

# Acid Mine Drainage, Krugersdorp

Tristan Brooks, Stuart Cloete, Amy Govender, James Myhill, Maxine-Anne Smuts

Trinityhouse Randpark Ridge



## INTRODUCTION

Acid Mine Drainage (AMD) is the formation and movement of highly acidic water rich in heavy metals and chemicals.

The effect of AMD on the Lancaster dam in Krugersdorp and the surrounding settlements and environments, will be unpacked. The metals affecting the Krugersdorp region include: magnesium, aluminum, iron, uranium, lead and cadmium namely; along with the chemicals: arsenic and sulfuric acid. Not only does Acid Mine Drainage make water sources contaminated, it kills aquatic life and the environment surrounding it.

The main mines adding to the issue of AMD in this region include the Lancaster mine, Mogale Gold Mine and Harmony Gold Mine. This major issue is caused mainly by the natural reaction between oxygen, sulfur and water forming sulfuric acid that then seeps into the ground water bodies in the surrounding area. This happens when the sulfurous rock left by the mining activity is then reacted with rain water and oxygen. Some of the affected settlements in the area are Olivanna, Sinqobil and West Village.

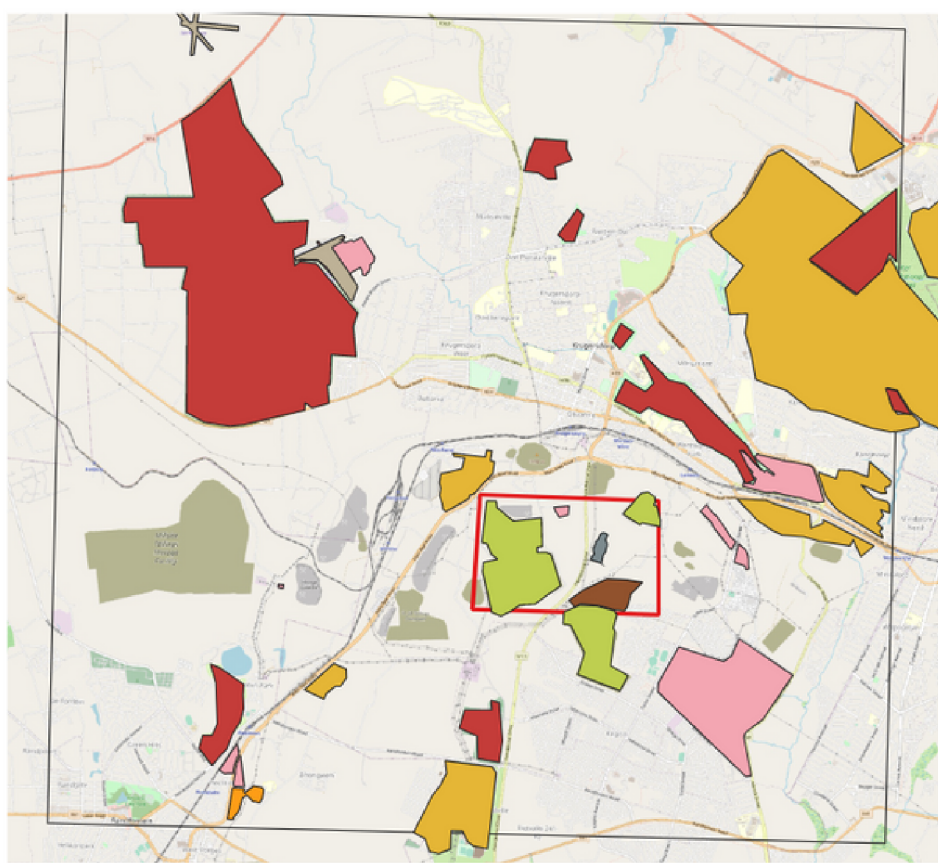


Figure 1: AMD water, Lancaster Dam

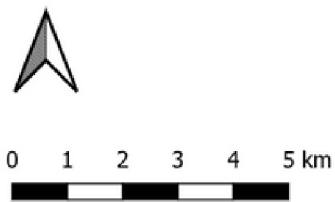


Figure 2: AMD water from a stream located near Lancaster Dam

## MAP



- Legend:**
- Mine Tailings
  - Lancaster Dam
  - Informal Settlement
  - Airport
  - Natural Areas
- Land Use**
- landuse\_industrial
  - landuse\_commercial
  - landuse\_residential
  - Study Area
  - Krugersdorp



## METHODOLOGY

Objective	Method
To determine the chemical composition of the water contaminated with AMD in the Krugersdorp area	Water samples from multiple sources were collected in order to allow for testing.
To determine the effect of AMD on the Krugersdorp area's ecology	Water samples and plant samples were collected for testing and research was conducted in the field
To determine the effect of AMD on the surrounding settlements in the Krugersdorp area	Historic and modern resources were consulted to see the effect of the AMD on the area
To determine the socio-economic effects and deterioration of infrastructure in Krugersdorp due to AMD.	Multiple resources were consulted, meetings with a professional in the field along with viewings of dilapidated infrastructure



