Stream/aquifer guidelines

Department of
Infrastructure, Planning and Natural Resources

Management of stream/aquifer systems in coal mining developments

Hunter Region

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DIPNR

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Contents

What are these guidelines? 3

What is the scope of these guidelines? 3

What are the objectives of these guidelines? 5

How do you use these guidelines? 6

Definitions 7

Stream systems 7

Stream orders 7

Stream categories 8

Procedure for stream assessment (Flow Chart) 9

Schedule requirements 10

Schedule 1 streams 10

Schedule 2 streams 14

Schedule 3 streams 21

How should stream systems be monitored? 22

What are adequate remediation procedures? 24

Glossary 25

What are these guidelines?

This guideline assists the coal mining industry to meet the requirements the Department of Infrastructure, Planning and Natural Resources (DIPNR). This guideline highlights the management of risk in relation to impacts to stream systems.

This guideline provides:

- assessment of importance of streams and associated alluvial groundwaters in the Hunter Region
- protective mechanisms for critical river systems in the Hunter Region
- monitoring and remedial procedures to address mining-induced impacts to stream systems where they occur.

These guidelines should be used to help mining companies reduce the risk of liability resulting from mining related impacts to a stream/aquifer system. This liability includes possible legal action, replacement of lost water to water users, mitigative works to offset long term increases of salinity in stream systems caused by mining activities, and the cost of remedial works on impacted streams and associated alluvial aquifers.

What is the scope of these guidelines?

DIPNR is the manager of State waters, including stream and river flows, groundwaters and the riverine corridor, extending to 40 metres from the top of bank of streams. Approvals required for new mining developments, or significant risk of damage to stream systems requires a detailed assessment. The most appropriate time to consider these issues is during the environmental impact assessment period prior to obtaining development consent. The consideration of new or altered mining developments by DIPNR will use the principles of this guideline. Existing mining operations should use this guideline in considering the monitoring and remediation required where mining impacts on a stream.

It is not intended that these guidelines should restrict innovation in the management of stream systems. However, it should be recognised that mining-induced impacts to stream systems may have significant long term consequences to the environment and other water users. Mining companies should accept the responsibility to properly remediate any adverse environmental impact caused by their operations, including those observed post-mining.

These guidelines has specific provisions for new coal mining developments. The Environmental Impact Assessment (EIA) for new mining development proposals should include detailed assessments and frameworks for monitoring and remediation where required. This should include the specific assessment and management requirements identified in this guideline.

Existing mining developments are subject to consent conditions as granted by consent authorities and to conditions in Mining Operation Plans and Subsidence Management Plans approved by the Department of Primary Industries (DPI). The framework for consents and specific conditions imposed will require protective measures and detailed assessment where identified sensitive or high risk areas are identified in relation to surface or groundwater sources. DIPNR reserves the right to require remedial works where adverse impacts are caused.

These guidelines have been written taking into account the statutory regime established by the *Water Act 1912* (WA), and the *River and Foreshores Improvement Act 1948* (RFIA), and will be amended to allow for the operation of the *Water Management Act 2000* (WMA), when the relevant provisions of that Act come into force.

The WMA was passed by Parliament in December 2000 and will eventually replace both the WA, and the RFIA. The WMA places stronger obligations on individuals operating under it than the RFIA and WA. For example, it requires that all actions taken under the WMA uphold the objectives and principles of the Act. These include a requirement “to protect, enhance and restore water sources, their associated ecosystems, ecological biodiversity and their water quality” and “to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water” including benefits to the environment, urban communities, agriculture, fisheries, industry, recreation, culture and the Aboriginal community.

Under the WMA, RFIA Part 3A permits will become controlled activity approvals, while WA Part 5 groundwater extraction licences and WA Part 2 surface water extraction licences will be replaced by a combination of access licences, water use approvals and water management works approvals. In addition, the WMA will establish a system of aquifer interference approvals which regulate circumstances where large scale excavation works may affect the integrity of an aquifer. The approvals and licensing sections of the WMA have commenced where Water Sharing Plans are in force – currently on the Hunter/Glennies Creek Regulated River Water Sources, the Wybong Creek Water Source and the Karuah River Water Source. DIPNR is currently developing the policies and procedures needed to support the new licensing and approvals system.

What are the objectives of these guidelines?

Mining developments near stream systems should be able to be undertaken to deliver outcomes for both the natural systems and coal mining. Consistent with this, the outcomes for this guideline are:

- **Sustainable resource recovery of coal in the Hunter Region without degradation to the river systems.**
- **Maintenance of stable stream systems, including stream channels, floodplains and alluvial groundwater aquifers in the vicinity of mining developments.**
- **Enhancement and protection of riparian and groundwater-dependent ecosystems in the vicinity of mining developments.**
- **Protection of existing water user access rights.**
- **Awareness of environmental considerations when mining in the vicinity of river systems.**
- **Improved understanding of DIPNR requirements during the environmental impact assessment process.**
- **Integrated whole of government approach to coal mining.**

The general outcome for any mining development should be a transparent and accountable process to:

- identify where likely adverse impacts on stream systems may be anticipated
- develop management programs to maintain streams to agreed geomorphological and ecosystem outcomes
- monitor and identify changes within the stream system due to mining impacts
- develop agreed remediation outcomes and timeframes to achieve stability, flow maintenance and ecosystem resilience

Specific objectives for the guidelines are:

