicating limits on economic resources on the project area.	Exploration data for all areas likely to be considered for spoil dumping are sufficient to indicate that no economic resources underlie those areas.		*The cost of double-handling spoil will reduce profit margins & can influence the economic feasibility of working*	

• ensured that the underlying land is not significantly mineralised?				*lower grade, deeper or more difficult ore zones.*	
3.3 - conducted appropriate environmental & heritage surveys?	Results of surveys	Survey data include information on distribution of: • rare & endangered species • heritage sites • valuable ecosystems • natural drainage pattern characteristics			
3.4 - carefully considered design & operational alternatives which will reduce the need for rehandling of spoil material?	Mine Plan which cross-relates operational requirements & layout, with rehabilitation & post-mine landform design	Mine Plan describes how material should be placed to meet both short-term operational & long-term rehabilitation requirements. Minimum rehandling of spoil, tailings, topsoil & other materials.	The Mine Plan & Rehabilitation Plan should be reviewed periodically (& no less than every five years) & amended to maintain operational & rehabilitation efficiencies (ie minimise costly rehandling of materials).		
3.5 Have you designed the surface shape of the spoil to reduce the potential for sudden or long-term failure, maximise	Specifications for surface design in Rehabilitation Plan	Rehabilitation Plan includes specifications for slope lengths, slope angles, slope profiles & other surface shaping	Best practice is to define specifications which closely mimic the pre-mine condition, or are compatible with natural landforms in the district. These should meet community	*In general, slope lengths should be no more than 50m; slopes less than 20o (36%) on erosive materials (this is also the working limit for safe bulldozer operation); &*	

the probability of success for revegetation, & conform with legislative requirements?			expectations for appearance & land use. Shaping can be a two-stage process to suit operational efficiency through staging of works.	*hills on the constructed landform should be no higher than natural surrounding hills.*	
3.6 Have you incorporated design elements relating to the character of the spoil?	Information on spoil character in Rehabilitation Plan	Evidence that design of landform elements considers the physical & chemical characteristics of the spoil, eg dispersivity, infiltration rates, erodibility, swelling coefficient & chemical reactivity.	Characterisation of different spoil types to be encountered from place to place & at different times during mine life. Landform design which optimally places each type & designs local landform elements within the overall landform design to match their characteristics.	*Spoil characteristics such as differential volume increase & settling can result in major disruption to the design surface, resulting in disrupted drainage courses, waterlogging etc. Volumes & surfaces can be calculated to compensate for later changes from compaction, swelling etc.*	
3.7 Have you considered the polluting potential of the spoil material in your design?	Rehabilitation Plan addresses contaminated & potentially polluting material	Character of contaminated/potentially polluting material described in Rehabilitation Plan & measures included in landform design to reduce risk of exposure or leachates.	Figures 11-13 show the difference in construction of concave & convex landforms over inert & unstable materials respectively.	*Concave shapes are commonly used to reduce runoff by increasing infiltration. If the material includes contaminated material then in general, convex surfaces should be used to reduce infiltration & resultant groundwater contamination. Case Study 5 describes shaping & capping of contaminated material.*	
3.8 Have you incorporated design	Landform design includes	Landform design likely to result in a land capability for		*Land capability classes are described in Table 1*	

elements relating to land capability?	assessment of resultant land capability	the constructed landform which is compatible with: • land capability classes of the surrounding land • regulatory requirements and/or • community expectations		*in the booklet.Land use is unlikely to be exactly the same as before mining. Options may include industrial, recreational, residential, habitat reconstruction, agriculture, grazing. Ongoing community consultation throughout mine life is critical. Different land uses may require different types of revegetation & decommissioning - refer to the Sustainable Minerals booklets on Rehabilitation & Revegetation, & Mine Decommissioning. Slope angle can place major limitations on land use options.*	
3.9 Have you incorporated design elements relating to the slopes of the constructed water courses?	Landform design specifies tolerances for bed slope & cross sections for constructed water courses	Specifications for watercourse bed slopes & cross sections based on calculations of estimated maximum flow regimes	Parameters also based on measurements of nearby/pre-existing undisturbed watercourses with similar flow regimes		
3.10 Have you incorporated design elements relating to the visual	Landform design specifies shapes, slopes, catchment sizes &	Landform design specifies shapes, slopes, catchment sizes & watercourse densities similar to natural landscape in	Landform model & its visual appearance agreed with community & authorities early in mine		

appearance of the end landform?	watercourse densities over areas of reshaped soil similar to natural landscape in surrounding district	surrounding district	planning/mine life. No hills in constructed landform higher than natural surrounding hills.		
3.11 Have you incorporated design elements relating to the interface with the surrounding land?	Landform design includes details for construction of interface areas with surrounding land.	Design incorporates features to minimise risk of erosion, differential settling, collapse or blocking by sedimentation along edges of constructed landform.	Careful matching of design & flow capacities of constructed & natural watercourses. Design adjustments to offset impacts from differential settlement or swelling of spoil.		
3.12 Does your design for the final landform to be constructed from the spoil either reflect the pre-mine condition of the area, or community expectations for post-mine land condition & use, or both?	Report assessing the constructed landform surface against agreed targets	Objective assessment, including both quantitative & qualitative measures	Parameters for assessment agreed with relevant community representatives & regulatory agencies. Inclusion of community & regulatory representatives on assessment panel.		
3.13 Does your design for the final landform to be constructed from the spoil meet legislative requirements?	Rehabilitation Plan includes checklist of features against regulatory requirements	Rehabilitation Plan meets all regulatory requirements			

3.14 Does the landform design incorporate measures to reduce the risk of erosion, & exposure of contaminated or hazardous material?	Design identifies any contaminated or hazardous materials & specifies features to minimise risk of exposure by erosion, settlement or collapse	Design identifies any contaminated or hazardous materials & specifies features to minimise risk of exposure by erosion, settlement, collapse	Best practice requires potentially hazardous material to be tested to determine potential for contamination, eg acid producing potential calculations for sulphidic waste rock. Encapsulation, treatment or capping systems designed specifically for the waste on your site.		
3.15 Is your landform planning able to accommodate probable changes to volume & area changes in mining, & changing regulatory or community requirements & expectations?	Periodic review of plan to assess compatibility with changes in mine status, regulatory requirements, & community expectations	Evidence of modifications to plan & conformity with current mine volumes (spoil, voids), regulations & community expectations	Annual review of Rehabilitation Plan.		
3.16 Do your operations include a program for progressive construction of the final landform (as far as is practicable) during the mine operations phase?	Mine Plan requiring progressive rehabilitation	Mine Plan requiring progressive rehabilitation, compatible with progressive achievement of the final landform design	Progressive landform construction includes early stabilisation & vegetation. When complete, some areas may be used for the intended post-mine land use to test land capability against objectives & demonstrate success to stakeholders (eg grazing	*Topsoil can be relocated direct from new areas of stripping onto progressive rehabilitation areas to maximise soil microfauna & seed bank viability. Some jurisdictions will reduce rehabilitation liabilities/pay back bonds as the total area requiring*	

			stock, cropping).	*rehabilitation is reduced through a progressive approach.*	
3.17 Have you used design tools which will reduce the risk of error in design & construction cost calculations?	Design involves quantitative survey data & use of precision 3D design tools	Design involves quantitative survey data & use of precision 3D design tools.	Appropriate tools include: • on-site digital surveying methods to capture the pre-mine condition • Digital Terrane Models (DTMs) • computerised 3D terrane modelling	*An example of a system devised for mine landform design is ARGUS, developed by ACIRL. Note the result is only as good as the inputs, remember "garbage in, garbage out!" Case Studies 6 & 7 give examples of reducing errors in dragline spoil calculations, & comparison of the pre-mine landform with post-mine landform design.*	
Part 4: Surface Water Control and Revegetation					
4.1 Have you incorporated features in the general design to minimise erosion?	Landform design in Rehabilitation Plan contains section on erosion control	Landform design incorporates measures to: • avoid topsoil loss during rehabilitation • minimise long-term erosion • establish a self-sustaining vegetation cover		*More useful information is in the Water Management Sustainable Minerals booklet.*	
4.2 Have you chosen a ground surface design which will reduce	Landform design in Rehabilitation Plan incorporates features to reduce	Inclusion in the landform design of features to: • maximise infiltration	Control of erosive forces should be inherent in the basic landform design, through careful choice of	*Concepts for small-scale surface shaping to reduce runoff energy & control flow direction are shown*	

erosional forces in runoff?	quantities & rates of runoff	(over inert material only) • control & direct water flow • disperse energy	catchment sizes, slope lengths, angles & profiles, & long section & cross section watercourse profiles. Control structures such as retention ponds, surge ponds & drop structures should be used only as a last resort, or as back-up / failsafe features.	*in Figures 15 & 16.*	
4.3 Have you incorporated features in the design to minimise contamination?	Landform design in Rehabilitation Plan contains section on pollution control	Landform design incorporates measures to: • separate clean from contaminated water • contain, collect & intercept contaminated water for re-use or treatment.	Best practice techniques include: • diverting runoff from disturbed areas to maintain water quality • collecting runoff from disturbed areas for treatment (eg settlement) 7 re-use • collecting runoff from plant/workshop areas for treatment (eg oil separation, neutralisation etc) • containing decant & process waters in a closed circuit • interception & return or treatment of tailings water seepage & saline groundwater.	*More useful information is in the Water Management Sustainable Minerals booklet.*	

4.4 Does your works program include provision for speedy application of measures to stabilise the final landform & reduce the risk of erosion or other failure?	Mine Plan & Rehabilitation Plan require early stabilisation of the constructed landform	Mine Plan & Rehabilitation Plan requires early stabilisation of the constructed landform & therefore should specify timelines & techniques to be used.	The period of susceptibility to & degree of erosion damage can be reduced by: • delaying topsoiling & cultivation to as close as possible to the sowing date • sowing when soil moisture & weather conditions are most favourable for rapid germination & growth • including in the seed mix at least one species which will grow quickly to provide early ground cover (even if it will not form part of the long-term species mix) • cultivation on the contour & avoiding traffic diagonally or up & down the slopes • cultivation in one pass, & deep enough to penetrate the underlying spoil material • mulching to retain moisture & resist	*Techniques include hydro-seeding, hay mulching, "Finn" technique. Other approaches include placement of topsoil & vegetable trash as soon as the landform surface is available (eg directly transported from pre-strip area to maintain seed & soil microfauna viability). Refer to the Rehabilitation & Revegetation Sustainable Minerals booklet*.	

			erosion		
Part 5: Landform Considerations Relating to Mine Pits					
5.1 Have you considered the option of in-filling the mine voids?	Consideration of options for spoil & tailings placement in EIS & Mine Plan	Full evaluation of the in-pit option, including detailed cost calculations & estimates of impacts on post-mine land capability, land values & community acceptance.	Best practice is to avoid leaving mine voids where practicable.	*Efficient pit design & excavation & trucking considerations often make in-pit replacement of spoil & tailings impracticable. In some cases at least part of the pit must be left open if there is an option to extend into a later phase of underground mining. Small orebodies may be mined & stockpiled before processing begins (eg Case Study 5). Long or pod orebodies may allow progressive backfilling. Old adjacent pits can be backfilled if available.*	*If cliff forms are not collapsed, access should be controlled through perimeter ditches and/or bunds, fences, & signage. Surface runoff should be diverted away from the tops of cliff faces.*
5.2 If spoil is not going to be returned to the voids, have you incorporated safety features in the design of the final void?	Landform design incorporates safety features	Landform design incorporates safety features to reduce risk of: • people, livestock, & wildlife falling over highwalls & other steep areas • people, livestock, & wildlife entering steep-shelving water bodies • people, livestock, &	Voids reshaped to reduce risk of long term failure; collapse of highwalls will assist safety by removing dangerous cliffs & encouraging vegetation cover which will improve surface stability. This approach also improves visual amenity by reducing or avoiding bare rock surfaces.		

		wildlife accessing contaminated water bodies or surface materials • ignition of coal seams			
5.3 If spoil is not going to be returned to the voids, have you considered potential beneficial uses for the remaining voids?	Mine Plan & Rehabilitation Plan incorporate measures for beneficial uses of voids	Evidence of consultation with community & authorities to determine acceptable uses, & associated design work.	Key requirements for beneficial use include physical stability of walls & other structures, & achievement of a stable water quality appropriate to the intended use.	*Suitable uses for voids include water storage, surge & flood mitigation, recreation (including water sports, fishing, & establishment of flora, fauna or wetland reserves).*	

Checklist for Managing Sulphidic Mine Wastes and Acid Drainage

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information & Planning - refer Chapter 4 in the Sulphidic Mine Waste & Acid Drainage Sustainable Minerals booklet					
1.1 Have you determined whether any of the rock materials on your operation have the potential to cause acid drainage?	Results of geochemical tests on acid producing potential of rock samples from your operation	Geochemical testing includes static & kinetic testing methods (refer to Questions 1.8 - 1.11)		*Pointers to the potential significance of acid drainage at you site may be gained from a review of acid generation at any other similar mines in the region. Case Study 2 in the Sustainable Minerals booklet describes sampling, testing, modelling approaches & characterising rock types into blocks representing different*	

				acid potential characteristics.	
1.2 Have you collected & tested rock samples as early as possible in your operation to determine appropriate handling & management strategies as early as possible?	Suite of data on acid producing potential commencing from exploration phase & continued throughout the operation	Suite of data based on exploration drilling, resource delineation, metallurgical testing & operational stage sampling & testing	Progressive geochemical results on acid producing potential of rock samples from your operation collected throughout exploration, resource development, mine construction & mining operations	*Case Studies 2 & 3 describe approaches to characterising the acid potential of different materials & prescribing different techniques to manage their potential to impact on the environment.*	
1.3 Have you characterised the main rock types at your operation?	Suite of data on acid producing potential of all significant rock types	Data on acid producing potential include test results on ore, waste, & materials to be used in construction.			
1.4 If you have sulphidic material at your site, have you assessed the primary factors which will influence the rate & degree of oxidation?	Information on: • water availability for oxidation & transport • oxygen availability • physical characteristics of the material • temperature • pH • ferric/ferrous iron equilibrium • microbiological activity	Evidence of estimates of the likelihood of these factors being significant in influencing the rate & degree of oxidation of the sulphidic materials		*Access to oxygen & water are critical to the rate & degree of oxidation of pyrite. Oxidation may be abiotic, but bacteria accelerate oxidation rate in nearly all cases of acid drainage. Oxidation is greatest between pH 2.4 - 3.6. In acidic conditions ferric iron is a powerful oxidising agent which commonly promotes oxidation of other sulphide minerals.*	
1.5 If you have sulphidic material	Information on minerals present within ore, waste &	Evidence of calculation of the amount of alkaline		*The amount of alkaline material can be sufficient to*	

at your site, have you assessed the secondary factors influencing acid generation?	other rock materials which can moderate the amount of acid drainage produced	minerals present, ie carbonates, silicates & aluminosilicates		*offset acid producing potential, although oxidation can still take place in non-acid conditions; kinetic testing is required to accurately determine acid producing potential and rates.*	
1.6 If you have sulphidic material at your site, have you assessed the tertiary factors influencing acid generation?	Information on rainfall, temperature, surface runoff, infiltration resulting from rainfall, physical properties of sulphide-bearing waste piles, & chemical properties of receiving waters	Evidence that the influence of these factors has been taken into account in estimating the potential for acid drainage on the site		*Sulphide oxidation is markedly faster in air than in water, hence loose, coarse waste piles allow greater oxygen fluxes & faster oxidation. Surface runoff will carry the acid into the environment & cause degradation, although high volume runoff can dilute acidity to benign levels. Alkaline receiving waters can moderate pH & promote precipitation of metals to less toxic forms. Dissolved organic matter may complex metals in solution.*	
1.7 Based on the information you have collected, have you undertaken an acid drainage risk analysis?	Acid drainage risk analysis	Acid drainage risk analysis: • characterises the acid generating potential of the materials • characterises the mobility of metals & other environmentally		*Potential impacts on mine operations & the environment to be considered by the analysis include:* • *mine water quality (limiting reuse of mine water & process water, & causing*	

		significant constituents of the acid drainage • estimates the potential for oxidation products to migrate to the environment • estimates environmental sensitivity & assimilation capacity of the host environment		*corrosion problems)* • *effects of acidity & dissolved metals on downstream aquatic ecosystems* • *effects on downstream riparian ecosystems, such as tree deaths or decline of keystone species* • *possible degradation of groundwater quality, especially shallow aquifers* • *impairment of beneficial use of downstream waters, ie water supply, irrigation, stock watering, recreation, fisheries* • *difficulties in revegetating & stabilising mine wastes* • *rehabilitation costs* • *potential long term liability for mine operators, regulators & community. See the Framework for Risk Analysis for Managing Sulphidic Mine Wastes*	

				produced by ACMER.	
1.8 Have you observed correct procedures in collecting your samples for acid potential analysis?	Samples collected, packaged & stored to prevent degradation prior to analysis	Samples are: • representative, based on accepted statistical procedures, & including samples of all geological units • sufficient in number to reflect geological variability & complexity of rock types • sufficient in number to provide confidence in predictive ability	Samples should be: • stored in a cool, dry place to minimise oxidation prior to testing • sufficient in quantity to allow for both heterogeneity in the sample unit & to allow repeat analysis to validate results.	*Tips on sampling techniques for assessment of acid drainage potential are given in volume 2 of the MEND report. Problems with geological variability are discussed in the proceedings of the 3rd ACMER Workshop on Acid Mine Drainage.*	
1.9 Have you included geochemical static tests in your analysis of samples for acid potential?	Geochemical analysis includes static test methods	Static geochemical testing includes: • acid base accounting or net acid producing potential (NAPP) test • net acid generation (NAG) test • saturated paste pH & conductivity (EC) • total & soluble metal analysis	Results from a single type of test may be misleading. Interpretation of results should be based on a range of static & kinetic analytical techniques & careful consideration of the full suite of results. See Questions 1.10 & 1.11.	*NAPP estimates the theoretical maximum acid producing potential by subtracting the acid neutralising capacity from the total potential acidity of the sample.* *NAG is a simple & fast, direct, method to determine the net result of acid & base reactions. Saturated paste/EC gives a preliminary indication of in-situ pH, &*	

				the level of soluble constituents. *T & S metal analysis determines the increase in metal mobility by the acidity which would be released from the material.*	
1.10 Have you included geochemical kinetic tests in your analysis of samples for acid potential?	Geochemical analysis includes kinetic test methods	Data available from column tests &/or humidity cells using material from this site	Expert assistance should be accessed when selecting, designing & interpreting kinetic tests	*Standard testing usually takes 8 - 10 weeks for coal mine material, & longer for hardrock mine material. Column tests are considered more representative of field conditions & allow for remediation options to be tested & compared. Testing techniques & associated issues are discussed in the 3rd & 4th ACMER Workshops on Acid Mine Drainage, & in volume 2 of the MEND report.*	
Part 2: Management & Operation - refer Chapter 5 & Chapter 6 in the Sulphidic Mine Waste & Acid Drainage Sustainable Minerals booklet					
2.1 Do you have a commitment from management to implement effective strategies for control of acid mine drainage?	High level corporate commitment to investigation into & control of acid drainage, & appropriate funding line	Commitment to control of acid drainage mentioned in Corporate Environmental Policy & detailed in Environmental Management Plan		*Case Study 4 describes a corporate philosophy for acid drainage management, which includes an integrated risk management approach.*	
2.2 Is the commitment to	The range of policy, planning & operational	Environmental Management System & operational	Documents state quantitative environmental protection		

management of acid drainage translated into operational documents?	documents reinforces commitment to control of acid mine drainage	manuals contain sections devoted to acid drainage	targets as limits for pH & dissolved metals which pose no significant risk to downstream aquatic & riparian ecosystems		
2.3 Are staff aware of correct procedures for management of acid drainage?	Staff aware of their responsibilities through operational manuals, signage and duty statements.	Procedures available to all staff, & prominently displayed at key locations, such as at pumping stations, dump areas for sulphidic material			
2.4 Are staff trained in acid drainage operational & issues management?	Staff knowledgeable of their individual & collective responsibilities in managing acid drainage	Staff trained, with frequent refresher courses	All new staff should be inducted into site environmental protection requirements & procedures including acid drainage management, within 2 weeks of appointment.		
2.5 Are procedures for management of acid drainage integrated with the mine water management plan & system?	Integrated plan, system & protocol for managing mine water & acid drainage	Acid drainage procedures & systems form an integral part of the water management system within the environmental management plan for the site		*Case Study 1 in the Sustainable Minerals booklet describes the importance of integrating the acid drainage & water management systems on a mine site.*	
2.6 Have you selected strategies to control acid drainage at source, which are tailored to the characteristics of your operation?	Acid drainage management system which is optimal for the site & which minimises the amount of acid which may need to be treated or remediated later	Acid drainage management system, which, considering the characteristics of the site, minimises: • access of oxygen, water & bacteria to the sulphidic material	Measures to prevent or reduce acid generation at source are much preferred over measures which set out only to treat the uninhibited acid flow	*Common techniques for reducing oxygen & water access to sulphidic material are:* • *soil covers - reduces air & water access* • *water covers -*	