Figure 9: Collecting a water sample from stream near Lancaster Dam (Tristan Brooks)



Figure 10: Western Basin AMD Treatment Facility Settle Plant

## CONCLUSION

The Acid Mine Drainage problem is a grave issue affecting the West Rand and Krugersdorp area. Although it can be acknowledged that this is a problem, the following solutions can be considered in order to combat the issue of Acid Mine Drainage:

### Land Use:

- Improving the security regarding the entry points of the dump sites will limit the access to the dump site and decrease accidents that take place in the area.
- Raise awareness of AMD and it's affected areas, in the form of increased news circulation as well as integration into school syllabi.

### Pipes:

- To combat the issue of the lack of longevity as well as the dumping of pipe infrastructure:
- Bury old pipes underground to limit buildup of dumps.
- Conduct investigations into the possibility of chemical use to remove residue buildup in the pipes.
- Provide tax reliefs to the private companies that contribute to pipe replacement.

### Impact on the community:

- As there is a huge increase in issues regarding sickness in the community, the following solutions can be applied to help curb the medical issues:
- Provide medical aid for the communities affected by AMD; for example, a specific clinic that is allocated to treat AMD issues.
- Provide clean water filters for the communities in the area in order to provide clean water for community consumption.
- Subsistence farming in the informal settlement - government should provide boxes for planting vegetables. This planting soil will be full of nutrients (as opposed to the soil that is affected by the AMD), thus allowing for the growth of healthy and nutritional food for the community.

## RESULTS

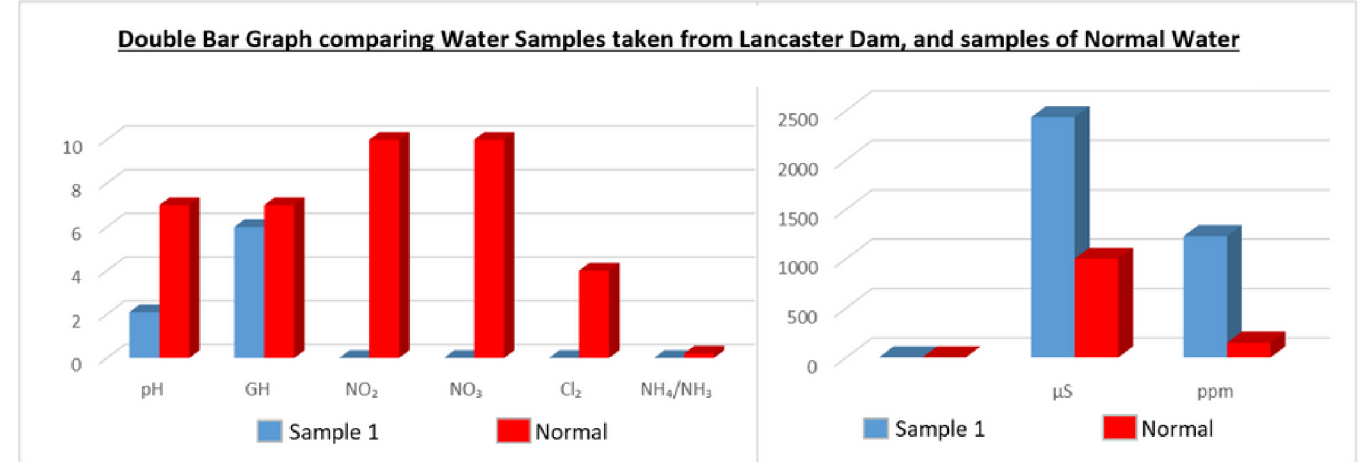


Figure 3: Bar graph containing water sample results

### Dams and Water Bodies

Water samples taken from Lancaster Dam indicate a very low pH of 2.1 (hydrochloric acid has a pH of 1.08) showing that the water is highly acidic. This high level of acidity in the water means that it is highly unsuitable for both human use and aquatic life. Testing shows the absence of biowaste such as NO<sub>2</sub>, NO<sub>3</sub> and NH<sub>4</sub> which indicates the absence of life in this water. The mid range of water conductivity, which is the background for most major rivers, is 200 to 1000 microsiemens per centimetre (μS/cm). The sample from Lancaster dam tested a high conductivity of 2433 μS/cm which is far outside the range indicating that the water is not suitable for life. The high concentration of chemical contaminants of 1228 ppm (ppm = parts per million) present in the sample is an indicator of the danger of consuming this water.