1. **The protection of riverine integrity, which involves retention of environmental and use values, maintenance of the river system within its geomorphic boundaries and of its geomorphic character, and protection of dependent ecosystem values.**
2. **Ensuring minimal adverse impact on stream flows, and groundwater availability due to mining activities.**
3. **Maintaining water quality within acceptable limits. This includes maintaining groundwater quality within its current beneficial use class, and surface water quality within the background limits of variability. This includes salinity, pH, and trace metals.**
4. **Ensuring the integrity of the landform and barrier land to alluvial floodplains and river systems remains into the post-mining period.**

Protection requirements include defining boundary conditions, which provide a mitigation zone or barrier between mining areas and rivers or alluvium. Boundary conditions include many uncertainties, particularly in dealing with groundwater interactions. Mitigation or remediation may involve management techniques which may not be available, or may be extremely costly. Any mining development proposal should take into account potential remediation costs as part of the project cost-benefit analysis. This assessment should include any remediation and associated management costs of adverse impacts on streams and alluvium against the beneficial use of surface and ground waters for water users and the community.

How do you use these guidelines?

DIPNR is an approval body for many mining projects under the terms of the Integrated Development Approvals System - under the *Environmental Planning & Assessment Act 1979* (EPAA). As part of the development application process, assessment of existing environmental impacts and predicted impacts caused by mining operations is required. These guidelines provide a format for required information on existing and predicted impacts caused by mining operations. Prior to consent being granted for the proposal, and ideally before a development application is lodged with the consent authority, the specific requirements DIPNR should be sought. The recommended process is:

- Mining companies contact the Resource Access Manager of DIPNR, Hunter Region, with notification of a mining proposal, location and extent of the lease area, and the presence of stream systems involved.
- DIPNR requirements will be requested by the consent authority following the planning focus meeting for the development proposal, and/or when an application for a permit, licence or approval is made.

- Mining companies keep DIPNR informed on a regular basis of progress on mine plans and environmental assessment process undertaken for the development, as requested.
- Mining companies submit assessment/monitoring reports as required under consent conditions or permit/licences conditions.

DIPNR is responsible for determinations under the WA and RFIA (currently), and under the WMA (as parts of the Act commence), which includes works for monitoring or remediation of stream systems. Mining companies are required to submit detailed assessments of monitoring and potential remediation as part of the application to obtain an approval. Mining companies must ensure that they meet the requirements of the department in order to obtain any required approvals or licences which apply to their operations.

For approvals which are applied for without development consent (Part 5 assessment and approval under the EPAA, the following approach is recommended:

- Mining companies contact the mining review coordinator, DIPNR Hunter Region, to determine the relevant stream corridor considerations: whether the stream is a schedule 1, 2 or 3 stream system, the applicability of relevant standards or guidelines to the proposal.
- Pre-mining assessment reports be conducted or relevant pre-mining information compiled to assess the level of impact or change to the stream system.
- Post-mining impact reports submitted along with relevant technical information accompanying the application for approval by the department.
- Timeframes for remediation programs be submitted with the application for department approval.

Definitions

Stream Systems

Stream systems comprise the watercourses or rivers, adjacent banks and associated alluvial groundwaters (where there is an interconnection or bi-directional flow of groundwaters).

Stream Orders

The use of first, second and third or higher order streams in this document utilises the Strahler stream order system. The Strahler ordering system begins with first order streams at the catchment watershed. Refer to the Stream Orders map of the Hunter Region available from DIPNR.

The Strahler system explained:

- Starting at the top of a catchment, any watercourse draining from a catchment divide, or which has no other watercourse flowing into it is classed as a first order watercourse.
- Where two first order watercourses join, the watercourse becomes a second order watercourse.
- When two or more second order watercourses join they form a third order watercourse.
- A third order watercourse does not become a fourth order watercourse until it is joined by another third order watercourse.

