





**DRINKING WATER FROM MINE WATER USING THE HIPRO® PROCESS -  
OPTIMUM COAL MINE WATER RECLAMATION PLANT**

Kathy Karakatsanis<sup>1</sup> and Vik Cogho<sup>2</sup>

<sup>1</sup> Keyplan (Pty) Ltd, Johannesburg, Gauteng, South Africa  
<sup>2</sup> Optimum Coal Mine, Department Environment and Projects, Pullensthep, Mpumalanga, South Africa





IMWA 2010 Symposium  
Sydney, Nova Scotia, Canada  
6<sup>th</sup> September 2010

**OUTLINE**

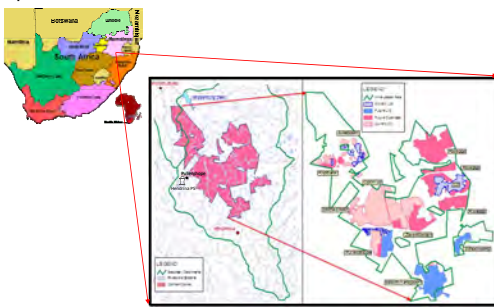


- Background
- Mine Water Reclamation Project
  - Mine Water Collection and Transfer
  - Mine Water Treatment Plant
  - Treated Water Collection and Distribution
  - Waste Disposal
- Conclusion
  - Recovery
  - Waste Production
  - Operating Costs

2

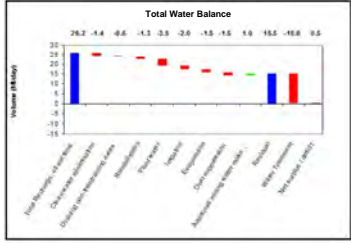
**BACKGROUND**

- Optimum Coal Mine

**BACKGROUND**

- Water Management Scheme



Category	Volume (Mm³)
Total Recharge (Surface)	26.2
Total Recharge (Groundwater)	-1.4
Chlorination (Wastewater)	-0.6
Chlorination (Municipal Sewerage)	-1.3
Chlorination (Municipal Wastewater)	-2.0
Evaporation	-1.5
Evaporation (Municipal Wastewater)	-1.5
Chlorination (Municipal Wastewater)	1.0
Chlorination (Municipal Wastewater)	15.5
Chlorination (Municipal Wastewater)	-16.8
Chlorination (Municipal Wastewater)	0.5

4






**BACKGROUND**

- Selection of Water Treatment Technology
  - >98% Water Recovery
  - Minimum Brine Waste Generation
  - Potentially Useful Solid By-products
  - High Quality Drinking Water (SANS highest standard)
  - Large-scale Commercially Proven Technology

**HiPRO® PROCESS**  
(High Recovery Precipitation Reverse Osmosis Process)

5

**BACKGROUND**

- eMalahleni Water Reclamation Plant
  - Anglo Coal & BHP Billiton joint initiative
  - 25Ml/day Treated Water Production
  - >99% Water Recovery
  - Guaranteed <450mg/l product water TDS



6

**MINE WATER RECLAMATION PROJECT**

7

**MINE WATER RECLAMATION PROJECT**

- Mine Water Collection and Transfer

8

**MINE WATER RECLAMATION PROJECT**

- Mine Water Quality

Water Quality Parameter	Unit	Evaporation Dam Water	
		50 percentile	95 percentile
<b>Inorganic quality:</b>			
pH	-	7.0	8.5
Conductivity	mS/m	525	635
TDS	mg/l	5220	6380
Sodium, Na	mg/l	110	140
Potassium, K	mg/l	50	85
Calcium, Ca	mg/l	550	595
Magnesium, Mg	mg/l	570	750
Chloride, Cl	mg/l	35	45
Sulfate, SO <sub>4</sub>	mg/l	3500	4400
M Alkalinity, CaCO <sub>3</sub>	mg/l	340	465
Fluoride, F	mg/l	0.5	0.8
Nitrate, NO <sub>3</sub> -N	mg/l	0.2	1.2
Ammonia, NH <sub>3</sub> -N	mg/l	0.4	1.7
<b>Metals:</b>			
Iron, Fe	mg/l	0.01	0.6
Aluminum, Al	mg/l	0.02	0.5
Manganese, Mn	mg/l	0.2	2.4
<b>Trace elements:</b>			
Barium	mg/l	0.02	0.03
Silica, SiO <sub>2</sub>	mg/l	2.3	5.8
Strontium	mg/l	N/A	N/A
<b>Organic:</b>			
Suspended Solids	mg/l	56	150
TOC	mg/l	11	30
Chlorophyll	µg/l	9	30

