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ENGINEERING GEOLOGY IN AUSTRALIA: A PROFESSION AT THE FAULT LINE OF POLICY, PRACTICE, AND PERFORMANCE

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ABSTRACT

Australia's built and natural environment sectors are facing escalating costs, delays, and safety risks due to systemic shortcomings in ground risk management. This paper explores the under-recognition of engineering geology as a profession and its consequences on project performance, immigration policy, and national standards. Through comparative analysis with other high-income English-speaking nations, the study highlights inconsistencies in role definitions, education pathways, and professional accreditation. It proposes a framework for reform, including the establishment of a dedicated registration pathway for engineering geologists, improved integration of geoscience in engineering education, and the adoption of a hazard-first approach to ground risk management. The findings underscore the urgent need for structural change to mitigate socio-economic impacts and enhance national resilience.

1 INTRODUCTION

Despite a record-breaking infrastructure cycle funded by mineral exports, Australia's approach to ground risk management remains questionable. Its failure to formally recognise key ground engineering vocations—particularly Engineering Geology—is evident in both economic indicators and professional frameworks.

Ground risk management relies on a multidisciplinary sector, where competence stems from education and ongoing professional development. Yet inconsistent recognition, especially in registration requirements, undermines this workforce. As Packer et al. (2024) note, the absence of legislative accreditation for Engineering Geologists in Australia triggers a cascade of impacts—limiting practice, distorting migration pathways, and weakening sector resilience. This sequence is shown in **Figure 1**.

Figure 1: Detrimental sequence caused by the lack of legislative professional accreditation

To investigate this the Australian ground engineering sector must be examined by comparison to other English-speaking high-income economies with respect to:

- The roles and titles within the sector
- Education and skills in ground engineering
- Occupation recognition, registration and immigration
- Engineering geological hazards and the socio-economic effects on Australian
- Standards in ground risk management

Where appropriate recommendations will be made for how Australia can make progress in its ground engineering sector by taking best practice and pragmatism from other similar nations.

2 ENGINEERING GEOLOGY AND THE GROUND ENGINEER SECTOR

The term ground engineering is a recognition of the geoscience connection to civil engineering. How those enter into and practice within the sector vary internationally but the drivers from education, job title (given by employers), occupational skills and competence (directed governing institution and/or skill assessment bodies) should be to be consistent, but it seems this is not the case throughout the industry.

2.1 ROLES AND TITLES

Fookes (1997) defined three ground engineering roles (**Figure 2**) noting that while Geological Engineer is uncommon in British practice, it is recognized in North America. Later Sections 2.2 and 2.3 address how evolving sector demands and education governance blur these distinctions.

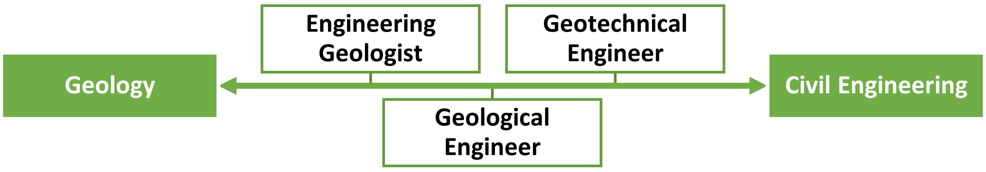


Figure 2: Roles in Ground Engineering based on technical training according to Fookes (1997)

There are three core principles to the ground engineering sector in which all three occupations are involved in. These are

- Site and earth materials characterisation
- Hazard identification and risk management, and
- Engineering design

Based on the definition of each occupation in nine comparable English-speaking economies (UK, Ireland, United States, Canada, Australia, New Zealand, South Africa, Hong Kong and Singapore) each has been plotted on the Ternary diagram in **Figure 3** to try to appreciate the amount of involvement the three occupation types have in each of these principles and how these might vary Across the 9 nations. Countries where the various role titles are recognised and used as job titles are detailed in **Table 1** which is appended to this paper. It should be noted that Geological Engineer is only recognised in Canada and the US, there were no definitions for any of the three occupations in any Singapore based reference.

Nevertheless, the **Figure 3**shows a broad spectrum of variance amongst the discipline for these occupations. Traditionally it might have been expected that engineering design would feature only in the engineering occupation definitions, but this was not case with design activity in relation to engineering featuring in the Engineering Geologist definitions for Australia, New Zealand, US, Canada and South Africa.

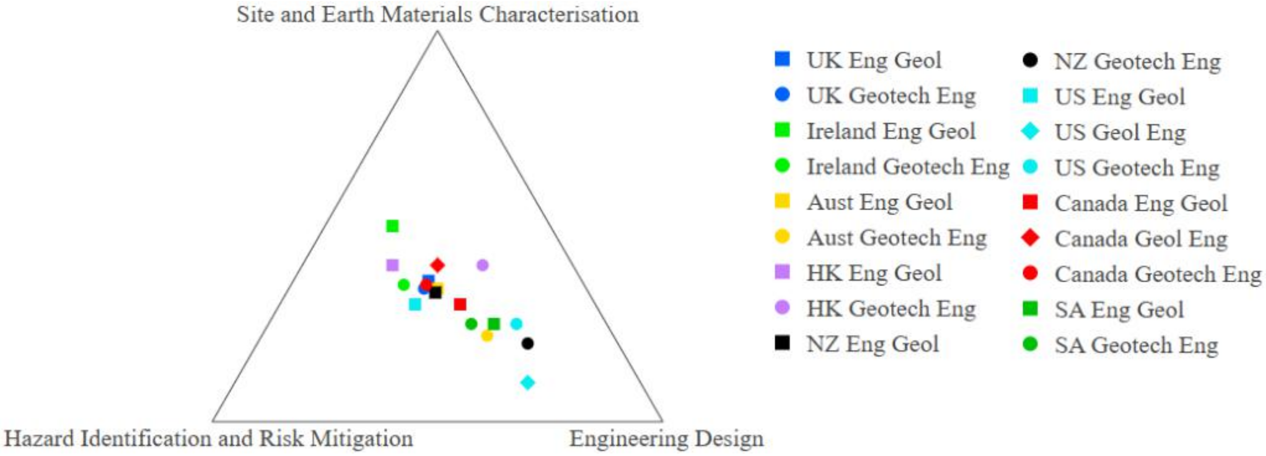


Figure 3: Nations where the various roles and titles are recognised and defined

It is noted that while the International Association of Engineering Geology and the Environment (IAEG) is recognised by these countries but the context here is regarding application of role titles and descriptions either by their governments, industry bodies or the local employment sector. Another interesting aspect is how design is mentioned in the engineering geologist definitions for Australia, New Zealand, US, Canada and South Africa. Furthermore, the UK government definition for Geotechnical Engineer covers engineering geology.

Fookes notes in his paper that the term Geotechnical Engineer could reflect any aspect within ground engineering, and this is seen in job title data not only in the UK but also in North America i.e. the job title is Geotechnical Engineer, yet the description is either one of engineering geology or site investigation.

Professionals with geological training often work in ground engineering under varied titles, including 'engineer', depending on the country. Many enter with geology degrees and gain engineering competence through formal study or practical experience, recognised by local employment markets.