		- transport of acid away from the oxidation site by limiting percolation into & through the oxidising material - solubility of oxidation products & other soluble constituents through pH control		*maximum concentration of oxygen is about 25000 times lower than in air* *selective handling & isolation of sulphidic waste - ie isolation or encapsulation* *compaction - by truck or roller, reduces infiltration & air flux* *mixing in of alkaline material - ie lime, fly-ash or limestone* *blending - with alkaline waste material* *bacterial inhibition - application of bactericide is only a short-term solution for applications such as temporary stockpiles.* *The engineering options for reducing acid generation in mine waste dumps & tailings storages are summarised in Table 1 of the Sustainable Minerals booklet.*	
2.7 Have you selected acid drainage	Acid drainage management system which is optimal for the site & which	Acid drainage management system, which, considering the characteristics of the site,	Best practice is for "no release" water management systems on mines, so that	*Common techniques for treating acid water are:*	

treatment strategies which are tailored to the characteristics of your operation?	minimises the risk of acidic mine water flowing to the environment	minimises: • the volume of water to be treated • the acidity of the water released into the environment • the concentrations of metals & other constituents which may pose a risk to ecosystem health & to downstream water users & uses	there is effectively no risk of impact from contaminated water, including acidic & metal-rich mine water. Where a "no release" policy is not feasible due to high rainfall/low evaporation, care should be taken to divert as much clean water as possible away from areas of potential contamination to minimise the volumes requiring treatment	• *neutralisation with alkaline reagents (eg limestone, hydrated lime, quicklime, caustic soda or caustic magnesia), followed by settlement to recover fine metal precipitates (hydroxides). This sludge needs special separate disposal. This approach is costly & high maintenance, therefore unsuitable for long term application.* • *metal recovery; if in high enough concentrations, dissolved metals may be economically recovered by solvent extraction, leaching & electrowinning* • *passive systems to introduce alkalinity through limestone-lined drains or combined limestone/organic matter systems (suited to low-flow situations,*	

				requiring some maintenance & replacement of alkaline material) • *wetland filter systems which combine physical, chemical & biological processes to moderate pH & attenuate metal concentrations.* *The design of some passive control techniques are illustrated in Figures 13-16 of the Sustainable Minerals booklet.*	
Part 3: Monitoring & Assessment - refer Chapter 7 in the Sulphidic Mine Waste & Acid Drainage Sustainable Minerals booklet					
3.1 Is there a monitoring regime in place for detecting & monitoring acid drainage?	Mine EMP includes a documented monitoring regime for acid drainage	Monitoring regime comprehensive & includes all areas where acid drainage may be generated & move to, including all pathways for potential release of into the environment with emphasis on surface water drainage & ground water; & direct monitoring of wildlife & livestock	Essential components of a best practice monitoring regime for acid drainage are: • background studies to identify environmental values requiring protection, including ecosystem characteristics & catchment water quality • classification of all materials during mine development & operations	*The Environmental Monitoring & Performance Sustainable Minerals booklet discusses design of monitoring programs.* *The most common indicators for sulphide oxidation is SO4. Other possible indicators are iron, copper, zinc, manganese, lead & cadmium, & major ions calcium, magnesium, aluminium, sodium & potassium.* *High SO4 concentrations &*	

			- point source monitoring to locate any areas of sulphide oxidation & acid generation - monitoring of catchments & groundwater systems upstream & downstream of the mine to identify any impacts & long term trends - monitoring of control strategies to determine effectiveness - continuation of monitoring post mine closure.	*reduced alkalinity in drainage indicates sulphide oxidation even when pH is around neutral. Decreasing pH & increased metal concentrations can lag behind increases in sulphate due to buffering & neutralisation.* *Specific variables in receiving waters (eg total carbon, alkalinity) should be measured to assess buffering capacity & to help predict potential & actual impacts on aquatic environments.*	
3.2 Does the monitoring program include an inventory of all waste types, materials classification & production levels?	Inventory. All areas of the operation & all material with the potential to generate acid drainage are captured by the monitoring program	Monitoring program includes: - static & kinetic testing data to classify wastes & identify selective h&ling requirements - production requirements of respective waste rock types - storage location & date of emplacement	Non-acid producing & alkaline material should be inventoried & their suitability as cover or encapsulating agents assessed.	*The acid potential of new types of materials encountered during mine life may differ from material characterised at the beginning of mining. Sampling & testing using static & kinetic techniques should continue throughout the mining phase. Data - particularly long-term data - will be critical to effective rehabilitation design.*	

		of identified mine wastes			
3.3 Are higher risk materials closely monitored?	Monitoring data. Build good underst&ing of stockpile behaviour for sulphidic material & trends over time	Data on oxygen & water flux conditions, & assessment of effectiveness of any control strategies such as temporary or permanent clay caps and blending		*Case Study 1 in the Sustainable Minerals booklet describes temporary reduction of acid drainage with water covers.*	
3.4 Are covers or surrounding material for isolating sulphidic materials being monitored?	Monitoring data to assist in rehabilitation planning	Where rehabilitation strategies include the use of covers & encapsulation, monitoring should include: • oxygen ingress diffusion rates (determined by oxygen partial pressures within the stockpile) • temperature profiles in the stockpile • water flux through the stockpile (using lysimeters & piezometers • physical stability, ie cracking, erosion, of the cover material		*Long term monitoring is important as many mining l&forms may become permanent l&scape features.* *The major factors which determine long term environmental risk from acid drainage are:* • *the characteristics & behaviour of the mined materials* • *the geographical characteristics of the site including its location* • *the regional climatic conditions.*	
3.5 Does the mine closure plan incorporate	Mine closure plan considers long term risk from acid drainage &	Mine closure plan: • assesses long term	To reduce cost & liability for ongoing maintenance, treatment systems should as	*Case Studies 5 & 6 describe approaches for covering & encapsulating sulphidic*	

strategies to minimise risk of long term impacts from acid drainage?	includes measures to minimise that risk	risk & areas of higher potential for acid generation & movement • includes features to reduce acid generation after mine closure as far as practicable • includes features designed to treat any acid drainage with the potential to reach the environment • is based upon performance objectives which are protective of the downstream aquatic & riparian environments, & are within prescribed guidelines for downstream actual or potential water uses	much as possible be low-maintenance passive systems, such as wetland filters or alkalinity-reproducing systems for low flows	*materials in waste dumps, pits & tailings dams for final mine rehabilitation.*	

Checklist for Mine Decommissioning

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: General Planning and Principles- refer to Chapter 3 in the Sustainable Minerals booklet					

1.1 Do you have a mine closure policy?	Mine Closure Policy	• Policy developed as early as possible - at the feasibility stage for new mines • Policy encompasses closure issues related to landform, land use, community expectations, ramifications for mine planning design, & approximate costs	Decisions on mine layout, mine size, dump location, style of mining & equipment, tailings storage & disposal, & water management system principles made with reference to mine closure policy & objectives.	*Also refer to the Sustainable Minerals booklet on Mine Planning. ANZMEC/MCA has produced a Strategic Framework for Mine Closure.*	
1.2 Have you developed a conceptual Mine Closure Plan?	Conceptual Mine Closure Plan	Conceptual plan translates the closure policy into tangible landform design plans, with proposed rehabilitation strategies for open pits, waste dumps & underground voids, feasible land use options, & vegetation & surface drainage outcomes appropriate to the site.	Best practice conceptual plans are based on the objective of returning the mined land to a land capability not less than the pre-mining condition - refer to the Sustainable Minerals booklet on Landform Design for Rehabilitation		
1.3 Were stakeholders engaged in the development of the conceptual plan?	• Conceptual mine closure plan acceptable to key stakeholders. • Reports of consultative meetings, correspondence.	Evidence that: • stakeholders & interested parties are properly identified • consultation is effective &		*The Sustainable Minerals booklet on Community Consultation & Involvement provides advice on effective communication methods. Case Study 1 & Case Study 2 provide*	

		inclusive • the company developed a targeted communication strategy & followed it • adequate resources are allocated to ensure effectiveness of the consultation process		*examples of effective consultation at this stage.*	
1.4 Have you established a framework for developing & maintaining an operational Mine Closure Plan?	Mine Plan & management directives require development of a Mine Closure Plan	Mine management has endorsed a framework for a Mine Closure Plan which stipulates: • mine closure planning & practice shall be integral to the whole of mine life plan • a risk-based approach to reduce uncertainties & costs • technical, economic, environmental & social assessments of the plan to ensure its feasibility • the plan shall be amended regularly	• Significant new developments are being made into approaches, techniques & technologies relevant to mine decommissioning • Regular reviews should include assessment of new developments & their possible application to your site	*Case Study 3 describes a systems approach to the regular review & continual improvement of a mine decommissioning system.*	

		to maintain relevance to the current mine status & development plans • regular, critical review to reflect changing circumstances.			
1.5 Has adequate financial provision been made for the closure program?	Feasibility planning includes economic evaluation of mine closure costs	• The cost estimate for closure is developed directly from the closure plan • closure costs reviewed regularly to reflect changing circumstances • the financial provision should match the real cost • accepted accounting standards should be used as the basis for the financial provision • adequate securities should protect the community from closure liabilities		*The ANZMEC/MCA Strategic Framework for Mine Closure (2000) sets out principles for appropriate financial provisions.*	
1.6 Have appropriate standards & criteria	Closure standards & criteria	The broad framework for the closure standards		*Case Study 5 is an example of closure*	

been set for closure?		should be based on regulatory requirements. Standards should be: • acceptable to key stakeholders & the company • achievable • transparent. • specific to the mine in question • supported by targeted research		*issues featuring prominently in gaining approval to develop a new mine. Case Study 6 is an example of how appropriate closure standards can be developed from research into potential long term effects.*	
1.7 Is mine closure planning treated as an ongoing & significant operational management issue?	Mine closure treated as an integral issue for current & future operational & financial planning	• Evidence that mine closure planning & activities are integrated into day-to-day operations (eg as a regular agenda item in operational planning & review meetings) • Evidence of progressive rehabilitation & decommissioning works as opportunities arise	As operational elements become redundant, action can be taken to completely decommission & rehabilitate them - eg stabilise, shape, cap & revegetate completed waste dumps, dismantle superseded plant, fill open pits with waste rock to avoid increasing footprint of mine.	*Progressive rehabilitation is a key best practice component of mine closure, effective rehabilitation, & delivery of community expectations. Progressive rehabilitation is discussed in the Sustainable Minerals booklet on Rehabilitation & Revegetation.*	
1.8 Are opportunities for progressive closure identified &	Progressive works during operations to reduce closure liabilities	• Annual operational works program includes progressive		*Effective progressive decommissioning & rehabilitation can be*	

activated?		decommissioning & rehabilitation elements • Site inspection.		*used to reduce the size of rehabilitation bonds held by regulatory authorities, & reduce the cost, length &scale of the effort required at the end of mining.*	
Part 2: Developing and Maintaining the Mine Decommissioning Plan - refer Chapter 4 & Chapter 6 in the Sustainable Minerals booklet					
2.1 Is the Mine Closure Plan properly integrated with other operational & management plans?	Integrated management systems across all operations including future mine closure	• Closure Plan cross-referenced to other operational plans & EMS • Objectives & procedures of all operational plans are consistent with closure objectives & efficient attainment of closure design.		*Decisions in all operations should be made bearing closure design in mind, eg waste dump locations & heights should conform to closure landform design to avoid the cost of double-handling.*	
2.2 Does the Plan include detailed cost estimations & financial provisioning related to a detailed plan of works?	Detailed & fully costed plan of works for mine closure	• Indicative costs used in early stages. More precise estimates provided as mine life & experience grows • Estimates incorporate a contingency factor for cost over-runs.& include post-closure management &	A series of spreadsheets can be developed to factor in more accurate data on volumes/costs/ time as they become known.	*Tables 4.2 to 4.4 provide examples of indicative costs for earthworks, topsoil spreading, ripping, seeding, infrastructure demolition & disposal. Management & monitoring costs typically range from 10-25% of total costs depending on the site.*	

		monitoring costs.			
2.3 Have you used a risk-based approach to improve the reliability of the Plan?	Risk assessments on mine closure elements	Evidence of risk assessment of the closure plan & procedures, including: • quantification of subjective factors • uncertainty analysis of design performance & costs • environmental, engineering, financial, legal & community aspects considered.		*The risk analysis should involve appropriate site/consultant specialists in the various specialist fields.*	
2.4 Do you have a plan of research related to decommissioning?	Mine closure research plan & program	Research program objectives based on better defining: • mine closure plan objectives • areas of uncertainty identified in risk analysis • methodologies & specifications of works to achieve standards, targets & objectives			

2.5 Does the plan evolve to reflect changes in mine status, character, size, research outcomes etc?	Revised mine closure plans tailored to current mine characteristics & best estimates of status at closure	• Current mine closure plan reflects current mine status. • Evidence of incorporation of research results. • Evidence of periodic updating		*The plan must be revised whenever changes to mine life, mine throughput, mining or processing techniques, nature of materials mined or wastes produced, mine footprint or operational systems are planned or encountered.*	
2.6 Is the Plan periodically reviewed to gauge technical, economic, environmental & social feasibility?	Review reports assessing technical, economic, environmental social feasibility	Review reports should provide incisive & objective commentary on the closure plan's feasibility & identify any possible liabilities	Continued community consultation on the closure plan through the operational phase & more intensively when the final plan is determined.	*Case Study 5 is an example of how decommissioning objectives were radically changed to improve their social & environmental acceptability & feasibility.*	
2.7 Is the plan periodically reviewed against regulatory requirements & commitments to stakeholders?	Review reports assessing adequacy of plan against regulatory requirements & commitments to stakeholders	Review reports assess adequacy of plan against regulatory requirements & commitments to stakeholders		*Note that regulatory requirements may change, associated with changes to State & local government legislation, codes & by-laws. Changes to the plan should be carefully screened for variances from commitments agreed with stakeholders including the local community.*	
2.8 Is the plan periodically reviewed	Review reports assessing cost liabilities & implications for the	Review reports assess cost liabilities & implications		*Incremental changes to the plan may result in*	

to determine cost liabilities & implications for the financial operations of the company?	financial operations of the company	for the financial operations of the company		*significant deviations in cost from the original plan estimates.*	
2.9 Have you incorporated arrangements in the Plan in the event of sudden unplanned or temporary closure?	Mine Closure Plan includes provisions for unplanned or temporary closure	• Provisions for unplanned or temporary closure accurately reflect current mine status • objectives for unplanned final closure are the same as for the Mine Closure Plan • objectives for temporary closure meet basic requirements for safety, health & environmental protection	Contingency planning for temporary closure extends to funding & programming provisions for caretaker maintenance & environmental monitoring through to mine recommencement	*Case Study 7 presents an example of the liabilities that can be transferred to the community (ie government) when a mining operation ceases without proper or adequate closure planning & procedures.*	
Part 3: Implementing the Decommissioning Program - refer Chapter 5 in the Sustainable Minerals booklet					
3.1 Have you developed an accepted closure systems framework?		Framework for developing a mine closure works plan agreed with regulatory authorities	Evidence of acceptance of framework for mine closure by regulating authority/ies.		
3.2 Does the framework include a detailed schedule of works related to all of the physical & process components		Detailed mine closure works plan. As relevant, the works plan addresses: • underground voids & shafts (stope		*Schedule of works identifies for each component:* • *issues & relevant to*	

of the site?		failure/void collapse), surface subsidence, acid drainage, hydrocarbon bon pollution, public safety, fauna, post-mining land uses • open cut pits (acid drainage, leachates, wall stability, public & fauna safety, aesthetics, post-mining land use) • tailings storage facilities (erosion & structural instability, acid drainage, dust, groundwater, aesthetics, public & fauna safety, long term viability of rehabilitation) • waste rock landforms (erosion/ instability, surface water, ground water, acid drainage, dust, aesthetics, post-mining land use) • treatment plant, office buildings & maintenance		*decommissioning* • *options for satisfactory decommissioning* • *techniques to be employed*	

		facilities (salt, heavy metals & hydrocarbons, buildings, process chemicals, infrastructure, services, concrete, drainage, pre-post mining heritage, compaction • mine townships (social dislocation, regional economic loss, social services, townsite infrastructure & buildings • water storage dams (altered ecosystems, process water dams, siltation, downstream shadow, long term stability, water quality, safety, post-mining land use) • services infrastructure (above ground powerlines, roads, railways, airstrips, borefields, ports etc; below ground cables & pipes, vent rises, escape ways			

		& service tunnels.			
3.3 Is the decommissioning plan of works supported by the company board or mine owners & senior operations managers?	Corporate commitment to implementation & completion of decommissioning program	Documented commitment by company board or mine owners & senior operations managers			
3.4 Have adequate financial & human resources been allocated?	Adequate funding sufficient to complete works as described in the decommissioning plan	Evidence that full decommissioning costs are accounted for in company operating budget allocations & forward estimates			
3.5 Have stakeholders been involved in designing the objectives for the final decommissioning plan of works & consulted on procedures?	Stakeholder acceptance of plan of works & procedures to be implemented	Documented agreement by key stakeholder groups. Minutes of meetings. Interviews with key group representatives			
3.6 Have you made appropriate leadership arrangements for the decommissioning phase?	Clear responsibility for management & leadership, & evidence of level of management commitment	Notice of formal appointment of responsibilities of key staff responsible for management of the closure program		*The change after many years of mining to the closure plan of works represents a major shift in objectives, work practices, routines, standards & supervisory streams for many workers. Careful change*	

				management is required to ensure that staff understand & commit to the new work arrangements & the closure objectives.	
3.7 Does the plan of works contain time lines for completion of work elements & efficient/effective interconnection of tasks?	Time lines representing critical flow paths in tasks to best achieve economic & environmental objectives	Plan of works indicates timelines for each task, inter-connections with other elements of the program, & critical control & decision points		*Careful planning may be required, eg coordination of truck load dumping to ensure placement of contaminated material or acid-producing rock within benign material to reduce the risk of long term pollution. Timing of some tasks may be critical, eg placement of topsoil before rain to avoid compaction & bogging, & to allow seed broadcasting just prior to expected rains.*	
3.8 Is progress regularly audited & are outstanding items actioned?	Regular audit review of progress, action agenda & assessment of progress against action targets	Evidence of regular audits to review progress, development of action agenda, & assessment of progress against action targets	The decommissioning phase is commonly an intensive period of work & a system of ongoing workflow monitoring is commonly warranted.		
Part 4: Post-Closure Care - refer Chapter 7 in the Sustainable Minerals booklet					
4.1 Do you have a monitoring program for the passive care stage?	Post-closure monitoring program	Documented post-closure monitoring plan, acceptable to regulators			

4.2 Does the monitoring program include monitoring of all key areas & environmental variables, including: - waste rock landforms?	Post-closure monitoring program addresses waste rock landforms	Monitoring parameters include erosion, vegetation establishment, biological activity, dust & acid drainage	Monitoring parameters also measure for comparison against rehabilitation objectives	*The Environmental Monitoring & Performance Sustainable Minerals booklet provides guidance on the design of environmental monitoring systems.*	
4.3 - tailings storage facilities?	Post-closure monitoring program addresses tailings storage facilities	Monitoring parameters include seepage, erosion, vegetation establishment, dust, surface contamination	Monitoring parameters should also measure for comparison against rehabilitation objectives, ie so that progress towards attainment of 'rehabilitation success' criteria can be gauged. Case Study 8 gives an example of Ecosystem Function Analysis being used to measure ecosystem development & demonstrate successful closure through achievement of rehabilitation objectives.	*The Environmental Monitoring & Performance Sustainable Minerals booklet provides guidance on the design of environmental monitoring systems.*	
4.4 - process plant site?	Post-closure monitoring program addresses the site of the processing plant	Monitoring parameters include vegetation establishment, dust & surface contamination			
4.5 - roads, hardstand & infrastructure areas?	Post-closure monitoring program addresses roads, hardstand & infrastructure areas	Monitoring parameters include • vegetation establishment • dust			
4.6 - underground workings?	Post-closure monitoring program addresses underground workings	Monitoring parameters include subsidence, shaft & vent capping, groundwater movement & quality			
4.7 - open pits?	Post-closure monitoring program addresses open pits	Monitoring parameters include pit wall stability, abandonment bund condition, pit water quality, water level, groundwater movement & quality.			

