CONSTRUCTION | PLANT HIRE | MINING

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Safe Road System: Maintenance Road Watering Improvement Process.

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Maintenance Watering of Mine Roads is the conundrum of managing risk on the road network; it reduces one hazard and increases another. This paper is an examination of that procedure and the development of an improved and safer operational process.

Road Material Audit

- Determine appropriate water application rates for at risk road materials

Water Truck Audit

- Can the water truck deliver required water application rate and appropriate watering method at relevant speeds?
- Water delivery system features:
  - Adjustments and modifications
  - Spray settings, pump settings and automated pulse values

Road Watering Audit

- Can the operator deliver the required water application rate & appropriate watering method on at risk road materials?
- Operator training and awareness of:
  - Water delivery system and water application rates
  - Watering methods and road materials

Safe Road System

- Is the road network maintaining a competent level of friction supply through appropriate water application rate and watering method?
- Regular monitoring and continual improvement risk management triggers:
  - New road materials
  - New water trucks
  - New operators

1. Background

Uncontrolled vehicle movements account for a notable proportion of safety related reportable mine incidents and uncontrolled movements due to deficient surface friction.

[1]*Analysis of reported incidents and observations by inspectors during follow-up inspections has shown:*

> *Most of the incidents (59%) took place on ramps*
> ***Watering or excessive watering was identified as the primary cause of such incidents (46%)***
> *Wet road conditions due to rain has been a causal factor in (8%) of incidents*

The challenge confronting surface mining operators is the inherent conflict of dust management without compromising safe road surface friction levels. This situation is exacerbated by demanding and changing road geometry, construction limitations and water sensitive friction properties of substandard competent material type.

A Safe Road System can be established where the available friction supply exceeds normal vehicle operation friction demand and provides a measurable '*factor of safety*' margin for safer operation of mine vehicles.

2. The Safe Road System Model

The *Safe Road System Model* was developed for mine road networks to address the correlation between the three foremost road safety critical elements. This paper has a focus on the road water application component of the model.

Assessment Tools

1. **Road Material Audit**
2. **Road Watering Audit**
   Water Truck Audit
   Operational Road Watering Audit
3. **Road Geometry Audit**

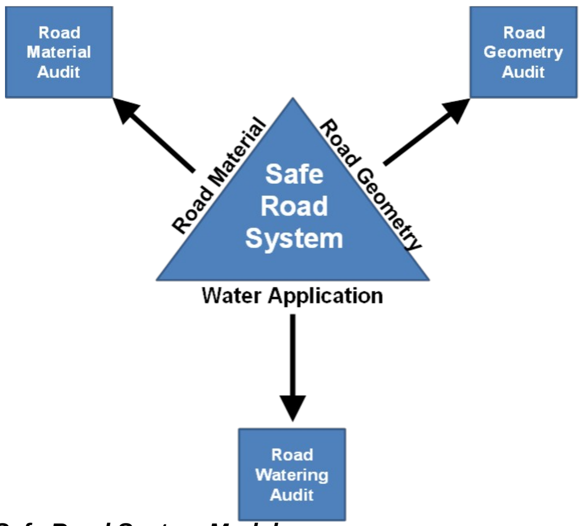


Figure 2. Safe Road System Model

[1] Safety bulletin no. 99 (Version 1) 23 August 2010

2.1 Mine Road Watering Improvement Process

The watering improvement process displayed in *Figure 2A* integrates an auditing methodology that utilises the safe road system principal branches in a continual improvement risk management procedure.