While job titles may appear similar, their definitions, and who defines them, vary significantly. Ideally, employers would shape role expectations via industry bodies (e.g. AIG, SEG), which would inform government policy on education and immigration. This could support consistent national frameworks for assessing qualifications and experience.

However, across English-speaking high-income nations, title definitions remain fragmented. Australia reflects a broader inconsistency, not an exception.

2.2 INTERNATIONAL EDUCATION

Presumably based on this experience until the late 1990s, Fookes also detailed the areas of training included between the civil engineering and geological sciences disciplines.

- Geology areas of expertise based on technical training – Physical Geology, Petrology, Structural Geology, Palaeontology, Stratigraphy, Geomorphology, Field Mapping Techniques
- Civil Engineering areas of expertise based on technical training – Physics, Statics, Dynamics, Material Strength, Highways, Hydraulics, Mechanics, Thermodynamics, Structures, Public Health

A key divergence is governance: engineering programs follow international accords (Washington/Sydney/Dublin), supposedly creating consistent outcomes with varying yet minimal earth science content (<3 modules in most civil degrees; **Figure 4**)

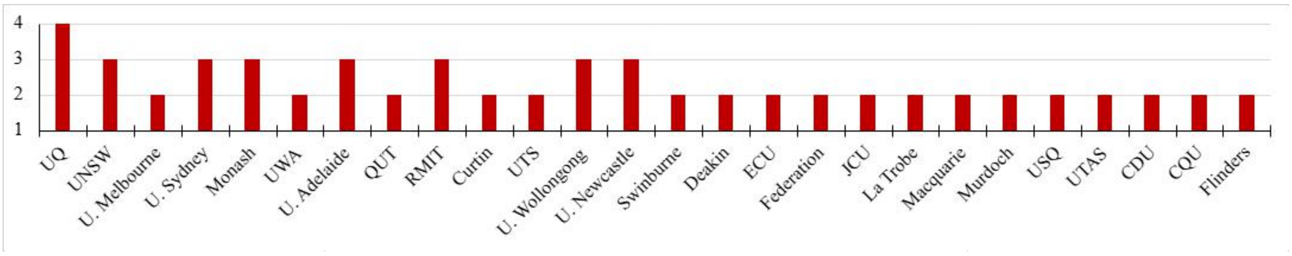
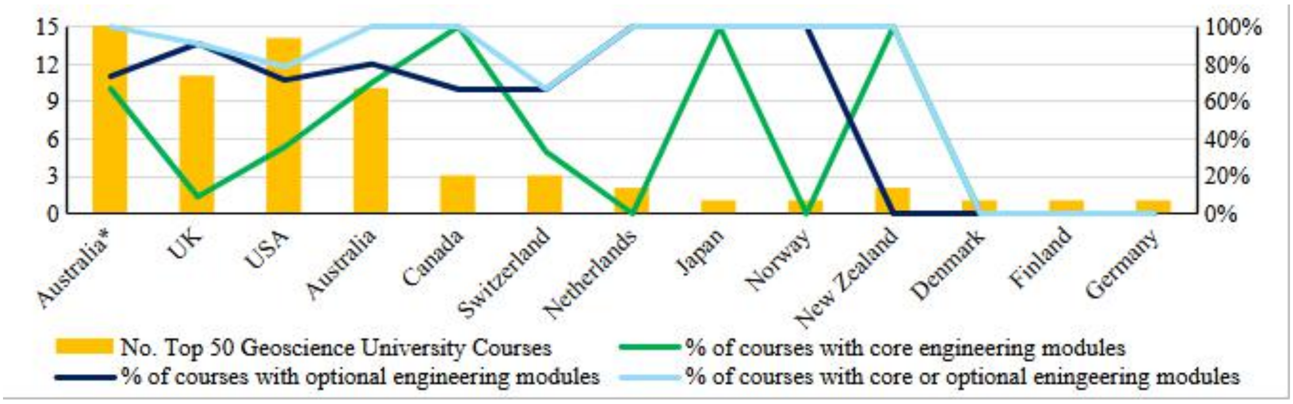


Figure 4: Number of applied earth science modules on 4-year Civil Engineering Degree programs



*denotes all Australian courses (even those outside the global top 50)

Figure 5: Comparison of quantity of engineering content on the global top 50 Geoscience courses and those of Australia

By contrast the education of Geology varies even more significantly and examples can be seen in the variation in the global top 50 Geoscience courses (TopUniversities.com, 2025). **Figure 5** shows the number of Geology or Earth Science Bachelor courses in the top 50 global rankings by country compared with all the Australian courses. Also shown in the figure is the percentage of those courses which have engineering content (such as Engineering Geology, Geological Engineering, Geotechnics, Geotechnical Engineering, Rock/Soil Mechanics) by country either optionally or as requisite. Limitations should be noted with this data for example what is considered core and optional will vary with major/minor degrees. However, what should be observed from this is what potential learning outcomes can be taken from someone with a geoscience degree in terms of engineering content by contrast with those on Washington accord programmes.

Australian geoscience programs rank well globally for applied and engineering content, though Canada and New Zealand appear stronger in depth. A broader trend shows a tiered university system: elite institutions (e.g. Russell Group, Ivy League) emphasise academic geology, while others tailor curricula to local industry needs, often with applied modules concentrated in final-year study.

With no single unified agreement in Geoscience like the Washington Accord for Engineering, the International Union of Geological Sciences has established ‘The Commission on Geoscience Education since 2004’. The commission’s objectives include:

- Establishing a global geoscience education network
- Developing guidelines for good practice in geoscience education
- Coordinating geoscience education activities at the international level

Despite positive developments, current geoscience programs remain distant from Washington Accord alignment or show limited intent to develop an equivalent accord for applied geoscience. Many courses globally include engineering content, but flexible module structures and mixed major/minor pathways complicate comparisons with the International Engineering Alliance’s three-tier system.

In Australia, recognition in engineering hinges on educational background and IEA alignment. Yet meaningful assessment requires a detailed review of transcripts and course specifications by a suitably qualified evaluator, an uncommon resource, with no transparent evaluation framework currently in place.

Compounding this, some geoscience degrees offer more ground engineering content than Washington Accord programs. This exposes serious flaws in how competence for registration is assessed, especially when typical geoscience curricula and learning outcomes are examined closely.

2.2.1 Detailed Learned Outcomes

Paul (2024) discusses the state of geological education in Australia. Within the paper is the indicative pathway to Geomechanics. However, this is misleading on at least three specific issues as case examples

Dip, strike, and dip direction are core mapping techniques taught universally in geology degrees, typically followed by stereographic projection methods. These skills are introduced in mid-degree years and underpin rock mechanics modules in applied final-year curricula. Mathematical approaches to planar and wedge failure are generally covered in engineering geology units, forming a bridge between geoscience and engineering practice, an intersection explored later in this paper.

Though civil engineering physics isn’t the focus here, it’s incorrect to assume physics is peripheral in geoscience education. Biology is limited to palaeontology electives, while chemistry features in mineralogy and petrology. Physics, however, is central to informing topics like the Hjulström curve, seismology, geophysics, and rock/soil mechanics.