Table Displaying results of AMD water testing:

	Water Samples			
	Sample 1 (Lancaster Dam)	Sample 2 (Stream by Lancaster Dam)	Untreated AMD (Western Basin Treatment Facility Settle Plant)	
Test strips	pH	6.4	6.4	
	KH	0	10	
	GH	6	4 to 8	
	NO <sub>2</sub>	0	0	
	NO <sub>3</sub>	0	0	
	Cl <sub>2</sub>	0	0	
Tests	NO <sub>2</sub>	0	0	
	NO <sub>3</sub>	0	0	
	NH <sub>4</sub> /NH <sub>3</sub>	0	0.25	
	Machine test	pH	2.1	6.58
		μS	2433	1407
		ppm	1228	704
Temp		23.2	23.4	

The general hardness (GH) is the amount of calcium and magnesium ions present in the water. The ideal GH for humans is a GH of between 0 and 7°dH. The water sample from the stream on the other side of the retaining wall of the dam had a GH of 8°dH, which is outside of the needed range. In the last century 73000 tons of uranium has been mined and dumped in this area. This uranium is capable of spontaneously giving off energy and particles that have potential to break chemical bonds and damage living cells; this property is known as radio-toxicity, and has the potential to affect the surrounding environment and people who come into contact with it.



Figure 4: Untreated AMD water at Western Basin AMD Treatment Facility Settle Plant



Figure 5: Mine Dump Land, Krugersdorp



Figure 6: Bird skeleton located near Lancaster Dam

### Health and Vegetation

The AMD contains the carcinogenic compounds: As and Pb, as well as the heavy metals: Cd, Co, Cr, Cu, Mn and Zn (which are harmful in high quantities). These compounds have many effects on the flora and fauna. The AMD has a devastating effect on the ecology of the region - the poisonous heavy metals as well as low pH of the water results in the death of aquatic life and the decline in aquatic species population. The contaminated water also affects terrestrial flora life. This can be seen by the large number of invasive red gum (Eucalyptus camaldulensis) trees found around the Lancaster dam, which is infested with the red lerp psyllid (Glycaspis brimblecombei). The infestation can be attributed to a lack of naturally occurring predators and the run-down nature of the trees due to the toxic nature of the water. The consumption of the nutritious sap by G.brimblecombei further worsens the condition of the trees, leading to a vicious cycle of habitat loss due to invasive plants and the AMD contaminated water. The contamination of drinking water supply contaminates the food chain resulting in it affecting the local inhabitants. These contaminants enter the food chain through AMD contaminated water. Heavy metals in the water will collect in the tissues of fish and other animals whose meat is consumed. If enough metals collect, it can be toxic to the fish, other animals or to any creature that eats them. These metals can be ingested by humans through drinking water supplies or through the food chain causing severe health problems: Lead causes brain, kidney, and nervous system damage; Cadmium causes high blood pressure, liver damage, cancer; Mercury causes deterioration of the nervous system; Arsenic and Lead cause deterioration of the nervous system as well as many cancers

### Urban Settlement

To compliment the health risks caused by AMD, there are also numerous social factors to be considered. There are many settlement areas found near the mines and this will have an impact on their day to day lives. Thabo hlaole place is a lower income residential area that is an example of this and will be analysed. Due to the areas proximity to the mines, majority of adults work in the mining sector. In doing this, it does not only pose health risks but demands long working hours, meaning little time at home. As a result, children are left alone at home.

Furthermore, these children are exposed to the harmful environment. When they play in the area or swim in dams with friends, they are unknowingly putting their lives at risk. Lastly, water is a key component to any human's survival. It is not certain, but it can be believed that the tap water that individuals may be consuming is also contaminated. Although residents may not notice immediate effects, it can have devastating consequences in the long run.



Figure 7: Informal settlement near Lancaster Dam



Figure 8: Children playing in AMD water, Lancaster Dam



Figure 11: AMD pipes

### Business, Tourism, Socio-economic issues and Crime

The South African tourism industry is one of the main sources of income for the country. In the Krugersdorp area, many residents and businesses are affected due to lack of maintenance of infrastructure. As of recently, Krugersdorp was known to be a tourist attraction hub, which includes game farms, mining sites, airports and caves. Due to the acid mine drainage, these businesses and attractions are being heavily affected. This is evident in the many run down areas and lack of maintenance from government. Another example of government being neglectful, is in the form of water pipes - which begin to fill up with the acid mine drainage residue and thus need to be replaced. The resulting maintenance costs are expensive as the pipes must be replaced every 3-6 months, depending on how much residue has formed in them. Used pipes are inoperative due to the metal deposits and residue and as a result are dumped on surrounding land. This leads to to wastage and ineffective use of resources.

Although the government has pledged a long term solution of implementing R12 Billion to combat Acid Mine Drainage in 2016, 7 years later the situation has deteriorated dramatically.

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