Subsidence Advisory

Development Application – Merit Assessment Policy

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Acknowledgement of Country

The NSW Department of Customer Service acknowledges the Traditional Custodians of the lands where we work and live. We celebrate the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of NSW.

We pay our respects to Elders past, present and emerging and acknowledge the Aboriginal and Torres Strait Islander people that contributed to the development of this Policy.

We advise this resource may contain images, or names of deceased persons in photographs or historical content.

Development Application – Merit Assessment Policy

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1 Introduction

1.1 About Subsidence Advisory NSW

Subsidence Advisory NSW administers the *Coal Mine Subsidence Compensation Act 2017* (the Act) to provide a fair, efficient, and sustainable compensation framework.

Under the Act, Subsidence Advisory provides the following functions to communities of NSW:

- manages compensation claims for mine subsidence damage to homes and other structures
- manages and assesses subsidence risks by regulating development in Mine Subsidence Districts to protect homes and other structures from mine subsidence damage.

Development in Mine Subsidence Districts is assessed in accordance with Subsidence Advisory's development policy framework.

Active Coal Mining Areas

Predicted subsidence occurs in active coal mining areas. The Department of Planning and Environment (DPE) & Department of Regional NSW (DRNSW) assess mining proposals in NSW.

Historical Coal Mine Workings

Subsidence may also occur in areas where historical coal mine workings are present and may become unstable over time.

1.2 Development applications assessed under this policy

Any erection or alteration of an improvement or subdivision on land within a Mine Subsidence District (District) requires Subsidence Advisory 's approval.

Districts are a land zoning tool administered by Subsidence Advisory under the Act to help protect homes and other structures from potential mine subsidence damage.

Subsidence Advisory regulates building and subdivision works within Districts to ensure new homes and structures are built to an appropriate standard that reduces the risk of damage should subsidence occur.

Each property in a District is assigned a Surface Development Guideline (Guideline) that specifies the requirements for standard residential construction on a property based on applicable mine subsidence risks. The Guidelines can be accessed at: nsw.gov.au/subsidence-advisory/publications

To find out if a property is in a District and the Guideline that applies, please visit the NSW Planning Portal eSpatial Viewer. Further information is available at: nsw.gov.au/subsidence-advisory/districts#toc-nsw-planning-portal-eplanning-spatial-viewer

Subsidence Advisory has issued an order under s24 of the Act, allowing certain low-risk applications that comply with the applicable Guideline to be assessed by a certifier or council. Refer to **Table 1** for a brief description of each Guideline and details of applications that can be assessed by certifiers or councils.

Applications for proposed development that do not comply with the applicable Surface Development Guideline are assessed by Subsidence Advisory in accordance with this policy.

Table 1: Summary of Subsidence Advisory's Surface Development Guidelines

Surface Development Guidelines		Brief description	Assessor
Guideline 1	Historical mine workings - risk of pothole subsidence	Residential development up to two storeys limited to a maximum length of 24 metres and maximum footprint size of 400m^2. Slab on ground in habitable areas not permitted. Specific foundation design and type of construction dependent upon number of storeys and site classification.	Subsidence Advisory
Guideline 1A	Historical mine working – risk of goaf consolidation	Residential development up to two storeys limited to a maximum length of 24 metres and maximum footprint size of 400m^2. Waffle slab on ground permitted. See Guideline for slab design requirements.	Subsidence Advisory
Guideline 2	Historical mine workings – possible subsidence risk	Residential development up to two storeys limited to a maximum length of 24m and maximum footprint of 400m^2. Standard slab on ground permitted. Up to two dwellings that conform with the above on a single lot.	Certifiers* Councils* Subsidence Advisory
Guideline 3	Historical mine workings – remote subsidence risk	Up to four storey residential structures in accordance with all standards and codes. Ground floor commercial allowed.	Certifiers* Councils* Subsidence Advisory
Guideline 3A	Historical mine workings – low subsidence risk	Up to two storey brick veneer developments or up to three storey lightweight clad frame developments erected on reinforced concrete footings/slab to comply with AS2870. These improvements are limited to a maximum length of 36 metres and maximum footprint size of 600m^2.	Certifiers* Councils* Subsidence Advisory
Guideline 4	Current mining areas – high predicted subsidence impact	Single storey clad frame on strip footings or waffle slab to minimum H2 AS2870 site classification. Maximum length 18m and maximum footprint of 250m^2.	Subsidence Advisory
Guideline 5	Current mining areas – moderate predicted subsidence impact	Single or two-storey clad frame or brick veneer on footings/slabs to minimum H2 AS2870 site classification. Maximum length of 24m and maximum footprint of 400m^2.	Subsidence Advisory
Guideline 6	Current mining areas – minimal predicted subsidence impact	Single or two-storey clad frame or brick veneer on AS2870 slabs/footings Maximum length of 30m and maximum footprint of 500m^2.	Certifiers* Councils* Subsidence Advisory
Guideline 7	On application	The complexity of the geotechnical environment or lack of information regarding subsidence risk requires that all surface development be assessed by Subsidence Advisory.	Subsidence Advisory

Surface Development Guidelines	Brief description	Assessor
Guideline 8 No restrictions	Based on available records Subsidence Advisory has assessed the subsidence hazard to be negligible.	*Certifiers *Councils Subsidence Advisory

** Pursuant to section 24 of the Act, Subsidence Advisory NSW has exempted works that comply with Guidelines 2, 3, 3A, 6 and 8 from the operation of section 21 of the Act provided that certification is provided by a council or registered certifier (as defined in the Environmental Planning and Assessment Act 1979) as compliant with the relevant guideline.*

2 Policy Statement

This policy provides a framework for the assessment and determination of development applications within Districts that do not comply with the Subsidence Advisory Guideline assigned to the property.

2.1 Objectives

The objective of this policy is to:

- communicate to applicants the requirements for approval given the size and location of a development proposal
- provide a clear framework for assessing applications for proposed development that do not comply with a property's Guideline
- ensure conditions of approval for proposed development are commensurate with subsidence risks
- provide clear timeframes for assessment of proposed developments that do not comply with a property's Guideline.

2.2 Scope

This policy applies to:

- all officers, consultants, contractors, and outsourced service providers performing work for Subsidence Advisory
- activities that involve assessment of applications for proposed surface development that do not comply with Subsidence Advisory's Guidelines.

2.3 Ethical Conduct

All activities must be conducted in an ethical and transparent manner and comply with the values, principles, and articles in the Department of Customer Service Code of Ethics & Conduct.

Staff will ensure they are not, or are not perceived to be, in a conflict of interest with any stakeholders. Those staff who have, or may be perceived to have, a perceived conflict of interest in the outcome of a development application or related decision should disclose any perceived conflict to their manager and discuss whether they should exclude themselves from any role in the consideration of the application.

3 Lodging an Application

This policy applies to the assessment and determination of development applications:

- Made directly to Subsidence Advisory under section 22 of the Act; or,
- referred to Subsidence Advisory as integrated development under Division 4.8 of the *Environmental Planning and Assessment Act 1979*.

Applications for development within a District may be submitted directly through the online portal at nsw.gov.au/subsidence-advisory/portal or by integrated referral from a local council using the NSW Planning Portal.

3.1 Application requirements

Applications must include the following requirements:

- approximate cost of proposed development
- property details (i.e., Lot / DP / section number / street address)
- type of application (new structure / modification to existing structure)
- brief description of proposed development, including
    - number of structures
    - number of storeys
- detailed plans of the proposed structure, including the site, elevation and floor plan clearly showing all relevant building dimensions.

3.2 Advisory Services

Subsidence Advisory offers expert advice on mine subsidence considerations and matters relating to proposed development or subdivision of land, regardless of whether land is located within a District.

Any interested party, including councils, can approach Subsidence Advisory for advice on mine subsidence matters, including requests for comment on development proposals that are not integrated development. Formal enquires should be lodged via Subsidence Advisory's online portal at nsw.gov.au/subsidence-advisory/portal.

3.3 Definitions

Base Lot	A parcel of land that is proposed to be divided into a subdivision.
Subdivided Lot	A lot, parcel, or other division of land, that is a division of a base parcel.
Subdivision	The division of land into parts for separate occupation and/or disposition. The land may be subdivided either vertically or by stratum.
Improvement	As defined by the Coal Mine Subsidence Compensation Act 2017, refers to: (a) any building or work erected or constructed on land, (b) infrastructure, whether above or below the surface of the land.

Subdivision Infrastructure	Refers to any proposed improvements (as above) related to the subdivision.
Structure	Refer to definition of 'Improvement'.
Exploration Licence	includes Authorisations, Exploration Licences, Exploration (Prospecting) Licences and Assessment Leases.
Mining Lease	includes Consolidated Coal Leases, Coal Leases, Consolidated Mining Leases, Mining (Mineral Owner) Leases and Mining Leases.
Extraction Approval	includes areas that are subject to an extraction plan approved by the Department of Planning and Environment.
Licence or leaseholder	the authorised holder of an exploration licence, mining lease or extraction approval.
Active mining area	where an exploration licence, mining lease or extraction approval has been granted, or future mining is intended.
Historical mining area	where underground coal mining has occurred, abandoned workings exist and future mining is not intended.

4 Assessment process

4.1 Assessment overview

The assessment process aims to consistently apply appropriate controls to eliminate or reduce applicable mine subsidence risks associated with the scale and location of proposed development.

As part of the assessment process for development applications that do not comply with a property's Surface Development Guideline, Subsidence Advisory will consider the:

- likelihood that mine subsidence events will occur
- consequence of mine subsidence events on surface infrastructure and public safety
- reliability of information used to determine the above, including mine plans, assumed pillar and extraction dimensions, and assumptions regarding geotechnical modelling
- risks arising from the proposed engineering controls.

The assessment process will vary depending on the type, size, potential repair cost of the proposed development, and whether it is in an area affected by historical, current, or future mining.

Subsidence Advisory aims to determine applications under the policy within **40 calendar days** of receipt of the application, excluding time pending additional information or response from the applicant as may be requested by Subsidence Advisory.

Applications may be approved with conditions to better protect the proposed structure from potential subsidence damage. Conditions of approval are based on design requirements.

Please refer to attachments A & B for detail on likely design requirements and conditions of approval.

- For classification of the proposed building type see **Attachment A: Subsidence Advisory NSW Classification of building type for merit-based assessments**
- For subdivisions located in current mining areas, where underground coal mining is occurring or may occur in future see **Attachment B: Assessment procedure for areas that are located within an active mining area**
- For development located outside of current mining areas that are in proximity to historical coal mine workings see **Attachment C: Assessment procedure for historical coal mining areas.**

4.2 Preliminary assessment

Following receipt of a development application, Subsidence Advisory will complete a preliminary assessment to determine whether:

- the application is a complying development under the applicable Guideline or requires assessment under this policy
- the application is within a current or historical mining area
- additional information is required from the applicant, a licence/leaseholder or the Resources Regulator within the Department of Regional NSW (DRNSW).

Note: Subsidence Advisory will notify an applicant within **14 calendar days** of receipt of the application if additional information is required.

4.3 Active (current or future) Coal Mining Areas

This section applies to areas located within an active mining area or an area where DRNSW has indicated future mining may occur. Properties in these areas are assigned a Guideline 4, 5 or 6.

4.3.1 Assessment procedure

In assessing risks associated with mine subsidence for development applications within an active mining area, Subsidence Advisory will consider advice from the leaseholder on the following criteria:

- the current exploration license, mining lease or extraction approval under the site
- any plans to extract coal under the site, including the likely timeframe and predicted subsidence impacts
- the potential consequences of predicted subsidence on proposed development and the appropriate engineering controls required to mitigate against subsidence damage.

Subsidence Advisory may consult with the DRNSW to confirm timeframes and impacts advised by the licence/leaseholder.

A detailed description of the assessment process and likely approval conditions is outlined in **Attachment B.**

4.3.2 Consultation with external parties

Subsidence Advisory will request consultation with the leaseholder and/or DRNSW within **7 calendar days** of receipt of the application.

Leaseholders can provide advice on the likely timeframe and predicted ground surface subsidence impacts of their operations relevant to the site. Any additional advice received through consultation that is not required to facilitate the application assessment will not be considered.

Subsidence Advisory will consider the predicted subsidence impacts and timeframes received in accordance with tables B1 & B2 of **Attachment B**.

Where a response is not received within **7 calendar days** of the request, Subsidence Advisory will determine the application without leaseholder input, based on the information currently available.

In areas where there are previous mine workings in a current licence or lease, Subsidence Advisory will also assess the mine subsidence risk in accordance with section 4.4 of this policy.

4.4 Historical (non-active) Coal Mining Areas

Some Districts have been declared in areas where historical mine workings are present. Historical mine workings can become unstable over time for a number of reasons. When historical mine workings fail, they may cause mine subsidence. This may result in a depression over a broad area or a localised depression or sinkhole.

