

Mine subsidence

Environmental Sustainability Branch

Introduction

This Primefact provides the community with a brief overview of mine subsidence, its causes, potential impacts and the NSW Government's regulatory controls. By publishing this document, the Department of Primary Industries seeks to increase the community's knowledge of mine subsidence and identify opportunities for public participation.

The general meaning of subsidence

The term 'subsidence' commonly refers to a point (or points) on or in the earth's surface moving vertically to a lower level. To understand and manage any potential impacts of subsidence, it is important to pay attention to both the vertical and horizontal component of these movements.

Subsidence can result from natural causes such as earthquakes and from human activities such as removal of materials from below the surface or extraction of groundwater from alluvial aquifers.

Mine subsidence

The extent of areas affected by subsidence due to underground coal mining can be more significant than subsidence resulting from other forms of activity such as tunnelling. Therefore this document specifically refers to 'mine subsidence' as being subsidence caused by underground coal mining.

'Longwall' mining is the safest, most efficient and most commonly used method of underground coal mining in Australia and other developed countries. Although this method is the major cause of mine subsidence in NSW, it should not be viewed as the sole cause of mine subsidence.

To help understand 'mine subsidence', Figure 1 illustrates:

- The extraction of coal may cause subsidence of the rock and soil mass above the extracted coal seam. The area of subsidence influence is shown in lighter yellow in Figure 1.
- The limit, magnitude and nature of subsidence movements are dependent on numerous factors, such as mine design, geological conditions, surface topography, and the distance between the mine workings and the ground surface (or point of interest).
- The rock or soil mass within the influence of mining may move three-dimensionally at any given point. In other words, the extraction of coal may result in vertical as well as horizontal subsidence movements.

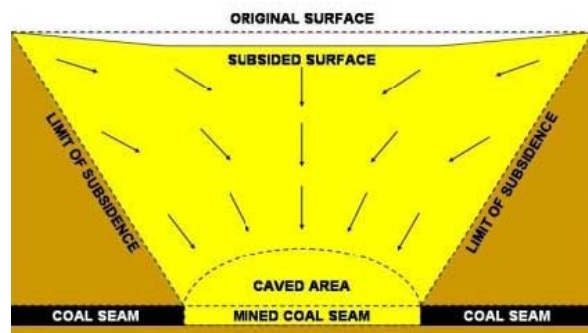


Figure 1: Diagram of mine subsidence development from underground coal mining.

Understanding the potential impacts of mine subsidence

The development of mine subsidence can potentially impact on both natural and man-made surface and sub-surface features. The management of these impacts requires an understanding of fundamental aspects of mine subsidence such as:

- The magnitude and direction of subsidence movements at any point within the influence of mining.
- Differential subsidence movements between parts of a given surface or sub-surface feature. Such differences (either in the direction or magnitude of movements) may lead to impacts on a surface or sub-surface feature. For



example, if every part of a building (or a given natural feature) is subject to movement of the same magnitude in one direction, this building is unlikely to be damaged.

- The tolerance of a given surface or sub-surface feature to the influence of mine subsidence. Depending on their characteristics and site-specific conditions, the natural environment and man-made structures can withstand certain levels of mine subsidence. Not every feature will be affected. The occurrence, nature, severity, duration or 'reparability' of subsidence impacts depend strongly on the magnitude/nature of subsidence, and the nature of the environmental system or man-made structure in question.

Mine subsidence and rivers

Mining under watercourses on floodplains, or in other relatively flat-lying areas, may result in localised diversion of water flows and possible increases in the incidence of flooding, erosion and other impacts.

Mining under watercourses in steep valleys may result in small areas of ground in valley floors being forced upwards to relieve stress, an effect known as 'upsidence'. Upsidence can result in a number of short-term impacts. Surface water may permeate into the shallow groundwater system through the resulting open fractures. This water will usually return to the surface further downstream, but may be chemically altered by minerals in the rock strata. During extended periods of dry weather, the loss of surface water from rivers or creeks may become evident with a noticeable but localised reduction in surface flows. Altered flows and stream chemistry may have an impact on the lifecycle of aquatic species and riparian vegetation.

Subsidence prediction and management of impacts

The prediction and management of mine subsidence aims to produce outcomes that are consistent with community and government expectations for responsible mining. The required management outcomes cannot be achieved without adequate understanding and assessment of site-specific factors that may affect the development of subsidence, and the responses of the environmental system or man-made structures in question.

Like many other engineering disciplines involving geological materials, uncertainties are an inherent part of subsidence engineering and management. Management of subsidence must be risk-based, flexible, responsive and capable of dealing with unexpected changes or uncertainties.

In recent years, significant progress has been made towards achieving a better understanding of subsidence development related to the natural environment. This has led to improvements in the accuracy of mine subsidence impact predictions.

The NSW Government actively encourages the use of new mining techniques which have the potential to minimise subsidence or the effects of subsidence. The mining industry is in the process of developing and trialling technologies to meet these objectives.

Economics of coal mining

Coal mining continues to be an integral part of the NSW economy and is vital to the local power, steel and other industries. Domestic consumption of coal for these purposes was 33 million tonnes in 2003-04.

