CHAPTER 1 - INTRODUCTION

1.1 Introduction

Mining accounts for 8.1% of the Gross Domestic Product (GDP) which rises to over 12% if the multiplier effects are included (Baxter, 2003). Gold remained the country's major export and earned the biggest foreign currency until 2001 (Chamber of Mines of South Africa, 2002). Gold accounted for R32 776 441 000 in export sales in 2003, the highest for a mineral in South Africa, followed by Platinum Group Minerals (PGM) at R25 553 565 000 (Chamber of Mines of South Africa, 2004). This significant gold production and associated contribution to South Africa's economy, however, tends to generate pollution. It results in air pollution through release of gases, metal vapours, radioactive particles and dust. Soil pollution occurs in the form of subsidence, soil erosion, sinkholes and chemical pollution. Gold mining is associated with landscape changes that consequently change biological habitats, populations, communities and ecosystems. Damage to water resources is the most significant consequence of gold mining. Large quantities of this scarce resource are used in the various ore processing activities as well as potable use. Water quality is threatened by release of metals, cyanide and acid mine drainage.

This study focuses on the impacts of gold mine waste on the water quality and the change in landuse resulting from the mining activities on the West Rand Region.

1.2 Problem Identification

South African law stipulates that pollution be prevented (National Environmental Management Act No. 107 of 1998) and water resources be protected (National Water Act No. 36 of 1998). Specific regulation applicable to mining requires a person in control of a mine to prevent water containing waste which is likely to cause pollution from entering a water resource. In addition to these laws and regulations, the Department of Water Affairs and Forestry (DWAF) has proposed a system aimed at recovering the costs of water quality management from the polluter.

Mining activities may result in adverse environmental changes that can be irreversible. The study aims to identify the sources of pollution, quantify the environmental changes associated with the pollution and predict the extent of the changes in future for West Wits operations of AngloGold Ashanti. The West Wits area, in Carltonville, straddles North West and Gauteng Provinces, and includes the deep level gold mines of Mponeng, Savuka and Tautona. Savuka and Tautona share a processing plant, while Mponeng has its own processing plant. The Elandsrand mine, which was part of AngloGold (before AngloGold merged with the Ghanaian-based Ashanti Goldfields Limited and became AngloGold Ashanti) was sold to Harmony Gold Mining Co. Ltd in 2001.

1.3 Aims and Objectives of the Study

The aims of the study are to:

1. Identify all sources of pollution
2. Characterise the chemical environment and therefore quantify the extent of the pollution
3. Determine the impacts and potential impacts of the pollution on surface water, groundwater and vegetation
4. Quantify environmental change resulting from mining activities.
5. Investigate management options which will help minimize the impacts of the pollution and reduce associated costs.

1.4 Methodology

Background data of the area- location, landuse and drainage patterns was gathered from a 1:50 000 topographic map of Carltonville (2627AD). The sampling of surface water, groundwater and wastewater from the tailings dams was done by the mine personnel. The samples collected from the tailings dams were analyzed for pH, sulphur and pyrite while both surface and groundwater were analysed for major cations (Ca, Mg, Na, and ammonia), major anions (Cl, SO4, NO_3, PO4, and F), metals (Fe, Cu, Zn, Pb, Mn, Au) and other parameters (pH, EC, TDS, alkalinity, and total hardness). Effluent from sewage works, in addition to pH, TDS, SO4, Cl, NO3 analysis, were also analysed for Suspended Solids (SS), free and saline ammonia, nitrites, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), absorbed oxygen, temperature and *faecal coli*. The quality of the water from the above-mentioned sources was determined using the effluent water quality standards specified by the Department of Water Affairs and Forestry (Refer to Table 1 below for the standards). The data was statistically analysed using EcoSSe (Eco Statistical Evaluation) software.

Remotely sensed data, in the form of aerial photographs, Thematic Mapper bands and ASTER data were analysed in a geographic information system (GIS) to assess environmental changes in the West Rand Region.

Table 1.1 DWAF's Water Quality Standards for Different Water Uses (DWAF, 1996)

Variable	**Domestic use limit (mg/l)**	**Irrigation use limit (mg/l)**	**Aquatic Ecosystems limit (microg/l)**
pH	6.0-9.0#	6.5-8.4#	not vary by more than 5%/0.5 pH unit of the background pH
Conductivity	70 *	<40*	
TDS	450		< 15% of the normal cycle of water
Total hardness	100		
Ca	32		
Mg	30		
Na	100	<70	
Cl	100	<100	
NO_3	6		
SO_4	200		
Fe	0.1	<5.0	< than 10% background Fe conc.
Zn	3	<1.0	<2.0
Mn	0.05	<0.02	<180
Cu	1	<0.2	between <0.3 & <1.4
Pb	0.01	<0.2	between <0.2 & <1.2
Cd	0.005	<0.01	between 0.15 & 0.4 depending on how how hard the water is
N (ammonia)	1		<7
SS		<50	<10% of background SS concentration
F	<3-6	<2.0	
CN			<1.0
Ni		<0.2	

- no units

* - mS/m