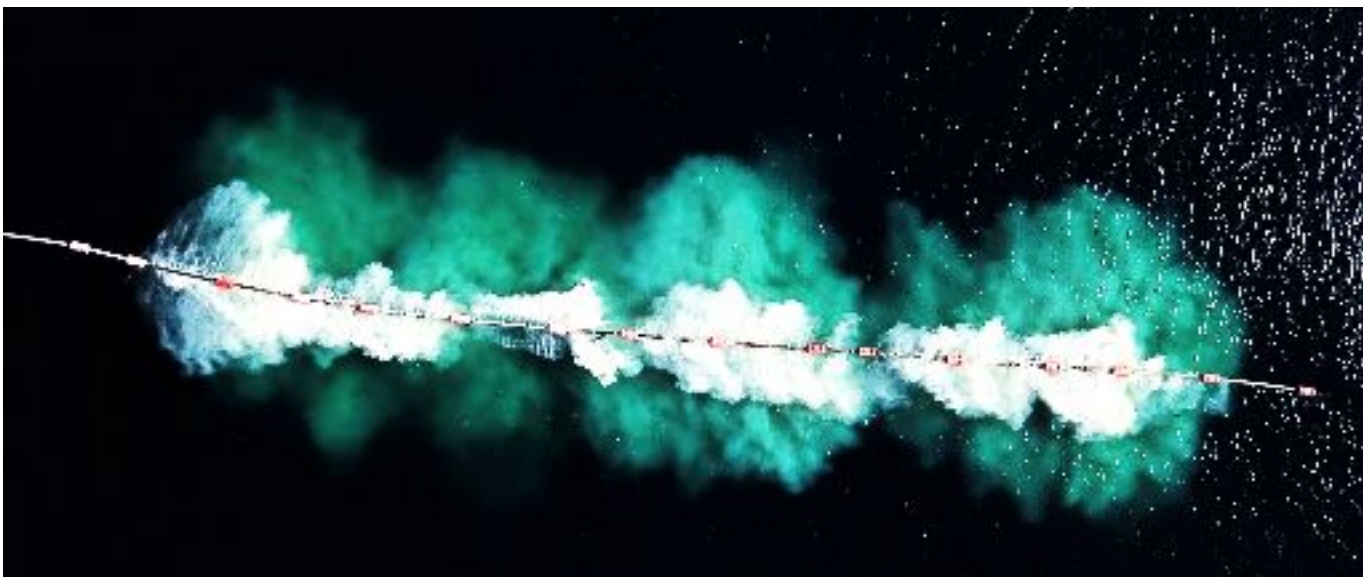


Case Study

**The use of Enviro Catalyst to treat
Acid Mine Water to enable
release into the environment.**

27 November 2017



Case Study: The use of Enviro Catalyst to treat Acid Mine Water to enable release into the environment.

Problem: The decontamination of a pit located in the Northern Territory holding 1,380 mega-litres of acidic water with a high level of dissolved potentially toxic metals. The pit contour approximates a V-shape with dimensions 600m length x 100m width x 40m depth.

The desired outcome is for the final water quality above 25m depth (approximately 80% of the total volume of the pit) to achieve ANZECC 80% standards with minimal dilution enabling approved release into the environment.

Summary: Micronised Mineral Solutions (MMS) has developed an innovative solution for the decontamination of Acid Mine Water. This process significantly reduces the key dissolved metals to enable efficient (low dilutions rate) and safe release (better than ANZECC 80% standard) of the treated water into the environment.

In this trial MMS used a combination of 1,760 tonnes of its proprietary reagent, Enviro Catalyst (patent pending), and its specifically designed Dry Shear (patent pending) technology to process the 1,380 mega-litres of Acid Mine Water stored in the pit.

At the completion of the trial the following advantages in the use of MMS's Acid Mine Water Decontamination Process were confirmed:

- High reduction in dissolved metals (approximately 99.6% of measured metals were precipitated from the pit water).
- Achieved ANZECC 80% standards without dilution for measured metals.
- Stable and uniform water quality following the trial.
- No requirement for fresh, pH neutral water for the treatment process (in situ pit water used).
- No requirement for expensive slaking infrastructure.
- Treatment volumes of up to 170 tonnes of Enviro Catalyst per 12 hours of operation, potential to treat 1,380 mega-litres in 8 days.
- High pH levels achieved and maintained (8.5pH as at the date of this case study).
- Stabilised sulphate level of 2,000mg/litre.
- Uniform penetration of the reagent over the 600m length of the pit and throughout the various depths of the water during processing.
- Resistance to rainfall and surface water contamination (no negative change in dissolved metals with an initial 160mm of rain post processing of the pit)
- Independent, third party sampled and reported data.

Further investigations will see the effectiveness of the decontamination of the pit water confirmed through a series of Ecotoxicology Tests (expected December 2017).