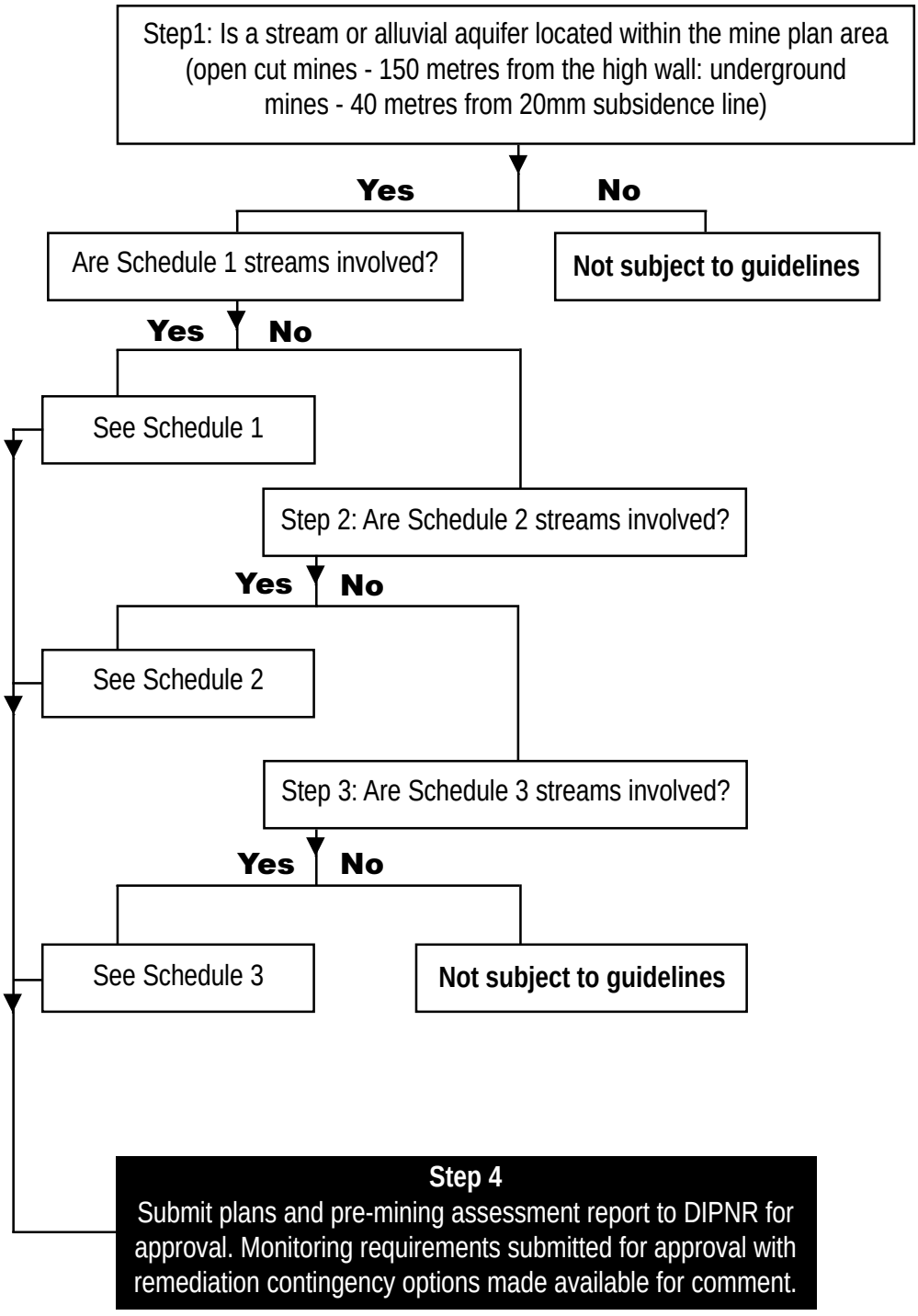
Stream Categories

Schedule 1 streams comprise first and second order watercourses and are usually intermittent (streams showing evidence of permanent flow are Schedule 2 streams).

Schedule 2 streams comprise primarily third order and higher streams, which drain into primary catchment rivers systems.

Schedule 3 streams comprise major rivers and connected alluvial groundwaters. The stream including the major river systems of the Hunter River, Goulburn River and catchment tributaries flowing into it; Dart Brook, Glennies Creek, Pages River, Paterson River, Rouchel Brook, Williams River, Wollombi Brook and Wybong Creek and associated alluvial groundwater zones.

Procedure for stream assessment



Schedule requirements

The following management considerations relate to stream category where stream importance increases with the higher categories. Each stream schedule includes the requirements of the preceding schedules. Therefore, Schedule 2 stream assessments will include Schedule 1 requirements, and Schedule 3 stream assessments will include requirements for Schedules 1 and 2 stream systems.

Schedule 1 Streams

Information requirements

DIPNR is an approval body under the Integrated Development Assessment System. DIPNR's approvals relate to stream systems in the following areas:

1. Surface water extraction, easements and works on streams, stream diversions and flood control levees (Parts 2 and 8 of the WA).
2. Works which intersect the groundwater table, including bores, monitoring piezometers and mine pits/underground workings (Part 5 of the WA).
3. Extraction of soil or other material within 40 metres of a defined watercourse - except for works which require approval from DPI and are located on a mine lease (RFIA).

DIPNR's role in environmental impact assessment stems from its responsibility as the manager of the State's waters, soil and vegetation resources. DIPNR, therefore, should be consulted at an early opportunity to ensure that its requirements are included in the environmental assessment for new mine projects (including mine extensions and modifications).

Risk Analysis

The primary focus of management on Schedule 1 streams is to provide stable stream lengths with minimal incision or erosion. Loss of flow from fracture or other impacts on Schedule 1 streams should be managed in terms of the mine water management system. Where possible, fractures should be sealed. The risk of fracture development on Schedule 1 streams should be undertaken with potential downstream impacts the primary focus of any program.

A risk analysis is preferred for Schedule 1 streams, which focusses on erosion initiation, remediation and provision of a stable stream system which has a system of controls relying primarily on vegetation. This is required to provide long term stability with minimal maintenance.

Monitoring

The performance of stabilisation techniques which are applied to Schedule 1 stream systems depends strongly on the condition of the works which are installed, and the flexibility in providing for stream adjustments. This should include, where applicable, provision for lateral migration or gravel bar deposition points, pools and riffles and potential incision to maintain pools along defined stream lengths.

Monitoring on Schedule 1 streams affected by mining activities should be focussed on comparable records of pre and post- mining conditions. Photographic records are applicable for Schedule 1 streams, with detailed assessments (including survey and planform designs) only required where full diversions are anticipated.

Lifespan

Schedule 1 streams may be controlled with reasonable certainty through soft or hard engineering works. The lifespan of these works should be included in any design for remediation or management works on these stream systems. The mine company should accept full responsibility for maintenance of all works until bond relinquishment is agreed with DPI, at which time a nominated management body should be identified.