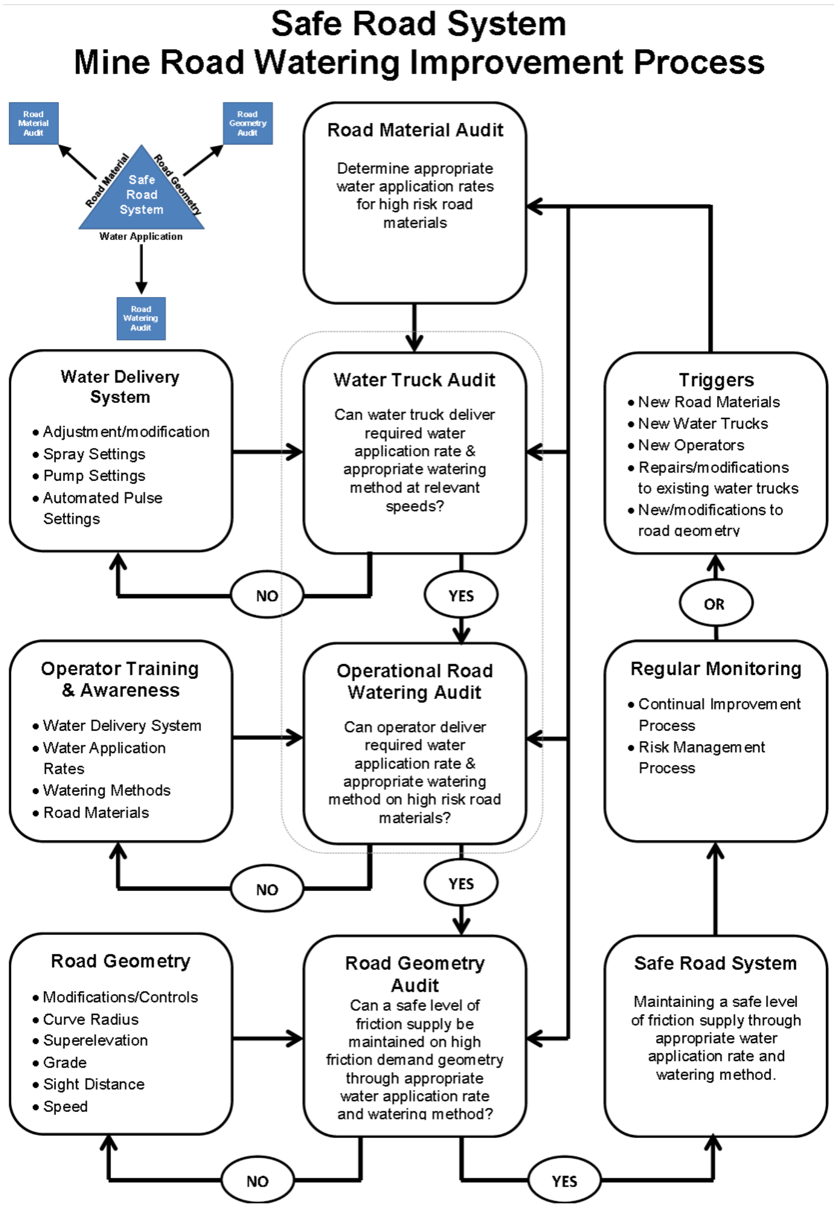


Figure 2A. Tulloch/Stocker Process flowchart

The above process expanded on in subsequent pages; begins with a *Road Material Audit* to identify higher risk roads and determine appropriate water applications rates. This is followed by a *Road Watering Audit* consisting of a *Water Truck Audit* and an *Operational Road Watering Audit*.

The *Water Truck Audit* determines whether water trucks can deliver the required application rate and appropriate water application method. The *Operational Road Watering Audit* concludes whether the operators control or determine the situational awareness of changing conditions and appropriate watering method on at risk roads.

The final procedure in the process is *the Road Geometry Audit* which governs whether a safe operating level of friction supply can be maintained on high friction demand geometry such as ramps, curves and intersections through appropriate water application rate and watering method.

3. Road Material Audit (Higher Risk Roads)

The Road Material Audit identifies the higher risk water sensitive road materials and determines the appropriate water application rates to maintain a safe operating level of friction supply. The model illustrated in *figure 3* provides a guide to operating levels of friction for mine vehicles, including haul trucks, founded on extensive field research and development conducted by the authors of this paper.