For more information about this project please contact Micronised Mineral Solutions on Ph: 08 8947 1872 or admin@micronisedminerals.com



Fig 1: Pit transition in colours through the processing period

Case Study: The use of Enviro Catalyst to treat Acid Mine Water to enable release into the environment.

Description: The pit of water to be treated has been contaminated over time through the Acid Mine Drainage (AMD) process. AMD is created when water flows over or through sulphur-bearing materials and forms an acidic solution. This acidic solution dissolves the metals contained within the rocks which then flows into the pit water. It is a subset of these soluble heavy metals which are toxic to the environment.

The pit water is non-flowing and detailed sampling of the pit prior to treatment showed the water parameters (pH, dissolved metals and electrical conductivity) were uniform across the surface and throughout the depth.

The pit had a low pH and high dissolved metals content due to the extended period the AMD water has been stored within the pit. The pit is long and narrow in shape, and only accessible from one end. To be effective the process needs to be able to disperse efficiently throughout the water for the 600m length of the pit.

Pit Specs: Dimensions: V-shaped, approximately 600m x 100m, maximum depth 40m.
Volume: 1,382 mega litres.
Acidity: pH 3.98 (pre-treatment).
Data Points: 12 samples, 3 depths (3m, 10m and 20m) spread across 3 locations down the 600m length of the pit.

Parameters of the water body to be treated before processing.

Parameter	Units	Average	Std. Deviation
Acidity	pH	4.0	0.39
Electrical Conductivity	$\mu\text{S/cm}$	2,900	0.00
Sulphate	mg/L	1321	279.17
Aluminium	$\mu\text{g/L}$	27,083	670
Arsenic	$\mu\text{g/L}$	<50*	N/A
Cadmium	$\mu\text{g/L}$	<10*	N/A
Copper	$\mu\text{g/L}$	2,183	58
Iron	$\mu\text{g/L}$	163	5
Lead	$\mu\text{g/L}$	<30	N/A
Manganese	$\mu\text{g/L}$	22,500	522
Zinc	$\mu\text{g/L}$	2,400	74

* Measurement was below detection limits.

Samples taken by an independent environmental consultancy and metals measurements data reporting from a qualified laboratory.

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Material: The project was designed to trial the effectiveness of MMS's proprietary reagent, Enviro Catalyst in the treatment of the pit water. Enviro Catalyst has similar chemical outcomes to Hydrated Lime, a strong reagent in the decontamination of AMD water. Enviro Catalyst has a higher specific gravity, lower cost of production and equivalent decontamination outcomes compared to Hydrated Lime. Importantly, Enviro Catalyst can also be used without a slaking process and does not require a pH neutral water source to create a milk of lime.

The properties of Enviro Catalyst are:

Properties	Method	Enviro Catalyst™	
		Typical	Range
CaO Available	AS4489-1997	72%	70% MIN
ENV*	AS4489-1997	104.5%	100% MIN
SiO ₂	XRF	1.0%	1.0% MAX
Al ₂ O ₃	XRF	0.5%	0.5% MAX
Fe ₂ O ₃	XRF	0.1%	0.1% MAX
MgO	XRF	1.5%	1.5% MAX
SO ₃	XRF	0.19%	0.19%MAX
pH in slurry	AS4489-1997	12	11 MIN

*Theoretical Effective Neutralisation Value

Physical Properties	Typical	Range
Grain Size (< 100µm)	>95% Passing	90 -100%
Surface Area (/kg)	930 m ²	900-1000 m ²
Bulk Density	1050 kg/m ³	950-1100 kg/m ³

Preparation: MMS initiated the project with a number of bench tests to determine the levels of Enviro Catalyst required to effectively treat the pit water to achieve ANZECC 80% standards. This requires elevating the pH of the pit water to a level where the dissolved metals precipitate out of the treated test solution. The target level was 9.0pH, at this point it is expected that a significant amount of dissolved metals will be precipitated out.

Finalising the appropriate treatment rate from the bench tests, MMS conducted a 1,000 litre time trial using water from the same pit. The trial involved the daily application of 10% of the total mass of Enviro Catalyst required for 10 days.