4.8 - adjacent & downstream water courses & bodies?	Post-closure monitoring program addresses adjacent & downstream water-courses & bodies	Monitoring parameters include dust, surface water quality, nutrient levels, aquatic ecosystem health			
4.9 Do you regularly report monitoring results to regulators & stakeholders?	Monitoring reports	Reports of monitoring results provided at least annually	In areas with strong seasonal climatic variation, data should be collected & reported to represent performance under each seasonal condition		
Part 5: Mining Title Relinquishment - refer Chapter 7.2 in the Sustainable Minerals booklet					
5.1 Have you checked that the completed works program satisfies fundamental mine closure criteria?	Closure criteria for basic human & environmental protection	Closure criteria satisfy requirements for human & fauna safety, human health, surface stability & water quality			
5.2 Have you identified the authority responsible for making the final decision on attainment of closure standards & objectives?	Mine Closure Plan identifies the agency responsible for deciding on the attainment of closure standards & objectives	Mine Closure Plan identifies the agency responsible for deciding on the attainment of closure standards & objectives		*The responsible authority is commonly a delegate to the State Minister for Environment or Mines. In some instances where success criteria or methods to assess them are difficult to define or agree on, an independent environmental expert may be engaged to review progress & recommend to the relevant authority when,*	

				in his/her opinion, success is achieved.A fundamental criterion should be that ongoing land maintenance & management costs should be no greater than those for the land surrounding the mined area.	
5.3 Have you arranged formal agreements with relevant government authorities relating to future liabilities?	Formal agreement signed by authoritative government body/ies & mine executive/CEO	Formal agreement signed by authoritative government body/ies & mine executive/CEO		*An agreement may be necessary to define any outstanding liabilities should any mine-related failure occur after the mine tenure is relinquished.*	
5.4 Have you provided to the relevant authorities a record of the mining land use, & issues relevant to future possible land use, disturbance, & environmental health?	Record of mining activities on the land, including placement of materials during mining & decommissioning/rehabilitation works	Record of mining activities on the land, including placement of materials during mining & decommissioning/ rehabilitation works	Record to contain sufficient information to construct a 3D map of potentially hazardous materials, ie • chemical characteristics of all mine waste, process, product, reagent, hydrocarbon-contaminated materials, tyres, rubbish or tailings • location, depth,	*The Sustainable Minerals booklet on Contaminated Sites provides information on recording & treatment of these materials.*	

			any measures to isolate them		

Checklist for Mine Planning

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Issues to Consider - refer to the Mine Planning for Environment Protection Sustainable Minerals booklet. Effective mine planning requires extensive gathering of information which is also a major component of Environmental Impact Assessment, described in the Environmental Impact Assessment Sustainable Minerals booklet.					
1.1 Have you determined the environmental issues associated with your proposed project related to: - air quality?	Report assessing the probability of dust generation	Assessment report addresses: • potential sources of dust • possible dust concentrations & deposition rates • dust particle size distribution • dust vectors • possible impacts on people, environment & visual amenity	A dust deposition target of <$2g/m^2$/ month should retain environmental amenity. There are no national standards for short term dust concentrations, but the USEPA standards are relevant: 24 hour average readings of $260mg/m^3$ for human health & $150mg/m^3$ for environmental protection, which should not be exceeded more than once per year.	*The environmental issues related to dust are described in the Dust Control Sustainable Minerals booklet.*	
1.2 Have you determined the environmental issues associated with your proposed project related to: - noise & vibration?	Report assessing the probability of noise & vibration	Assessment report addresses: • potential sources of noise & vibration • possible intensities & frequencies of noise & vibration	Appropriate noise limits could be 130dBL for human health & safety, & 115-118dBL for amenity. Vibration limits could be <50mm/sec for buildings & 10mm/sec for amenity;	*Higher noise levels may be permissible during the relatively short construction phase. Atmospheric inversions at night can increase noise by up to 10dBL at*	

		• possible impacts on people, environment & visual amenity	sensitive cultural or heritage sites may be affected by peak particle velocities of 2-5mm/sec.	*a time when the community is most aware of noise levels. The environmental issues related to noise & vibration are described in the Noise Vibration & Airblast Control Sustainable Minerals booklet.*	
1.3 Have you determined the environmental issues associated with your proposed project related to: - water management?	Report assessing the probable risks & issues related to water management	Assessment report addresses: • meteorological data for the site • water balance modelling • probability levels of system overcapacity or of insufficient water • appropriate flood intensity for design planning	• Engineering parameters for water containment structures & channelways based upon "Probable Maximum Flood" • Modelling based on computer simulations using long term meteorological data	*Mine dewatering can depress the water table for considerable distances, potentially affecting water supply to surrounding landholders; community consultation, & provision of alternative water supply, is indicated. The environmental issues related to water management are described in the Water Management Sustainable Minerals booklet.*	
1.4 Have you determined the environmental issues associated with your proposed project related to: - water	Report documenting pre-mine development water quality & assessing the probable risks & issues related to	Assessment report addresses: • potential sources of water contamination (particulates, minerals, metals, process chemicals, hydrocarbons,	Sedimentation ponds to allow settling of particulates should provide 200 - 600 m3 retention capacity per hectare of disturbed ground. Water from process plant,	*Contamination of surface & ground waters is the single biggest type of environmental impact from mining. The environmental issues*	

quality?	water quality	acidity, salinity, sewage, radiochemicals) • possible concentrations & pathways for contaminant transport • toxicity of contaminants to aquatic biota • possible impacts on human health & amenity	refuelling & workshop areas should be separately collected & put through oil separators. Water should be managed on the basis of quality, & clean water prevented from contact with contaminated water. Ore & waste rock should be tested for their potential to release contaminants.	*related to water quality are described in the Water Management Sustainable Minerals booklet. Water contamination related to cyanide & acid mine drainage is described in the Cyanide Management & Managing Sulphidic Mine Wastes & Acid Drainage BPEM booklets.*	
1.5 Have you determined the environmental issues associated with your proposed project related to: - soil conservation?	Report identifying the character of soils in the project area & assessing the probability of soil loss & degradation	Assessment report identifies: • actions where soil will be disturbed • volumes, depths & types of disturbed soils • opportunities for stockpiling & re-use • options to minimise disturbance • options for speedy re-use	Specific planning provisions for soil handling, storage, & re-use.	*Long term storage requires thin stockpiles for soils to preserve their biological vigour. Speedy re-use ensures viable soil nutrients, microbial activity & seedbank is introduced to the new area. The Rehabilitation & Revegetation Sustainable Minerals booklet discusses issues related to soil conservation.*	
1.6 Have you determined the environmental issues associated with your proposed project	Report documenting the flora & fauna of the project area	Report catalogues: • individual species • floral habitats • any rare or endangered	Evaluation of the flora & fauna of the project area in a broader context, & provisions for establishing corridors between habitat		

related to: - flora & fauna?		species & measures needed for their protection • options to minimise disturbance of higher-value areas	islands, exclusion of feral weeds & fauna impacting upon the health of natural ecosystems		
1.7 Have you determined the environmental issues associated with your proposed project related to: - archaeology & heritage protection?	Report documenting the archaeological & heritage values of the project area	Report catalogues sites & individual artefacts, & describes options to minimise disturbance of significant areas	Engagement of local indigenous people & heritage groups to assist in survey work & developing recommendations for minimising damage, conservation, restoration	*The Community Consultation & Involvement Sustainable Minerals booklet describes techniques for engaging local expertise & ensuring adequate consultation.*	
1.8 Have you determined the environmental issues associated with your proposed project related to: - transport?	Documentation of mine transport needs, existing transport infrastructure, & the range of impacts different options will have on the local community	Report includes sensitivity analysis of the different options in terms of number of movements, size of transport units, frequency & time of movements, noise, safety	Extensive consultation with the community to develop suitable options. Road/rail additions or upgrades which continue to benefit the community after mining.	*Truck movements through towns are commonly a significant issue because of perceived impacts on noise, safety, & amenity. The Community Consultation & Involvement Sustainable Minerals booklet describes techniques for engaging local expertise & ensuring adequate consultation.*	
1.9 Have you determined the environmental issues associated with your proposed project related to: -	Documentation of estimates of subsidence	Assessment of impacts from subsidence, on buildings, road & path pavements, power supply AND reticulation	The magnitude of surface strain, ground movement & slope change can be predicted with empirical models or with finite element computer		

subsidence?			simulations.		
1.10 Have you determined the environmental issues associated with your proposed project related to: - rehabilitation?	Report evaluating rehabilitation issues & options	Mine Plan includes a Rehabilitation Plan which: • is integrated with other elements of the mine management plan • states clear rehabilitation objectives • takes into account an appropriate & agreed final land use • describes the level of management needed to maintain the agreed land use	The agreed land use should be determined in consultation with government departments, local councils, traditional owners & private landholders	*Rehabilitation is a cornerstone of ecologically sustainable development & a fundamental community expectation for environmentally & mining. Refer to Case Study 2 in the Mine Planning booklet, & to the Rehabilitation & Revegetation Sustainable Minerals booklet.*	
1.11 Have you determined the environmental issues associated with your proposed project related to: - visual impacts?	Report evaluating potential for significant visual impacts	Report considers the "visual catchment" of the project site, the nature & location of viewing points, & the quality of the pre-mining visual landscape	Planning visual safeguards could include pre-mine tree plantings, community forestation projects, suitable colour selection for buildings & equipment, & site perimeter screening with bunds or vegetation.		
1.12 Have you determined the environmental issues associated with your proposed project related to: - hazard & risk assessment?	Report evaluating the hazards associated with the proposed mine & the associated risks	Report covers all aspects of mine operation & natural hazards, from mine opening collapse & flooding, surface inundation, earthquakes, bushfires, embankment failure, chemical spills, transport accidents, hazardous materials handing & storage & flyrock from blasting.	Mine planning incorporates features to reduce or remove all identified significant potential risks	*The Sustainable Minerals booklet Environmental Risk Management is relevant here.*	
1.13 Have you determined the	Report assessing the potential impacts	Report covers:	Cleaner production principles striving for	*Useful information is included in the*	

environmental issues associated with your proposed project related to: - waste management?	from wastes	- overburden - tailings/rejects/slimes - spent reagents & solutions - used oils, greases - sewage - rubbish	minimal use of materials, re-use, recycling, & improved efficiency, addressed in the mine plan	*Sustainable Minerals booklets on Cleaner Production & Hazardous Materials Management, Storage & Disposal.*	
1.14 Have you determined the socio-economic issues associated with your proposed project?	Report identifying & assessing likely socio-economic impacts	Report addresses both positive & negative aspects of impacts to the local community, including environmental, social, & economic.	Consultation with the community start early in project planning & continues for the life of the mine. Impacts addressed include issues which extend beyond mine closure, eg to reduce unemployment growth on mine closure through stimulating the development of new local enterprises & supporting skills development	*A successful mine plan will be developed after the concerns of the local people are understood & the means of accommodating their needs considered. The Community Consultation & Involvement Sustainable Minerals booklet describes techniques for engaging local expertise & ensuring adequate consultation.*	
Part 2: Developing the Mine Plan					
2.1 Have you considered possible constraints on the location of the project in terms of environmental sensitivities: - positioning within the drainage basin?	Report evaluating catchment dynamics	Report considers: - whether the mine will flood - is there a substantial upstream catchment which should be diverted around the site - the classification of the receiving watercourses - water usages downstream -	Report fully evaluates options & advances recommendations as a basis for consultation with the community & key stakeholders		

		who, what for • ecological needs of aquatic & terrestrial fauna & flora • will there be enough water to operate the mine?			
2.2 Have you considered possible constraints on the location of the project in terms of environmental sensitivities: - proximity to utility infrastructure?	Report evaluating utility infrastructure	Report considers: • where are the nearest main roads, railways, water supply, sewerage, electricity, telecommunications, ports • do they have sufficient capacity to cope with the added pressures from the proposed mine • will this increased use cause environmental, social or economic impacts • can existing infrastructure be augmented or modified to satisfy the needs of the mine?	Report fully evaluates options & advances recommendations as a basis for consultation with the community & key stakeholders		
2.3 Have you considered possible constraints on the location of the project in terms of environmental sensitivities: - surrounding land use?	Report evaluating surrounding land use	Report considers: • how is surrounding land currently used • what is the land zoning for future development • are there sensitive land uses that need to be accommodated in the mine	Report fully evaluates options & advances recommendations as a basis for consultation with the community & key stakeholders		

		plan?			
2.4 Have you considered possible constraints on the location of the project in terms of environmental sensitivities: - the labour market?	Report evaluating the labour market	Report considers: • is there an adequate local labour market • will workers move in to the area when the mine starts • if so, are there enough housing & community facilities to accommodate them • should employees be flown in/out, or should a viable community be established • how acceptable will construction camps be • is there potential for conflict between wealthy mine workers & local unemployed/poorer people • is there potential for cultural conflicts?	Report fully evaluates options & advances recommendations as a basis for consultation with the community & key stakeholders		
2.5 Have you considered possible constraints on the location of the project in terms of environmental sensitivities: - visual exposure?	Report evaluating visual exposure	Report considers: • is the deposit in a visually prominent area • if so, does it matter to the local community • what can be done via screening or carefully choosing the location of facilities to minimise future	Report fully evaluates options & advances recommendations as a basis for consultation with the community & key stakeholders.		

		visual impact?			
2.6 Have you considered possible constraints on the location of the project in terms of environmental sensitivities: - cumulative impacts?	Report evaluating cumulative impacts	Report considers: • is there potential for this mine to add to impacts from other operations • will there be competition for water, transport services or employees • will air quality, noise or water quality be cumulatively satisfactory?	Report fully evaluates options & advances recommendations as a basis for consultation with the community & key stakeholders.		
2.7 Have you collected sufficient information to adequately understand the characteristics of the resource to be developed, & the environmental characteristics of the area & surrounds?	Report providing information on the resource, mining & metallurgical parameters, & all of the environmental issues listed in Part 1 of this Checklist	• Report covers all issues in appropriate detail & depth • Environmental data collected over at least one year to reflect seasonal variation eg in climate, migratory species, presence of annual plants	Ideally, environmental data should be collected over at least 3 years, particularly for major projects	*Adequate baseline information is necessary before mines can be planned in an environmentally responsible way.*	
2.8 Have you designed measures to ensure that the environmental & social impacts during the construction phase are minimised?	Report separately evaluating the environmental & social impacts of the construction phase	Report identifies the added pressures during the construction period & assesses resultant impacts, eg larger workforce of contractors who may have different environmental awareness or ethics	Separate Environmental Management Plan prepared specifically for the different activities & intensity of works during the construction phase	*Pollution controls during construction are sometimes designed to low standards because they do not form part of the ongoing mine. However, there is little point in building elaborate controls for the mine operational*	

				phase if the environment has been severely impacted during construction.	
2.9 Have you included pollution prevention & control measures?	Report identifying pollution potential from all site facility components & specifying built-in features to: • avoid pollution from occurring • control & contain any pollution which does occur	Comprehensive & detailed site design drawings & specifications for each identified site facility component with potential to cause pollution, showing features specifically included to avoid & minimise pollution	As far as possible, all components should be designed along a "no release" principle, & include failsafe features such as double-bunding, automatic pumping in the event of over-filling etc.	*Effective pollution prevention demands that pollutants are contained within the mine site, is "no release" policy*.	
2.10 Does the mine design incorporate features to limit biophysical impacts?	Mine design incorporates design features to protect landscape & ecological values	Mine design includes features to: • minimise erosion of watercourses & land surface • contain sediment & contaminated water on site • efficiently re-use soil • use endemic native plants in the revegetation program	The mine plan may specify maximum slopes on disturbed & revegetated areas to minimise erosion, eg 1 in 5 slope angle. Areas of remnant natural vegetation with native fauna can be linked with corridors of native vegetation to promote migration & interbreeding between small communities to promote chances for sustainability of		

			populations.		
2.11 Does the mine plan incorporate measures to limit socio-economic impacts & build positive community relationships?	Mine plan includes measures addressing socio-economic issues affecting the local community	Mine plan addresses: • employment • community infrastructure • land use planning • archaeology & cultural heritage • impact of mine on surrounding land values	It is important to determine a clear policy on land acquisition' surrounding landowners are commonly more concerned about the impact on their land value than they are on the other impacts from the mine.		
2.12 Have you included a comprehensive environmental monitoring regime tailored to the characteristics of the site & surrounds?	The mine plan includes an Environmental Monitoring Plan	The Environmental Monitoring Plan is comprehensive, & covers all significant pathways for contamination including to air, surface water, groundwater, noise & vibration, & land condition.	The EMP should be flexible to allow changes in sampling type, location & frequency depending on environmental performance. The EMP should set out standards for sample collection, storage, transport, analysis & interpretation. The EMP may be integrated with monitoring of social impact, & staff environmental awareness.	Environmental monitoring, including physical, chemical & biological elements, should be extended to areas beyond the minesite which could be affected. Development of an EMP is described in the Environmental Monitoring & Performance Sustainable Minerals booklet.	
2.13 Does the mine plan include a decommissioning plan?	The mine plan includes a Decommissioning Plan	The Decommissioning Plan is linked to the agreed land use outcome sets out specific steps for progressive rehabilitation	The Decommissioning Plan incorporates research trials to evaluate the effectiveness of landforming, rehabilitation & revegetation techniques best suited to achieving mine closure objectives.	*The Revegetation & Rehabilitation & Landform Design for Rehabilitation Sustainable Minerals booklets are relevant here.*	

Checklist for Noise, Vibration and Airblast Control

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
1.1 Have you determined the sources of noise, vibration and airblast in your operation?	Report listing potential sources of noise, vibration & airblast	Comprehensive list of individual sources, including drilling, excavation, transfer, crushing & screening equipment, haul trucks, reversing alarms, process plant, generators, bird scarers, mine vehicles on public roads.	Sources considered for each stage of the mine, ie exploration, construction, operation, decommissioning, rehabilitation and closure.	*Almost all forms of mining create noise and vibration. Even at the exploration stage significant levels of noise, vibration & airblast can be produced from engines, airblast drilling equipment, shot hole drilling & blasting or vibration machinery for seismic surveying.*	
1.2 Have you attempted to quantify the intensity of noise, vibration and airblast that will be produced?	Estimates of noise, vibration and airblast likely to be produced	Estimates based on typical measured levels for mining plant, eg see Table 1 in Noise, Vibration & Airblast Control Sustainable Minerals booklet	Estimates made of all potential sources for each stage of the mine, ie exploration, construction, operation, decommissioning, rehabilitation and closure	*The information gathering stage is a major component of EIA, which is described in the Environmental Impact Assessment Sustainable Minerals booklet. Note similar noise & vibration levels are felt much more at night because of lower background values, air inversion effects, & people's lower activity levels. Section 2.5 of the booklet describes meteorological effects on noise & airblast levels.*	
1.3 Have you undertaken an impact	Identification of sensitive receptors,	Assessment identifies levels likely to be	Assessment of possible impacts addresses subjective	*Case Study 7 describes a detailed environmental noise*	

assessment to identify possible impacts arising?	and assessment of maximum levels to avoid impacts, significant concerns or discomfort	experienced at key locations, ie closest residences, paddocks with domestic stock & possible impacts	issues of annoyance & intrusiveness related to intensity, frequency & timing	*model for a mine which takes into account local topography, and considers potential impacts over 96km2 surrounding the site.*	
1.4 Based upon the impact assessment, have you developed a draft management strategy?	Initial planning should include development of a draft management strategy which: • identifies all of the potential sources & risks • sets out objectives for environmental protection and risk minimisation • provides a framework for evaluating different options and choosing a design which reflects site conditions and environmental sensitivities	A draft management strategy which incorporates input from the community and regulatory authorities and addresses the full suite of environmental and social issues likely to arise from noise, vibration & airblast form the proposed project	Consultation with key stakeholders during preparation of the draft management strategy		