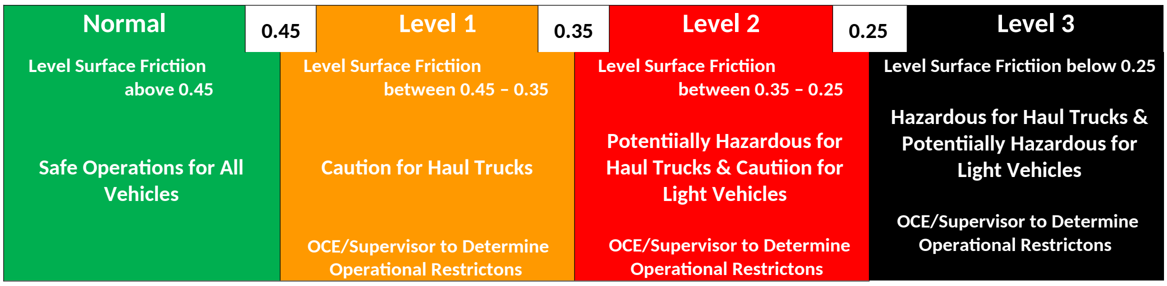


Figure 3. Tulloch/Stocker Global Road Friction Risk Model

The Road Material Audit is completed by performing a series of *Mine Friction Tests* on the mine road network firstly under dry conditions and then followed by a measured water application rate of 0.3mm per square metre of road surface. This procedure measures the available friction supply and allows the road material to be firstly classified and then identified as a higher risk road using the above *Friction Guide.*

The *Mine Friction Test* involves driving a mine ABS equipped light vehicle at ~35km/h across the subject road material and applying emergency ABS braking until the vehicle comes to a complete stop. The available friction supply is measured using a portable accelerometer based device fitted to the interior of the vehicle that displays the test results in real time.

A mine road material audit does not require an exhaustive test regime. The audit process to classify an individual wearing course material risk profile using a typical mine light vehicle takes about 5 minutes using a calibrated water truck; with no interference to mining activities or operational road safety.

With a focus on the higher risk classified road surfaces, a safe application rate[2] can be determined taking into account the effect of seasonal and ambient mine conditions at any particular time during day or night time operations.

[2] Water application methodology such as spot or strip watering, not examined in this paper, forms part of safe watering procedures.

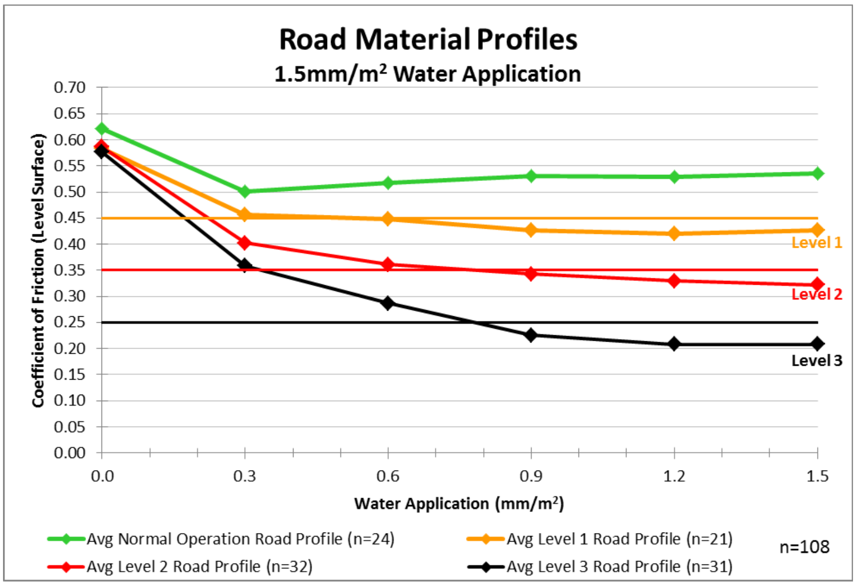


Figure 3A. Mine Road Friction Performance Profiles (Global Data)

3.1 Safe Water Application (Higher Risk Roads)

The measured data displayed in *figure 3*A represents thousands of individual field tests on 108 diverse road wearing course surface profiles at 18 operational mine sites throughout Queensland.