Applicants planning to develop land in areas where there are historical mine workings are encouraged to contact Subsidence Advisory in the preliminary stages of the project to establish what requirements may be present.

4.4.1 Assessment procedure

The conditions that Subsidence Advisory applies to developments located in historical mine areas are dependent on the scale of the development and the associated mine subsidence risks.

As required, Subsidence Advisory may request additional information as outlined below in section 4.4.2.

A detailed description of the assessment process is outlined in **Attachment C.**

4.4.2 Requests for further information to facilitate assessment

Subsidence Advisory may require additional information to facilitate assessment of an application, including geotechnical studies or investigations into potential subsidence risk.

Subsidence Advisory will notify applicants when further information is required to progress the assessment of a development application within **14 calendar days** of receipt. In instances where geotechnical investigations are required, Subsidence Advisory will outline the necessary scope or objectives of the investigations.

If further information has been requested from the applicant, the development application will be placed on hold until the information has been received. If the applicant has not provided the requested information within three months of the request, Subsidence Advisory may close the application and notify the applicant by email. Applicants may resubmit their application at any time.

a) Geotechnical investigations

Subsidence Advisory may require an applicant to engage a geotechnical practitioner to investigate and report on the following site details and/or conditions:

- desktop studies of mining history, geological/geotechnical conditions, subsidence history
- ground surface observation and geotechnical mapping
- subsurface investigation
- stability and subsidence analysis
- risk assessment and development of risk mitigation measures.

The extent of investigation requirements will depend on anticipated subsidence hazards as well as the size and scale of the proposed development.

In areas with minimal well-defined subsidence hazards, Subsidence Advisory may deem a desktop study to be sufficient.

Development applications in areas with a high-risk or history of subsidence and complex ground conditions are more likely to require a subsurface investigation, analysis, assessment, and reporting.

The selection of investigation techniques and the evaluation of pillar stability and subsidence impacts should be well considered. The applicant may contact Subsidence Advisory technical staff

for advice on the adequacy of any investigation that has been proposed by their geotechnical practitioner.

Subsidence Advisory's standards and requirements for geotechnical analysis and reporting for mine subsidence are outlined in **Attachment D: Subsidence Advisory's Minimum Requirements for Geotechnical Reports.**

b) Subsidence Advisory – Suitably Qualified and Experienced Geotechnical Practitioners

Applicants must only engage suitably qualified and experienced geotechnical practitioners to provide services required under this Policy.

In order to be considered suitably qualified and experienced, geotechnical practitioners must:

1. Either:
    - Have completed an accredited 4 year full-time or equivalent part-time undergraduate bachelor degree in:
        - Engineering with a major in geotechnical engineering or civil engineering or
        - Civil engineering, or
        - Geotechnical engineering

or

    - Be eligible for registration as a 'design practitioner – geotechnical engineering' or a 'professional engineer – geotechnical' as defined in *the Design and Building Practitioners Regulation 2021*, and
2. Be indemnified under a professional indemnity insurance policy against any liability to which the geotechnical practitioner may become subject as a result of carrying out the relevant work, in compliance with the *Design and Building Practitioners Regulation 2021*, and
3. Have a minimum of three years' experience in preparing geotechnical reports and assessments relating to abandoned coal mines.

These requirements will be reviewed by Subsidence Advisory from time to time and evidence of compliance with them may be requested.

Subsidence Advisory maintains a list of suitably qualified and experienced geotechnical practitioners who meet the requirements listed above. The *Subsidence Advisory – Suitably Qualified and Experienced Geotechnical Practitioners List* (the Geotechnical Practitioners List) can be provided to applicants.

If an assessment or documentation is submitted by a geotechnical practitioner who is not listed on the Geotechnical Practitioners List, in addition to requiring evidence of compliance with the requirements listed above, Subsidence Advisory may also require that a peer review of the assessment or documentation be carried out by a suitably qualified and experienced geotechnical practitioner from the Geotechnical Practitioners List.

Geotechnical practitioners seeking to be included on the Geotechnical Practitioners List should submit a CV detailing their qualifications and experience and provide evidence that they meet the above requirements.

4.5 Designing for mine subsidence

Subsidence Advisory may require certification from a structural engineer to confirm that the development has been appropriately designed to accommodate mine subsidence. See **Attachment F: Mine Subsidence Design Structural Engineer Certification Form.**

Refer to Sections 4.5.1 and 4.5.2 for instances where structural engineering certification is required in current and historical mining areas.

Subsidence Advisory may require a Mine Subsidence Engineering Impact Statement in lieu of the Structural Engineer Certification Form. This will require the engineer to consider whether various subsidence mitigation measures should be incorporated into the design.

A guide for designing for mine subsidence for residential structures is outlined in **Attachment G: Guide for Designing for Mine Subsidence.**

4.5.1 Design requirements in Current or Future Mining Areas

A Structural Engineer Certification Form (**Attachment F**) is required if:

- The application is located within an exploration licence or mining lease, in an area where coal extraction has not yet occurred, and
- The estimated subsidence impact is greater than 2mm/m strain or 10km Radius of curvature or 4mm/m tilt.

A **Peer Review** of the form is required if:

- The construction cost of the proposed development exceeds $5M, or
- The development is in an area where secondary extraction approval has been granted to the leaseholder.

4.5.2 Design requirements in Historical Mining Areas

A Structural Engineer Certification Form (**Attachment F**) is required if:

- The estimated subsidence impact is greater than 2mm/m strain or 5km Radius of curvature or 2mm/m tilt.

A **peer review** of the form is required if:

- The construction cost of the proposed development exceeds $5M

4.6 Peer review requirements

The peer review should undertake review of the Engineering Impact Statement or Structural Engineering Certification Form (**Attachment F**) the applicant has provided to meet Subsidence Advisory's conditions of approval.

The review should include a written, itemised evaluation of the accompanying Engineering Impact Statement or Structural Engineering Form, and whether it meets the performance criteria set out in Subsidence Advisory's conditions of approval.

If it has been assessed that the design does not meet the performance criteria, the author should present suggested design alterations that would allow the design to meet Subsidence Advisory's requirements.

4.7 Design performance requirements

The following defines the design performance requirements outlined in this document.

4.7.1 Definition for Serviceable or Serviceability

The improvements shall be designed to accommodate all Subsidence Advisory prescribed mine subsidence ground movements such that it will have at least a 95% probability of damage being limited to damage category 1 and less than or equal to a 5% probability of damage being limited to damage category 2 and a 0% chance of damage exceeding category 2 as outlined in Tables C1 and C2 of AS2870-2011.

In addition to the above, the improvement shall remain continuously serviceable, fit for its approved use if subject to Subsidence Advisory prescribed mine subsidence ground movements, and that any damage that may occur due to mine subsidence can be repaired with only minor disruption to the use and enjoyment of the improvement.

Example 1

Design for multistorey building containing a lift. Structure must be designed such that there is capacity to accommodate the prescribed mine subsidence ground movements and allow for the lift mechanism to be adjusted if required, with minor disruption to its operation.

Example 2

Design for industrial building with automated loading facilities. Structure must be designed such that the prescribed mine subsidence ground movements do not result in impacts to floor deflections that adversely impact the continued use of any automated loading mechanisms.

Example 3

Design for a two-storey residence. Residence must be designed such that any damage due to mine subsidence can be repaired with minor disruption to the use and enjoyment of the structure. Deformations or movements resulting from mine subsidence movement are to be controlled so that any damage is generally within the performance criteria set out in Section 1.3 and Appendix B and C of AS2870-2011.

The improvement shall be designed for full utilisation and continuous operation whilst any damage due to mine subsidence is repaired and generally complies with Appendix C of AS1170 where the effects of mine subsidence are treated as an applied action.

4.7.2 Definition for Safe or Safety

The improvements shall be designed to accommodate the estimated mine subsidence ground movements such that they will remain structurally sound, fully accessible, and safe following a mine subsidence event.

Note: Subsidence Advisory's safety requirements and definitions in no way abrogates developers' and/or leaseholders' duties, obligations and/or liabilities under other legislation or at common law, foremost the duty of care to not expose other persons to health and safety risks under Section 19(2) *Work Health and Safety Act 2011*.

5 Determinations and approvals

Subsidence Advisory has authority to refuse, approve with conditions or unconditionally approve any application for the subdivision of land within a District.

5.1 Section 22 Approval

For applications lodged directly to Subsidence Advisory by the applicant, approval is granted by Subsidence Advisory under Section 22 (3) of the Act. Copies of this approval can be used to accompany a Development Application with the relevant local council.

5.2 Division 4.8 of the *Environmental Planning and Assessment Act 1979*

Applications lodged through the NSW Planning Portal under Division 4.8 of the *Environmental Planning and Assessment Act 1979* will be processed within **21 calendar days** of referral to Subsidence Advisory, excluding where further information is required to assess the application.

If Subsidence Advisory requires further information to assess a Development Application, the additional information will be requested from council within **14 days of receiving the application**.

Subsidence Advisory will specify whether an approval or a conditional approval has been granted under section 22 of the Act.

In instances where Subsidence Advisory grants conditional approval, the applicant is required to meet all applicable conditions imposed by Subsidence Advisory in order for any improvements to be eligible for compensation under the Act in the event of subsequent damage arising from mine subsidence.

If Subsidence Advisory refuses to grant general terms of approval, the referring council is required to refuse the subdivision application.

5.3 Meeting Conditions of Approval

Applications that are assessed under this policy may require specific mine subsidence engineering measures to be incorporated into the design.

In certain circumstances, dependent upon the type of development and the nature and degree of mine subsidence risk, the removal of that risk by way of grouting the remnant mine voids may also be required.

Evidence that approval conditions have been met must be submitted to Subsidence Advisory for acceptance as per the details set out in Subsidence Advisory's determination letter.

5.4 Refusals

Subsidence Advisory may refuse a development application where the risks arising from mine subsidence are considered unacceptably high. Examples of Development Applications that Subsidence Advisory may refuse include:

- Development Applications where Subsidence Advisory has determined the potential subsidence impact cannot be effectively mitigated through engineering design

- Areas where the subsidence hazard has been assessed by Subsidence Advisory to present a credible and unacceptable public safety risk and an effective mitigation strategy is not feasible
- Development Applications that allow for the creation and divestment of additional property titles that Subsidence Advisory considers to have an unacceptable mine subsidence risk.

In such cases, Subsidence Advisory officers are available to meet with the applicant to discuss options permissible under the Act and this policy.

6 Reviews and Dispute resolution

Applicants who are not satisfied with the outcome of a Development Application determined under this policy have the option to request a review of the determination.

6.1 Internal review process

Requests for reviews of a determination of a Development Application are to be submitted in writing to subsidenceadvisory@customerservice.nsw.gov.au.

Submissions must outline why a review of the determination should occur, e.g. how the determination is not consistent with this policy and/or why an alternative determination would be appropriate.

Subsidence Advisory's Manager, Subsidence Risk Evaluation & Regulation will consider all submissions and may elect to complete a review to further investigate the concerns raised by the applicant.

Reviews will be completed by a Subsidence Advisory officer who was not involved in the initial determination. As part of this process, the officer will complete an independent review, consider all available information and the submission provided by the applicant. Review findings are to be submitted to the Manager, Subsidence Risk Evaluation & Regulation and Chief Executive, Subsidence Advisory NSW for approval.

The review findings and recommendations are to be finalised and shared with the applicant within **40 calendar days.**

7 Key Performance Indicators

Subsidence Advisory operates under the following key performance indicators:

- If the application is made under section 22 of the Act or as an integrated referral via the NSW Planning Portal, Subsidence Advisory will advise the applicant/council if additional information is required to progress their application within **14 calendar days** of receipt.
- Applications for proposed development under section 22 of the Act that do not comply with the applicable Surface Development Guideline will be determined within **40 calendar days** of receipt unless additional information is requested by Subsidence Advisory to progress the application.
- Integrated development applications made under Division 4.8 of the *Environmental Planning and Assessment Act 1979* will be determined within the applicable statutory timeframes, unless additional information is required to process the application.

Note: assessment durations exclude periods where applications are placed on hold pending further information required for the assessment process.