Open cut mines

Outcomes

Open cut mines are responsible to minimise their impacts on watercourse stability, water quality and ecosystem maintenance. Outcomes to achieve this include:

- stream stability maintained where stream corridors are left
- stable stream channels maintained where temporary diversions are installed
- stable stream channels with similar stream lengths and grades for permanent diversions
- stream channels maintained with minimal erosion
- erosion control maintained primarily by vegetation controls

DIPNR will provide detailed requirements for mine environmental impact assessments when requested.

The current information requirements for Schedule 1 streams for open cut operations are:

1. Location of mine lease boundaries, the footprint of mine workings, including pits/voids, infrastructure, haul roads and conveyors and non-extraction works within 40 metres of defined watercourses.

2. Location of streams of 1st and 2nd order in the vicinity of mine workings. Generally, for Schedule 1 streams this will include streams located on the mine lease area.
3. For open cut operations, drainage catchments reporting to the mine pit, diversion outlines and modified catchment areas, and dams or basins constructed on streams.

Proponent responsibilities

Remediation techniques recommended for mining-impacted streams include measures to:

- prevent bed scour and subsequent incision into the stream bed
- stabilise stream banks
- seal bed cracks and fractures
- restore stream flows interrupted by bed cracking or fracture development

Open cut mining operations are responsible to:

- Construct any approved stream diversion works to a standard approved by DIPNR.
- Identify any adverse impact which affects stream stability or water quality and notify the department of the level of impact and options for remediation.
- Implement approved remediation works to a standard approved by DIPNR any adverse impact on stream stability and water quality resulting from the mining operation.
- Design engineering works for an agreed lifespan. Long term stability should be achieved through the use of vegetation as the primary engineering tool.

A defined mitigation zone is not necessarily required for Schedule 1 streams. However, any necessary erosion control measures should be installed prior to the completion of mining in order to prevent stream degradation. The threshold grade for potential degradation following stream subsidence will vary, depending on the consistency of bed and bank material. An assessment of stream power and tractive stress should be undertaken to determine critical grade thresholds and bed materials. A management system of periodic assessment of streams in areas of mine subsidence will determine the need for erosion controls works.

Underground mines

Outcomes

Underground mines are responsible to prevent, and where necessary, remediate damage which their operations cause to watercourses. This requires:

- stream stability maintained where subsidence occurs
- stream fracture minimised where possible
- stream channels maintained with minimal incision from bed grade change
- stream bed grade change minimised to provide stable stream length
- stream stability controls to be provided primarily by vegetation

Information requirements

The current information requirements for Schedule 1 streams are:

1. Location of mine lease boundaries, the footprint of mine workings, including pits/voids, infrastructure, haul roads and conveyors and non-extraction works within 40 metres of defined watercourses.
2. Location of streams of 1st and 2nd order in the vicinity of mine workings. Generally, for Schedule 1 streams this will include streams located on the mine lease area.
3. For underground operations, depth of cover to the land surface and an outline of the cumulative subsidence envelope and an assessment of likely subsidence expressions on surface (including upsidence and tension/compression fracturing).

Underground mining operations are responsible to:

- Identify, to a standard approved by DIPNR, any existing degradation in the streams prior to mining to allow differentiation of that degradation induced by the mining.
- Conduct a post-mining assessment, to a standard approved by DIPNR, of any streams within the area of mine subsidence within six (6) months of the initial subsidence. Conduct a subsequent assessment within eighteen (18) months of the initial subsidence to confirm that post-mining degradation resulting from the mining is successfully remediated.
- Implement remediation works, to a standard approved by DIPNR, where the assessment has indicated degradation of the streams in the area of mining induced subsidence, and thereafter on an annual basis until any mining induced stream instability is addressed to the standard approved.
- Maintain a photographic record of stream stability for areas where either fracturing is detected (at maximum strain points), or at maximum tilts within the subsidence envelope.
- Report in the Annual Environmental Management Report (AEMR) the pre- and post-mining assessment data and details and outcomes of any remediation works.

Schedule 2 streams

Schedule 2 stream systems are dynamic and complex systems, whose long term behaviour cannot always be predicted in advance. Their dynamic nature requires allowances for degrees of freedom in management. Mining companies must be aware of this and include a flexible approach to management which aims at short term engineering works and long term stabilisation which allows stream adjustment to changed hydrological conditions in the stream. It is the responsibility of the mining company to demonstrate that mining will have minimal adverse impact on stream stability or water quality. The mine plan should aim at minimising adverse impacts on Schedule 2 streams. Schedule 2 stream requirements include the measures identified for Schedule 1 streams, with the following additional requirements.

Schedule 2 streams in the Hunter Region exhibit complex forms, often with abandoned meander channels, perched groundwater tables, channel avulsion patterns and interactions with the surrounding vegetative, geological and flood boundary controls. They require a high level of understanding of the hydrologic regime and ecosystems in engineering design and management to provide flexible stability (dynamic equilibrium).

Water quality protection is a crucial element of Schedule 2 stream management. The interaction between surface and ground water flows requires detailed assessment to manage water quality within background ranges. Water quality is a critical indicator of stream management. Inadequate measures to manage these stream systems may lead to long term degradation of water quality which affects not only water users along the stream, but those located on the primary receiving rivers, and the dependent ecosystems along them.