This distinction is critical when evaluating the scientific competence of geoscience-trained professionals. Assumptions of deficiency in core science knowledge during skills assessments or registration processes are not only unfounded but risk undervaluing a curriculum deeply rooted in applied physical science.

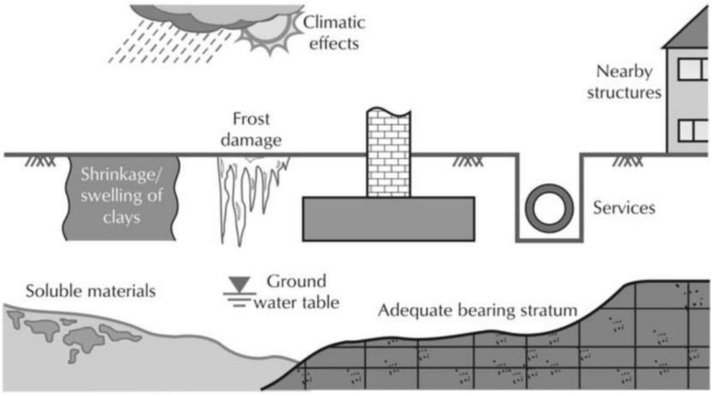


Figure 6: Geohazards defining limit states

Engineering geology extends beyond model development; it centres on hazard identification and risk assessment and mitigation. Limit states in geotechnical design are derived from geohazards, as illustrated in **Figure 6** taken from Bond & Harris (2006) and discussed further in Section 4.

2.3 GROUND ENGINEERING SPECTRUM AND SKILLS

Fookes originally drew clear lines between Engineering Geology (defining ground conditions) and Civil Engineering (calculating ground stability). However, these boundaries have since blurred and relying solely on educational background to assess competence risks overlooking skilled professionals. Traditionally, geologists led hazard identification and ground investigation design, producing geological models, while civil engineers handled parametrisation and geotechnical modelling, but this division is no longer universal.

Paul's pathways diagram provides a critical spectrum based on the tree of education provision as shown in **Figure 7** and it is important that this is compared with the industry skills spectrum for ground engineering shown in **Figure 8**.

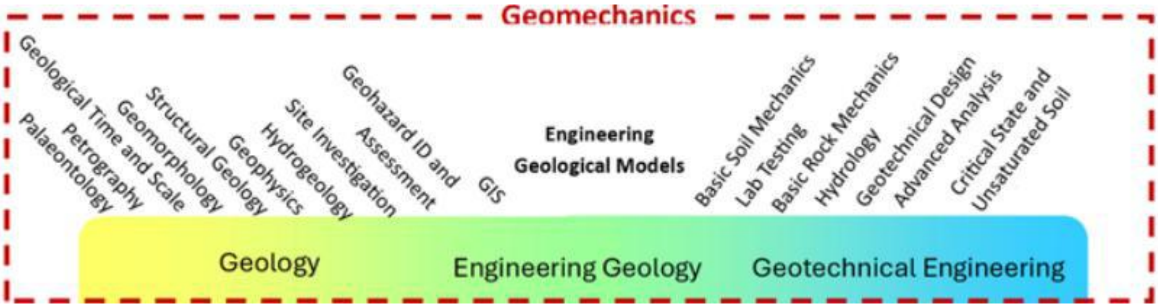


Figure 7: Geomechanics spectrum of education content

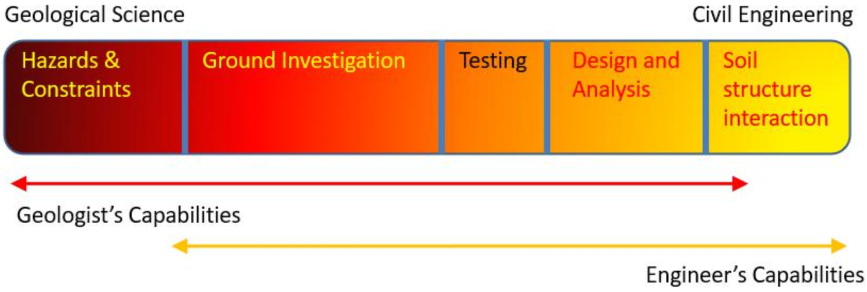


Figure 8: Ground Engineering Skills Spectrum

These two diagrams highlight a key discrepancy between the learning outcomes from the ground engineering education sector in Australia and the capabilities of ground engineering staff across the sector internationally.

Figure 8 is based on the skills capabilities observed in the UK by Geology graduates with applied final-year modules and accredited ground engineering training, Geology graduates without applied modules but a ground engineering MSc and accredited training, Civil Engineering graduates with a ground engineering related MSc.

UK geology graduates are well-equipped to identify hazards and conduct risk assessments, applying field and lab skills to produce engineering geological models from concept to construction. With project experience and structured training, they progress into limit state definition and stability analysis, occasionally extending into advanced numerical methods like FEA, though typically not into constitutive modelling.

Conversely, civil engineering graduates with ground engineering Masters may be proficient in constitutive models but often lack the earth science foundation for hazard identification. This highlights a flaw in registration frameworks that assess competence solely through engineering education, overlooking geoscience-trained professionals with relevant expertise.

2.4 REGISTRATION, OCCUPATIONS AND IMMIGRATION

Packer et al. (2024) highlighted the absence of formal accreditation for engineering geologists in Australia and the registration challenges they face. Due to international variability in titles (Section 2.1), overseas professionals applying under ANZSCO 233212 (Geotechnical Engineer) must obtain state registration for permanent residency, mandatory in all states by 2027.

For those without Washington, Sydney, or Dublin Accord qualifications, the immigration skills assessment via Engineers Australia mirrors the Stage 1 registration process, making it unlikely that geoscience-trained applicants will succeed.

As discussed earlier, many overseas ground engineering professionals with geological degrees hold titles like Geotechnical or Geological Engineer. However, without registration, they cannot legally practise in some states—risking prosecution and jeopardizing visa eligibility. This issue is compounded by the lack of ANZSCO codes for Engineering Geologists or Geological Engineers.

Practitioners with geoscience backgrounds may apply under ANZSCO 234411 (Geologist), but success hinges on alignment with VETASSESS's narrow task list, focused on resource exploration, specimen analysis, environmental impact, and lab supervision, rather than engineering-related ground investigation or design. Those focused on ground characterisation, parameterisation, and design, toward the right of **Figure 8**, will struggle to meet these criteria.

This misalignment creates a significant barrier for qualified international professionals seeking entry into Australia's ground engineering and engineering geology workforce.

However, Australia is not unique in coupling its immigration requirements with registration. Out of the 9 high-income English-speaking nations mentioned previously, 7 require compulsory registration for Civil/Geotechnical Engineers but only 2 require it for Geologists/Engineering Geologists.

However, as registration is State led for Australia, it is important to put this comparison into context with similar nations and state unions.

Figure 9 shows that Australia is the only state where 100% of states do not require registration of Engineering Geologists. As Packer et al highlight in their paper, there isn't a compulsory registration for Engineering Geologists in Australia.