1,000 Litre Test Results

Day	1	2	3	4	5	6	7	8	9	10
pH*	3.8	4.3	4.4	4.7	4.9	5.3	5.7	7.4	8.9	8.8

* pH reading taken prior to application of Enviro Catalyst

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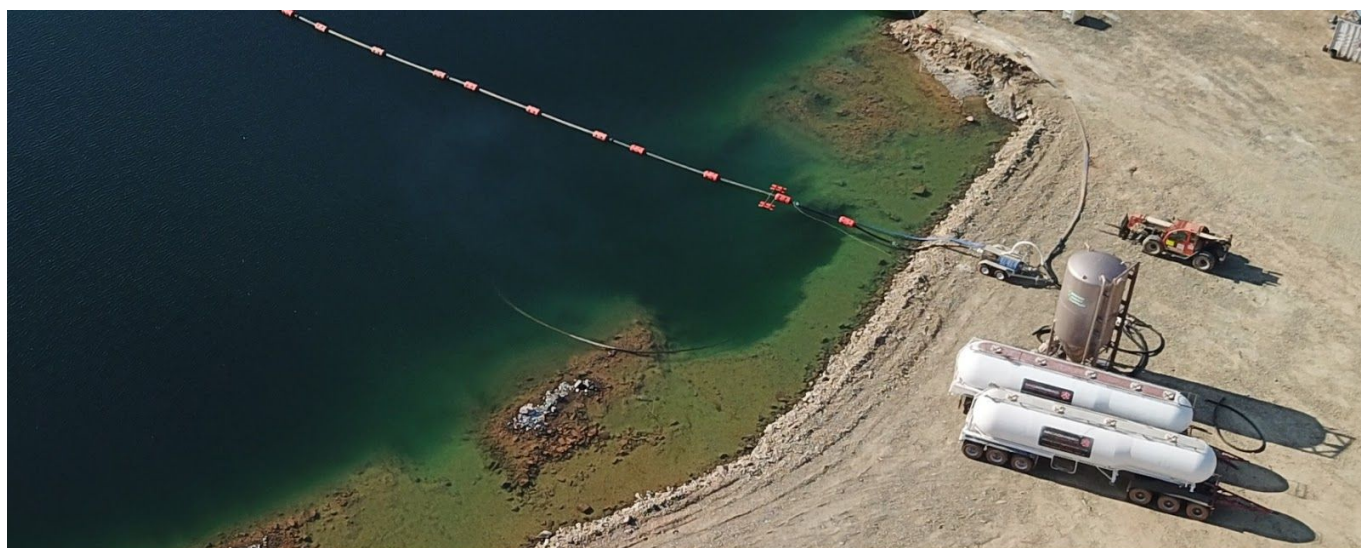
Metal Content Results from 1,000 litre trial

Parameter	Units	Before Processing	After Processing
Acidity	pH	4.0	8.8
Electrical Conductivity	µS/cm	2,900	2375
Sulphate	mg/L	1321	1910
Aluminium	µg/L	27,083	10.2
Arsenic	µg/L	<50*	N/A
Cadmium	µg/L	<10*	0.3
Copper	µg/L	2,183	5.1
Iron	µg/L	163	10
Lead	µg/L	<30	0.1
Manganese	µg/L	22,500	875
Nickel	µg/L	19,300	60.2
Zinc	µg/L	2,400	21.1

* Measurement was below detection limits.

Equipment: The project required the following equipment at site for the processing of the acid water body.

1. High Flow Water Pump (not visible in photo).
2. MMS's Dry Shear (patent pending)
3. Portable Lime Silo's to hold 90+ tonnes of material (used to reduce time spent on site by delivery agents).
4. 100m 6" diffusion pipeline.
5. High Flow Air Pumps for the fluidising of the reagent (not visible in photo).



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Fig 2: Equipment Installed

Processing: Site preparation - 2 days equipment assembly in preparation for processing.

Processing of the water was completed in 17 days. At the end of the processing period the pit water's pH exceeded 9. The pit water was sampled on a weekly basis by a third party and sent to an accredited laboratory for analysis and reporting. Approximately 6 weeks from the completion of the processing stage the advantages of MMS's Acid Mine Water Decontamination Process were confirmed.

The trial achieved a reagent processing rate of 170 tonnes in a 12 hour window, suggesting with improved logistics this project could have been completed in 8 days, using 2 people on site.

The results obtained show a better than 99.6% reduction in measured metals, with a significant number of metal ions showing levels better than ANZECC 95% requirements.

Excluding Sulphate levels, the data shows all metals are within ANZECC 80% Standards.

The process has increased sulphate levels to 2000 mg/L which will be the deciding factor in dilution rates on this site. The Ecotoxicology tests are being conducted to determine the marginal effect of this higher sulphate level on the environment. The Ecotoxicology results are due January 2018.

Results 7 weeks post processing

Parameter	Units	Before Processing	After Processing
Acidity	pH	3.98	8.54
Electrical Conductivity	µS/cm	2,900	3,100
Sulphate	mg/L	1321	2,000
Aluminium	µg/L	27,083	106 ¹
Arsenic	µg/L	<50*	3.14 ³
Cadmium	µg/L	<10*	0.14 ³
Copper	µg/L	2,183	1.5 ²
Iron	µg/L	163	10*
Manganese	µg/L	22,500	179 ³
Lead	µg/L	<30*	1.0 ³
Nickel	µg/L	19,300	14.4 ¹
Zinc	µg/L	2,400	7.4 ³

* Measurement was below detection limits.

¹ Measurement is within ANZECC 80%

² Measurement is within ANZECC 90%

³ Measurement is within ANZECC 95%

Samples collected by a third party and tested for metals content by an accredited laboratory.

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