9

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant

10

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant – Pretreatment
  - Stage 1
    - Feed - Neutral pH, Low Mn & Fe
    - No Neutralisation
    - Ozone – oxidation & disinfection
    - Clarifiers – solids settling
    - Sand Filters - polishing
  - Stage 2 & 3
    - RO reject feed – supersaturated
    - Precipitation reactors – high pH with lime
    - Hydrocyclones – solids classification
    - Clarifiers – solids settling

11

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant - Pretreatment

12

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant – Ultrafiltration
  - Solids removal
  - Total of 11 UF Skids
    - Stage 1 – 7 Skids
    - Stage 2 – 3 Skids
    - Stage 3 – 1 Skid
  - Dead-end mode operation
  - Automatically and intermittently backwashed
  - Backwash water collected in Plant Sump and retreated
  - Antiscallant dosing

13

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant - Ultrafiltration



14

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant – Reverse Osmosis
  - Dissolved Salts removal
  - Total of 7 UF Skids
 

• Stage 1 – 4 Skids	70% Recovery	13 bar
• Stage 2 – 2 Skids	65% Recovery	18 bar
• Stage 3 – 1 Skid	60% Recovery	30 bar
  - Permeate – to potable or excess water distribution
  - Reject – to next stage or brine pond

15

**MINE WATER RECLAMATION PROJECT**

- Mine Water Treatment Plant – Reverse Osmosis



16

**MINE WATER RECLAMATION PROJECT**

- Treated Water Collection and Distribution
  - Potable Water
    - Stabilised and Disinfected RO Permeate
    - Guaranteed <450mg/l TDs and SANS Class 0 compliant
    - Hendrina Municipality
    - Current capacity 5ML/day
  - Excess Water
    - RO Permeate
    - Guaranteed <450mg/l TDs and SANS Class 0 compliant
    - Released to clean water canal, upstream of mine workings
    - Balance of 15ML/day not assigned to potable water

17

**MINE WATER RECLAMATION PROJECT**

- Waste Disposal
  - Mixed Sludge
    - Transferred to lined Sludge Pond with large settling capacity
    - Supernatant is returned to WTP for further treatment
    - Solids content 10-15% (m/v)
    - Primarily Mg(OH)<sub>2</sub> and CaSO<sub>4</sub> fines
  - Gypsum Sludge
    - Dewatered by means of a Vacuum Belt Filter
    - Filtrate is returned to WTP for further treatment
    - Dewatered Gypsum is stockpiled with prospect of sale to potential users
  - Brine
    - Stage 3 RO reject ~30 000mg/l TDS
    - Brine Pond - evaporation

18



**CONCLUSION**

- Recovery
  - 98% Potable Water Recovery
- Waste Production
  - Mixed Sludge
    - 2.34 m<sup>3</sup>/h water AND 3.52 t/h solids
  - Gypsum Sludge
    - 0.55 m<sup>3</sup>/h water AND 1.28 t/h solids
  - Brine
    - 6.1 m<sup>3</sup>/h water
    - ~ 30 000 mg/l salinity
- Operating Costs (March 2010) – 15ML/day
  - Variable: ~R5.00/m<sup>3</sup> (excl. Power)
  - Fixed: ~R2.50/m<sup>3</sup>

1 CAD = 6.67 ZAR

19



Construction of Optimum Water Reclamation Plant - September 2009