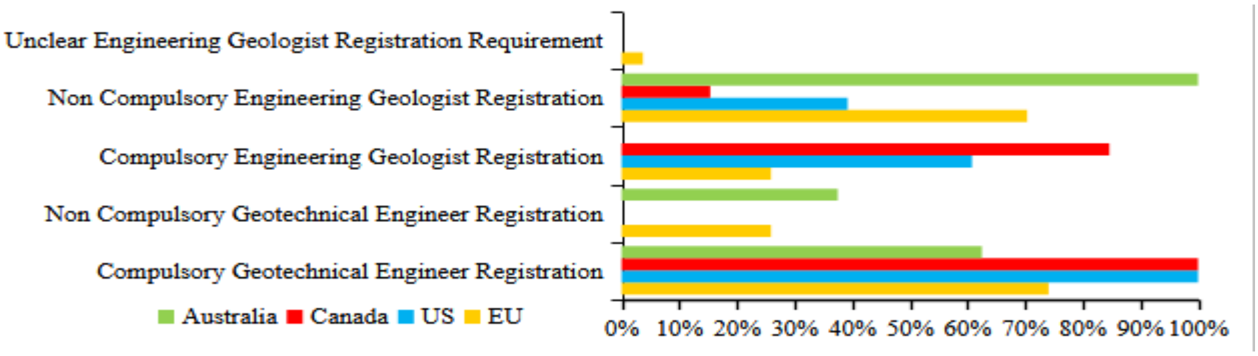


Figure 9: Percentages of states requiring registration for Geotechnical Engineers and Engineering Geologists.

Given the issues described so far regarding registration, occupation, education and skills recognition and the contribution this is creating to immigration coupled with the acute skills shortage Australia appears relentless in trying to backfill. The impacts must be being felt and observed by some measure.

3 SOCIO ECONOMIC IMPACT

Economic impacts often reveal skill shortages, yet data linking ground risk management to performance remains limited. One proxy is how well projects handle ground conditions. With adequate engineering geology expertise in transport, water, mining, and energy sectors, geological hazards could be more reliably identified and mitigated.

A review of news and articles on projects commissioned since 2000 reveals that ground-related challenges have significantly impacted infrastructure projects across Australia, particularly in tunnelling, often resulting in billion-dollar cost overruns, construction halts, or deferrals. **Figure 10** provides a summary of those findings. Notably, most ground conditions were unremarkable, except for one mining project facing extreme subsurface temperatures.

Rather than faulting individual projects, the evidence points to a broader misalignment in ground risk recognition by the Australian Government, as highlighted in the National Study of Infrastructure Risk.

A summary of the top five risks of projects from the government vs national construction contractors shows the stark difference the government agencies have when it comes to ground risks when compared to the contracting companies. The study showed the top 5 risks of each in order of importance:

- National Construction Contractors - utilities and ground conditions, land contamination, shortage of professional talent, shortage of general labour, complex policy and regulation
- Government - contractor capacity, shortage of professional talent, project management skills, shortage of general labour, planning approvals

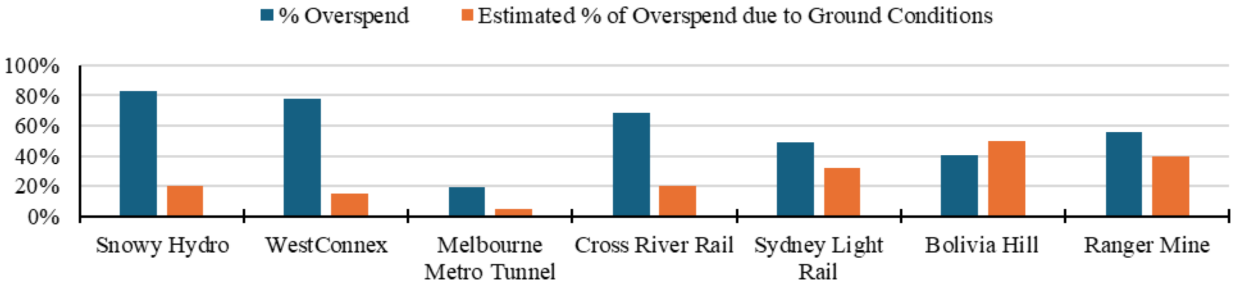


Figure 10: Selection of projects impacted by ground conditions

The study also highlights skills shortages in professional areas, geotechnical engineering and tunnelling, land contamination and challenging ground conditions as common delivery risks which are amplified by project and systemic risks such as insurance liabilities, climate change, geological hazards, cost and delivery risks. It should be noted however, that these are mostly hardest felt by the transport infrastructure sector.

The study also stated the same reoccurring theme that ground conditions are often poorly understood during the early stages of project planning, despite that being the most effective time to mitigate associated risks. Both industry experts and contractors agree that proactive hazard identification and mitigation should occur before construction begins, particularly for unpredictable or poorly characterised subsurface elements. The implication is clear; delayed recognition of ground risks leads to avoidable complications, and early-phase 'geotechnical' input is essential for project resilience.

It is ironic that the failure to understand ground conditions early in the planning and development of projects is still said today despite **Figure 11** which Fookes purported in 1997.

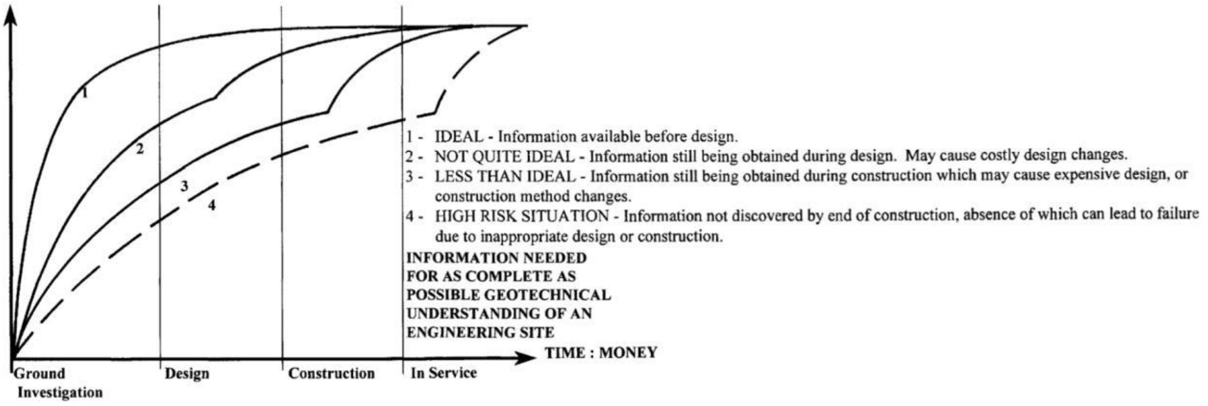


Figure 11: The optimisation of ground condition information gathering during the stages of a project.