In 2003-04 the NSW coal mining industry produced 114.2 million tonnes of saleable coal, of which 33.9 million tonnes was produced by longwall mining. In 2003-04, these activities provided direct employment for 9998 people, as well as \$4.8 billion dollars of saleable coal, \$354 million in royalties to the NSW Treasury and \$3.7 billion in exports.

High quality coking coal from southern Sydney and the Illawarra cannot be readily replaced by other sources, or economically mined by methods which do not result in subsidence. Although NSW is fortunate to have large amounts of coal, most of this resource is not mineable due to factors such as:

- poor coal quality
- inadequate seam thickness for practical mining
- difficult access
- geological factors such as faulting
- conflicting land uses (e.g. National Parks, dams and high density developments).



Figure 2: Longwall coal shearer and hydraulic roof shield supports.

Government regulation of mine subsidence impacts in NSW

NSW Government policies aim to balance the economic and social benefits of mining with the Government's commitment to ensuring that the industry meets contemporary standards of environmental management.

The NSW Government introduced a new subsidence management policy and approvals process in March 2004. This was to improve the assessment, management and regulation of subsidence effects due to underground coal mining, although the process applies to all mining likely to result in subsidence.

Subsidence management plans (SMPs)

The NSW Government subsidence management policy and approvals process requires mining operators to provide a Subsidence Management Plan (SMP) which must include:

- a full description of the area proposed to be impacted by mining activity, including areas of environmental, heritage or archaeological sensitivity
- an outline of existing mine workings within the application area, the proposed mine plan and a schedule of proposed mine development for the period to be covered by the SMP
- predictions of the expected extent of subsidence
- a full assessment of the potential environmental, land use and other impacts
- an assessment of the economic and social benefits and impacts of the proposed mine development
- relevant extracts of associated development consents, licences, and policies of other agencies
- a description of subsidence projections and actual impacts associated with any previous activities
- proposals to minimise impacts of surface subsidence, particularly in areas of environmental, heritage or archaeological sensitivity, or important built surface features
- proposals for ground and surface water management
- proposals for rehabilitation of subsidence impacts
- results of consultation with affected landowners, State and local agencies, and the general community
- details of proposals for ongoing community consultation.

The SMP must be of a level of detail appropriate to the sensitivity of surface features, and the magnitude, extent and nature of the anticipated

subsidence impacts arising from the proposed mining.

The essential purpose of the SMP is to provide for the protection of important natural and built features.

Protection may involve the avoidance of damage to particularly significant features, the mitigation of damage, or its rehabilitation. These protection measures are specifically designed for each longwall and its unique environment and are a key component of an SMP.

The NSW Scientific Committee recently listed 'alteration of habitat following subsidence due to longwall mining' as a key threatening process under the *Threatened Species Conservation Act 1995*. The Minister for the Environment has determined that the current SMP process addresses this key threatening process and that the development of a Threat Abatement Plan would be unnecessary.

The SMP approval process

Approvals will be granted only after consideration of all potential impacts on landholders and the environment. Should the potential impacts be deemed significant and unacceptable, particularly with regard to adjacent rivers and water supplies, then the proposal will be either modified or refused.

An SMP is first assessed by an internal DPI review committee which reviews the technical merits and adequacy of the SMP regarding the potential impacts of subsidence. This committee may request amendments, or refer the SMP to an interagency committee comprising senior representatives from DPI, the Department of Environment and Conservation (DEC), the Department of Planning (DoP), and the Mine Subsidence Board. Representatives from other agencies (such as the Sydney Catchment Authority, Dam Safety Committee, Roads and Traffic Authority and Heritage Office) are also involved where appropriate.

The interagency committee considers:

- the potential impacts of the proposed activities on the environment
- the results of on-site monitoring
- whether there is a need to consult outside expertise in considering and conditioning subsidence-related environmental impacts
- whether the mining company should obtain an independent environmental audit or assessment.

The committee develops conditions of approval and makes recommendations to the approval authority (the Director-General of DPI). These approvals are restricted to a maximum period of 7 years and are subject to annual review.

Community involvement after an SMP is approved

The mining company may include proposals for ongoing community consultation within their SMP. This would usually be required in sensitive areas, or in areas where significant numbers of residents are directly affected by proposed mining operations. If no ongoing consultation has been proposed by the mining company, DPI may require this as a condition of the SMP approval.

The NSW Mine Subsidence Board

The [Mine Subsidence Board](#) is a service organisation operating for the community in coal mining areas of NSW, and is responsible for administering the *Mine Subsidence Compensation Act 1961*. This Act provides for compensation or repair services where buildings or other improvements are damaged by mine subsidence resulting from the extraction of coal. The Act also makes the Board responsible for reducing the risk of mine subsidence damage to properties by assessing and controlling the types of buildings and improvements which can be erected in Mine Subsidence Districts.

Further information

More information on the NSW subsidence management approvals process can be found at <http://www.minerals.nsw.gov.au/environment/Subsidence>

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www.dpi.nsw.gov.au/primefacts

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