8 Related Policies and Documents

Issuer	Document Name
NSW Government	*Coal Mine Subsidence Compensation Act 2017*
NSW Government	*Coal Mine Subsidence Compensation Regulation 2017*
NSW Government	*Environmental Planning and Assessment Act 1979*
NSW Government	*Environmental Planning and Assessment Regulation 2000*
NSW Government	*State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*
NSW Government	*State Records Act 1998* (regarding the creation, management and protection of records and public access to those records)
NSW Government	*Government Information (Public Access) Act 2009* (regarding public access arrangements to agency information)
NSW Government	*Privacy and Personal Information Protection Act 1998* (regarding the collection and protection of personal information)
NSW Government	*Independent Commission Against Corruption Act 1988* (regarding reporting of any matter suspected on reasonable grounds to involve corrupt conduct)
NSW Government	NSW Integrated Mining Policy - Indicative Secretary's Environmental Assessment Requirements for State Significant Development - Mining (Hotlink)
NSW Public Service Commission	The Code of Ethics and Conduct for NSW government sector employees
Department of Customer Service	Code of Ethics and Conduct

9 Document Control

9.1 Document Approval

Name and Position	Signature	Date
Joseph D'Ermilio Chief Executive Officer		30/3/23

9.2 Review Date

The attachments to this policy will be reviewed and updated as required. A formal review will be undertaken every five years. Feedback from applicants and other stakeholders will be considered during the review process.

Attachment A: Subsidence Advisory NSW Classification of Building Type for Merit Based Assessments

Subsidence Advisory NSW category	General Classification of Building type
B1	• Up to $1.5M construction cost; and • Up to and including 3 storeys (including basements and rooftop access other than those accessible for maintenance); and at least one of the following: • All structures classified as having an Importance Level 1 under AS1170 regardless of use (Tables 3.1 and 3.2); or • Residential Structures having an Importance Level 2 under AS1170 (Tables 3.1 and 3.2)
B2	• Under $7.5M construction cost; and • Up to and including 4 storeys (including basements and rooftop access other than those accessible for maintenance); and • Other than Residential Structures, structures classified as having an importance Level 2 under AS1170 (Tables 3.1 and 3.2)
B3	Structures not classified as B1, B2 or B4.
B4	• Classified as having an Importance Level 4 or 5 under AS1170 (Tables 3.1 and 3.2).

Attachment B: Assessment Procedure for Active Coal Mining Areas

1. Identification of Active Coal Mining Areas

Subsidence Advisory has applied a Surface Development Guideline 4, 5 or 6 to areas that may be at a risk of being impacted by future or current coal mining activity. Guideline 7 may also apply to properties within active mining areas.

To confirm whether a property is located in an active coal mining area, please lodge an enquiry with Subsidence Advisory through our online portal at nsw.gov.au/subsidence-advisory/portal.

2. Identification of site location relative to existing mining approvals

To determine whether the property is located in an area that is within an exploration licence, mining lease or extraction approval, refer to DPE and DRNSW websites here:

www.planningportal.nsw.gov.au/major-projects

minview.geoscience.nsw.gov.au

Alternatively, an enquiry can be lodged with Subsidence Advisory.

3. Request for information from external parties

Subsidence Advisory will consult with the leaseholder and/or DRNSW if the application is within a an exploration licence or mining lease, or in an area where DRNSW has indicated future mining may occur.

Subsidence Advisory may also consult with external parties such as the DPE or with local council and consider their responses as part of the application assessment.

In making the determination, Subsidence Advisory will consider the following information if available:

- Response provided by the leaseholder - detailing the likely timeframe for mining and the estimated impact
- Response provided by DRNSW
- Existing approvals granted by the DPE and DRNSW to the leaseholder, including subsidence impact assessments that were submitted in support of their approval.

Subsidence Advisory will consult with the leaseholder and/or DRNSW within **7 calendar days** of receiving the application. If no response is received by the leaseholder and/or DRNSW within **7 calendar days**, Subsidence Advisory will make a determination using the information available at the time.

4. Design requirements for new structures

Table B1 provides the design requirements for new construction that has been classified as building type **B1** (refer **Attachment A** for building classification).

Table B2 provides the design requirements for developments that have been classified as building type **B2 or B3**.

Design requirements for development that has been classified as **B4** will be considered on a case-by-case basis. The assessment will consider responses provided by the leaseholder, an engineering impact assessment provided by the applicant (if requested) and any other available information.

Considerations for **B4** structures will include:

- potential for future extraction.
- likelihood and timeframe of future application to extract coal.
- likelihood that the development could be designed for Serviceability (refer to Section 4.7) under the estimated worst-case impacts (if available).
- likelihood of the development being subject to non-conventional subsidence impacts.

An enquiry can be lodged with Subsidence Advisory prior to making an application to identify the potential mine subsidence risk for a site. It is recommended that as much detail as possible regarding the proposed size and scale of the development and the location relative to property boundaries is provided by the applicant.

5. Design requirements for additions and alterations to existing structures

Table B1 provides the conditions for additions and alterations to existing developments that have been classified as building type B1 (refer Attachment A for building classification).

Table B2 provides conditions for additions and alterations to existing developments that have been classified as building type B2 or B3.

Application for additions, renovations or alterations to an existing structure will be considered by Subsidence Advisory as a new build if:

- The number of additional storeys is greater than the existing number of storeys or if it exceeds 3 additional storeys
- The alterations and additions require structural alterations to the existing development and would be classified as either a B2, B3 or B4 following the proposed renovations
- The additional plan footprint area is greater than 50% of the existing plan footprint area.

6. Design requirements for internal retrofits to existing structures

Subsidence Advisory's Exempt Development List can be found here;

nsw.gov.au/subsidence-advisory/exempt-developments

Note: The Exempt Development List allows for internal retrofit works up to $7.5M provided no structural alterations are made. In instances where the cost of an internal retrofit is greater than $7.5M and/or structural alterations are included, Subsidence Advisory will consider the requirement for engineered subsidence mitigation measures if:

- A greater safety risk to occupants has been identified and/or
- The retrofit results in a change of use that causes a greater safety risk to be present.

Should the above factors be identified, Subsidence Advisory may impose conditions as part of the determination to ensure the structure remains safe in the event of subsidence.

Table B1: Design requirements for structures classified as B1 in Attachment A and are located within an active mining area

Site location	Design Requirements
• **Located outside of an exploration licence or mining lease** • **Active Surface Development Guideline applied to base lot**	**New Structure:** • Design for **Safety & Serviceability*** to accommodate the applicable subsidence design parameters derived using an industry standard method or the Surface Development Guideline assigned to the property. **Additions and alterations to existing structure** • Design the addition for **Safety*** to accommodate the applicable subsidence design parameters derived using an industry standard method or the Surface Development Guideline assigned to the property.
• **Within a exploration licence or mining lease and:** o **There is no existing project approval to mine; or** o **No current application to mine.** • **This may include areas that have been previously impacted by mining in one seam and subsidence from previous mining is effectively complete.**	**New structure:** • Design for **Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property; • Design for **Safety*** to accommodate the subsidence design parameters derived following consultation with the leaseholder • Submit a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) using the nominated subsidence design parameters. **Additions and alterations to existing structure:** • Design for **Safety*** to accommodate the subsidence design parameters derived following consultation with the leaseholder.

Site location	Design Requirements
• **Existing project approval to mine with planned mine subsidence impacts; or** • **Current SEARS application with supporting EIS showing planned subsidence impacts**	**New structure:** • Design for **Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property; • Design for **Safety*** to accommodate the estimated worst-case subsidence design parameters derived following consultation with the leaseholder • Submit a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) using the nominated subsidence design parameters. **Additions and alterations to existing Structure:** 1. **Additional Plan footprint** • Design the addition for **Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property; • Certify the final built structure for **Safety*** to accommodate the estimated worst-case subsidence design parameters derived following consultation with the leaseholder – Note: Subsidence Advisory will consult with the leaseholder. 2. **Additional Storey:** • Certify the final built structure for **Safety*** to accommodate the estimated worst-case subsidence design parameters derived following consultation with the leaseholder.
• **Within mining lease where secondary extraction approval granted.**	**New Structure or additions and alterations to an existing Structure:** Contingent on advice provided by leaseholder, refusal of application until mining and active subsidence is complete. Residual subsidence design parameters may be applied to an approval subject to deferred commencement.

***Refer to Section 4.8 for definition for Safety & Serviceability design requirements**

Table B2: Design requirements for structure classified as B2 or B3 in Attachment A and are located within an active mining area.

Site location	Design Requirements	
• **Located outside of a mining lease or exploration licence** • **Active Surface Development Guideline applied to base lot**	**DRNSW response indicates that mining is not possible** No design requirements for future active mining.	**DRNSW response indicates that mining is possible** **For property classified as B2 and B3** • Design for **Safety & Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property • Submit a **Mine Subsidence Design Structural Engineer Certification Form or Engineering Impact Statement** (Attachment F) using the nominated subsidence design parameters. **For property classified as B3** • Submit a peer review of the **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) **or Engineering Impact Statement** by a structural engineer experienced in mine subsidence design using the nominated subsidence design parameters.
• **Within mining lease, or exploration licence and** • **Outside of area where there is a current application or approval for planned mine subsidence** • **This may include areas that have been previously impacted by mining in one seam and subsidence**	**For property classified as B2** • Design for **Safety & Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property • Submit a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) **or Engineering Impact Statement** using the nominated subsidence design parameters.	**For property classified as B3** • Considered on a case-by-case basis • Determination based on Subsidence Advisory's assessment of the likelihood, timing, and impact of subsidence. The assessment will take into consideration responses provided by DRNSW, coal mine operator and any other available information. Considerations will include: • Potential for future extraction • Likelihood and timeframe of future application to extract coal

Site location	Design Requirements	
from previous mining is effectively complete		• The likelihood that the development could be designed for **Safety & Serviceability*** using the estimated worst-case subsidence design parameters (if available) • The likelihood of the development being subject to non-conventional subsidence impacts.
• Existing mining lease and project approval to mine with planned mine subsidence impacts; or • Current application for project approval with supporting EIS showing planned subsidence impacts	**For property classified as B2 and B3** Considered on a case-by-case basis. **Proposed development located in area with estimated minimal subsidence impact (i.e. outside estimated 20mm subsidence contour or angle of draw) based on Subsidence Advisory assessment of the proposed mine plan and projected impacts outlined in EIS.** The assessment will consider responses provided by the leaseholder, an engineering impact assessment provided by the applicant (if requested) and any other available information. Considerations will include: • Potential for future extraction • Likelihood and timeframe of future application to extract coal • The likelihood that the development could be designed for **Safety & Serviceability** * under the estimated worst-case impacts (if available) • The likelihood of the development being subject to non-conventional subsidence impacts. **Proposed development located in area impacted by mining based on proposed mine plan and projected impacts outlined in EIS.** Contingent on advice provided by leaseholder, refusal of application until mining and active subsidence is complete. Residual subsidence design parameters may be applied to an approval subject to deferred commencement.	
• Area where extraction plan approval granted.	**For property classified as B2 and B3**	

Site location	Design Requirements
	Contingent on advice provided by leaseholder, refusal of application until mining and active subsidence is complete. Residual subsidence design parameters may be applied to an approval subject to deferred commencement.

*Refer to Section 4.8 for Definition for Safety & Serviceability design requirements

Attachment C: Assessment Procedure for Historical Coal Mine Areas

1. Request for additional information

Prior to submitting a development application, an enquiry can be lodged with Subsidence Advisory to determine the requirements for a geotechnical assessment or geotechnical investigation. It is recommended that as much detail as possible regarding the proposed size and scale of the development and the location relative to property boundaries is provided by the applicant.

Subsidence Advisory may require additional information to assess a Development Application. If required, Subsidence Advisory will make a written request within **14 calendar days** of receipt of the application.

2. Trough subsidence risk

Trough subsidence in historical mine workings typically occurs due to failure of a mines pillar system. Pillar failures occur when remnant coal pillars become unstable over time for a variety of reasons such as weathering and changes in state of the mine workings.

Subsidence Advisory apply different conditions of approval depending on:

- The proposed building classification (For a classification of building type see Attachment **A**
- The Geotechnical Risk Factor (GRF) outlined below and in Table C1
- The pillar panel Factor of Safety (FoS) that has been assessed for the site.

3. Geotechnical Risk Factor (GRF)

The GRF is a qualitative risk assessment that is based on the level of uncertainty regarding four risk factors; the geological environment (R1), level of geotechnical investigation (R2), coal mine plans and records (R3) and the method used to assess stability and subsidence impact (R4).

The weighting applied to each of these four risk variables (R1 to R4) and uncertainty value (U) that applies to each is outlined in Table C1.

Once these have been determined, the overall GRF can be calculated by application of these values into the following formulae.

$$GRF = (R1 \times U) + (R2 \times U) + (R3 \times U) + (R4 \times U)$$

The risk classifications used for the assessment of geotechnical risk are:

- Low Geotechnical Risk ≤16
- Moderate Geotechnical Risk 17 to 22
- High Geotechnical Risk ≥23

Depending on the type and scale of development, it is more likely that a geotechnical investigation will be required where ‘high’ geotechnical uncertainty exists.

4. Factor of Safety (FoS)

When assessing the Pillar Panel FoS, Subsidence Advisory requires the following:

- The pillar dimensions should assume a full seam thickness unless it can be demonstrated that intact coal is present in the floor
- The average panel pillar FoS
- The pillar loading environment should be appropriately assessed.