1.5 Have you devised approaches to mitigate impacts to acceptable levels?	Strategy includes section addressing mitigation of noise, vibration & airblast	Strategy incorporates "built in" design features to minimise generation of noise, vibration & airblast at source			
1.6 Have you considered the probable regulatory requirements?	Noise, Vibration & Airblast strategy documents relevant standards & regulations	Level to which targets in the strategy conform to standards & regulations, and factor in estimates of inputs from all probable sources of noise, vibration or airblast	Targets in the strategy aim for noise levels generally no greater than 5dBA above background; blast vibration levels < 10mm/sec & no blasting at night.	*Higher levels may be appropriate in remote & undeveloped areas. The NSW EPA considers that higher noise levels (10-20dBA above background) are acceptable for short periods such as the construction phase, provided they persist for less than 6 months. Standards BS 7385.2 & AS 2187.2 recommend maximum vibration levels for different building types.*	
1.7 Are the target levels developed in consultation with the community?	Maximum intensity levels explained to and agreed with community	Documented agreement on maximum permissible levels between company & key community group/s	Establish formal and frequent consultation with the local community early in the planning process	*Meaningful consultation with the local community will commonly smooth the assessment and approvals process for a new development - refer to the Community Consultation and Involvement Sustainable Minerals booklet*	
Part 2: Management and Operation					
2.1 Have you prepared an operational noise, vibration and airblast management plan?	Noise, vibration and airblast management plan	• Management Plan sets out targets and management strategies for all issues identified in impact assessment and in community	The Environmental Management Systems Sustainable Minerals booklet describes the components of a fully integrated EMS for all environmental aspects of a minesite. Many companies	*Operators can use and seek certification to published EMS standards such as ISO 14000. Software obtainable from this site includes complete prewritten procedures, record forms, and an Environment*	

		consultations. • Management Plan integrated with other operational plans into an overall EMS for the project.	seek certification to international standards such as ISO 14001 to help demonstrate their environmental commitment to regulators and other stakeholders.	*Manual which can be customised. An implementation guide is also included.*	
2.2 Is the Management Plan known and understood by all staff, including plant operators?	Staff aware of the Management Plan & its contents	Relevant documentation readily available to staff, regulators and auditors	Management Plan available to staff; staff instructions on control of noise, vibration & airblast; regular checks on effectiveness of operational systems; noise, vibration & airblast including in environmental awareness training sessions	*The Workforce Environmental Awareness Sustainable Minerals booklet describes general approaches to raising awareness and commitment amongst the workforce, including contractors.*	
2.3 Have you selected appropriate options to minimise the generation of noise?	Few significant issues related to noise at the site	• Evidence of good design to reduce noise generation through mine design, choice of equipment, and work practices • Consistent application of good design across all types of noise sources, including road transport outside the mine	Acoustical & blast trials help to optimise the mine plan & blast design. Use computer modelling to investigate the control measures needed to achieve targets. Construction of noise bunds between mine and housing close to the noise source (refer Case Study 3 in Noise, Vibration & Airblast Control Sustainable Minerals booklet.	*Primary measures to effectively minimise noise impacts include selection of low noise plant, acoustical screens around noisy fixed plant (eg crusher), "smart" reversing alarms which lower noise volumes at night, well placed waste dumps, haul roads etc, construction of noise bunds, buffer zones & set-back distances; refer Case Study 1. Case Study 6 describes the use of a trail blast to validate techniques to be used near a very sensitive site.*	
2.3 Have you	Few significant issues	• Evidence of	All reasonable measures	*Examples of retrofitting*	

incorporated design features to mitigate the potential impacts from the noise levels generated at your site?	related to noise at the site	installation of engineering works, equipment modification to deflect or muffle noise • Any significant noise sources identified via monitoring have been objectively evaluated and remedial action taken	taken to reduce noise from all fixed and mobile noisy equipment	*include exhaust & radiator silencers on large earthmoving plant, attenuators on mine ventilation fans (refer Case Study 2), acoustical sheeting around crushers and grinders, ventilation openings angled away from sensitive receptors. Acoustic treatment of dwellings is inconsistent with a best practice as it does not address outdoor noise impacts.*	
2.4 Have you selected appropriate options to minimise the generation of vibration?	No significant issues related to vibration	Evidence of good design to reduce vibration generation through mine design, choice of blasting patterns & techniques & timing	Careful refinement of blast design to reduce vibration and optimise use of explosives. Case Study 5 describes the "BAM" model to predict noise levels up to 40 km from blasts, and the use of small pilot blasts to validate the modelling results.	*Ground vibration can be reduced from blasting by:* • *reducing the maximum instantaneous charge by using delays, reduced hole diameter and /or deck loading* • *changing the burden & spacing by altering the drill pattern and/or delay layout, or changing hole inclination* • *strict control over spacing & orientation of all blast drill holes;* • *minimum sub-drilling* • *matching blast timing to suit local*	

				conditions/sensitivities • *using rock breakers or rippers instead of blasting for shallow breaking*	
2.5 Have you incorporated design features to mitigate the potential impacts from the vibration levels generated at your site?	No significant risk of structural failure to buildings & infrastructure	Evidence of installation of engineering works & equipment modification to reduce the risk of structural failure of buildings and other infrastructure	• Vulnerability survey of all buildings & infrastructure • works program to upgrade where necessary to reduce risk of damage or failure	*Include offsite infrastructure services in the survey where communities exist close to the mine*	
2.6 Have you selected appropriate options to minimise the generation of airblast?	No significant issues related to airblast	Evidence of good design to reduce airblast generation through mine design, choice of equipment and work practices	Investigate measures to reduce impacts or risks, and implement where appropriate.	*Techniques include:* • *reducing maximum instantaneous discharge* • *ensure adequate stemming depth & type* • *orientate rock faces away from sensitive receptors* • *use a hole spacing & burden which will deliver the minimum explosive force needed to break ore into required size* • *where face is already broken, deck load to avoid broken ground or*	

				cavities	
2.7 Have you incorporated design features to mitigate the potential impacts from the airblast levels generated at your site?	No significant issues related to airblast	Evidence of installation of engineering works, and changes to work practices etc to reduce impacts from airblast		*Techniques include:* • *eliminate exposed detonator cord and secondary blasting* • *blast in favourable weather conditions* • *careful positioning & orientation of blastholes* • *blast at set times, or send warnings to sensitive receptors.* *In addition to reducing airblast, these techniques will maximise rock breaking efficiency, optimise explosives consumption, and reduce costs.*	
2.8 Is there documentation to demonstrate that the Noise, Vibration & Airblast Management Plan is carried out properly?	Reports of activities against the requirements of the management plan	Regular reports, eg monthly, of noise, vibration & airblast activities and assessment against control targets	Standard operating procedures for staff working in noisy plant areas, operating noisy equipment, and involved in drilling & blasting activity, setting out responsibilities, & methods for limiting & reporting noise, vibration & airblast incidents.		
Part 3: Remediation/Closure					
3.1 Do the provisions of the operational	Decommissioning, rehabilitation &	Decommissioning, rehabilitation & closure	Plans incorporate provisions which reflect the specific	*Higher noise levels may be permissible following*	

noise, vibration and airblast management plan also apply to the mine decommissioning, rehabilitation and closure stages?	closure plans all include provisions for control of noise & vibration	plans all include provisions for control of noise & vibration	activities involved at the end of mining	*consultation with regulators & the community for high intensity, short-term activity such as relocation of overburden stockpiles and landforming (similar to the construction phase - refer Question 1.6 in this Checklist.*	
Part 4: Monitoring and Assessment					
4.1 Is there a monitoring regime in place which addresses all of the possible areas for environmental and social impact from noise, vibration and airblast identified at the planning stage?	Documented Environmental Monitoring Program for noise, vibration & airblast	Monitoring regime comprehensive and includes measurement of levels at key receptor areas such as nearest houses and domestic stock, community facilities such as schools & libraries, bridge foundations on nearby public roads etc. Monitoring regime sets out: • parameters to be monitored • monitoring locations • monitoring interval • data & data analysis requirements for monitoring reports • reporting interval	Reporting & record keeping includes: • recording intervals • location of attended & unattended monitoring instruments • tabulation of statistical noise level descriptors and notes identifying principal noise sources • graphed vibration monitoring results • blast designs and blast locations	*Case Study 4 describes monitoring to ensure the protection of a fragile heritage building.*	
4.2 Are environmental	Control targets agreed	Control targets agreed with	Noise, vibration & airblast	*The Environmental Monitoring*	

and community protection targets set, and are the layout, techniques, frequency, quality and sensitivity of monitoring and sampling appropriate to these targets?	with the community are set out in the management plan & monitoring regime	the community are set out in the management plan & monitoring regime and are used as key benchmarks to evaluate adequacy of performance in regular monitoring reports.	performance reported against the community-agreed targets in public reports, including annual environmental report	*& Performance Sustainable Minerals booklet discusses design of monitoring programs.*	
4.3 Are data collected in accordance with the requirements of the monitoring regime?	Monitoring data cross-referred to monitoring regime requirements	Monthly and annual reports of noise, vibration & airblast data, which cross-refer to monitoring regime requirements	Monthly and annual reports of environmental data include a checklist of requirements	*Appendix E in the Noise, Vibration & Airblast Control Sustainable Minerals booklet gives a simple example monitoring checklist.*	
4.4 Are the data analysed and regularly reported to the regulatory authorities?	Refer to regulatory authorities			*The Environmental Monitoring & Performance Sustainable Minerals booklet discusses how environmental performance should be measured against the objectives of the Environmental Management Plan*	
4.5 Are non-compliance issues or abnormalities in the data routinely investigated?	Register maintained of non-compliance and unplanned events	Register of non-compliance and unplanned events, indicates time of event, time of action, type of action, result, and interaction with authorities	Regulatory authority advised immediately of all non-compliance and significant unplanned events		
4.6 Is liaison with the community maintained in relation to noise, vibration and airblast issues?	Documentation of community liaison meetings which address noise, vibration and airblast	Documentation of community liaison meetings which address noise, vibration and airblast	Community meetings held regularly not less than six months apart with noise, vibration & airblast a standing agenda item; special meetings held immediately	*The Community Consultation and Involvement Sustainable Minerals booklet gives more information on community consultation issues and techniques.*	

			after a significant event raising community concern		

Checklist for Onshore Minerals and Petroleum Exploration

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning - refer to chapter 1 & section 3.1 of the Onshore Minerals & Petroleum Exploration Sustainable Minerals booklet					
1.1 Do you have an environmental policy which is applicable to exploration?	Company environmental policy	Company environmental policy includes exploration activity	Company environmental policy supported by documented protocols for environmental protection during exploration	*Case Study 2 gives an example of an environmental protocol specifically for exploration.*	
1.2 Do your protocols for exploration follow appropriate relevant codes & guidelines?	Environmental protocol	Environmental protocol refers to appropriate codes & guidelines		*State government departments & chambers of mines provide codes of conduct for environmentally sensitive mineral exploration, eg: Queensland (follow links to Codes of Environmental Compliance). Some international resources are listed by UNEP's MRF*	
1.3 Have given a copy of your environmental policy & protocols to all employees & contractors?	Distribution of environmental policy & protocols	All staff & contractors on the exploration area know of & have ready access to the policy & protocols	Copies of policy & protocols provided at all activity centres on the exploration area, in vehicle cabs, & posted in mess		
1.4 Have you nominated a person	Individual nominated as environmental	• Evidence of formal	The site exploration manager is nominated as the		

responsible for environmental protection of the exploration area?	coordinator-manager for the exploration area	notification to staff & contractors • provision of necessary powers to control / modify all activities with potential to cause environmental impact	environmental coordinator		
1.5 Do you have reliable information on land ownership & use?	Map or register of land ownership & use	Availability of map or register of land ownership & use		*Contact all owners, lessees & land users in the exploration area & surrounds.* *Permits may be required form local, State or national government authorities, & from land owners, lessees or land users. Special conditions may be attached to the tenement/exploration permit.*	
1.6 Have you obtained the appropriate permits?	Register of permits	Register of permits, & copies of permits, available at exploration office & to environmental coordinator			
1.7 Have you investigated whether the exploration area is	Report on environmental, social & business features of	Report should cover: • high	• An on-site inspection of the area prior to start of exploration, with	*Check with:* • *land owner &/or lessee,*	

special, unique or otherwise sensitive?	the area which might render it or parts of it special, unique or sensitive	agricultural or pastoral values; • risk of plant disease, weeds or feral animals • important Aboriginal cultural or archaeological values • high conservation values • important water resources • special entry or other restrictions • issues affecting seasonal access, eg flooding, bird migration/nesting & bush fire restrictions • community concerns about exploration	representatives of the people/groups listed at right, will reduce risk of misunderstanding or oversight of significant issues. • It may be necessary to initiate & receive reports from specialists (eg botanist, Aboriginal consultant, archaeologist) to investigate issues before this report can be finalised.	*govt dept* • *land owner &/or lessee, govt depts of agric & environment, pasture protection board* • *local aboriginal people, land council, ATSI, govt agencies* • *Environment/conservation depts, local environmental NGOs* • *local & state water supply authorities, mines dept/geological survey office* • *depts for land administration, Dept of Defence* • *land owner/lessee, local govt, dept environment dept & NGOs, bush fire authority* • *state govt depts for social impact, local council, ratepayers' association*	

1.8 Is the environmental coordinator aware of any special environmental & social aspects?	Environmental coordinator advised of outcomes of the report on environmental, social & business features of the area which might render it or parts of it special, unique or sensitive	Level of understanding by the environmental coordinator of the contents of the report			
1.9 Have you prepared a plan of you intended operations?	Plan of intended operations	Plan describes • type of work, timing of work, & areas affected • proposals to protect or minimise damage to areas with high environmental, social or other values	Plan addresses the issues identified in the report on special, unique & sensitive features, & includes description of how possible impacts on environment & community will be managed & mitigated (ie minimise surface disturbance, noise, dust & number of vehicles, choice of optimal operation times, vehicle types, routes used).		
1.10 Have you supplied copies of the plan of intended operations to stakeholders?	Distribution of plan of intended operations emphasising techniques to avoid unacceptable environmental & other impacts	Plan distributed to relevant authorities & to community groups	Public meeting to present the plan of intended operations. • Discussion with community on options to reduce any significant impacts. • Presentation/negotiation	*The Sustainable Minerals booklet on Community Consultation & Involvement gives advice on methods for positive engagement with the community.*	

			with community & other stakeholders led by the environmental coordinator.		
1.11 Have you advised employees & contractors of any special requirements, restrictions & sensitivities?	Distribution of plan of intended operations emphasising techniques to avoid unacceptable environmental & other impacts	• Plan distributed to all employees & contractors • Arrangements in place for distribution to new staff/contractors at commencement			
1.12 Have you received completed contracts from contractors which accept responsibilities for environmental protection?	Contracts finalised with all contractors specifying their environmental responsibilities	Responsibilities for contractors conform with: • corporate environmental policy & objectives • environmental protocols for the exploration project • the special requirements, restrictions &	Contracts include termination clauses related to non-observance of environmental conditions		

		sensitivities of the exploration area.			
1.13 Do all contractors carry workers' compensation & public liability insurance?	All contacts with contractors include workers' compensation & public liability insurance	Check all contracts			
1.14 Have you made a photographic record of conditions on-site prior to exploration commencing?	Photographic record of pre-exploration conditions	Photos include all of the special, unique or sensitive sites as listed (see Question 1.7)	Also include photos of tracks, general bushland, water supplies, airstrips and similar facilities likely to be subjected to use by the exploration team.	*Recording of the date & location on photos will assist in record-keeping & may help in later discussions or disputes. Periodic re-photoing of key areas is advisable.*	
Part 2: Exploration Operations - refer to section 3.2 of the Onshore Minerals & Petroleum Exploration Sustainable Minerals booklet					
2.1 Have owners, lessees & land users been visited to advise that the exploration program has commenced?	Personal visits to ensure authoritative contact & establish proper communication channels	Record of visits to all relevant persons on the register of land owners, lessees & land users (see Question 1.5).			
2.2 Is your campsite located/designed to minimise potential environmental impacts?	Camp situated & operated to minimise risk of significant environmental impact	Campsite: • is away from high value vegetation, sites of Aboriginal significance or other			

		special areas • is more than 100m from nearest water body • has adequate precautions against wild fire, & propagation of fire from the camp into the bush (including fuel storage area) • has toilet & rubbish disposal areas designed to avoid environmental impacts • well-sited in relation to existing tracks flooding & minimal clearing of vegetation			
2.3 Are tracks used & managed to reduce potential for significant	Reduced erosion, reduced area of compaction & surface	• existing roads & tracks used in preference		*Figures 1,2,3 & 4 in the booklet show environmentally sound principles for temporary track &*	

degradation?	& vegetation disturbance or destruction	to making new ones • any new roads/tracks avoid places of high natural or social value • siting & construction of tracks & roads planned with heavy rain in mind • entry/exit points from existing roads concealed to discourage tourist & other casual use		*road construction, & simple erosion control structures.*	
2.4 Have vehicles & exploration techniques been selected which will have minimal impact?	Reduced disturbance, eg compaction, wheel ruts, damage to vegetation, narrower tracks	Evidence of vehicles & systems which are sensitive to site conditions	Low impact tractor-mounted light drill rigs & handheld augers can significantly reduce disturbance from drilling. A heavy roller can be used instead of a grader to prepare a seismic line.		
2.5 Are all vehicles checked for environmental acceptability?	Environmental protocol specifies a system for checking vehicles for	Vehicles coming on to site are free of seeds, mud, fuel & muffler leaks	All vehicles should be required to carry safety gear.		

	environmental acceptability				
2.6 Do you provide fire-fighting equipment in all vehicles & campsites?	• Environmental protocol specifies that all vehicles carry fire extinguishers • Fire fighting gear stored at all campsites.	All vehicles carry fire extinguishers. Campsites carry tools for constructing fire breaks, back-burning & portable water hosing.	Establish emergency procedures with local fire authorities.		
2.7 Are drill sites located & laid out to minimise environmental impact?	Environmental protocol specifies methods to reduce environmental disturbance at drill pads	• Evidence of drill pads sited on pre-existing disturbed areas, eg on track, or sited away from denser vegetation • Sumps large enough to contain all slurry	Digging of sumps can be avoided by constructing an elevated sludge box around the drill collar & piping to a tank placed on the ground. A working platform of timber pallets can be laid down to reduce compaction.		
2.8 Are measures taken to minimise damage to vegetation?	Environmental protocol specifies methods to preserve vegetation	Procedures include: • bans on smoking & controls on use of camp fires (eg no	GPS systems allow accurate location & remove need for line-of-sight grid/drill lines. Rollers can be used to improve load bearing surface strength across light vegetation for drill		

		multiple fires) • minimal vegetation cleared for track, gridline or drill pad construction • costeans kept to minimum size necessary • excavated spoil placed carefully to minimise impact on vegetation • cleared vegetation ("trash") stockpiled & reused for revegetation • minimum depth of vegetation clearing to minimise damage to root systems & soil structure	rig access instead of grading tracks. Topsoil & trash stockpiling & replacement will retain seed bank & enhance revegetation.		
2.9 Are measures taken to minimise damage to topsoil?	Environmental protocol specifies methods to preserve	Procedures include: • topsoil stored		*Figures 1 & 2 show simple principles for topsoil management applied to track*	

	topsoil	separately from subsoil • topsoil stored in heaps less that 2m deep • topsoil being re-applied to disturbed areas as soon as the excavation has served its purpose		*construction & rehabilitation. Further information is in the Rehabilitation & Revegetation Sustainable Minerals booklet.*	
2.10 Are measures taken to prevent liquid & solid spillages?	Environmental protocol specifies methods to prevent liquid & solid spillages	Procedures include: • application of procedures required to meet regulations governing the storage & use of fuel & other liquids • routine maintenance to check & repair leakage & spillage from vehicles, machines & equipment		*Techniques for handling & storage of fuels & other liquids are described in the Sustainable Minerals booklet on Hazardous Materials Management, Storage & Disposal.*	