Information requirements

The environmental impact assessment process identified for Schedule 2 streams requires information gathering to adequately address potential impacts on streams, floodplains and alluvial groundwater resources. The information requirements should be provided as:

Pre-planning (leading to a planning focus meeting)

1. Location of mine lease boundaries, the footprint of mine workings, including pits/voids, infrastructure, haul roads and conveyors and non-extraction works within 40 metres of defined watercourses.
2. Location of streams of 3rd order and above in the vicinity of mine workings. Generally, for Schedule 2 streams this will include streams located on the mine lease area, and the immediate vicinity of the mine lease boundary.
3. Location of alluvial boundaries, terraces, transition zones, and establishment of transmission pathways and major geological structures which affect the proposal.

Environmental Impact Assessment (from planning focus meeting to the approval of the mine, including environmental impact statements and commissions of inquiry)

1. Location of all 3rd order and greater streams within the defined notification area relevant to the mine proposal – as indicated for specific notification zones for open cut and underground mining operations.
2. Location of mine workings and associated works which include excavation, intrusion into the groundwater table, surface infrastructure and roads, sediment control structures and drainage inverts to streams.
3. Detailed investigations related to potential impacts on streams, flood zones and associated alluvial groundwater aquifers. This is to occur wherever Schedule 2 stream systems are located within the defined notification area.

These investigations are to include:

i. Stream condition

1. The length of stream involved.
2. The location of any meander cutoffs, out of channel runners or distributory channels.
3. The location of any identified stream bed and bank controls.
4. General vegetation communities along the affected stream.
5. Any existing erosion along the stream.
6. An indication of flood break out points, or areas which would be sensitive to erosion or scour under minor flood conditions.
7. The location of alluvial groundwater, mapped alluvium and any associated colluvial aprons.
8. Water quality within channel and in associated alluvium.

ii. Mine layout

With proximity to watercourses and/or alluvial groundwater zones and significant surface/groundwater dependent ecological communities

iii. Impacts from mining activities

In the reporting of monitoring along the stream system affected by mining operations, a documented report into stream channel changes, and the incipient or actual initiation of erosion along the stream must be included. The report should be framed in such a way as to report on the following:

1. The current bed slope of the stream, including current pool-riffle sequences.
2. Incipient bank erosion or bed incision, and energy relationships within the system.
3. Alteration in bed slopes and gradients along channel
4. Depths of activation along the stream, and storativity and relationship with adjacent groundwater systems.
5. Effects on vegetative cover, including any exposed areas where vegetative cover has been lost.

6. Changes in stream bed controls, with particular attention given to any changes in vegetative controls (woody debris) along the stream.
7. Any observable fracture development on the stream, evidence of salinsation of the stream from fracture discharge, or sediment fans from tunnelling of the adjacent hillslope or floodplain.
8. Groundwater assessment, as required by DIPNR Groundwater Monitoring Guidelines (2000).

Monitoring and contingency plans

Monitoring is to be designed to detect changes in the surface/ground water system and to assess whether and what kind of available contingencies can be used to remediate any damage which is caused to the stream system. The monitoring program should include:

1. Documentation of the approval for mining in the affected area, and identification of any adjacent or preceding mining which may have had an impact on the stream system.
2. The layout and timing of mining activities in the affected area.
3. A discussion of any known previous assessments of monitoring reports in the vicinity of the mining operation, and the results of previous assessments for erosion occurrence or hazard.
4. An assessment of likely erosion points, fracturing or seepage zones from the mining area to the stream, along the stream channel occurring as a result of mining activities. The survey discussion must be adequate to address this point, as it is the purpose of the survey report to identify incipient or actual problems to be addressed.
5. An assessment of any required remedial works on the affected stream, including:

    - options considered for the remediation program
    - anticipated lifetime of the remedial works
    - details of the engineering design or process for engineering design of the remediation works
    - long term remediation requirements, including revegetation of the site
    - this assessment is to be included, as it will form the preliminary assessment of the remediation program for departmental approval under Part 3A of the RFIA (controlled activity approval under the WA)
6. Photographic records from all stream control points, survey control points, vegetation associations, pool/riffle sequences, any incipient or actual erosion and salt efflorescence or tunnelling/dispersible soils.

Remediation programs

Mining companies are responsible to:

- assess risks to stream degradation occurring as a result of mining operations
- monitor the status of stream systems in the area of mine subsidence
- implement remediation works (approved by DIPNR) where required to restore stream stability following any adverse impact of mining
- continue an assessment program of stream conditions

A list of outcomes is presented below, to which proponents should demonstrate commitment in developing stream management programs:

1. The stream system must have remediation of any fractures or identified transmission zones of saline or contaminated water from operational or rehabilitated mining/industrial lands.
2. The stream system must have channel capacity which can accommodate flows up to a level prescribed for that stream character. For example, gravel bed streams must be able to accommodate flows up to the entrainment level of the largest fraction of bed load within the channel.
3. The stream system must maintain bed gradients, which are suitable for the channel form, nature of bed load material, comparable to bed gradients above and below the area of affectation. No long term steepening of bed gradient should be permitted, unless drop structures are included which will remain stable or can be maintained over an extended period.
4. All diversions must address issues of bed gradient steepening and loss of gradient variability (such as pool/riffle sequences) with long term stability. Short term methods to provide bed stability, such as reno mattresses or gabion baskets, should not be used unless a program is agreed for their replacement with more suitable, long term structures. Only those structures which can be demonstrated to remain stable under anticipated flow conditions over a long term should be used as permanent installations in stream beds.
5. Pre-disturbance channel character must be maintained, or brought to a level similar to pre-disturbance conditions. For example, gravel bed streams must have allowance for pool/riffle sequences, while sand-bed streams must have stable terraced planforms to allow vegetation growth and vegetative stabilisation of stream beds. Terrace/point bar areas must have allowance for vegetative controls, and any pre-disturbance bedrock controls must have similar controls in remediation programs.
6. Stream banks must reflect morphology and controls present in pre-disturbance conditions.
7. Ecosystem integrity should be encouraged by providing allowance for variability in stream character by providing variable bed load/substrate and planform. This must be at least to pre-disturbance levels.
8. Where required, fish passage must be maintained.