5. Anomalous subsidence impacts

Subsidence Advisory may require an assessment of the likelihood and magnitude of anomalous subsidence impact associated with trough subsidence.

Anomalous subsidence can be expressed on the surface as tension cracks, compression humps, localised areas of excessive tilt or abrupt scarps. The likelihood and magnitude of anomalous impact is elevated with decreasing mining depth, shallow soil cover, near surface blocky strata (massive sandstone or conglomerate), steep topography or the presence of major geological structures such as faults or dykes. A sedimentary boundary between geological units with different material properties can also experience anomalous subsidence impact.

If a significant risk of anomalous subsidence potentially impacting the site has been identified, Subsidence Advisory may require design, mitigation or remediation to address these impacts in addition to those outlined for trough subsidence.

6. Design requirements – Trough Subsidence

For a summary of design or remediation requirements for new developments refer to **Table C2**.

If the proposed development is for an addition or alteration to an existing structure, design requirements are listed in **Table C3**. Please note that the building classification is based on final built structure following any proposed addition or alteration.

Application for additions or alterations to an existing structure will be considered as new structure if:

- The alterations and additions require structural alterations to the existing development, and would result in an increase in building category to B3 or B4 following the proposed renovations (See **Attachment A**); or
- The additional plan footprint area is greater than 50% of the existing plan footprint area; or
- The number of additional storeys is greater than the existing number of storeys (note that uninhabitable rooftop access is not considered as an additional storey).

7. Sinkhole risk

Sinkhole subsidence (also called pothole subsidence) typically occurs due to the roof of a coal mine progressively failing until it reaches the surface. These failures may occur over time for a variety of reasons such as ongoing weathering, water inflow, and changes in state of the mine workings.

Subsidence Advisory classify sinkhole risk into low, medium or high based on either:

- An assessment by Subsidence Advisory; or
- An accepted assessment of sinkhole risk by a geotechnical practitioner with experience in shallow mine subsidence.

Assessments of sinkhole risk typically consider the following characteristics:

- cover depth
- borehole information on state of the workings
- overburden characteristics

- seam dip
- the previous history of pothole formation on site or in surrounding areas and
- the age and type of mine workings that are present.

Subsidence Advisory is able to provide an assessment of a site's sinkhole risk and the likelihood of a sinkhole impacting the site. Requests can be made as a general enquiry prior to submitting an application. The level of sinkhole risk is based on the likelihood of sinkhole subsidence impacting the site over the lifetime of the structure and the consequences for the development if it occurs.

8. Design Requirements - Sinkhole risk

The attached tables (**Tables C4 and C5**) provide an outline of conditions that Subsidence Advisory may apply in these areas. The table provides guidance on Subsidence Advisory design requirements for new structures and alterations to existing structures.

In the event that foundations designed to cater for sinkhole subsidence are required, Subsidence Advisory will require a footing inspection prior to the placement of concrete. No concrete is to be placed to the footings before an officer of Subsidence Advisory has inspected the reinforcement steel when in position. Note: Subsidence Advisory requires a minimum of 48 hours' notice for a footing inspection.

9. Block failure risk

Block failures may occur in areas where the mine workings are relatively shallow (typically <50m), a competent material such as conglomerate or massive sandstone is present in the overburden and where secondary extraction has occurred.

In areas that have been identified as possessing a potential block failure risk, Subsidence Advisory may require:

- a geotechnical investigation be carried out to determine the state of the workings and/or
- a geotechnical assessment of the spanning characteristics and likelihood of failure and/or
- an assessment of the potential impact.

Where a credible block failure risk has been identified, this risk must be removed.

10. Design requirements for internal retrofits to existing structures

Subsidence Advisory's Exempt Development List allows for internal retrofit works up to $7.5M provided no structural alterations are made. Subsidence Advisory's Exempt Development List can be found here;

nsw.gov.au/subsidence-advisory/exempt-developments

In instances where the cost of an internal retrofit is greater than $7.5M or structural alterations are included, Subsidence Advisory will consider the requirement for engineered subsidence mitigation measures if:

- A greater safety risk to occupants has been identified by Subsidence Advisory and/or
- The retrofit results in a change of use that causes a greater safety risk to be present.

Should the above factors be identified, conditions may be imposed to ensure the structure remains safe in the event of subsidence.

11. Mine openings, shafts and drifts

Shafts are vertical excavations that extend from the surface to the mine workings. Drifts are inclined tunnels that extend from the surface to the mine workings.

Subsidence Advisory will require that proposed development is located away from mine openings or that the risk to both public safety and surface infrastructure be removed by fully remediating the mine opening. Where a shaft or drift is present within close proximity to a proposed development, the mine opening is required to be fully remediated. This will include inspection by a Subsidence Advisory officer of the mine entry at time of remediation.

Table C1: Geotechnical Risk Factor

	Low Uncertainty U value = 1	Medium Uncertainty U value = 2	High Uncertainty U value = 3
Geological Environment (R1) Value = 3	**Mine plans, published geological maps, borehole information or other published sources indicate that;** • No significant geological structures are present within the mined panel that underlies the site.	**Mine plans, published geological maps, borehole information or other published sources indicate that;** • A dyke (of any width) is present within the mined panel; **or** • Faulting (single fault > 0.3m throw or more than one fault) is present within the mined panel; **or** • The mine plan indicates that a geological feature consistent with a dyke or fault may be present within the mined panel (i.e. modified layout, truncated roadways etc.).	**Mine plans, published geological maps, borehole information or other published sources indicate that;** • A dyke (of any width) is present within the mined panel and within 50m of the site; **or** • Faulting (single fault > 0.3m throw or more than one fault) is present within the mined panel and within 50m of site; **or** • The mine plan indicates that a geological feature consistent with a dyke or fault may be present within 50m of the site (i.e. modified layout, truncated roadways etc.); **or** • Soft roof / floor conditions are present.
Level of Geotechnical Investigation (R2) Value = 2	**Geotechnical investigation sufficient to confirm;** • Depth of all mine workings present below the site, **and** • Confirmation of location of record tracing including void heights and widths, minimum pillar dimensions and any other pertinent information below site; **and**	**Geotechnical investigation sufficient to confirm;** • Depth of all mine workings present below the site; **and** • General information regarding void heights and widths, minimum pillar dimensions and other pertinent information; **and**	**No site-specific borehole data, or boreholes located outside of the mined panel**

	• Material properties of overburden, roof and floor; **and** • State of workings (failed or standing)	• state of workings (failed or standing).	

	Low Uncertainty	Medium Uncertainty	High Uncertainty (U)
	U value = 1	U value = 2	U value = 5
Coal Mine Plans and Records (R3) Value = 3	**Regular workings** • Pillar width and length show little variation. Headings and cut throughs are aligned. Pillars are parallel along their long axis and no secondary extraction is present within same mined panel; **or** • Previously fully extracted longwall panel; **or** • Panel pillar dimensions indicate that the average pillar w/h ratio > 5.	**Semi regular workings** • Pillar widths and lengths show some variation but show an approximate alignment along their long axis. Cut throughs and headings are not always aligned or cut in a straight line between pillar groups throughout panel. Pillars show similar shape in plan; **or** • Secondary extraction of pillars within same mined panel (excluding full extraction); **or** • Panel pillar dimensions indicate that the average pillar w/h ratio is > 2 but < 5.	**Irregular workings** • Pillar widths, roadway widths and long axis of pillars show significant variation. Significant differences in pillar shape and size; **or** • Secondary extraction of pillars is shown within the mined panel and within 50m of site (excludes areas where pillars have w/h ratios of > 5 and FoS > 2.1 under abutment loading conditions, excluding areas of full extraction); **or** • Panel pillar dimensions indicate that the average pillar w/h ratio is < 2.

	Low Uncertainty	Medium Uncertainty	High Uncertainty (U)
	U value = 1	U value = 2	U value = 3
Method used to assess stability and impact (R4) Value = 3	• Assumptions in geotechnical model based on results of geotechnical investigation (i.e. state of workings, overburden lithology, cover depth, pillar dimensions, propensity for roof / floor failure); **and** • Method used to assess stability of pillars and subsidence impact has been validated by use of another method – i.e. numerical modelling has been validated by an empirical method; **and** • Pillar Stability calculations are based on the average pillar FoS for panel; **and** • Other potential pillar loading scenarios fully considered and accounted for in model; **and** • All variables and assumptions used in estimating both pillar stability and subsidence impact clearly outlined with justification; **and** • A sensitivity analysis has been carried out on all critical assumptions used in model.	• Assumptions in geotechnical model partially validated by geotechnical data (i.e. state of workings, overburden lithology/properties, cover depth); **and** • Pillar loading has been estimated using analytical / mechanistic methods**; and** • Pillar Stability based on the average pillar FoS for panel	• Geotechnical model not supported by any relevant geotechnical data; **or** • The pillar loading environment is complicated by geological or geotechnical factors that have either not been or are not able to be accounted for. These may include; - geological structures or intrusions - areas of secondary pillar extraction - stiff units present in the overburden - interactions between multi seam workings**.**

Table C2: Design requirements for new structures - trough subsidence risk

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
B1	FoS >1.63 (1:1000)	FoS >1.8 (1:10,000)	N/A	No design requirements.	• Design for **Safety*** to accommodate the subsidence design parameters provided by Subsidence Advisory; • If the proposed structure is not able to be designed for **Safety*** to accommodate the subsidence design parameters, mitigation or elimination of the risk of mine subsidence will be required. • Following design, a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) **or Engineering Impact Statement** will be required. • Following construction, confirmation that the construction is in accordance with the plans approved by Subsidence Advisory is required.

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
B2	FoS >1.8 (1:10,000)	FoS >1.95 (1:100,000)	N/A	No design requirements.	• Design for **Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property and design for **Safety*** under the subsidence design parameters provided by Subsidence Advisory NSW. • If the proposed structure is not able to be designed to be **Safe*** or **Serviceable***, mitigation or elimination of the risk of mine subsidence will be required. • Following design, a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) **or Engineering Impact Statement** will be required. A peer review of these documents may also be required. • Following construction, confirmation that the construction is in accordance with the plans approved by Subsidence Advisory is required.
B3	FoS >1.95 (1:100,000)	FoS >2.1 (>1:1,000,000)	N/A	• A peer reviewed geotechnical report with confirmation and certification	• Design for **Serviceability*** to accommodate the subsidence design parameters provided by a

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
				that the mine workings meet the minimum criteria may be required. Subsidence impact parameters (assuming all pillars with W/h ratios of less than 5 and FoS of <2.1 fail) should be provided. • Design for **Safety*** to accommodate the subsidence design parameters provided by a geotechnical practitioner or those provided by Subsidence Advisory. • Following design, a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) or **Engineering Impact Statement** will be required. Following construction, confirmation that the construction is in accordance with the plans approved by Subsidence Advisory is required.	geotechnical practitioner or by Subsidence Advisory. • If the proposed structure is not able to be designed to be **Serviceable***, mitigation or elimination of the risk of mine subsidence by grouting of the mine will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**, followed by a peer review as outlined in **Attachments D.** • Following design, a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) or **Engineering Impact Statement** is required, demonstrating the structure will remain **Serviceable*** under either the subsidence design parameters or the residual subsidence parameters given in the grout design. • Detailed design drawings prior to commencement construction are required to be submitted, with the subsidence design

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
					parameters designed for clearly marked on the plan. • Several permanent survey marks will be required so that building movement can be monitored should mine subsidence occur. • Following construction, confirmation that the construction is in accordance with the plans approved by Subsidence Advisory is required.
B4	Considered on a case-by-case basis			Conditions of approval considered on a case-by-case basis and based on assessed level of mine subsidence risk.	