2.11 Are measures taken to control litter?	Environmental protocol specifies methods for control of litter	Procedures include: • provision of rubbish bins at campsites & main activity areas (eg drill pads) • regular collection/emptying of rubbish bins • appropriate disposal of rubbish	Sorting & recycling of all rubbish should be encouraged wherever practicable	*Clean 20l or 200l drums lined with plastic garbage bags are cheap to install & empty. Rubbish can be disposed of in local council tip if available, or purpose-built pit on the exploration lease (check that permits allow this).*	
2.12 Are measures in place to manage water so as to avoid significant environmental impacts?	Environmental protocol specifies methods for use & handling of water	Procedures include: • reduction of water use in areas where water is in short supply • testing of groundwater prior to release to ensure suitable quality - eg avoid damage to vegetation from release of saline groundwater	• Portable toilets can be provided in areas of concentrated activity away from the main camp • Properly constructed sullage & septic systems at main camp		

		from drill holes • prevention of release of contaminated water, eg from mess kitchen, sludge from drill pad mud pits			
2.13 Are measures in place to maintain good relationships with the local community?	Environmental protocol sets out communication channels & suitable behaviour to meet community expectations	Procedures include: • wishes of land owners/lessees met • domestic pets denied access to livestock or native animals • firearms banned or strictly controlled • respect for private property & privacy • public requests for information met fully & promptly			

2.14 Is there ongoing communication with contractors to ensure their compliance with environmental protection requirements?	System of regular communication with contractors regarding environmental controls & behaviours	System of regular communication with contractors regarding environmental controls & behaviours			
Part 3: Rehabilitation refer to chapter 4 of the Onshore Minerals & Petroleum Exploration Sustainable Minerals booklet					
3.1 Have disturbed areas been rehabilitated according to the requirements of the environmental protocol?	All disturbed areas rehabilitated	Site inspection to check for: • topsoil return • ripping or scarifying • return of trash, +/- seed distribution +/- seedlings planted	All windrows, track/road beds & other areas impacted by exploration activity scarified, reseeded and revegetated		
3.2 Has all rubbish been removed or properly disposed of?	All rubbish removed	Site inspection for: • all rubbish removed • rubbish disposed of into off-site landfill or burned on-site & buried in pits at least 1m deep			
3.3 Have all drill holes	All drill holes filled	Site inspection: all	Figures 5 & 6 show how drill	*Any holes intercepting significant*	

been filled or capped?	or capped	drill holes filled or capped in accordance with local regulations & guidelines, & to remove trap structures for small animals	holes can be cheaply plugged to prevent them acting as animal traps. & be readily relocated if required	*aquifer flows should be completely backfilled to avoid inter-aquifer contamination or aquifer depletion.*	
3.4 Have all drill sumps been filled & rehabilitated?	All drill pad sumps backfilled & rehabilitated	Site inspection: all drill pad sumps backfilled & rehabilitated	Drill mud should be left to dry out completely before back-filling.	*Steps for rehabilitating drilling sumps are described in Case Study 3.*	
3.5 Have all excavations been refilled & rehabilitated?	All excavations back-filled & rehabilitated	Site inspection: surfaces graded & revegetated to blend with surrounding undisturbed ground	Areas should be mounded to compensate for consolidation & prevent ponding.		
3.6 Has all equipment been removed off site?	All materials moved off-site	Site inspection			
3.7 Have all grid pegs been recovered or laid flat on the ground?	All grid pegs pulled out	Site inspection			
3.8 Have landowners/lessees/land users had the opportunity to inspect the site?	Key stakeholders aware of site condition	• Record of tour involving all land owners, lessees & land users • Tour extensive, including all areas of interest to stakeholders.	Invite representative of regulatory authorities (local council, mines & environment depts) & relevant community groups to attend.		

		Record of any concerns arising			
3.9 Has action been taken to address any issues arising from the inspection by landowners/lessees/ land users?	Key stakeholder concerns on site condition addressed to their satisfaction	• All matters of concern arising from site tour with stakeholders addressed • Written report provided to company management	Follow-up site tour with interested stakeholders, authorities & community groups.		
3.10 Has compensation been paid for loss of earnings or damage to improvements?	Damage to property & loss of earnings by land owners/lessees/land users rectified	Evidence that the complete log of claims is satisfied	Inspection tour of rehabilitation works can have the joint purpose of inspecting & agreeing on matters relating to property damage & loss of income, to reduce misunderstanding or disparity in estimations of costs.		
3.11 Have photos been taken of disturbed sites after rehabilitation is completed?	Photographic record of site condition at conclusion of rehabilitation program to reduce room for misrepresentation & disputation	Photographic record of all significant operational sites including drill pads, tracks, sumps, pits, campsites, costeans & rubbish pits	Include photos of all of the special, significant & sensitive sites record prior to exploration.	*Include dates & exact locations for all photos.*	
3.12 Have arrangements been made for checks of rehabilitation & for any	Monitoring data on progressive rehabilitation & achievement of	• Annual collection & reporting of data	Use of independent consultant acceptable to the company, community & regulators with decrease potential for disputes		

maintenance work that may become necessary?	objectives	• Annual assessment of rehabilitation status & progress towards achieving objectives			
3.13 Have you checked the exploration/tenement permit to ensure all licence conditions have been met?	Improved estimation of time at which rehabilitation bond etc is recoverable	Record of evaluation of rehabilitation outcomes against all regulatory requirements			
3.14 Are regulators & landowners /lessees/land users satisfied with the rehabilitation?	• Smooth progress towards recovery of rehabilitation bond • Low probability of any long term claims against the company	Written agreement from regulators, land owners, lessees & land users that the level of rehabilitation is accepted by them			

Checklist for Planning a Workforce Environmental Awareness Training Program

Issue	Outputs	Performance Measure	Improvement	Comments	Notes

Part 1: Introduction - refer Introduction in Planning a Workforce Environmental Awareness Training Program Sustainable Minerals booklet					
1.1 Have you identified the factors critical to the success of your training program?	Documented set of success factors for each element of the training program	Success factors identified for each of the following steps: • communication • urge • leadership • team work • understanding • recognition • empowerment	Key elements to be covered by your training program are best identified through an audit of the environmental performance of your operations, staff attitudes & understanding towards environmental protection, & stakeholder opinion. Refer to the Environmental Auditing Sustainable Minerals booklet.	*Success factors relevant to each step are suggested in part 2 of this checklist.* *Note this checklist does not set out specific technical & presentational content for your training program, because these will differ for each site depending on the type of operation & the associated environmental issues, as well as the current level of environmental awareness & the sort of relationship you have with stakeholders.*	
1.2 Does your training program include techniques to align people & their values with your company's environmental vision & mission?	Training program presents company environmental policy & structured to reinforce the policy				

1.3 Is your training program receptive to the ideas & perspectives of key interest groups in the community?	Training program describes environmental concerns of community & other groups for the operation	Evidence of linkage between surveys of community attitudes & content of the training program			
1.4 Does the training program integrate with & complement the management systems for the operation/company?	Training program describes mine management systems relevant to environmental protection, eg water, hazardous materials	Training program describes mine management systems relevant to environmental protection, eg water, hazardous materials	• Analysis of environmental performance & risks posed by various components of the mine operations is presented to participants • workshopping of consequences/ responses/responsibilities		
1.5 Is the training designed to provide the right sort of knowledge, skills & resources to the trainees, in respect of their work roles & responsibilities?	Training plan tailored to the knowledge levels & skills range of the participants, & their work roles & responsibilities	Training plan tailored to the knowledge levels & skills range of the participants, & their work roles & responsibilities			
1.6 Does the training program set out to deliver measurable outcomes?	Training plan sets out pragmatic objectives for the training program	Training program includes periodic evaluation to determine if participants understand what they have been told & whether they are likely to implement this new understanding	Ongoing periodic assessment of employee environmental understanding & attitudes used to assess effectiveness of training & plan future training needs		

		effectively in the workplace			
Part 2: Implementation - refer Chapters 2-7 in Planning a Workforce Environmental Awareness Training Program Sustainable Minerals booklet					
2.1 Does the training program incorporate features to provide effective communication on environmental matters? - style of presentation	Training materials & presentations avoid jargon & acronyms, & technical terms explained in simple & clear language	• Readability index • Sentence length • Frequency of jargon/acronyms • Inclusion of glossaries	Standard of language & style of presentation is sensitive to the level of education & work experience of participants, & is sensitive to local customs, beliefs, concerns & taboos.	*Ensure:* • *reasoning behind a directive & its place in the overall strategy is explained* • *the message is not over-complicated through too much information* • *all relevant information is disseminated* • *all information is credible & is not misleading* • *any targets set are reasonable & achievable* • *adequate back-up is provided to achieve goals - especially management support;* • *managers deliver all promised initiatives*	
- presentation method	Presentation recognises different needs, outlooks & working methods of different	• Degree of line manager involvement in environmental training			

	management levels, & uses appropriate staff & techniques to deliver the program.	• Message consistent with & aligned to business strategy			
- language mix	Employ a corporate focus, but with sensitivity to local language & communication skills of participants	Degree of understanding by participants - use exit questionnaires to evaluate effectiveness of communication	Where the local first language is not English, present in the local language - eg interpreters, or better still staff who speak the local language		
- frequency	Frequent communication of environmental issues	Training is continual, not one-off or periodic	• Mix of internal & external sources & presenters • Messages reinforced through different media.	*Media can include message boards (keep up-to-date!), tool-box talks, work group forums to discus environmental targets/progress, joint discussion of environmental & Safety issues, regular publications & leaflets, special promotions (eg calendars), posting of performance charts etc, as well as occasional formal training courses.*	
2.2 How motivated is your operation towards urging its staff on the need for environmental protection & to assume responsibility for it? - employee receptiveness	Employees readily accept/adopt new environmental initiatives or directives	Number of environmental initiatives & ideas volunteered by employees	Management support to schemes to encourage employees to contribute ideas for environmental improvement	*Suggestion boxes; standing agenda item at toolbox meetings etc. Workers in larger operations may be more motivated if they relate to smaller work groups with identifiable improvement objectives.*	

- managers' receptiveness	Managers' job descriptions & duties include environmental protection	• Environmental objectives set out in the EMS for the operation • Number of environmental performance complaints.	Manager salary review includes environmental performance as a determinant	*Avoid:* • *recruiting managers whose personal values are at odds with organisational values; overloading staff with to many changes* • *sending wrong messages by indifferent actions*	
- resourcing	EMS & environmental training are line items in the operation's annual budget	Percentage of annual budget allocated to EMS & environmental training	Training & awareness for environmental management allocated a specified budget percentage		
- support	Environmental awareness training undertaken	Percentage of annual budget allocated to environmental training	Comprehensive environmental training covers all environmental facets of the operation, with annual refresher courses	*Training should include contractors as well as permanent employees, & environmental induction courses for new employees/contractors as soon as possible after commencement. Case study 5a at page 19 in the Sustainable Minerals booklet describes SANTOS's approach to staff induction.*	
2.3 Does the organisation provide strong & clear leadership on the	Corporate policy on environmental protection backed up with explicit	Corporate policy on environmental protection backed up with explicit guidelines & an EMS.	Corporate environmental policy & Business Unit environmental policies	*Case study 1 on page 8 of Sustainable Minerals booklet gives an example of an environmental awareness*	

importance of environmental awareness? - commitment	guidelines & an EMS			*campaign at EXXON coal mines & the positive impacts it had on increasing understanding & commitment & improved corporate profile in the community.*	
- accountability	Job descriptions which set out environmental responsibilities for line managers, including accountability for some key environmental issues	• Responsibilities for line managers include environmental roles & accountability for some key environmental issues • All staff have some specific environmental accountability • Presence of systems to validate accountability	• Job descriptions for senior managers include specific environmental accountabilities • Staff positions carrying specific environmental responsibilities set out in EMS & disseminated to all staff	*Leadership can be demonstrated through:* • *a corporate policy which includes environmental values & vision;* • *application of an integrated EMS;* • *board members who take the trouble to understand environmental issues, concepts, responsibilities & practices;* • senior managers adopting environment as a priority; • *supervisors conducting training & awareness sessions; and* • *environmental performance as part of a manager's performance review.* *Case Study 2 describes how a management initiative to*	

				improve the visual aesthetics of the Kidston mine was embraced & taken over by an enthusiastic workforce.	
- personal demonstration	Evidence of commitment from senior management	• Public & private statements from senior management on the importance of environmental protection • employee perception of senior management commitment	Active involvement by senior managers in supporting & maintaining environmental initiatives.	*Avoid:* • *not communicating the organisation's values & environmental policy* • *failing to clarify or prioritise environmental issues for action* • *no penalty for poor environmental performance* • *measuring performance solely on production* • *ignorance of broad issues such as greenhouse, ozone, & your mine's contributions to them*	
2.4 Do you encourage teamwork at your operation? - ared environmental values & vision	Environmental policy statement including a values statement, widely posted	All staff have an appreciation of the organisation's shared environmental values	The environmental vision is clearly translated into specific objectives & actions in the EMS		
- self-managing teams	Evidence of multi-disciplinary teams	Percentage of multi-disciplinary teams including members with		*Team work environments can increase worker motivation, commitment, morale, job*	

		environmental skills		*performance, cooperation & communication; provide an effective training function; generate ideas; & help to identify environmental risks to test disaster planning.* *Avoid:* • *lack of support by senior manager* • *threats to senior managers because of conflicts over decision-making* • *lack of performance feedback* • *insufficient allocation of time & resources* • *unclear accountabilities* • *environmental inputs limited only to obvious environmental problems* • *unclear purpose / operating boundaries* • *insufficient team environmental capabilities* • *lack of respect fro different opinions;* • *non-recognition of teams*	

				• *too many teams*	
2.5 Is training building into increased understanding, ie knowledge & skills amongst staff? - knowledge	Employees able to understand local & global environmental issues	Participation of employees in workshops to discuss environmental issues; annual refresher courses for all employees & contractors		Videos & brochures are available on many environmental issues affecting the mining industry. However, information direct from supervisors underlines corporate knowledge & commitment to environmental protection. Case Study 6 describes BHP Coal's competency-based training program.	
- skills	Employees understand rationale behind impacts & actively seek solutions	Staff delegated responsibility for certain environmental functions, eg operational & emergency cleanup	Work teams generate solutions for environmental problems, including preventative measures. People generally learn more effectively when they are actively involved & using as many senses as possible. Therefore training in the real work environment is commonly most effective (eg in toolbox sessions).	*Specialist environmental trainers can be used to build up internal training skills, eg by:* • *conducting a training needs analysis* • *establishing a policy on training program objectives & Structure* • *developing train-the-trainer programs;* • *providing trainer information kits & aids* • *providing expert advice* • *conducting training evaluation, and* • *maintaining full*	

				training records	
2.6 Do you provide recognition to reinforce appropriate environmental behaviour? - acknowledgement	Managerial acknowledgement of teams or individuals for environmentally responsible initiatives	Formal system in place to identify & recognise environmentally responsible initiatives	Corporate acknowledgement of environmentally responsible initiatives	*Recognition should be:* • *specific to the task* • *immediate* • *take into account the challenge involved* • *given meaningful attention by senior management*	
- reward	Evidence of rewards having been given	Formal system in place to identify & recognise environmentally responsible initiatives worthy of reward & identifying appropriate awards to be given	Corporate promotion of the rewards system by senior management	*Rewards may be:* • *simple verbal recognition* • *allotting of new tasks & responsibilities* • *written record of recognition* • *merit award eg plaque, name roll, prize* • *recommendation for promotion* • *pay bonus.* *Avoid:* • *alienating team members by rewarding only one member* • *giving a gift with no lasing value/benefit* • *creating a "what's in it*	

				for me" attitude by rewarding everyday tasks • *building competitiveness which could reduce information sharing & cooperation* • *inappropriate & untimely feedback* • *insincere acknowledgement.*	
2.7 Have you a system for empowerment of staff through delegation of responsibilities? - recognition of responsibility	Evidence that environmental responsibilities are provided to staff other than environmental managers	Documented consideration of environmental impacts in key management decisions	Environmental team provides a support role & are consulted where environmental impacts are likely	*Environmental managers should not delegate responsibilities unless they are confident the team or person they are empowering has the necessary knowledge & skills to perform the assigned task.* *Case Studies 4, 7a & 7b* *provide examples of employees making recommendations & decisions of environmental significance.*	
- authorisation	Evidence of employee initiatives	Initiatives generated by employees supported by management	Delegation of responsibility to employees & guidance notes on how to undertake environmental responsibilities	*Empowerment can increase job satisfaction & lead to:* • *higher morale* • *lower staff turnover* • *employee initiatives appropriate to the organisational culture* • *improved*	

				environmental performance. *Avoid:* • delegating only unpleasant tasks • *overloading employees with additional tasks* • *failing to work in accordance with the environmental management plan* • *reluctance to reduce level of management control;* • *over-organising the task*	
- resource	Funds allocated for environmental initiatives from staff	Number of initiatives supported.	Funds allocation based on improvements in environmental performance & corporate environmental image rather than operational cost		
Part 3: Monitoring and Assessment					
3.1 Do you monitor the level of environmental awareness at your operation?	Evidence of assessment of environmental awareness by the workforce	• Tracking of environmental performance in the annual report. Assessment of environmental performance by different parts of the operation	Benchmarks for continual improvement can be set for segments of the operation. Failure to meet realistic targets, or any signs of declining environmental performance, should be investigated & appropriate remedial action taken.	*Benchmarking involves setting realistic targets based on other known good performers in the mining industry.*	

		• Analysis of reasons for environmental non-compliance • Surveys of staff attitudes & understanding towards environmental protection.			