9. Diffuse salt discharges and erodibility of soil materials must approximate pre-disturbance conditions.
10. Vegetation communities must be re-established where they have been modified, disturbed or removed, using endemic native species.

Barrier zones

The range of stream systems which fall under Schedule 2 of this guideline is large. In certain cases, underground mining operations should provide a minimum barrier between the 20 millimetre line of subsidence and the bank of Schedule 2 streams. Open cut operations should provide a barrier of 150 metres between an agreed point on the highwall and Schedule 2 stream system. The imposition of a barrier will be considered where inadequate pre-mining assessment or highly significant risk of long term damage are identified.

Open cut operations

Open cut stream management outcomes include:

- Streams should remain within their pre-mining dimensions, bed grades and with similar bed load material (both in terms of available transportable bed load and particle sizes).
- Alluvial areas (perched groundwater tables, abandoned meanders, alluvial flood sheets) should be maintained intact.
- Interconnecting saline groundwater/alluvial groundwater should be managed with similar pressure gradients and connectivities.

Information requirements

The detailed list of information required for open cut operations should only be used in cases where Schedule 2 streams are to be directly affected (ie mined through) by mining operations. Where operations will mine through Schedule 2 streams, the full range of information listed above will be required. In other cases, where open cut mining will operate within 150 metres of Schedule 2 streams or associated alluvial zones, the following information should be provided:

- location of nearest pit/void face to the stream system, distances between the excavation area and the high bank of the stream or the boundary of alluvium
- relative heights between the base of pit and the adjacent Schedule 2 stream bed, banks and base of associated alluvium.
- geological structures in the barrier area, with particular attention to preferential transmission through jointing, faults or other structures
- groundwater transmission rates through the barrier zone in pre-mining, operational and predicted post-mining phases of development
- options to minimise risk of connection between the mining operations and Schedule 2 streams and/or their associated alluvium

Proponent responsibilities

Open cut mines

- construct any approved stream diversion works to the standard specified by DIPNR
- identify any adverse impact which affects stream stability or water quality and notify the DIPNR of the level of impact and options for remediation
- monitor the barrier between the open cut and any Schedule 2 streams which lie within 150 metres of the open cut workings, and assess leakage rates, connectivity and depressurisation between the open cut operate and the saturated zone underlying the stream
- implement approved remediation works to the standard specified by DIPNR any adverse impact on stream stability and water quality resulting from the mining operation

Underground

Outcomes for underground mining operations in the vicinity of Schedule 2 streams include:

- streams should maintain pre-mining course, and maintain bed channel gradients which do not initiate erosion
- streams should maintain pool riffle sequences where they pre-existed, or should have pool riffle sequences installed where appropriate
- connectivity to underground workings, and flow loss to fracture zones should be maintained in similar levels to pre-mining
- water quality should be maintained within pre-mining ranges

Underground mining operations information requirements

Information which is required for underground operations includes:

- outline of the mining operation proposal underlying Schedule 2 streams and associated alluvial groundwater zones
- depth of cover to the land surface
- outline of the cumulative subsidence envelope and an assessment of likely subsidence expressions on surface (including upsidence and tension/compression fracturing)
- location of significant geological structures and transmission pathways for groundwaters within the cumulative subsidence envelope for the proposal

Mine layout information

1. The layout of mine workings - longwall panels, galleries and first workings (adits, longwall drivages, header galleries and ventilation/ dewatering structures)
2. The presence of geological structures, indicating groundwater flow pathways
3. Depth of cover to the mine working area, and indication of dip of seam
4. Timeframes for driving headers and completion of longwall panel sections or galleries

5. For individual longwall panels, the single subsidence trough to be developed along the panel (including cumulative subsidence occurring in association with other longwall panels). For multiple longwall panel assessments, the cumulative subsidence envelope to the 20mm line of subsidence, and the presence of chain pillars and subsidence contours

Monitoring and contingency plans

Survey lengths and bed gradients along the affected stream (for underground mining). This must be discussed in terms of:

- channel capacity, including within the low flow channel and within terraces or benches along the channel reach
- sediment sizing and sorting
- presence and location of bedrock or vegetative controls
- cross section assessment of stream capacity and form
- depth of activation in bed sediments, and the level of imbrication of bed material (ie gravel or rock armouring)
- depositional and erosional zones along the stream
- changes (predicted and actual) in bed grade or avulsion/ activation of flood runners or distributory channels
- pool/riffle sequences
- vegetative cover, roots or debris forming controls, and any habitat which may require assessment under the *Threatened Species Conservation Act 1995*
- existing erosion along the stream channel (with particular focus on nickpoints, bed incision, or fracturing along the stream length)
- survey chain points and stream lengths are to be used in the identification of any of the above features, with a diagram of the stream length with features noted on it