*Refer to Section 4.8 for Definition for Safety & Serviceability design requirements

Table C3: Design requirements for additions and alterations to existing structures - trough subsidence risk

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
B1	FoS >1.63 (1:1000)	FoS >1.8 (1:10,000)	N/A	No design requirements.	**Additional Storeys** Certify the final built structure for **Safety*** using the subsidence design parameters provided by Subsidence Advisory **Additional Plan footprint** Design for **Safety*** to accommodate the subsidence design parameters provided by Subsidence Advisory
B2	FoS >1.8 (1:10,000)	FoS >1.95 (1:100,000)	N/A	No design requirements.	**Additional Storeys** Certify the final built structure for **Safety*** using the subsidence design parameters provided by Subsidence Advisory **Additional Plan footprint** Design for **Serviceability*** to accommodate the subsidence design parameters that are consistent with the Surface Development Guideline assigned to the property Design for **Safety*** to accommodate the subsidence design parameters provided by Subsidence Advisory

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
B3	FoS >1.95 (1:100,000)	FoS >2.1 (>1:1,000,000)	N/A	No design requirements.	**Additional Storeys** Certify the final built structure for **Safety*** using the subsidence design parameters provided by a geotechnical practitioner or by Subsidence Advisory. If the proposed structure is not able to be designed to be **Safe***, mitigation or elimination of the risk of mine subsidence by grouting of the mine will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**, followed by a peer review as outlined in **Attachments D.** If remediation is required, certification that the final built structure will remain **Safe*** under the residual subsidence parameters given in the grout design will be required**.** **Additional Plan footprint** Design for **Serviceability*** to accommodate the subsidence design parameters provided by a geotechnical practitioner or by Subsidence Advisory. If the proposed structure is not able to be designed to be **Serviceable***, mitigation or elimination of the risk of mine subsidence by grouting of the mine will be required. This will include a Grout Design, Implementation, Verification

Building Type	Minimum FoS Allowable			Design Requirements if minimum FoS has been met	Design Requirements if minimum FoS has not been met
	Low Geotechnical Risk Factor (<16)	Moderate Geotechnical Risk Factor (<23)	High Geotechnical Risk Factor (>=23)		
					Plan completed in accordance with **Attachment E**, followed by a peer review as outlined in **Attachments D.** Following design, a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) or **Engineering Impact Statement** is required, demonstrating the structure will remain **Serviceable*** under either the subsidence design parameters or the residual subsidence parameters given in the grout design.
B4	Considered on a case-by-case basis			Conditions of approval considered on a case-by-case basis and based on the assessed level of mine subsidence risk.	

***Refer to Section 4.8 for Definition for Safety & Serviceability design requirements**

Table C4: Design requirements for B1 structures - sinkhole risk

Sinkhole Risk	Design Requirements – New Structures	Design Requirements – Alterations and Additions to Existing Structures
Low	Design for **Serviceability*** to accommodate the maximum sinkhole that is consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. Following design, a **Mine Subsidence Design Structural Engineer Certification Form** (Attachment F) **or Engineering Impact Statement** will be required.	**Additional Storey – final built structure 2 storeys** No Design requirements **Additional Storey – final built structure 3 storeys** Final built structure is to be designed for **Serviceability*** to accommodate the maximum sinkhole that is consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. If it cannot be demonstrated that the proposed structure can be designed to accommodate the estimated subsidence impacts, then elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E** **Additional Plan footprint** Design for **Serviceability*** to accommodate the maximum sinkhole consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory.

Sinkhole Risk	Design Requirements – New Structures	Design Requirements – Alterations and Additions to Existing Structures
Moderate	Design for **Serviceability*** to accommodate the maximum design sinkhole consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. If the proposed structure is not able to be designed to be **Serviceable***, elimination of the risk of mine subsidence by grouting of the mine will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**, followed by a peer review as outlined in **Attachment D**.	**Additional Storey – final built structure 2 storeys** Final built structure is to be designed for **Serviceability*** to accommodate the maximum sinkhole consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. If it cannot be demonstrated that the proposed structure can be designed to accommodate the estimated subsidence impacts, then elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E.** **Additional Storey – final built structure 3 storeys** Elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E** **Additional Plan footprint** Design for **Serviceability*** to accommodate the maximum sinkhole consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. If it cannot be demonstrated that the proposed structure can be designed to accommodate the estimated subsidence impacts, then elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E.**

Sinkhole Risk	Design Requirements – New Structures	Design Requirements – Alterations and Additions to Existing Structures
High	Design for **Serviceability*** to accommodate the maximum design sinkhole consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. If the proposed structure is not able to be designed to be **Serviceable***, elimination of the risk of mine subsidence by grouting of the mine will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**.	**Additional Storey – final built structure 2 storeys or Additional Plan footprint** Certify that final structure will remain **Serviceable*** under the maximum design sinkhole consistent with the Surface Development Guideline assigned to the property or provided by Subsidence Advisory. If the proposed structure is not able to be designed to be Serviceable*, elimination of the risk of mine subsidence by grouting of the mine will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E.** **Additional Storey – final built structure 3 storeys** Elimination of the risk of mine subsidence by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E.**

Table C5: Design requirements for B2, B3 and B4 structures - sinkhole risk

Building Type	Sinkhole Risk	Design Requirements – New Structures	Design Requirements – Alterations and Additions to Existing Structures
B2	Low Risk	**New Build** Elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**.	**Additions and Alterations to Existing Structures** **Additional Storey – final built structure 4 storeys** Certify that final structure will remain **Serviceable*** under the maximum design pothole provided by Subsidence Advisory. If it cannot be demonstrated that the proposed structure can be designed to accommodate the estimated subsidence impacts as outlined above, then removal of the risk of mine subsidence to the structure by a suitable means such as grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**. **Additional Plan footprint** Certify that final structure will remain **Serviceable*** under the maximum design pothole provided by Subsidence Advisory. If it cannot be demonstrated that the proposed structure can be designed to accommodate the estimated subsidence impacts as outlined above, then removal of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**, followed by a peer review as outlined in **Attachments D.**

Building Type	Sinkhole Risk	Design Requirements – New Structures	Design Requirements – Alterations and Additions to Existing Structures
	Moderate High Risk	**New Build** Elimination of the risk of mine subsidence to the lot by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**.	**Additions and Alterations to Existing Structures** **Additional Storey – final built structure 4 storeys, or Additional Plan footprint** Remove the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**, followed by a peer review as outlined in **Attachments D.**
B3	Low Risk	Elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**.	**Additional Storey or Additional Plan Footprint** Elimination of the risk of mine subsidence to the structure by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**.

Building Type	Sinkhole Risk	Design Requirements – New Structures	Design Requirements – Alterations and Additions to Existing Structures
	Moderate	Elimination of the risk of mine subsidence to the lot by grouting will be required. This will include a Grout Design, Implementation, Verification Plan completed in accordance with **Attachment E**.	
	High Risk		
B4	Low / Moderate / High Risk	**New Build** Elimination of sinkhole risk – areal extent of remediation and conditions of approval made on case-by-case basis.	**Additions and Alterations to Existing Structures** Elimination of sinkhole risk – areal extent of remediation and conditions of approval made on case-by-case basis.

*Refer to Section 4.8 for Definition for Safety & Serviceability design requirements

Attachment D: Subsidence Advisory's Minimum requirements for Geotechnical Reports

Geotechnical reports submitted to Subsidence Advisory as part of a development application should clearly address the following:

1. The likelihood of mine subsidence affecting the site

An assessment of this should be clearly stated in the report, including, where applicable, an assessment of:

- Pillar failure
- Surface pothole formation
- Non-systematic subsidence events e.g. block failure, tension cracks etc
- Migration of overlying soil into subsidence cracks or mine voids
- Susceptibility of drifts and shafts to fail
- Residual subsidence due to ongoing goaf consolidation and settlement of the overburden
- The potential for variability in any assumptions used in the assessment (as described above) including:
    - Parametric Analysis: Identify the primary variables and provide their adopted values and expected variability
    - Sensitivity Analysis: Assessment of how outcomes or risks are affected by variations in input values for a parameter
    - The sources of information on which the assessment is based and their reliability, including a discussion of geotechnical data and perceived gaps, if any, in information with reference to the geotechnical model as defined in AS1726-2017 Geotechnical site investigations
    - Comment on potential changes in state of the workings over time.

The geotechnical practitioner should provide recommendations on geotechnical investigation requirements to confirm that the assumptions made in the assessment are suitable and remove any perceived gaps in geotechnical data (i.e. where assessment identifies parametric sensitivity, variable or poor geological conditions, poor confidence in mine records, condition/layout/state of the workings is unknown).

2. The consequence of subsidence

Including, where applicable, predictions of:

- Surface deformations including
    - Vertical subsidence (mm)
    - Horizontal displacement both tensile and compressive (mm/m)
    - Tilt (mm/m)
    - Radius of curvature (km-1)

- Potential for non-conventional subsidence events and estimated type and impact
- Potential for block failure.

3. Recommendation on appropriate engineering controls (if applicable)

All engineering controls should be accompanied by clear justification as to how and why the adopted methods are appropriate. The likelihood and consequence of a subsidence event with the controls in place should be assessed.

4. Reporting

Each report should, if applicable, include the following in assessing subsidence risk:

- Seams worked (single or multi-seam, seam thickness and structure)
- The class of mine workings (i.e. historical, operational or future)
- The characteristics of mine workings (e.g. depth, extraction height, percentage of extraction, geotechnical conditions)
- Mine workings type, age and level of confidence in accuracy (bord and pillar, pillar extraction, longwall/miniwall, mining height, 1st workings, 2nd workings)
- Georeferencing of the mine workings to surface cadastre and level of confidence in accuracy
- Regional geology (stratigraphy/dip/faults/dykes)
- Overburden properties (soil cover, rock strength, discontinuities, moisture sensitivity, water table, potential for time dependent strength and stiffness changes (i.e. creep)
- Mine workings roof, seam and floor properties (as per overburden properties plus peak and residual strength and stiffness of coal pillars, strain hardening goaf)
- Propensity for pillar geometry change (rib spall, roof collapse)
- Standing pillars factor of safety (FoS), panel (FoS), goaf, bearing capacity of roof and floor, pothole development potential
- Justification for adopted parameters
- Mine subsidence parameters for systematic behavior (vertical subsidence, horizontal strain, tilt, curvature)
- Likelihood and allowance for non-systematic mine subsidence behavior (e.g. dependent on geological structure: faults, dykes, slip planes and / or topography, cuttings)
- Potential for block failure
- Clear recommendations – The geotechnical practitioner is to clearly put forward their conclusions and recommendations and avoid the use of ambiguous language.

5. Geotechnical Investigation

Subsurface investigation requirements:

- All subsurface investigations (borehole, test pit etc) are to be logged in accordance with AS1726-2017: Geotechnical site investigation observed by suitably qualified and experienced geotechnical engineer or engineering geologist
- A log is to be provided for each test location. Pertinent investigation details should also be recorded on the log (details of mine workings including depths of voids, rubble and mine/seam

floor, drilling methods and depths, casing types and depths, groundwater observations, drill fluid/air loss etc)

- Core photos and point load strength testing results are to be provided for cored boreholes. Test pit photos are to be provided
- The test locations should be surveyed, and the coordinates and surface level recorded on the log. A test location plan is to be provided showing the test locations with respect to the proposed development and the mine record trace
- The number of test locations and the investigation methods (non-cored or cored) should be sufficient to develop a geotechnical model of the site and reduce uncertainty in the layout (dimensions) and condition of the workings
- The subsurface investigation method is to be suitable for the site considering geology, groundwater and contamination aspects. The method is to be appropriate so as to not introduce new or increase existing site risks considering the investigation may encounter mine workings (i.e. increase the potential for subsidence or investigation related events for e.g. surface depression/sinkhole, in seam fires etc). Methodology should include sealing of boreholes with grout following investigation, appropriate backfilling of test pits, suitable drilling and casing methods for geological conditions at the site, etc
- Additional investigation methods such as downhole camera, sonar and geophysical logging tools are to be undertaken to support the assessment where a poor level of confidence in the mine records and current condition of the workings is identified. The test location plan is to be marked up showing the results of the camera and sonar investigations.

6. Modelling

In some instances, numerical modelling may be required to assess the risk and magnitude of subsidence impacts for a proposed development.

Subsidence Advisory requires that the appropriate modelling package is selected for the intended use.

All inputs and assumptions are to be clearly defined (including supporting references) to allow assessment by Subsidence Advisory and potential peer reviewer/s.

Any assumptions applied to the numerical modelling are to be fully justified in the report.

A sensitivity analysis should also be carried out using worst case assumptions.

An electronic copy shall be provided to Subsidence Advisory on request so that the model can be reverse engineered in the event that mine subsidence occurs.

7. Peer Review

Peer reviews of geotechnical reports, numerical models and/or grouting/remediation plans may be requested by Subsidence Advisory. Peer reviews are to

- Be conducted by a practitioner appropriately/expertly experienced in the area in which the report was written (geotechnical, numerical modelling or subsidence remediation/prevention measures) and who are considered acceptable by Subsidence Advisory
- Review the report in its entirety
- Comment on whether the assessment conforms with Subsidence Advisory's policy requirements as described above. If not, the reviewer is to outline the areas that the assessment is lacking for the author to address

- Provide any additional information, comment, or analysis that the reviewer considered pertinent to the assessment.

The reviewer is to confirm the method and outcomes of the initial assessment. If the reviewer determines the assessment outcomes are based on insufficient or inaccurate information, the reviewer is to outline the areas that the assessment is lacking for the author to address.

Attachment E: Grouting/Remediation Plans, Verification and Reporting Requirements

The following outlines minimum requirements for grout/remediation plans.

