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Incorporating geomorphology into mining river diversion designs

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Rivers are often diverted as part of mining operations. Streams are permanently diverted to allow access to access ore, or to avoid flooding of the mine. Mining diversions are common, especially in Australia, but they are seldom discussed because of commercial sensitivity. Also, many mine diversions perform poorly, with accelerated erosion, up and downstream impacts, and substantial damage to natural rivers. The result is that regulators are now demanding that diversions eventually develop the characteristics of natural rivers. Geomorphologists are getting involved in the design of diversions, which can potentially represent huge experiments in channel dynamics. Historically river diversions have experienced heightened rates of erosion, a lack of vegetation on the channel bed and in some cases, complete diversion failure. Poor diversion performance, both during the operational life of mines and following closure, has highlighted the need to incorporate geomorphic features endemic to the natural river channels being diverted.

This study examines the performance and design of river diversions, that divert ephemeral channels around large open-cut iron-ore mines in the semi-arid Pilbara Region of Western Australia. Analysis of existing diversions identifies shear-stress thresholds at which vegetation will establish, and at which severe erosion will occur. Two-dimensional hydraulic modelling also shows these diversions have higher shear stresses than their natural counterparts.

Hydraulic values for river diversions channels were calculated under a range of flow conditions to simulate changes in flow hydrodynamics with varying degrees of natural channel morphology. Results suggest that diversion channels have the ability to establish geomorphic units (bars and islands) if designed to limit shear stress and stream power values to a threshold allowing vegetation to establish. These vegetated features increase channel heterogeneity and promote morphological stability. Given the correct design dimensions, substrate and suite of appropriate vegetation, it is likely that river diversions designed in this manner will be able to withstand greater magnitude flow events and will be more likely to function naturally following mine closure.