Proponent responsibilities

Underground mining operations are responsible to:

- identify, to a standard approved by DIPNR, any existing degradation in the streams prior to mining to allow differentiation of that degradation induced by the mining
- conduct a post-mining assessment, to a standard approved DIPNR, of any streams within the area of mine subsidence within six (6) months of the initial subsidence - subsequent assessment should be conducted within eighteen (18) months of the initial subsidence to confirm that post-mining degradation resulting from the mining is addressed
- implement remediation works, to a standard approved by DIPNR, where the assessment has indicated degradation of the streams in the area of mining induced subsidence
- report in the Annual Environmental Management Report (AEMR) pre and post-mining assessment information, and outcomes of any remedial programs

- assess the risk of redistribution of flood waters or stream avulsion (redirection)
- report in the AEMR the pre and post-mining assessment data and details and outcomes of any remediation works.
- assess the risk of any redistribution of flood waters or stream avulsion (redirection of primary channel) which may occur as a result of mining. Where appropriate, modify mine operations to minimise this risk.
- identify high quality groundwater resources. Assessments should identify the beneficial use class of this resource, the level of existing use for groundwaters, and an agreed process to manage groundwaters without significant degradation of streams or groundwaters occurring

Schedule 3 streams

Barrier area

DIPNR is adopting a precautionary approach to mining in the vicinity of important water resources. A notification area is defined between underground and open cut mines and Schedule 3 rivers and their associated alluvial groundwater systems. The aim of the area is to provide zero mining induced ground movements or fracturing, with an additional factor of safety for risk management.

The minimum defined notification area is 150 metres from the high bank of a Schedule 3 river or the defined edge of alluvium to an agreed point on the highwall of open cut mines, or 40 metres from the 20 millimetre point of subsidence for underground mines, using an angle of draw as approved by DPI.

Any proposed mining within the defined notification zone requires a detailed assessment developed to a standard approved by DIPNR, indicating that likely impacts on stream flow, stability or water quality in surface or ground waters will be negligible.

Mining within the Notification Area

The assessment process outlined for Schedule 2 streams should be followed to provide an assessment of the likely impacts which may be encountered. The assessment is triggered for any coal extraction which occurs in the defined barrier zone.

Mining companies which intend to mine within the notification zone should assess the likely impacts to occur to the surface/ground water regime, and adopt a range of scenarios in likely surface and groundwater changes. In the case of subsidence, sensitivity analysis of formula variables, and subsided strata behaviour is critical. Geological assessment, including ‘hanging strata’ assessment should also be conducted. DIPNR reserves the right to oppose any mining proposal within the barrier area where it is not satisfied that significant impacts on the river system are negligible or avoided.

DIPNR should be notified in the pre-planning phase of any development where Schedule 3 stream systems and associated groundwaters are part of a mining proposal. The notification should proceed by stages as the data gathering process is conducted. The notification process should progress through information exchange to formal notification as part of the integrated development approval process. Notifications should include a map of the conceptual layout of longwall panels or the location of the highwall, depth between surface elevations and seam extraction, and indicative stratigraphic analysis. A procedure should be developed to monitor and manage stream stability and surface/ground water management, in compliance with DIPNR Groundwater Monitoring Guidelines, or to departmental standards for surface stream system monitoring procedures.

DIPNR reserves the right to impose barriers to Schedule 3 stream systems where adequate prevention or remediation of adverse impacts cannot be demonstrated, in order to prevent impacts where adequate remediation cannot be provided.

How should stream systems be monitored?

Monitoring of stream stability is critical to proper management of stream systems. It is poor management to leave destabilised streams until major problems have developed, before undertaking monitoring and stabilisation.

An acceptable monitoring program for streams which are affected by subsidence, fracture development or diversion is:

All streams

- baseline information demonstrating the conditions along the stream prior to mining commencing

Schedule 1 streams

- annual assessments (site inspections, aerial photogrammetry or survey) of affected streams, to detect deviations from baseline conditions

Schedule 2 streams

In addition to requirements for Schedule 1 streams - for areas of direct impact on stream stability or water quality:

- define control points and survey cross section stations upstream, downstream and within subsided channels

- map stream length, pool/riffle sequences, bed controls and vegetation communities
- survey on an annual basis the location of control pool/riffle sequences, bed controls, vegetation cover, extent, community structure and vegetation affected by subsidence or erosion and bed/bank scour or erosion
- survey any destabilisation, bed fracturing or bed incision which occurs after mining
- survey all diversion re-entry points and assess bed/bank state of all exposed surfaces

Schedule 3 streams

In addition to requirements for Schedules 1 and 2 stream systems - for areas of impact on stream stability or water quality:

- define control points and survey cross section stations upstream, downstream and within subsided channels
- survey stream lines to establish bed levels, long profile bed gradient, pool/riffle sequences and depth of activation (where mobile bed materials exist), protective vegetation cover, bedrock or woody debris stream controls and existing bed/bank scour points before mining proceeds - depth of bed transport activation and movement of mobile gravel point bars should be included where applicable
- assess stream flows over a range of flow conditions, including flood flows over a suitable range which may be encountered during mine life (1:5, 1:20, 1:50, 1:100, 1:200 year events)
- survey on an annual basis the location of control pool/riffle sequences, bed controls, vegetation cover and bed/bank scour or erosion
- survey any destabilisation, bed fracturing or bed incision which occurs after mining
- survey all diversion re entry points and bed/bank state of all exposed surfaces

What are adequate remediation procedures?