Checklist for Rehabilitation and Revegetation

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Planning and Management					
1.1 Did you prepare a rehabilitation plan before mining commenced?	Rehabilitation Plan	Rehabilitation Plan prepared before mining commences	Rehabilitation Plan prepared in consultation with stakeholders & local community	*Most State governments produce guidelines for mine rehabilitation & closure, which expects the Rehabilitation Plan to include:* • *maps of topography, hydrology, biological information at closure* • *maps of works affecting topography, hydrology, & biology to be completed each year (preferably using GIS)* • *description of rehabilitation strategy, timing & techniques to meet rehabilitation success & closure criteria* • *description of objectives & methodology of any research or rehabilitation trails to be undertaken* • *details of the materials, operational & financial*	
1.2 Does the rehabilitation plan contain clearly stated objectives for mine rehabilitation?	Rehabilitation Plan	Rehabilitation Plan includes clearly stated objectives for mine rehabilitation	Objectives determined through extensive consultation with stakeholders, including local landowners & users		

				resources required • *a monitoring program to evaluate success against the rehabilitation acceptance criteria.* *Example objectives include:* • *reshape surface to obtain stability, adequate drainage & slopes suitable for target land uses* • *minimise long term visual impacts by shaping similar to surrounding natural landforms* • *reinstate natural drainage patterns where possible* • *use catchment parameters based on natural pre-existing condition* • *minimise potential for water & wind erosion during & post mining* • *remove & control hazardous materials* • *identify & manage potentially toxic strata (refer Acid Mine Drainage Sustainable Minerals booklet).* *More extensive coverage for landform aspects of this topic is provided in the Landform Design for Rehabilitation Sustainable Minerals booklet.*	
1.3 Do the objectives include an agreed long-term post-mining land use?	Rehabilitation Plan contains objectives which are attainable & match regulatory & community expectations	Objectives cover: • post-mining land use • land stability • resistance to erosion • vegetation types, species diversity & density • water quality.	Objectives should be reviewed on a regular basis to take into account research results, new technologies/knowledge of rehabilitation & revegetation techniques, changes to mine operations, size, predicted mine life etc, & any changes in regulatory	*Useful references on community consultation include the Sustainable Minerals booklet on Community Consultation & Involvement, & the NSW Mining Councils Guidelines for Best Practice Community Consultation in the NSW Mining & Extractive Industries.* *Case Study 3 includes an example objective based on cattle grazing pastures.*	

		Objectives agreed with regulators & key community & landowner/user representatives.	requirements, guidelines, & community expectations & desires		
1.4 Are you committed to progressive rehabilitation works during mining operations?	Rehabilitation Plan, mine Environmental Management Plan	• Commitment to progressive rehabilitation stated in Rehabilitation Plan, & mine Environmental Management Plan • Annual reports of progressive rehabilitation works given in mine/ corporate annual environmental report. Evidence from site inspection	Targets set for progressive rehabilitation & performance against targets reported annually	*Targets for progressive rehabilitation can be eg total disturbed & unrehabilitated area not to exceed a certain size; annual reductions of unrehabilitated areas, or% of rock dumps shaped to final landform etc. Effective reduction in the area requiring rehabilitation can translate into reduced rehabilitation bonds held by government.*	
1.5 Do you have procedures in place to prevent the introduction of noxious weeds, pests &	Rehabilitation Plan, mine Environmental Management Plan, operational manuals	• EMP, Rehabilitation Plan, operational manuals set out procedures to prevent introduction of			

diseases?		noxious pests, weeds & diseases • Level of knowledge of these procedures amongst staff & contractors • Evidence that procedures are operational.			
1.6 Are you minimising the amount of land clearing?	Environmental Management Plan	EMP sets targets for maximum area of disturbance	Pre-mine stripping of new areas can be linked directly to progressive rehabilitation by direct relocation of vegetative track & topsoil.	*Minimal disturbance is a key principle in best practice mining & rehabilitation, & also reduces costs at the end of operations.*	
1.7 Do you have a program of research into rehabilitation & revegetation issues?	Environmental Management Plan contains requirements for rehabilitation research	• Rehabilitation Research Plan documenting key rehabilitation issues & research objectives • Evidence of research work eg onsite laboratory, greenhouse, ground trials, contracts	Research should be on-going throughout mine life & extend to field trials to prove techniques prior to post-operational rehabilitation works phase.	*Research should cover:* • *structure & function of the pre-mine ecosystem, hydrology & land surface* • *pre-mine vegetation data, including upper, mid & understorey species & groundcovers* • *pre-mine fauna baseline data* • *soil & overburden properties, & identification of potential for plant growth* • *identification of any difficult materials requiring treatment or avoidance as growth media* • *species selection for soil stabilisation & ecosystem reconstruction* • *ecology of native species* • *seed biology*	

		with/sponsorship of research providers • Comprehensive flora and fauna survey during planning phase		• *plant establishment techniques* • *plant symbioses* • *surface preparation techniques to enhance infiltration, moisture retention, reduce erosion* • *stressors which may constrain rehabilitation success, & their mitigation (eg Case Study 4 includes research into the effects of fire).* *In addition to professional groups, considerable expertise is available from Landcare groups in flora surveys.*	
1.8 Is the rehabilitation & revegetation plan reviewed regularly?	Review reports	Documented review procedures & outcomes	Review encompasses consultation with local community stakeholders, land users & regulators.		
Part 2: Rehabilitation Procedures - refer sections 3.1 - 3.4 in the Rehabilitation & Revegetation Sustainable Minerals booklet					
2.1 Do you have appropriate procedures for topsoil handling, relating to: - topsoil salvage?	Rehabilitation Plan	• Rehabilitation Plan sets out relevant procedures • Site inspection to determine if procedures are implemented		*Topsoil should be treated as a valuable resource. Topsoil should be characterised, retained for use in rehabilitation, & tested for contamination, pathogens & weed seeds.*	
2.2 Do you have appropriate procedures for topsoil handling, relating to: - timing of topsoil	Rehabilitation Plan	• Rehabilitation Plan sets out relevant procedures. • Site inspection to determine if procedures are implemented		*Soils should not be stripped when too wet or too dry, as this can lead to compaction, loss of structure, & loss of seedbank & mycorrhizal viability. Where possible, clearing & topsoil stripping should follow seed-set to maximise the amount of seed stored in the soil. Non-seed propagules are best collected by stripping in cool & moist conditions, but this may jeopardise other soil values & increase the risk of spreading pathogens.*	

stripping?					
2.3 Do you have appropriate procedures for topsoil handling, relating to: - replacement & stockpiling of topsoil & preservation of microbiological activity?	Rehabilitation Plan	Rehabilitation Plan sets out relevant procedures. Site inspection to determine if procedures are implemented, eg • "direct return" used where practicable • stockpiles no more than 2m thick	Where possible, topsoil should be: • placed along the contour to help reduce downslope runoff & increase infiltration • immediately moved from the stripping operations to the final rehabilitation area ("direct return" - see Case Study 1 for an example.	*Direct return can reduce double-handling & stockpile management costs, avoid disturbing extra land for stockpiling purposes, & minimises degradation of structure, organics mater, microbiological activity, & seed viability.* *If soil must be stockpiled, the piles should:* • *be as short-lived as possible* • *no thicker than 2m & have a large surface area* • *be revegetated to minimise erosion, discourage weeds & maintain microbial activity* • *located where they are unlikely to be disturbed until they are to be used for rehabilitation (excess handling destroys soil structure).* *Micorrhizal activity is particularly important in Australia, are necessary for some plant species to establish, & increase P uptake in P-deficient soils.*	
2.4 Do you have appropriate procedures for topsoil handling, relating to: - plant pathogens?	Rehabilitation Plan	• Rehabilitation Plan sets out relevant procedures • Site inspection to determine if procedures are implemented.		*If soils are infected with Phytopthera or Armillaria, procedures should involve:* • *strict separation of infected & uninfected soils* • *controlled movement of infected soil* • *avoid creating conditions conducive to spread & intensification* • *control measures, eg fungicides.*	
2.5 Do you have alternative	Rehabilitation Plan	• Rehabilitation Plan sets out relevant		*Alternatives are indicated where natural soil is:* • *not present in sufficient quantity*	

strategies in situations where the quantity of topsoil is insufficient, or where topsoil is inappropriate?		procedures • Site inspection to determine if procedures are implemented.		• *highly affected by weed seed or plant pathogens.* *Subsoil, overburden, waste rock or similar material can be prepared provided their physical & chemical properties are thoroughly investigated. Improvement methods include:* • *addition of organic matter eg manure* • *gypsum to reduce pH & improve structure* • *lime to raise pH* • *inorganic fertilizers* • *soil conditioners* • *growing & incorporating green manure crops* • *establishing N-fixing species* • *adding mulch.*	
2.6 Have you developed a detailed plan for landform design & reconstruction?	Rehabilitation Plan	Rehabilitation Plan includes specific guidelines for landform design & reconstruction, aimed at maximising: • stability • hydrological compatibility	Constructed landform design is based on emulating pre-mine land slope angles, lengths & shapes, & drainage patterns & densities.	*Reshaping & grading are inescapable components of a rehabilitation program. Good planning & management can minimise reshaping needs & costs. Extensive advice is provided in the Sustainable Minerals booklet on Landform Design for Rehabilitation.*	
2.7 Have you incorporated features in the landform design which will control erosion?	Rehabilitation Plan	• Rehabilitation Plan includes specific guidelines for minimising erosion • Site inspection		*Vegetation cover is a key, long term protection strategy. Other methods include:* • *wind erosion: mulching, maintaining a moist & compacted surface, & windbreaks* • *water erosion: upstream diversions, flow energy reduction structures, mulching & protective*	

		for evidence of implementation in progressive rehabilitation works.		*matting to increase infiltration & protect from rainsplash etc.*	
PART 3: REVEGETATION PROCEDURES - refer sections 3.5 - 3.8 in the Rehabilitation & Revegetation Sustainable Minerals booklet					
3.1 Have you selected an appropriate suite of species for revegetation which matches the specific natural habitat and post-mine land use objectives?	List of selected species, research results	• List of selected species which suits post-mine land use objectives, based on baseline studies of analogue land use sites, &/or specific on-site research & field trials • Post revegetation flora and fauna surveys correlate with pre-mining survey		*Information on native seed biology & selection is available from ACMER: http://www.acmer.com.au/publications/proceed_nsbfr.html*	
3.2 If the objective includes establishment of native species, have	Rehabilitation Plan	• Rehabilitation Plan sets out from where native species seeds are to be sourced		*As the soil types & profiles in the constructed landform will differ from natural pre-mine soils, it is possible that local species are unsuited. In this case, natural soils which more closely resemble the coils in the constructed landform should be located ("analogue sites") & seeds of species resembling the local species sourced from there.*	

you considered the appropriate provenance of native seeds?		• Evidence of seed collection/acquisition consistent with the plan			
3.3 If the objective includes agricultural post-mine land use, does your species selection take into account post-mine soil character & fertility?	List of selected species, research results	List of selected species which suits post-mine land use agricultural objectives, based on studies of post-mine soil characteristics, &/or specific on-site research & field trials			
3.4 Have you considered the benefits of including a fast cover species to reduce erosion risk?	Rehabilitation Plan, research results	Results of research or field trials into soil stability, erosion characteristics, & effectiveness of vegetation & other erosion control techniques		*See also Question 2.7. Hybrid grass species which do not set seed are particularly useful (eg Sudax), as they do not represent major competition to slower-establishing species after the first year.*	
3.5 Have you determined the most appropriate technique or mix of techniques for	Rehabilitation Plan, research results	Results of field trials into techniques for establishing vegetation		*Appropriate techniques include:* • *spreading topsoil (& seedbank)* • *broadcasting seed* • *harvesting & spreading bradyspores (seed retained on the plant in persistent woody capsules)* • *transplanting of recalcitrant species*	

establishing vegetation compatible with the endemic ecosystem?				• *planting of seedlings*	
3.6 If using native species, have you determined appropriate seed collection techniques?	Rehabilitation Plan, research results	Application of techniques recommended by specialist groups, or from site-specific research		*State government departments of land, agriculture & environment, some university research departments, & Landcare groups produce guidelines on seed collection techniques.* *Good practice entails:* • *establishing a seed orchard to produce seed for rare species or where seed is limited or difficult to collect* • *identifying collection areas before the seed matures* • *collect only mature seed* • *avoid seed/fruit attacked by insects or fungal infection.* *Some seed can be collected using vacuum equipment.* *Seed can be collected from trees when felled in the pre-strip campaign.*	
3.7 If you are purchasing seedstock, have you considered how to reduce the risk of poor quality of supply?	Report assessing risks in seed quality & supply	Identified risks taken into consideration in determining seed purchase options	Partnership arrangements can be established with local indigenous & Landcare groups to provide small business opportunities, benefit from local knowledge, & share information	*You are recommended to:* • *purchase from reputable seed merchants* • *set up long term contracts with suppliers for particular species* • *know where the seed provenance is* • *know the date of collections & conditions of seed storage* • *obtain the germination rates for each species of the*	

				seed provided • *ensure that seed of agricultural species is certified by the State agriculture department.*	
3.8 If you are collecting your own seed, are you aware of the need for care in: - seed processing?	Rehabilitation Plan procedural guidelines.	• Rehabilitation Plan sets out guidance for seed processing techniques • Techniques sourced from seed preparation experts or from specific research.		*Seed should be cleaned before storage to remove debris, chaff, fruit flesh, pods etc. Processing methods are often species-specific, eg drying, threshing, burning, soaking etc.* *Store seed in dry, insect & vermin-proof containers which are clearly labelled with species, collection date & location data. Store at low humidity (<10%) & temperature - requirements differ for temperate & tropical species.*	
3.9 If you are collecting your own seed, are you aware of the need for care in: - seed storage?	Rehabilitation Plan procedural guidelines	• Rehabilitation Plan sets out guidance for seed storage techniques • Techniques sourced from seed merchants, published guidelines, botanical experts or from specific research		*Seed is commonly treated with insecticide & fungicide before storage. CO_2 is an effective insecticidal fumigant. Note that loss of viability during storage is common.*	

3.10 If you are collecting your own seed, are you aware of the need for care in: - seed treatment?	Rehabilitation Plan procedural guidelines	• Rehabilitation Plan sets out guidance for seed treatment techniques • Techniques sourced from seed merchants, published guidelines, botanical experts or from specific research.		*Treatment requirements differ markedly bete\ween species. Many Australian species require immersion in boiling water to soften seed coats, or smoking to enhance germination rates. Inoculation with rhizobia is needed for agricultural legume seed, & some native legumes also benefit.*	
3.11 If using seedstock for re-establishment of vegetation, have you specified appropriate seed bed preparation techniques?	Rehabilitation Plan procedural guidelines	• Rehabilitation Plan sets out guidance for seedbed preparation techniques • Techniques sourced from seed merchants, published guidelines, botanical experts or from specific research.		*Key factors include:* • *good seed/soil contact to allow water absorption by the seed* • *soil loose enough to allow aeration &ready root development* • *seed bed free of weeds.* *Do not over-prepare the seed bed as a rougher surface provides more niches to hold the seed & encourages infiltration. Seed before surface crust forms. Avoid compaction. Mulching can improve the seed micro-environment.*	
3.12 If using	Rehabilitation	• Rehabilitation		*Techniques include manual broadcasting, or mechanical*	

seedstock for re-establishment of vegetation, have you specified appropriate seeding methods & timing?	Plan procedural guidelines	Plan sets out guidance for seeding techniques & timing • Techniques sourced from seed merchants, published guidelines, botanical experts or from specific research.		*broadcasting, drilling, hydroseeding, hydromulching, or aerial spreading. Technique is determined from topography, size of area & seed type. The large range in seed size for native species makes mechanical application difficult.* *In most cases, seed should be sown just before expected onset of reliable rains. Native seed may require particular moisture & temperature conditions. Sowing too early exacerbates seed theft by ants, birds & small mammals.*	
3.13 Do you have a program of weed control?	Rehabilitation Plan procedural guidelines	Rehabilitation Plan sets out guidance for weed control. Manual for field operators	Weed identification charts with specific treatment regimes	*Infestations can be very difficult to control, so prevention is much better than treatment. Control weeds in areas adjacent to rehabilitation to reduce seed load. Avoid introduction of weeds via manures, poorly cleaned seed-stock. Avoid fertilizers which encourage strong weed growth. Hand weeding is expensive but effective in small areas. Herbicide control is often limited to spot spraying, selective herbicides (eg to knock out grass amongst non-grass species), & wick applicators to kill weeds when taller than desired species.*	
3.14 Have you determined appropriate requirements for fertilizers & soil amendment?	Rehabilitation Plan procedural guidelines	• Rehabilitation Plan sets out guidance for application of fertilizers & soil amendments • Information	Different soil treatments, & fertilizer types & application rates established for each different soil type & vegetation type within the constructed post-mine landform.	*N can promote weeds & cause them to out-compete desired species as well as increasing fire hazard. Some vegetation types are susceptible to certain fertilizers, eg heath plants do not tolerate P. Soil treatments include:* • *introduction of symbiotic fungi (eg miccorhiza)* • *pH adjustment to suit certain species* • *gypsum to improve sodic soils*	

		accessed from botanical experts & specific research		• *incorporation of organic wastes to improve nutrient levels.*	
3.15 Does the revegetation program include methods to improve nutrient accumulation & recycling in the post-mine soil profile?	Rehabilitation Plan procedural guidelines	Rehabilitation Plan sets out operational strategies designed to promote nutrient accumulation & recycling		*Techniques include:* • *deep ripping to relieve compaction & improve water infiltration* • *introduce N-fixing plants to build nitrogen capital* • *initial application of P fertilizer, or miccorhizal inoculation, to build phosphate levels.*	
3.16 Have you incorporated measures to encourage faunal recolonisation?	Rehabilitation Plan procedural guidelines.	Rehabilitation Plan sets out operational strategies designed to encourage fauna to move into rehabilitated areas		*Some invertebrates will come back in replaced topsoil. Other fauna require food, shelter, breeding sites & native vegetation to recolonise. Information on habitat reconstruction to assist faunal recolonisation is available from ACMER:* *http://www.acmer.com.au/publications/proceed_fhr.html* *Techniques include:* • *placing hollow logs, nest boxes etc* • *providing fauna corridors into rehabilitated areas from undisturbed areas* • *transfer from another area* • *captive breeding & release* • *protection from predators & other stressors*	
Part 4: Maintenance and Monitoring - refer sections 3.9 - 3.10 in the Rehabilitation & Revegetation Sustainable Minerals booklet					

4.1 Have you set out a maintenance schedule for rehabilitated & revegetated areas?	Rehabilitation Plan & post-mine management plan include procedural guidelines & maintenance schedules	Rehabilitation Plan & post-mine management plan set out procedural guidelines & maintenance schedules designed to reduce deterioration in rehabilitation works & foster progression to a stable climax vegetation & fauna consistent with rehabilitation & post-mine land use objectives	Techniques developed to reflect special ecosystem characteristics of the district: eg, whilst special precautions are usually needed to reduce the damage to newly revegetated areas from fire, in some cases fire can be necessary to encourage germination &suppress competition to native trees & understorey from grasses - refer Case Study 4	*Maintenance may include:* • *replanting failed or unsatisfactory areas* • *repairing any erosion problems* • *fire management* • *pest & weed control* • *control of feral & native animal populations. including fencing* • *fertilizer applications* • *watering plants in drier areas, especially in establishment phase* • *application of lime or gypsum to control pH & improve soil structure.*	
4.2 Have you developed appropriate indicators for measuring the performance of rehabilitation & revegetation?	Rehabilitation Plan & post-mine management plan include indicators for assessing rehabilitation success	Indicators are site-specific, based on: • research & field trials • data on the natural condition of surrounding undisturbed analogue areas • quantification of objectives set by regulatory requirements & stakeholder expectations	Principal key indicators of success are that the rehabilitated areas require no more maintenance than surrounding areas for their designated land use, & are resistant to fire & flood.	*Case Study 1 gives examples of success indicators to be measured in the monitoring program. Information on developing indicators to assess ecosystem & rehabilitation success is available from ACMER :* *http://www.acmer.com.au/publications/proceed_ioers.html*. *Components of success criteria can include:* • *physical (stability, resistance to erosion, re-establishment of drainage)* • *biological (species richness, plant density, canopy cover, seed production, fauna return, weed control, productivity, establishment of nutrient cycles)* • *water quality standards for grainage water* • *public safety issues.*	

		• requirements needed to attain outcomes consistent with proposed post-mine land use			
4.3 Have you consulted key stakeholders on criteria for determining rehabilitation success & the need for maintenance or intervention?	Rehabilitation Plan & post-mine management plan include indicators for assessing rehabilitation success	• Indicators are formulated in consultation & agreement with key stakeholders. • Evidence of consultation, eg minutes of meetings, written submissions; & of acceptance of indicators by regulatory & key stakeholder & community representatives		*Development of monitoring plans is described in the Sustainable Minerals booklet on Environmental Monitoring & Performance*.	
4.4 Do you have a monitoring plan for rehabilitation?	Rehabilitation Plan & post-mine management plan include monitoring	Monitoring plan incorporates techniques to evaluate the condition of the rehabilitated sites against the agreed	Provisions should be made to continue monitoring until the success criteria are satisfied. They should include budgetary		

	plan for rehabilitated areas	success criteria, & a schedule of tasks & timing for monitoring during mining & after mine closure	provisions for monitoring resources & any maintenance requirements.		