1. General

- The grout designer is to develop a remediation strategy specific to the site that will remove the subsidence risk. The strategy is to outline the methodology for grouting/remediation and provide a framework for verifying the works
- The plan is to be prepared by a qualified geotechnical practitioner who is familiar with the site conditions and experienced in the development and writing of grout/remediation plans and the supervision of grouting/remediation projects
- The plan should provide clear roles and responsibilities for all who are involved in the works (e.g., grout designer, drilling contractor, grouting contractor and site verification engineer)
- The plan should provide a summary of expected ground conditions at the site, i.e. overburden, coal seam depths, mined seams at the site, depth to the workings, condition of the workings etc
- The plan is to clearly describe any geotechnical risks specific to the site and risks associated with the proposed grouting/remediation method. The plan is to outline controls required to mitigate these risks (e.g., appropriate casing materials and seating requirements for ground conditions). During the works, the site verification engineer is to ensure the controls are adequate and have been implemented.

2. Drilling

- The plan must show the location of the proposed boreholes and give sufficient information for borehole set out (e.g., dimensions shown on plan, survey coordinates)
- The plan is to describe the minimum drilling requirements including: drilling methods (e.g. rotary mud, air percussion etc); borehole diameter; casing material types and depths; and give borehole termination criteria (e.g. 1 m below seam level)
- The boreholes are to be logged by either the driller or a suitably experienced person. The drilling log is to record (at a minimum): Borehole number; date drilled; borehole inclination/azimuth; driller; casing details and depths; strata – depth of soil, top and bottom of any coal seams, voids, rubble/goaf and seam floor; borehole end depth; drilling water/air loss; and any other notable observations
- The condition and layout of the workings should be confirmed using downhole camera, sonar and/or geophysical tools. At a minimum, downhole camera inspection is to be undertaken to confirm the condition of the workings. In instances where wide borehole spacing is proposed, the dimensions and layout of the mine workings are to be confirmed with measurement tools such as sonar or laser. The results of the boreholes, camera and sonar are to be compared with the geo-referenced mine record traces
- Include a procedure to assess the potential to impact the grout design intent should the ground conditions differ to that assumed during design (e.g., allowance for hiatus in program to review conditions and confirm borehole spacing/grout sequence is appropriate, redrilling boreholes at an offset for boreholes that encounter coal, etc)
- Borehole spacings are to be suitable for the condition of the workings and for the proposed grout mix

- Each borehole location and collar Reduced Level (AHD - Australian height Datum) is to be surveyed and recorded.

3. Grouting

- The plan is to provide requirements for the design grout mix (compressive strength, proposed mix constituents, desired flowability characteristics – high or low mobility grouts, etc). The proposed design grout mix is to be suitable for the current state of the mine workings (e.g., in flooded or dry workings, open void or collapsed/goafed conditions etc) and require evidence be provided to show the mix does not segregate. The site verification engineer is to confirm the suitability of the proposed grout mix/es prior to use
- The plan is to provide quality control and assurance (QA/QC) requirements that are appropriate for the grout mix/es (e.g., sampling and testing regime undertaken to recognised standard, nominate target compressive strengths for standard curing ages – noting that at a minimum 7 day test should be carried out, consistency testing range for desired flow characteristics and any other criteria specific to the works). Grout compressive strength testing is to be undertaken at an interval that is commensurate with the grout volume estimate but at intervals of not greater than 200m3. The consistency of each batch of grout is to be tested. Where a continuous mixing plant is used, consistency testing is to be undertaken at intervals of not greater than 10m3. If the verifying engineer observes consistent test results for the day, the interval may be increased to a test every hour thereafter. Higher testing frequencies should be used where the grout consistency is observed to vary. A procedure is to be provided in the plan should QA requirements not be met
- A grout volume estimate is to be provided
- The plan is to outline a sequence in which the boreholes will be grouted
- The plan is to state grout tremie pipe requirements (e.g., tremie at the base of the workings and raised as progressively as the workings fill)
- All boreholes drilled should be grouted to the surface. Consideration is to be given where surface assets (public or private) are to be reinstated (e.g., footpaths, road pavements, concrete slabs etc). A robust procedure is to be provided detailing how the borehole will be plugged/backfilled if a borehole is not grouted to refusal. This is to include a method to test and confirm the borehole has been adequately sealed prior to removal or grouting of the borehole casing. The site verification engineer is to confirm that the borehole plug/backfill works were completed satisfactorily and that there is no risk of failure of the borehole seal
- The plan is to outline rectification measures should the grout not meet the grout plan objectives/design intent (e.g., inadequate grout strengths, permeation of rubble etc).

4. Verification Methodology

Clearly outline the method or framework by which the verification engineer and grouting contractor is to confirm works have been completed satisfactorily.

The method/framework is to include:

- Monitoring requirements during drilling and grouting activities (e.g., site observations, borehole dip levels, review of borehole logs/conditions encountered in boreholes, monitoring grout flow with borehole camera etc)
- Requirement for camera/sonar inspection of mine workings during the works for verification of mine layout and to confirm satisfactory grouting
- Requirement for check testing of or supervision of grouting contractor QA/QC testing by site verification engineer

- Provision of QA/QC results in timely manner to site verification engineer
- Provide minimum requirements for boreholes drilled to verify the works (e.g., drilling method cored/non-cored, downhole camera / sonar / laser inspection, number of boreholes etc). Video footage should be available to Subsidence Advisory NSW for viewing when submitting the grout verification output report for approval
- Where practicable, sampling and testing of installed grout to confirm in-situ grout strengths.
- Any other requirements specific to the grouting/remediation methodology or to confirm grout design/numerical modelling assumptions.

The Grout Verification Output Report is to include

- A summary of drilling and grouting works undertaken at the site
- A summary of evidence provided to confirm suitability of utilised grout mix/es including comment on segregation
- Confirmation that the grouting works were undertaken in accordance with the grout plan including any additional measures that were required to achieve the grout design intent. The grout designer is to confirm the completed grouting works achieve the design intent
- Confirmation of post grouting subsidence design parameters, if applicable
- Confirmation of any other related conditions stated in the Notice of Determination
- A copy of grout records per borehole, tremie depths, QA/QC results, borehole logs, camera/sonar/laser interpretation logs, geophysical tool logs, borehole collar survey results, grout volume records such as delivery dockets/weighbridge dockets etc.

Drawings are to include:

- The location of the boreholes with identifier to show if the borehole intersected workings or coal. Where the boreholes are inclined, the surface and at seam level locations are to be shown
- For both mapped and unmapped workings, show an interpretation of the layout of the workings based on drilling, camera, sonar/laser results. Include interpretation on overlay of mine record trace, if available
- The location of the grout areas and grout volumes per borehole
- Outline of proposed development.

Any variation to the grout plan is to be submitted to Subsidence Advisory NSW for review and not undertaken until consent is given.

Alternate remediation/preventative measures may be considered. The measures must achieve the same design intent as grouting (i.e., removal of subsidence risk) and must provide evidence showing proof of concept for assessment by Subsidence Advisory NSW.

Attachment F: Mine Subsidence Design Structural Engineer Certification Form

Form is available at: nsw.gov.au/subsidence-advisory/publications.

Attachment G: Guide for Designing for Mine Subsidence

Subsidence Advisory NSW (Subsidence Advisory) Guide to Designing for Mine Subsidence for Merit Assessment Policy (the Guide)

1. Introduction

The Guide provides information to assist applicants with designing for mine subsidence under Subsidence Advisory's Merit Assessment Policy. The Guide provides practical measures for consideration of designers, in a format that follows the "Mine Subsidence Design Structural Engineer Certification Form" (the Form), which must be attached to a proposal to assess the application on merit.

The Guide primarily addresses residential structures, in addition to building structures. Subsidence Advisory recommends that the applicant seek specialist mine subsidence advice regarding the design of other structures to accommodate potential mine subsidence movements, including bridges and large, complex residential and commercial structures.

The Guide is provided as general guidance only and in no way can replace the services of a professional consultant on a particular project.

2. Effects of Mining

Underground mining can result in vertical and horizontal movement of the ground surface. Mine subsidence movements are typically described in the following terms:

- Vertical subsidence
- Tilt
- Curvature
- Horizontal displacement
- Horizontal strains

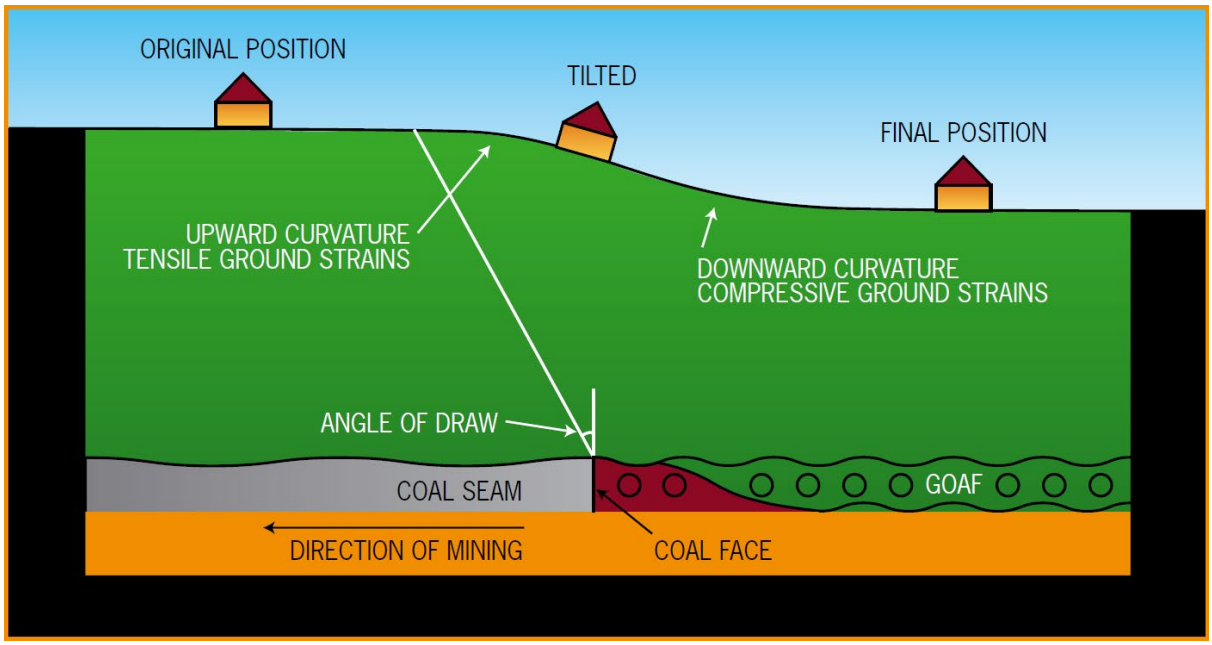

Figure 1 – Long section showing the effects of longwall mining travelling beneath a house

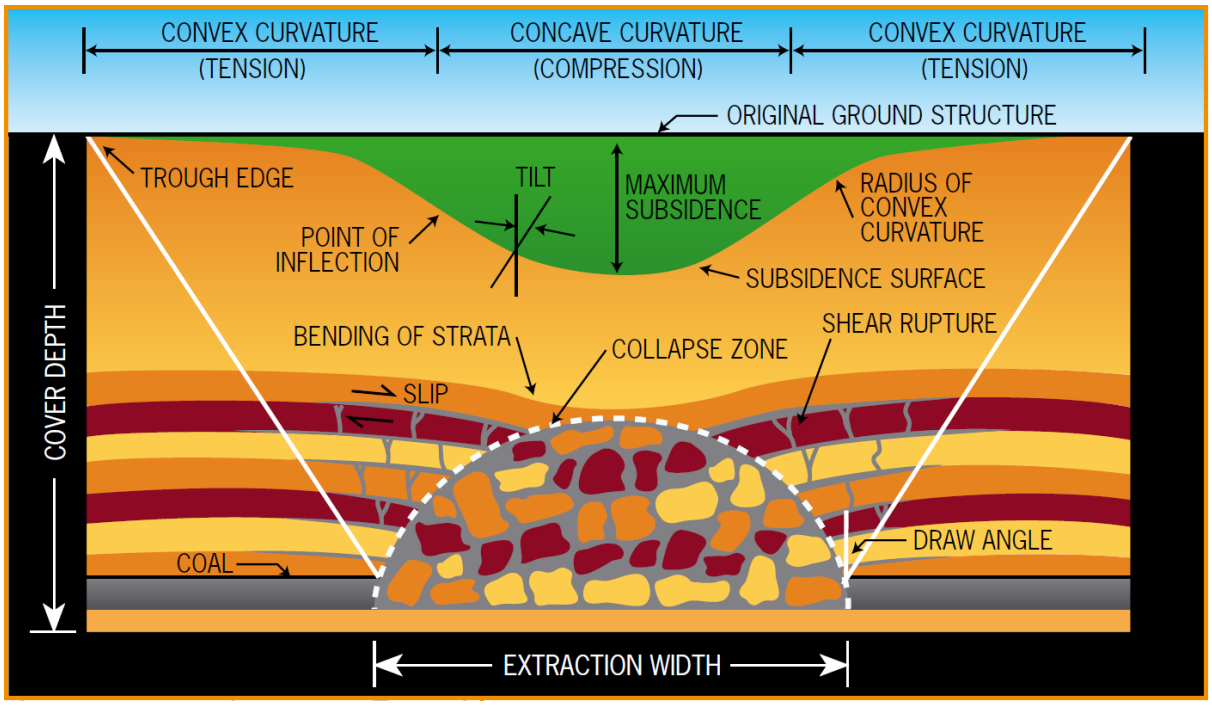

Figure 1 – Cross section showing surface effects of longwall mining (drawn to an exaggerated scale)

3. Designing structures to accommodate mine subsidence movements

Engineering and architectural considerations can significantly minimise the risk of all types of structures experiencing mine subsidence damage. Special design and detailing techniques are adopted to allow structures, including buildings, roads, railways, services, etc, to withstand anticipated movements from earthquakes and unstable foundation material.