The study found that inadequate planning significantly contributes to uncertainty in ground conditions, with cost uplifts in transport projects—particularly those involving tunnelling—ranging from 60–80%. Unpredictable subsurface conditions were a consistent challenge across major infrastructure projects, and industry participants indicated a declining willingness to absorb such risks. This underscores the need for stronger collaboration between government and contractors to manage geotechnical uncertainty. The $2 billion cost overrun on Melbourne Metro was partly attributed to unexpected soil density, which delayed excavation. Stakeholders broadly support shared risk models, but concerns remain over the use of 'no-reliance' geotechnical data during tendering. Contractors argue that if provided information proves inaccurate, they should be entitled to time and cost relief. Melbourne's inconsistent geology heightens the risk of undetected subsurface features, and even comprehensive pre-construction sampling may miss critical anomalies. Ultimately, the severity of unknown ground conditions depends heavily on regional geology, and full understanding prior to construction is rarely achievable.

Poorly informed views such as these are undermining the industry. Melbourne's geology is not inherently unpredictable; it's poorly understood due to limited investigation. Ground certainty depends on informed analysis, not geology alone. A shortage of expertise is hindering the detection of unforeseen conditions, reinforcing the need for comprehensive, phased investigations including geophysics.

A further measure of geohazard impact is Australia's landslide fatality rate, which ranks high among peer nations. Countries with effective ground risk management typically adopt preventative strategies. Despite differences in climate and terrain, the 12-year comparative data (2004–2016) offers a compelling socioeconomic lens.

Figure 12 shows Australia ranks fourth in average annual landslide fatalities among high-income English-speaking nations, second when adjusted for population, and third by population density, behind only New Zealand, the US, and Canada.

These rankings suggest a shortfall in geohazard risk management capability. While population density may also reflect regulatory effectiveness, the elevated fatality rates warrant closer scrutiny of how ground risks are currently managed.

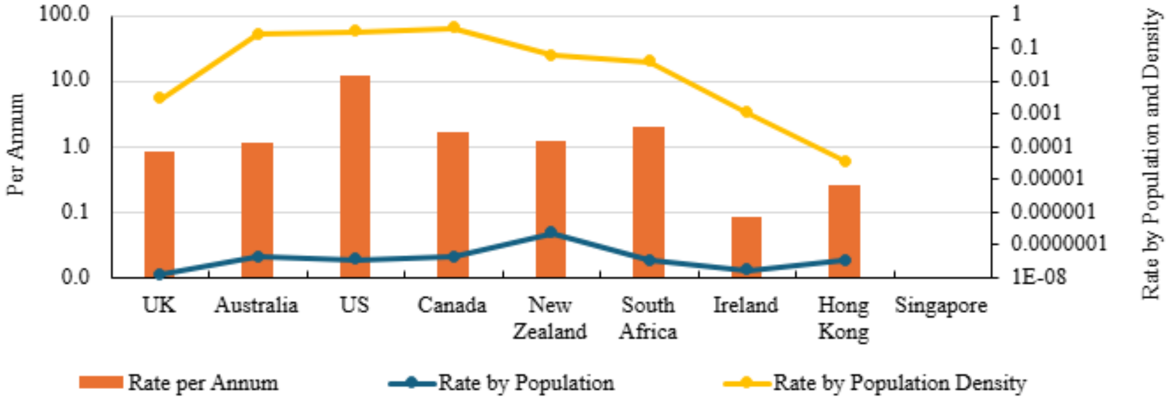


Figure 12: Comparison of average annual rate of landslide fatalities by population size and density

4 GROUND RISK MANAGEMENT STANDARDS

Ground risk management begins with identifying hazards through prior knowledge and desktop research i.e. a Desk Study or Literature Review. This stage aims to recognise and preliminarily quantify risks, forming initial conceptual and geological models. These models remain dynamic and are refined throughout the ground investigation process. Following a phased approach of investigation survey techniques which will target; hazards so that they can be risk assessed, geological complexity and uncertainty, qualitative data acquisition of ground information to enable ground characterisation and parameterisation for design.

Following this the objective should be for geological hazards to be risk assessed, mitigated and transferred. The conceptual, geological and engineering models fully developed to define receptors, RAG (red - amber - green) rate site hazards, and convey uncertainty. The design limit states fully developed with geological hazards considered and designed for.

The next section of will go into the aspects of this process which are directly relevant to engineering geology and affected by the topics covered so far but also how other nations approach these methods.

4.1 HAZARDS

Identifying and understanding ground hazards comes from a knowledge of, tectonic stress history, erosion and depositional history, historical and current climate, previous development, recent military conflict.

While geoscientists are naturally equipped for this work, engineers with strong geological competence also contribute. The key lies in linking hazards to the design limit state and anticipating the next phase, typically ground investigation, where health and safety issues emerge. This is where engineering geologists begin developing design skills, while engineers often overlook their need to deepen geological understanding in ground engineering.

Rumsfeld (2011) is often attributed to the categorisation of hazards into four classifications.

- Known knowns – expected and identified hazards e.g. dams prone to slope instability
- Known unknowns – hazards that are identifiable but have not been researched for the project at hand
- Uknown knowns – identifiable hazards that are not recognised as identifiable
- Uknown unknowns – unexpected and unprecedented hazards that cannot be researched

How this classification allows for the illustration of hazards and the links to health and safety and design limit states as shown in **Figure 13**

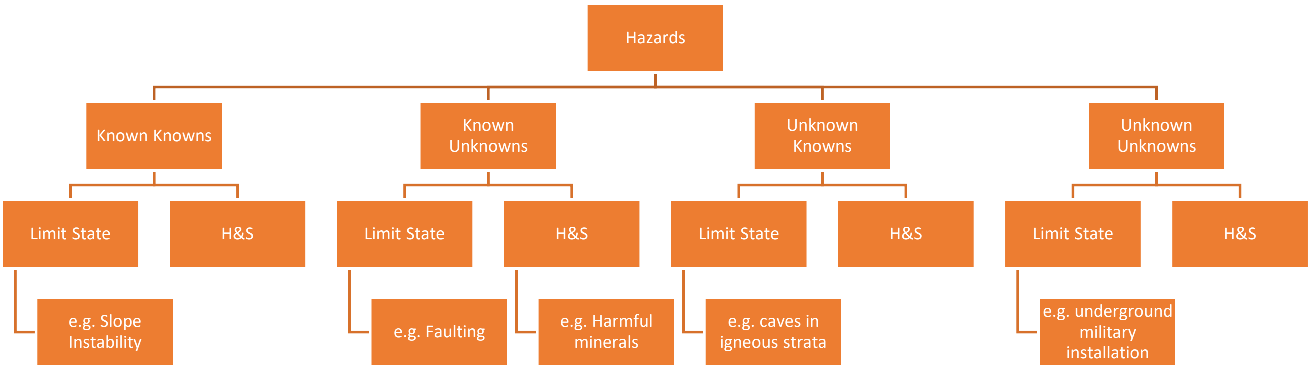


Figure 13: Hazard categories and the connectivity with design and Health and Safety

4.2 DESK STUDY

The desk study is the key initial step for identifying ground hazards and typically precedes site investigations. Its requirement, along with the scope of risk assessments and sources consulted, varies across countries. **Figure 14** shows the varying national ground engineering standards and their requirements for a desk studies and risk assessments in the early phases based on the author's review.