Real world watering application to ground rates from these operational mines was measured at between 0.15-1.2mm/m² with an observed mean most commonly in a range of 0.3-0.6mm/m².

The safe road system model defines the importance of classifying mine roads to determine road risk profiles on the network. High friction performing roads displayed in *figure 3A* as normal operations (green) and Level 1 (amber) are relatively friction insensitive surfaces and consequently represent a low risk to water application rate anomalies during mining operations.

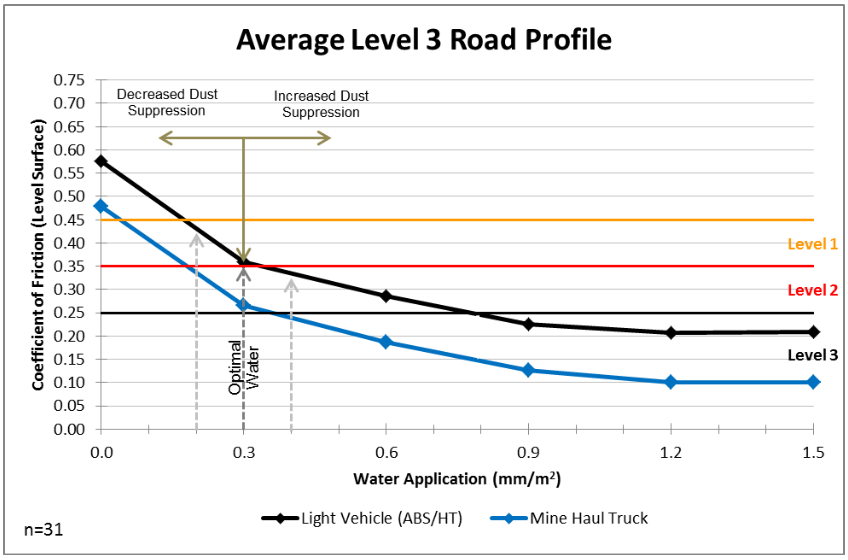


Figure 3B. High Risk Road Profile (Global Data)

A road wearing course surface classified at Level 3 (black), requires significant compromise between adequate dust suppression and safe operating friction values if remedial treatment such as road surface sheeting is not a viable option. An optimal water application to ground rate range is depicted in *figure 3B*, subject to seasonal and other site specific conditions.

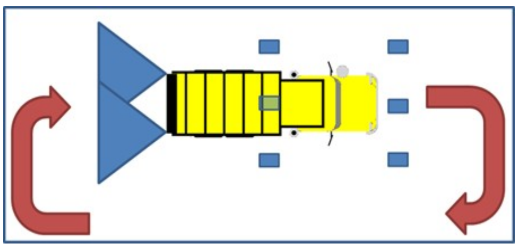
4. Water Truck Audits

The *Water Truck Audit* was developed to determine whether water trucks could actually deliver the required water application rate and appropriate watering method on high risk road materials at the relevant operational speeds particularly on ramps, curves and main haul roads.

Visits to some 18 mine sites has resulted in detailed measurements of application rates, operational observation and interviews with about 40 water truck operators. This extensive research has provided a solid basis to provide valid commentary on current industry practices and existing operational water truck fleet capacity.

The water truck audit examines current practices for each water truck delivery system. The purpose is to benchmark and improve upon current road watering practices. The wide variety of water trucks and delivery systems currently in use provides an imperative that any prescribed water truck audit is straightforward and sufficiently robust to accurately measure any unit used in field operations.

Figure 4. Water Truck Audit (Calibration) in Progress



$$A_W = \frac{V}{(A_S \times n)}$$

Aw = $Water\ Application\ Rate\ (mm/m^2)$
V = $Volume\ of\ Water\ Captured\ (litres)$ As
= $Surface\ Area\ of\ Containers\ (m^2)$
n = $Number\ of\ Passes\ in\ Water\ Truck$

Figure 4A. Calibration procedure diagram & water application rate formula