Mine subsidence is just another form of ground movement that can be designed for. Design principles and techniques that allow structures to accommodate ground movement resulting from mine subsidence have been used extensively in England and Europe since the 1920s and in Australia since the 1960s.

Designing for mine subsidence parameters that have been provided by Subsidence Advisory will reduce the likelihood and consequences of mine subsidence. It is possible, however, that actual subsidence movements are greater than design parameters. It is therefore important that designers consider the consequence of impacts if greater movements occur.

At the design stage it is possible to select a type of structure that, with appropriate detailing, will allow the structure to accommodate these subsidence effects. Designers aim to provide a structure where damage is non-structural and the building remains:

- Safe - no danger to users;
- Serviceable - available for its intended use; and
- Repairable - damaged components economically replaceable.

4. Description of Structure

Some commentary is provided below for each question in the form.

a) Brief description of structure

It is important for Subsidence Advisory to understand the intended purpose of the structure.

Critical public structures and commercial structures, for example, must remain operational during normal operating hours during and after mine subsidence movements occur. Designs for these structures should, therefore, consider how the structure can be repaired whilst remaining operational even if actual mine subsidence movements exceed the prescribed design parameters.

b) Description of site

A short description of the site setting is requested. Subsidence Advisory does not expect geotechnical investigations to be conducted solely for the purposes of providing information for the Merit Assessment, particularly for applications to construct single dwellings.

c) Footing type(s)

A short description of the footing design is requested. Further information regarding footing designs is provided later in the Guide.

d) Foundation bearing material

A short description of the foundation bearing material is requested. Subsidence Advisory does not expect geotechnical investigations to be conducted solely for the purposes of providing information for the Merit Assessment, particularly for applications to construct single dwellings.

e) Plan footprint dimensions

It is appreciated that plans will be provided with the application. A simple summary of the overall length and width of the footprint is requested.

f) No. of storeys and height, single / split level

It is appreciated that plans will be provided with the application. A simple description is requested.

g) Construction type(s)

It is appreciated that plans will be provided with the application. A short description of the construction type(s) is requested.

There is extensive experience of mining beneath structures in NSW. Experience has found that timber and steel framed structures with flexible external linings such as timber, weatherboard, or metal sheet are flexible can accommodate greater differential mine subsidence movements than structures with rigid materials such as masonry walls. These structures are also generally easier to repair in the event that mine subsidence impacts occur.

Structures can be designed to accommodate differential mine subsidence movements with rigid materials, through the inclusion of construction and articulation joints. This also applies to larger, reinforced concrete framed structures.

Further information is provided later in this Guide.

h) Basements / integral retaining structures

A short description is requested. Further information regarding basements and structures with retaining structures are discussed later in this Guide.

5. Subsidence Design Requirements

a) Vertical subsidence

In general terms, ground subsidence represents a rigid body movement that has no effect on surface structures. As such, vertical subsidence by itself is seldom a significant factor in the design of individual buildings.

Structures will be left at a lower level but this normally has no adverse effect on them except in the case of buildings that are in close proximity to watercourses. Mine subsidence may expose such houses to an increased flooding risk. In these cases, the habitable floor levels should be designed to be comfortably above the 1% Annual Exceedance Probability or AEP (100 Year Average Recurrence Interval level or ARI).

Generally, services such as drainage would subside with the building so very little differential vertical movement would occur.

b) Tilt

As shown in Figure 1, vertical subsidence does not develop uniformly above the underground mine. Tilt is defined as a change in slope, or difference in vertical subsidence at two points, divided by the horizontal distance between them. It is typically expressed in units of mm/m.

Ground tilts will develop during the course of mining operations and in multiple directions. Some structures may experience greater transient tilts than the final tilt after mining, as shown in Figure 1. The final tilt for other structures may represent the maximum tilt that is experienced, such as structures that are located near the side of a longwall, as shown in Figure 2.

Whilst ground tilts will introduce additional bending moments in structures, the additional loads due to tilt rarely result in significant impacts on the structure. Tilt impacts are more often noticed to adversely affect the serviceability of structures.

Small tilts generally do not affect the usage of a building and can be catered for by providing such things as generous falls for services. Construction tolerances are typically in the order of 3 to 4 mm/m and drainage structures are usually built with grades that are greater than 10 mm/m.

Further information on designing for tilt is provided later in this Guide.

c) Curvature

Curvature refers to the mining-induced bending of the ground. In mathematical terms, curvature is the second derivative of subsidence, or the rate of change of tilt. Curvature is usually inverted and expressed as the Radius of Curvature.

Curvature can occur in both hogging or sagging forms and can be oriented in multiple directions. As described for tilt, curvature will develop during the course of mining operations. Some structures may experience greater transient curvatures than the final curvature after mining.

In practice, damage from mine subsidence will often be a result of the combination of curvature and ground strains. Further information on designing for curvature is provided later in this Guide.

d) Strain

Underground mining often results in the development of horizontal movements. The movements are generally oriented towards the mining activity. As for vertical subsidence, horizontal movements do not develop uniformly over the surface and differential horizontal movements result in strains.

The subsidence design requirements for strain refer to normal strain, which is the differential horizontal movement of the ground. If the distance between two points on the surface increases, a tensile strain is induced and if the distance between two points on the surface reduces, a compressive strain occurs. The design must account for both tensile strains (expressed as positive) and compressive strains (expressed as negative) and strains can be oriented in multiple directions.

Both tensile and compressive strains can generate damage in buildings. In most buildings, the materials are generally weaker in tension than compression, hence tensile forces are the more difficult to accommodate. Further information on designing for strain is provided later in this Guide.

6. Certification to Australian Standards

a) Design to current Australian Standards

It is expected that the structures will be designed to good engineering practice. This includes designing in accordance with current, relevant and applicable Australian Standards and the National Construction Code. Some of these standards including requirements for designing for mine subsidence movements.

7. Comparison to Development Guidelines

a) Reason for Merit Assessment

A brief description is requested to describe what elements of the design do not comply with the Subsidence Advisory Surface Development Guideline that has been assigned to the property.

8. Subsidence mitigation measures for tilt

a) Gradients on wet area floors, roof gutters and gravity pipework

It is recommended that drainage elements in the structure, including gutters, wet area drainage and gravity pipework be designed with generous grades to ensure that they remain serviceable if the gradients are reduced by the tilt specified in the subsidence design requirements.

The design grades would ideally be greater than the addition of the minimum design grades from Australian Standards and the mining-induced tilt prescribed by Subsidence Advisory.

b) **Has the house been designed to be readily relevelled if required?**

This question was restricted to cases where the prescribed tilt in the subsidence design requirements are greater than 4 mm/m. This is because construction tolerances are typically in the order of 3 to 4 mm/m.

Tilts over 7 mm/m will start to affect the serviceability of the building and the type of construction will be restricted to allow economical repair.

Suspended flooring systems can be relevelled economically where access is available to the supporting bearers and joists. Brick houses on strip footings cannot be easily relevelled if the brickwork extends unbroken from the ground to eaves. Some architectural treatment is preferred at the damp proof course to potentially avoid replacing all of the brickwork.

If sufficient ceiling height has been provided in the original design, and if appropriate detailing has been adopted, it may be possible to relevel floor slabs by adding a topping layer to recover original grades.

Domestic floor slabs are not normally strong enough to withstand relevelling by jacking. Other types of slabs may be designed with jacking points and sufficient strength to be relevelled after subsidence. Alternatively, slabs can be relevelled using grout injection techniques.

It would be beneficial for services pipework to located around the perimeter of the house to reduce the impact of relevelling.

c) **Have the walls, cavity and brick veneer wall ties and roof-framing been designed for the impact of tilt?**

Additional ties are recommended to be specified in the design

d) **Are there any other subsidence mitigation measures for tilt in design?**

The above questions refer to design techniques that are commonly used in the design of subsidence mitigation measures. Subsidence Advisory is, however, open to alternative or additional design ideas.

9. Subsidence mitigation measures for curvature (hogging and sagging) and strain (tensile and compressive)

In practice, damage from mine subsidence will often be a result of the combination of curvature and ground strains.

Tensile strains can cause cracks in brickwork, internal linings such as plasterboard, pulled joints in pipework, cracks and separation of joints in paving.

Compressive strains can cause spalling of brickwork, crushing of components, closure of door and window openings, buckling of materials, buckling of pipes, paving and other components.

Not all strain in the ground will be transferred into the structure. This is due to a number of factors including foundation type, ground material, the presence of sliding layers, and the location and orientation of the mining in relation to the structure.

In general terms, ground strains are transferred into footing systems by friction beneath and beside the footing elements. The obvious solution, therefore, is to reduce such friction and, wherever possible, separating the footing structure from the soil. This may be achieved by providing a slip layer between the structure and the ground to allow the ground to move without damaging the structure.

Footings can be designed to minimise the effect of strains on the superstructure by making them as shallow as possible and by placing them on slip layers. Deep foundations such as piled foundations are not preferred.

When deep foundations are unavoidable, the forces imposed can be reduced by excavating trenches around the structure. These trenches are placed as near as practical to, and extend to just below the underside of, the foundation. They can be backfilled with a compressible material which is strong enough to support the sides of the excavation but more compressible than the natural soil. This fill will crush and not transfer all of the forces to the foundation. Coke, slabs of expanded polystyrene foam, vermiculite, cork and void formers have historically been used for this purpose.

Various techniques have been used to allow footings to slip relative to the foundation material. The sides and bottoms of footings and slabs are kept as smooth as practical and are often poured on slip layers that incorporate plastic or bituminous membranes over layers of granular materials (sands). Exaggerated slopes are used on transition zones between stiffening beams and slabs to facilitate shearing actions.

The effects of ground curvature can be minimised by panelling and articulating walls to move without developing strains or cracks or causing doors and windows to jam. Vertical articulation joints are provided at appropriate intervals and at sections where the wall stiffness changes.

Damage due to curvature can also be minimised by eliminating brickwork above windows, doorways and arches. If such details are included, special attention must be paid to provision of bond beams and strengthening panels that incorporate arches.

Some typical examples of design features that can accommodate curvature and strain are shown in Figure 3.

