Modelling to develop post-mining landform designs

Implications for Leading Practice

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- Leading practice is to ensure no erosion features remain on a post-mining landform where they result in the exposure of encapsulated hostile material
- To increase the likelihood of establishing a stable landform, leading practice emphasises designing landforms with clear, well-defined objectives aimed at ensuring erosional stability, particularly by reducing rill formation and preventing gully erosion
- Site-specific risks that have potential to make a landform unstable must be addressed in landform design
- Modelling and erosion studies are key tools applied to inform landform design
- OQMRC Technical Papers outline some key models and their applications - informative to assist with model and parameter selection and model validation
- Laboratory and field studies should be undertaken on the materials that a landform will be constructed from and used to inform the landform design

Background

Open cut mining removes large volumes of overburden to access mineral resources. Stabilising this material and establishing a viable post-mining land use after mining are key challenges for mine rehabilitation.

Mine waste landforms are constructed from unconsolidated materials and are highly susceptible to erosion (Australian Government 2016). The movement of sediment and other contaminants (e.g. saline or sulfidic material) from erosion features on mine waste landforms may destabilise the landform making it unsafe and unavailable for its post-mining land use (PMLU) and may impact the wider receiving environment.

A post-mining landform needs to be properly designed and constructed to minimise erosion and achieve long-term stability. Predictive erosion models provide a powerful way to test and compare landform design options. Modelling can be used to see how varying height, slope length, the use of different materials and surface protections will influence stability and help to gain insights and arrive at an optimal landform design. However, landform and erosion modelling requires a high level of technical expertise. The Office of the Queensland Mine Rehabilitation Commissioner (OQMRC) worked with technical experts to prepare information and advice on the topic of designing final landforms using erosion and landform evolution models. Two papers have been published – Hancock et al. (2025) and Loch et al. (2025).

Landform design studies

For post-mining landforms to be stable and functional, designs must be informed by an understanding of material properties, climate setting, the receiving environment and post-mining land use. Arbitrary designs developed without due consideration of site-specific circumstances and materials do not represent leading practice.

Landform design requires planning and a coordinated strategy and provides several benefits such as:

- reduced material movement and the resultant cost savings
- optimised final landforms in regard to shape, rates of erosion, vegetation establishment and ecological integration
- increased potential for sustainable use and minimal ongoing management of the landform post closure

These benefits are the direct result of a coordinated approach to planning and management of mine waste streams, setting clear objectives for the landform to achieve, understanding site-specific erosional processes, and applying erosion and predictive models to inform the design.

(Hancock et al. 2025, Loch et al. 2025).

Landform objectives

In developing leading practice advice on erosion modelling, we identified that appropriate target erosion rates are crucial for modelling purposes. Gully erosion is a critical failure point for landform stability; exposure of underlying contaminants is not acceptable, and rills are the pre-cursor to gullies. These principles inform what a target rate will be for the modelling study and establish the benchmark for a stable landform. However, post-construction any erosion rate is unacceptable if it leads to exposure of hostile materials and impacts to receiving environments in the final landscape.

Site-specific risks

The approach used to model erosion and develop landform designs should be consistent with guidance described in Loch et al. (2025) that requires:

- the level of modelling complexity and accuracy to be proportionate to site risks and defined according to a hierarchy
- that modelling demonstrates a conservative rate of predicted erosion can be met for high-risk scenarios such as where erodible materials are used, or off-site impacts are likely
- modelling to be robust and meet requirements described in the checklist on how to assess a modelling report.

Tunnel erosion (also known as ‘piping’) is not predicted by any of the models presented in the papers. Tunnels will grow each time they experience water flow, tend to collapse and form gullies. As tunnelling poses a risk to the stability of a final landform, risks regarding tunnel development must be considered when designing a landform, particularly where materials are dispersive.

Model selection and supporting data

To inform the landform design, several laboratory and field-based investigations are necessary to ensure material properties (e.g. salinity, potential for development of acid and metalliferous drainage (AMD), pH, permeability, water storage capacity, chemical fertility, erodibility and physical stability) are thoroughly understood. Digital elevation models (DEMs) and other survey techniques are necessary to provide a topographical understanding of the surrounding landscape, at a variety of scales, for modelling studies.

Different types of erosion prediction models are available, and each has its own approach, utility and limitations. As a result, it is critical that the model (or combination of models) selected for a study is capable of addressing the risks inherent in the landform, is supported by laboratory and field data, that site-specific parameters are developed and preferred over generic parameters, and that the model is tested and validated in its context (Hancock et al., 2025; Loch et al., 2025; State of Queensland 2018).

Post-construction, monitoring programs can be used to demonstrate the landform is achieving its objectives by informing maintenance programs and ensuring the landform is on a trajectory to a stable condition (Hancock et al., 2025).

Application to different landforms

Erosional processes can impact highwall crests and low walls of residual voids and can cause them to fail externally, intersecting with adjacent watercourses or diversions, roads, power and communication infrastructure and areas with other types of PMLU (Office of the Queensland Mine Rehabilitation Commissioner (OQMRC) 2025). The advice presented in Hancock et al. (2025) and Loch et al. (2025) is applicable to various types of landforms such as mine waste landforms, tailings storage facilities (TSFs), permanent levees, and residual voids which will remain in the post-mining landscape. Where engineered covers are required for AMD management on landforms such as TSFs, the function and resilience of these can be tested using erosion models.

Conclusion

As stated in Hancock et al. (2025:22) there are several benefits associated with using predictive erosion models:

> *They identify both short and long term erosion risk; can optimise both on-site and off-site environmental outcomes; provide a tool with which to assess financial liability and maintenance needs and cost; can assess risk of exposure of encapsulated or suboptimal materials; and are an accepted tool with which defensible predictions about landform performance can be made to government, industry and the community.*

An optimised landform design lays a strong foundation for successful achievement of a stable landform once constructed.

References

Australian Government (2016) *Leading practice sustainable development program for the mining industry: mine closure*, https://www.industry.gov.au/sites/default/files/2019-05/lpsdp-mine-closure-handbook-english.pdf.

Hancock G, Nicolson L, Purtill J and Dunlop J (2025) *Applying erosion and landform evolution models to assess post-mining landform stability: technical paper*, Office of the Queensland Mine Rehabilitation Commissioner, Queensland Government, Brisbane, https://www.qmrc.qld.gov.au/__data/assets/pdf_file/0027/383274/applying-erosion-lem-assess-post-mining-landform-stability.pdf, accessed 14 October 2025.

Loch R, Dunlop J and Nicolson L (2025) *Leading practice guidance on erosion and landform evolution modelling to design post-mining landforms: Technical Paper*, Office of the Queensland Mine Rehabilitation Commissioner, https://www.qmrc.qld.gov.au/__data/assets/pdf_file/0019/401671/erosion-lem-design-post-mining-landforms.pdf.

Office of the Queensland Mine Rehabilitation Commissioner (OQMRC) (2025) *Management of coal mine voids as non-use management areas: Practice Note*, Office of the Queensland Mine Rehabilitation Commissioiner, Queensland Government, Brisbane, Australia, https://www.qmrc.qld.gov.au/__data/assets/pdf_file/0036/391698/practice-note-management-coal-mine-voids-numa.pdf.

State of Queensland (2018) *QWMN good modelling practice principles*, Queensland Government, Brisbane, Australia, https://science.desi.qld.gov.au/__data/assets/pdf_file/0011/81110/qwmn-good-modelling-practice-principles.pdf.

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