Remediation procedures should be implemented as soon as survey/ monitoring shows scour and erosion or a significant risk of erosion occurring as a result of mining operations. Monitoring of stream status should be reported to DIPNR, along with surface and groundwater monitoring results, to ensure that adequate protection is afforded to streams and groundwater systems.

Where streams require remediation from bed cracking or bed degradation, DIPNR requires outcomes that demonstrate long term stability. This is consistent with the principles of Ecologically Sustainable Development relating to intergenerational equity. As a measure of long-term stability, DIPNR seeks remediation outcomes which will be stable for at least 100 years, according to reasonable prediction.

Remedial works must be conducted to contemporary best practice standards and demonstrate long term stability. Companies should be aware that DIPNR may seek additional remediation works if predictions of long term stability are not achieved in practice. An approval will be required for remediation of impacted streams.

DIPNR will require a full justification of any option for remediation of impacted streams. Short term engineering proposals will be assessed against DIPNR standards for river management works, along with required stabilisation of disturbed areas and management of any biota in the stream system. Long term stabilisation requirements should be developed for any subsided land, long term remediation of fractures or fracture zones developing above underground mining or adjacent to open cut mining operations. Remediation programs should include monitoring of the effectiveness of the works, as well as the impacts on water quality and instream ecosystems. All plans, maps and assessments required for monitoring programs should be submitted to DIPNR.

For further information contact:
Resource Access Manager
DIPNR Hunter Region
Telephone: 02 4929 4346

Glossary

Area of affectation
A defined envelope surrounding a mine lease area. The area of affectation includes the area of coal extraction, cumulative subsidence envelope, barrier areas and stream length from the closest upstream and downstream control points from the barrier limit.

Barrier
A barrier, in the terms of the guidelines, is an area which is to remain with intact, undisturbed geological strata. A barrier, in this definition, is an area of nil mining-induced disruption to the stable geology fringing a stream/aquifer system. Mining-related activities which do not impact on geological integrity, such as haul roads, surface structures, dams or rehabilitation areas are permitted within the barrier zone.

Connectivity
The existence of fractures or breakage of rocks which permits groundwater flow between aquifer systems or groundwaters of differing chemical make up or beneficial use class. Increased connectivity can be seen in terms of bi-directional flow between hard rock and alluvial groundwaters and flow directions.

Degradation
Degradation is defined in the guidelines as any adverse impact on the access, use, geomorphology or ecosystem values of stream systems. It extends beyond obvious immediate impacts to include initiation of erosion, loss of protective vegetative cover .

Mitigation area
Areas of stream corridor affected by mining operations, where remediation works are required. Generally, Schedule 1 streams (first and second order streams) will require only mitigation where impacts occur, without notification to the department. Schedule 2 and 3 streams require initial notification prior to mitigation areas being defined. Mitigation areas should be identified where monitoring programs detect incipient or actual impacts occurring to a stream system, and a program of works is required.

Notification area
Areas where mining operations are proposed within nominated assessment boundaries require detailed monitoring to detect impacts which are caused by mining operations. The notification area identifies the area of detailed groundwater and stream stability assessment. The notification area will determine whether monitoring and remediation procedures will be adequate to minimise mining-induced impacts. Generally notification areas will apply only in Schedule 2 and 3 streams. See *mitigation area* and *barrier*.

River systems

River systems include the active channel of the river and the riparian zone extending beyond its banks (low and high banks). It encompasses all alluvial processes including river channels, low and high banks, floodway zones and connected alluvial groundwaters. This includes, but is not limited to, the area where controlled activity approvals are required for works within 40 metres of a stream.

Subsidence envelope

The 20 millimetre point of subsidence is the effective zero line of calculation for these guidelines for underground operations. This provides a means to define the lowest measurable point of subsidence from the goaf.

Timeframe

Timeframes are developed in the guidelines in three stages. The stages are:

1. Monitoring timeframe. This applies from within 3 months of a mining pass within a stream system, as defined within the guidelines, to a period at which subsequent erosion is stabilised.
2. Response timeframe (short-medium timeframe). This timeframe should be seen as an immediate response to incipient erosion or monitored change in stream character which is the result of mining activities. This timeframe extends to a period when written agreement on stability has been reached by the Department of Infrastructure, Planning and Natural Resources. For minor activities, this may be finalised within one year. For major works, this may be extended to ten-twenty years.
3. Stabilisation timeframe (long term timeframe). The timeframe for which stabilisation works must be designed is into geomorphic time, which begins at 20 years and extends to over 100 years (ARRR, 1989). 100 years is accepted as a planning timeframe for long term stabilisation, as it is the timeframe for riverworks stabilisation programs (DWR, 1992), and is the standard acceptable timeframe for flood response planning (DIPNR, 1996).

Unsealed fracturing

Hard rock aquifers transmit groundwaters in the order of 1.10^{-9} metres per day. Alluvial groundwaters may move between 1.10^{-2} to several metres per day. Fracture zones may increase saline groundwater flow rates several orders of magnitude above background flux rates. Unsealed fractures occur where surficial or connecting fractures do not seal with material, whether natural or artificial, within twelve months of original fracture development.

Department of
Infrastructure, Planning and Natural Resources