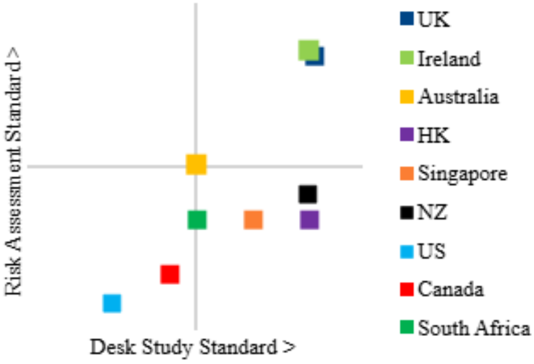


Figure 14: National ground engineering standards and the mandating of desk studies

While some national standards don't explicitly define the desk study as a formal investigation stage, they do emphasise preliminary assessments. At minimum, guidance should be provided on typical information sources, especially in standards framed as best practice versus minimum compliance.

The level of detail varies widely. The UK's BS5930 outlines desk study requirements extensively, including content, interpretation, sources, structure, and links to health and safety legislation, reinforcing a hazard-led approach.

In contrast, Australia's decentralised data landscape complicates desk study compilation. While national and state portals offer impressive spatial coverage, usability and geological data quality vary. Inconsistencies across state geological maps, such as missing sections, dip markers, or linear features, can hinder interpretation. Key geohazard maps like subsidence (QLD & NSW only) and naturally occurring asbestos (NOA, NSW only) are not universally available.

Understanding map limitations is critical. NOA maps, for instance, only reflect surface geology, requiring users to infer subsurface potential from regional structure. Similarly, detailed units may appear in one area due to supporting data but be absent elsewhere, despite likely presence. These nuances demand education for non-geoscientists and should be addressed in AS1726. Moreover, some listed sources aren't available nationwide, and valuable datasets like geophysical maps are omitted.

Sector-specific guidelines (e.g. CD622, QLD Geotechnical Guideline) often provide more detailed requirements than AS1726, especially for infrastructure projects. Overall, there are clear disparities in desk study expectations across national, state, and sector standards.

4.3 MODELS

Model development is integral to identifying, assessing, and mitigating ground engineering risk. Broadly, there are three types of models in ground engineering.

- Conceptual model (CSM) – Originating from contamination studies, CSMs highlight hazards and receptors to guide targeted investigations. Common in infrastructure and dam projects, they are schematic rather than factual.
- Geological Model – A dynamic, evolving subsurface representation refined through investigation. Initially basic, it gains precision with data and typically uses modelling software. QA processes are essential for complex projects.
- Geotechnical or Engineering Ground Model – A simplified, parametrised version used for design. Though often associated with later stages, early versions can emerge from desk studies—provided derivation is justified.

ANCOLD references all three, but most Australian state guidelines do not, except the Northern Territory's CSM guidance. Internationally, Canada and the UK mandate CSMs under environmental standards; ISO 21365:2020 offers broader applicability. IAEG's Commission 25 is the only document integrating all three models.

Countries with clearer engineering geology recognition such as Hong Kong, New Zealand, Canada, the UK, and Ireland better incorporate these models into design frameworks. In contrast, AS1726 focuses on investigation scope rather than hazard-led model development, limiting its alignment with risk-based approaches.

4.4 RISK ASSESSMENT, MANAGEMENT AND REGISTER

Risk assessment is closely tied to model development, yet its implementation varies more widely across countries and sectors than desk studies or modelling. Ireland, Hong Kong, and the UK embed live risk registers from project inception in national standards and infrastructure guidelines. Other countries may use geotechnical risk registers as management tools, but adoption depends on project scale and sector.

AS1726 references geotechnical risk assessment only late in the process—within the interpretive report—limiting alignment with hazard-led engineering geology approaches. In Australia, risk registers appear in state-level requirements for mine closure, rehabilitation, and environmental hazard management. Canadian-developed guidelines also promote their use in stockpile, waste dump, and open pit slope design.

5 CONCLUSIONS AND A WAY FORWARD FOR AUSTRALIA

The fatality statistics alone should compel urgent action. The regulatory threats facing geoscience-trained ground engineering professionals in Australia are not only financially damaging—they are costing lives.

The following sections summarise key findings and offer targeted recommendations to address the interconnected issues outlined in this paper.

5.1 RECOGNITION

Government ignorance of the discipline as an occupation is not accepted. While OSCA recognises Engineering Geologist as a Geologist specialisation (ABS, 2024), this must be reflected in the ANZSCO 234411 classification to ensure consistency in migration pathways. Otherwise, fluctuating demand across subfields (e.g. Engineering Geologists vs Palaeontologists) risks undermining visa allocations or removing the broader occupation from state lists.

To address this, two options exist. Petition Engineers Australia to recognise applied geoscience graduates as qualified for engineering tasks as supported in Section 2.3. Otherwise, Advocate for Engineering Geoscientists, including Engineering Geophysicists, to be recognised as a standalone occupation with a dedicated skills assessment body.

5.2 ALIGNMENT OR DEVOLUTION

Engineers Australia's reliance on the International Engineering Alliance (IEA) accords creates an exclusionary framework that undermines the role of geoscience-trained professionals in ground engineering. The IEA's vague educational criteria contrast with ABET's clearer definition of engineering as the applied use of mathematical and natural sciences, criteria geology inherently meets, especially in hazard-related applications.

Despite the mathematical rigor in applied geological education, EA is unlikely to diverge from IEA standards. This reinforces the need for an independent body to assess engineering geology qualifications for registration and immigration, based on actual competencies rather than rigid accords.

Geologists working in civil engineering, particularly in ground design, clearly meet engineering thresholds. Arguments that exclude them based on “design” misunderstand the nature of geotechnical calculations, which relate to ground limit states, not structural elements. The design of natural rock slopes, for instance, demands structural geology expertise, not just civil engineering credentials.

If EA does not reform its recognition policies, alternative governance must be pursued to ensure fair registration and protect public safety.

5.3 GOVERNANCE, IMMIGRATION AND REGISTRATION

There are currently three industry bodies which offer governance in terms of professional qualification or registration to the Engineering Geology occupation for Australia; Australian Institute of Geoscientists (AIG), Geological Society of Australia (GSA), Australasian Institute of Mining and Metallurgy (AusIMM)

The absence of a unified professional body has caused issues elsewhere, such as in the UK, where merging the Institute of Geologists into the Geological Society led to the Royal Charter, Chartered Geologist (CGeol) status, and the foundation for Ground Engineering Registration. Ireland followed suit, with Engineers Ireland and the Institute of Geologists of Ireland formally supporting RoGEP alongside UK institutions like ICE, GSL, and IOM3.

Australia could adopt a similar model to New Zealand’s PEngGeol qualification. This is feasible, as most state legislation does not specify which body must assess engineering registration or define qualification criteria in detail. Thus, states could theoretically endorse a dedicated assessment body for Engineering Geologists.

An internationally affiliated body, such as IAEG, linked with ISSMGE, ISRM, and governed under FedIGS, would be ideal. Their collaborative stance reinforces the reality that engineering geology and geotechnical engineering are interwoven disciplines. Whether trained in civil engineering or geoscience, practitioners are equipped to contribute across the ground engineering spectrum.