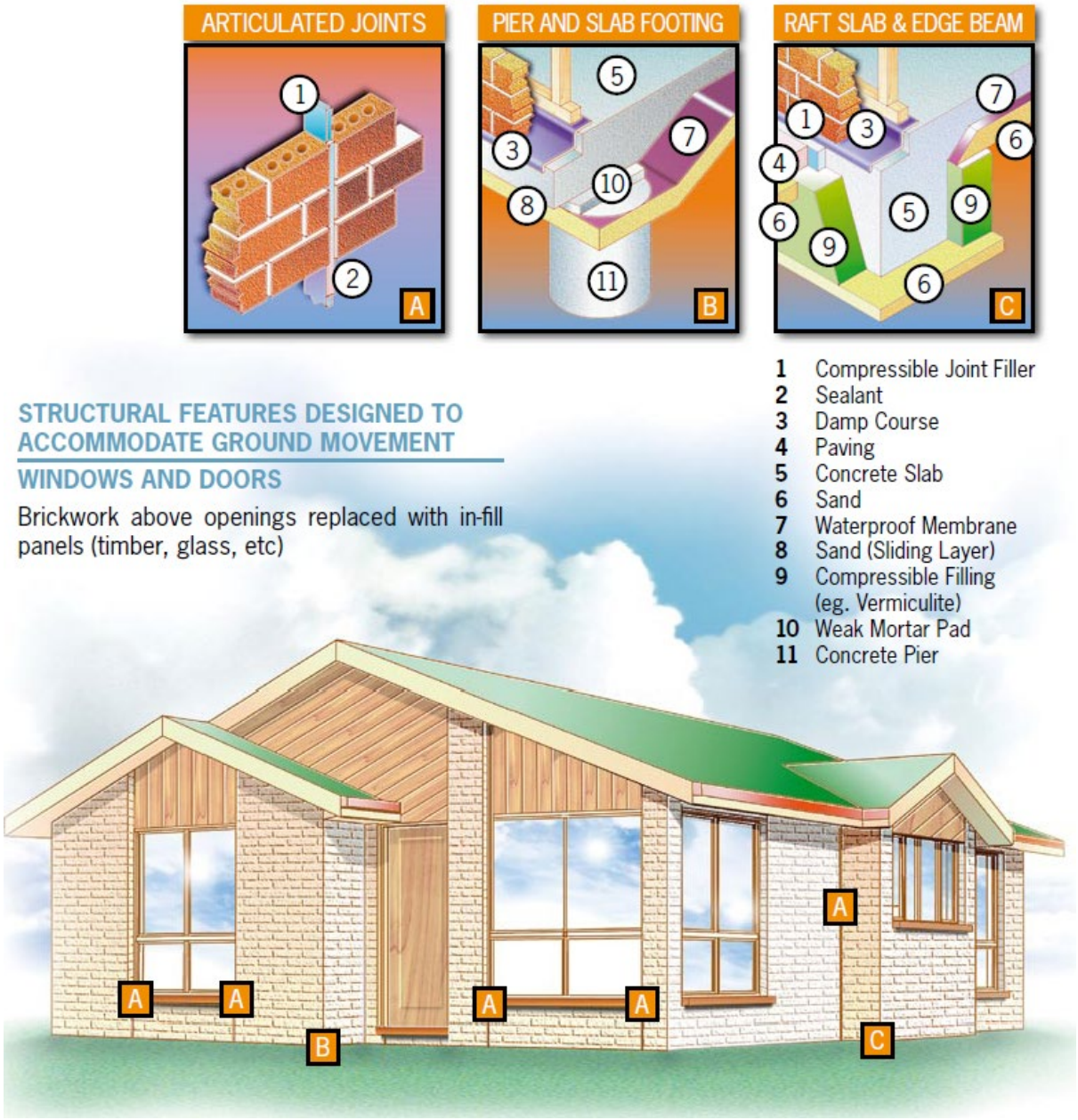

Figure 2 – Design features that can accommodate curvature and strain

Foundation and sub-floor design

a) **Are the base(s) of ground slabs formed on one level plane, with sand bedding and plastic membranes beneath (if applicable)?**

The base of slab(s) are preferred to be on one level plane. If the ground slabs are required to step down the slope, the slabs are recommended to be isolated, with articulation joints included in the superstructure at the interface(s).

In-ground step beams / drop edge slabs are discouraged as they anchor the structure to the ground at these locations and, therefore, more readily transfer ground strains into the structure at concentrated location(s). Structures with these features are also very difficult to relevel.

Sand bedding and plastic membranes provide a slip plane between the ground and the underside of ground slabs. They also provide a buffer between the ground and the slab.

Figure 3 – Mine subsidence resulted in a crack, which has occurred between two separate ground slabs that are founded at different elevations, with no articulation joint in the overlying brickwork.

b) Is there separation between in-ground footings (e.g. piers, ground beams, etc,) and superstructure (if applicable)?

This design feature is preferred to minimise transfer of mining-induced ground strains into superstructure and facilitate relevelling of the structure if required. Cracking can also occur at the connections between the footings and the superstructure as mining-induced ground strains will result in differential movements between the footings.

Ties between in-ground footings and superstructure are discouraged as it is difficult to relevel structures if the footings are tied.

For steel and concrete framed structures, it is not recommended to tie ground slabs to the superstructure, or pour ground slabs over column baseplates, preventing adjustment in the future.

Figure 4 – Column baseplates are recommended to be exposed to facilitate future inspections and adjustment if required

c) **Are the retaining walls / basements structurally isolated from superstructure?**

It is very difficult to repair / relevel sub-floor areas and the superstructure when they are tied together.

The founding level of footings are encouraged to be beyond the angle of influence of base of retaining wall from a safety and serviceability point of view.

d) **Are there construction joints and/or articulation joints at the cut/fill interfaces or changes in foundation materials (if applicable)?**

Mine subsidence impacts are commonly observed to structures, pavements and pipework at cut-fill interfaces or changes in foundation materials. Articulation is recommended at the cut-fill interfaces or changes in foundation materials where possible.

e) **Are there any geotechnical challenges associated with the site? If so, how has the structural design taken these challenges into account?**

Geotechnical challenges may include a steeply sloping site, distinct changes in geology within the site, geological faults, igneous intrusions, or challenges associated with groundwater flows.

If geotechnical challenges are known to be present on site, the structural design may need to consider the possibility that differential movements may focus at the interface(s) between geological features. Slippage has been observed to occur at the interfaces between geological features, including geological faults or along bedding planes

Subsidence Advisory does not expect geotechnical investigations to be conducted solely for the purposes of providing information for the Merit Assessment. Single lot residential developments in relatively flat terrain do not normally require detailed geotechnical investigations and a response to this effect would be acceptable.

f) **Is the development proposed to be constructed above an infilled creek?**

Constructing houses directly above infilled creeks or near the bases of natural creeks is strongly discouraged as they are more likely to experience elevated compressive strains (valley closure) and increased hogging curvature (upsidence). Valley closure and upsidence movements are consistently observed when mining is conducting beneath valleys.

Additional subsidence mitigation measures are, therefore, expected to be included in the design of structures that are located directly above infilled creeks.

The applicant may be requested to seek specialist advice on potential mine subsidence movements if seeking to build structures above buried creeks.

g) For excavations, are compressible fillers documented between footings / walls and excavated rock faces and other natural materials to reduce transfer of ground strains into structure?

When coal is extracted by underground mining methods, such as longwall mining, the ground is consistently observed to move horizontally above and adjacent to the longwall. The directions and magnitudes of movement are not uniform but most horizontal movements are orientated inwards towards the mining activity and a net ground shortening is consistently observed.

When the ground moves in, it can distribute the movements on existing joints, or distribute the movement relatively evenly. The ground movements can, however, concentrate at planes of weakness, resulting in localised, high differential movements.

Sub-surface monitoring, mainly by inclinometers, has commonly detected shearing of the rock mass in response to mine subsidence movements. Shearing typically occurs at bedding planes, often at an interface between claystones or siltstones.

For excavations in rock, it is possible that shearing can develop along bedding behind the footings or retaining walls, resulting in impacts. An effective design solution is to place compressible fillers between the footings or retaining walls and the rock faces.

h) Are there any other subsidence mitigation measures included in the design of foundations and sub-floor areas?

The above questions refer to design techniques that are commonly used in the design of subsidence mitigation measures. Subsidence Advisory is, however, open to alternative or additional design ideas.

Superstructure design

i) Are there construction or articulation joints in the floor slabs and walls and at the interfaces between other rigid elements?

Construction joints are required where there are changes in footing or foundation types. To avoid the types of impacts shown by the example provided in Figure 4.

Construction joints are required where extensions are proposed to adjoin the existing structures. Articulation joints are required where there are changes in construction type, including number of levels, changes in floor level, etc.

j) Is the damp proof course designed to be level between each of the construction joints (if applicable)?

Masonry walls are commonly observed to slip on the damp proof course in response to normal and shear strains, particularly when they are founded on strip footings.

Stepped damp proof courses can result in cracking at the step changes, as shown in Figure 6.

For structures on sloping ground, these can usually be resolved by introducing a construction joint at the step change.

Figure 5 – Mine subsidence resulted in a crack that concentrated at a step in the damp proof course

k) Does the design include architectural relief at the damp proof course (if applicable)?

If masonry walls experience slippage on the damp proof course due to differential mine subsidence movements, the impact is very noticeable if the walls were designed to be continuous and planar across the damp proof course. In these instances, the common method of repair is to replace the affected wall. This is not only an expensive repair but also a substantial inconvenience for the owner. An extreme example is shown in Figure 7.

An architectural relief is encouraged at the damp proof course, particularly for structures on strip footings. Examples include an expressed brick / corbel or a shadowline at the damp proof course, a movement joint in the render, or a separate external finish between the masonry walls above and below the damp proof course. Alternatively, the external panel could be designed to be removeable.

Figure 6 – Mine subsidence resulted in slippage of the damp proof course (this is an extreme example)

l) **Are there articulation joints at window and door openings? Do the windows extend up to the eaves? Alternatively, are there flexible panels above windows and doors?**

As discussed in the introduction to this section of the Guide, the effects of ground curvature can be minimised by panelling and articulating walls to move without developing strains or cracks or causing doors and windows to jam.

An extreme example of mining-induced cracking at a window opening is shown in Figure 8.

Figure 7 – Mine subsidence resulted in cracking around window openings (this is an extreme example)

m) **Are there articulation joints specified in the architectural finishes to reflect construction joints in the structure?**

Rigid architectural finishes such as floor and wall tiles and timber flooring are required to have articulation joints specified at the construction joints in the structure. The mining-induced crack in floor tiles shown in Figure 9 was aligned with the same step in the ground slab that was shown in Figure 4.

Articulation or other architectural relief is encouraged for flexible linings (flexible sealants at cornices, shadowlines in set ceilings, construction joints aligned with internal walls).

Figure 8 – Mine subsidence resulted in cracking of floor tiles directly aligned with the same step in ground slab shown in Figure 4.

n) **Are there flexible sealants at tile wall and floor junctions?**

It is good practice to include flexible sealants at tile wall and floor junctions, regardless of mitigating against differential mine subsidence movements. Flexible tile adhesives are also recommended between tiles and FC sheeting and concrete slabs to reduce the potential for cracking across joints in the sheeting and reflected slab cracking.

o) **Are there flexible joints or separation between external pavements and the building structure(s)?**

External pavements commonly move differentially to the building structure(s). They can move away in some places and push into the structure(s) in other places, damaging the building structure(s). An extreme example is shown in Figure 10.

Flexible joints are required where external pavements are designed to adjoin the building structure (e.g. driveway slab next to built-in garage).

Figure 9 – Mine subsidence resulted in damage along a mortar bed where an external pavement was formed against an external brick wall

p) Is there articulation and sand bedding below in-ground pipework?

Differential mine subsidence typically occurs between pipework and building structures. Pipework is typically laid in trenches that have been bedded with sand. The pipework is able to slide relative to the ground in response to mining-induced ground strains, while building structures act like anchors in the ground. Impacts are also commonly experienced at the interface between the structure and the ground.

Flexible joints in pipes shall be designed in accordance with AS2870-2011 to minimum H2 site classification specifications to accommodate curvature in any plane, coupled with tensile or compressive strain.

Branches, bends and valve stems shall be protected by flexible wrapping or shrouds to prevent shearing of the pipes as ground movement occurs. Flexible joints shall be provided where pipes are connected to chambers or gullies.

The bases of downpipes could be designed without physical connections to in-ground drains. Holes in the structure for pipework should be over-sized to accommodate differential movements.

q) Are there any other subsidence mitigation measures that are included in the design of superstructure?

The above questions refer to design techniques that are commonly used in the design of subsidence mitigation measures. Subsidence Advisory is, however, open to alternative or additional design ideas.

10. Designing for greater than anticipated subsidence

a) **Has the structure been designed so that it remains safe, serviceable and readily repairable if it experiences greater than anticipated differential subsidence movements?**

Subsidence Advisory require the applicant to design structures to accommodate the prescribed mine subsidence parameters. While the mine subsidence parameters are reasonably conservative, the actual mine subsidence movements could be less than or greater than the design parameters.

Subsidence Advisory is not requiring the structure to be designed to withstand greater than anticipated subsidence effects, but is seeking evidence of ductility and redundancy in the design so that it is likely to remain safe, serviceable and readily repairable if it experiences greater than anticipated subsidence movements.

It is recommended that the applicant consider scenarios where the structure experiences twice the subsidence design parameters (tilt, curvature and strain), or as a minimum, subsidence design parameters as specified in Surface Development Guideline 4. It is also recommended that designers consider ground strains and curvature concentrating across a point or line at the structure.

A higher level of protection is required for critical public and private infrastructure, where it is not possible to relocate occupants. These structures should be designed such that they remain safe, serviceable and repairable if they experience greater than anticipated subsidence movements. For these cases, the applicant may be requested to seek specialist advice on potential mine subsidence movements and how the structure(s) can be designed to meet these criteria.

b) **How would the structure be repaired if it experiences greater than anticipated differential subsidence movements?**

Some of the earlier questions in this Guide (e.g. designs at the damp proof course, pouring ground slabs over baseplates) are relevant when answering this question.

In-ground pipework is recommended to be placed around the perimeter of houses that are constructed on ground slabs to facilitate repairs if the pipework is damaged.

A higher level of protection is required for critical public and private infrastructure. These structures should be designed such that repairs can be carried out with minimum impact to the use of the structure(s). For these cases, the applicant may be requested to seek specialist advice on potential mine subsidence movements and how the structure(s) can be designed to meet these criteria.

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