Checklist for Tailings Containment

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning					
Questions 1.1 to 1.7 relate to the mine planning stage of a mining operation					
1.1 Have you determined the rate of production & the total quantity of tailings?	Where are the estimated rate of production & total quantity of tailings documented?	Relevant information included in publicly accessible planning proposals/EIS	Further details on mine planning are contained in the Mine Planning for Environment Protection Sustainable Minerals booklet	*Design for the tailings facility in the mine plan & EIS must consider the rate & total volume of tailings to be produced & the long- term possible impacts.*	
1.2 Have you collected information to assist in selecting the most appropriate site for the tailings facility?	Do you have: • a topographic map which notes major features • aerial photos & ground photos to assist in planning • a biological assessment of the area & a map of biological values including any rare	Site suitability report prepared by technical specialists evaluating suitability of different parts of the mine project area, including • options for tailings disposal off-site (eg disused voids) • assessments of biological values • possible	The information gathering stage is a major component of EIA, which is described in the Environmental Impact Assessment Sustainable Minerals booklet	*Regulators are increasingly basing regulatory standards on the health of identified sensitive species or ecosystems eg Queensland Guidelines for an Environmental Management Plan for exploration & mineral development*	

	• or endangered species or ecosystems • a technical report on foundation conditions & availability of construction materials?	environmental & other impacts in normal operations & from accidental releases of tailings & tailings water.			
1.3 Have you enough information to assess the environmental characteristics of the site, including long term natural variability?	Have you: • collected current & historical data on climate • assessed historical earthquake records • gathered data on local water quality & variability • studied the local hydrological, geochemical & groundwater regimes?	Report documenting the environmental attributes which may be put at risk.	Specific research to determine maximum pollutant loads & concentrations which do not cause mortality or significant behavioural changes in flora & fauna.	*Previous EIS reports for mining proposals in the surrounding region will assist in identifying local environmental characteristics.*	
1.4 Have you assessed the nature of environmental impact of the tailings facility, in terms of normal operations & in the event of failure?	Have you: • evaluated the physical, chemical & mineralogical characteristics of the tailings • established the	Environmental risk analysis report		*Many tailings have the potential to form acid, ie AMD. Techniques for assessing this risk are described in the* *Managing Sulphidic Mine Wastes & Acid Drainage Sustainable*	

	environmental values of the potential receiving waters • assessed the potential for short & long-term pollution of ground & surface water?			Minerals booklet	
1.5 Have you assessed the nature of socio-environmental impact in terms of normal operations & in the event of failure?	Have you: • assessed the likely impacts on nearby areas from dust, noise, radiation, aesthetics, & property values?	Social risk factors included in risk analysis	Establish formal & frequent consultation with the local community early in the planning process.	*Meaningful consultation with the local community will commonly smooth the assessment & approvals process for a new development - refer to the* Community Consultation & Involvement Sustainable Minerals booklet	
1.6 Have you considered the probable regulatory requirements?	Initial planning should include knowledge of regulatory limits for water quality, dust, noise, cultural & heritage protection, zoning, transport, & urban & utility plans.	Documentation of all relevant legislation, regulation, codes & standards for mining, environmental protection, planning, land use at the federal, state & local government levels	Establish formal & frequent consultation with the relevant regulatory authorities early in the planning process.	Case Study 4 *in the Environmental Risk Management Sustainable Minerals booklet describes a risk study undertaken for a project proposal which incorporates a tailings facility.*	
1.7 Have you prepared a draft management strategy?	Initial planning should include development of a draft management strategy which:	A draft management strategy which incorporates input from the community & regulatory authorities &	Consultation with key stakeholders during preparation of the draft management strategy	*The* Mine Planning for Environment Protection Sustainable Minerals booklet *describes the*	

	• identifies all of the potential risks • sets out objectives for environmental protection & risk minimisation • provides a framework for evaluating different options & choosing a design which reflects site conditions & environmental sensitivities	addresses the full suite of environmental & social issues likely to arise from the proposed tailings facility		*environmental issues to be addressed & appropriate planning approaches to minimise possible impacts.*	
Questions 1.8 to 1.12 relate to the construction planning stage of a mining operation					
1.8 Have you collected information about the ground conditions & how the ground should be prepared for foundation construction?	Have you: • conducted a detailed study of the soil profile • studied the water table over a 12 month period • determined the characteristics of in-situ material & its suitability for construction • made arrangements for topsoil stripping & stockpiling for	• Detailed site-specific data included in tailings facility design brief • Proportion of rehabilitation topsoil recycled from stockpile		Chapter 2 *of the Tailings Containment Sustainable Minerals booklet discusses site suitability issues & detailed site investigations.*	

	use in rehabilitation				
1.9 Have you sufficient technical expertise to make informed decisions on the type of containment structure & its design?	• Geo-technical report evaluating design options • Selection of preferred design based on optimal safety & environmental performance	Evidence that a qualified geo-mechanical engineer was used to evaluate data & recommend the type of dam & design it	The extra shear force caused by possible earthquakes should be included in all dynamic analyses for tailings dams.	*Most jurisdictions require that dams containing hazardous materials (including tailings), or over a certain size, must be designed to specified criteria. Check with you State Departments of mines & environment.*	
1.10 Have you considered the likely capital costs of construction, maintenance & decommissioning?	• Geo-technical report evaluating design options • Selection of preferred design based on consideration of whole-of-mine-life performance of the dam, including costs to construct & maintain high safety & environmental performance during operation & costs of decommissioning	Geo-technical report evaluating design options. Selection of preferred design based on consideration of whole-of-mine-life performance of the dam, including costs to construct & maintain high safety & environmental performance during operation & costs of decommissioning	Full cost analysis over the complete life of the structure should extend to alternative options, including those with apparent higher build costs but lower maintenance & decommissioning costs. Also investigate possible options for re-use of the tailings, especially for coal rejects (eg articles in AusIMM Bulletin August 2002).	*Options for consideration may include tailings dewatering, paste technologies, central thickened discharge, & backfilling of voids on & off site.*	
1.11 Is the dam design chosen the most appropriate type to minimise the level of environmental impact?	Evidence of a full comparative assessment of impacts from different dam types, eg in EIS	Design should incorporate features to limit any possible pathways for environmental contamination identified in the EIS process, eg liners,	• Chapter 3 of the Tailings Containment Sustainable Minerals booklet	*A discussion of the reasons for tailings failures & their environmental impacts can be found in: ICOLD*	

		seepage collectors, disposal in prepared voids	describes different design types • Case Studies 1,2 & 3 describe three different sites & the design option chosen for each to reduce the risk of environmental impact.	*2001. Tailings dams: risk of dangerous occurrences & lessons learnt from past experience. International Committee on Large Dams Bulletin no 121*	
1.12 Have the design limits for the dam been based on a full hydrological model using local meteorological data?	Capacity, freeboard & pumping specifications should be based on locally derived current & historical rainfall data	The operator should set appropriate specifications in consultation with the regulator, taking into account the results of hydrological & operational risk assessment for the facility	The Water Management Sustainable Minerals booklet describes how the tailings facility must be designed as a totally integrated element of the mine water management system.	*An optimum design caters for "probable maximum precipitation" (PMP) which have an annual recurrence interval of 10^4 - 10^6. A design safety factor of 10^3 is commonly considered to reflect current best practice at most sites.*	
1.13 Has the dam been built by a suitably qualified person?	• Construction contract with recognised & appropriately qualified engineer/engineering company • High probability that dam is constructed as designed	Dam construction undertaken by a suitably qualified person acceptable to relevant government authorities		*Most jurisdictions require that construction is undertaken by suitably qualified persons.*	

Part 2: Management and Operation					
2.1 Are the environmental management aspects of the tailings facility fully integrated with other operations on the minesite?	A fully integrated Environmental Management System for the minesite	The Environmental Management System should demonstrate effective inter-linkages between the tailings facility, the water management system, dust management, emergency procedures, & rehabilitation planning including progressive rehabilitation.	The Environmental Management Systems Sustainable Minerals booklet describes the components of a fully integrated EMS for all environmental aspects of a minesite. Many companies seek certification to international standards such as ISO 14001 to help demonstrate their environmental commitment to regulators & other stakeholders.	*Operators can use & seek certification to published EMS standards such as ISO 14000. Software obtainable from this site includes complete prewritten procedures, record forms, & an Environment Manual which can be customised. An implementation guide is also included.*	
2.2 Is there documentation to demonstrate that the Management Plan for the tailings facility is carried out properly?	Management Plan available to staff; staff instructions on the tailings facility; regular checks on effectiveness of operational systems	Relevant documentation should be readily available to staff, regulators & auditors			
2.3 Are systems in place & methods used to maximise the consolidation of the tailings pile?	Settled density achieves target set in Mine Plan, or consistent with density required for effective rehabilitation (ie target set in Rehabilitation Plan)	• A target settled density based on maximising dam stability during operation, & effective rehabilitation at closure, should be set out in the Mine Plan • Ongoing monitoring is essential • If difficulties arise, the company must	Specialist geotechnical expertise is generally required		

		commit to research & possible significant changes to operational procedures in order to avoid significant long-term risk			
2.4 Are measures taken to prevent water from weakening the physical strength of the tailings pile?	Geotechnical assessments of the facility should demonstrate a high level of confidence in the physical integrity of the structure.	• Decant pond/tailings water managed to minimise possible effects on embankment stability from phreatic surface • slimes prevented from settling against embankments or forming layers in between higher permeability tailings		*Figure 12 of the Sustainable Minerals booklet (from Fell et al 1992) summarises the factors influencing the phreatic surface for upstream embankments.*	
2.5 Are all design characteristics of the facility incorporated to reduce environmental risk, operated & maintained properly?	• Dam constructed as designed • all environmental components of the facility operational & covered by ops manuals • staff trained	• Dam constructed as designed • all environmental components of the facility operational & covered by ops manuals • staff trained			
2.6 Are methods used to control dust?	• Wetting of tailings surface or use of sealers.	Monitoring data demonstrate low dust emission levels from the tailings surface	High-volume air samplers may be required to adequately monitor dust levels. Concern about the health impacts of very fine	*The Dust Control Sustainable Minerals booklet describes health & environmental impacts from dust,*	

			dust particles is leading to improved dust sampling technologies & more stringent standards. Real-time sampling should be considered when mine near community population.	*modelling & prediction, emission sources, control techniques & monitoring methods.*	
2.7 Are there procedures set out in the case of an emergency?	Documented Mine Emergency Plan or similar.	Mine Emergency Plan includes procedures relevant to tailings facility: procedures in the event of flooding, embankment failure, slurry line rupture			
2.8 Are tailings management plans & systems regularly reviewed & amended?	Regular review & updating of management plans, systems, procedures & associated manuals	Annual review & updating of plans & systems based on assessment of monitoring data, non-compliance events, & geo-technical inspections			
Part 3: Remediation					
3.1 Are there procedures in place for clean-up in the event of accidental release etc?	Documented operational procedures for clean-up, including responsibilities, standards, & reporting requirements		Copy of operational procedures provided to regulatory authority.		
3.2 Does the tailings facility design incorporate features to facilitate rehabilitation?	Construction should provide for topsoil stockpiling & re-use, & design parameters consistent with rehabilitation outcomes sympathetic to the surrounding natural landscape & viable future	All aspects of the tailings facility should reflect environmental protection in their design - eg tailings pipeline routing away from sensitive areas; "failsafe" bunding along tailings corridor; sediment traps & surge ponds downstream of	• The Rehabilitation & Revegetation Sustainable Minerals booklet sets out key principles for mine rehabilitation, including the need for a mine	*ACMER runs training courses & provides publications on rehabilitation & revegetation planning & operation.*	

	land-use options	all possible discharge points	rehabilitation plan before mining starts • The tailings facility is commonly one of the biggest single elements to be considered in a rehabilitation planning & management context		
3.3 Is there a closure plan?	Documented Closure Plan.	Closure Plan taking into account: • characteristics of the tailings • long term climatic extremes • the features of the tailings facility & inherent physical properties			
3.4 Does the Closure Plan include landform & revegetation designs?	Closure Plan with capping, landform & revegetation design consistent with Mine Plan & commitments given at planning approval & community consultation stages	Capping, landform & revegetation designs likely to provide high levels of physical & chemical stability from the short to the long term, & minimal risk of offsite impact	Designs should incorporate: • passive management systems & failsafe systems against contaminant release (eg wetlands, sediment ponds)	*Design should be based on site-specific characteristics, but as a general rule slopes should be less than 50m long & 20% to provide high protection from erosion - refer Landform Design for Rehabilitation*	

			• "natural" landform features to reduce risk of erosion & need for maintenance	Sustainable Minerals booklet, & *DME Western Australia Guidelines for Mining in Arid Environments*	
Part 4: Monitoring & Assessment					
4.1 Is there a monitoring regime in place which addresses all of the possible areas & pathways of environmental impact identified at the planning stage?	• Documented Environmental Monitoring Program for ground water; nearby surface water; runoff • stability including hydrostatic head in embankments, freeboard & erosion; & dust	Monitoring regime comprehensive & designed for early detection of movement of contaminants from tailings facility		• *The Environmental Monitoring & Performance Sustainable Minerals booklet discusses design of monitoring programs.* • *Critical issues to be monitored in tailings dams (and requiring installation of piezometers) are the phreatic surface in the down-slope retaining embankment, & excess pore pressures below an upstream type embankment.*	
4.2 Does the monitoring regime	Documented Environmental Monitoring	Monitoring program includes noise, dust, seepage, leachate	Where residences, community facilities or		

include provisions to monitor potential impacts on the community?	Program addresses potential impacts of concern to the community	& other issues of concern to local residents. Sampling locations chosen to reflect community sensitivities	active land use occurs in proximity, environmental performance targets should be stringent, & include trigger levels for remedial actions to be taken prior to the onset of significant impacts.		
4.3 Are environmental protection targets set, & are the layout, techniques, frequency, quality & sensitivity of monitoring & sampling appropriate to these targets?	Should be set out in Environmental Management Plan & used as the benchmark environmental protection targets in the annual environmental report	Targets based on toxicity tests on local species, & monitoring frequency & distribution reflects operational & natural variability	• Particular emphasis on monitoring & minimising seepage & surface water flows from the tailings facility • Best practice target is for no release/no seepage	*The Environmental Monitoring & Performance Sustainable Minerals booklet discusses design of monitoring programs.*	
4.4 Are data collected in accordance with the requirements of the monitoring regime?	Monthly & annual reports of environmental data	Monthly & annual reports of environmental data include a checklist of requirements			
4.5 Are the data analysed & regularly reported to the regulatory authorities?	Refer to regulatory authorities			*The Environmental Monitoring & Performance Sustainable Minerals booklet discusses how environmental performance should be measured against the objectives of the Environmental Management Plan.*	
4.6 Are non-	Register maintained of non-	Register of non-compliance	Regulatory authority		

compliance issues or abnormalities in the data routinely investigated?	compliance & unplanned events	& unplanned events, indicates time of event, time of action, type of action, result, & interaction with authorities	advised immediately of all non-compliance & significant unplanned events		
4.7 Is the tailings facility inspected regularly by geotechnical experts & the monitoring data reviewed?	Annual inspection report by certified dam engineer	Annual inspection report by certified dam engineer			

Checklist for Water Management

Issue	Outputs	Performance Measure	Improvement	Comments	Notes
Part 1: Information and Planning see Chapter 2 in the Water Management Sustainable Minerals booklet					
1.1 Are mine management and staff committed to sound practice in mine water management?	Corporate Environmental Policy	Corporate Environmental Policy refers to objectives for protection of water resources.			
1.2 Have you collected hydrological information relevant to developing your Mine Water Management Plan (MWMP)?	Information on the hydrological setting of the mine project area	Hydrological information includes data on: • precipitation (all types of precipitation; estimate of PMP		*Box 2 shows a simple diagram of the key hydrological processes to be considered when designing a mine water management plan.* *Compaction reduces infiltration rates. Spoil heaps can absorb a lot of water via infiltration, but this can result in contaminated leachate which may*	

		[Probable Maximum Precipitation event] & possible long term trends in precipitation related to climate change & Greenhouse effect) • infiltration (taking into account different soil types) • runoff • vegetation cover • evaporation • stream flows (upstream & downstream) • groundwater flow • seasonal variation, including estimates of variations in water quantity, quality & concentrations of contaminants		*need to be treated.* *Runoff is relevant to estimates of erosion, size & shape of drainage channels, stability of spoil piles & leachate production.* *Vegetation cover reduces soil water levels, reduces runoff, & increases infiltration & soil stability.* *Evaporation is relevant as a tool to lose excess water, as well as away that valuable water resources can be reduced.* *Upstream flows can pose major risks to mine operations (ie flooding), the community may depend on downstream flows for agriculture, urban supply etc.* *Groundwater regime may be accessible to contamination, or high flows may pose a cost/safety issue to mining.* *Information on rainfall & runoff calculations is available at* *Engineers Australia On-line*.	

		- random variation, ie calculate local severe events as "Annual Exceedance Probabilities" - hydrological parameters for the catchments and sub-catchments of the project area			
1.3 Have you established effective communication with regulatory agencies?	Understanding of regulatory requirements for use, management and discharge of surface and ground waters	List or regulatory requirements related to water, including state local & catchment management group requirements and guidelines	Best practice requires a whole-of-catchment approach to water management, involving consultation with surrounding water users & decisions made with group expectations in mind	*Regulatory agencies, local government & community groups may already interact as members of catchment management groups or Landcare groups. The Sustainable Minerals booklet on* Community Consultation & Involvement *provides guidance on consultation mechanisms.*	
1.4 Have you established effective communication with the community?	Understanding of water consumption and purpose patterns in the community and community concerns	Evidence of meetings & other communications with community groups & surrounding landholders/land users			
1.5Have you developed a Mine Water Management Plan	MWMP	MWMP based on site-specific hydrological data (see Question 1.2), which considers			

(MWMP)?		water supply/ transfer/ storage/ treatment /disposal aspects for: • dams • bores • natural water bodies • pumps • pipelines • open channels • water storages • open cut pits • tailings dams • evaporation basins • controlled releases • uncontrolled releases • groundwater recharge • sediment basins • wetlands • chemical treatment			
1.6 Does the MWMP incorporate Cleaner Production concepts for the use of water?	Optimal use of water in terms of quantity (reduced use) and quality (reduced contamination)	MWMP contains provisions for: • limiting the consumption & use of clean water	Biological sampling can be used to establish an environmental baseline for limits& parameters for water release, & biological monitoring can be used throughout mining to	*The Sustainable Minerals booklet on Cleaner Production explains these concepts. An example for water is the use of contaminated water for dust control instead of clean water.* *Box 3 in the Water Management*	