It should then fall on this internationally accredited Australian Engineering Geology governance body to lobby Australian Home Affairs and Immigration departments to recognise Engineering Geologists as its own occupation. Then advise VETASSESS on how the tasks specified on the skills assessment information should reflect that of Engineering Geologists. Alternatively, become its own skills assessment body for immigration, registration and professional qualification.

Lastly the same industry body will likely be the conduit to improving the standards relating to ground engineering through the technical knowledge of members and self-appointed technical committees in line with the international governance inputs.

5.4 GROUND RISK MANAGEMENT & STANDARDS

As already mentioned in Section 4, desk study compilation in Australia is often inefficient due to fragmented data sources and inconsistent presentation. This may discourage clients and practitioners from engaging in this critical phase. To improve uptake, state and federal datasets should be centralised via user-friendly portals, with clear guidance on data limitations and training for non-geoscientists. AS1726 should explicitly address this need.

Comparative analysis shows AS1726 lacks emphasis on hazard identification through desk studies. Greater alignment with state and sector guidelines, and international best practice, is needed. Rather than setting a minimum baseline, AS1726 should reflect optimal standards and promote a hazard-first approach.

Consistency across national, state, and sector frameworks should centre on three pillars: hazard identification, ground models, and risk registers. These elements, illustrated in **Figure 15** form the basis of the Ground Engineering Risk Management Process (GERMP).

What is covered by these three components are:

- Early hazard identification – this includes reinforcement of a well put together and detailed desk study which assigns what hazards fall into the 4 ‘Rumsfeld’ categories.
- Engineering Geological Models – as per IAEG's Commission 25 (C25) and like ANCOLD, covering conceptual, geological and engineering models
- A live risk register – linking with the EGM and the hazards identified a live risk register works as the key conduit for ensuring adequate geotechnical design and limit state development. The risk register remains live from inception to commissioning and should conform into the overall project risk register following the completion of geotechnical construction.

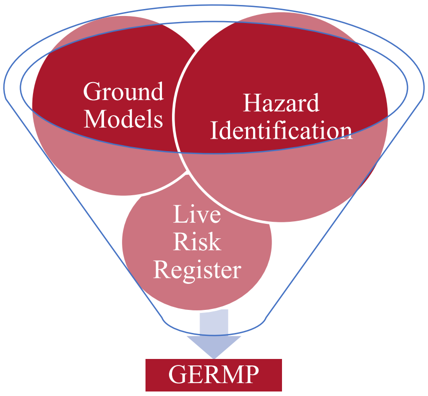


Figure 15: Core components of a Ground Engineering risk management process

An example full flow process for this is illustrated in **Figure 16**

The proposed flow diagram aims to supplement or replace Figure 1 in AS 1726:2017 by shifting the focus of ground investigations toward hazard identification from project inception. Instead of defining scope and objectives upfront, the process begins by identifying hazards, which in turn define the design limit states.

Where hazard data exists, the desk study or literature review begins by default; where it doesn't, the hazard is logged and the risk register initiated, activating two of the three core GERMP elements. The desk study should yield early geological and conceptual models that combine factual geology with interpretive uncertainty, allowing practitioners to assess potential impacts on receptors and assign risk ratings. This links hazard identification, model limitations, and live risk assessment directly to design development.

Even if the desk study concludes with all available data consulted, the geological model and risk register must remain live, acknowledging that new hazards may emerge during subsequent investigation stages. Maintaining flexibility and strategic focus is essential, which is why remote and non-intrusive methods should be considered next.

A resurgence in remote techniques—such as photogrammetry, LiDAR, airborne geophysics, satellite sensing, muography, and InSAR, offers a chance to reassess hazards while prioritising safety, sustainability, and innovation before intrusive works begin. These methods help refine live models and the risk register before putting boots on the ground.

The intrusive investigation phase should follow a hazard- and risk-led approach, targeting engineering and ground characterisation. Given the remote nature of many Australian sites, this stage should maximise onsite efficiency through advanced methods like downhole and cross-hole geophysics, televiewers, instrumented drilling, and dual rigs combining sonic, rotary percussive, and CPT capabilities. Results from this phase feed back into the live models and risk register, which continue to evolve through design and construction.

Throughout, the risk register should be updated to reflect mitigated hazards and transferred residual risks across stakeholders. The ground model must be validated during construction to support commercial decision-making and manage project complexity.

6 CLOSING REMARKS

This strategic shift will require most importantly collaboration from across the ground engineering spectrum but also an education from those in engineering geology to take best practice from Australia and other nations beyond those mentioned in this paper.

Terzaghi once said that engineering geology preceded soil mechanics by over a century, the first geological map of a country was prepared and published by a civil engineer, William Smith, in 1815, and not by geologists, and the first textbook on engineering geology was published as early as 1875. He also noted the crucial efficiency of geological reports for engineering projects, after several engineering failures he gave focus to engineering geological site investigation and gave the engineering geology courses himself at Harvard University.

This demonstrates that geotechnical engineering does not stop where engineering geology starts, it is one discipline, the ground engineering discipline and competent practitioners come from various relevant educational backgrounds with varying engineering and geological content. To progress where the industry has failed in Australia, better education, recognition, representation and standardisation is needed.

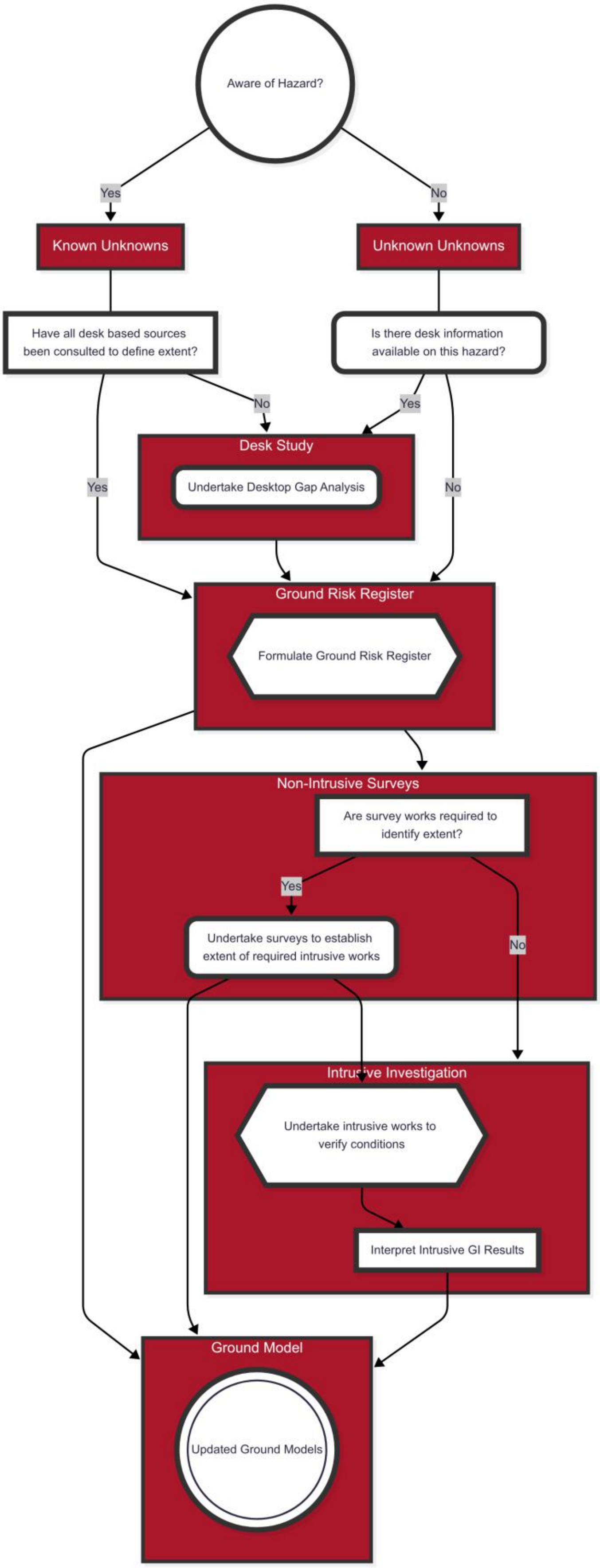


Figure 16: A Prototype of a Ground Engineering Risk Management Process

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Table 1: Nations where the various roles and titles are recognised and defined

COUNTRY	ENGINEERING GEOLOGIST	GEOLOGICAL ENGINEER	GEOTECHNICAL ENGINEER
UK	Engineering geologists are involved in processes that modify surface and sub-surface geology for the built environment (Geological Society, 2025)	*Not Recognised*	Geotechnical engineers assess the properties and behaviour of soil and rock formations. Geotechnical engineering is a collective term for the more individual disciplines of: • Soil mechanics • Foundation engineering • Engineering geology and hydrology • Environmental science • Rock mechanics • Rock engineering (UK Government, 2006) Geotechnical engineers use their expertise in soil and rock to assess risks and address challenges on a variety of infrastructure projects. (Prospects, 2025)
Ireland	Engineering geologists apply their knowledge of rocks and soils to civil engineering projects such as bridges, factories and dams (GradIreland, 2023)	*Not Recognised*	As a geotechnical (geotech) engineer you will support construction and design professionals by carrying out tests and analysis to ensure risks to both people and the environment are mitigated against when planning a construction project. (Construction Jobs Ireland, 2025)
Australia	Engineering geoscientist's role focusses primarily on the understanding of geological and geotechnical conditions and how they may change in time and space in regard to particular engineering projects such as major construction, infrastructure, mining and resource developments and include ground and slope stabilisation, foundations characterisation and design, interpretive modelling, sourcing of suitable materials, recognition of hazards and risk factors and the forensic investigations after failures. They are specialist geologists dealing in the measurement, assessment and review of soils, water and rocks and the engineering impacts of natural processes or human activities such as construction projects, urban or industrial development, mining and resource developments and	*Not Recognised*	Geotechnical engineers identify, design and implement practical solutions to engineering problems concerning soil, rock and groundwater. They apply scientific and engineering techniques to predict and manage the behaviour of the ground where it interacts with or responds to human activity (Engineers Australia, 2022)

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	the maintenance and monitoring of the outcomes of these projects. (AIG, 2025)		
Hong Kong	*Engineering Geologists are…* primarily concerned with the determination of geological and hydrogeological conditions to facilitate ground engineering with respect to the recognition and management of geotechnical risk. This requires the application of geological knowledge and skills to define and communicate the potential and actual variations in ground conditions that are relevant to the engineering project at hand. (CEDD, 2007)		Geotechnical Engineers plan, organise, perform site investigation (on geotechnical aspects) to determine and design the type of foundations, earthworks, and/or pavement subgrades required for the intended man-made structures to be built. (VTC, 2025)
Singapore	*No definition given by a Singapore source or body*	*Not Recognised*	*No definition given by a Singapore source or body*
New Zealand	A Professional Engineering Geologist (PEngGeol) applies specialised knowledge of geology to evaluate and manage the interaction between geological conditions and engineering activities. They play a key role in identifying and mitigating ground-related risks, ensuring the safety, efficiency and sustainability of infrastructure and resource development projects. Professional engineering geologists demonstrate their competence by integrating geoscience expertise with engineering practices. (Engineering New Zealand, 2025) Engineering geologists are specialist earth scientists who apply the geological sciences to engineering study to account for geological factors regarding the location, design, construction, operation and maintenance of engineering works in the design. Engineering geologists provide geological and geotechnical recommendations, analysis, and design associated with human development and various types of structures. The principal objective of the engineering geologist is, by careful investigation and	*Not Recognised*	Geotechnical engineers are specialist civil engineers who analyse, plan and construct foundations and support structures. These professionals use engineering principles and applications to ensure a structure's stability and longevity. Geotechnical engineers often work in offices; they also conduct site visits and field work. The principal objective of the geotechnical engineer is the protection of life and property against damage caused by various geological conditions by careful design of underground or ground supporting structures. (NZGS, 2025)

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	characterisation of the ground, the protection of life and property against damage caused by various geological conditions. There is a large overlap between engineering geology and geotechnical engineering. In simple terms, engineering geologists identify and define a problem, then geotechnical engineers design the solution (NZGS, 2025)		
United States	Engineering Geologists are indispensable professionals who analyse geological data to inform the design, construction, and maintenance of infrastructure projects, thereby ensuring stability and safety (SEG, 2023)	Geological engineers design mines to safely and efficiently remove minerals for use in manufacturing and utilities (U.S. Bureau of Labor Statistics 2025).	Geotechnical engineers assess ground conditions and design foundations, slopes, and earth retaining structures. (American Profession Guide, 2025)
Canada	Engineering Geologists have specialized knowledge in geological sciences and the principles and methods of engineering analysis acquired through professional education and practical experience. Engineering geologists are qualified to apply such knowledge, skill, and judgment to a wide variety of civil and mining works, and the prevention and remediation of geological hazards. They complete geological and geotechnical studies, inspections and analyses of, and provide recommendations and geological design associated with natural and built environments. They also develop measures to prevent, mitigate, and remediate geological hazards. Engineering geologists are critical to and should be considered as the principal developers of the conceptual ground model for a given site. (CGS, 2025)	Geological engineers conduct geological and geotechnical studies to assess suitability of locations for civil engineering, mining and oil and gas projects; and plan, design, develop and supervise programs of geological data acquisition and analysis and the preparation of geological engineering reports and recommendations. (Government of Canada, 2021)	Geotechnical Engineers analyse soil, rock, groundwater, and other earth materials to inform and guide construction projects and environmental conservation. Their work supports infrastructure development like buildings, bridges, and dams, balancing technical requirements with environmental stewardship. This profession requires a blend of fieldwork, analysis, and collaboration with multidisciplinary teams to solve complex engineering problems. (ECO Canada, 2025)
South Africa	Engineering geologists investigate and provide geologic and geotechnical recommendations, analysis, and design associated with human development. (SAIEG, 2025)	*Not Recognised*	Geotechnical engineers are responsible for structures' foundations. Work includes assessing data from the field, finding ways to ensure foundations or slopes are stable, designing foundations, and overseeing work on a construction site

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			(South African Geotechnical Division, 2025).