		• re-use of water • water recycling • water treatment • release of water without significant impact on natural volumes/flows & quality	determine environmental effects .The National Freshwater Quality Guidelines set out approaches to environmental protection based on natural variability & biological health.	*booklet describes an approach to defining environmental values of significance to a wide range of stakeholders.*	
1.7 Have you established a Mine Water Management Committee?	Focussed management, control and ongoing review of water management issues and effectiveness of WMS	Documented & formalised Mine Water Management Committee	Membership includes company environmental & process managers, water consultants, & representatives of regulatory agencies and stakeholders	*Close community consultation on water management & availability is described in Case Study 4.*	
1.8 Have key stakeholders agreed to you MWMP?	Agreement on adequacy of MWMP from key stakeholders	Signed agreement to adequacy of MWMP from key stakeholder groups	Signatories include local landholders, council, & catchment management group representatives		
Part 2: Developing the Mine Water Management Plan - see Chapters 3 & 4 in the Water Management Sustainable Minerals booklet					
2.1 Does the MWMP describe both physical and process elements of the water management system?	MWMP describes all the physical components of the water management system & how they are to be operated	• Physical components are dams, bores, natural water bodies, pumps, pipelines, open channels, water storages, open cut pits,	• It is important that the MWMP contains information for each element on critical factors which may affect safe operation & effective environmental protection, such as safe maximum operating	*The Sustainable Minerals booklet Hazardous Materials Management Storage & Disposal contains information useful to developing the hazardous materials management plan.* *The Sustainable Minerals booklet Environmental Monitoring & Performance contains relevant*	

		tailings dams, evaporation basins, controlled releases, uncontrolled releases, groundwater recharge, sediment basins, wetlands & chemical treatment facilities • process elements are: - operational manuals - erosion/sediment control plan - chemical assessment plan - hazardous materials management plan - inspection & maintenance plan - monitoring plan - reporting	levels & freeboard, maximum permissible contaminant concentrations or loads, pipeline pressures & ground pressures • All operating limits should include factors of safety to reduce risk of sudden failure • Remedial/emergency actions should be described in operating manuals & on notices posted at key locations should these levels be exceeded	*information for developing the monitoring plan. Table 5 in the booklet outlines the main requirements for the development & operation of a water management system (WMS) for a minesite.*	

		requirements			
2.2 Does the MWMP adopt a catchment-based approach to water management?	Catchment approach reflects different flow rate, volume & quality characteristics for different parts of the site	Emphasis in MWMP on characterising different catchment & sub-catchment regimes & management techniques tailored to each one	• Diversion of clean flows to minimise volumes of contaminated water requiring treatment • Water treatment systems tailored to characteristics for that sub-catchment, eg chemical treatment, wetlands absorption/bioaccumulation & sediment settling ponds		
2.3 Does the MWMP address all phases of mine development, operation and closure?	MWMP contains sections addressing all operational phases of the project	MWMP addresses (as appropriate): • exploration • resource development • mine design • operation • rehabilitation • post closure		*Table 5 in the booklet outlines the main requirements for the development & operation of a water management system (WMS) for the different phases of a mining project.*	
2.4 Does the MWMP use an integrated "whole of mine" approach?	MWMP refers to all operational components with the potential to impact on water quantity & quality	MWMP covers all aspects of operations, activities & infrastructure likely to impact of water quality & quantity,	The MWMP should address all issues likely to arise from inception through to closure & beyond	*The Sustainable Minerals booklet on Mine Planning for Environmental Protection provides more information on whole-of-life mine planning.*	

		including exploration, excavation, processing, waste, workshops, rehabilitation & mine closure			
2.5 Is a risk management approach used to inform on the design of the water management system and the MWMP?	Probability of failure reduced through possible risks being taken into account during planning of the WMS	The MWMP & the WMS show evidence of design parameters based on assessment of risk, in terms of: • hydrological risk - low probability extreme climatic events can cause devastating damage • operational risk - accidents, breakdowns & breakages can result in major economic & environmental consequences	Best practice for managing hydrological risk requires: • formal risk management approach to define appropriate measures & responses • evaluation of event risks & hazards over the full range of event severities. Best practice in operational risk requires all activities that represent a risk to water management to be identified and the risks evaluated.	*Risk management practices are described in the Sustainable Minerals booklet on Environmental Risk Management. A brief outline is given in Box 4 of the Water Management booklet.*	
2.6 Have you undertaken technical studies to validate the	Technical reports, technical information in (Environmental Impact Statement) EIS	Technical information available which demonstrates the validity of the	Best practice requires periodic reassessment of the WMS, its individual components, & operating systems, to identify		

assumptions used in designing the physical & process elements of the water management system?		physical components which make up the WMS, in terms of • processes, systems & technologies • capacities & designs of components • operational systems to be used	opportunities to improve efficiency & effectiveness.		
2.7 Have you considered the full range of options for design & management of the water management system before selecting the design you will use?	Technical reports, technical information in EIS	Technical information demonstrates a wide range of options evaluated & objectively compared, & choice based on this objective comparison		*Case Study 5 describes considerations for designing a WMS for a mine in an arid environment.*	
2.8 Is the MWMP fully integrated with other plans for management & operation of the site?	No gaps or conflict between MWMP & other management plans for the site	• MWMP refers to all areas of the site where water is stored, used or transferred, & where contaminants are used,	Duty statements of all facility & operational managers include specific & general responsibilities for water management		

		produced or released • Cross referencing between all operational plans			
2.9 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **minesite water balance?**	Water management system designed & operated to maintain a balance between water inputs & outputs - both controlled & uncontrolled - through the life of the mine	Evidence of water balance calculations & predictions, including: • estimate of annual shortfall or excess of water on the site, taking into account seasonal variability in rainfall & evaporation • identification of areas where data or reasonable estimates of water use/consumption are missing or poorly known • evidence that the broad	Water balances can be calculated for individual components of the WMS to identify robust & vulnerable elements & target areas where modification is required in order to avoid operational interruption etc.	*A simple example of a component water balance is:* *" Storage dam capacity = Rainfall + Groundwater flow + Runoff + Returns from process - Inputs to process - Evaporation - Seepage - Discharge +/- capacity of pump transfers."*	

		annual framework is used as a basis for more detailed calculations on water balance, eg on a monthly basis			
2.10 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **monitoring of hydrological processes?**	Monitoring data during all phases of the operation	• Baseline monitoring data - to establish pre-mining quality & quantity levels • Operational monitoring - to gauge effectiveness of MWMP & WMS & identify areas requiring improvement - data to include rainfall, evaporation, streamflow & water quality • Post-mining monitoring - to assess effectiveness	Best practice in water monitoring requires: • an adequately resourced & well designed baseline monitoring program, ideally starting at least 3-5 years before mine construction to acquire reliable data on natural variability for climate & water quality • technical & financial support & maintenance • annual review of effectiveness • reliable equipment Whilst expensive, biological monitoring techniques provide direct information on water & riparian health, & provide powerful information to satisfy stakeholders on the	*Peak conditions are critical to accurate estimates of inputs to the water balance model, & can only be determined from continuous sampling. Automatic high-frequency or continuous samplers are now available to provide accurate data in real time, eg on flood heights, flow rates, turbidity. Data can be telemetered to provide real-time information to assist decision-making at critical times.*	

		of decommissioning & rehabilitation & identify if & how intervention is required to avoid undue impacts on surface & ground water quality & flows	level of protection being achieved.		
2.11 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **operational monitoring?**	Information on how the WMS system is being operated & whether volumes, levels quality & transfer rates conform to MWMP & WMS limits	Operational monitoring should include such observations as: • flows in key pipelines • hydraulic integrity of key pipelines • water levels & quality in key storages, especially of contaminated water • minesite rainfall • silt accumulation	• The monitoring system should have agreed performance indicators, eg peak water levels in contaminated water storages, to act as "action triggers" for pump transfer or opening flumes, & to allow effectiveness of WMS operational performance to be evaluated • Emergency action levels should also be identified • Annual reports on water use should be compiled to provide	*When designing the monitoring program, mine managers should seek advice from regulatory agencies.* • *send annual water quality reports to regulatory agencies for review & comment* • *ensure all relevant parameters are monitored* • *include physical, chemical & biological parameters.* *Box 5 in the booklet briefly discusses biological monitoring & provides useful references. Also relevant are the National Freshwater Quality Guidelines.*	

		in silt traps & wetlands • bed & bank erosion in channels	accurate information on quantities & qualities used, & to provide information for improving water balance calculations & operational water management practices.		
2.12 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **emergency monitoring?**	MWMP includes procedures for monitoring to be followed in the event of an emergency	Comprehensive information available for emergency, non-compliant & "unplanned" events which is sufficient to identify water quantities & quality in different WMS components, the magnitudes of impacts & circumstances that caused them.	• The mine should have an emergency monitoring plan based on a risk analysis of the WMS & its individual components.Emergency monitoring should include data on the volume, discharge rate & quality of "escaped" water, & its impacts on downstream water bodies • The emergency monitoring plan includes arrangements to alert downstream landholders & water users of emergency incidents & likely impacts on water supply & quality		
2.13 Does the	MWMP includes	MWMP includes:	Flood risk management plan	*Hazard 'seriousness' may range from*	

MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **flood risk & hazard?**	design features & procedures to mitigate flood risk & hazard	• identification of minesite elements that may be affected by flood • evaluation of the hazards associated with these elements • flood risk management plan specific to the site	provides specific risk & hazard assessments, & appropriate responses for different mine infrastructure elements, eg: • structural works such as levees, creek diversions • infrastructure planning, eg siting plant away from flood-prone areas • building controls, eg minimum height floor levels, sensitive electrics elevated • emergency measures eg flood warning & evacuation	*nuisance (ie delayed access from flooded road crossings etc), to economic (lost production), to a threat to the safety or even lives of mine personnel.* *If the flood risk management plan includes structural works, consider their impact on downstream habitat & water users.* *A useful on-line reference is the Australian Institution of Engineers book on rain fall & runoff* *http://www.engaust.com.au/arr.html*	
2.14 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **water supply?**	MWMP addresses water supply	MWMP describes water supply system specific to the needs of the site & available water resources	Best practice involves: • recycling as much water as possible to reduce demand • considering feasibility of a joint water supply scheme with other major consumers • evaluating the risk of supply shortfalls & developing contingency plans • assessing the quality of the water supply &		

			installing any necessary treatment facility • assessing the impact of surface storages on the downstream flow regime, habitat, & water users • assessing the risks & consequences of dam failure of surface storages • assessing possible beneficial uses of water supply systems & storages after mining, eg for recreation, irrigation		
2.15 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for:Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **soil erosion?**	MWMP addresses soil erosion	MWMP includes erosion management sub-plan which: • identifies areas of existing or likely erosion & proposed controls • focuses on controlling erosion at source		*Seek regulatory input & agreement to the erosion control plan before implementing it.*	

2.16 Does the MWMP include site-specific standards, targets, operational and/or contingency plans & procedures for: - **water quality?**	MWMP addresses water quality	MWMP includes a water quality management sub-plan which identifies issues & means of control. Essential features are: • sub-plan submitted to regulator for approval before implementation • clean area run-off diverted from 'dirty' runoff, contaminated & disturbed areas & water bodies • pollutants & contaminants controlled at source • monitoring programs to measure water quality parameters in baseline, operational & emergency			

		situations			
2.17 Have you identified appropriate performance indicators?	MWMP contains performance indicators for satisfactory operation of the WMS	Performance indicators for: • general water management • erosion management • water quality management	• Performance indicators agreed with regulatory authorities • Annual report prepared to report on performance relative to the agreed indicators • Operational systems & MWMP reviewed & amended when performance indicators are not being achieved	*The performance indicators provide an auditable check of the effectiveness of the WMS in meeting environmental protection targets.*	
2.18 Does the MWMP require the use of computer models?	MWMP requires use of water management computer models for calculation & simulation of natural & mine water systems	MWMP requires use of water management computer models for calculation & simulation of natural & mine water systems. Evidence that: • assumptions inherent in the models are appropriate to the minesite • input data checked for reliability • time & space		*If calibration data are unavailable or uncertain, output from the models should be used cautiously.* *Use of experienced modellers is a major factor in getting reliable results. A range of models is described in Appendix 3 of the Sustainable Minerals Water Management booklet, covering Rainfall Intensity, Runoff Routing Models, Daily Rainfall - Runoff Models, Open Channel Models, Groundwater Models. Water Quality Models, System Models, Calibration & Verification, & Temporal & Spatial Scales .*	

		scales appropriate to the situation • real data are entered to calibrate the model			
2.19 Does the MWMP require staff training in water management?	MWMP requires staff training in water management & the WMS	Staff training: • clearly defines areas of responsibility & chains of command • explains the overall WMS to all operators • ensures operators are trained in their respective areas of responsibility			
2.20 Does the MWMP contain requirements for ongoing research?	MWMP requires ongoing research relevant to the WMS	Evidence of ongoing research into avenues for improving the effectiveness & reliability of the WMS	• Research focuses on areas of weakness identified from regular audits & reporting, & from risk assessments • Research covers infrastructure, technology, operating limits, & routine &	Regular review & amendment of MWMP, WMS , operating limits, performance measures & operational manuals based on results of research, audits & performance reviews.	

			emergency operating systems		
Part 3: Operating the Mine Water Management System - see Chapters 5 - 8 in the Water Management Sustainable Minerals booklet					
3.1 In the exploration phase, have you implemented measures to reduce the impacts on surface & ground waters?	Measures to reduce impacts on surface & ground waters from the full range of exploration activity	Evidence of appropriate management of: • erosion from temporary roads, drill pad & grid/survey line construction • drilling fluids • camp wastes • storage, handling & disposal of fuels & lubricants • empty containers, tyres, broken equipment	Techniques & equipment are available which require minimal surface disturbance for access & drilling, such as: • rollers to compact natural surface for drilling rig access instead of track construction • GPS survey equipment to avoid need for cleared line-of-site survey lines • light hand-held or utility-mounted soil sampling drill equipment.	*The Onshore Minerals & Petroleum Exploration Sustainable Minerals booklet gives advice on low-impact methods for exploration, including construction & rehabilitation of temporary exploration tracks, & use & rehabilitation of sumps for drilling muds.*	
3.2 In the exploration phase, have you collected information to assist in designing the MWMP?	Data on natural water system volumes & quality; data on potential environmental problems related to rock chemistry	Data on hydrology, hydrogeology & rock chemistry collected & used to for preliminary assessment of parameters for water management on the	During exploration, an automatic weather station & several monitoring sits should be established to measure creek discharge & water quality. If encouraging exploration results are evident, it is appropriate to:	*In the exploration phase there may be no qualified personnel to do the monitoring. Careful instructions will need to be provided, & a trained person should visit periodically to check the monitoring is being done properly.*	

		site, including: • preliminary calculation of water availability & balance • preliminary calculation of potential water quality impacts from exposure of potentially contaminating rock types (ie principally rocks with acid-producing potential)	• extend the monitoring program to additional sites across the permit area • start baseline monitoring in a 'companion catchment' which will not be affected by mining • review the official stream gauging network & request installation of an official gauging station at a key point.	*Note some more complex procedures may be too dangerous or not feasible without trained personnel (eg using nitric acid to fix water samples for subsequent metal analysis).*	
3.3 In the resource development phase, have you implemented measures to address the increased intensity of activities?	More extensive measures to control risk of impacts on water from erosion & contamination	Documented procedures to: • control erosion from semi-permanent roads & additional drill pads • manage camp wastes, allowing for increased personnel for	Collection of baseline data relevant to refinement of the MWMP must be continued without a break from the exploration to resource delineation phases, & on through mine planning & mine construction stages. This provides a sound baseline dataset over a continuous period, & maximises information on natural variability so that the accuracy of risk assessment calculations		

		longer periods than for exploration.	can be improved.		
3.4 In the mine design phase, have you implemented measures for ongoing refinement of data collection?	Monitoring & data collection regimes tailored to site characteristics	• Evidence of review of data collected in exploration & resource delineation phases • redesign of monitoring program			
3.5 In the mine design phase, have you determined the information necessary to develop the MWMP?	Comprehensive dataset covering all aspects of design for a water management system tailored to the site, & a related MWMP	Information required includes: • expected water requirements for the operation & modelling of water supply requirements • quality & quantity of water needed for different components of the operation • an expected minesite water balance		• *Consider reliability (eg seasonal variation), & potential environmental & social impacts of draw-off/draw-down* • *consider types, location, & timing of water requirements during mine life* • *consider the location & expected rate & type of chemical alterations* *Important components to control water quality & the transport of particulates & contaminants (including heavy metals) to the environment are sediment traps/basins, & wetland filters. These are described in Appendices 1 & 2 of*	

		• an audit of potential mine-related contaminants • quantified potential contaminant transport & the preferred pathways • the probable environmental impacts • a risk assessment of events & hazards related to water management • development of strategies to minimise the risk of water contamination • design of a preliminary water transfer system to meet water supply & environmental contingency needs • a preliminary runoff		*the Water Management booklet*.	

		drainage system to manage high-rainfall events • contingency procedures • a data collection program for design performance validation			
3.6 Have you finalised the proposed location of long-term monitoring stations & the parameters to be measured?	MWMP shows locations of key monitoring points & lists parameters to be monitored	MWMP shows locations of key monitoring points & lists parameters to be measured	Key monitoring locations & monitoring parameters agreed with regulators & key stakeholders. Locations include all potential release points & downstream watercourses at lease boundary. Monitoring parameters include key biological indicators.	*Comprehensive guidance on water quality standards are given in the* National Freshwater Quality Guidelines*. Monitoring approaches are presented in the associated guidelines on* Water Quality Monitoring. Case Study 1 *describes monitoring & controlled release systems to protect the salinity content of a watercourse for downstream users.*	
3.7 Have you determined the compliance monitoring sites?	MWMP lists the locations of compliance sites & parameters to be measured	MWMP lists the locations of compliance sites & parameters to be measured, plus sampling methods & frequencies	• Locations discussed & agreed with regulators & key stakeholders including community representatives. • Monitoring parameters include key biological indicators.	*Compliance monitoring during construction will ensure that construction operations do not unduly affect water quality. Compliance requirements during construction may differ significantly from those applying during mining operations - check with the regulating authority.*	

3.8 Have you developed procedures & contingency plans to monitor impacts from unplanned events?	Documented procedures & contingency plans which apply during unplanned events including emergency events	Documented procedures & contingency plans which apply during unplanned events including emergency events	Use risk assessment to define the nature & location of potential incident sites		
3.9 Have you consulted with regulators & the community on your proposed water management system & its performance indicators?	Meetings with regulators & community representatives	Minutes & matters arising from meetings with regulators, community representatives & stakeholders	Public meetings should be held in the local community to give everyone a chance to learn about the proposed MWMP & the performance indicators.	*Case Study 3 describes how a high-quality WMS was developed at a mine in an environmentally sensitive area to meet stringent regulatory requirements & high community expectations.*	
3.10 In the operation & rehabilitation phase, have you: - **validated design predictions & collected data to reduce the uncertainties in design, where necessary?**	Design predictions for performance on water quality & consumption compared with monitoring & performance data	Evidence that design predictions for performance on water quality & consumption are compared with monitoring & performance data, & amendments to system/management design as required	Early in the operational & rehabilitation stages, comparison of data with design predictions should be made on an intense basis, including daily at key locations	*A major consideration in mine closure is whether to retain the mine pits & their suitability for long term storage of water. Case Study 6 considers this issue for a gold mine with acid-producing waste rock.*	
3.11 In the operation & rehabilitation phase, have you:	Operational performance of the MWMP continuously assessed against	• Regular assessment of all monitoring data against	Monthly assessment of performance, & reporting to management, regulators, & key stakeholder groups		

- **monitored the environmental & operational performance of the water management system?**	performance data & environmental monitoring data	performance indicators. • Evidence of amendments to MWMP/WMS to reduce incidences of unplanned events, environmental impacts, & breaches of performance indicators			
3.12 In the operation & rehabilitation phase, have you: - **developed accountabilities for maintenance, operation & contingency actions?**	Certainty of responsibilities & decision-making from list of accountabilities for maintenance, operation & emergency/'unplanned' events	Documented staff responsibilities & accountabilities for maintenance, operation & contingency management of the WMS		*Benefits of good water management, including appropriate allocation of responsibilities, & benefits flowing through to mine decommissioning & closure, are summarised in Case Study 7.*	
3.13 In the operation & rehabilitation phase, have you: - **trained operators?**	Training program for staff	• Training schedule which ensures that all relevant staff are trained in maintenance, operation, & contingency			

		procedures • Regular training as refresher courses & to capture new staff & contractors			
3.14 In the operation & rehabilitation phase, have you: - **continued to investigate new & alternative systems?**	Periodic reviews of WMS & its elements	Evidence of periodic assessment of the WMS physical & mechanical components, & their flexibility to cope with extreme events	"Continuous improvement" is a fundamental principle in best practice. As new techniques or better equipment become available, their application to your minesite should be evaluated & a decision to install made on a balanced appraisal of economic & environmental cost & benefits.	*Case Study 2 describes how operational systems were changed at a mine to prevent recurrence of uncontrolled releases & resultant impacts on downstream water quality.*	
3.15 In the operation & rehabilitation phase, have you: - **identified & managed risks?**	Periodic risk assessment in water management	Evidence of periodic review of risk in the WMS in terms of probability of failure, & environmental impact, at different levels of significance	Inherent risk in the WMS should be assessed annually, & measures taken to amend the MWMP & WMS where risk probabilities are considered unacceptable, or increasing.	*As more data are collected on natural variability, calculated risk probabilities often change (eg on extreme rainfall & flood events & their frequencies).*	
3.16 In the operation & rehabilitation phase, have you: - **developed techniques for, & implemented, progressive**	Progressively more information gathered to assist in rehabilitation planning & reduction of uncertainty in rehabilitation outcomes	Evidence of research into rehabilitation techniques relevant to control of erosion & water quality	Research objectives should focus on impacts on surrounding land, long-term impacts & land capability.	*The Rehabilitation & Revegetation & Landform Design for Rehabilitation Sustainable Minerals booklets contain relevant information.*	

rehabilitation?					
3.17 In the post-mining phase, have you: - **developed a data collection program for rehabilitation performance, post-mining?**	Monitoring plan for the site after mining ceases	Documented post-mining monitoring plan	Plan lists location points, sampling techniques, frequency, parameters, & performance objectives	*The Environmental Monitoring & Performance Sustainable Minerals booklet contains relevant information.*	
3.18 In the post-mining phase, have you: - **collected data to determine performance against agreed post-mining objectives?**	Monitoring data on the post-mining condition of land & water	Post-mine monitoring information includes data on: • landform activity • water volumes • water quality • erosion rates • land use • a comparison with environmental targets	Annual report provided to regulatory authorities, local government and key relevant community groups		
3.19 In the operation & rehabilitation phase, have you: - **published the information?**	Published information of the level of post-mining environmental protection achieved	Annual reports available to relevant stakeholders, including local community groups, landholders, local government & regulatory authorities		*Objective information allows government & industry to better understand the effectiveness of current practice & identify areas for improvement.*	